

# The 2<sup>nd</sup> International Conference on Smart Mechatronics

" Empowering Smart Mechatronics Innovations:  
Robotics, AI, and Intelligent Systems  
for a Connected Intelligent World "

Bandung, 9-11 June 2026  
The Trans Luxury Hotel



## PROGRAM BOOK

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IEEE Indonesia Section



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# Program Book

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## ICSMech 2026

### The 2<sup>nd</sup> International Conference on Smart Mechatronics

*“Empowering Smart Mechatronics Innovations:  
Robotics, AI, and Intelligent Systems for a Connected Intelligent  
World”*

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**Trans Luxury Hotel, Bandung – Indonesia  
9–11 June 2026**

*Organized by*

© **Research Center for Smart Mechatronics (PRMC)**

National Research and Innovation Agency (BRIN)

*and*

School of Industrial Engineering, Telkom University, Bandung

2026



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# Table of Contents

Table of Contents .....	7
Preface .....	9
ICSMech 2026 Information.....	11
Conference Topics .....	12
Publication .....	13
Scientific Committee .....	13
Organizing Committee .....	16
ICSMech 2026 Secretariat .....	19
Floor Plan & Room Allocation .....	21
Plenary Program (Grand Ballroom 1-2) .....	21
Parallel Program (Grand Ballroom 1-2).....	21
Virtual Session Rules.....	23
Rules of Conference for Virtual Presenters and Participants .....	23
Schedules .....	24
Day 1: Plenary Programme .....	25
Day 1: Parallel Technical Sessions.....	27
Day 2: Morning Parallel Sessions.....	30
Day 2: Afternoon Keynote & Parallel Sessions .....	40
Day 3: City Tour (Tentative).....	43
Programme Summary.....	44
Operational Notes for Facilitators & Technical Hosts .....	44
Keynote Speakers.....	45
Safe and Collaboration-Friendly Perception and Localization for Autonomous Systems .....	45
The Role of PT Len Industri (Persero) in Realizing Technological Innovation Independence .....	46
LiVEMechX Integration: Toward Biohybrid Autonomy .....	48
AI Brain Analytics for Mental Well-Being and Intervention .....	49

Emerging Smart Technologies for Precision, Efficiency, and Intelligent Automation .....50

    From Programmable to Autonomous: How Robotics Is Entering Our Lives ..... 51

    Integrated Vision System for Real-Time Monitoring and Enhancement Using YOLO-Based Deep Learning in the Placement of Concrete Armor Unit during Breakwater Construction ..... 53

Parallel Session Abstracts .....55

    Track 1: Robotics, Perception, and System Intelligence.....55

    Track 2: Autonomous Vehicles and Smart Machine ..... 66

    Track 3: Dynamics, Control, and System Modeling .....75

    Track 4: Intelligent Instrumentation and Embedded Systems ..... 84

    Track 5: Biomechatronic and Smart Assistive Systems .....93

    Track 6: Information Systems for Mechatronics ..... 102

Appendix..... 126

    Author Index ..... 126

    Country Index ..... 133

## Preface

We proudly present this program book of the 2nd International Conference on Smart Mechatronics (ICSMech 2026), organized by the Research Center for Smart Mechatronics, National Research and Innovation Agency (BRIN), in collaboration with Telkom University, and financially co-sponsored by the IEEE Indonesia Section. Held in a hybrid format on 9–11 June 2026 in Bandung, Indonesia, ICSMech 2026 brings together researchers, engineers, and practitioners from across the globe under the theme **“Empowering Smart Mechatronics Innovations: Robotics, AI, and Intelligent Systems for a Connected Intelligent World.”** The conference reflects a growing recognition that the convergence of robotics, artificial intelligence, embedded intelligence, and human-centered design is reshaping how we live, work, and interact with our environment.

I am pleased to share that ICSMech 2026 received strong support from the global research community. From more than **270 submissions**, we have accepted approximately **120 high-quality peer-reviewed papers** representing researchers from Indonesia, Japan, Malaysia, Vietnam, Taiwan, the United Kingdom, the Philippines, the United Arab Emirates, and beyond. These contributions span six technical tracks: Robotics and System Intelligence, Autonomous Vehicles and Smart Machines, Dynamics Control and System Modeling, Intelligent Instrumentation and Embedded Systems, Biomechatronics and Smart Assistive Systems, and Information Systems for Mechatronics. Each track reflects a frontier where fundamental science meets real-world impact.

We are pleased to welcome our distinguished keynote and panel speakers whose expertise spans the breadth of our conference themes: **Prof. Michael Milford** (Queensland University of Technology, Australia), **Prof. Keisuke Morishima** (Osaka University, Japan), **Prof. Abdul Wahab Bin Abdul Rahman** (International Islamic University Malaysia), **Prof. Joga Dharma Setiawan** (President Director, PT LEN Industri (Persero)), **Prof. Dr. Maman Abdurohman** (Telkom University), **Dr. Francesco Cursi** (Senior Research Engineer, Huawei R&D), and **Prof. R. Haryo Dwito Armono, S.T., M.Eng., Ph.D.** (Dean, Department of Ocean Engineering, Institut Teknologi Sepuluh Nopember). Together, they bring perspectives from fundamental research, applied engineering, and industrial practice, offering a rich and grounded view of where smart mechatronics is headed.

We are grateful to our generous sponsors whose continued support has made this conference possible. I would like to express my deepest gratitude to every member of the Organizing Committee for their extraordinary dedication and tireless effort in bringing ICSMech 2026 to life. The reviewers who gave their time and expertise to ensure the quality of our technical program, the authors who trusted us with their finest work, and the participants who have traveled near and far to be part of this event: you are the very reason this conference exists.

Science advances one conversation at a time. May the discussions sparked in these halls and in our virtual rooms will plant seeds that grow into innovations that matter. I invite you to engage fully: ask the difficult questions, forge new collaborations, and let Bandung's inspiring atmosphere be the backdrop for ideas that will shape the future of intelligent systems. We hope this program book serves as a useful companion throughout the conference, and that the work presented at this conference contributes meaningfully to the advancement of smart mechatronics research and its applications.

**Roni Permana Saputra, S.T., M.Eng.Sc., Ph.D., DIC.**

*General Chair, ICSMech 2026*

Research Center for Smart Mechatronics

National Research and Innovation Agency (BRIN), Indonesia

*Bandung, June 2026*

## ICSMech 2026 Information

Welcome to ICSMech 2026 — the 2<sup>nd</sup> International Conference on Smart Mechatronics, held under the theme “Empowering Smart Mechatronics Innovations: Robotics, AI, and Intelligent Systems for a Connected Intelligent World.”

The Research Center for Smart Mechatronics (PRMC) of the National Research and Innovation Agency (BRIN), in collaboration with the School of Industrial Engineering of Telkom University (Tel-U), Bandung, is proud to host this premier international gathering at the Trans Luxury Hotel, Bandung, Indonesia, from 9 to 11 June 2026.

ICSMech 2026 continues the tradition established by its inaugural edition as a convergence point for researchers, engineers, industry professionals, government representatives, and academics working at the frontier of mechatronics and its interdisciplinary applications. The conference encompasses cutting-edge topics including *Robotics, Perception, and System Intelligence, Autonomous Vehicles and Smart Machine, Dynamics, Control, and System Modeling, Intelligent Instrumentation and Embedded Systems, Biomechatronic and Smart Assistive Systems, and Information Systems for Mechatronics.*

This edition features distinguished keynote addresses from world-leading experts, a comprehensive two-day parallel presentation programme accommodating both onsite and virtual hybrid sessions, and an optional city tour on Day 3. Accepted and presented papers are eligible for consideration in the conference proceedings, which will be submitted for indexing in the IEEE Xplore digital library.

We extend our deepest gratitude to all authors, reviewers, sponsors, session chairs, and organizing committee members whose dedication and hard work made this conference possible. We also warmly welcome all participants — whether joining us in person in Bandung or virtually from around the world.

We trust that ICSMech 2026 will be a memorable and intellectually enriching experience for all attendees.

Item	Details
<b>Conference Name</b>	The 2 <sup>nd</sup> International Conference on Smart Mechatronics (ICSMech 2026)
<b>Theme</b>	“Empowering Smart Mechatronics Innovations: Robotics, AI, and Intelligent Systems for a Connected Intelligent World”
<b>Date</b>	Tuesday–Thursday, 9–11 June 2026
<b>Venue</b>	Trans Luxury Hotel, Bandung Jl. Gatot Subroto No. 289, Kota Bandung, Jawa Barat 40273, Indonesia
<b>Format</b>	Hybrid (Onsite + Virtual)
<b>Organizers</b>	Research Center for Smart Mechatronics (PRMC), National Research and Innovation Agency (BRIN) and School of Industrial Engineering, Telkom University, Bandung

### Conference Topics

1. Robotics, Perception, and System Intelligence
2. Autonomous Vehicles and Smart Machine
3. Dynamics, Control, and System Modeling
4. Intelligent Instrumentation and Embedded Systems
5. Biomechatronic and Smart Assistive Systems
6. Information Systems for Mechatronics

## Publication

- ▶ Selection and peer-review of extended abstracts and full papers is conducted under the responsibility of the Research Center for Smart Mechatronics – National Research and Innovation Agency (PRMC-BRIN).
- ▶ Selected peer-reviewed and presented ICSMech papers will be eligible for inclusive consideration for submission to the conference proceedings, which will be submitted to the IEEE Xplore digital library.
- ▶ ICSMech Proceedings will be available in electronic format.
- ▶ Previous [ICSMech](#) Conference:

	Website	Publisher
ICSMech 2024	<a href="https://conference.brin.go.id/jcsm2024/">https://conference.brin.go.id/jcsm2024/</a>	IEEE Xplore

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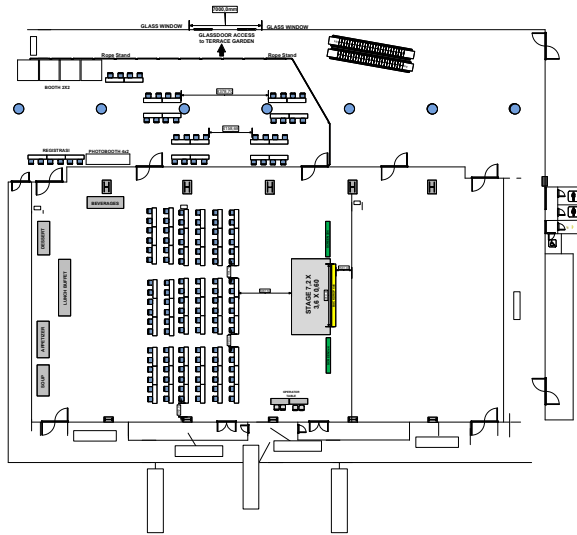
**Email** : [icsmech@brin.go.id](mailto:icsmech@brin.go.id)

**Website** : <https://conference.brin.go.id/icsmech2026/>

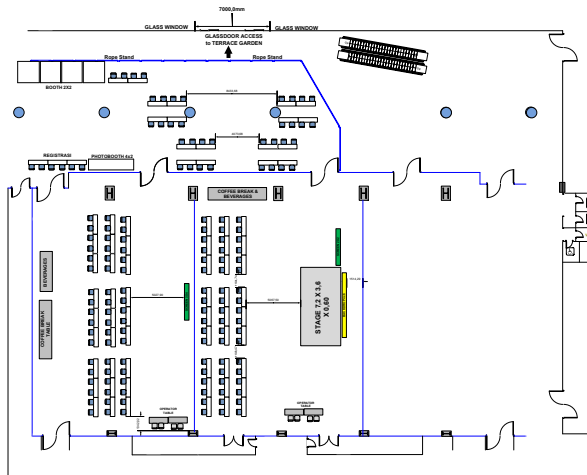


## Floor Plan & Room Allocation

### Plenary Program (Grand Ballroom 1-2)



### Parallel Program (Grand Ballroom 1-2)





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## Virtual Session Rules

### Rules of Conference for Virtual Presenters and Participants

1. We kindly ask virtual presenters/participants to use your full name for your ID in this hybrid conference.
  - Onsite room: R1, R2
  - Virtual room: V1, V2, V3, V4

For presenters, please use:

**“presenter\_room name\_submission ID\_full name”**

for example : presenter\_R1\_1571237449\_Baswara

For **participants**, please use:

**“participant\_affiliation\_full name”**

for example : participant\_BRIN\_Bambang Wahono

2. Please use ICSMech 2026 virtual background ([https://s.brin.go.id/I/ICSMech2026\\_VB2](https://s.brin.go.id/I/ICSMech2026_VB2)).
3. Feel free for virtual participants to attend any sessions or events that interest you, including keynote talks and parallel paper presentations.
4. The virtual participants will be “muted” for voice hearing during the presentations.
5. The virtual participants will be able to provide questions by clicking raise hand in the chat room during the “discussion session”.
6. We kindly ask all the virtual participants to not ask personal questions or non-subject related questions during the event.
7. We will share attendance form link in the chat room, kindly fill the form during the event.

## Schedules

### 2<sup>nd</sup> International Conference on Smart Mechatronics

“Empowering Smart Mechatronics Innovations: Robotics, AI, and Intelligent Systems for a Connected Intelligent World”

<b>Event</b>	ICSMech 2026 — 2 <sup>nd</sup> International Conference on Smart Mechatronics
<b>Dates</b>	Tuesday–Wednesday, 9–10 June 2026 (Conference) · Thursday, 11 June 2026 (Ancillary)
<b>Venue</b>	The Trans Luxury Hotel Bandung · Jl. Gatot Subroto No. 289, Bandung, West Java, Indonesia
<b>Format</b>	Hybrid (Onsite + Virtual) Grand Ballroom · 3rd Floor Breakout Room · Zoom Breakout Room V1–V4
<b>Scale</b>	119 Total Presenters · 48 Onsite Presenters · 71 Virtual Presenters · 6 Research Tracks
<b>Slot Duration</b>	Onsite & Virtual: 15 min (12 min presentation + 3 min Q&A)
<b>Organized by</b>	Research Center for Smart Mechatronics – National Research and Innovation Agency (PRMC-BRIN) & School of Industrial Engineering – Telkom University (SIE – Tel-U)

## Day 1: Plenary Programme

Conference Day 1 · Tuesday, 9 June 2026 · Grand Ballroom, The Trans Luxury Hotel Bandung

Link Zoom: <a href="https://brin-go-id.zoom.us/j/94567403363?pwd=cyaE6d1YMu7oLBx3PcqXh9eqi33Hq.1">https://brin-go-id.zoom.us/j/94567403363?pwd=cyaE6d1YMu7oLBx3PcqXh9eqi33Hq.1</a>				
Time (WIB)	Official Session / Programme Title	Speakers / Session Facilitators	Venue / Room Assignment	Delivery Mode
07:30–07:55	Participant Registration & Delegate Check-in	Conference Secretariat	Grand Ballroom — Foyer & Registration Desk	Onsite
07:55–08:00	Opening and Introduction by the Master of Ceremonies	MC	Grand Ballroom	Hybrid · Live Stream
08:00–08:05	Indonesia Anthem	All Delegates & Invited Guests	Grand Ballroom	Onsite
08:05–08:10	Traditional Welcoming Dance: Ronggeng	MC	Grand Ballroom	Hybrid · Live Stream
08:10–08:15	Welcoming Remarks by General Chair of ICSMEch 2026	General Chair, ICSMEch 2026	Grand Ballroom	Hybrid · Live Stream
08:15–08:30	Opening Remarks by IEEE Indonesia Section	Representative, IEEE Indonesia Section	Grand Ballroom	Hybrid · Live Stream
08:30–08:45	Opening Remarks by Rector of Telkom University	Rector of Telkom University, or representative	Grand Ballroom	Hybrid · Live Stream
08:45–09:15	Opening Speech & Official Opening of ICSMEch 2026 by Chairman of BRIN	Chairman of the National Research and Innovation Agency (BRIN), Republic of Indonesia	Grand Ballroom	Hybrid · Live Stream
09:15–09:30	Group Photography & Coffee Break	All Delegates & Invited Guests	Grand Ballroom · Prefunction Area	Onsite

09:45–10:45	Keynote Address I	Prof. Michael Milford, Queensland University of Technology, Australia	Grand Ballroom	Hybrid · Live Stream
10:45–11:45	Keynote Address II	Prof. Joga Dharma Setiawan, Director General, PT LEN Industri (Persero), Indonesia	Grand Ballroom	Hybrid · Live Stream
11:45–12:30	Networking Luncheon	All Delegates, Organizing Committee & Invited Guests	Grand Ballroom · Dining Area	Onsite
12:30–15:00	Plenary Session — Expert Panel Q&A	Prof. Keisuke Morishima ( <i>Department of Mechanical Engineering, Graduate School of Engineering, Osaka University</i> ) · Prof. Dr. Abdul Wahab ( <i>International Islamic University Malaysia</i> ) · Prof. Dr. Maman Abdurachman ( <i>Head of COE Pratama Advanced ICT Infrastructure and Services, Telkom University</i> ) — Panel moderation & audience Q&A (Hybrid format)	Grand Ballroom	Hybrid · Panel Session
15:00–15:30	Coffee Break		Grand Ballroom	Hybrid · Panel Session

### Evening Programme

Time (WIB)	Official Session / Programme Title	Speakers / Session Facilitators	Venue / Room Assignment	Delivery Mode
19:00–21:00	Gala Dinner & Closing Ceremony — Best Paper Awards Presentation	All Delegates, Keynote Speakers & Invited Guests	Ballroom 2 [Banquet Hall]	Onsite · Formal Dinner

## Day 1: Parallel Technical Sessions

Conference Day 1 · Tuesday, 9 June 2026 · 15:30–17:05 WIB · Simultaneous Onsite & Virtual Delivery

Onsite Rooms R1 & R2 (15-minute slots) run concurrently with Virtual Rooms V1, V2 & V3 (15-minute slots). Delegates may attend sessions in either mode.

### II.A Onsite Parallel Sessions — Rooms R1 & R2 · 15:35–17:05 WIB · Slot Duration: 15 Minutes Per Presenter

Link Zoom: <a href="https://brin-go-id.zoom.us/j/94567403363?pwd=cyaE6d1YMu7oLBx3PcqXh9eqi33Hiq.1">https://brin-go-id.zoom.us/j/94567403363?pwd=cyaE6d1YMu7oLBx3PcqXh9eqi33Hiq.1</a>		
Time (WIB)	R1 — Robotics, Perception, and System Intelligence	R2 — Robotics, Perception, and System Intelligence
	Session Chair: <b>Widia Febriyani, S.Kom., M.Kom.</b>	Session Chair: <b>Dr. Naeem Ul Islam</b>
15:35–15:50	Seq. 15 · Submission 1571237449 <b>CLBF-Based Decentralized Safety Control with Conflict Resolution for Multi-Robot Systems</b> Baswara et al. <i>Robotics, Perception &amp; System Intelligence</i>	Seq. 91 · Submission 1571267646 <b>Evaluating Truncated Quantile Critics and Twin Delayed DDPG for Robotic Manipulation Tasks</b> Awan & Islam <i>Robotics, Perception &amp; System Intelligence</i>
15:50–16:05	Seq. 16 · Submission 1571237475 <b>Discrete PID Control for Waypoint Tracking of an IMU-Based Tendon-Driven Continuum Robot</b> Aryaputra et al. <i>Robotics, Perception &amp; System Intelligence</i>	Seq. 93 · Submission 1571267962 <b>Task-Space Dynamics Control of a 6-DoF Manipulator with an Admittance Model-Based Force-to-Velocity Conversion</b> Ivansyah et al. <i>Robotics, Perception &amp; System Intelligence</i>
16:05–16:20	Seq. 57 · Submission 1571257482 <b>Stability Analysis, Simulation, and Real-World Implementation of a Kinematics-Based 6-DoF End-Effector Position Control</b> El Fawwaz et al. <i>Robotics, Perception &amp; System Intelligence</i>	Seq. 107 · Submission 1571270602 <b>Development of a Smart Biomimetic Fish Robot Integrating Autonomous Navigation, Obstacle Avoidance, and Real-Time Motion Control</b> Muhida et al. <i>Robotics, Perception &amp; System Intelligence</i>
16:20–16:35	Seq. 81 · Submission 1571266342 <b>RT-DETR Guided Deep Reinforcement Learning for Vision-Based Robotic Target Reaching</b> Shah <i>Robotics, Perception &amp; System Intelligence</i>	Seq. 116 · Submission 1571271052 <b>Implementation of Ant Colony Optimization for UAV Waypoint Ordering Optimization with CoppeliaSim Simulation Validation</b> Saffitra et al. <i>Robotics, Perception &amp; System Intelligence</i>

<p><b>16:35–16:50</b></p>	<p>Seq. 88 · Submission 1571267022  <b>Design and Real-Time Implementation of an Autonomous Indoor Navigation System for Service Robots</b>                      Indriani et al.  <i>Robotics, Perception &amp; System Intelligence</i></p>	<p>Seq. 117 · Submission 1571271058  <b>Adaptive Hybrid Control Strategy Using Extremum Seeking and Pure Pursuit for Mobile Robot Navigation in Unknown Environments</b>                      Mariel et al.  <i>Robotics, Perception &amp; System Intelligence</i></p>
<p><b>16:50–17:05</b></p>	<p>Seq. 89 · Submission 1571267032  <b>Design of a Robot for Pothole Detection and Depth Estimation</b>                      Putri et al.  <i>Robotics, Perception &amp; System Intelligence</i></p>	<p>Seq. 133 · Submission 1571272006  <b>Evaluation of YOLOv5 and HSV-Based Segmentation for Orange Flare Detection in Obstacle Avoidance of Autonomous Underwater Vehicles</b>                      Suprpto et al.  <i>Robotics, Perception &amp; System Intelligence</i></p>

17:05 · Conclusion of Day 1 Onsite Parallel Sessions

**II.B Virtual Parallel Sessions — Rooms V1, V2 & V3 · 15:35–16:35 WIB · Slot Duration: 15 Minutes Per Presenter**

<p><b>Link Zoom:</b>  <a href="https://brin-go-id.zoom.us/j/94567403363?pwd=cyaE6d1YMu7oLbX3PcqXh9eqj33Hiq.1">https://brin-go-id.zoom.us/j/94567403363?pwd=cyaE6d1YMu7oLbX3PcqXh9eqj33Hiq.1</a></p>			
Time (WIB)	V1 — Autonomous Vehicles and Smart Machine	V2 — Information Systems for Mechatronics	V3 — Biomechatronic and Smart Assistive Systems
	<p>Session Chair:  <b>Lenny Rosita, S.T., M.MT.</b></p>	<p>Session Chair:  <b>Istifa Shania Putri, S.Si., M.T.</b></p>	<p>Session Chair:  <b>Syfa Nur Latifah, S.Kom., M.T.</b></p>
<p><b>15:35–15:50</b></p>	<p>Seq. 35 · Submission 1571248373  <b>Evaluating the Robustness of Deep Q-Network Variants Against Visual Perception Errors in Traffic Signal Control</b>                      Sulistiawan et al.  <i>Autonomous Vehicles &amp; Smart Machine</i></p>	<p>Seq. 13 · Submission 1571237365  <b>An Edge-to-Cloud Multimodal Monitoring System for Deception-Indicative Cues Using Physiological Sensors and MediaPipe-Based Facial Features</b>                      Saleh &amp; Lubis  <i>Information System for Mechatronics</i></p>	<p>Seq. 24 · Submission 1571240293  <b>Hunger Games Search-Based ECG Feature Selection for Arrhythmia Classification</b>                      Nababan et al.  <i>Biomechatronic &amp; Smart Assistive System</i></p>
<p><b>15:50–16:05</b></p>	<p>Seq. 120 · Submission 1571271452  <b>A Comparative Study of Classical Lane Detection Methods in</b></p>	<p>Seq. 28 · Submission 1571242939  <b>Beyond Digital Adoption: Orchestrating Human</b></p>	<p>Seq. 73 · Submission 1571263288  <b>Influence of Bicycle Geometry on Teenage Cycling</b></p>

	<p><b>Straight and Curved Road Conditions</b> Erwin et al. <i>Autonomous Vehicles &amp; Smart Machine</i></p>	<p><b>Capital and Strategy for MSME Scalability in the Creative Economy</b> Fachmi et al. <i>Information System for Mechatronics</i></p>	<p><b>Posture: A Sagittal Plane Biomechanical Study</b> Taqriban et al. <i>Biomechatronic &amp; Smart Assistive System</i></p>
16:05–16:20	<p>Seq. 162 · Submission 1571272939 <b>Performance Analysis of Ultracapacitor in Stabilizing Boost Converter, Buck Converter and Sepic Converter Output Voltage During Voltage Sag</b> Izzulhaq et al. <i>Autonomous Vehicles &amp; Smart Machine</i></p>	<p>Seq. 33 · Submission 1571247385 <b>Expert Validation of a Public Value Maturity Framework for E-Government</b> Ramadhane et al. <i>Information System for Mechatronics</i></p>	<p>Seq. 255 · Submission 1571278672 <b>Python-Based Gait Cycle Algorithm Design for Ankle Kinematics Analysis as a Basis for Preliminary Bionic Ankle Design</b> Lestari et al. <i>Dynamics, Control &amp; System Modeling</i></p>
16:20–16:35	<p>Seq. 164 · Submission 1571272949 <b>Unstructured Road Segmentation Using Vision-Based Edge Detection</b> Prajitno et al. <i>Autonomous Vehicles &amp; Smart Machine</i></p>	<p>Seq. 36 · Submission 1571248547 <b>Modeling Legal Data Quality in the NSESDN System: A Deep-SEM Approach with Synthetic Latent Augmentation</b> Asyrofi et al. <i>Information System for Mechatronics</i></p>	

16:35 · Conclusion of Day 1 Virtual Parallel Sessions

## Day 2: Morning Parallel Sessions

Wednesday, 10 June 2026 · 08:00–12:00 WIB · Rooms R1, R2 (Onsite) + V1,V2,V3,V4 (Virtual)

### III.A Onsite Parallel Sessions — Rooms R1 & R2 · 08:15–12:00 WIB

<b>Link Zoom:</b> <a href="https://brin-go-id.zoom.us/j/94567403363?pwd=cyaE6d1YMu7oLBx3PcqXhgeqi33Hq.1">https://brin-go-id.zoom.us/j/94567403363?pwd=cyaE6d1YMu7oLBx3PcqXhgeqi33Hq.1</a>		
<b>Time (WIB)</b>	<b>R1 — Robotics, Perception, and System Intelligence &amp; Dynamics, Control, and System Modeling &amp; Biomechatronic and Smart Assistive System</b>	<b>R2 — Biomechatronic and Smart Assistive System &amp; Information System for Mechatronics &amp; Intelligent Instrumentation and Embedded Systems</b>
<b>08:00–08:15 · Opening Ceremony &amp; Technical Systems Verification (All Rooms)</b>		
	Session Chair: <b>Dr. Dina Fitria Murad, S.Kom., M. Kom., CEEA., SMIEEE</b>	Session Chair: <b>Dr. Eng. Ir. Suci Dwijayanti, S.T., M.S.</b>
<b>08:15–08:30</b>	Seq. 6 · Submission 1571221437 <b>Piecewise Constant Curvature-Based Kinematics of a Tendon-Driven Continuum Robot with a Thermoplastic Polyurethane Backbone</b> Putri et al. <i>Robotics, Perception &amp; System Intelligence</i>	Seq. 196 · Submission 1571277040 <b>Development of a Lie Detection System Based on Wearable Photoplethysmography Sensor and Heart Rate Variability Analysis Using Support Vector Machine</b> Mizoguchi et al. <i>Biomechatronic &amp; Smart Assistive System</i>
<b>08:30–08:45</b>	Seq. 180 · Submission 1571276557 <b>A Framework for Integrating Robotic Filling and Digital Traceability Systems in Toiletries Manufacturing for Regulatory Compliance</b> Prathama et al. <i>Robotics, Perception &amp; System Intelligence</i>	Seq. 208 · Submission 1571277604 <b>Biomechatronics Approach in User Experience: A Pilot Study Using Eye-Tracker on a Single-Participant Multi-Task E-Commerce Interaction</b> Sya'ban et al. <i>Biomechatronic &amp; Smart Assistive System</i>
<b>08:45–09:00</b>	Seq. 291 · Submission 1571290888 <b>Enhancing Real-Time Object Detection via Early Fusion of Radar and LiDAR Using CNN-LSTM Networks</b> Venica et al. <i>Robotics, Perception &amp; System Intelligence</i>	Seq. 272 · Submission 1571283296 <b>Carbon Nanotube-Dependent Electrical and Piezoresistive Performance of Hydrogel-Based Flexible Strain Sensors</b> Alifah et al. <i>Biomechatronic &amp; Smart Assistive System</i>
<b>09:00–09:15</b>	Seq. 66 · Submission 1571261111 <b>Prediction and Control of Limit Cycle Oscillation in Nonlinear System</b> Al-Farabi et al. <i>Dynamics, Control &amp; System Modeling</i>	Seq. 21 · Submission 1571239138 <b>Digitalization of Learning Evaluation Using the QuizApp Application</b> Riswanto et al. <i>Information System for Mechatronics</i>

Link Zoom: <a href="https://brin-go-id.zoom.us/j/94567403363?pwd=cyaE6d1YMu7oLBx3PcqXh9eqi33Hiq.1">https://brin-go-id.zoom.us/j/94567403363?pwd=cyaE6d1YMu7oLBx3PcqXh9eqi33Hiq.1</a>		
Time (WIB)	R1 — Robotics, Perception, and System Intelligence & Dynamics, Control, and System Modeling & Biomechatronic and Smart Assistive System	R2 — Biomechatronic and Smart Assistive System & Information System for Mechatronics & Intelligent Instrumentation and Embedded Systems
09:15–09:30	Seq. 128 · Submission 1571271901 <b>Velocity-Aware Control Barrier Function for Dynamic Obstacle Avoidance in Manipulators Using Kalman-Estimated Obstacle Velocity</b> Rumi et al. <i>Dynamics, Control &amp; System Modeling</i>	Seq. 26 · Submission 1571240519 <b>Evaluating User Experience of the Asset Recovery Application Using Usability Testing</b> Risqi et al. <i>Information System for Mechatronics</i>
09:30–09:45	Seq. 135 · Submission 1571272074 <b>Physics-Based Scaling and Nonlinear Maximum Power Point Tracking Control Strategy Performance Analysis of a Vertical-Axis Wind Turbine</b> Irawan et al. <i>Dynamics, Control &amp; System Modeling</i>	Seq. 34 · Submission 1571248011 <b>When Every Kilowatt Matters: Intelligent Management of Residential EV Charging Rates Under Cost-Peak Trade-Offs</b> Rumengan et al. <i>Information System for Mechatronics</i>
09:45–10:00	Seq. 146 · Submission 1571272458 <b>Robust Control of a Floating-Based Two-DoF Manipulator Under Wave-Induced Disturbances</b> Ramadiansyah et al. <i>Dynamics, Control &amp; System Modeling</i>	Seq. 38 · Submission 1571248707 <b>Data-Driven Clustering for Mapping Batik SMEs: The Role of Green Innovation in Organizational Performance and Competitive Advantage</b> Achmad et al. <i>Information System for Mechatronics</i>
<b>10:00–10:15 · Morning Refreshment &amp; Networking Break</b>		
	Session Chair: <b>Dr. Slamet Supriadi</b>	Session Chair: <b>Dr. Micky Prathama S.T., M.T</b>
10:15–10:30	Seq. 2 · Submission 1571208005 <b>Comparison of SynRM Rotors for a Rehabilitation Exoskeleton Robot</b> Azhari et al. <i>Biomechatronic &amp; Smart Assistive System</i>	Seq. 103 · Submission 1571270311 <b>Comprehensive Technical Planning of 5G NR Standalone Network at 3.5 GHz in Padang City</b> Sumanto et al. <i>Information System for Mechatronics</i>
10:30–10:45	Seq. 97 · Submission 1571269438 <b>Real Time Hand Gesture Recognition Using Full 8 Channel sEMG from the Myo Armband with MAV RMS Feature Fusion and Random Forest Classification</b>	Seq. 184 · Submission 1571276762 <b>Dynamic Risk Monitoring and Mitigation Model for Ammunition Storage Systems Using ANP-System Dynamics</b> Sulistiyawati

<b>Link Zoom:</b> <a href="https://brin-go-id.zoom.us/j/94567403363?pwd=cyaE6d1YMu7oLBx3Pcqhx9eqi33Hiq.1">https://brin-go-id.zoom.us/j/94567403363?pwd=cyaE6d1YMu7oLBx3Pcqhx9eqi33Hiq.1</a>		
Time (WIB)	R1 — Robotics, Perception, and System Intelligence & Dynamics, Control, and System Modeling & Biomechatronic and Smart Assistive System	R2 — Biomechatronic and Smart Assistive System & Information System for Mechatronics & Intelligent Instrumentation and Embedded Systems
	Wahyudi et al. <i>Biomechatronic &amp; Smart Assistive System</i>	<i>Information System for Mechatronics</i>
10:45–11:00	Seq. 156 · Submission 1571272854 <b>A Curve Fitting Approach for Asymmetric Chaining Design Based on Crank Torque Data</b> Syafiq et al. <i>Biomechatronic &amp; Smart Assistive System</i>	Seq. 188 · Submission 1571276855 <b>Hybrid Data-Driven and Knowledge-Informed Multisensor Fusion for Failure Mode Forecasting in Power Plant Heat Exchanger</b> Fano et al. <i>Information System for Mechatronics</i>
11:00–11:15	Seq. 177 · Submission 1571275908 <b>Real-Time GUI and UDP Communication Framework for Dual Capacitive Smart Insole Gait Acquisition</b> Adli et al. <i>Biomechatronic &amp; Smart Assistive System</i>	Seq. 191 · Submission 1571276927 <b>YOLO-Guided Visual Information System for Autonomous Robotic Arm Control in a 3D Simulated Environment</b> Ahmadi et al. <i>Information System for Mechatronics</i>
11:15–11:30	Seq. 181 · Submission 1571276580 <b>Noise-Aware Lightweight 1D CNN for Robust Inter-Patient ECG Beat Classification Under Controlled Noise Stress</b> Basyith et al. <i>Biomechatronic &amp; Smart Assistive System</i>	Seq. 205 · Submission 1571277540 <b>Development of Large Language Model for Intelligent Root Cause Failure Analysis in Induced Draft Fan Systems</b> Hidayat et al. <i>Information System for Mechatronics</i>
11:30–11:45	Seq. 251 · Submission 1571278645 <b>Biomechanical Sensitivity Evaluation of Dynamic Suspension Systems Under Stochastic Road Profiles Using ISO 8608 and ISO 2631 Frameworks</b> Adyono et al. <i>Dynamics, Control &amp; System Modeling</i>	Seq. 80 · Submission 1571265322 <b>Experimental Performance Analysis of a 10 Wp Polycrystalline PV Module with Flat Mirror Reflector and Thermoelectric Cooling System</b> Bayusari et al. <i>Intelligent Instrumentation &amp; Embedded Systems</i>
11:45–12:00	Seq. 231 · Submission 1571278435 <b>Preliminary Study on the Development of a Wearable sEMG System for Muscle Activity Analysis During Elbow Flexion</b> Pasaribu & Lestari	Seq. 132 · Submission 1571272005 <b>Impact of Rotational Motion on RSSI in Wireless IoT Communication: Experimental Comparison of Bluetooth, Wi-Fi and LoRa</b>

<b>Link Zoom:</b> <a href="https://brin-go-id.zoom.us/j/94567403363?pwd=cyaE6d1YMu7oLBx3PcqXh9eqi33Hiq.1">https://brin-go-id.zoom.us/j/94567403363?pwd=cyaE6d1YMu7oLBx3PcqXh9eqi33Hiq.1</a>		
<b>Time (WIB)</b>	<b>R1 — Robotics, Perception, and System Intelligence &amp; Dynamics, Control, and System Modeling &amp; Biomechatronic and Smart Assistive System</b>	<b>R2 — Biomechatronic and Smart Assistive System &amp; Information System for Mechatronics &amp; Intelligent Instrumentation and Embedded Systems</b>
	<i>Biomechatronic &amp; Smart Assistive System</i>	Putri et al. <i>Intelligent Instrumentation &amp; Embedded Systems</i>

11:45–13:00 · Networking Luncheon · All Rooms Suspended

**III.B Virtual Parallel Sessions — Rooms V1, V2, V3 & V4 · 08:00–11:00 WIB · Slot Duration: 15 Minutes Per Presenter**

<b>Link Zoom:</b> <a href="https://brin-go-id.zoom.us/j/94567403363?pwd=cyaE6d1YMu7oLBx3PcqXh9eqi33Hiq.1">https://brin-go-id.zoom.us/j/94567403363?pwd=cyaE6d1YMu7oLBx3PcqXh9eqi33Hiq.1</a>				
<b>Time (WIB)</b>	<b>V1 — Information Systems for Mechatronics</b>	<b>V2 — Autonomous Vehicles and Smart Machine &amp; Information System for Mechatronics</b>	<b>V3 — Intelligent Instrumentation and Embedded Systems</b>	<b>V4 — Dynamics, Control, and System Modeling &amp; Robotics, Perception, and System Intelligence</b>
	Session Chair: <b>IR. Joko Supriyono ST, MMT, PE, MIEAust</b>	Session Chair: <b>Muhammad Fakhru Safitra, S.Kom., M.Kom.</b>	Session Chair: <b>Friady Amaluddin SE, MSc, MSE</b>	Session Chair: <b>Dr. M Danny Pratama Lamura</b>
<b>08:00–08:15</b>	Seq. 45 · Submission 1571250601 <b>Combining RSM and User Need Identification for Effective Requirements Engineering: Evidence from a Feedback System Project</b> Azzahro et al. <i>Information System for Mechatronics</i>	Seq. 43 · Submission 1571250496 <b>Design of a Conveyor-Based Material Handling System for Extruder-to-Molding Transfer in Roof Tile Manufacturing</b> Yekti et al. <i>Autonomous Vehicles &amp; Smart Machine</i>	Seq. 59 · Submission 1571258612 <b>Real-Time Polyphonic Digital Talempong Using Piezoelectric Sensing and GPIO-Based Strike Detection</b> Aisuwarya & Fikri <i>Intelligent Instrumentation &amp; Embedded Systems</i>	Seq. 64 · Submission 1571260143 <b>Modeling of the Longitudinal Dynamic Braking System for a High-Speed Train</b> Paryanto & Harjono <i>Dynamics, Control &amp; System Modeling</i>
<b>08:15–08:30</b>	Seq. 74 · Submission	Seq. 131 · Submission	Seq. 86 · Submission	Seq. 79 · Submission

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Time (WIB)	V1 — Information Systems for Mechatronics	V2 — Autonomous Vehicles and Smart Machine & Information System for Mechatronics	V3 — Intelligent Instrumentation and Embedded Systems	V4 — Dynamics, Control, and System Modeling & Robotics, Perception, and System Intelligence
	1571263434 <b>Enhancing IT Service Level Management in a National Oil and Gas Company Through the Implementation of Robotic Process Automation and Document Understanding in the Automation of IT</b> Kurniawan & Rakhmawati <i>Information System for Mechatronics</i>	1571271990 <b>An IoT-Based Real-Time Monitoring System for Municipal Solid Waste Mini-Incinerators</b> Permana et al. <i>Information System for Mechatronics</i>	1571266720 <b>Smart Monitoring and Machine Learning Approaches for Preventing Fraud in Subsidized Fuel Distribution Systems</b> La Suci et al. <i>Intelligent Instrumentation &amp; Embedded Systems</i>	1571264872 <b>The Design of a* Algorithm for Intelligent Navigation of Automated Service Robots in UIGM Canteen: A Simulation</b> Puspasari et al. <i>Robotics, Perception &amp; System Intelligence</i>
08:30-08:45	Seq. 76 · Submission 1571264257 <b>Risk-Performance Coupling Matrix for Baseline Prioritization: Integrating HACCP Hazard Significance and Lean Six Sigma Loss Metrics in a Mango Pulp Line</b> Sykilili et al. <i>Information System for Mechatronics</i>	Seq. 145 · Submission 1571272457 <b>Orchid Leaf Disease Classification Using Convolutional Neural Network (CNN) and Transfer Learning Based on ResNet50</b> Al Hijran et al. <i>Information System for Mechatronics</i>	Seq. 99 · Submission 1571269718 <b>GestPLC: Real-Time Hand Gesture Recognition for PLC Control Using MediaPipe and Modbus TCP for Industry 4.0 Applications</b> Prayogo et al. <i>Intelligent Instrumentation &amp; Embedded Systems</i>	Seq. 100 · Submission 1571269812 <b>Improving Vision-Guided Robotic Grasping via Regression-Based Pose Compensation</b> Tarigan <i>Robotics, Perception &amp; System Intelligence</i>
08:45-09:00	Seq. 101 · Submission	Seq. 148 · Submission	Seq. 108 · Submission	Seq. 122 · Submission

Link Zoom: <a href="https://brin-go-id.zoom.us/j/94567403363?pwd=cyaE6d1YMu7oLBx3PcqXh9eqi33Hiq.1">https://brin-go-id.zoom.us/j/94567403363?pwd=cyaE6d1YMu7oLBx3PcqXh9eqi33Hiq.1</a>				
Time (WIB)	V1 — Information Systems for Mechatronics	V2 — Autonomous Vehicles and Smart Machine & Information System for Mechatronics	V3 — Intelligent Instrumentation and Embedded Systems	V4 — Dynamics, Control, and System Modeling & Robotics, Perception, and System Intelligence
	1571270164 <b>Designing a Socio-Technical Architecture for Bias Mitigation in Intelligent Decision Support Systems</b> Prathama et al. <i>Information System for Mechatronics</i>	1571272603 <b>Design of a Context-Aware Decision Support System for Smart Greenhouse Using IoT and MCP</b> Ramadhan et al. <i>Information System for Mechatronics</i>	1571270606 <b>An Integrated Smart Anti-Flooding System: Design, Control, and Educational Simulation for Sustainable Urban Resilience</b> Legowo et al. <i>Intelligent Instrumentation &amp; Embedded Systems</i>	1571271678 <b>Dynamics Aware Intelligent Control for a Post Stroke Hand Rehabilitation Device Using sEMG and IMU Sensing</b> Winata et al. <i>Dynamics, Control &amp; System Modeling</i>
09:00–09:15	Seq. 104 · Submission 1571270482 <b>Spatio-Temporal Non-Homogeneous Poisson Process Modeling with Residual-Based Zoning for Smart City Advertising Optimization</b> Yutanto et al. <i>Information System for Mechatronics</i>	Seq. 152 · Submission 1571272638 <b>Drone-Based Vehicle Detection Using YOLOv11 for Urban Traffic Monitoring in Bandung, Indonesia</b> Naufan & Bayuwindra <i>Information System for Mechatronics</i>	Seq. 140 · Submission 1571272257 <b>Experimental Evaluation of VLAN-Based Network Slicing for Industrial Communication in SDN-Enabled Mechatronic Networks</b> Tabayun et al. <i>Intelligent Instrumentation &amp; Embedded Systems</i>	Seq. 125 · Submission 1571271720 <b>Dynamics of Soil Fertility and Intelligent Irrigation Control in a Portable IoT-Based Smart Farming System</b> Prameswari et al. <i>Dynamics, Control &amp; System Modeling</i>
09:15–09:30	Seq. 105 · Submission 1571270586 <b>A Hybrid GA-ACO Intelligent Routing and Decision Support System for</b>	Seq. 159 · Submission 1571272917 <b>Human-Machine Interface Design for Smart Modular</b>	Seq. 190 · Submission 1571276909 <b>Charging System with Cell Balancing Feature on Picobot Ankle-</b>	Seq. 160 · Submission 1571272923 <b>Modeling and Approach-to-Equilibrium-Based Performance</b>

Link Zoom: <a href="https://brin-go-id.zoom.us/j/94567403363?pwd=cyaE6d1YMu7oLBx3Pcqhx9eqi33Hiq.1">https://brin-go-id.zoom.us/j/94567403363?pwd=cyaE6d1YMu7oLBx3Pcqhx9eqi33Hiq.1</a>				
Time (WIB)	V1 — Information Systems for Mechatronics	V2 — Autonomous Vehicles and Smart Machine & Information System for Mechatronics	V3 — Intelligent Instrumentation and Embedded Systems	V4 — Dynamics, Control, and System Modeling & Robotics, Perception, and System Intelligence
	<p><b>Marine Tourism Under Dynamic Environmental Constraints</b> Kalua et al. <i>Information System for Mechatronics</i></p>	<p><b>Fitness Systems: A User-Centered Approach Integrating Usability, Interaction, and Adoption</b> Banua et al. <i>Information System for Mechatronics</i></p>	<p><b>Foot Orthosis Robot Using CC-CV Method with Battery Temperature Consideration</b> Subayu et al. <i>Intelligent Instrumentation &amp; Embedded Systems</i></p>	<p><b>Evaluation of an Industrial High Temperature Shift Reactor Under Catalyst Deactivation</b> Samban <i>Dynamics, Control &amp; System Modeling</i></p>
09:30–09:45	<p>Seq. 106 · Submission 1571270590 <b>Design and Implementation of an IoT-Enabled Smart Rotary Vial Filling and Capping System with Real-Time Monitoring and Control</b> Legowo et al. <i>Information System for Mechatronics</i></p>	<p>Seq. 161 · Submission 1571272924 <b>Design of an Interactive IoT Dashboard for Intelligent Cattleya Orchid Cultivation Using the Design Thinking Method</b> Preciosa et al. <i>Information System for Mechatronics</i></p>	<p>Seq. 230 · Submission 1571278416 <b>A Lightweight Heterogeneous Data Framing Protocol for Real-Time Image and Sensor Transmission in Drone-Based Mobile IoT Systems</b> Mirda et al. <i>Intelligent Instrumentation &amp; Embedded Systems</i></p>	<p>Seq. 198 · Submission 1571277107 <b>Mitigating Load Intermittency for BESS Integration: A Novel Hybrid Harmony Search-Fuzzy Forecasting Approach in a Jakarta Commercial Office Building</b> Wijaya &amp; Muhammad <i>Dynamics, Control &amp; System Modeling</i></p>
09:45–10:00	<p>Seq. 109 · Submission 1571270609 <b>An IoT-Enabled Smart MPPT-Controlled Photovoltaic-Solid Polymer</b></p>	<p>Seq. 174 · Submission 1571275165 <b>A Hybrid Fuzzy Logic Model for Predicting Driver Safety Risk Using</b></p>	<p>Seq. 234 · Submission 1571278460 <b>Design of an Automated Water Treatment System (WTP) for YAP Tank</b></p>	<p>Seq. 203 · Submission 1571277493 <b>Design and Implementation of a PID-Based Automated Fan-Mist Control</b></p>

Link Zoom: <a href="https://brin-go-id.zoom.us/j/94567403363?pwd=cyaE6d1YMu7oLBx3Pcqhx9eqi33Hiq.1">https://brin-go-id.zoom.us/j/94567403363?pwd=cyaE6d1YMu7oLBx3Pcqhx9eqi33Hiq.1</a>				
Time (WIB)	V1 — Information Systems for Mechatronics	V2 — Autonomous Vehicles and Smart Machine & Information System for Mechatronics	V3 — Intelligent Instrumentation and Embedded Systems	V4 — Dynamics, Control, and System Modeling & Robotics, Perception, and System Intelligence
	<b>Electrolyte System for Real-Time Optimized Hydrogen Production</b> Muhida et al. <i>Information System for Mechatronics</i>	<b>Vehicle Telematics Data</b> Wahyuni & Dewi <i>Information System for Mechatronics</i>	<b>(Bak YAP) Based on Programmable Logic Controllers (PLCs)</b> Roodhiyah et al. <i>Intelligent Instrumentation &amp; Embedded Systems</i>	<b>System for Thermal Comfort in Open-Space Restaurants</b> Muhida et al. <i>Dynamics, Control &amp; System Modeling</i>
<b>10:00–10:15 · Morning Refreshment &amp; Networking Break (Virtual Rooms on Hold)</b>				
	Session Chair: <b>Ir. Ardi Hartanto, S.T., M.M.</b>	Session Chair: <b>Hilda Nuraliza, S.Kom., M.Kom.</b>	Session Chair: <b>Ir. Wahyuni Eka Sari, S.Kom., M.Eng.</b>	Session Chair: <b>Dr. Syarif Fitriya, S. T</b>
<b>10:15–10:30</b>	Seq. 118 · Submission 1571271403 <b>A Framework for Hybrid Automatic Speech Recognition and Rule Classification in Real-Time Tajwid-Oriented Pronunciation Error Assessment and Explainable Feedback</b> Lubis et al. <i>Information System for Mechatronics</i>	Seq. 194 · Submission 1571276952 <b>Network-Aware Intelligent Transport Optimization with Constraint-Based Route Sequencing: An Enterprise AI Integration Framework for Sustainable Urban Logistics</b> Hutapea <i>Information System for Mechatronics</i>	Seq. 263 · Submission 1571281971 <b>Design and Implementation of an IoT-Based Smart Electrical Monitoring and Control System Using the SDLC Approach</b> Zhafira et al. <i>Intelligent Instrumentation &amp; Embedded Systems</i>	Seq. 215 · Submission 1571278086 <b>Evaluation of Ride Comfort Decoupled Modal PID-Based Skyhook Control Design Model for Active Suspension of Railway Vehicles Under Payload and Track Irregularities</b> Widyasto & Darwito <i>Dynamics, Control &amp; System Modeling</i>
<b>10:30–10:45</b>	Seq. 119 · Submission 1571271405	Seq. 201 · Submission 1571277380	Seq. 269 · Submission 1571283014	Seq. 248 · Submission 1571278614

<b>Link Zoom:</b> <a href="https://brin-go-id.zoom.us/j/94567403363?pwd=cyaE6d1YMu7oLBx3Pcqhx9eqi33Hiq.1">https://brin-go-id.zoom.us/j/94567403363?pwd=cyaE6d1YMu7oLBx3Pcqhx9eqi33Hiq.1</a>				
Time (WIB)	V1 — Information Systems for Mechatronics	V2 — Autonomous Vehicles and Smart Machine & Information System for Mechatronics	V3 — Intelligent Instrumentation and Embedded Systems	V4 — Dynamics, Control, and System Modeling & Robotics, Perception, and System Intelligence
	<p>Toward a Confidence-Aware Validation Workflow for Real-Time Pronunciation Assessment: Human Review, Uncertainty Communication, and Evidence Logging in Tajwid-Oriented Feedback Systems</p> <p>Lubis et al. <i>Information System for Mechatronics</i></p>	<p>A Conceptual Framework of Decision Support System for Incinerator-Based Solid Waste Management in Bandung City</p> <p>Damayanti et al. <i>Information System for Mechatronics</i></p>	<p>Design and Evaluation of an Embedded Smart Stethoscope for Heart and Respiratory Sound Monitoring</p> <p>Murtiadi et al. <i>Intelligent Instrumentation &amp; Embedded Systems</i></p>	<p>Experimental Study on Feedback vs. Feedback-Feedforward Control for Hydrogen Flow and Pressure in Open-Cathode PEMFCs</p> <p>Fahruci et al. <i>Dynamics, Control &amp; System Modeling</i></p>
10:45–11:00	<p>Seq. 127 · Submission 1571271831</p> <p><b>Integration of Integrative Restoration GAN (IRGAN) and YOLOv8 for Escalating Oil Palm Tree Detection in UAV Imagery: A Task-Driven Super Resolution Approach</b></p> <p>Irwansyah et al. <i>Information System for Mechatronics</i></p>	<p>Seq. 204 · Submission 1571277531</p> <p><b>Knowledge Graph-Grounded BDI Architecture for LLM-Based Multi-Agent Orchestration in Enterprise Workflow Automation</b></p> <p>Febryanto et al. <i>Information System for Mechatronics</i></p>	<p>Seq. 275 · Submission 1571284056</p> <p><b>Mitigating Man-in-the-Middle Attack: A Rapid-Response Framework Using Optimized Random Forest Classifiers in Cyber-Physical Systems (Work in Progress)</b></p> <p>Hermansyah et al. <i>Intelligent Instrumentation &amp; Embedded Systems</i></p>	<p>Seq. 5 · Submission 1571220800</p> <p><b>Dual-Frame Extended Kalman Filter Localization System on Clearpath Husky Robot</b></p> <p>Saputra et al. <i>Robotics, Perception &amp; System Intelligence</i></p>

11:00–13:00 · Networking Luncheon · Virtual Rooms on Hold



## Day 2: Afternoon Keynote & Parallel Sessions

Wednesday, 10 June 2026 · 13:00–15:30 WIB

### IV.A Afternoon Plenary Keynote Address

Link Zoom: <a href="https://brin-go-id.zoom.us/j/94567403363?pwd=cyaE6d1YMu7oLBx3PcqXh9eqi33Hq.1">https://brin-go-id.zoom.us/j/94567403363?pwd=cyaE6d1YMu7oLBx3PcqXh9eqi33Hq.1</a>				
Time (WIB)	Official Session / Programme Title	Speakers / Session Facilitators	Venue / Room Assignment	Delivery Mode
13:00–14:30	Plenary Session — Expert Panel Q&A— Rooms R1, R2 & V1–V4 Suspended – Moderator (Sapdo Utomo Ph.D.)	Dr. Francesco Cursi – Senior Research Engineer, Noah’s Ark Lab, Huawei Technologies Ltd.  Prof. R. Haryo Dwito Armono, S.T., M.Eng., Ph.D – Dean, Department of Ocean Engineering, Institut Teknologi Sepuluh Nopember	Grand Ballroom · All Zoom Rooms Connected	Hybrid · Live Stream

### IV.B Onsite Parallel Sessions — Rooms R1 & R2 · 14:00–15:00 WIB · Commencing Upon Conclusion of Keynote Address

Link Zoom: <a href="https://brin-go-id.zoom.us/j/94567403363?pwd=cyaE6d1YMu7oLBx3PcqXh9eqi33Hq.1">https://brin-go-id.zoom.us/j/94567403363?pwd=cyaE6d1YMu7oLBx3PcqXh9eqi33Hq.1</a>		
Time (WIB)	R1 — Autonomous Vehicles and Smart Machine	R2 — Autonomous Vehicles and Smart Machine & Intelligent Instrumentation and Embedded Systems
	Session Chair: <b>Ndaru Adyono, S.Si., M.T.</b>	Session Chair: <b>Elysa Nensy Irawan, Ph.D.</b>
14:30–14:45	Seq. 126 · Submission 1571271747 <b>Experimental Evaluation of Reused Battery-Based Hybrid Energy Storage System Under Transient Load Conditions</b> Rohman et al. <i>Autonomous Vehicles &amp; Smart Machine</i>	Seq. 168 · Submission 1571274045 <b>Speed Control of a Small-Scale Car for Developing Autonomous Driving Algorithms for Forward and Reverse Parking</b> Rijanto et al. <i>Autonomous Vehicles &amp; Smart Machine</i>
14:45–15:00	Seq. 129 · Submission 1571271976 <b>Road Type Prediction System Using Machine Learning Method Based on Voltage and Current Data of Steering DC Motor</b>	Seq. 292 · Submission 1571291053 <b>Model Predictive Control for Vehicle Speed Based on LiDAR Sensor Data for Autonomous Vehicle Systems</b>

	Venica et al. <i>Autonomous Vehicles &amp; Smart Machine</i>	Wahid et al. <i>Autonomous Vehicles &amp; Smart Machine</i>
15:00–15:15	Seq. 155 · Submission 1571272779 <b>A SegFormer-Based Semantic Segmentation Approach for Autonomous Driving Decision Making Using Stereo Vision</b> Gianti et al. <i>Autonomous Vehicles &amp; Smart Machine</i>	Seq. 239 · Submission 1571287516 <b>Real-Time IoT Water Table Monitoring in Peatlands for Acacia Plantation Water Management</b> Rahmawaty & Ricky <i>Intelligent Instrumentation &amp; Embedded Systems</i>
15:15–15:30	Seq. 158 · Submission 1571272909 <b>Design of a PID-Based Steering Controller for Autonomous Vehicles Using an Improved Swerve Drive</b> Suprpto et al. <i>Autonomous Vehicles &amp; Smart Machine</i>	Seq. 274 · Submission 1571283947 <b>Online Continual Learning-Based Intrusion Detection in Industrial Control Networks</b> Manurung & Harwahyu <i>Intelligent Instrumentation &amp; Embedded Systems</i>

15:00 · Conclusion of All Day 2 Onsite Parallel Sessions

**IV.C Virtual Parallel Sessions — Rooms V1, V2 & V3 · 14:00–15:15 WIB · Resuming After Afternoon Keynote Address**

<b>Link Zoom:</b> <a href="https://brin-go-id.zoom.us/j/94567403363?pwd=cyaE6d1YMu70LBx3PcqXh9eqi33Hiq.1">https://brin-go-id.zoom.us/j/94567403363?pwd=cyaE6d1YMu70LBx3PcqXh9eqi33Hiq.1</a>			
Time (WIB)	V1 — Information System for Mechatronics	V2 — Robotics, Perception, and System Intelligence & Biomechatronic and Smart Assistive System	V3 — Autonomous Vehicles and Smart Machine & Biomechatronic and Smart Assistive System
	Session Chair: <b>Yumna Zahran Ramadhan, S.Kom., M.Kom.</b>	Session Chair: <b>Artha Ivonita Simbolon, S.Si., M.T.</b>	Session Chair: <b>Safara Cathasa Riverinda Rijadi, S.T., M.T.</b>
14:30–14:45	Seq. 3 · Submission 1571220161 <b>Design of Production Productivity Indicators Based on Overall Equipment Effectiveness (OEE)</b> Syamsi et al. <i>Information System for Mechatronics</i>	Seq. 7 · Submission 1571221812 <b>Object Detection System Implementation Using 360 Degree Cameras and 3D LiDAR on a Clearpath Husky A200 Mobile Robot Platform</b> Munggaran et al. <i>Robotics, Perception &amp; System Intelligence</i>	Seq. 222 · Submission 1571278201 <b>Text-Based Traffic Sign Recognition in ADAS Based on Adaptive Image Preprocessing</b> Suardi & Nurtanio <i>Autonomous Vehicles &amp; Smart Machine</i>

<p><b>14:45–15:00</b></p>	<p>Seq. 236 · Submission 1571278502 <b>Anomaly Detection Based on Deep Learning in Sales Gas Compressor Sensor Reading Systems for Predictive Maintenance</b> Zulkarnain et al. <i>Information System for Mechatronics</i></p>	<p>Seq. 172 · Submission 1571274564 <b>Optimized Portable Face Recognition on Raspberry Pi Using Refined Knowledge Distillation Method</b> Puji &amp; Kosasi <i>Robotics, Perception &amp; System Intelligence</i></p>	<p>Seq. 250 · Submission 1571278640 <b>Autonomous Braking System on Micro Electric Autonomous Vehicle Using Fuzzy Logic Control</b> Tsukamoto and Mamdani Inference Pangdefan et al. <i>Autonomous Vehicles &amp; Smart Machine</i></p>
<p><b>15:00–15:15</b></p>	<p>Seq. 268 · Submission 1571282891 <b>Machine Learning-Based Prediction of National Salt Supply and Demand Using Historical Data Analysis</b> Kristanto et al. <i>Information System for Mechatronics</i></p>	<p>Seq. 144 · Submission 1571272422 <b>Application of CNN Model for Early Detection of Tuberculosis in Chest X-Ray Images</b> Alvareezi et al. <i>Biomechatronic &amp; Smart Assistive System</i></p>	<p>Seq. 252 · Submission 1571278659 <b>Comparative Analysis of PID and Fuzzy Logic Controller Performance for Steering Control in Micro Electric Autonomous Vehicle</b> Chang et al. <i>Autonomous Vehicles &amp; Smart Machine</i></p>
<p><b>15:15–15:30</b></p>	<p>Seq. 286 · Submission 1571286181 <b>Enhancing YOLOv11 for Over-Dimension Truck Detection Using Complementary Attention Mechanisms</b> Putrawanto &amp; Indraswari <i>Information System for Mechatronics</i></p>	<p>Seq. 243 · Submission 1571278563 <b>Development and Evaluation of a Posture Monitoring and Feedback System for Improving Posture Awareness and Reducing Sedentary Behavior</b> Allic et al. <i>Biomechatronic &amp; Smart Assistive System</i></p>	<p>Seq. 253 · Submission 1571278664 <b>Bird's-Eye View Semantic Segmentation for Autonomous Driving via Limited Multi-Modal Sensor Fusion</b> Baskoro et al. <i>Autonomous Vehicles &amp; Smart Machine</i></p>
<p><b>15:30–15:45</b></p>	<p>Seq. 137 · Submission 1571272205 <b>UNETR-1D: A Hybrid Transformer-CNN Architecture for Non-Invasive Fetal ECG Extraction</b> Rahmawati &amp; Setiawan <i>Biomechatronic &amp; Smart Assistive System</i></p>	<p>Seq. 293 · Submission 1571297970 <b>Unsupervised Geometric Recognition and Classification of Sheet-Metal Parts from CAD Nesting</b></p>	<p>Seq. 278 · Submission 1571284834 <b>Comparative Performance Analysis of Lightweight CNN Architectures for Multi-Class Ocular Disease Classification</b> Rachman et al.</p>

		<b>Data</b> Sinh <i>Biomechatronic &amp; Smart Assistive System</i>	<i>Biomechatronic &amp; Smart Assistive System</i>
<b>15:45–16:00</b>	Seq 62 · Submission 1571259487 <b>Artificial Intelligence Integration as a Catalyst for SMEs Transformation: Determinants and Performance Impact</b> Linsi et al. <i>Information System for Mechatronics</i>		

15:15 · Conclusion of All Day 2 Virtual Parallel Sessions

### Day 3: City Tour (Tentative)

Time (WIB)	Agenda
<b>08:30 – 09:30</b>	3 <sup>rd</sup> Day Registration at The Grand Ballroom 1-2 (tentative)
<b>09:30 – 12:00</b>	Visit to (TBA)

## Programme Summary

Consolidated capacity overview and guidelines for session facilitators, room moderators, and technical hosts.

Session	Time (WIB)	Onsite Rooms	Virtual Rooms	Subtotal
Day 1 — Onsite Parallel Sessions	15:35–17:05	R1 + R2 · 12 Presenters	—	12
Day 1 — Virtual Parallel Sessions	15:35–16:35	—	V1 + V2 + V3 · 11 Presenters	11
Day 2 Morning — Onsite Parallel	08:15–11:45	R1 + R2 · 28 Presenters	—	28
Day 2 Morning — Virtual Parallel	08:00–10:45	—	V1 + V2 + V3 + V4 · 44 Presenters	44
Day 2 Afternoon — Onsite Parallel	14:00–15:00	R1 + R2 · 8 Presenters	—	8
Day 2 Afternoon — Virtual Parallel	14:00–15:15	—	V1 + V2 + V3 · 16 Presenters	16
<b>AGGREGATE PROGRAMME TOTAL</b>		<b>48 Presenters (Onsite)</b>	<b>71 Presenters (Virtual)</b>	<b>119 Presenters</b>

## Operational Notes for Facilitators & Technical Hosts

### 1. Virtual Room V4 — Supplementary Breakout

Room V4 operates as an additional breakout within the same Zoom/Teams environment. No additional physical infrastructure is required — activation is handled entirely within the conferencing application.

### 2. Reserve Capacity Slots

Reserve slots may be activated in the event of last-minute presenter additions or substitutions, confirmed at the point of delegate registration.

### 3. Presentation Slot Protocol (Onsite & Virtual)

Each presenter — whether onsite or virtual — is allocated 12 minutes for their presentation followed by 3 minutes of open Q&A (15 minutes total). The session moderator is responsible for signalling the presenter at the 12-minute mark.

### 4. Schedule Reference & Moderator Preparation

This programme is indexed by Seq. Number and Submission ID. Session moderators and technical hosts are strongly advised to print or download this document alongside the full presenter roster from the conference registration management system prior to each session.

## Keynote Speakers



### Prof. Michael Milford

Director of QUT Centre for Robotics, Faculty of Engineering, School of Electrical Engineering & Robotics, Queensland University of Technology, Australia

*“Safe and Collaboration-Friendly Perception and Localization for Autonomous Systems”*

Michael conducts interdisciplinary fundamental and applied research at the boundary between robotics, neuroscience, computer vision and machine learning. From 2022 – 2027 he is leading a large research team combining bio-inspired and computer science-based approaches to provide a ubiquitous alternative to GPS that does not rely on satellites. His team has worked on autonomous vehicle technology with companies like Ford and Caterpillar, and been funded by and/or collaborated with organizations like Amazon, Intel and Google DeepMind. He is also one of Australia’s most in demand experts in technologies including self-driving cars, robotics and artificial intelligence, and is a passionate science communicator and mentor. Michael currently holds the position of Director of the QUT Centre for Robotics and Australian Research Council Laureate Fellow, and is a Microsoft Research Faculty Fellow and Fellow of the Australian Academy of Technology and Engineering. He recently won the 2025 Eureka Prize for Outstanding Mentor of Researchers.

### **Safe and Collaboration-Friendly Perception and Localization for Autonomous Systems**

For robots and autonomous vehicles to be deployed ubiquitously, they must meet certain requirements. Firstly, they must be performant, where most research has focused on increasing so-called benchmark performance. Secondly, many robot deployments will involve some form of collaboration or supervision, bridging the gap between human-only models and fully autonomous systems. Collaboration requires key capabilities from autonomous systems, most notably introspection. Finally, they must be safe and fit for purpose, with research metrics ideally predicting these properties. In this talk, I'll highlight challenges and limitations in these areas and showcase work addressing them through applied industry and fundamental research projects. I'll also showcase the QUT Centre for Robotics and its portfolio of robotics research ranging from blue sky to commercial, and across skies, ground, underground, on the water and underwater.



### Prof. Joga Dharma Setiawan, Ph.D.

Chief Executive Officer (CEO) PT Len Industri (Persero)

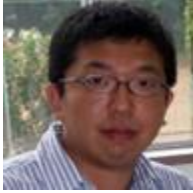
*“The Role of PT Len Industri (Persero) in Realizing Technological Innovation Independence”*

Dr. Joga Dharma Setiawan is the President Director of PT Len Industri (Persero) – DEFEND ID Holding, with extensive experience in robotics, automation, aerospace, and defense technology development. He earned his Ph.D. in Mechanical Engineering from Michigan State University, USA, as well as an M.Sc. in Aeronautics and Astronautics from the Massachusetts Institute of Technology (MIT), USA. Throughout his career, Dr. Joga has held various academic and industrial positions in Indonesia, Malaysia, and the United States, including Lecturer and Head of the Robotics and Automation Laboratory at Diponegoro University, Senior Lecturer at Petronas University of Technology, and R&D Engineer at Beacon Power Co., USA. He is also the Chief Scientific Officer of PT Solusi Teknologi Automasi Robotika (STARNSAT). His expertise covers medical robotics, industrial automation, autonomous systems, satellite technology, and computer vision. He has led and contributed to the development of autonomous saildrones, underwater and surface vehicles, amateur rockets, and mobile tracking antennas for low-orbit satellites. Dr. Joga is actively involved in international research collaborations, including projects with the MIT Media Lab focused on climate resilience using satellite data. He is also a member of IEEE and serves on the Expert Councils of PRISAI and IABIE.

### **The Role of PT Len Industri (Persero) in Realizing Technological Innovation Independence**

PT Len Industri (Persero) was established from a research institution called LEN (National Electronics Institute) in 1965. In 2022, PT Len Industri (Persero) was appointed as the holding company (DEFEND ID), overseeing PT Pindad, PT Dirgantara Indonesia, PT PAL, and PT Dahana. In 2025, Len became part of Danantara Indonesia. DEFEND ID envisions becoming an advanced, strong, independent, competitive national defense industry and a leader in the global market, with a target of entering the Top 50 Global Defence Companies. The company’s management and human resource’s structure consists of 3 Board of Commissioners, 5 Directors, and is supported by 1,885 employees in carrying out Len’s business portfolios, namely Defense & Security, Renewable & Sustainable Energy, Transportation & Navigation, and Public Services & Protection. Achievements obtained by Len through its developed products include refurbishment of KRI (Kapal Republik Indonesia), AXYS – Combat Management

System (CMS), Communication Tactical Data Link System (CTDLS) Link ID, NCS Link ID, Cross-Technology Interoperability (integration of two different CMS technologies), UAV Mission System – AUTACS, Radar System Integration & MRO, Earth Observation Satellite, and electric vehicles, specifically trail-type electric motorcycles powered by electricity, with 5,000 units already distributed and certified for type approval, domestic content requirements (TKDN), and intellectual property rights (IPR). Several UAV developments carried out include Aerobait, ISS Kamikaze Folding Wing, Helidrone, Aerosight, ISS Tail Seater, Kumbang, and FPV Kamikaze. In realizing the Asta Cita of the Republic of Indonesia and maintaining the relevance of its business portfolio, Len launched a strategic initiative titled “Asta Cita Len Industri,” which consists of Artificial Intelligence, Satellite & Remote Sensing Technologies, Semiconductor, Electro-Optic & Sensor Technologies, C2, Datalink & Combat Management System, Robotics, Automation & Electronics for UAS, Radar & Electronic Warfare System, and Cybersecurity. These initiatives are interconnected and mutually reinforcing, forming an integrated and sustainable technology development strategy. In addition, Len collaborates with the Ministry of Higher Education, Science, and Technology as well as BRIN through the downstreaming of research and development activities.

**Prof. Keisuke Morishima** 

*Department of Mechanical Engineering, and The Center for Advanced Medical Engineering and Informatics, University of Osaka, Japan*

*“LiVEMechX Integration: Toward Biohybrid Autonomy”*

Keisuke Morishima is a Professor, Department of Mechanical Engineering, and The Center for Advanced Medical Engineering and Informatics, The University of Osaka, JAPAN; he graduated from Nagoya University where he received his PhD in Engineering in 1998. In 1997, he was JSPS Postdoctoral Research Fellow. From 1998 to 2001, he was a Postdoctoral Research Associate, Department of Chemistry, Stanford University, USA. He joined Kanagawa Academy of Science and Technology as a Research Scientist in 2001. In 2004, he was a Visiting Research Fellow at Lund Institute of Technology, Sweden. In 2005, he joined Department of Mechanical Systems Engineering, Tokyo University of Agriculture and Technology as an Associate Professor. In 2007, he joined Department of Bio-Mechanics and Intelligent Systems. In 2011, he moved to Department of Mechanical Engineering, Osaka University as a Professor. He is mainly engaging in the research fields of Micro-Nano Robotics and its application to the micro-nanomanipulation, BioMEMS, living machine, soft & wet nano robotics.

**LiVEMechX Integration: Toward Biohybrid Autonomy**

The fundamental principles of emergence of intelligence and motor control acquired by living things have yet to be fully elucidated. If we can artificially construct such mechanisms learning from nature and integrate them with living systems as materials, devices, and micro and nano robot systems, enabling autonomy, the dream of realizing micro- and nano-robots like naturally occurring life forms such as microorganisms and insects will expand, and their applications will be unlimited. In this talk, I will introduce our approaches, “LiVEMechX Integration” that cover everything from the micro- and nano-worlds approaching the molecular and cellular scales, biological tissues, microorganisms, and insect cyborg, to macro-scale AI robots and human science. We have developed in situ flexible production system for dynamically reconfigurable microrobots, which can continuously manufacture a large variety of microrobots in small quantities and integrate and assemble actuators in one place. It can be expected to develop innovative energy-saving new principle devices that are fundamentally different from conventional energy-consuming manufacturing. I will also show one of the project to build AI platform using cyborg insect as a tool to design biohybrid intelligent matter, inspired by self organization process in natural behavior of insects.



**Prof. Dr. Abdul Wahab Bin Abdul Rahman** 

Kulliyah of Information and Communication Technology (KICT),  
International Islamic University Malaysia (IIUM)

*“AI Brain Analytics for Mental Well-Being and Intervention”*

Professor Abdul Wahab began his career with Hewlett Packard, working in Singapore and Colorado, USA, before joining Nanyang Technological University (NTU), Singapore, in 1990. In 2009, he joined the Kulliyah of Information and Communication Technology (KICT), International Islamic University Malaysia (IIUM). He has served as visiting researcher at NTU and San Diego State University, and as consultant to OMNI DESIGN Singapore for ergonomic input devices. He chaired the Technical Committee reviewing safety standards for IT equipment (1994–1999) and held leadership roles with Singapore’s Islamic Religious Council (MUIS), Malay Chamber of Commerce, and various community organizations, including Mercy Relief (2003–2013). His current research focuses on neuro-cardiological modeling (EEG/ECG) to understand brain and heart functions, with applications in learning disorders, addiction behavior, emotional stress analysis, driver profiling, PTSD, epilepsy prediction, and neuro-feedback. He also develops computational models and psychological instruments for brain-inspired affective and blended care.

### **AI Brain Analytics for Mental Well-Being and Intervention**

The absence of practical psychological tools for predicting mental health conditions often means individuals remain unaware of their state until it is too late, making consistent monitoring difficult. With the rise of consumer-grade Electroencephalogram (EEG) devices, however, new opportunities have emerged for both professional and personal use. These devices, which are portable and affordable, can record and analyze brain waves, making them valuable for researchers, educators, clinicians, and families. They also enable self-care and home-based interventions, allowing individuals to track their mental state, identify early warning signs, and take preventive steps to maintain a healthier lifestyle. Advances in affective psychology and Artificial Intelligence (AI) further expand these possibilities. AI can assess mental states, detect addictive behaviors, and predict personality-related tendencies, providing deeper insight into individual well-being. It can also uncover hidden addictions and learning disabilities, offering timely interventions not only in clinical settings but also through personalized support at home. To support these developments, the NeuroCoach Digital Lab (NDL) offers brain measurement and analytics services for mental well-being to the public, and is currently based at the Kulliyah of Information and Communication Technology (KICT), International Islamic University Malaysia (IIUM).



**Prof. Dr. Maman Abdurohman, S.T., M.T.** 

*Head of Centre of Excellence for Advanced ICT Infrastructure and Services (AIIS), Telkom University*

*“Emerging Smart Technologies for Precision, Efficiency, and Intelligent Automation”*

Prof. Maman Abdurohman is a distinguished academic and researcher at Telkom University, Indonesia, where he has served in the Faculty of Informatics since 1999. With more than two decades of experience in higher education, he has contributed extensively to teaching, research, and academic leadership at undergraduate, master's, and doctoral levels. His teaching expertise encompasses a broad range of subjects, including Research Methodology, Philosophy of Science, Computer Organization and Architecture, Digital Systems, Embedded Systems, Distributed Systems, and Operating Systems. His research focuses on intelligent and connected technologies, particularly in the fields of smart card systems for university environments, intelligent lighting systems for developing IoT-based green ecosystems, and SmartTag IoT Analytics Dashboard platforms for real-time supply chain visibility and precision monitoring. In addition to his academic contributions, he has held numerous strategic leadership positions at Telkom University, including Manager of the Telkom University Library, Manager of Institutional and Language Development, Dean of the Faculty of Informatics, and Director of Bandung Techno Park. He currently serves as the Head of the Center of Excellence for Advanced ICT Infrastructure and Services (AIIS) at Telkom University, where he continues to promote innovation, collaborative research, and the advancement of smart digital infrastructure.

### **Emerging Smart Technologies for Precision, Efficiency, and Intelligent Automation**

Emerging smart technologies play an important role in improving precision, efficiency, and intelligent automation in modern industries and smart environments. This keynote speech discusses several smart technology applications, including smart cards system, smart lighting systems for intelligent buildings, and smart tags for precision detection in manufacturing processes. The presentation highlights how technologies such as AIoT, embedded systems, sensors, and wireless communication can improve system performance, energy efficiency, security, and automation. These technologies help industries and buildings become more adaptive, connected, and efficient. In addition, the speech explores the future opportunities and challenges of implementing smart technologies in Society 5.0 and smart infrastructure development. The keynote aims to provide insights into how intelligent systems can support sustainable innovation and improve the quality of modern industrial and public services.

**Dr. Francesco Cursi**

Senior Research Engineer, Noah's Ark Lab, Huawei Technologies Ltd.


*"From Programmable to Autonomous: How Robotics Is Entering Our Lives"*

Francesco Cursi is a Senior Research Engineer in Huawei, Hong Kong. His research focuses on different aspects of robot learning, such as foundation models for robotics, VLAs, reinforcement learning and traditional robot control. Before joining Huawei, he was Algorithm Engineer in FLAIR, Hong Kong where he worked on computer vision for automated defect detection on LCD screens in manufacturing. Francesco holds a PhD from Imperial College London, supervised by Petar Kromushev, Eric Yeatman, and Guang-zhong Yang. His work focused on integrating machine learning and robot control for modelling and control of a tendon-driven robot for surgery. Prior to his PhD, he obtained master's degree in mechanical engineering from Sapienza University of Rome, Italy and New York University.

**From Programmable to Autonomous: How Robotics Is Entering Our Lives**

Robotics has seen major transformation over the past few years, primarily led by advancements in other fields like hardware design, LLM, computer vision. Robots have been considered as intelligent machines, but always deployed in structured and constrained environments, where repetitive tasks could be easily automated. Teams of engineers were needed to make a robot perform a specific task, like sorting, picking and placing objects, etc. With the latest developments in AI, instead, robots have started to become more autonomous. Nowadays robots can be more easily deployed in more challenging environments, understanding human textual/voice instructions and how to interact with the environment from multiple sensors. Progress in hardware has made them capable of replicating human movements and even going beyond average human's performance. Some questions still exist, but how will our life change with more robots within us? The talk will address the evolution of robots and the current trends and limitations of developments in robotics.



**Prof. Ir. Haryo Dwito Armono, ST., M.Eng., Ph.D.,  
IPU, ASEAN Eng **

Lecturer and head of the Coastal and Port Infrastructure Laboratory in the Department of Ocean Engineering, Sepuluh Nopember Institute of Technology (ITS)

*“Integrated Vision System for Real-Time Monitoring and Enhancement Using YOLO-Based Deep Learning in the Placement of Concrete Armor Unit during Breakwater Construction”*

Dr. Haryo Dwito Armono is a lecturer and head of the Coastal and Port Infrastructure Laboratory in the Department of Ocean Engineering, Sepuluh Nopember Institute of Technology (ITS), Surabaya. This Belitung-born man has been teaching at ITS since 1995 and has been appointed as the 220th ITS Professor in the field of Coastal Protection Structures. He completed his undergraduate education in Civil Engineering at Gadjah Mada University and his postgraduate studies in Canada. He obtained his M.Eng degree from Memorial University of Newfoundland in 1999, then moved to Kingston, Ontario, to continue his doctoral studies at Queen's University until 2003. He has been actively involved in the planning and design of various environmentally friendly coastal structures (submerged breakwaters, groins, jetties, seawalls), the planning of various port infrastructure (piers, jetties, breakwaters, reclamation), and the management and planning of shipping lanes (dredging, channel maintenance, sedimentation prevention and reduction). One of his inventions, Hexareef, an artificial reef as an environmentally friendly submerged breakwater, has been implemented in Tiangoh Village, Bangkalan, Madura; Raja Ampat; and Gangga Island, Manado. This innovation aims to prevent coastal erosion and restore marine ecosystems. Hexareef was developed into IMHAR (Interlocking Modular Hexagonal Artificial Reefs) with his doctoral students from the Marine Management Institute, Ministry of Maritime Affairs and Fisheries. Since 2017, together with researchers from BRIN, he has also been involved in the development and implementation of several Concrete Armor Units (CAU), such as BPPT-loc, BRIN lock, and BRIN pod, at various ports and coastal protection structures. Currently, Dr. Armono is developing Hexaloc—a concrete armor unit used as the primary protective rock for coastal structures—that performs better than tetrapods, dolos, and other conventional artificial rocks/CAUs commonly used in Indonesia. He is the idea initiator and is conducting research on developing a real-time YOLO-based CAU detection system to monitor the placement of Concrete Armor Units on breakwaters. He is open to research collaboration in robotics and AI to build smart, connected, and climate-adaptive coastal and port infrastructure.

## **Integrated Vision System for Real-Time Monitoring and Enhancement Using YOLO-Based Deep Learning in the Placement of Concrete Armor Unit during Breakwater Construction**

In the monitoring of the condition of the Concrete Armor Unit during breakwater construction, we still face two main challenges: 1) low image quality due to turbidity, scattering, and minimal lighting, and 2) inaccurate unit detection in real-time. This study integrates image enhancement methods with a YOLO-based deep learning model to build a robust underwater vision system. In the pre-processing stage, several image enhancement methods such as CLAHE, dehazing, and white balancing are compared to improve the contrast and clarity of underwater images. The optimized image results are then used as input for the YOLOv5/YOLOv8 model for real-time armor unit detection. Performance evaluation is based on mAP detection accuracy, FPS, and robustness to turbid water conditions. The results show that integrating image enhancement with YOLO significantly improves CAU detection accuracy compared to the YOLO baseline without pre-processing, while maintaining the real-time performance required for monitoring coastal protection structures. The proposed system has the potential to serve as the basis for a Digital Twin and autonomous underwater inspection of modular concrete armor units during breakwater construction.



## Parallel Session Abstracts

### Track 1: Robotics, Perception, and System Intelligence

Seq: 5 | ID: 1571220800

#### Dual-Frame Extended Kalman Filter Localization System on Clearpath Husky Robot

A. M. R. M. Saputra<sup>1</sup>, R. P. Saputra<sup>2</sup>, M. H. Nugraha<sup>2</sup>, M. Mirdanies<sup>2,3</sup>, D. K. Dewi<sup>2</sup>, M. Munadi<sup>1</sup>, J. D. Setiawan<sup>1</sup> | <sup>1</sup>Diponegoro University; <sup>2</sup>National Research and Innovation Agency (BRIN); <sup>3</sup>Universiti Teknologi Malaysia

This paper presents a robust localization method for the Clearpath Husky A200 robot that leverages a Dual-frame Extended Kalman Filter (EKF) to fuse data from GPS, an IMU, and wheel odometry, implemented using the Robot Operating System (ROS). The method is validated through both Gazebo simulations and real-world field experiments, with ground-truth provided by an Xsens Vision Navigator system. The simulation results indicate that sensor fusion reduces the average positional error to 0.044 m (x) and 0.105 m (y), significantly outperforming standalone odometry, which exhibits deviations of 329.31 m (x) and 689.85 m (y). In real-world experiments with loop-closure, EKF-based fusion achieved a combined error of 1.89 m compared to 187.55 m for odometry alone. These findings highlight the effectiveness of multi-sensor fusion for robust, accurate localization across diverse motion scenarios.

**Keywords:** *dual-frame extended kalman filter, localization, multi-sensor fusion, robot operating system, clearpath husky robot*

Seq: 6 | ID: 1571221437

#### Piecewise Constant Curvature-Based Kinematics of a Tendon-Driven Continuum Robot with a Thermoplastic Polyurethane Backbone

H. Putri<sup>1</sup>, H. M. Saputra<sup>2</sup>, D. Sangaji<sup>2</sup>, H. Septanto<sup>2</sup>, D. B. Nugroho<sup>1</sup> | <sup>1</sup>Sumatera Institute of Technology; <sup>2</sup>National Research and Innovation Agency (BRIN)

This paper presents the modeling and simulation of a tendon-driven continuum robot equipped with a flexible backbone made of thermoplastic polyurethane (TPU). The objective is to model and design the motion of the continuum robot based on piecewise constant curvature (PCC) kinematics through the derivation of forward and inverse kinematics as well as workspace evaluation. The simulation results validated the designed PCC kinematics-based motion. The results show that forward kinematics effectively generates continuous backbone configurations by sequentially mapping tendon length variations, while the closed-form inverse kinematics approach provides a practical solution for position-based motion planning. These findings, combined with the 3D workspace analysis, corroborate the proposed framework's computational efficiency, systematic formulation, and reliability for the modeling and prototyping of tendon-driven continuum robots. Future work will concentrate on implementing the proposed PCC-based kinematic model on a physical prototype and

extending the kinematic analysis through the integration of Cosserat rod theory for more comprehensive modeling.

**Keywords:** Continuum robot, tendon-driven actuator, Thermoplastic polyurethane backbone, Piecewise constant curvature, surgical robotics.

Seq: 7 | ID: 1571221812

### Object Detection System Implementation Using 360 Degree Cameras and 3D LiDAR on a Clearpath Husky A200 Mobile Robot Platform

J.P. Munggaran<sup>1</sup>, A. Adiwilaga<sup>1</sup>, D. Pradeka<sup>1</sup>, M. S. P. Saragi<sup>1</sup>, D. K. Dewi<sup>2</sup>, R. P. Saputra<sup>2</sup> | <sup>1</sup>Indonesia University of Education; <sup>2</sup>National Research and Innovation Agency (BRIN)

This paper presents an implementation of a 360-degree perception system that fuses six Arducam IMX477 cameras with a Velodyne VLP32C on a Clearpath Husky A200 for indoor supervision. YOLOv11m-seg runs on each camera, LiDAR points are projected into the image space, and in-mask points yield per-object distance and base frame coordinates. The system runs in ROS 2 Humble on an NVIDIA Jetson AGX Orin 32 GB. The detector achieves a precision score of 0.863, recall of 0.870, F1 of 0.867, mAP@0.5 of 0.680, and mAP@0.5:0.95 of 0.442. Distance errors range from an MAE of 0.14 to 0.33 m and an RMSE of 0.17 to 0.36 m. Mean coordinate errors are approximately 1.05 m on the X-axis, 2.82 m on the Y-axis, and 2.77 m on the Z-axis. A black-box check was also performed, confirming a stable 2 × 3 OpenCV panel designed for operator supervision. The pipeline is simple and can provide operator-ready readouts.

**Keywords:** object detection, instance segmentation, YOLOv11m-seg, LiDAR, 360-degree cameras, mobile robot, OpenCV

Seq: 15 | ID: 1571237449

### CLBF-Based Decentralized Safety Control with Conflict Resolution for Multi-Robot Systems

A.S. Baswara<sup>1</sup>, M.Z. Romdloni<sup>1</sup>, H. Septanto<sup>2</sup>, N.A. Wahab<sup>3</sup>, M.A. Ismail<sup>1</sup> | <sup>1</sup>Telkom University; <sup>2</sup>National Research and Innovation Agency (BRIN); <sup>3</sup>Universiti Teknologi Malaysia

This paper proposes a CLBF-based decentralized safety controller with CBF-based conflict resolution (CBF-CR) for nonholonomic multi-robot systems. The controller combines a Control Lyapunov Function (CLF) for stability and a Control Barrier Function (CBF) for safety, formulated as a single closed form equation via Sontag's formula. A path prediction algorithm is utilized alongside the CLBF-based position controller to improve robot navigation. The CBF-CR is incorporated by uniquely parameterizing the CBFs, enabling priority-based conflict resolution where higher-priority robots are prioritized over lower-priority ones. Each robot independently computes its own control, communicating directly only with robots within a limited range. The system is validated via MATLAB simulation on six nonholonomic robots in a closed warehouse environment with static obstacles, a dynamic human obstacle, and walls as boundaries. Results show all robots complete their tasks safely with no collisions, and CBF-

CR effectively resolves conflicts across congestion, path yielding, and dock occupancy scenarios.

**Keywords:** control Lyapunov-barrier function, decentralized control, safety control, conflict resolution, multi-robot systems

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Seq: 16 | ID: 1571237475

### Discrete PID Control for Waypoint Tracking of an IMU-Based Tendon-Driven Continuum Robot

N. R. Aryaputra, S Abidin, J. Hendry | Gadjah Mada University

This paper presents a low-cost, single-segment tendon-driven continuum robot using an IMU and discrete PID control for waypoint tracking and disturbance rejection. The prototype is actuated by four DC motors controlled by an ATmega2560 microcontroller with Kalman-filtered IMU feedback. The system is evaluated on triangle and square reference paths, as well as under external perturbations. Results demonstrate that the platform successfully performs waypoint tracking and disturbance rejection using only onboard IMU sensing and classical PID control, providing an accessible platform for continuum robot research and education.

**Keywords:** Tendon-driven continuum robot, soft robotics, IMU-based feedback, discrete PID control, trajectory tracking, disturbance rejection

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Seq: 57 | ID: 1571257482

### Stability Analysis, Simulation, and Real-World Implementation of a Kinematics-Based 6-DoF End-Effector Position Control

M.A.A. El Fawwaz<sup>1</sup>, Y. B. Ivansyah<sup>1</sup>, A. A. Wardana<sup>1</sup>, H. Septanto<sup>2</sup>, R. P. Saputra<sup>2</sup> | <sup>1</sup>Airlangga University; <sup>2</sup>National Research and Innovation Agency (BRIN)

This paper presents modeling, stability analysis, simulation, and real-world experimental studies of a kinematics based control for the UR5e robot arm manipulator. A kinematics based proportional controller with a manipulability measure based null-space policy is developed, with formal stability guarantees via a differential kinematics model accounting for external disturbances, Jacobian uncertainty, and measurement noise. In the simulation, an examination regarding UR5e under a singularity situation is conducted on the Docker version of URSim. Furthermore, an experimental study of the kinematics based UR5e's end-effector control is deployed on physical UR5e hardware. Two different end-effector target velocity scenarios are conducted in the experiment that confirms the property of boundedness of error in stability analysis. Quantitative performances are evaluated based on mean error and root mean square error.

**Keywords:** kinematics-based control, null-space policy, manipulator, lumped disturbance, stability

**Seq: 79 | ID: 1571264872****The Design of A\* Algorithm for Intelligent Navigation of Automated Service Robots in UIGM Canteen: A Simulation***S. Puspasari, C. N. Tanugraha, R. Baasith, D. F. Putra, R. Queen, M. Aliyudi | Universitas Indo Global Mandiri*

Navigation in a canteen environment for an automated service robot requires an approach that ensures both efficiency and safety in path planning. This study implements the A\* algorithm within an intelligent navigation system, using the canteen at Indo Global Mandiri University (UIGM) as the experimental setting. The selection of A\* is based on its capability to integrate the accumulated movement cost with a heuristic estimation toward the goal, allowing the system to identify an optimal route. The environment is represented using a two-dimensional grid model that distinguishes navigable areas from static obstacles such as tables, service counters, pillars, and walls. Based on this representation, the system autonomously computes the most efficient path from the robot's starting position to the designated customer table. The findings demonstrate that the proposed approach is able to generate effective navigation paths that correspond well with the predefined environmental model. This work can serve as a foundation for further improvements, particularly by introducing dynamic obstacles and benchmarking against alternative pathfinding methods.

**Keywords:** *A\* Algorithm, Pathfinding, Service Robot, Artificial Intelligence, Intelligent Navigation*

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**Seq: 81 | ID: 1571266342****RT-DETR Guided Deep Reinforcement Learning for Vision-Based Robotic Target Reaching***S. H. Shah | Yuan Ze University, Taiwan*

Robust robotic manipulation in real-world environments requires reliable visual perception and stable control policies capable. This paper presents an integrated perception–control framework that combines transformer-based object detection with deep reinforcement learning for robotic target-reaching tasks. The perception module employs the Real-Time Detection Transformer (RT-DETR) architecture to perform scene-aware object detection and accurate target localization. The detected target position is then used by a reinforcement learning controller based on the Deep Deterministic Policy Gradient (DDPG) algorithm to learn continuous control policies for guiding a robotic manipulator toward the target. To improve learning efficiency and policy stability, this work systematically investigates the influence of different reward formulations, including sparse, dense, and hybrid reward structures. Experimental validation on the UFactory Lite6 robotic arm demonstrates the effectiveness of the proposed framework for reliable robotic target-reaching in realistic environments.

**Keywords:** *Reinforcement Learning, RT-DETR, Object Detection, DDPG, Target Reaching*

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**Seq: 88 | ID: 1571267022****Design and Real-Time Implementation of an Autonomous Indoor Navigation System for Service Robots***M. Indriani, M. F. Alrizki, M. D. H. Chandra, S. Dwijayanti, B. Y. Suprpto, Rendyansyah | Sriwijaya University*

Service robots have the potential to replace human labor in delivering services to customers in various indoor environments. To operate effectively, these robots require an autonomous navigation system that integrates mapping, self-localization, and path planning. However, many previous studies have addressed these components separately and have not fully integrated them into a unified real-time navigation framework for service robots. Therefore, this study aims to design, implement, and evaluate an integrated autonomous navigation system that operates in real time. In this work, a navigation system for a service robot was developed using the RPLIDAR A3 sensor to generate environmental maps through the Hector Simultaneous Localization and Mapping (SLAM) algorithm. The resulting map quality was evaluated and showed a mean square error of 0.81 compared with the GMapping and Karto SLAM methods. For self-localization, the Adaptive Monte Carlo Localization algorithm was employed by combining rotary encoder data with RPLIDAR A3 measurements to estimate the robot's position and orientation. Global path planning was performed using the A\* algorithm to determine the optimal route, while local path planning used the Timed Elastic Band-planner to avoid obstacles in dynamic environments. Real-time experiments and Gazebo simulations demonstrated that the system enables reliable and autonomous indoor navigation.

**Keywords:** *Service Robot, Navigation, RPLIDAR, Hector SLAM, AMCL, Path Planning, A-Star, TEB planner*

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**Seq: 89 | ID: 1571267032****Design of a Robot for Pothole Detection and Depth Estimation***A. N. Putri, M. R. Mutaqin, S. Dwijayanti, B. Y. Suprpto, R. Prasetyo | Sriwijaya University*

Potholes pose significant risks to road users, and their repair requires accurate estimation of size and depth. Manual inspection methods are often inefficient and time consuming; therefore, this study proposes an automated mobile robot for pothole detection and depth estimation. The robot integrates an HC-SR04 ultrasonic sensor for depth measurement, a deep learning-based camera for pothole detection, and a GPS module for location identification. The robot's motion system is controlled using a PID controller, which achieves a very small steady-state error of 0.0028 compared with the system without PID control. Real-time experiments demonstrate a depth detection mean square error (MSE) of 2.89%, a location error of 0.04%, and a visual detection success rate of 75%. The developed robot can operate on highway surfaces and is controlled using a joystick controller, demonstrating its capability to effectively detect potholes and estimate their depths.

**Keywords:** *Mobile robot, Pothole detection, Ultrasonic sensor, PID control*

Seq: 91 | ID: 1571267646

**Evaluating Truncated Quantile Critics and Twin Delayed DDPG for Robotic Manipulation Tasks**

H. Awan, N. U. Islam | Yuan Ze University, Taiwan

One of the central challenges in robotics and artificial intelligence is enabling robots to interact effectively with their surroundings. Tasks such as lifting objects and opening doors require precise control and environmental understanding. Twin Delayed Deep Deterministic Policy Gradient (TD3) has shown strong potential for such tasks; however, it is prone to overestimating value functions. Truncated Quantile Critics (TQC) address this limitation by applying distributional reinforcement learning and truncating high-quantile estimates. In this study, we compare TD3 and TQC on the Lift and Door tasks using the Robosuite simulation framework. Experiments were conducted using three random seeds: 42, 123, and 456. The results show that TQC consistently outperformed TD3, demonstrating greater robustness and more stable learning behavior. We further investigate the effect of the number of quantiles on TQC performance using 15, 25, 35, and 50 quantiles. The results indicate that increasing the number of quantiles improves performance on both tasks, with 50 quantiles achieving the best overall results. These findings suggest that the number of quantiles plays an important role in model performance, particularly in tasks requiring higher precision.

**Keywords:** Reinforcement Learning, Robotic Manipulation, TD3, TQC, Robosuite, Quantile Critics

Seq: 93 | ID: 1571267962

**Task-Space Dynamics Control of a 6-DoF Manipulator with an Admittance Model-Based Force-to-Velocity Conversion**Y. B. Ivansyah<sup>1</sup>, M. A. A. E. Fawwaz<sup>1</sup>, A. A. Wardana<sup>1</sup>, H. Septanto<sup>2</sup>, R. P. Saputra<sup>2</sup> | <sup>1</sup>Airlangga University; <sup>2</sup>National Research and Innovation Agency (BRIN)

Task space control has emerged as a critical framework for enabling robotic arm manipulators to execute complex, real-world applications requiring precise end-effector positioning and dynamic environmental interaction. However, implementing theoretical dynamics-based control laws on commercial collaborative robots, such as the Universal Robots UR5e, presents a significant challenge because their low-level industrial controllers natively accept kinematic inputs (velocity or position) rather than direct joint torque commands. This paper presents a complete design, simulation, and real-world implementation of a dynamics-based task space control architecture tailored for velocity-controlled manipulators. To bridge the hardware control gap, an admittance model-based converter is employed. It converts the task-space force control signal into the corresponding end-effector position rate so that, through inverse differential kinematics calculations, the control signal in the form of joint velocity can be obtained. The proposed controller architecture's performance is evaluated against another algorithm, which demonstrated severe trajectory divergence (RMSE 1.17 m, 0.60 m, and 0.06 m on the X-, Y-, and Z-axes, respectively). In contrast, using the admittance-model-based conversion, it exhibited excellent tracking during physical 3D trajectory experiments, yielding

a Root Mean Square Error (RMSE) of 5.0 mm, 14.1 mm, and 3.5 mm on the X-, Y-, and Z-axes, respectively.

**Keywords:** *Task Space, Dynamics-based control, Admittance Model, Conversion, Manipulator*

Seq: 100 | ID: 1571269812

### Improving Vision-Guided Robotic Grasping via Regression-Based Pose Compensation

R. S. Tarigan<sup>1</sup>, A. A. A. Rizqi<sup>1</sup>, R. P. Saputra<sup>2</sup> | <sup>1</sup>Gadjah Mada University;

<sup>2</sup>National Research and Innovation Agency (BRIN)

Vision-guided robotic manipulation enables robots to perform pick-and-place tasks by estimating object poses using visual perception. However, perception noise, camera perspective distortion, and calibration inaccuracies often introduce systematic offsets between the detected object pose and the actual grasp position required by the robot. This paper proposes a regression-based grasp pose compensation approach to improve the accuracy of vision-guided robotic grasping. A second-order polynomial regression model is trained using experimentally collected robot execution data to map the detected AprilTag pose to a corrected grasp target position. The method is evaluated using a UR5e robotic manipulator and an overhead RGB-D camera in a  $7 \times 5$  grid workspace with 175 grasp trials. Experimental results show an overall grasp success rate of 86.9% with a mean positioning error of 0.317 mm, despite an average perception offset of 21.075 mm between the detected tag position and the grasp target. The results demonstrate that the proposed regression-based compensation method effectively improves grasp accuracy and robustness in vision-guided robotic manipulation.

**Keywords:** *vision-guided manipulation, robotic grasping, pose compensation, regression-based calibration, pick-and-place robotics*

Seq: 107 | ID: 1571270602

### Development of a Smart Biomimetic Fish Robot Integrating Autonomous Navigation, Obstacle Avoidance, and Real-Time Motion Control

R. Muhida<sup>1</sup>, A. Legowo<sup>2</sup>, M. Riza<sup>1</sup>, A. Djajadi<sup>3</sup>, A. Cucus<sup>4,5</sup>, R. Muhida<sup>5</sup>, E. Y. T. Adesta<sup>1</sup>, J. D.

Setiawan<sup>6</sup>, T. Thamrin<sup>7</sup> | <sup>1</sup>Bandar Lampung University; <sup>2</sup>Higher Colleges of Technology, United Arab Emirates; <sup>3</sup>Universitas Multimedia Nusantara;

<sup>4</sup>Universiti Malaysia Pahang Al-Sultan Abdullah; <sup>5</sup>Universitas Putra Indonesia YPTK;

<sup>6</sup>Diponegoro University; <sup>7</sup>Bina Nusantara University

This paper presents the development and experimental evaluation of a smart biomimetic fish robot integrating semi-autonomous navigation, reactive obstacle avoidance, and real-time motion control within a unified mechatronic system. The proposed robot employs a multi-joint mechanical structure driven by coordinated servo actuators to mimic natural fish locomotion. An embedded control system processes real-time sensor data from proximity sensors to enable adaptive motion and responsive navigation. A hybrid control architecture is implemented, allowing both semi-autonomous operation and Bluetooth-based

teleoperation, thereby enhancing system flexibility. Experimental validation was conducted through leakage testing, stability analysis, propulsion performance, and obstacle avoidance evaluation. Quantitative results show that the robot achieves an average swimming speed of 0.12 m/s, a turning angle of 30°, and a response time of 0.8 s, with an estimated navigation error of 5%. The relationship between oscillation frequency and swimming speed indicates improved propulsion efficiency with increasing frequency up to a saturation point. Although the system demonstrates stable and effective performance in controlled environments, limitations such as the absence of advanced sensor fusion and restricted testing conditions are identified. Future work will focus on integrating additional sensors and intelligent navigation algorithms to enhance system autonomy and real-world applicability. The proposed system provides a practical platform for advancing biomimetic underwater robotics with semi-autonomous capabilities.

**Keywords:** *Biomimetic robot; robotic fish; autonomous navigation; obstacle avoidance; real-time control; underwater robotics; sensor-based control; mechatronic system*

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**Seq: 116 | ID: 1571271052**

### **Implementation of Ant Colony Optimization for UAV Waypoint Ordering Optimization with CoppeliaSim Simulation Validation**

*M. D. Saffitra, A. Z. Fuadi, A. Rusdinar | Telkom University*

This study presents the implementation of Ant Colony Optimization (ACO) for optimizing the waypoint visiting order of an Unmanned Aerial Vehicle (UAV) on three trajectory patterns, namely circle, square, and zigzag, each representing a different evaluation role. The circle trajectory is used as the main analysis scenario because it provides a smooth and continuous path, the square trajectory is used for validation on paths with distinct directional changes at corners, and the zigzag trajectory is used as a complexity test due to its more challenging geometric structure. ACO determines the optimal waypoint sequence based on pheromone intensity and heuristic information defined as the inverse of Euclidean distance. The optimized path is then executed in CoppeliaSim via the ZMQ Remote API by moving a quadcopter target progressively toward each waypoint. Performance is evaluated using convergence curves and visual comparisons among the target path, optimized path, and actual trajectory. The results show that ACO performs well on all three trajectory patterns, with the most stable behavior observed on the circle trajectory, consistent validation on the square trajectory, and the greatest challenge found on the zigzag trajectory.

**Keywords:** *Ant Colony Optimization, UAV, waypoint optimization, path planning, CoppeliaSim, circle, square, zigzag*

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Seq: 117 | ID: 1571271058

### Adaptive Hybrid Control Strategy Using Extremum Seeking and Pure Pursuit for Mobile Robot Navigation in Unknown Environments

R. Mariel, A. Z. Fuadi, A. Rusdinar | Telkom University

Navigating wheeled mobile robots in unstructured environments demands a delicate balance between global trajectory tracking and local obstacle avoidance. Traditional geometric trackers like Pure Pursuit excel at path following but fail against unmapped obstacles, while reactive planners frequently suffer from local minima. This paper proposes a lightweight, hybrid control architecture fusing the geometric stability of Pure Pursuit with the model-free optimization of Extremum Seeking Control (ESC). By evaluating a composite objective function of safety and progress, the ESC injects real-time steering perturbations, acting as a biological avoidance reflex. Evaluated through discrete-time kinematic simulations, the topology-agnostic system successfully navigated complex variable curvatures on a Figure-8 path, executed rapid transient evasions on a sinusoidal path, and demonstrated asymptotic steady-state error recovery on a large curved trajectory. The proposed method guarantees collision-free navigation without requiring explicit environmental mapping or computationally expensive local re-planning.

**Keywords:** *Mobile Robot, Extremum Seeking Control, Pure Pursuit, Obstacle Avoidance, Kinematics, Reactive Control*

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Seq: 133 | ID: 1571272006

### Evaluation of YOLOv5 and HSV-Based Segmentation for Orange Flare Detection in Obstacle Avoidance of Autonomous Underwater Vehicles

F. M. Vioneidy, B. Y. Suprpto, S. Dwijayanti, R. Farhan, M. A. Novryanto | Sriwijaya University

Autonomous Underwater Vehicles (AUVs) require robust perception systems to support navigation and obstacle avoidance in challenging underwater environments characterized by limited visibility, lighting variations, and color distortion due to light absorption and scattering. This study presents a comparative evaluation of a deep learning-based object detection approach using You Only Look Once (YOLOv5) and a conventional color segmentation method based on the Hue, Saturation, Value (HSV) color space for detecting orange flare objects. Experiments were conducted using an AUV platform equipped with an NVIDIA Jetson onboard computer and an underwater camera for real-time perception. A custom dataset was collected in a controlled swimming pool environment, and the YOLOv5 model was trained for 150 epochs. Experimental results show that YOLOv5 achieved a detection accuracy of 100%, successfully identifying all test samples, while the HSV-based method achieved 60% accuracy. Although HSV offers lower computational complexity and faster processing suitable for real-time implementation, its performance is sensitive to lighting and color variations. In contrast, YOLOv5 demonstrates superior robustness and reliability under varying underwater conditions. These findings indicate that YOLOv5 is more suitable for dynamic underwater environments, while HSV remains applicable in controlled conditions with consistent illumination and object color characteristics.

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**Keywords:** HSV Color Segmentation, YOLOv5, Obstacle Avoidance, Object Detection, Autonomous Underwater Vehicle

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Seq: 172 | ID: 1571274564

### Optimized Portable Face Recognition on Raspberry Pi Using Refined Knowledge Distillation Method

M. N. Puji, R. Kosasi | Bina Nusantara University

Facial recognition is widely used in applications such as authentication and surveillance. However, to enable on device application, efficient models are required. Large facial recognition models typically achieve high accuracy but usually are too large and computationally expensive for real time deployment on low-power edge devices like the Raspberry Pi. This work applies knowledge distillation (KD) to obtain a lightweight yet accurate face recognition model that is practical for deployment on such devices. KD setup is then used to distill an ArcFace-ResNet100 teacher into a MobileFaceNet v2 student, resulting in a low accuracy model and highlighting that a weak teacher limits simple KD. Using a stronger AdaFace IR-101 teacher (99.41% accuracy) and a refined KD strategy combining embedding-level and relational KD (RKD) resulted in a student model that attains an accuracy of 88.82% and only 2.86M parameters compared to the teachers 65.22M. The model is able to run smoothly in real time on a Raspberry Pi 5, achieving 96 FPS on model inference alone and 30 FPS end-to-end including face detection, recognition, and display, showing the effectiveness of KD.

**Keywords:** Knowledge distillation, face recognition, edge devices, Raspberry Pi, ArcFaceResNet-100, MobileFaceNet, AdaFace IR-101.

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Seq: 180 | ID: 1571276557

### A Framework for Integrating Robotic Filling and Digital Traceability Systems in Toiletries Manufacturing for Regulatory Compliance

M. Prathama<sup>1,2</sup>, I. Baihaqi<sup>1</sup>, N. A. A. Rakhmawati<sup>1</sup> | <sup>1</sup>Institut Teknologi Sepuluh Nopember, <sup>2</sup>Institut Bisnis Muhammadiyah

Smart manufacturing technologies enable automation and digital data integration in industrial Production. In the toiletries manufacturing sector, regulatory frameworks such as Good Manufacturing Practices (GMP) require strict documentation and traceability. However, many systems remain fragmented, where robotic monitoring, material tracking, and compliance documentation are not fully integrated. This study proposes an integrated framework that connects robotic filling systems, barcode-based material tracking, and ERP platforms to support compliance-oriented manufacturing. Using a case study approach, the research examines how existing technologies can be aligned within a real production environment. The framework adopts a compliance-by-design approach, transforming operational and traceability data into structured digital records for audit and documentation purposes. The study highlights that the main challenge lies in system integration rather than

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technology availability, and provides a practical framework to support regulatory compliance in manufacturing.

**Keywords:** *Robotic, Traceability System, Regulatory compliance.*

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Seq: 291 | ID: 1571290888

### **Enhancing Real-Time Object Detection via Early Fusion of Radar and LiDAR Using CNN-LSTM Networks**

L. Venica<sup>1</sup>, D. I. H. Putri<sup>1</sup>, F. Latifah<sup>1</sup>, R. M. A. Kindi<sup>1</sup>, M. Pratama<sup>2</sup>, M. K. A. Wardana<sup>2</sup>, N. Hasanah<sup>2</sup> | <sup>1</sup>Indonesia University of Education; <sup>2</sup>National Research and Innovation Agency (BRIN)

Reliable object detection in autonomous systems remains challenging due to the inherent limitations of single sensors. Radar provides robust velocity information but suffers from low spatial resolution, while LiDAR offers precise spatial measurements without direct motion sensing. This paper proposes an early fusion framework that integrates radar and LiDAR data using a hybrid CNN–LSTM architecture to jointly learn spatial–temporal features. Sensor data from a Continental ARS408-21 radar and a Hokuyo UST-10LX LiDAR were synchronized within a ROS-based system and fused at the raw data level. Experimental results show that the proposed method significantly outperforms single-sensor approaches. At a detection threshold of 0.6, the fused model achieved a precision of 0.9774, recall of 0.9319, and an F1-score of 0.9533, compared to 0.5041 (radar-only) and 0.3196 (LiDAR-only). The model also demonstrated stable training performance with 94% accuracy and low prediction error (MAE: 0.03–0.05; RMSE: 0.16–0.22). Qualitative evaluations under occlusion, low-light, and outdoor conditions confirm the robustness of the proposed approach, indicating its suitability for real-time autonomous applications.

**Keywords:** *Radar–LiDAR Fusion, CNN–LSTM, Early Fusion, Object Detection, Autonomous Systems, Sensor Fusion.*

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## Track 2: Autonomous Vehicles and Smart Machine

Seq: 35 | ID: 1571248373

### Evaluating the Robustness of Deep Q-Network Variants Against Visual Perception Errors in Traffic Signal Control

E.C. Sulistiawan, I.S. Edbert, D. Fitriannah | Bina Nusantara University

Deep Reinforcement Learning, specifically Deep Q-Network (DQN), has become a popular method for traffic light control. However, most current models assume perfect information of the current state, ignoring sensory noise caused by real-world environmental factors like fog. This research examines how robust DRL agents are against inaccuracies in computer vision due to changing visibility conditions. We test different architectures and training modifications and compare them with the baseline of a fixed-time-based system. We utilize a physically grounded atmospheric fog to simulate visual degradation in a foggy scenario with 5 different seeds for each scenario. The result of the experiment is that the DQN model is performing better (with around ~20s average delay) than a fixed-time based system (with around ~90s average delay). The Dueling and N-Step also proved to be able to further improve the efficiency and stability.

**Keywords:** Reinforcement Learning, Deep Q-Network, Dueling Deep Q-Network, N-Step Deep Q-Network. Traffic Light Signal, Sim2Real, Computer Vision, YOLO, Object Detection

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Seq: 43 | ID: 1571250496

### Design of a Conveyor-Based Material Handling System for Extruder-to-Molding Transfer in Roof Tile Manufacturing

Y. N. D. Yekti, S. Canny, B. A. Ramadhan, K. N. Ismail, A. Mardatillasya, K. N. Dantika | Telkom University

Traditional roof tile factories in developing countries still rely on manual material handling, particularly for transferring clay material from the extruder to the molding machine, resulting in high physical workload, increased risk of musculoskeletal disorders, and inefficient material flow. This study designs a conveyor system as Material Handling Equipment (MHE) to improve transfer efficiency and reduce operator workload. The study employs field observations, Systematic Handling Analysis (SHA), ergonomic analysis based on anthropometric data, and discrete-event simulation. In addition, the proposed system introduces a conceptual integration with sensor-based monitoring and IoT technology, representing a semi-automated mechatronic material handling system. The system incorporates load and proximity sensors, a microcontroller or PLC-based control unit, and the potential integration with an IoT communication layer to enable real-time data acquisition and monitoring. Simulation results show that the proposed system achieves a production output of 2,824 tiles per day, exceeding the target of 2,200 tiles by 28.4%. Ergonomic evaluation indicates reduced posture risk, while economic analysis shows a payback period of 3.66 years, ROI of 27.3%, positive NPV, and BCR greater than one. These results confirm that the proposed system is

efficient, ergonomically beneficial, economically feasible, and supports the transition toward Industry 4.0.

**Keywords:** material handling system; conveyor system; roof tile manufacturing; Systematic Handling Analysis; ergonomics

Seq: 120 | ID: 1571271452

### A Comparative Study of Classical Lane Detection Methods in Straight and Curved Road Conditions

I.M. Erwin<sup>1</sup>, D.R. Prajitno<sup>1,2</sup>, E. Suryawati<sup>1</sup> | <sup>1</sup>National Research and Innovation Agency (BRIN); <sup>2</sup>Universiti Teknologi Malaysia

Lane detection is a central feature of autonomous driving systems and advanced driver assistance systems (ADAS). Although various classical algorithms such as edge detection, Hough transform, and region-based methods are still widely used, a clear evaluation of the trade-off between detection accuracy and computational time under different road conditions is still needed. This study aims to compare two classical lane detection methods, namely StraightLD and CurveLD, to assess their performance differences in terms of detection accuracy and computational time, especially for straight lanes (StraightLD) and lanes for various road conditions (CurveLD). The first method uses color filtering, edge detection, Hough transform, and linear equations to detect straight lanes. The second method uses perspective mapping, histogram, sliding windows, and curve fitting to detect lanes under more varied road conditions. Experimental results indicate that StraightLD attains an average accuracy of 99.01% with a computational time of 16.5 milliseconds per frame, whereas CurveLD achieves an accuracy of approximately 98.95% with a computational time of 104.7 milliseconds per frame. These findings demonstrate that simple classical methods are still relevant for real-time implementations, although further development is needed to handle roads with extreme curves and more dynamic environments

**Keywords:** classical lane detection, straight road, curved road, real-time, computational time, accuracy.

Seq: 126 | ID: 1571271747

### Experimental Evaluation of Reused Battery-Based Hybrid Energy Storage System Under Transient Load Conditions

Y. F. Rohman, M. B. Ashlah, C. Y. Tu, R. A. Sobhita, W. Y. Sean | National Chung Hsing University, Taiwan

The electrification of agricultural machinery introduces challenges for energy storage systems operating under dynamic and transient load conditions. Conventional battery-only systems are required to repeatedly supply high peak currents, leading to voltage instability and accelerated degradation, particularly in reused lithium-ion batteries. To address this issue, this study proposes a hybrid energy storage system (HESS) integrating a reused lithium-ion battery with an ultracapacitor module. A rule-based real-time power management strategy is implemented to coordinate power sharing based on load demand. The system is

experimentally validated under controlled and real-world conditions. The results show that the hybrid configuration effectively reduces peak battery current and improves voltage stability during transient operation. These findings demonstrate that the proposed HESS provides a practical solution for enhancing the performance and reliability of second-life batteries in dynamic applications.

**Keywords:** Hybrid energy storage system; Second-life battery; Ultracapacitor; Real-time power management

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Seq: 129 | ID: 1571271976

### Road Type Prediction System Using Machine Learning Method Based on Voltage and Current Data of Steering DC Motor

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<sup>1</sup>Indonesia University of Education; <sup>2</sup>National Research and Innovation Agency (BRIN)

Accurate road surface detection is crucial for driving safety. Since visual sensors struggle in poor conditions, this study proposes a non-visual approach using DC steering motor voltage and current data. Real-time data from a micro electric vehicle (MEVi) underwent statistical feature extraction. Two labeling schemes were evaluated: road type only, and road type combined with steering direction. SVM, KNN, and GBDT models were tested using K-Fold cross-validation and unseen data. Results reveal that increased label complexity negatively impacts performance. While KNN and GBDT demonstrated robust generalization with F1-scores ranging from 0.998 to 1.000, SVM suffered severe overfitting, with its F1-score dropping to 0.706 on the more complex combined-label dataset. This contrast highlights SVM's sensitivity to parameter tuning in multi-class tabular data, whereas KNN and GBDT effectively captured the non-linear relationships. Ultimately, these findings confirm that steering electrical signals offer a reliable, weather resilient alternative for road classification in Advanced Driver Assistance Systems (ADAS) and autonomous vehicles.

**Keywords:** Road Type Prediction, Supervised Learning, Steering DC Motor, Support Vector Machine, K-Nearest Neighbors, Gradient Boosting Decision Tree

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Seq: 155 | ID: 1571272779

### A SegFormer-Based Semantic Segmentation Approach for Autonomous Driving Decision Making Using Stereo Vision

M. S. Gianti<sup>1</sup>, M. R. Subiyanto<sup>1</sup>, D. Zakaria<sup>1</sup>, N. Hasanah<sup>2</sup>, M. Pratama<sup>2</sup>, B. Wahono<sup>2</sup>, T. I. Salim<sup>2</sup>, M. R. Wahid<sup>3</sup> | <sup>1</sup>Indonesia University of Education; <sup>2</sup>National Research and Innovation Agency (BRIN); <sup>3</sup>Institut Teknologi Bandung

Accurate environmental perception remains a major challenge in autonomous driving systems, particularly in object detection and distance estimation for decision making. While LiDAR sensors offer high accuracy, they come with high implementation costs, and bounding box-based object detection frequently results in inaccurate object localization. This study proposes an autonomous driving decision-making system based on semantic segmentation using the SegFormer-Bo model and stereo vision. A ZED 2i stereo camera is utilized to obtain

depth information for the distance estimation of detected objects. The proposed system integrates semantic segmentation and a decision making algorithm to determine vehicle movement based on environmental perception. The results show that the proposed system achieves 96.75% accuracy in detecting vehicles within an 8-meter range. Additionally, the system is capable of adapting to vehicle speed and making driving decisions in real time. These results demonstrate that the proposed approach provides an effective and cost-efficient solution for autonomous driving perception and decision-making systems.

**Keywords:** *Autonomous Driving, Semantic Segmentation, SegFormer-Bo, ZED 2i, Depth Estimation*

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**Seq: 158 | ID: 1571272909**

### **Design of a PID-Based Steering Controller for Autonomous Vehicles Using an Improved Swerve Drive**

*F. Muhammad, B.Y. Suprpto, S. Dwijayanti, O. D. Laksono, A. H. Novera, O. Bimantara | Sriwijaya University*

This study proposes a steering control system for autonomous electric vehicles (AEVs) based on a simplified swerve drive mechanism and a PID control strategy. Unlike conventional swerve systems that rely on complex gear configurations, the proposed mechanical design reduces structural complexity while maintaining omnidirectional mobility. A kinematic model is developed to map vehicle velocity commands into individual wheel steering angles and speeds. To enhance steering precision, a closed-loop PID controller is implemented and evaluated under multiple driving scenarios, including straight-line tracking, 90° turning, parallel parking, and dynamic obstacle avoidance. Controller parameters are initially obtained using Ziegler–Nichols and MATLAB autotuning, followed by refinement through experimental optimization. Experimental results on a prototype platform demonstrate improved tracking performance, achieving a trajectory deviation below 3-6% and positioning accuracy within  $\pm 0.5^\circ$ . Compared with baseline tuning methods, the proposed approach achieves a faster settling time and reduced oscillation under nonlinear conditions. The findings indicate that integrating a simplified swerve mechanism with optimized PID control offers a practical and efficient solution for high maneuverability autonomous vehicles.

**Keywords:** *Autonomous Electric Vehicle, PID, Improved Swerve Drive, Steering Control, Trial and Error*

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**Seq: 162 | ID: 1571272939**

### **Performance Analysis of Ultracapacitor in Stabilizing Boost Converter, Buck Converter and Sepic Converter Output Voltage During Voltage Sag**

*M. L. Izzulhaq, M. Facta, I. Setiawan | Diponegoro University*

This research was conducted to examine the performance of boost converters, buck converters, and SEPIC converters under voltage sag conditions. These three power electronic converters share the same characteristic of maintaining the output voltage polarity, making

them widely applied in modern multi-converter systems. The research methodology includes designing a system integrated with an ultracapacitor as backup energy storage and implementing voltage sag regulation at the voltage source. The ultracapacitor significantly reduces the severity of voltage sag and recovery transients compared to conventional methods. Under voltage sag conditions with step-down (buck) operation, the ultracapacitor acts as an active buffer that effectively compensates for extreme disturbances, maintaining the output voltage at 5.04 V. Meanwhile, under voltage sag conditions with step-up (boost) operation, the voltage drop is greater than that of the step-up (SEPIC) operation, with a difference of 0.0363 V. During the converter operation experiment, an overshoot of 0.5 V above the output voltage occurred after the voltage sag event. A possible solution to mitigate the overshoot is to implement an appropriate control system in the converter circuit.

**Keywords:** *boost converter, buck converter, sepic converter, voltage sag*

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**Seq: 164 | ID: 1571272949**

### **Unstructured Road Segmentation Using Vision-Based Edge Detection**

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<sup>1</sup>National Research and Innovation Agency (BRIN); <sup>2</sup>Universiti Teknologi Malaysia

Based on the presence of lane markings and environmental structure, roads can generally be categorized into structured and unstructured roads. Although many previous studies have focused on structured-road detection, research on unstructured roads remains relatively limited. This paper presents a computer vision-based edge detection approach for segmenting road areas in unstructured road environments. The proposed method adapts the structured-road lane detection workflow introduced by Udacity to identify edge features in unstructured roads. Dual edge detection is applied on both road and non-road segments to reduce the number of non-road segments. The experimental results demonstrate that edge detection can be used for unstructured road segmentation and that dual edge detection effectively reduces segments originating from non-road objects. Two edge detection methods, namely the Sobel and morphological transform methods, were also evaluated. Both methods achieved comparable performance; however, the morphological transform method produced more consistent results across all evaluation metrics.

**Keywords:** *unstructured road, lane detection, edge detection, morphological transformation, curve fitting*

Seq: 168 | ID: 1571274045

**Speed Control of a Small-Scale Car for Developing Autonomous Driving Algorithms for Forward and Reverse Parking**

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<sup>2</sup>Indonesia University of Education

Autonomous miniaturized vehicles (AMVs) provide a safe and cost-effective platform for validating autonomous driving algorithms, particularly for low-speed parking maneuvers that require precise forward and reverse velocity control. However, practical nonlinear effects such as slack zones, mechanical delays, and asymmetric transient responses are rarely quantified experimentally. This paper presents the design and implementation of a local velocity control system using a digital proportional-integral (PI) controller combined with a rule-based strategy on a rear-wheel-drive AMV. Experimental evaluations using stationary-forward-stationary and stationary-reverse-stationary profiles reveal significant nonlinear behavior. A forward slack zone of 1495–1547 pulse-width modulation (PWM) value produces a mechanical response delay of 36.40 s, while a reverse slack zone of 1522–1494 PWM value yields a 20.30 s delay. The accelerating and decelerating response times are also direction-dependent, measuring 52.60 s and 28.34 s in forward motion, and 59.36 s and 65.42 s in reverse motion, respectively. These results demonstrate strong asymmetry and hysteresis in the longitudinal dynamics that must be considered in autonomous parking controller design. The proposed experimental characterization provides practical insight for robust low-speed autonomous vehicle control development.

**Keywords:** *autonomous parking, autonomous vehicles (AVs), forward–reverse asymmetry, proportional-integral (PI) control, pulse-width modulation (PWM) motor drive, slack zone, velocity control*

Seq: 222 | ID: 1571278201

**Text-Based Traffic Sign Recognition in ADAS Based on Adaptive Image Preprocessing**

C. F. Suardi, I. Nurtanio | Hasanuddin University

Text recognition on traffic signs is essential for Advanced Driver Assistance Systems (ADAS), as it is necessary for the vehicle to understand the information provided on road traffic signs automatically. However, long-distance detection of text-based traffic signs is challenging due to the limited resolution of the detected region of interest (ROI). Although images may be captured using a high-resolution dashcam, distant traffic signs often produce small ROIs after detection and cropping, resulting in low-resolution text regions that degrade Optical Character Recognition (OCR) performance. This paper proposes an adaptive image preprocessing approach to improve OCR robustness for low-resolution text-based traffic signs. The proposed algorithm makes use of Adaptive Lanczos Interpolation and Nonlinear Unsharp Masking to improve character visibility before applying the OCR stage. Lanczos Interpolation is applied adaptively based on the ROI size to increase resolution. Nonlinear Unsharp Masking will improve the sharpness of edges and text structure. Experimental

results show that the proposed approach improves character level accuracy from 88.64% to 92.39% and word level accuracy from 65.88% to 70.46%.

**Keywords:** ADAS, Text-Based Traffic Sign Recognition, Adaptive Image Preprocessing, OCR, Lanczos Interpolation, Nonlinear Unsharp Masking.

Seq: 250 | ID: 1571278640

### Autonomous Braking System on Micro Electric Autonomous Vehicle Using Fuzzy Logic Control Tsukamoto and Mamdani Inference

C. S. Pangdefan<sup>1</sup>, T. I. Salim<sup>2</sup>, H. R. Ali<sup>1</sup>, B. Wahono<sup>2</sup>, A. Waskito<sup>2</sup>, Y. Putrasari<sup>2</sup>, M. K. A. Wardana<sup>2</sup>, A. Tjolleng<sup>3</sup> | <sup>1</sup>Gadjah Mada University; <sup>2</sup>National Research and Innovation Agency (BRIN); <sup>3</sup>Bina Nusantara University

The increasing integration of automation in transportation systems has heightened the need for intelligent safety mechanisms, particularly in urban environments where traffic accidents are prevalent. This study focuses on the design and implementation of an Autonomous Braking System for Micro Electric Autonomous Vehicles (MEVi) using Fuzzy Logic Control (FLC) with Tsukamoto and Mamdani inference methods. The system utilizes real-time inputs from LiDAR sensors and rotary encoders to detect obstacles and vehicle speed, respectively, and employs an electric rod actuator to apply braking pressure. A comparative analysis of the Tsukamoto and Mamdani methods is conducted, evaluating performance metrics such as target brake tracking, final distance to obstacle, and braking smoothness. Results indicate that the Mamdani method achieves shorter final obstacle distances—1,152.3m compared to 1,368.8m, suggesting more efficient braking, while both methods exhibit comparable tracking errors. Mamdani also have more smooth braking than Tsukamoto shown by the absolute differential of velocity—0.05264 for Tsukamoto and 0.03971 for Mamdani. This study highlights the potential of fuzzy logic control in enhancing MEVi safety and provides insights for future improvements in autonomous braking technology.

**Keywords:** brake control, fuzzy logic, Tsukamoto inference, Mamdani inference, autonomous vehicle, micro electric autonomous vehicle

Seq: 252 | ID: 1571278659

### Comparative Analysis of PID and Fuzzy Logic Controller Performance for Steering Control in Micro Electric Autonomous Vehicle

N. B. Chang<sup>1</sup>, H. R. Ali<sup>1</sup>, T. I. Salim<sup>2</sup>, B. Wahono<sup>2</sup>, Y. H. Siregar<sup>2</sup>, Suherman<sup>2</sup>, I. Abdurahman<sup>2</sup>, A. Tjolleng<sup>3</sup> | <sup>1</sup>Gadjah Mada University; <sup>2</sup>National Research and Innovation Agency (BRIN); <sup>3</sup>Bina Nusantara University

Autonomous vehicles rely on precise steering control for navigation, obstacle avoidance, and path tracking. This study compares PID and Fuzzy controllers under varying conditions, including different speeds and obstacle configurations on micro electric autonomous vehicles. The findings provide insights into selecting optimal control strategies for autonomous micro-vehicle steering systems. This paper focuses on steering control in autonomous vehicles, a critical component that determines how autonomous vehicles

interpret sensor data, avoid obstacles, and follow desired paths. Provided the comparison for each control system in minimizing error and settling time. PID exhibited more stable performance across different time instances with 2 – 12 cm difference in 0.75 m/s and 1.5 m/s. However Fuzzy logic controller has the superior overall performance particularly its effectiveness at 0.75 m/s with only 5 – 20 cm error.

**Keywords:** *autonomous micro electric vehicles, steering control, PID controller, Fuzzy logic controller, path tracking*

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**Seq:** 253 | **ID:** 1571278664

### **Bird's-Eye View Semantic Segmentation for Autonomous Driving via Limited Multi-Modal Sensor Fusion**

M. A. R. Baskoro<sup>1</sup>, T. I. Salim<sup>2</sup>, H. R. Ali<sup>1</sup>, B. Wahono<sup>2</sup>, A. Praptijanto<sup>2</sup>, R. I. Pramana<sup>2</sup>, M. Furqon<sup>2</sup>, A. Tjolleng<sup>3</sup> | <sup>1</sup>Gadjah Mada University; <sup>2</sup>National Research and Innovation Agency (BRIN); <sup>3</sup>Bina Nusantara University

Bird's-Eye View (BEV) semantic segmentation is vital for autonomous navigation but often requires extensive sensor suites unsuitable for cost-constrained platforms. This study investigates BEV segmentation viability on a Micro Electric Autonomous Vehicle (MEVi) equipped with only a single front camera and a single top-mounted LiDAR. A multi-modal fusion approach is proposed, utilizing EfficientNetV2-S and SECOND-based backbones for camera and LiDAR feature extraction, respectively. These features are integrated using a cross-attention mechanism where camera features query LiDAR features to leverage semantic richness and spatial precision. Evaluated on an adapted nuScenes dataset subset, the model achieves a 49.4% mean Intersection over Union (mIoU) on the validation set, comparable to a 6-camera baseline (LSS) but below richer fusion methods (BEVFusion). While demonstrating strong performance identifying drivable areas (82.7% IoU), significant challenges persist in segmenting thin structures like lane/road dividers (23-34% IoU). The results indicate the potential for minimalist sensor fusion to enable crucial perception tasks like navigable space detection on resource-constrained vehicles, though further work is needed to improve fine-grained segmentation and generalization.

**Keywords:** *Autonomous Driving, Bird's-Eye View (BEV), Semantic Segmentation, Sensor Fusion, Multi-Modal Fusion, Cross-Attention, Deep Learning*

Seq: 292 | ID: 1571291053

### **Model Predictive Control for Vehicle Speed Based on LiDAR Sensor Data for Autonomous Vehicle Systems**

M. R. Wahid<sup>1</sup>, A. T. Ismahani<sup>1</sup>, T.I. Salim<sup>3</sup>, M. Tongroon<sup>2</sup>, D. Zakaria<sup>1</sup>, Z. Arifa<sup>1</sup>, A. Nur<sup>3</sup>, M. K. A. Wardana<sup>3</sup> | <sup>1</sup>Indonesia University of Education; <sup>2</sup>Kasetsart University, Thailand; <sup>3</sup>National Research and Innovation Agency (BRIN)

The development of autonomous vehicle systems necessitates a robust speed control mechanism to ensure safe, efficient, and smooth transportation. The key novelty lies in integrating MPC with LiDAR sensor data for object detection (distance and angle up to 4 meters), allowing the system to autonomously regulate speed by changing the motor voltage. Data collection for the sensor and motor speed was performed using a Robot Operating System (ROS)-based system, followed by a pre-processing phase including data adjustment, selection, and normalization (Min-Max Scaler). It is important to note that the MPC controller is validated through simulation using experimentally collected data. The simulation results show that the MPC speed ( $v_{\text{mpc\_sim}}$ ) remains stable and aligns well with the reference speed, achieving a root mean square error (RMSE) of 0.23 m/s and a settling time of approximately 3.2 seconds.

**Keywords:** *Autonomous Vehicle, Model Predictive Control, Speed Planning, LiDAR Sensor, Real-Time Control.*

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## Track 3: Dynamics, Control, and System Modeling

Seq: 64 | ID: 1571260143

### Modeling of the Longitudinal Dynamic Braking System for a High-Speed Train

P. Paryanto<sup>1</sup>, A. B. Adriathma<sup>1</sup>, M. S. Harjono<sup>2</sup> | <sup>1</sup>Diponegoro University;

<sup>2</sup>National Research and Innovation Agency (BRIN)

The safety of high-speed train operation strongly depends on the reliability and accuracy of its braking system. This paper presents a longitudinal dynamic model of a high-speed train braking system developed in MATLAB/Simulink to optimize braking performance prior to manufacturing. A combined regenerative and electro-pneumatic braking strategy is investigated for a three-car train operating on a straight track. Regenerative braking with a force of 95.46 kN decelerates the train from 220 km/h to 90 km/h within 67 s over a distance of 3.1 km, with a response time of 5 s and an energy recovery of 286,333 kJ. Electro-pneumatic braking is subsequently applied to stop the train from 90 km/h, using a braking force of 296.4 kN, a response time of 15 s, and a braking duration of 6 s over 305 m. Simulation results confirm the effectiveness of the proposed braking strategy and provide quantitative guidance for improving braking system reliability and design optimization.

**Keywords:** *Digital model, high-speed train, control system, braking system*

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Seq: 66 | ID: 1571261111

### Prediction and Control of Limit Cycle Oscillation in Nonlinear System

F. A. Al-Farabi, M. Nasirudin, Z. Abidin | Institut Teknologi Bandung

One of the major challenges in control systems is dealing with nonlinear elements. Nonlinearities can cause a phenomenon known as limit cycle oscillation, which may lead to degraded performance or even system instability. The existence of limit cycle oscillations can be predicted using the describing function method. In this study, the describing function method successfully predicted the occurrence and parameters of limit cycle oscillations in a nonlinear system, with an error of less than 2% compared with the simulation results. Furthermore, these oscillations can be suppressed using appropriate control techniques. The controllers implemented in this study include conventional PID-based controllers, a modified PID controller, and a Model Reference Adaptive Control (MRAC) system. Among these controllers, four were able to suppress the limit cycle oscillations, namely the PD, PID, modified PID, and MRAC controllers. The modified PID controller with a back-calculation anti-windup mechanism demonstrated the best overall performance in terms of overshoot, rise time, and settling time. These results indicate that the modified PID controller provides an effective solution for suppressing limit cycle oscillations in nonlinear systems.

**Keywords:** *nonlinear element, limit cycle oscillation, describing function, PID controller, MRAC*

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Seq: 122 | ID: 1571271678

**Dynamics Aware Intelligent Control for a Post Stroke Hand Rehabilitation Device Using sEMG and IMU Sensing**A. Winata<sup>1</sup>, A. S. Nugraha<sup>2</sup>, A. A. Zamzami<sup>1</sup>, S. Utomo<sup>2</sup>, R. J. Prameswari<sup>1</sup>, M. I. Devi<sup>2</sup> |<sup>1</sup>Airlangga University; <sup>2</sup>National Research and Innovation Agency (BRIN)

This research examines the design and first development phases of a smart hand therapy apparatus for stroke sufferers. It examines the movement of the wrist and the corresponding musculature. The primary actuator in this system is a Dynamixel MX-28AT servo, which enables wrist flexion, extension, and radial-ulnar deviation. A 6-degree-of-freedom inertial measurement unit (IMU) and surface electromyography (sEMG) serve as the principal sensing devices. The sEMG sensor tracks the activity of the flexor carpi radialis (FCR) muscle, chosen for its significance in the forearm, while the IMU assesses three-dimensional acceleration and angular velocity to determine wrist positioning during rehabilitation exercises. An architecture employing two microcontrollers is established: an ESP32 for real-time data acquisition and preprocessing, and an Arduino Uno for actuator control, required due to the Arduino Uno's limitation of single serial transmission. In the pre-research phase, sensing and actuation processes were assessed by examining signal quality at various electrode sites and wrist movements, including flexion, extension, radial deviation, ulnar deviation, and rest. The precise alignment of electrodes with muscle orientation significantly reduced noise in sEMG recordings without requiring filtering, and the duration after hand 76tilizing application had no considerable effect on signal quality. IMU measurements proficiently distinguish between flexion, extension, and radial-ulnar deviation trajectories through accelerometer and gyroscope data. The compiled temporal sEMG-IMU dataset is intended to train an upcoming multi-head Long Short-Term Memory (LSTM) model for classifying joint motions and predicting required assistive force. The results indicate that a dynamic sensor and actuation system may provide intelligent, 76tilizing76 upper-limb rehabilitation.

**Keywords:** *stroke rehabilitation, sEMG, IMU, sensor fusion, wearable robotics*

Seq: 125 | ID: 1571271720

**Dynamics of Soil Fertility and Intelligent Irrigation Control in a Portable IoT-Based Smart Farming System**R. J. Prameswari<sup>1</sup>, S. Utomo<sup>2</sup>, A. A. Zamzami<sup>1</sup>, A. S. Nugraha<sup>2</sup>, A. Winata<sup>1</sup>, M. I. Devi<sup>2</sup> |<sup>1</sup>Airlangga University; <sup>2</sup>National Research and Innovation Agency (BRIN)

Conventional agricultural practices often face challenges with water efficiency and real-time soil health assessment, both of which are critical for sustained crop cultivation. This study aims to develop a portable, intelligent irrigation and monitoring system leveraging the Internet of Things (IoT) to improve water efficiency and maintain soil fertility. The system 76tilizin an Arduino Uno for sensor data gathering and processing, while an ESP32 serves as the primary controller overseeing IoT communication, data processing, and real-time output on an OLED display. It 76tilizin a multi-sensor array to assess soil factors — including moisture, temperature, pH, and NPK levels — with environmental parameters such as ambient

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temperature and humidity (SHT3x) and light intensity (BH1750). To enhance automation, two Long Short-Term Memory (LSTM) models are employed: one for classifying soil fertility situations. Preliminary results from the pre-research phase, 77tilizing clay soil samples, suggest that calibrated digital sensors produce measurements that are generally consistent with traditional analogue and semi-digital reference instruments; however, variations in probe depth were observed to influence moisture status readings. Field testing in open terrain validated that the moisture sensor accurately detects water absorption via soil strata. Comprehensive systprecisoem integration and additional calibration are essential to enhance overall accuracy prior to full deployment.

**Keywords:** *smart farming, precision agriculture, irrigation system, monitoring system, IoT*

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Seq: 128 | ID: 1571271901

### **Velocity-Aware Control Barrier Function for Dynamic Obstacle Avoidance in Manipulators Using Kalman-Estimated Obstacle Velocity**

*M.J. Rumi, G. Herrmann, O.F. Argin | University of Manchester, United Kingdom*

Safe operation of robot manipulators in dynamic environments requires real-time obstacle avoidance that accounts for obstacle motion. Control Barrier Functions (CBFs) provide a formal safety guarantee for static obstacles, but position-only CBF formulations neglect obstacle velocity in the barrier time derivative, leading to constraint violations when an obstacle approaches the end-effector. This paper proposes a time-varying CBF (TV-CBF) for a UR5 manipulator that incorporates Kalman-estimated obstacle velocity directly into the quadratic programming (QP) constraint, accounting for the uncontrolled term that degrades position-only CBF performance under moving obstacles. A practical safety degradation bound is derived, showing that under bounded estimation errors the guaranteed safe set degrades from the nominal set to an enlarged set whose size depends on estimation accuracy and CBF gain. Simulations in ROS2 and Gazebo demonstrate that the position-only CBF produces larger safety violations under approaching obstacles than the proposed TV-CBF, increasing the minimum robot-obstacle distance by 0.011–0.033m (5.9–21.0%) across the tested obstacle speeds. The observed minimum true barrier value remains above the practical bound across three values of the Kalman filter measurement-noise tuning parameter.

**Keywords:** *control barrier functions, robot safety, obstacle avoidance, Kalman filter, manipulator control, quadratic programming*

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Seq: 135 | ID: 1571272074

### Physics-Based Scaling and Nonlinear Maximum Power Point Tracking Control Strategy Performance Analysis of a Vertical-Axis Wind Turbine

E. N. Irawan<sup>1,3</sup>, K. Shibuya<sup>1</sup>, M. Miyagawa<sup>1</sup>, H. Ishikawa<sup>1</sup>, D. I. H. Putri<sup>3</sup>, K. I. Yamashita<sup>2</sup>, G. Fujita<sup>1</sup> |  
<sup>1</sup>Shibaura Institute of Technology, Japan; <sup>2</sup>Meisei University, Japan;  
<sup>3</sup>Indonesia University of Education

This study proposes a physics-based scaling and nonlinear maximum power point tracking framework for a vertical-axis wind turbine by integrating aerodynamic similarity analysis with dynamic control design. A laboratory scale Darrieus prototype using the NREL S809 airfoil was used as the reference model, and its aerodynamic characteristics were scaled to a medium-scale wind energy conversion system with a rated power of 3000 W at a wind speed of 12 m/s. The system dynamics were modeled in Simulink to capture the coupled aerodynamic, mechanical, and electrical behavior of the turbine-generator system under transient operating conditions. Based on this model, a perturb and observe maximum power point tracking algorithm was implemented. The results show that the baseline system exhibits strongly nonlinear transient behavior. After applying maximum power point tracking, the electrical power output consistently increased across all investigated wind speeds, with steady-state improvements becoming more pronounced at higher wind speeds and reaching up to 15 % under rated conditions. Under variable wind speed operation, the proposed control strategy also maintained superior power extraction and achieved an average power gain of approximately 10.6% during active generation intervals, demonstrating its effectiveness and robustness for medium-scale vertical-axis wind turbine applications.

**Keywords:** *Darrieus, maximum power point tracking, perturb and observe, vertical-axis wind turbine.*

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Seq: 146 | ID: 1571272458

### Robust Control of a Floating-Based Two-DoF Manipulator Under Wave-Induced Disturbances

M. L. Ramadiansyah<sup>1</sup>, S. A. K. Ghazali<sup>2</sup>, E. Yazid<sup>1</sup>, B. Heryadi<sup>2</sup>, Z. Abidin<sup>2</sup> |  
<sup>1</sup>National Research and Innovation Agency (BRIN); <sup>2</sup>Institut Teknologi Bandung

The study of control strategies for robotic arms has mainly focused on ground-based analysis. This paper proposes a model-based robust controller for position control of a two-degree-of-freedom (DoF) manipulator mounted on a ship under ocean wave excitation. The six-DoF ship motion, acting as the disturbance, is generated from numerical hydrodynamic response under random wave conditions. Azimuth and elevation controllers are developed based on Model Reference Adaptive Control (MRAC), while the Lagrange-Euler method dynamic model is used to derive the integrated ship-manipulator system. Position control is applied within a multibody dynamics framework and evaluated by comparing MRAC and Linear Quadratic Regulator (LQR) controllers, which were optimized using Particle Swarm Optimization (PSO) algorithm.

Furthermore, to address system uncertainties, a robust control approach based on H-infinity theory is proposed, referred to as Robust MRAC (RMRAC). The result shows that RMRAC

achieves the lowest error compared to LQR and MRAC with a Root Mean Square Error (RMSE) of  $0.279^\circ$  in azimuth and  $0.070^\circ$  in elevation under ship motion disturbances. RMRAC also effectively handles structured uncertainties in the manipulator links, whereas LQR and MRAC became unstable. The proposed controller is applicable to both ground-based and non-ground-based manipulator systems.

**Keywords:** *robust control, adaptive control, floating-based manipulator, multibody dynamics, wave-induced disturbance.*

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**Seq: 160 | ID: 1571272923**

### **Modeling and Approach-to-Equilibrium-Based Performance Evaluation of an Industrial High Temperature Shift Reactor Under Catalyst Deactivation**

G. R. S. Rande, M. M. Azis, S. Purwono | *Gadjah Mada University*

The performance of High Temperature Shift (HTS) reactors is strongly influenced by catalyst activity, which may deteriorate abruptly under abnormal operating conditions. This study presents a mathematical modeling and performance evaluation of an industrial HTS reactor using the Approach to Equilibrium (ATE) as a key performance indicator under catalyst deactivation. A steady-state reactor model based on mass and energy balances and reaction kinetics was applied to 612 industrial data points collected over nearly two years. The dataset includes fresh catalyst conditions, a sudden deactivation event, and operation under partially deactivated conditions. Significant catalyst deactivation occurred due to a process upset in which the natural gas supply to the secondary reformer was interrupted, allowing excess air to enter the HTS reactor and oxidize the iron-based catalyst. During fresh catalyst operation, ATE approached zero, indicating near-equilibrium performance. After the upset, ATE increased significantly, accompanied by reduced CO conversion. Increasing HTS inlet temperature partially restored performance by improving conversion and reducing ATE. The results confirm that ATE is an effective indicator for evaluating HTS reactor performance and assessing the impact of catalyst deactivation and operational adjustments.

**Keywords:** *High Temperature Shift, Approach to Equilibrium, Catalyst Deactivation, Process Modeling, Industrial Data*

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**Seq: 198 | ID: 1571277107**

### **Mitigating Load Intermittency for BESS Integration: A Novel Hybrid Harmony Search-Fuzzy Forecasting Approach in a Jakarta Commercial Office Building**

I. G. N. A. M. Wijaya, M. A. Sidqi | *PLN Institute of Technology*

Accurate load forecasting is essential to mitigate load intermittency and enable the efficient integration of Battery Energy Storage Systems (BESS) in commercial office buildings. However, conventional statistical methods like Autoregressive Integrated Moving Average (ARIMA) and machine learning approaches such as Long Short-Term Memory (LSTM) often suffer from limited predictive accuracy and high computational costs when processing dynamic building loads. This work evaluates a novel hybrid Harmony Search-Fuzzy Inference

System (HS-FIS) forecasting approach using actual operational data from a commercial office building in Jakarta. Empirical assessments validate the effectiveness of the proposed framework, which demonstrates superior accuracy by reducing Mean Absolute Error (MAE) by 51% and 61% against the LSTM and ARIMA baselines, respectively, while successfully mapping 93% of the load variance. By suppressing peak prediction errors by 88%, the model mathematically eliminates the risk of BESS over-provisioning. In terms of computational efficiency, the HS-FIS approach achieves a 20% reduction in structural complexity relative to deep learning networks. Consequently, this computational efficiency renders the proposed architecture highly suitable for localized edge implementations, particularly where high-performance computing resources are restricted.

**Keywords:** *short-term load forecasting, harmony search, fuzzy inference system, BESS optimization, commercial building energy*

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**Seq: 203 | ID: 1571277493**

### **Design and Implementation of a PID-Based Automated Fan-Mist Control System for Thermal Comfort in Open-Space Restaurants**

R. Muhida<sup>1</sup>, A. Legowo<sup>2</sup>, M. Riza<sup>3</sup>, A. Djajadi<sup>4</sup>, A. Cucus<sup>3</sup>, R. Muhida<sup>3</sup>, E. Y. T. Adesta<sup>3</sup>, H. Murwad<sup>3</sup>, T. Thamrin<sup>3</sup> | <sup>1</sup>Universitas Putra Indonesia YPTK;

<sup>2</sup>Higher Colleges of Technology, United Arab Emirates;

<sup>3</sup>Bandar Lampung University; <sup>4</sup>Universitas Multimedia Nusantara

Maintaining thermal comfort in open-space environments is challenging due to dynamic variations in temperature and humidity influenced by external disturbances. This paper presents the design and implementation of a PID-based automated fan-mist control system for regulating environmental conditions in open-space restaurants. The system integrates temperature and humidity sensors, a microcontroller-based control unit, and a custom-built fan-mist actuator to achieve real-time closed-loop control. The PID controller is implemented to regulate airflow and mist generation based on environmental feedback. Experimental results demonstrate that the system successfully maintains target conditions of 26°C and 56% relative humidity under varying ambient conditions. Sensor calibration results show measurement errors below 3%, ensuring reliable input for control. The system exhibits stable performance with minimal oscillation, achieving a settling time of approximately 120 minutes and a steady-state error below 3%. The relationship between fan speed and temperature reduction shows nonlinear behavior, indicating the importance of airflow optimization. In addition, the Heat Index (HI) is used to evaluate thermal comfort, where the system reduces HI from approximately 49°C to 27°C, indicating significant improvement in perceived comfort. The results confirm that the proposed system provides an effective, energy-efficient, and practical solution for thermal comfort control in open environments.

**Keywords:** *PID control, thermal comfort, misting system, temperature control, humidity control, evaporative cooling, embedded systems, PWM, open-space restaurant.*

Seq: 215 | ID: 1571278086

### Evaluation of Ride Comfort Decoupled Modal PID-Based Skyhook Control Design Model for Active Suspension of Railway Vehicles Under Payload and Track Irregularities

L. A. Widyasto, P. Darwito | Institut Teknologi Sepuluh Nopember

The ride comfort of passengers under stochastic track irregularities and payload uncertainties is a major challenge to manage in the dynamics of railway vehicles. The presented study investigates the ride comfort of an 8-DOF vertical railway vehicle model with an active suspension system. Since passive damping is the main limitation to the control of stationary passenger vehicles in such cases, a PID-Based Skyhook control strategy is implemented. This controller combines the absolute-velocity damping philosophy in the Skyhook reference model with the tracking feature of a Decoupled Modal PID controller. The performance of the system is assessed using the ISO 2631-1 RMS acceleration index on the ORE B176 stochastic track profile, running at a fixed speed of 30 m/s and with extreme payload characteristics from tare weight (AWo) to crush load (AW4). The results corroborate that the PID-Based Skyhook approach is an efficient and stable solution to improve railway ride comfort under different operating conditions.

**Keywords:** Active Suspension, Railway Vehicle, PID Control, Skyhook Philosophy, Ride Comfort, ISO 2631-1, Payload Variation.

Seq: 248 | ID: 1571278614

### Experimental Study on Feedback vs. Feedback-Feedforward Control for Hydrogen Flow and Pressure in Open-Cathode PEMFCs

A. Fahruzi<sup>1</sup>, K. Indriawati<sup>1</sup>, M. Syaini<sup>2</sup> | <sup>1</sup>Institut Teknologi Sepuluh Nopember;

<sup>2</sup>Politeknik Perkapalan Negeri Surabaya

This paper presents an experimental study comparing two control schemes for managing hydrogen supply in an open-cathode proton exchange membrane fuel cell (OCPEMFC): (1) a conventional feedback (PID) controller acting on anode inlet pressure, and (2) a hybrid feedforward–feedback (FFPID) scheme in which a feedforward term, proportional to stack current demand, prescribes hydrogen supply flow rate and a PID loop corrects residual pressure error. Experiments were conducted on a lab-scale OCPEMFC stack under load constant and various. The steady-state error of the inlet pressure, ripple coefficient, and hydrogen efficiency were recorded as performance indicators. The results indicate that the performance of FFPID control is superior to PID control, particularly under high loads. In constant load tests at 5A, 10A, and 15A, FFPID control was able to reduce the steady-state error of the hydrogen supply pressure with an average value of 5.9%. Regarding the ripple coefficient, FFPID also significantly improved the stability of the hydrogen supply pressure and flow rate, reducing their ripple coefficients by an average of 29% and 159.7%, respectively. Furthermore, under various loads, FFPID also reduced the steady-state error and ripple coefficient of the hydrogen supply pressure by 2.2% and 47.6% respectively.

**Keywords:** Open-Cathode PEMFC, flow rate, pressure, feedback-feedforward, supply hydrogen

Seq: 251 | ID: 1571278645

**Biomechanical Sensitivity Evaluation of Dynamic Suspension Systems Under Stochastic Road Profiles Using ISO 8608 and ISO 2631 Frameworks**N. Adyono<sup>1</sup>, S. Kaleg<sup>2</sup>, W. D. Lestari<sup>1</sup>, M. D. P. Lamura<sup>1</sup>, R. Ruviana<sup>1</sup>, A. N. Izzah<sup>1</sup> |<sup>1</sup>Universitas Pembangunan Nasional Veteran Jawa Timur;<sup>2</sup>National Research and Innovation Agency (BRIN)

This study investigates the performance of an active suspension system based on a quarter-car model under stochastic road excitation defined by ISO 8608. The road profile is modeled as a spatial power spectral density process representing Class E conditions, and transformed into the time domain for dynamic simulation. A PID controller is implemented, and its parameters are systematically varied using a design of experiments approach to evaluate control performance. System behavior is analyzed through a multi-domain framework, including time-domain response, frequency-domain characteristics, spectral energy distribution, and biomechanical evaluation based on ISO 2631. The results show that passive suspension exhibits significant resonance in the low-frequency range (0.5–2 Hz), which coincides with the most sensitive band of human vibration perception. Variant 7 is the optimum configuration that achieves substantial reductions in both displacement and acceleration, with RMS acceleration decreased from 0.257 m/s<sup>2</sup> (passive) to 0.058 m/s<sup>2</sup>, corresponding to a 77.29% improvement. This reduction places the system within the comfortable category according to ISO 2631. The findings demonstrate that suspension performance is governed by its ability to suppress vibration energy within human sensitive frequency ranges. Therefore, effective suspension design should be approached as a frequency-shaping problem to achieve both mechanical performance and ride comfort.

**Keywords:** Active suspension, quarter-car model, PID control, stochastic road profile, ISO 8608, ISO 2631, ride comfort, vibration control, frequency-domain analysis, power spectral density (PSD), biomechanical response, motion sickness.

Seq: 255 | ID: 1571278672

**Python-Based Gait Cycle Algorithm Design for Ankle Kinematics Analysis as a Basis for Preliminary Bionic Ankle Design**W. D. Lestari<sup>1</sup>, N. Adyono<sup>1</sup>, E. Maulana<sup>2</sup>, D. B. Darmadi<sup>2</sup>, R. Bintarto<sup>2</sup>, M. D. P. Lamura<sup>1</sup> |<sup>1</sup>UPN Veteran Jawa Timur; <sup>2</sup>Brawijaya University

Bionic ankle design requires representative ankle-angle references so that motion range, phase timing, and control targets can be defined from biomechanical evidence. This study presents a Python-based gait cycle algorithm for sagittal-plane ankle kinematics analysis as a basis for preliminary bionic ankle design. Ankle-angle data from five healthy young adults were processed through low-pass filtering, gait-cycle segmentation, 0–100% phase normalization, waveform visualization, and extraction of key kinematic parameters. Peak dorsiflexion ranged from 12.1° to 15.2°, peak plantarflexion from -19.5° to -23.1°, total range of motion from 33.0° to 38.3°, and push-off timing from 50% to 54% of the gait cycle. The results show that the algorithm produced stable and comparable ankle-angle profiles across subjects

while preserving inter-subject variation. These findings indicate that the proposed workflow can generate interpretable ankle kinematic references for early-stage mechanism sizing, trajectory definition, and control-logic formulation in bionic ankle development.

**Keywords:** *gait cycle, Python, ankle kinematics, bionic ankle, biomechanics, assistive mechatronics.*

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## Track 4: Intelligent Instrumentation and Embedded Systems

Seq: 59 | ID: 1571258612

### Real-Time Polyphonic Digital Talempong Using Piezoelectric Sensing and GPIO-Based Strike Detection

R. Aisuwarya, M. F. Fikri | Andalas University

This paper presents the design and implementation of an 8-note digital talempong system using piezoelectric strike sensors and a Raspberry Pi platform with GPIO-based event detection. The prototype emulates the traditional Talempong Duduak layout and produces sound through sample-based WAV playback. To enable reliable real-time interaction, a strike detection framework is developed that combines multi-sensor scanning with debounce filtering and per-sensor refractory timing to suppress residual vibration-induced re-triggering. Performance evaluation is conducted using simulation-assisted analysis and hardware-based measurements. The system achieves a precision of 0.782 for strike detection, indicating high sensitivity with manageable false triggering. End-to-end latency from strike detection to playback invocation shows a mean of 15.08 ms, remaining within perceptually acceptable limits for percussive performance. Multi-hit experiments further confirm stable polyphonic playback without detection loss or timing distortion. These results demonstrate the feasibility of a low-cost embedded approach for digitizing traditional percussion instruments while preserving responsiveness and playability.

**Keywords:** *digital musical instrument, digital talempong, piezoelectric sensor, Raspberry Pi, strike detection, polyphonic interaction*

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Seq: 80 | ID: 1571265322

### Experimental Performance Analysis of a 10 Wp Polycrystalline PV Module with Flat Mirror Reflector and Thermoelectric Cooling System

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The performance of photovoltaic (PV) modules is strongly influenced by solar irradiance and operating temperature, particularly in tropical regions where high temperatures can significantly reduce electrical efficiency. This study proposes a hybrid enhancement method by integrating a flat mirror reflector and a thermoelectric cooler (TEC) controlled by an Arduino-based temperature control system to improve the performance of a 10 Wp polycrystalline PV module. Two configurations were experimentally evaluated: a conventional PV module and a modified module equipped with both a reflector and TEC cooling system. Measurements were conducted for 10 days from 09:00 to 16:00 to analyze voltage, current, output power, efficiency, and panel surface temperature. The results show that the enhanced system achieved higher electrical performance, producing a maximum voltage of 12.86 V and current of 0.504 A compared to 11.983 V and 0.448 A for the conventional system. In addition, the proposed configuration increased the maximum output power from 5.36 W to 6.48 W and improved efficiency from 5.97% to 7.15%. These results demonstrate that combining reflective

concentration and Arduino-controlled thermoelectric cooling effectively enhances PV performance in tropical environments.

**Keywords:** Photovoltaic module, thermoelectric cooler, solar energy, reflector, cooling system

**Seq: 86 | ID: 1571266720**

### Smart Monitoring and Machine Learning Based Approaches for Preventing Fraud in Subsidized Fuel Distribution Systems

L. S. L. Suci, A. E. U. Salam, F. A. Samman | Hasanuddin University

This research presents an anomaly analysis of subsidized fuel transaction logs using the Isolation Forest algorithm within the framework of a proposed Internet of Things (IoT)-based monitoring system. The analyzed dataset consists of 40 transaction records collected between January 8, 2026, and January 30, 2026. Three features were utilized in the detection process: flow rate (mL/min), transaction volume (liters), and transaction time. Using 200 isolation trees with a contamination parameter of 5%, the model successfully identified two anomalous transactions. The most prominent anomaly occurred on January 16, 2026, characterized by relatively low flow rates of 2398 mL/min and 3596 mL/min, accompanied by reduced transaction volumes of 19.381 liters and 19.627 liters. These methods is positioned as a preliminary feasibility study and prototype demonstration under real field constraints. The dataset size is limited due to early-stage deployment in a remote archipelagic region.

**Keywords:** isolation forest, IoT, monitoring, anomaly, fuel

**Seq: 99 | ID: 1571269718**

### GestPLC: Real-Time Hand Gesture Recognition for PLC Control Using MediaPipe and Modbus TCP for Industry 4.0 Applications

R. C. Prayogo, A. Istiqomah, M. Hersaputri, A. R. H. Tahier, L. Mohammad, L. Y. Roodhiyah | Diponegoro University

Shared control panels on production lines create contamination risks in food-grade and cleanroom environments. We built GestPLC to test whether a regular USB webcam paired with a geometric rule-based classifier is capable of controlling a Schneider Modicon M221 PLC without a GPU or a trained neural network. MediaPipe extracts 21 hand landmarks per frame on an Intel Core i7 CPU; The corner threshold engine then converts these landmarks into Modbus TCP coil write commands via the FC15. Camera capture, gesture classification, and Modbus I/O each run on their own Python thread so slow network replies don't stop the vision loop. At 300 lux illumination, the classifier achieved a macro F1 score of 95.4% and an average Modbus round-trip of 12.3 ms. The 24-hour endurance test recorded 872,640 transactions with a write success rate of 99.97%, although the mean time between communication failures was only 8.2 hours. Landmark geometry, not deep learning, proved adequate for six-gesture PLC control on commodity hardware.

**Keywords:** Hand Gesture Recognition, PLC Control, MediaPipe, Modbus TCP, Industry 4.0, Threading.

Seq: 108 | ID: 1571270606

### An Integrated Smart anti-Flooding System: Design, Control, and Educational Simulation for Sustainable Urban Resilience

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Flooding is a major environmental challenge that causes significant infrastructure damage and threatens human safety, particularly in urban areas. This paper presents an Integrated Smart Anti-Flooding System (SAFS) that combines real-time sensing, embedded control, renewable energy, and simulation-based learning within a unified framework. The system employs water level and ultrasonic sensors, while a microcontroller processes real-time data to regulate pump and valve operations using Pulse Width Modulation (PWM). It operates autonomously under three predefined conditions—normal, warning, and danger—based on specific water level thresholds. A laboratory-scale prototype was developed and experimentally tested, demonstrating stable operation with a response time of 1.2–1.8 seconds and sensor accuracy within  $\pm 1.5$  cm. The integration of photovoltaic (PV) panels and a water turbine enhances system sustainability and resilience during power outages. In addition, filtering techniques and sensor redundancy improve reliability under disturbed conditions. A simulation platform is also incorporated to support system analysis and experiential learning. The results indicate that the proposed SAFS provides an effective, scalable, and sustainable solution for flood mitigation while offering added value for engineering education.

**Keywords:** Smart Anti-Flooding System; Flood Management; Embedded Control System; Pulse Width Modulation (PWM); Renewable Energy; Photovoltaic (PV); Mechatronics; Simulation-Based Learning; Smart City; Urban Resilience.

Seq: 132 | ID: 1571272005

### Impact of Rotational Motion on RSSI in Wireless IoT Communication: Experimental Comparison of Bluetooth, Wi-Fi and LoRa

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This study investigates the effect of rotational motion on the Received Signal Strength Indicator (RSSI) of three wireless communication technologies: Bluetooth, Wi-Fi, and LoRa. An experimental platform was developed using a Raspberry Pi Zero 2 W mounted on a rotating car wheel to emulate rotating IoT devices in mechatronic systems. Experiments were conducted at rotational speeds ranging from 10 km/h to 70 km/h, generating a total of 2,100 RSSI samples. The results show that Bluetooth maintains relatively stable RSSI values, ranging from -29.34 dBm to -23.83 dBm. Wi-Fi exhibits moderate degradation, with RSSI values decreasing from -38.91 dBm to -42.65 dBm. In contrast, LoRa demonstrates significant signal deterioration, with RSSI dropping from -68.63 dBm at 10 km/h to -89.06 dBm at 70 km/h. Spearman correlation analysis indicates a very strong negative correlation for LoRa ( $r = -0.96$ ,  $p = 0.0004$ ), while Bluetooth ( $r = 0.75$ ) and Wi-Fi ( $r = -0.75$ ) show moderate but statistically

insignificant relationships. These findings highlight the impact of rotational dynamics on wireless communication performance and provide insights for designing reliable wireless sensing systems in rotating IoT and mechatronic application

**Keywords:** *IoT communication, RSSI, rotational motion, LoRa, Wireless sensor systems.*

**Seq: 140 | ID: 1571272257**

### **Experimental Evaluation of VLAN-Based Network Slicing for Industrial Communication in SDN-Enabled Mechatronic Networks**

*H. S. Tabayun, M. T. Kurniawan, R. A. Fauzan, E. A. Fansyah, D. S. Thamrin | Telkom University*

Software Defined Networking (SDN) offers programmable and centralized network control that is increasingly relevant to industrial communication in mechatronic and cyber-physical systems, where controllers, sensors, actuators, and monitoring services share the same infrastructure but require logical isolation. However, lightweight segmentation methods for small- to medium-scale industrial environments are still needed, especially when low complexity and ease of deployment are prioritized. This study proposes and experimentally evaluates a VLAN-based network slicing approach using OpenFlow and Open vSwitch in Mininet to emulate a shared industrial communication network with logically separated traffic domains. The proposed mechanism applies VLAN tagging and controller-based flow rules to isolate communication between slices representing independent industrial workcells or service classes. Performance evaluation is conducted using ping and iperf to measure intra-slice connectivity, inter-slice isolation, latency, and throughput. The results show reliable intra-slice communication with zero packet loss and average round-trip time (RTT) below 1 ms under stable conditions, while inter-slice traffic is fully blocked. These results indicate that the proposed approach can provide a low-complexity baseline for SDN-enabled industrial communication and networked control scenarios, particularly for laboratory-scale mechatronic systems, IoT testbeds, and resource-constrained smart manufacturing environments.

**Keywords:** *Software Defined Networking, VLAN-Based Network Slicing, Industrial Communication, Networked Control, Mechatronic Systems, Mininet, Open vSwitch*

**Seq: 190 | ID: 1571276909**

### **Charging System with Cell Balancing Feature on Picobot Ankle-Foot Orthosis Robot Using CC-CV Method with Battery Temperature Consideration**

*A. Subayu, D. Adiputra, I. Hafidz | Telkom University*

Stroke rehabilitation often utilizes Ankle-Foot Orthosis (AFO) robots, which require reliable lithium polymer (Li-Po) battery power systems. However, fast charging multi-cell Li-Po batteries present thermal and voltage imbalance risks. This research proposes a fast-charging system for 6S Li-Po batteries that utilizes a buck converter and the Constant Current–Constant Voltage (CC–CV) method. The system integrates a PID-based current controller, a temperature-based current-limiting strategy, and a passive cell-balancing mechanism.

Controller design was verified via MATLAB/Simulink and validated through hardware experiments. Results indicate the PID controller stably maintains a 1–5 A charging current with an average steady-state error below 1.5%. At a constant current of 5 A, the system fully charged a 6S Li-Po battery to 4.00 V/cell in an average of 12.35 minutes ( $741 \pm 46.5$  s). The thermal protection successfully halted charging when temperatures exceeded 45 °C, ensuring safety. Furthermore, the passive balancing mechanism effectively reduced per-cell voltage discrepancies with a measurement error of 1.01–3.59%. This work contributes to a practical, safe, and efficient multi-cell charging solution specifically tailored for AFO rehabilitation robots.

**Keywords:** CC–CV, Fast charging, PID control, passive cell balancing, temperature-based current limiting.

**Seq: 230 | ID: 1571278416**

### **A Lightweight Heterogeneous Data Framing Protocol for Real-Time Image and Sensor Transmission in Drone-Based Mobile IoT Systems**

I. Mirda<sup>1</sup>, F. A. Fawwaddin<sup>1</sup>, N. A. Nathaniel<sup>1</sup>, R. Sarno<sup>1</sup>, A. Afriani<sup>2</sup>, K. R. Sungkono<sup>1</sup>, A. F. Septiyanto<sup>1</sup>, T. C. Amri<sup>1</sup>, S. S. Lee<sup>3</sup> | <sup>1</sup>Institut Teknologi Sepuluh Nopember; <sup>2</sup>Indonesian Oil Palm Research Institute; <sup>3</sup>Tottori University, Japan

The integration of Unmanned Aerial Vehicle (UAV) with Internet of Things (IoT) sensor networks has emerged as a promising approach for real-time water quality monitoring. This generates multimodal data comprising sensor telemetry and visual imagery. However, selecting an appropriate communication protocol significantly impacts system performance under UAV operational constraints, including limited bandwidth, constrained resources, and dynamic mobility over cellular networks. This study develops a comprehensive testbed evaluating five protocols, namely HTTP, MQTT, CoAP, WebSocket, and a proposed lightweight heterogeneous data framing protocol, on a drone-based IoT sensing platform over 4G LTE networks. The proposed protocol employs raw binary transfer for imagery to eliminate encoding overhead, a fixed nine-byte header for deterministic parsing, and TCP\_NODELAY for latency minimization. Results demonstrate the proposed protocol achieves the lowest average latency of 575.68 ms compared to 1310.99 ms for HTTP and 9638.58 ms for CoAP, lowest jitter of 398.22 ms, and highest packet delivery ratio of 99.78 percent. Multi-Criteria Decision Making analysis using SAW, TOPSIS, and VIKOR under three weighting scenarios confirms the proposed protocol as the best overall alternative, winning eight of nine evaluations. These findings provide practical guidelines for deploying UAV-IoT communication systems in environment monitoring applications, particularly for water quality assessment.

**Keywords:** communication protocol, environment, IoT, UAV, water quality.

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Seq: 234 | ID: 1571278460

### Design of an Automated Water Treatment System (WTP) for YAP Tank (Bak YAP) Based on Programmable Logic Controllers (PLCs)

L. Y. Roodhiyah, A. B. Putranto, I. S. Hutapea, N. D. Ramadhani | Diponegoro University

The Water Treatment Plant (WTP) plays a vital role in supplying clean water for both internal use and surrounding communities. One of its key units, the Bak YAP, is responsible for essential processes such as filtration, coagulation, flocculation, and sedimentation. However, in many WTPs, control systems are still operated manually, requiring direct coordination between operators to manage centrifugal pumps, chemical dosing, and valve operations. This manual approach often leads to inefficiencies, including delayed valve closure, excessive water usage, and inconsistent chemical dosing. To address these challenges, automation is required to improve system performance and reliability. Previous studies have demonstrated that programmable logic controllers (PLCs) are effective in optimizing water treatment operations, particularly at system inlets. This research presents the design and simulation of an automated control system for the Bak YAP unit using PLC integrated with Supervisory Control and Data Acquisition (SCADA). The system automates valve operation, pump control, and chemical mixing based on real-time data obtained from water level sensors, Total Dissolved Solids (TDS) measurements, and flow meters. The results indicate that the proposed system enhances operational efficiency, reduces resource waste, and enables real-time monitoring, thereby improving overall system effectiveness.

**Keywords:** PLCs, Water Treatment Plant, SCADA, Bak YAP, Automation.

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Seq: 239 | ID: 1571278516

### Real-Time IoT Water Table Monitoring in Peatlands for Acacia Plantation Water Management

M. Rahmawaty, D. Ricky | Politeknik Caltex Riau

Riau Province contains extensive peatland areas that are highly vulnerable to forest fires, particularly during the dry season, due to land clearing activities. Monitoring peat water table levels is crucial for maintaining soil moisture and reducing fire risk. However, existing systems often face limitations in remote areas due to unreliable power sources and communication networks. This study proposes an Internet of Things (IoT)-based water table monitoring system that uses LoRa for long-range, low-power data transmission. The system is powered by solar energy to enable continuous operation in off-grid environments. It is implemented in Industrial Plantation Forest (HTI) in Siak. The proposed system provides real-time monitoring to support early decision-making for peatland fire prevention.

**Keywords:** peatland, forest fire, water table level, data communication, IoT.

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Seq: 263 | ID: 1571281971

### Design and Implementation of an IoT-Based Smart Electrical Monitoring and Control System Using the SDLC Approach

A. A. Zhafira, A. F. Athaya, F. G. Rusli, A. R. Amira, A. M. I. T. Al-Ayyubi, A. F. M. Mulki |

*The state of Madrasah Aliyah 2 Makassar*

The increasing demand for electrical energy in residential and small-scale environments requires efficient monitoring and control systems to reduce energy waste and improve operational efficiency. This paper presents the design and implementation of an IoT-based smart sensing–actuation platform for electrical monitoring and remote load control developed using the System Development Life Cycle (SDLC) approach. The proposed system integrates an ESP32 microcontroller, a PZEM-004T energy sensor, a 4-channel relay module, Firebase cloud storage, and a mobile application for real-time monitoring and remote load control. The system measures key electrical parameters, including voltage, current, power, frequency, and energy consumption, while enabling remote ON/OFF switching of connected loads. Experimental validation was conducted under resistive, inductive, capacitive, and combined load conditions. The results show that voltage and frequency measurements remained stable, while current and power measurements exhibited acceptable deviations under varying load characteristics. In addition, the system achieved an average response time of approximately 1–2 s with a data update interval of about 1 s, indicating near real-time performance. These results demonstrate that the proposed SDLC-based smart sensing–actuation platform is feasible for supervisory electrical monitoring and remote load control in residential and smallscale smart energy applications.

**Keywords:** *IoT, electrical energy monitoring, ESP32, remote load control, SDLC.*

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Seq: 269 | ID: 1571283014

### Design and Evaluation of an Embedded Smart Stethoscope for Heart and Respiratory Sound Monitoring

N. N. A. Murtiadi, Salwa, A. F. P. Firman, C. R. P. Aulia, Z. Z. Hamzah, Erniwati |

*The state of Madrasah Aliyah 2 Makassar*

This study presents the design and evaluation of an embedded smart stethoscope for preliminary heart and respiratory sound monitoring. Conventional acoustic stethoscopes are widely used for auscultation but remain limited by subjective interpretation, lack of signal visualization, and limited support for digital monitoring. The proposed system integrates a MAX9814 acoustic sensor, an ESP32 microcontroller, signal conditioning, embedded signal processing, an OLED display, and a monitoring interface. Physiological sounds captured from the chest surface are converted into digital signals and visualized in real time to support preliminary digital auscultation. Experimental evaluation was conducted by comparing measurements from the proposed smart stethoscope with those from a conventional stethoscope across twenty subjects. Mean Absolute Percentage Error (MAPE) was used as the primary numerical error metric. The system achieved a MAPE of 1.99%, indicating close preliminary agreement with the conventional method at the prototype stage. These results

suggest the feasibility of the proposed system as a low-cost portable platform for cardiorespiratory sound monitoring.

**Keywords:** *embedded system, smart stethoscope, ESP32, MAX9814, digital auscultation, MAPE.*

**Seq: 274 | ID: 1571283947**

### **Online Continual Learning-Based Intrusion Detection in Industrial Control Networks**

*I. D. P. Manurung, R. Harwahu | Universitas Indonesia*

Digital transformation has rendered critical infrastructure and its supporting industrial control systems increasingly complex through the integration of advanced communication and computing capabilities. Consequently, Operational Technology (OT) networks have become progressively converged with Information Technology (IT) networks. While this integration significantly enhances process management and automation, it simultaneously increases the exposure of industrial control components to a diverse array of cyber threats. To address these emerging security challenges, the ability to identify specific threat vectors constitutes a primary defensive measure. Machine Learning-based Intrusion Detection Systems (IDS) offer high efficacy in detecting cyber threats, including novel attack patterns. This research addresses these challenges by implementing Online Continual Learning methods within industrial control networks. The proposed IDS is designed with a multi-layer architecture to maintain data confidentiality of industrial control processes. This study demonstrate that localized IDS models can achieve high reliability without compromising data privacy by exchanging telemetry data to central servers.

**Keywords:** *Intrusion Detection, Cybersecurity, Industrial control system, Online Continual Learning, Resilient Infrastructure, Privacy-preserving Security.*

**Seq: 275 | ID: 1571284056**

### **Mitigating Man-in-the-Middle Attack: A Rapid-Response Framework Using Optimized Random Forest Classifiers in Cyber-Physical Systems (Work in Progress)**

*A. Hermansyah<sup>1</sup>, D. Stiawan<sup>1</sup>, A. Heryanto<sup>1</sup>, D. Rosiyad<sup>2</sup>, M. R. Febrian<sup>1</sup>, R. Budiarto<sup>3</sup> |*

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*<sup>3</sup>Al-Baha University, Saudi Arabia*

The growing incorporation of Internet of Things (IoT) devices within Cyber-Physical Systems (CPS) has broadened the attack surface, especially with covert Man-in-the-Middle (MITM) attacks. This work presents a machine learning-driven Intrusion Response System (IRS) for real-time detection of Man-in-the-Middle (MITM) attacks and automated mitigation through passive traffic tapping, feature extraction by CICFlowMeter, Random Forest classification, and firewall-based response strategies. Experimental results indicate that the suggested system attains 87% accuracy, 100% precision, 83% recall, 91% F1-score, and an AUC of 0.959, demonstrating robust detection capability. The assessment of response time further validates the feasibility of real-time operation, with inference functioning within sub-millisecond to

millisecond intervals. The results illustrate the efficacy of the proposed IRS in enhancing CPS security via adaptive and automated mitigation of MITM attacks.

**Keywords:** MITM Attack, IRS, ML, Random Forest, IoT, CPS

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## Track 5: Biomechatronic and Smart Assistive Systems

Seq: 2 | ID: 1571208005

### Comparison of SynRM Rotors for a Rehabilitation Exoskeleton Robot

B. Azhari<sup>1,2</sup>, F. D. Wijaya<sup>2</sup>, E. Firmansyah<sup>2</sup>, E. Yazid<sup>1</sup>, M. L. Ramadiansyah<sup>1</sup>, M. F. Hikmawan<sup>1</sup> |  
<sup>1</sup>National Research and Innovation Agency (BRIN); <sup>2</sup>Gadjah Mada University

As the number of stroke cases rises, multiple rehabilitation robots have been proposed to assist the self-therapy for improving motor function after stroke-induced spasticities. An exoskeleton robot is considered the most promising device due to its practicality and portability. For the actuator component, SynRM has potential as a non-permanent magnet (PM) motor, providing a more secure option than PM-based motors in terms of supply chain and sustainability. With torque generation in SynRM heavily affected by the topology, shape, and dimensions of the rotor's flux barriers, several models have been proposed. In this paper, three barrier configurations are tested and compared: the existing rectangular and Joukowski models, as well as a proposed curve-shaped model. These rotors are installed within an initial small SynRM design. The results showed that under such design, the 3-barrier rectangular-shaped rotor resulted in the largest torque and minimum mass. It also results in the highest mechanical, although still far below the maximum allowable value. Further optimization, however, should consider the surface temperature limit, as it is already close to the limit.

**Keywords:** Curve rotor, Joukowski rotor, mass, rectangular rotor, SynRM, torque.

Seq: 24 | ID: 1571240293

### Hunger Games Search-Based ECG Feature Selection for Arrhythmia Classification

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<sup>1</sup>Bina Nusantara University; <sup>2</sup>STMIK Pelita Nusantara; <sup>3</sup>Universitas Jabal Ghafur;  
<sup>4</sup>Linnaeus University, Sweden; <sup>5</sup>Institut Teknologi Batam; <sup>6</sup>Universitas HKBP Nommensen

Feature selection plays a crucial role in improving the performance and efficiency of electrocardiogram (ECG)-based arrhythmia classification. High-dimensional feature spaces often contain redundant and irrelevant information, which can degrade classification accuracy and increase computational complexity. This study investigates the application of metaheuristic-based feature selection for ECG arrhythmia classification by comparing Hunger Games Search (HGS) with two well-established algorithms, Particle Swarm Optimization (PSO) and Grey Wolf Optimizer (GWO). The feature selection problem is formulated as a binary optimization task that jointly maximizes classification performance and minimizes the number of selected features. All algorithms are evaluated under a fair experimental framework using identical preprocessing, feature extraction, classifier, and evaluation protocols, with Support Vector Machine (SVM) employed as a fixed classifier. Experimental results show that PSO and GWO achieve the highest classification accuracy, while GWO maintains comparable performance with a smaller number of selected features, indicating higher selection efficiency. Although HGS yields lower classification performance under the

tested configuration, it produces relatively compact feature subsets, suggesting potential for further improvement through parameter tuning and alternative datasets. Overall, the results highlight the trade-off between classification accuracy and feature selection efficiency and demonstrate the importance of selecting appropriate optimization strategies for ECG-based arrhythmia classification.

**Keywords:** ECG signal processing, Feature selection, Hunger Games Search, Arrhythmia classification, Metaheuristic optimization.

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**Seq: 73 | ID: 1571263288**

### **Influence of Bicycle Geometry on Teenage Cycling Posture: A Sagittal Plane Biomechanical Study**

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<sup>1</sup>National Research and Innovation Agency (BRIN); <sup>2</sup>Center for Biomechanics, Biomaterial, Biomechatronics, and Biosignal processing (CBIOM3S); <sup>3</sup>PT Kaizen Tekno Kreatif;

<sup>4</sup>Universitas Negeri Yogyakarta; <sup>5</sup>Universitas Negeri Semarang

This manuscript examines the biomechanics of teenage cycling posture through the use of photographic analysis and computer-aided design (CAD) software. Images of participants were captured while riding different types of bicycles during four specific phases of the pedaling cycle. Joint angles were quantified by connecting anatomical landmarks from the neck to the ankle, including the upper extremities, using the sketch feature in SolidWorks. The measured joint angles were subsequently analyzed to identify variations among participants. The results indicate that, despite differences in angle magnitudes influenced by body height, individual conditions, and comfort factors, three participants exhibited similar joint-angle rhythm patterns across the cycling phases. These findings suggest consistent biomechanical movement patterns among teenage cyclists, with variability primarily attributed to anthropometric and subjective factors.

**Keywords:** bicycle, teenage, biomechanics, anthropometrics, SolidWorks

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**Seq: 97 | ID: 1571269438**

### **Real Time Hand Gesture Recognition Using Full 8-Channel sEMG from the Myo Armband with MAV-RMS Feature Fusion and Random Forest Classification**

B. Wahyudi<sup>1</sup>, R. Ismail<sup>1,2</sup>, M. Ariyanto<sup>1</sup>, N. Susanto<sup>1</sup> | <sup>1</sup>Diponegoro University;

<sup>2</sup>Center for Biomechanics, Biomaterial, Biomechatronics, and Biosignal processing (CBIOM3S)

Advancements in prosthetic control necessitate gesture recognition systems that balance accuracy with low latency. This study demonstrates that the Myo armband, leveraging its complete 8-channel sEMG array, serves as a robust platform for high-fidelity gesture recognition. We propose a streamlined pipeline fusing Mean Absolute Value (MAV) and Root Mean Square (RMS) features from all eight channels into a 16-dimensional vector, classified via Random Forest. Evaluated on 7,000 samples from ten participants across five body weight categories, the system achieves 96.64% cross-validated accuracy ( $\pm 0.72\%$  SD) with a weighted F1 score of 0.97. End-to-end latency averages 124 ms, below the 150 ms neuroergonomic

threshold for natural motor control. A custom PyQt5-based GUI unifies data acquisition, labeling, model retraining, and live prediction, enabling user-driven personalization without programming expertise. Misclassifications follow biomechanically plausible patterns, primarily mutual ambiguity between Finger and Tripod gestures, while functionally distinct pairs exhibit zero errors. The novelty lies in demonstrating that full utilization of an accessible 8-channel device achieves parity with research-grade systems, integrating a user-centered GUI for real-time iterative refinement, and validating robust preliminary generalization across anthropometric diversity.

**Keywords:** *EMG, Myo armband, 8-channel, gesture recognition, Random Forest*

Seq: 137 | ID: 1571272205

### UNETR-1D: A Hybrid Transformer-CNN Architecture for Non-Invasive Fetal ECG Extraction

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<sup>2</sup>National Research and Innovation Agency (BRIN)

Fetal distress that is caused by lack of oxygen is called intrauterine hypoxia and is still a serious concern in prenatal care. Cardiotocography (CTG) is a current instrument to detect that but potentially leads to unnecessary interventions, while integrating with fECG data increases diagnostic reliability. fECG data collection needs conventional methods that rely on invasive scalp electrodes. This study proposes a noninvasive fECG (NI-fECG) approach using UNETR-1D (1D UNet Transformer), a hybrid architecture designed to overcome morphological signal degradation caused by noise. By combining a Transformer encoder for global temporal dependencies with a CNN-based decoder for precise local reconstruction. Experiments on the ADFECGDB database using subject-wise cross-validation showed a mean Pearson Correlation Coefficient (PCC) of 0.828 and a Mean Squared Error (MSE) of 0.285. Furthermore, the model achieved 86.34% sensitivity in R-peak detection and a Positive Predictive Value (PPV) of 84.09%. These findings suggest that UNETR-1D could support the development of more reliable non-invasive fetal health monitoring systems.

**Keywords:** *Fetal distress, fetal electrocardiography, UNETR-1D*

Seq: 144 | ID: 1571272422

### Application of CNN Model for Early Detection of Tuberculosis in Chest X-Ray Images

N. A. Alvarezzi, S. I. Purnama, D. Zulherman | Telkom University

Tuberculosis (TB) remains a major health crisis that demands faster and more accessible diagnostic tools. While Chest X-Ray (CXR) is a standard screening method, its accuracy is often limited by the availability and subjective judgment of radiologists. This study evaluates a DenseNet121-based CNN for binary classification of TB using 4,784 local CXR images from a pulmonary hospital in Indonesia. We conducted five experiments to address common deep learning pitfalls, specifically overfitting and class imbalance. Our initial tests showed that training from scratch without regularization led to poor generalization. However, by integrating ImageNet transfer learning, a ReduceLRonPlateau scheduler, and class

weighting, we achieved a more reliable model with an AUC of 0.7778. Grad-CAM visualizations further confirm that the model identifies clinically relevant lung pathologies. These results suggest that with the right tuning, deep learning models can serve as effective diagnostic aids in resource constrained medical settings.

**Keywords:** Tuberculosis, Chest X-Ray, DenseNet121, Transfer Learning.

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**Seq: 156 | ID: 1571272854**

### **A Curve Fitting Approach for Asymmetric Chainring Design Based on Crank Torque Data**

*M. Syafiq, I. H. Wang, S. L. Chang | National Formosa University, Taiwan*

This study proposes a computational method for generating asymmetric chainring geometries based on crank torque data obtained during steady-state pedaling. The experimentally measured crank torque is aggregated over a 360° pedal cycle. Subsequently, a comprehensive torque distribution is constructed, and the mean pedaling torque is calculated. The resulting mean torque profile is then transformed into a polar representation. It is further converted into Cartesian coordinates to define the chainring boundary. To ensure an optimized and manufacturable geometry, a convex hull method is employed. The resulting boundary is subsequently scaled such that its perimeter matches the total pitch length required for a specified number of teeth. In addition, equally spaced pitch points are computed along the perimeter, corresponding to the number of chainring teeth used in the design. In this study, the Japanese Industrial Standard (JIS) U-type tooth profile is adopted. Finally, the results indicate that the generated asymmetric chainring geometry can potentially improve pedaling efficiency by reducing pedaling torque while increasing rear-wheel speed at the same pedaling cadence.

**Keywords:** Asymmetric Chainring Design, Crank Torque Analysis, Polar Representation, Convex Hull Optimization, Cycling Biomechanics, Pedaling Efficiency

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**Seq: 177 | ID: 1571275908**

### **Real-Time GUI and UDP Communication Framework for Dual Capacitive Smart Insole Gait Acquisition**

*A. S. Adli<sup>1</sup>, A. G. Risangtuni<sup>1</sup>, D. Adiputra<sup>2</sup>, Bahrudin<sup>3</sup>, K. H. Sanjaya<sup>3</sup>, A. Nugroho<sup>3</sup>, N. L. P. S. Diantari<sup>2</sup>, G. B. Randa<sup>3</sup>, F. Qathrunnada<sup>4</sup>, M. R. D. Anggara<sup>4</sup>, M. Dirayati<sup>4</sup> |*

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This paper presents the real-time acquisition and communication framework of a dual capacitive smart-insole system for gait measurement. Two ESP32-based wireless nodes and a Python GUI communicate over Wi-Fi UDP for tare calibration, synchronization, visualization, and CSV logging. Each insole provides eight multiplexed capacitive channels and two IMUs. The study asks whether this low-cost architecture can provide sufficiently stable timing despite very fast multiplexed capacitive readout, host-side polling jitter, and non-zero network latency. Evaluation on 90 left-foot and 90 right-foot CSV files from five subjects

shows a timing distribution composed of a stable nominal regime plus sparse long-interval disturbances. After steady-state filtering, the operating regime becomes tightly concentrated near the intended host polling behavior, indicating that the framework is sufficiently stable for research-grade smart-insole acquisition

**Keywords:** *Real-time data acquisition, UDP communication, capacitive insole, time synchronization, ESP32*

Seq: 181 | ID: 1571276580

### Noise-Aware Lightweight 1D CNN for Robust Inter-Patient ECG Beat Classification Under Controlled Noise Stress

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<sup>1</sup>Diponegoro University;

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<sup>3</sup>National Research and Innovation Agency (BRIN)

Automated ECG beat classification must generalize across patients, remain robust to signal corruption, and stay light enough for edge-oriented deployment. This study evaluates a noise-aware lightweight one-dimensional convolutional neural network for inter-patient arrhythmia classification on the MIT-BIH Arrhythmia Database using the standard de Chazal split and AAMI four-class grouping (N/S/V/F). Each target beat is represented by a triplet morphology window (previous, current, and next beat) combined with five RR-interval features. A patient-disjoint nested cross-validation scheme is used on DS1 for model selection, followed by final retraining on full DS1 and untouched testing on DS2. A clean baseline and a proposed noise-aware variant are compared using official MIT-BIH Noise Stress Test Database noise-only tracks under controlled signal-to-noise ratios from 24 to -6 dB. On the clean DS2 test, the proposed model improved macro-F1 from 0.650 to 0.713 and balanced accuracy from 0.648 to 0.708 while retaining a lightweight footprint of 76,337 parameters (~0.29 MB). Under mean noise stress, macro-F1 improved from 0.554 to 0.659, with especially large gains at 0 dB and -6 dB. The results indicate that noise-aware training can substantially improve robustness under a strict inter-patient protocol without sacrificing model compactness

**Keywords:** *ECG arrhythmia classification, inter-patient evaluation, noise-aware learning, lightweight 1D CNN, robustness, MIT-BIH*

Seq: 196 | ID: 1571277040

### Development of a Lie Detection System Based on Wearable Photoplethysmography Sensor and Heart Rate Variability Analysis Using Support Vector Machine

K. M. Mizoguchi, F. Samopa, I. A. Akbar, Y. S. Dharmawan |

Institut Teknologi Sepuluh Nopember

This paper presents a lie detection framework based on wearable photoplethysmography (PPG) and support vector machine classification to improve upon conventional polygraph approaches. Physiological data were collected from ten subjects across multiple experimental sessions, followed by PPG signal preprocessing and heart rate variability (HRV) feature

extraction. The extracted features span time-, frequency-, and nonlinear-domain HRV metrics derived from inter-beat interval signals, including Poincaré-based measures. Model evaluation employed leave-one-subject-out cross-validation with hyperparameter optimization via grid search under two settings: subject-specific and subject-independent. Subject-specific models achieved a mean accuracy of  $0.845 \pm 0.086$ , F1-score of  $0.862 \pm 0.090$ , and area under the curve (AUC) of  $0.831 \pm 0.099$ , while the subject-independent model achieved an accuracy of  $0.750 \pm 0.076$ , F1-score of  $0.758 \pm 0.092$ , and AUC of  $0.794 \pm 0.095$ . Predominant HRV features identified across evaluations include Normal-to-Normal (NN) intervals, the percentage of successive NN intervals exceeding 20 ms, low-frequency (LF) and high-frequency (HF) power, LF/HF ratio, and nonlinear Poincaré descriptors. These results indicate that the proposed framework captures discriminative autonomic patterns associated with deceptive conditions, though the performance gap between settings suggests that personalization strategies are necessary for improved generalization.

**Keywords:** *Lie Detection, Photoplethysmography, Support Vector Machine, Heart Rate Variability, Affective Computing*

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**Seq: 208 | ID: 1571277604**

### **Biomechanics Approach in User Experience: A Pilot Study Using Eye-Tracker on a Single-Participant Multi-Task E-Commerce Interaction**

Y. M. K. Sya'ban<sup>1</sup>, K. H. Sanjaya<sup>1</sup>, A. S. Adli<sup>2</sup>, Bahrudin<sup>1</sup>, N. S. Dewi<sup>1</sup>, M. Tajalli<sup>1</sup> |

<sup>1</sup>National Research and Innovation Agency (BRIN); <sup>2</sup>Institut Teknologi Bandung

This pilot study investigates user experience (UX) efficiency through eye-tracking metrics across multiple e-commerce interaction tasks. A single participant performed six purchase-related scenarios on Amazon.com and Rakuten.com platforms while ocular data—fixation count, blink rate, and pupil diameter—were recorded using the Pupil Labs Core eye tracker. The analysis focused on intra-individual variation across six tasks to evaluate visual attention, cognitive workload, and engagement. Results revealed that shorter task completion time and larger pupil dilation on Amazon.com indicated more efficient and focused interactions, whereas Rakuten.com induced higher blink rates and longer visual search durations, implying greater cognitive strain. Despite involving only one participant, this repeated-measure design demonstrates the potential of eye-tracking for detecting subtle usability differences between interfaces.

**Keywords:** *Eye tracking, User experience, Cognitive workload, Fixation, Blink rate, Pupil diameter, E-commerce usability.*

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**Seq: 231 | ID: 1571278435****Preliminary Study on the Development of a Wearable sEMG System for Muscle Activity Analysis During Elbow Flexion**

A. D. P. Pasaribu, W. D. Lestari | Universitas Pembangunan Nasional Veteran Jawa Timur

Assessing muscle activity during elbow flexion requires a signal acquisition system that is objective, portable, and cost-effective. This paper presents a preliminary study on the development of the OYSYNC wearable prototype, which integrates an OYmotion surface electromyography (sEMG) sensor, an ESP32-S3 Zero microcontroller, MicroSD storage, and a Blynk-based Internet of Things (IoT) interface for realtime muscle signal recording, processing, and visualization. The system was evaluated on 13 healthy subjects (aged 20–22 years) performing active elbow flexion-extension tasks under varying loads of 0, 2, 4, and 6 kg. sEMG signals from the biceps brachii and brachioradialis were processed into Root Mean Square (RMS) parameters and subsequently analyzed against load variations and subcutaneous fat thickness. The results demonstrate that the prototype consistently records muscle activation patterns, despite an empirical sampling frequency of 16–17 Hz due to hardware bottlenecks. Furthermore, subcutaneous fat thickness was identified to exert an exponential attenuation effect on pure sEMG amplitudes, which was modeled through the Constant Spasticity Load (CSL) parameter using an exponential model. The model exhibited high statistical significance ( $p$ -value of 0.001) and a strong coefficient of determination (0.7745). These findings suggest that OYSYNC serves as a viable preliminary platform for muscle activity analysis and sEMG-based quantitative model development. However, further validation in clinical populations is imperative before the system can be utilized for clinical spasticity interpretation.

**Keywords:** *wearable sEMG, muscle activity, elbow flexion, RMS, IoT, Constant Spasticity Load (CSL).*

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**Seq: 243 | ID: 1571278563****Development and Evaluation of a Posture Monitoring and Feedback System for Improving Posture Awareness and Reducing Sedentary Behavior**

A. N. D. Sabillena, L. Y. A. Villanueva, J. A. D. Allic, C. G. B. Bautista, A. M. Añonuevo, I. P. F. Eraga, J. T. Tenerife | Technological Institute of the Philippines, Philippines

Prolonged sitting and poor posture are common among students and desk-based workers, contributing to musculoskeletal discomfort, posture-related strain, and other sedentary-related health risks. This study presents the development and evaluation of a health-oriented posture monitoring and feedback system designed to increase posture awareness and reduce prolonged sedentary behavior. The system integrates a force-sensitive resistor and an infrared sensor to monitor posture and sitting duration continuously. Detected deviations in posture or extended sitting periods trigger non-intrusive light and sound cues via a desk lamp, providing real-time feedback to promote healthier habits. The system prioritizes usability, adaptability, and minimally intrusive intervention to encourage sustained behavioral change. A mixed-methods evaluation was conducted, including a survey of 116 respondents and five

interviews with industry experts to assess user preferences, technical feasibility, and potential health impacts. Data were analyzed using exploratory factor analysis and thematic analysis, guiding design refinements and validating adoption factors. Results demonstrate strong user interest in real-time feedback and reminders, supporting the system's

**Keywords:** posture monitoring system, embedded system, sensor-based feedback, preventive health monitoring, ergonomics

Seq: 272 | ID: 1571283296

### Carbon Nanotube-Dependent Electrical and Piezoresistive Performance of Hydrogel-Based Flexible Strain Sensors

A. H. Alifah<sup>1,2</sup>, F. Khoerunnisa<sup>1</sup>, N. Rohmah<sup>2</sup>, A. P. Kurnianta<sup>2,3</sup>, D. Nurcahyono<sup>2,4</sup>, A. A. Septevani<sup>2</sup> | <sup>1</sup>Indonesia University of Education; <sup>2</sup>National Research and Innovation Agency (BRIN); <sup>3</sup>Sumatera Institute of Technology; <sup>4</sup>Universitas Negeri Malang

Flexible and wearable strain sensors have gained increasing attention due to their conformal ability to irregular surfaces and accommodate mechanical deformation. This study investigates PVA hydrogels were synthesized via chemical crosslinking using borax with three different type of carbon nanotube (CNT) fillers with distinct properties namely two types of Multi Wall CNT (MWCNT) denoted as CNT<sub>1</sub>, CNT<sub>2</sub>, and Single Wall CNT (SWCNT) at a fixed PVA (MW 145 kDa) to evaluate their electrical conductivity, piezoresistive response, and surface hydrophilicity. The results showed that SWCNT exhibited the highest electrical conductivity ( $14.67 \times 10^{-2}$  S/m), then CNT<sub>2</sub> ( $4.62 \times 10^{-2}$  S/m) and CNT<sub>1</sub> ( $2.62 \times 10^{-2}$  S/m). SWCNT also demonstrated the highest piezoresistive sensitivity at every strain level, followed by CNT<sub>2</sub> and CNT<sub>1</sub>. Evaluation during finger bending tests revealed, SWCNT provided the highest sensitivity with a monotonic and consistent resistance response, while CNT<sub>2</sub> showed stable and moderate sensitivity compared to CNT<sub>1</sub>. All hydrogels maintained hydrophilic surfaces with SWCNT ( $\theta=27.22^\circ$ ), CNT<sub>2</sub> ( $\theta=29.81^\circ$ ), and CNT<sub>1</sub> ( $\theta=32.29^\circ$ ). In summary, SWCNT offering the best overall combination as superior electrical performance compared to MWCNT. Nevertheless, CNT<sub>2</sub> presents viable alternative providing a balance of electrical conductivity, piezoresistive sensitivity, signal stability, and potential scalability for flexible strain sensing applications.

**Keywords:** Hydrogels, polyvinyl alcohol, carbon nanotube, piezoresistive, flexible senso

**Seq: 278 | ID: 1571284834****Comparative Performance Analysis of Lightweight CNN Architectures for Multi-Class Ocular Disease Classification**R. Rachman<sup>1,2</sup>, E. S. Soegoto<sup>1</sup>, I. Afrianto<sup>1</sup>, I. D. Sumitra<sup>1</sup> | <sup>1</sup>Universitas Komputer Indonesia;<sup>2</sup>Universitas Ardhirajasa Reswara Sanjaya

The deployment of deep learning models for ocular disease screening in environments where resources are limited necessitates a balance between diagnostic accuracy and computational efficiency. The present study evaluates the performance of two lightweight Convolutional Neural Network (CNN) architectures, MobileNetV2 and ShuffleNetV2, in classifying ocular diseases using a four-class subset of the ODIR-2019 dataset. In contrast to conventional heavy architectures, these models are specifically optimised for implementation on mobile and edge devices. The research focuses on identifying which architecture maintains the highest predictive integrity under significant class imbalance, specifically for conditions such as glaucoma and diabetic retinopathy. The findings indicate that while ShuffleNetV2 offers superior inference speed, MobileNetV2 demonstrates higher robustness and consistency across minority disease classes. This comparative analysis provides a technical benchmark for selecting efficient models that do not compromise diagnostic reliability in remote clinical settings.

**Keywords:** *Ocular Disease Classification; MobileNetV2; ShuffleNetV2; Model Efficiency; Class Imbalance*

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## Track 6: Information Systems for Mechatronics

Seq: 3 | ID: 1571220161

### Design of Production Productivity Indicators Based on Overall Equipment Effectiveness (OEE)

D. Syamsi<sup>1</sup>, H. Fakhruroja<sup>1,2</sup>, O. Mahendra<sup>1</sup> | <sup>1</sup>National Research and Innovation Agency (BRIN); <sup>2</sup>Telkom University

Productivity measurement in manufacturing processes can be effectively conducted using the Overall Equipment Effectiveness (OEE) method, which provides valuable insights for improving operational efficiency and reducing resource waste. This study presents the design of a Human–Machine Interface (HMI)-based data analysis application for measuring production productivity. The system architecture consists of three main components: Data Generator, Data Collecting, and Data Processing, integrated through a Data Acquisition (DAQ) setup that captures production data digitally using a proximity sensor and CCTV on the production line. The software development process employs the Unified Modeling Language (UML) to model system requirements, use cases, activities, and interactions. Simulation results show that the designed HMI application accurately computes Availability, Performance, Quality, and overall OEE values based on the collected data. The findings indicate that this application model can serve as a foundation for developing productivity measurement systems in manufacturing environments, particularly those still relying on conventional machinery without digital capabilities.

**Keywords:** Overall Equipment Effectiveness, productivity, HMI, Data Acquisition, UML

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Seq: 13 | ID: 1571237365

### An Edge-to-Cloud Multimodal Monitoring System for Deception-Indicative Cues Using Physiological Sensors and MediaPipe-Based Facial Features

R. Z. Saleh, M. Lubis | Telkom University

An edge-to-cloud multimodal monitoring system is presented to integrate physiological telemetry and facial-behavior features for exploratory inspection of deception-indicative cues. An ESP32-based node streams heart rate and skin temperature to a WebSocket-enabled web dashboard for real-time visualization and timestamped logging, while MediaPipe-based facial analysis extracts landmark-derived indicators related to gaze deviation, eye activity, and facial tension. Timestamp synchronization and short-window aggregation are applied to align heterogeneous streams and produce session-level descriptors that are less sensitive to transient noise. Several lightweight baselines are evaluated, including physiology-only, vision-only, early fusion, late fusion, and a rule-based cue score that combines normalized signals through a bounded nonlinear function. Pilot sessions with three participants demonstrate end-to-end feasibility and yield analyzable logs across instructed truthful and deceptive segments. Vision-dominated baselines appear highly separable under the constrained protocol, yet cue variability across participants suggests that small-sample performance may reflect protocol effects rather than generalizable deception signals. Overall, the system

provides an extensible monitoring and logging pipeline with interpretable outputs to support future studies with larger and more diverse datasets.

**Keywords:** *edge-to-cloud monitoring, ESP32 telemetry, WebSocket dashboard, MediaPipe Face Landmarker, facial landmarks, multimodal fusion, physiological sensing, deception-indicative cues, session logging*

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**Seq: 21 | ID: 1571239138**

### **Digitalization of Learning Evaluation Using the QuizApp Application**

*B. Riswanto, T. Firmanto, Y. K. Utami, D. F. Murad, S. Maryam | Bina Nusantara University*

This research aims to develop a system that makes it easier for teachers to create, organize, and administer quizzes to students more efficiently. Furthermore, this system is expected to streamline the process of evaluating student learning outcomes and reduce the potential for human error in assigning grades. The development method used is Agile Software Development with the Scrum approach, consisting of the stages of planning, implementation, testing, documentation, deployment, and maintenance. The system was developed using the Laravel framework with a Model-View-Controller (MVC) architecture. The main features developed include user management, question bank, quiz creation, automatic grading, and a real-time learning outcome dashboard. The system was evaluated using Black Box Testing and User Acceptance Testing (UAT). Black Box Testing consisted of 48 test cases, with 47 passing successfully and one failing due to intentional restrictions on student access to the score dashboard. Furthermore, User Acceptance Testing (UAT) involved 22 respondents and System Usability Scale (SUS). The system achieved an average SUS score of 88.07, categorized as Excellent and Acceptable. These results indicate that the developed online quiz system meets the users' functional and non-functional requirements and is also suitable for implementation as a learning evaluation medium in the school environment. The findings further indicate that the system reduces the risk of cheating by implementing integrity controls that block users when switching tabs, changing applications, or accessing notifications during quizzes.

**Keywords:** *online quiz, information system, learning evaluation, Agile, Laravel, UAT.*

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**Seq: 26 | ID: 1571240519**

### **Evaluating User Experience of the Asset Recovery Application Using Usability Testing**

*S. F. Risqi, A. D. K. Wardani, Y. Y. Kadir, D. F. Murad | Bina Nusantara University*

The digital management of state-confiscated assets demands systems that are secure, efficient, and easy to use. This study evaluates the usability of the Asset Recovery using a Usability Testing approach supported by task observation and questionnaires. A total of ten participants from government institutions performed three main scenarios (login, data input, and export). Observation results show that the data-input process is the longest activity, with an average completion time of 134.7 seconds, while report export is the fastest at 19.2 seconds. The System Usability Scale (SUS) evaluation produced a score of 44.75, which falls

into the Poor usability category, indicating that users experienced substantial difficulty when interacting with the system. These findings highlight that workflow complexity and interface inconsistencies are the primary barriers to usability. This study provides empirical contributions to the development of digital systems in the public sector by recommending improvements to interface design, workflow simplification, and overall user experience enhancement.

**Keywords:** Usability Testing, User Experience, Asset Recovery, Digital Security, System Evaluation.

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**Seq: 28 | ID: 1571242939**

**Beyond Digital Adoption: Orchestrating Human Capital and Strategy for MSME Scalability in the Creative Economy**

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<sup>1</sup>Universitas Negeri Surabaya; <sup>2</sup>Trunojoyo University

The Small Mechatronic Manufacturing Enterprises acts as a post-pandemic growth engine, yet a significant gap remains between mere digital adoption and true scalability in Go Up a Class for Indonesian MSMEs. Grounded in the Resource-Based View (RBV) and Dynamic Capabilities View (DCV), This study specifically examines small-scale manufacturing units integrating mechatronics components and Industrial IoT (IIoT) to enhance production efficiency. Employing a mixed-method approach, the study utilizes PLS-SEM for hypothesis testing and qualitative observation of automated service workflows. The findings reveal that owning digital tools is insufficient; scalability is achieved when human agility is orchestrated through a mature digital strategy. Furthermore, the study identifies that service automation for Chatbots serves as a critical operational mechanism to bridge resource constraints and market efficiency. These insights provide a comprehensive roadmap for MSMEs to transition from survival to sustainable growth.

**Keywords:** Small Mechatronic Manufacturing Enterprises, MSME Scalability, Digital Dexterity, Entrepreneurial Bricolage, Digital Strategy Maturity, Automation Workflow

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**Seq: 33 | ID: 1571247385**

**Expert Validation of a Public Value Maturity Framework for E-Government**

T. Ramadhane, M. Lubis, L. Ramadani, E. A. Fansyah, A. N. Muttaqin | Telkom University

This study validates the Public Value-Based E-Government Maturity Framework developed to assess digital government implementation beyond technological adoption, emphasizing its contribution to public value creation. Using a quantitative expert assessment method, four experts in information systems and digital governance evaluated the framework's indicators. Content validity was measured through the Content Validity Ratio (CVR) and Content Validity Index (CVI), while inter-rater reliability was tested using Cohen's and Fleiss' Kappa. The results show that most indicators achieved high validity scores (CVR: 0.78-1.00; CVI: 0.83-0.89), indicating strong agreement on their relevance to the public value construct. Reliability

analysis revealed substantial to good inter-rater consistency (Cohen's Kappa = 0.74; Fleiss' Kappa = 0.71). These findings confirm that the framework is both valid and reliable, providing a robust foundation for evaluating e-government maturity from a public value perspective and guiding future digital governance assessments.

**Keywords:** *E-Government, Public Value, Maturity Framework, Expert Validation, Content Validity, Inter-Rater Reliability*

Seq: 34 | ID: 1571248011

### **When Every Kilowatt Matters: Intelligent Management of Residential EV Charging Rates Under Cost-Peak Trade-Offs**

Y. Rumengan, F. D. Wijaya, L. M. Putranto, M. I. B. Setyonegoro | *Gadjah Mada University*

The increasing adoption of electric vehicles in residential areas introduces new challenges for low-voltage distribution networks, particularly due to the coincidence of vehicle charging with existing household peak demand. Uncoordinated residential charging can lead to transformer overloading and increased operational risk, even when individual household limits are respected. This study investigates how charging rates can be intelligently managed at the household level to balance charging cost and transformer peak load. A coordinated residential charging framework is developed using a weighted-sum optimization approach. Charging decisions are formulated as household-level energy allocations over a 12-hour residential charging horizon from 17:00 to 04:00, divided into fixed one-hour time slots, which together determine the average charging rates of individual electric vehicles. The formulation explicitly enforces household power limits, charging constraints, and transformer capacity limits, allowing charging rates to be adjusted for each residence while satisfying vehicle energy requirements. Simulation results reveal a clear trade-off between charging cost and transformer peak load. Compared to uncoordinated charging strategies, the proposed method achieves a peak load reduction of approximately 54% relative to the cheapest-first strategy, approximately 63% relative to the ASAP charging strategy, and approximately 37% compared to the single-objective charging strategy while maintaining the same charging cost as the cost-optimal solution. Cost-oriented strategies tend to concentrate charging during low-tariff periods, increasing simultaneity among households and raising transformer loading. In contrast, peak-oriented strategies redistribute charging energy across time slots by moderating household charging rates, resulting in smoother transformer load profiles. A knee-point solution is identified using a distance-based formulation, providing an objective balance between economic efficiency and network operational constraints. The findings demonstrate that household-level charging rate management provides an effective and practical mechanism for coordinating residential electric vehicle charging. By controlling charging rates rather than relying on aggregate feeder-level actions, transformer stress can be mitigated without requiring network reinforcement.

**Keywords:** *Electric vehicle, residential charging, charging rate control, transformer loading, peak demand reduction, cost optimization, multi-objective optimization, weighted-sum method*

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Seq: 36 | ID: 1571248547

### Modeling Legal Data Quality in the NSESDN System: A Deep-SEM Approach with Synthetic Latent Augmentation

R. Asyrofi<sup>1,2</sup>, A. Tjahyanto<sup>2</sup>, E. B. Santoso<sup>2</sup>, I. Hafidz<sup>2</sup> | <sup>1</sup>Universitas Negeri Surabaya;

<sup>2</sup>Institut Teknologi Sepuluh Nopember

This study aims to develop a conceptual model of the legal quality of digital documents within Industrial IoT (IIoT) and Cyber-Physical Systems (CPS), using the Deep Structural Equation Modeling (Deep-SEM) approach. As data-driven decisions become critical for integrated mechatronic systems, ensuring the legal validity and authenticity of digital assets is essential for operational compliance. This model is built to identify and empirically measure the influence of critical factors such as data governance, data security, source reliability, system integrity, and regulatory compliance on the legal quality of documents. To address challenges related to non-normal data distributions and potential response imbalances in survey data, this study incorporates a synthetic data augmentation strategy within the Deep-SEM architecture, adapted for latent structural modeling. This approach integrates autoencoder-based representations and relational mapping using Graph Relational Networks. The experimental results confirm the efficacy of the proposed method, showcasing notable enhancements in model stability and prediction accuracy, with balanced accuracy reaching approximately 85.8%. These findings provide a conceptual contribution to the literature on data quality in connected industrial systems and offer practical guidelines for managing legal digital documents in smart manufacturing data pipelines.

**Keywords:** Data Governance, Deep-SEM, Digital Legal Quality, Industrial IoT (IIoT), Cyber-Physical Systems (CPS), Smart Mechatronics, Regulatory Compliance

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Seq: 38 | ID: 1571248707

### Data-Driven Clustering for Smart Technology Adoption Profiling in Manufacturing SMEs

F. Achmad<sup>1</sup>, M. D. Rial<sup>1</sup>, L. Andrawina<sup>1</sup>, I. I. Wiratmadja<sup>2</sup>, S. M. M. Shuhidan<sup>3</sup> | <sup>1</sup>Telkom University;

<sup>2</sup>Institut Teknologi Bandung; <sup>3</sup>Universiti Teknologi PETRONAS, Malaysia

Small and medium-sized enterprises (SMEs) in the manufacturing sector face increasing pressure to enhance organizational performance and sustain technology adoption amid growing environmental and digital transformation demands. Green innovation (GI) has emerged as a strategic mechanism to address these challenges; however, empirical evidence on how manufacturing SMEs are positioned based on GI and performance profiles remains limited. This study aims to map manufacturing SMEs by applying a data-driven clustering approach based on GI, organizational performance, and technology adoption. GI is measured through green product innovation and green process innovation, while organizational performance is assessed using operational and financial performance indicators. Technology adoption reflects the extent to which firms leverage production efficiency, process improvement, and competitiveness-related capabilities. Using survey data collected from manufacturing SMEs, cluster analysis is employed to identify distinct groups with homogeneous characteristics. The findings reveal clear performance-based clusters,

distinguishing SMEs with high levels of GI and superior performance from those with moderate or lagging profiles. The results demonstrate that SMEs adopting higher levels of green product and process innovation tend to achieve stronger technology adoption and organizational performance. These findings provide a data-driven basis for supporting the adoption of smart and energy-efficient manufacturing technologies, such as real-time monitoring systems and process optimization tools, tailored to different SME segments.

**Keywords:** *Green Innovation; Organizational Performance; Smart Technological Adoption; Clustering; Manufacturing SMEs*

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Seq: 45 | ID: 1571250601

### **Combining RSM and User Need Identification for Effective Requirements Engineering: Evidence from a Feedback System Project**

A. Azzahro<sup>1</sup>, M. Lubis<sup>1</sup>, H. Fakhruroja<sup>1,2</sup>, E. A. Fanyah<sup>1</sup>, M. Artamevia<sup>1</sup> | <sup>1</sup>Telkom University;  
<sup>2</sup>National Research and Innovation Agency (BRIN)

Effective information systems for laboratory and public service environments must balance technical correctness, user needs, and compliance with quality standards. This study presents the design and implementation of a Feedback Handling Information System at the National Research and Innovation Agency (BRIN) using an incremental Recognize–Scrutinize–Materialize (RSM) approach integrated with user-need identification. Iterative RSM cycles involved users to align requirements with organizational objectives and regulated laboratory workflows. Each stage produced measurable artifacts, including a validated requirement list, process models, and successive prototypes. The system is integrated within a Laboratory Information Management System (LIMS) and supports standardized handling of complaints, suggestions, and service satisfaction in accordance with ISO/IEC 17025:2017, ISO 9001, and PERMENPAN RB No. 14 of 2017. From an information-systems perspective, the solution applies a three-tier architecture (presentation, application, and data layers) and provides user-facing and monitoring modules (feedback submission, status tracking, service statistics, and satisfaction reporting) to support transparency and decision support. Usability was assessed through heuristic evaluation with 25 respondents, yielding an overall satisfaction score of 86.2% and ratings for clarity, efficiency, and consistency. The results indicate that combining RSM with structured user-need identification strengthens requirements engineering and delivers a user-centered, auditable, standards-compliant robust system for laboratory service governance

**Keywords:** *Requirements engineering, user-centered design, laboratory information management system (LIMS), three-tier architecture, usability evaluation*

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Seq: 62 | ID: 1571259487

### **Artificial Intelligence Integration as a Catalyst for SMEs Transformation: Determinants and Performance Impact**

A. N. M. Linsi, D. P. Alamsyah, D. Syamsuar | Bina Nusantara University

This study examines several variables in integrating artificial intelligence (AI), such as the perception of the benefits, the readiness of resources, and the social influence that causes the use of artificial intelligence, and this study also measures the subsequent impact of business performance. To find answers about how influential the integration of artificial intelligence is on the performance of SMEs, this study was conducted by collecting data with a quantitative approach using questionnaire surveys distributed to 316 SMEs owners and practitioners in Bandung City (Indonesia). The research results were analyzed using the PLS algorithm and bootstrapping techniques of SmartPLS software to ensure the validity of structured data. Integrating artificial intelligence into SMEs has been proven to have a real and significant positive impact after this research was conducted. This research shows the high effect of the integration of artificial intelligence on making the work of SMEs more effective and efficient. SMEs benefit from the knowledge gained from this study about how profitable it is to integrate artificial intelligence into operational processes, to make each process more effective and efficient.

**Keywords:** *Artificial Intelligence, ChatGPT, SMEs, Technology Integration, Business Performance*

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Seq: 74 | ID: 1571263434

### **Enhancing IT Service Level Management in a National Oil and Gas Company Through the Implementation of Robotic Process Automation and Document Understanding in the Automation of IT**

E. K. Kurniawan, N. A. Rakhmawati | Institut Teknologi Sepuluh Nopember

Incident and service request ticket management is a core process in IT Service Management (ITSM), especially in national oil and gas companies with high ticket volumes and operational complexity. Currently, tickets submitted via email and unstructured documents require manual triage and classification, causing delays, inconsistent categorization, and reduced SLA compliance. This study implements UiPath Document Understanding, integrating OCR, machine learning, and rule-based methods to automate ticket extraction, classification, and routing according to ITIL v4 practices. Using an experimental before-and-after approach, the research evaluates improvements in classification accuracy, triage time, and SLA compliance. The expected outcome is increased efficiency, consistency, and effectiveness of Service Level Management through Intelligent Document Processing based automation.

**Keywords:** *Document Understanding, UiPath, ITSM, Service Level Management, SLA, ITIL*

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**Seq: 76 | ID: 1571264257****Risk–Performance Coupling Framework for Intelligent Monitoring in Food Processing Lines**L. M. Syikilili<sup>1</sup>, M. L. Singgih<sup>1</sup>, D. Maryadi<sup>2</sup> | <sup>1</sup>Institut Teknologi Sepuluh Nopember;<sup>2</sup>Universitas Tridinanti

Food processing lines require not only strict food safety control but also stable operational performance, creating a need for more intelligent and structured monitoring approaches. This study proposes an intelligent monitoring framework that links Hazard Analysis and Critical Control Points (HACCP) hazard significance with Lean Six Sigma (LSS) performance loss indicators to support monitoring prioritization in a mango pulp production line. This study was conducted using an observational cross-sectional baseline design across 18 process steps. The baseline operational data included 340 cycle-time observations, 55 downtime incidents recorded over 27 shifts, defect proxy records, and 30-day yield measurements. HACCP hazard ratings were coded into numerical Risk Scores, while performance loss was quantified using normalized cycle-time, downtime, and defect-proxy indicators. These dimensions were integrated using a risk–performance coupling matrix to identify process hotspots where food safety criticality and operational instability converge. The results identified five high-coupling stages: offloading, sorting and crating, finishing/pulp refining, pulp storage, sterilization, and aseptic filling, with sterilization exhibiting the highest coupling intensity. Beyond baseline prioritization, the framework provides a structured basis for identifying candidate monitoring nodes for future sensor- or IoT-based supervision of critical control points and high-loss process steps. This study contributes a mechatronics-relevant analytical perspective for intelligent monitoring design in smart food processing systems.

**Keywords:** HACCP; Lean Six Sigma; Intelligent Monitoring; Risk–Performance Coupling Matrix; Food Processing Lines

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**Seq: 101 | ID: 1571270164****Designing a Socio-Technical Architecture for Bias Mitigation in Intelligent Decision Support Systems**M. F. Prathama<sup>1,2</sup>, M. I. Irawan<sup>2</sup>, R. V. H. Ginardi<sup>2</sup> | <sup>1</sup>Institut Teknologi PLN;<sup>2</sup>Institut Teknologi Sepuluh Nopember

Despite the rapid adoption of Artificial Intelligence (AI) in higher education, existing literature lacks comprehensive operational architectures designed to mitigate algorithmic bias, particularly for applicants from underdeveloped regions. Automated screening systems often exacerbate digital redlining by penalizing non-standard document formats or low-resolution uploads. To address this gap, this study proposes a 3-tier socio-technical architecture integrating a Large Language Model (LLM) API with a mandatory Human-in-the-Loop (HITL) audit workflow. Designed and implemented within a real-world university admission system, the architecture delegates routine data extraction to the AI while enforcing manual triage for edge cases, ensuring fairness. To validate the system, an AI evaluation framework was deployed using both quantitative bias metrics (Disparate Impact) and qualitative operational assessments. Initial implementation results indicate that the HITL architecture successfully

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achieved a 75% reduction in document processing time per applicant. Furthermore, real-time auditing validated the system's empirical equity, sustaining Disparate Impact (DI) scores well above the 0.8 threshold especially in geographic dimensions. The algorithmic triage interface also significantly enhanced system trust among admission officers. This study provides a foundational blueprint for developing fair, transparent, and accountable intelligent decision support systems in educational institutions

**Keywords:** *Socio-Technical Architecture, Algorithmic Bias, Human-in-the-Loop, Intelligent Decision Support Systems, Higher Education*

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**Seq: 103 | ID: 1571270311**

**Comprehensive Technical Planning of 5G NR Standalone Network at 3.5 GHz in Padang City**

*A. Y. Sumanto, I. I. Tritasmoro, H. M. Jumhur | Telkom University*

The exponential growth of mobile broadband traffic demands the deployment of advanced 5G New Radio (NR) technologies to fulfill the IMT-2020 high-level vision. This paper presents a comprehensive technical planning and feasibility study for a 5G NR Standalone (SA) network utilizing the mid-band 3.5 GHz frequency (Band n78) in Padang City. The study adopts an integrated coverage and capacity planning methodology across an effective urban area of 219.51 km<sup>2</sup>. The network's performance is strictly evaluated based on three primary metrics: Synchronization Signal-Reference Signal Received Power (SS-RSRP), Synchronization Signal-Signal to Interference and Noise Ratio (SS-SINR), and Downlink Throughput. Detailed link budget calculations and Maximum Allowable Path Loss (MAPL) derivations were formulated using the 3GPP 38.900 Urban Macro (UMa) propagation model. Simulation results demonstrate that the proposed geospatial design guarantees continuous signal coverage, achieving an excellent SS-RSRP target ( $> -85$  dBm) and optimal SS-SINR levels ( $\geq 20$  dB), successfully minimizing the risk of blank spots. Furthermore, the strategic site distribution paired with 128-element Massive MIMO technology and 100 MHz channel bandwidth achieves an average downlink throughput of 630.59 Mbps. This performance significantly exceeds the minimum enhanced Mobile Broadband (eMBB) requirements, establishing a robust, high-capacity digital infrastructure essential for accelerating the smart city ecosystem in Padang.

**Keywords:** *5G NR, Standalone, SS-RSRP, SS-SINR, Downlink Throughput, eMBB*

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Seq: 104 | ID: 1571270482

**Spatio-Temporal Non-Homogeneous Poisson Process Modeling with Residual-Based Zoning for Smart City Advertising Optimization**H. Yutanto<sup>1,2</sup>, N. Iriawan<sup>1</sup>, A. Choiruddin<sup>1</sup> | <sup>1</sup>Institut Teknologi Sepuluh Nopember;<sup>2</sup>UHW Perbanas

Out-of-Home (OOH) advertising placement in smart cities often relies on manual intuition, which fails to capture the stochastic dynamics of human mobility. This study proposes a data-driven decision support framework that integrates the Spatio-Temporal NHPP model followed by residual clustering analysis. Using one year of vehicle exposure data from nine key monitoring points in Madiun City, Indonesia, we construct a log-linear NHPP intensity function to model spatial and temporal exposure variations. Model parameters are estimated using MLE, demonstrating stable predictive performance (MAE = 3.33; RMSE = 4.18). Key findings reveal that advertising effectiveness is significantly influenced by road hierarchy and traffic volume; where both private and commercial vehicle volumes contribute positively to exposure, while Local roads exhibit significantly lower exposure compared to Arterial roads. To provide operational insights, the standardized Pearson residuals from the NHPP model were processed using the K-Means algorithm validated through Elbow Method and Silhouette Score analysis (score = 0.6014) to classify locations into three advertising priority zones: high, medium, and low. The zoning results indicate that Disdukcapil and Patung Gajah are key mobility hotspots. By integrating stochastic intensity estimation into actionable spatial zoning, this framework offers a replicable tool for adaptive and data-driven intelligent advertising governance.

**Keywords:** *Non-Homogeneous Poisson Process, Spatio-Temporal Modeling, Residual-Based Clustering, Smart City Decision Support*

Seq: 105 | ID: 1571270586

**BUNA-ROUTE: A Hybrid GA-ACO Intelligent Routing and Decision Support System for Marine Tourism Under Dynamic Environmental Constraints**A. L. Kalua<sup>1,2</sup>, M. A. Wibowo<sup>1</sup>, L. Latumakulita<sup>2</sup>, R. I. Turnip<sup>2</sup> | <sup>1</sup>Diponegoro University;<sup>2</sup>Sam Ratulangi University

Route optimization in marine tourism areas remains a challenging problem due to dynamic ocean currents, spatially dispersed dive locations, and conservation zoning constraints that limit feasible navigation paths. This study aims to develop an intelligent routing model for Bunaken diving tourism by combining Ant Colony Optimization (ACO) and Genetic Algorithm (GA) to identify the fastest and most feasible routes between diving spots. The proposed method employs a hybrid GA-ACO framework in which GA performs global exploration to generate candidate routes, while ACO refines the best solutions through pheromone-based local exploitation. The model integrates latitude, longitude, current speed, and zone type into a unified cost function to ensure both travel efficiency and compliance with protected-area regulations. The results show that the hybrid model is capable of generating optimized routes under heterogeneous spatial and environmental conditions, while effectively avoiding

restricted core zones and adapting to variations in ocean current speed. The two-stage optimization process also improves route feasibility and search efficiency compared with single-method approaches. These findings indicate that the proposed model can support sustainable marine tourism management by improving route planning quality, operational efficiency, and environmental compliance in protected marine destinations

**Keywords:** *Hybrid Metaheuristic Optimization; Ant Colony Optimization; Genetic Algorithm; Intelligent Routing System; Marine Tourism; Dynamic Environmental Constraints*

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Seq: 106 | ID: 1571270590

### **Design and Implementation of an IoT-Enabled Smart Rotary Vial Filling and Capping System with Real-Time Monitoring and Control**

A. Legowo<sup>1</sup>, R. Muhida<sup>2</sup>, M. Riza<sup>2</sup>, H. Saputro<sup>3</sup>, A. Cucus<sup>2</sup>, R. Muhida<sup>3</sup>, Y. Aprilinda<sup>3</sup>, A. Rahman<sup>2</sup>, Mulyana<sup>2</sup> | <sup>1</sup>Higher Colleges of Technology, United Arab Emirates; <sup>2</sup>Bandar Lampung University; <sup>3</sup>Universitas Putra Indonesia YPTK

This paper presents the design and implementation of an IoT-enabled smart rotary vial filling and capping system for automated small-scale manufacturing applications. The proposed system integrates a rotary-based mechanical mechanism with an ESP32-based control system and a cloud-based IoT platform to enable synchronized multi-stage processing, real-time monitoring, and remote operation. Unlike conventional linear and semi-automatic systems, the proposed approach improves operational efficiency by reducing idle time and enabling continuous processing within a compact design. Experimental evaluation was conducted to assess system performance in terms of communication latency, responsiveness, production efficiency, filling accuracy, and capping reliability. The results show that the system achieves stable IoT communication with latency ranging from 198 ms to 210 ms. The system response time varies between 0.30 s and 0.80 s depending on the type of operation. In addition, the system demonstrates consistent production performance with an average processing time of approximately 58–60 seconds per vial. The filling process achieves high precision with an average error of 0.43%, while the capping mechanism attains a success rate of 97%. The results indicate that the proposed system provides a reliable and efficient solution for automated vial processing, while enabling real-time monitoring and improved operational flexibility. This study contributes to the development of smart manufacturing systems by combining rotary-based mechanical design with IoT-enabled control in a scalable and cost-effective manner

**Keywords:** *IoT; Smart Manufacturing; Rotary System; Vial Filling Machine; ESP32; Automation; Real-Time Monitoring; Industrial Control System.*

Seq: 109 | ID: 1571270609

**An IoT-Enabled Smart MPPT-Controlled Photovoltaic-Solid Polymer Electrolyte System for Real-Time Optimized Hydrogen Production**

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This paper presents the design and experimental validation of an IoT-enabled Photovoltaic–Solid Polymer Electrolyte (PV–SPE) system for optimized hydrogen production. The proposed system integrates a maximum current-based Maximum Power Point Tracking (MPPT) control strategy with an ESP32-based Internet of Things (IoT) monitoring platform. A buck DC–DC converter is used to regulate power transfer and achieve dynamic impedance matching between the photovoltaic source and the electrolyzer. The MPPT controller adjusts the duty cycle to maximize the output current, which directly determines hydrogen production. Experimental results demonstrate that the system achieves fast MPPT convergence within 0.3–0.4 s and improves power utilization by up to 68% compared to non-MPPT operation, resulting in a 37% increase in hydrogen production. The IoT system enables real-time acquisition and remote monitoring of key parameters, including voltage, current, temperature, and hydrogen flow rate, with stable data transmission. The results also confirm a strong correlation between electrical input power and hydrogen generation. The proposed integrated approach enhances system efficiency, stability, and reliability, providing a scalable solution for renewable hydrogen energy applications.

**Keywords:** Photovoltaic–SPE System; Hydrogen Production; Maximum Power Point Tracking (MPPT); Internet of Things (IoT); DC–DC Converter; Smart Energy System; Renewable Energy; Real-Time Monitoring; ESP32; Electrolysis System.

Seq: 118 | ID: 1571271403

**A Framework for Hybrid Automatic Speech Recognition and Rule Classification in Real-Time Tajwid-Oriented Pronunciation Error Assessment and Explainable Feedback**

M. Lubis<sup>1</sup>, R. Z. Saleh<sup>1</sup>, R. A. Fauzan<sup>1</sup>, J. A. Wibowo<sup>1</sup>, K. B. A. Rahman<sup>2</sup>, N. M. B. M. Salleh<sup>2</sup> | <sup>1</sup>Telkom University; <sup>2</sup>Universiti Islam Selangor, Malaysia

This paper outlines a Tajwid-oriented framework for real-time pronunciation error assessment and explainable feedback. The design brings together automatic speech recognition, rule classification, decision fusion, confidence handling, and structured feedback so that speech evidence can be turned into segment-level corrective guidance rather than a single score. Instead of presenting a finished benchmark study, the manuscript specifies the assessment record, feedback-mapping logic, escalation policy, and validation dimensions that a later implementation would need. The framework is intended to support a more rigorous next phase involving controlled benchmark experiments, latency profiling, and pilot user evaluation.

**Keywords:** automatic speech recognition, Tajwid-oriented pronunciation assessment, rule classification, explainable feedback, human-machine interaction, real-time intelligent systems

Seq: 119 | ID: 1571271405

### **Toward a Confidence-Aware Validation Workflow for Real-Time Pronunciation Assessment: Human Review, Uncertainty Communication, and Evidence Logging in Tajwid-Oriented Feedback Systems**

M. Lubis<sup>1</sup>, R. Z. Saleh<sup>1</sup>, R. A. Fauzan<sup>1</sup>, J. A. Wibowo<sup>1</sup>, K. B. A. Rahman<sup>2</sup>, N. M. B. M. Salleh<sup>2</sup> |  
<sup>1</sup>Telkom University; <sup>2</sup>Universiti Islam Selangor, Malaysia

This paper proposes a confidence-aware validation workflow for real-time pronunciation assessment systems, using Tajwid-oriented feedback as the motivating application domain. Unlike system-design papers that primarily optimize recognition or diagnosis modules, this manuscript focuses on how a learner-facing assessment system should be validated before its feedback can be trusted in repeated practice. The workflow specifies an assessment record schema, confidence-banded message policy, expert-escalation rules, and evidence logging requirements that connect offline diagnosis metrics with online interaction behavior. It also introduces decision gates for release readiness so that recognition quality, uncertainty communication, actionability, and workflow robustness can be audited together rather than reported as isolated metrics. The contribution is therefore a validation-and-governance blueprint for intelligent pronunciation feedback systems operating under real-time constraints.

**Keywords:** *pronunciation assessment, validation workflow, uncertainty communication, human review, evidence logging, confidence estimation, real-time intelligent systems*

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Seq: 127 | ID: 1571271831

### **Integration of Integrative Restoration GAN (IRGAN) and YOLOv8 for Escalating Oil Palm Tree Detection in UAV Imagery: A Task-Driven Super Resolution Approach**

M. A. Irwansyah, I. Zulkarnain, H. Sujaini, Purwoharjono | Tanjungpura University

Resolution limitations in Unmanned Aerial Vehicle (UAV) imagery represent a critical bottleneck for small object detection, particularly oil palm trees in large-scale plantations. This paper presents IRGAN (Integrative Restoration Generative Adversarial Network), a task-driven super-resolution framework integrated end-to-end with YOLOv8 for detection-aware image restoration. IRGAN employs a Residual-in-Residual Dense Block (RRDB) architecture augmented with a Spatial Attention mechanism and an Activation Maximization-based loss function guided by YOLOv8 as a teacher model, ensuring that restoration actively reinforces semantically discriminative features rather than optimizing for perceptual metrics alone. Evaluated on synthetically degraded UAV imagery, IRGAN achieves Precision of 0.906, Recall of 0.940, mAP@50 of 0.940, and F1-Score of 0.904—improving over direct low-resolution detection by +494% in Precision and +125% in mAP@50, while closing the gap to Ground Truth high-resolution performance to within 3% across all metrics. These results confirm that task-specific restoration can transform low-quality UAV recordings into reliable inputs for automated oil palm inventory at scale.

**Keywords:** *IRGAN, YOLOv8, task-driven super resolution, spatial attention, oil palm detection*

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Seq: 131 | ID: 1571271990

### An IoT-Based Real-Time Monitoring System for Municipal Solid Waste Mini-Incinerators

A. G. Permana<sup>1</sup>, E. Rijanto<sup>2</sup>, S. Sumaryo<sup>1</sup>, E. Kurniawan<sup>1</sup>, J. F. Rusdi<sup>3</sup>, A. H. Setiawan<sup>4</sup> |

<sup>1</sup>Telkom University; <sup>2</sup>National Research and Innovation Agency (BRIN);

<sup>3</sup>Universiti Teknikal Malaysia Melaka, Malaysia; <sup>4</sup>PT Sarana Tunas Niaga

Real-time monitoring of combustion variables in mini-incinerators is essential for both operators and environmental agencies. However, previous studies on Internet of Things (IoT)-based monitoring have proven inadequate for evaluating the internal solid waste combustion process. This study developed an IoT-based system that records combustion chamber temperatures (ranging from 25 °C to 814.75 °C) and flue gas concentrations of CO and H<sub>2</sub>S in a mini hydrothermal incinerator. During a 30-minute experimental test, the system successfully transmitted time-series data to a cloud server via Wi-Fi at one-minute intervals, enabling remote smartphone-based monitoring and streamlined data visualization. Analysis of the time-series data demonstrates that steam injection into the combustion chamber significantly elevates the temperature to 814.75 °C while reducing CO levels from 5.95 ppm to 1.88 ppm, thereby enhancing combustion efficiency. Based on waste composition, acoustic signatures, and steam pressure, the process was categorized into five distinct phases: Initiation, Devolatilization, Backpressure, Steam Injection, and Stabilization. Installation of additional thermocouples and high-precision sensors may facilitate Artificial Intelligence-driven predictive modeling by integrating real-time data with laboratory analytical results.

**Keywords:** *combustion efficiency, flue gas emission, incinerator, IoT-based monitoring, solid waste*

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Seq: 145 | ID: 1571272457

### Orchid Leaf Disease Classification Using Convolutional Neural Network (CNN) and Transfer Learning Based on ResNet50

M. Q. A. Hijran<sup>1</sup>, H. Fakhruroja<sup>1,2</sup>, D. Pramesti<sup>1</sup> | <sup>1</sup>Telkom University;

<sup>2</sup>National Research and Innovation Agency (BRIN)

Orchids are among the most economically valuable ornamental plants due to their high aesthetic and commercial value. However, orchid cultivation is highly susceptible to leaf diseases such as leaf spot and leaf rot, which can significantly reduce plant quality and market competitiveness. Early and accurate detection of these diseases is essential to minimize economic losses and improve cultivation efficiency. This study proposes a transfer learning approach using a fine-tuned ResNet50 model for orchid leaf disease classification. The dataset consists of 1,000 images categorized into three classes: leaf spot, leaf rot, and healthy leaf. Data augmentation techniques were applied to improve model generalization under limited dataset conditions. The pretrained ResNet50 model was fine-tuned by unfreezing the final layers to adapt to domain-specific features. Experimental results show that the proposed model achieved 94.03% classification accuracy. Comparative evaluation with hybrid CNN-based machine learning classifiers indicates that the fine-tuned ResNet50 model achieved

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higher accuracy compared to SVM, Random Forest, and XGBoost-based approaches. These results demonstrate that transfer learning with fine-tuning improves classification performance in small-scale agricultural image datasets, particularly for ornamental plant disease detection.

**Keywords:** *Convolutional Neural Network, Image processing, Orchid leaf disease, Plant disease classification, ResNet50, Transfer learning*

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**Seq: 148 | ID: 1571272603**

### **Design of a Context-Aware Decision Support System for Smart Greenhouse Using IoT and MCP**

M. B. Ramadhan<sup>1</sup>, H. Fakhurroja<sup>1,2</sup>, S. Suakanto<sup>1</sup>, H. Bangkit<sup>2</sup> | <sup>1</sup>Telkom University;  
<sup>2</sup>National Research and Innovation Agency (BRIN)

Smart greenhouse systems are widely used to improve environmental monitoring and control in precision agriculture. However, many existing solutions rely solely on real-time sensor data and fail to incorporate broader context—such as historical trends, cultivation preferences, and disease records—leading to suboptimal decisions. This study proposes a context-aware decision support system for smart greenhouses using Internet of Things (IoT) and Model Context Protocol (MCP). The system integrates heterogeneous data sources—real-time telemetry, historical time-series data, weather forecast, cultivation knowledge, and disease logs—into a unified context layer. MCP serves as a standardized interface that decouples context retrieval from the reasoning layer. The architecture follows an event-driven microservices design: IoT devices communicate via MQTT, data is stored in a time-series database, and context is dynamically accessed through MCP servers. A hybrid intelligence approach incorporates rule-based fuzzy logic for environmental control with a large language model (LLM) for context-aware insights. Experimental evaluation on *Cattleya* orchids shows that multi-source context improves the relevance and adaptability of recommendations compared to sensor-only approaches, enhancing decision support in smart greenhouse systems.

**Keywords:** *Internet of Things (IoT), Model Context Protocol (MCP), Decision Support System, Greenhouse, Smart Agriculture*

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Seq: 152 | ID: 1571272638

### **Drone-Based Vehicle Detection Using YOLOv11 for Urban Traffic Monitoring in Bandung, Indonesia**

M. R. Naufan, A. Bayuwindra | Institut Teknologi Bandung

Urban traffic monitoring is a key component of intelligent transportation systems, particularly in densely populated cities with highly dynamic traffic conditions. This study proposes a drone-based vehicle detection approach using the YOLOv11 model on a locally collected aerial dataset captured in Bandung, Indonesia. The dataset consists of 1,522 annotated images obtained from multiple traffic scenarios, including intersections, road segments, and parking areas, providing a more realistic representation of urban traffic conditions compared to commonly used benchmark datasets. The model is trained to detect four vehicle classes, namely bus, car, motorcycle, and truck. Experimental results show that the proposed approach achieves a precision of 0.880, a recall of 0.738, and a mean Average Precision (mAP@0.5) of 0.814, indicating reliable detection performance in real-world scenarios. However, the results also reveal limitations related to class imbalance, particularly due to the dominance of motorcycles, as well as challenges associated with aerial perspectives such as occlusion, small object scale, and high vehicle density. Overall, this study highlights the importance of using representative local datasets and aerial sensing for improving the robustness and applicability of vehicle detection systems in intelligent transportation applications

**Keywords:** *vehicle detection, aerial imagery, drone-based monitoring, YOLOv11, intelligent transportation systems, urban traffic analysis*

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Seq: 159 | ID: 1571272917

### **Human-Machine Interface Design for Smart Modular Fitness Systems: A User-Centered Approach Integrating Usability, Interaction, and Adoption**

Z. G. C. Banua, K. Garcia, O. K. B. Edades, A. F. O. Encarnacion, N. A. C. Gamot, J. T. Tenerife | Technological Institute of the Philippines, Philippines

In the Philippines, physical inactivity remains a critical public health issue, driven by limited access to fitness facilities, space constraints, and low user motivation. This study investigates the market viability and Human–Machine Interface (HMI)-related factors influencing user adoption of Motivex, a smart modular fitness system designed for accessible home-based exercise. A convergent mixed methods approach was employed, integrating survey data from 140 respondents in the Greater Manila Area with qualitative insights from fitness and engineering experts. Results indicate that key HMI attributes—such as interface reliability, tracking accuracy, system transparency, and feedback clarity—significantly influence user trust, purchase intention, and sustained engagement. The findings underscore the critical role of human-centered HMI design in enhancing usability and long-term interaction in smart, home-based mechatronic fitness systems

**Keywords:** *modular fitness system, compact fitness equipment, health and wellness technology, technology-integrated fitness, human-machine interface*

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Seq: 161 | ID: 1571272924

### **Design of an Interactive IoT Dashboard for Intelligent Cattleya Orchid Cultivation Using the Design Thinking Method**

B. Preciosa, S<sup>1</sup>, H. Fakhurroja<sup>1,2</sup>, S. Suakanto<sup>1</sup>, H. Bangkit<sup>2</sup> | <sup>1</sup>Telkom University;

<sup>2</sup>National Research and Innovation Agency (BRIN)

One of the main challenges faced by orchid growers is the difficulty of consistently caring for orchids, particularly in monitoring environmental and plant conditions such as temperature, greenhouse humidity, soil moisture, and light intensity, which impact the quality of orchid growth. Many systems for plant maintenance have been developed, but most implementations focus on hardware and ignore the actual interface used by growers. This study designed an interactive web-based monitoring and control dashboard for Cattleya orchid cultivation using the Design Thinking method to ensure the system is centered on user needs. The resulting prototype displays real-time sensor data, remote irrigation and shade control, a plant disease classification system, and treatment recommendations based on IoT sensor data. The Empathy phase was conducted with 37 orchid cultivators to identify user needs and challenges. The prototype has been tested on 30 people and showed that all tasks were successfully completed with a 100% success rate with an average completion time of 16.6 seconds. With a SUS score of 84.8 and placing it in the "Excellent" category, this indicating that users found the dashboard easy and practical to use for orchid cultivation.

**Keywords:** *Cattleya orchid, smart farming, Internet of Things (IoT), user interface, user experience, Design Thinking, web dashboard, usability testing.*

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Seq: 174 | ID: 1571275165

### **A Hybrid Fuzzy Logic Model for Predicting Driver Safety Risk Using Vehicle Telematics Data**

A. Wahyuni, R. S. Dewi | Institut Teknologi Sepuluh Nopember

Driver behavior is a major factor in road traffic accidents worldwide. Widely adoption of vehicle telematics systems to monitor driving behavior gives large data to analyze. Most safety assessments rely on violation events and strict thresholds. These are not enough to characterize non-linear interactions and uncertainty of human behavior that also combine with contextual exposure factors that affect driver safety risk. This paper proposes a hybrid fuzzy logic framework for predicting driver safety risk using vehicle telematics indicators. The framework integrates a two-stage fuzzy inference system: (1) a Mamdani-based model to assess behavior-level risk derived from driving behaviors such as speeding, aggressive maneuvers, fatigue indicators, and night driving, and (2) a Sugeno-based model to incorporate exposure effects through driving distance. The final output is a continuous Driver Overall Risk Score (DORS) designed to support fair and interpretable risk assessment. Analytical assessment of the proposed framework through sensitivity and rule-based validation demonstrates monotonic behavior, logical consistency, and robustness. Using combined interpretability and numerical stability, this provides foundation of the model that

can be generalized for implementation of proactive and data-driven driver safety management across usage of diverse vehicle telematics.

**Keywords:** driver safety, vehicle telematics, hybrid fuzzy logic, risk prediction

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**Seq: 184 | ID: 1571276762**

### **Dynamic Risk Monitoring and Mitigation Model for Ammunition Storage Systems Using ANP-System Dynamics**

*N. E. Sulistiyawati | Institut Teknologi Sepuluh Nopember*

This study develops a dynamic risk monitoring and mitigation model for ammunition storage systems by integrating the Analytic Network Process (ANP) and System Dynamics (SD). Ammunition storage environments represent complex sociotechnical systems characterized by nonlinear risk propagation, which cannot be adequately captured by conventional static assessment approaches. The model employs ANP to quantify interdependencies among risk factors and mitigation alternatives, while SD represents the temporal evolution of risk through feedback-driven mechanisms. The integration embeds ANP-derived weights into the dynamic structure to construct a Total Risk Index (TRI) that evolves over time. Simulation results over a 60-month horizon indicate that environmental conditions and operational workload act as dominant risk drivers, whereas personnel compliance and inspection intensity function as stabilizing control variables. The results further demonstrate that ANP-based prioritization reduces TRI by 38.7% compared to non-prioritized strategies. The proposed model provides a decision-support tool for proactive and dynamic safety management.

**Keywords:** System Dynamics Simulation, Analytic Network Process, Risk Monitoring, Ammunition Storage Systems, Complex System Analysis

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**Seq: 188 | ID: 1571276855**

### **Hybrid Data-Driven and Knowledge-Informed Multisensor Fusion for Failure Mode Forecasting in Power Plant Heat Exchanger**

*N. F. Fano, F. Mahananto, M. N. Yuniarto, I. A. Akbar | Institut Teknologi Sepuluh Nopember*

To ensure the reliability of thermal power plant equipment, transitioning from reactive to preventive maintenance is essential. This study introduces a hybrid approach that integrates data-driven and knowledge-informed to predict failure mode in a heat exchanger equipment. The data-driven component employs Mahalanobis Distance analysis on multisensor data, transforming raw sensor readings into a univariate Failure Score that quantifies deviations from healthy conditions. The knowledge-informed aspect utilizes expert rules based on failure symptoms, for labeling that statistical methods can't replicate. An adaptive weighting mechanism balances both components, enabling the detection of subtle anomalies often overlooked by static approaches. Validation against maintenance logs demonstrated proactive anomaly detection in four out of five cases, with a highest lead time of 97.58 hours. For forecasting, a multi-step strategy with spike-aware weighting addressed class imbalance, where threshold exceeding events are critical is proposed. A comparative evaluation of four

ensemble models including, Random Forest, AdaBoost, CatBoost, and XGBoost were performed, where CatBoost identified as the best performing model, achieving Recall of 80.11%, an MAE of 0.2162, and an RMSE of 0.2842 through Bayesian optimization. These findings indicate that integrating statistical sensor fusion with domain knowledge provides a prognostic approach for predictive maintenance in industrial domain.

**Keywords:** *Predictive Maintenance, Health Index, Degradation Modeling, Multisensor Fusion, Failure Forecasting, Heat Exchanger*

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Seq: 191 | ID: 1571276927

### **YOLO-Guided Visual Information System for Autonomous Robotic Arm Control in a 3D Simulated Environment**

*I. F. Ahmadi, S. A. Putra, S. Siregar | Telkom University*

Visual processing plays a key role in controlling autonomous robotic arms, as shown in this study using a YOLO-based system trained in 3D simulations for agricultural use. This system first detects and extracts object-level information using YOLOv8. The information is then fed into the Deep Deterministic Policy Gradient (DDPG) controller to support decision-making. The study focused on 3D dry leaf objects within CoppeliaSim as targets for detection and interaction. To train the detection model, the dataset was taken directly in a simulation by capturing images of dry leaf objects from multiple camera angles in CoppeliaSim. This multi-view approach reflects how the robotic camera moves and observes the environment from different perspectives during training. The results showed strong detection performance, with a mAP@0.5 of 0.939 and a peak F1 score of 0.90 at a confidence threshold of 0.376. The DDPG algorithm can achieve a 60% success rate in 10 evaluation episodes. Training trends also show steady improvements, including higher rewards, longer task-focused episodes, and a steady convergence between Q-actor values and Q-targets. These findings suggest that the proposed perception-to-control pipeline holds promise for robotic arm learning simulations and that it will serve as a guideline for agriculture in the future.

**Keywords:** *robotic arm, agricultural robotics, CoppeliaSim, YOLO, DDPG, visual information processing*

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Seq: 194 | ID: 1571276952

### **Network-Aware Intelligent Transport Optimization with Constraint-Based Route Sequencing: An Enterprise AI Integration Framework for Sustainable Urban Logistics**

*N. T. H. Hutapea, U. Ciptomulyono, A. Utamima | Institut Teknologi Sepuluh Nopember*

Urban logistics in Indonesia faces increasing complexity due to rapid e-commerce growth, dense traffic conditions, heterogeneous fleets, and operational constraints such as vehicle capacity, road accessibility, and delivery time windows. Conventional routing approaches based on Euclidean distance and manual planning are inadequate for capturing real-world transportation dynamics, resulting in inefficient routing and increased operational costs and emissions. This paper proposes an Intelligent Transport Management framework that

integrates dual-stage clustering, network-based shortest path computation, and constraint-based route sequencing within an enterprise AI architecture. The proposed framework is implemented using API-based integration, semantic data pipelines, and MLOps practices to support realtime decision-making within Transport Management Systems. Evaluation using real-world logistics data demonstrates significant improvements, including a 15.3% reduction in total travel distance, a decrease in the number of delivery routes, elimination of constraint violations, and a reduction in route generation time from hours to seconds. These improvements result in substantial cost savings and an estimated annual reduction of 134 tons of CO<sub>2</sub> emissions. The results demonstrate that integrating network-aware routing and constraint-based optimization within an enterprise AI framework provides an effective and scalable solution for sustainable urban logistics.

**Keywords:** *Intelligent Transport Management, Urban Logistics, Dual-Stage Clustering, Network-Based Routing, Multi-Level Dijkstra Algorithm, Constraint-Based Optimization, Vehicle Routing Problem, OpenStreetMap, Enterprise AI Integration, Sustainable Logistics*

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Seq: 201 | ID: 1571277380

### **A Conceptual Framework of Decision Support System for Incinerator-Based Solid Waste Management in Bandung City**

S. E. Damayanti<sup>1</sup>, E. Rijanto<sup>2</sup>, Hidayat<sup>1</sup>, E. S. Soegoto<sup>1</sup> | <sup>1</sup>Universitas Komputer Indonesia;  
<sup>2</sup>National Research and Innovation Agency (BRIN)

To address the escalating waste crisis, Bandung City deployed 15 mini-incinerators by 2025; however, operations were halted following emission testing discrepancies, hindering the achievement of waste service targets. Given the scarcity of research on incinerator management in Indonesia, this study evaluates the implementation of these units using a mixed methods approach comprising literature reviews, site observations, and structured interviews. Results indicate that batch-based operations—characterized by unsorted waste and a lack of active combustion control potentially pose high risks of dioxin and furan emissions. Furthermore, excessive workloads for coordinators across service regions were found to impede the attainment for coverage goals. To mitigate these issues, this paper proposes a conceptual Decision Support System (DSS) framework incorporating a collaborative robotic system for automated segregation and real-time monitoring. By optimizing combustion set points and analyzing real-time logistic data, the proposed system aims to stabilize operations, ensure regulatory compliance, and prevent waste accumulation. The suggested framework is anticipated to promote more stable operations, enhance regulatory compliance, and lower the danger of waste accumulation by combining combustion set point optimization with real-time logistics data analysis.

**Keywords:** *collaborative robot, DSS, incinerator emission, solid waste management, urban waste service*

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Seq: 204 | ID: 1571277531

### Knowledge Graph-Grounded BDI Architecture for LLM-Based Multi-Agent Orchestration in Enterprise Workflow Automation

K. C. Febryanto<sup>1</sup>, R. Sarno<sup>1</sup>, K. R. Sungkono<sup>1</sup>, B. Amaliah<sup>1</sup>, S. Arifiani<sup>1</sup>, M. S. Hitam<sup>2</sup> |

<sup>1</sup>Institut Teknologi Sepuluh Nopember; <sup>2</sup>Universiti Malaysia Terengganu, Malaysia

Enterprise decision-making increasingly relies on multi-agent systems powered by large language models (LLMs), yet these systems lack structured reasoning for traceable, auditable decisions. Although many frameworks adopt Belief- Desire-Intention (BDI) terminology, surveys reveal pervasive conceptual retrofitting where beliefs, desires, and intentions serve as rhetorical labels without formal implementation. This paper introduces KG-BDI, a hybrid framework grounding BDI cognition in an enterprise knowledge graph, unifying three paradigms: BDI for structured deliberation, LLMs for flexible plan generation, and a knowledge graph for a queryable, auditable belief foundation. Factual beliefs are typed graph triples with provenance, inferred beliefs emerge from LLM-guided traversals, and episodic beliefs reside as vector embeddings. Desires are prioritized goal nodes with dependency edges; intentions are LLM-generated plans verified via three-stage pre-commitment checks. A five phase reasoning cycle governs agent behavior, and a shared knowledge graph layer enables multi-agent coordination. Ablation across 4,998 scenarios confirms each component addresses a distinct dimension: removing the knowledge graph causes the largest accuracy drop (-0.124) with hallucination rising to 37.3%, disabling the BDI cycle collapses explainability from 0.929 to 0.286, and substituting the LLM reduces accuracy by -0.094. Fully integrated, KG-BDI achieves 0.931 accuracy, 0.965 F1, 0.929 explainability, and 8.4% hallucination, outperforming all baselines.

**Keywords:** *Agentic AI, BDI Architecture, Enterprise, Knowledge Graph, Multi-Agent Systems, Technological Capabilities, Workflow Automation*

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Seq: 205 | ID: 1571277540

### Development of Large Language Model for Intelligent Root Cause Failure Analysis in Induced Draft Fan Systems

M. R. Hidayat, F. Mahananto, I. A. Akbar, M. N. Yuniarto | Institut Teknologi Sepuluh Nopember

Root Cause Failure Analysis (RCFA) is essential for maintaining the reliability of coal-fired power plants, particularly for critical components such as Induced Draft Fan (IDF) systems. However, conventional RCFA practices rely on manual analysis of unstructured reports and expert knowledge, making the process inefficient and difficult to scale. This study proposes an intelligent Root Cause Failure Analysis framework based on Large Language Model (LLM) to transform historical RCFA reports into a domain-specific knowledge system through supervised fine-tuning. Structured information is extracted from narrative RCFA reports and converted into a question-answer (QA) dataset, which is used to fine-tune Qwen 3 8B, LLaMA 3.1 8B, and Mistral 7B v0.3 using Parameter-Efficient Fine-Tuning (PEFT) with Low-Rank Adaptation (LoRA). Experimental results show that fine-tuning improves the performance across all models, however, evaluation scores must be interpreted alongside training

behavior, as models exhibiting overfitting may achieve inflated scores through memorization rather than genuine domain knowledge acquisition. Qwen 3 8B demonstrated the most stable generalization behavior and produced responses that were qualitatively verified against engineer-validated RCFA reports. The proposed framework enables LLM to function as both diagnostic assistant for performing RCFA and knowledge repositories, supporting more efficient, consistent, and reliable failure analyses in Indonesian coal-fired power plants.

**Keywords:** *Root Cause Failure Analysis, Large Language Model, Fine-Tuning, PEFT, Induced Draft Fan*

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**Seq: 236 | ID: 1571278502**

### **Anomaly Detection Based on Deep Learning in Sales Gas Compressor Sensor Reading Systems for Predictive Maintenance**

*A. D. Zulkarnain, C. Fatichah, R. Indraswari | Institut Teknologi Sepuluh Nopember*

The Jambaran Tiung Biru (JTB) Gas Field is a vital strategic asset for the gas supply in East and Central Java, where maintaining operational continuity of the Sales Gas Compressor (CP02-260-CG9101) is critical to preventing significant financial losses from unplanned shutdowns. Current monitoring relies on manual operator surveillance and static high/low thresholds, which are ineffective at identifying early-stage anomalies, thereby increasing the risk of unexpected failures. This research develops a Deep Learning-based early anomaly detection system for the compressor's lube oil sensors by evaluating Recurrent Neural Network (RNN), Long Short-Term Memory (LSTM), Gated Recurrent Unit (GRU), Bidirectional LSTM (BiLSTM), and Decision Tree Regression architectures. By using percentile-based statistical calculations to define dynamic thresholds for the models, the experimental results—conducted on 21,971 data points collected between April 23, 2024, and November 15, 2025, demonstrated a Mean Absolute Error (MAE) of 0,40639 and Root Mean Square Error (RMSE) of 1,13865. These findings indicate that the proposed system establishes a robust framework for predictive maintenance by dynamically defining normality limits, thereby significantly enhancing the operational reliability of the JTB gas supply."

**Keywords:** *Anomaly Detection, Deep Learning, Predictive Maintenance*

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**Seq: 268 | ID: 1571282891**

### **Machine Learning-Based Prediction of National Salt Supply and Demand Using Historical Data Analysis**

*T. Kristanto<sup>1</sup>, S. N. Khasanah<sup>1</sup>, R. A. S. Prayoga<sup>2</sup>, M. Kamal<sup>1</sup> | <sup>1</sup>Telkom University;*

*<sup>2</sup>Universitas Negeri Surabaya*

Salt is a critical commodity vital for national food security and numerous industrial sectors in Indonesia. The national salt sector encounters considerable obstacles, including output unpredictability, price volatility, climatic fluctuations, and alterations in trade policy, resulting in supply and demand uncertainty that disturbs market equilibrium. This research formulates a forecast model for national salt supply and demand utilizing machine learning techniques to

facilitate precise and prompt decision-making for sustainable food security. Data spanning from 2020 to 2025, encompassing production, consumption, pricing, precipitation, and import quantities, were sourced from PT Garam, Statistics Indonesia (BPS), and the Meteorology, Climatology, and Geophysics Agency (BMKG). The study included three algorithms: Random Forest, Support Vector Machine (SVM), and XGBoost. These three algorithms were implemented and evaluated using Mean Absolute Error (MAE), Root Mean Squared Error (RMSE), and R-squared ( $R^2$ ). The findings indicate that XGBoost surpasses all other models, achieving an MAE of 7.09 thousand tons, an RMSE of 10.76 thousand tons, and a  $R^2$  of 0.904, greatly outperforming traditional ARIMA models. Validation with out-of-sample data for 2024 indicates that the model effectively identifies seasonal patterns, achieving a monthly MAE of 1.67 thousand tons.

**Keywords:** *Salt Supply Prediction, Salt Demand Forecasting, Machine Learning, Time Series Forecasting, Food Security*

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**Seq: 286 | ID: 1571286181**

### **Enhancing YOLOv11 for over-Dimension Truck Detection Using Complementary Attention Mechanisms**

*D. I. Putrawanto, R. Indraswari | Institut Teknologi Sepuluh Nopember*

Over Dimension Over Load (ODOL) vehicles have become a critical issue in transportation systems because they contribute to infrastructure deterioration, traffic congestion, and increased accident risk. Conventional monitoring methods still depend on manual observation and weighbridge inspection, which often reduce efficiency in large-scale traffic supervision. This study proposes an enhanced object detection approach for over-dimension vehicle detection using the YOLOv11n model integrated with three attention mechanisms, namely Shuffle Attention (SA), Mixed Local Channel Attention (MLCA), and Efficient Local Attention (ELA). The proposed method aims to improve feature representation by combining spatial and channel information to better detect vehicles under complex traffic conditions. The dataset used consists of 1,095 annotated vehicle images divided into training, validation, and testing sets. Experimental results show that the proposed multi-attention model achieved the best performance with a precision of 0.729, recall of 0.858, mAP<sub>50</sub> of 0.802, and mAP<sub>50-95</sub> of 0.712, outperforming the baseline YOLOv11n model. In addition, the model maintained an inference speed of 4.1 ms, indicating that the proposed approach remains suitable for real-time implementation. These findings demonstrate that integrating multiple complementary attention mechanisms can improve vehicle detection performance while preserving computational efficiency for intelligent transportation applications.

**Keywords:** *ODOL, vehicle detection, YOLOv11, attention mechanism, object detection*

Seq: 293 | ID: 1571297970

## Unsupervised Geometric Recognition and Classification of Sheet-Metal Parts from CAD Nesting Data

H. V. Sinh<sup>1</sup>, L. B. Truong<sup>2</sup> | <sup>1</sup>Hanoi University of Science and Technology, Vietnam;

<sup>2</sup>Weldcom Industry JSC

This paper proposes a robust and computationally efficient unsupervised framework for geometric recognition and classification of sheet-metal parts directly from CAD nesting data. Unlike conventional approaches relying on heuristic rules or supervised learning models, the proposed method utilizes invariant geometric descriptors together with a hierarchical sequential filtering strategy to achieve accurate and scalable part identification without requiring labeled datasets. A compact feature representation is introduced, incorporating global geometric properties such as area, hole count, maximum spatial extent, and edge-distribution descriptors. Based on these features, a multi-stage filtering mechanism progressively eliminates geometrically inconsistent candidates before final validation. To support practical industrial deployment, a dynamic template generation mechanism is integrated, allowing the framework to adapt online to previously unseen part geometries without retraining. Experimental results on industrial CAD nesting datasets demonstrate recognition accuracy exceeding 99% while maintaining real-time processing performance. Comparative evaluations further show that the proposed method significantly improves robustness and accuracy under complex geometric conditions compared with conventional centroid-based matching approaches. The proposed framework provides a practical and scalable solution for industrial CAD-based recognition and downstream manufacturing automation

**Keywords:** *CAD nesting; geometric recognition; sheet-metal parts; sequential filtering; manufacturing automation; shape descriptors*

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# Appendix

## Author Index

Listed below are the authors of accepted papers in ICSMEch 2026

A. Ejah Salam	Alif Noorachmad Muttaqin
A. Muh. IL Tzar Al-Ayyubi	Allizza M. Añonuevo
Abang Muhammad Rayhan M Saputra	Amalia Utamima
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Agus Hendra Setiawan	Ari Legowo
Agustina Simangunsong	Arif Rahman
Ahmad Cucus	Arifin Nur
Ahmad Dimyani	Ariq Shaquille Baswara
Ahmad Fauzan Athaya	Aris Tjahyanto
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Aulia Riski Amira	Dian Raharjanti
Ayu Azzahro	Diana Eka Putri
Ayu Gareta Risangtuni	Dicky R Prajitno
Azam Zamhuri Fuadi	Didi Rosiyadi
Azhar Naufal Muammar Linsi	Diky Zakaria
Bagus Anugrah Ramadhan	Dimas Adiputra
Bahrudin	Dimas Sangaji
Bambang Riswanto	Dina Fitria Murad
Baringin Sianipar	Dita Pramesti
Bayu Wahyudi	Djarot B. Darmadi
Bhakti Yudho Suprpto	Djohar Syamsi
Bilqis Amaliah	Dodi Zulherman
Bintang Preciosa. S	Doni Bowo Nugroho
Budi Azhari	Doni Purnama Alamsyah
Budi Heryadi	Dwi Nurcahyono
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Gloria Belinda Randa	Isa Hafidz
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Rifki Farhan	Suherman
Rifki Muhida	Sunarto Kaleg
Rifky Ismail	Susmitha Canny
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Simon Siregar	Yuthsi Aprilinda

Zainal Abidin

Zainal Maji'u Syaikhul Anwar

Zaldi Arifa

Zaqiyah Zalzabilah Hamzah

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## Country Index

Indonesia

Japan

Malaysia

Philippines

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Sweden

Taiwan

Thailand

United Arab Emirates

United Kingdom

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