



ICECOS 2017

PROCEEDING

ICECOS 2017 CONFERENCE

**“Sustaining the Cultural Heritage Toward
the Smart Environment for Better Future”**



August 22-23, 2017
HORISON ULTIMA HOTEL
PALEMBANG

Organized by :



Co-Organized by :



Technical co-Sponsored by:



Supported by:



INTERNATIONAL CONFERENCE ON ELECTRICAL ENGINEERING AND COMPUTER SCIENCE (ICECOS) 2017

International Advisory Committee

Gopakumar, Indian university of Science Bangalore, (Power Electronics) IEEE fellow
Haitham Abu-Rub texas A&M University, Qatar
Z. Y. Dong, University of Sidney
Akhtar Kalam, Victoria University, Melbourne, Australia
Azha binti Mohamed, Universiti Kebangsaan Malaysia
Nasrudin bin Abd Rahim, Universiti Malaya

Steering Committee

Yanuarsyah Haroen, Institut Teknologi Bandung
Zainal Salam (UTM) Malaysia
Satrio Dharmanto, IEEE Indonesia Section (Chair)
Ford Lumban Gaol, Bina Nusantara University
Zainuddin Nawawi, Universitas Sriwijaya
Suwarno, Institut Teknologi Bandung
Hussein Ahmad (UTHM) Malaysia

General Chair

Siti Nurmaini, Universitas Sriwijaya, Indonesia

General co-Chairs

Muhammad Abu Bakar, Universitas Sriwijaya, Indonesia
Rahmat Budiarto, Al-baha University, Saudi Arabia
Zolkafle Buntat, Universiti Teknologi Malaysia, Malaysia
Iping Supriana Institut Teknologi Bandung, Indonesia
Khoirul Anwar Telkom University, Indonesia
Kridanto Surendro Institut Teknologi Bandung, Indonesia

Publication Chairs

Deris Stiawan, Universitas Sriwijaya, Indonesia
Firdaus, Universitas Sriwijaya, Indonesia
Tole Sutikno, Universitas Ahmad Dahlan, Yogyakarta, Indonesia

Finance Chairs & Treasurer

Rizda Fitri Kurnia, Universitas Sriwijaya, Indonesia
Caroline, Universitas Sriwijaya, Indonesia

Public Relation Chairs

Muhammad Irfan Jambak, Universitas Sriwijaya, Indonesia
Mochammad Facta, Universitas Diponegoro, Semarang, Indonesia
Teguh Bharata Aji, Universitas Gadjah Mada, Indonesia
Zulfatman, Universitas Muhammadiyah Malang, Malang, Indonesia
Yudistira Dwi Wardhana Asna, Institute Teknologi Bandung, Indonesia
I Wayan Mustika, Universitas Gadjah Mada, Indonesia
Noor Akhmad Setiawan, Universitas Gadjah Mada, Indonesia
Muhammad Syafrullah, Universitas Budi Luhur, Jakarta, Indonesia
Wikan Dinar Sunindiyo, Institute Teknologi Bandung, Indonesia
Anton Yudhana, Universitas Ahmad Dahlan, Yogyakarta, Indonesia

Endra Pitowarno, Politeknik Elektronika Negeri Surabaya – PENS, Indonesia
Feri Chandra Universitas Riau Indonesia

Technical Program Chairs

Reza Firsandaya Malik, Universitas Sriwijaya, Indonesia
Ivor Smith Loughborough University, United Kingdom (Great Britain)
Munawar A. Riyadi, Universitas Diponegoro, Semarang, Indonesia
Iwan Pahendra, Universitas Sriwijaya, Indonesia
Imam Much Ibnu Subroto, Universitas Islam Sultan Agung, Semarang, Indonesia

International Scientific Committee

Brian Kurkoski, School of Information Science Japan Advanced Institute of Science and Technology
(JAIST), Japan

Ahmad Hoirul Basori, King Abdulaziz University, Saudi Arabia
Germano Lambert-Torres, Universidade Federal de Itajuba, Brazil
Serhat Şeker, Istanbul Technical University, Turkey
Wazir Mustafa, Universiti Teknologi Malaysia
Mohammed Yahia Alzahrani, Al-baha University, Saudi Arabia
Ahmed Alahmadi, Al-baha University, Saudi Arabia
Gorakanage Arosha Chandima Gomes (UPM) Malaysia
Montserrat Ros (Wolongong University) Australia
Malik Elbuluk (The University Of Akron) USA
Vernon Coray (Uppsala University) Sweden
Mike Inggs, South Africa
Ilhan Kocaarslan (Istanbul University)
Gamal Abdel Fadeel Khalaf, Faculty of Engineering, Helwan University, Cairo, Egypt
Zhong Hu, South Dakota State University, Brookings, United States
Serdar Ethem Hamamci, Inonu University, Turkey
Gökhan Gökmen, Marmara University, Turkey
Mohd. Yazid Idris, Universiti Teknologi Malaysia
Audrius Senulis, Klaipeda University, Lithuania
Peng Peng, Sr. Development Engineer at Seagate Technology, United States
Kamal Bechkoum, School of Science and Technology, Northampton, United Kingdom
Simon Xu, Algoma University College, Canada
Aydin Nusret Güçlü, METU, Ankara, Turkey
Tahir M. Lazimov, Azerbaijan Technical University, Azerbaijan
Eleonora Guseinoviene, Klaipeda University, Lithuania
Sattar Bader Sadkhan. SMIEEE, University of Babylon, Iraq
Tahir Cetin Akinci, Kirklareli University, Turkey
Ahmad Salman Universiti Tenaga Nasional, Malaysia
Arslan Ahmad University of Cagliari, Italy
Awang Jusoh Universiti Teknologi Malaysia, Malaysia
Bayu Adhi Tama Pukyong National University, South Korea
Ghazali Sulong Universiti Teknologi Malaysia
Gundlapalli Satheesh Malla Reddy Engineering College, India
Haikal Satria Universiti Teknologi Malaysia
Indra Mulyadi Technische Universität Ilmenau, Germany
Ismail Musirin Universiti Teknologi Mara, Malaysia
Md Asri Ngadi Universiti Teknologi Malaysia, Malaysia
Md Salam Universiti Teknologi Brunei, Brunei Darussalam

Miguel Mira da Silva Technical University of Lisbon, Portugal
Mohd Riduan Ahmad Universiti Teknikal Malaysia Melaka, Malaysia
Mohd Zainal Abidin Ab Kadir Universiti Putra Malaysia, Malaysia
Mona Riza Mohd Esa Universiti Teknologi Malaysia, Malaysia
Naebboon Hoonchareon Chulalongkorn University, Thailand
Noor Azlinda Ahmad Universiti Teknologi Malaysia, Malaysia
Setyawan Widyarto Universiti Selangor, Malaysia
Wahyu Utomo Universiti Tun Hussein Onn Malaysia, Malaysia
Wazir Mustafa Universiti Teknologi Malaysia, Malaysia
Yanuar Arief Unimas, Malaysia

Local Chairs

Bhakti Yudho Suprpto, Universitas Sriwijaya, Indonesia
Djulil Amri, Universitas Sriwijaya, Indonesia
Irmawan, Universitas Sriwijaya, Indonesia
Abdul Haris Dalimunthe, Universitas Sriwijaya, Indonesia
Dessy Windiasari, Universitas Sriwijaya, Indonesia
Hera Hikmarika, Universitas Sriwijaya, Indonesia
Hermawati, Universitas Sriwijaya, Indonesia
Rahmawati, Universitas Sriwijaya, Indonesia
Suci Dwi Jayanti, Universitas Sriwijaya, Indonesia
Saparudin, Universitas Sriwijaya, Indonesia
Ermatita, Universitas Sriwijaya, Indonesia
Hadi Purnawan Satria, Universitas Sriwijaya, Indonesia
Ade Silvia, Polytechnic State of Sriwijaya, Indonesia
Nyanyu Latifah Husni, Polytechnic State of Sriwijaya, Indonesia
Syarifah Fitria, Universitas Sriwijaya, Indonesia
Sarifah Putri Raflesia, Universitas Sriwijaya, Indonesia
Rosi Pasarella, Universitas Sriwijaya, Indonesia
Ahmad Heryanto, Universitas Sriwijaya, Indonesia
Rahmat Ihwan Heroza, Universitas Sriwijaya, Indonesia
Alfarisi, Universitas Sriwijaya, Indonesia
Pacu Putra, Universitas Sriwijaya, Indonesia
Rido Zulfahmi, Universitas Sriwijaya, Indonesia
Buyung Munir Bina Nusantara University, Indonesia
Evizal Abdul Kadir Universitas Islam Riau, Indonesia
Hamzah Eteruddin Universitas Lancang Kuning
Lovinta Happy Atrinawati Institut Teknologi Kalimantan, Indonesia
Lukmanul Hakim Universitas Lampung, Indonesia
Mardiyono Politeknik Negeri Semarang, Indonesia
Moh Khairudin Universitas Negeri Yogyakarta, Indonesia
Muhammad Reza Kahar Aziz Institut Teknologi Sumatera, Indonesia
Muhammad Imran Hamid Universitas Andalas, Indonesia
Priza Pandunata Universitas Jember, Indonesia
Satria Mandara Telkom University, Indonesia
Teguh Prakoso, Universitas Diponegoro, Indonesia
Pekik Dahono Institut Teknologi Bandung, Indonesia
Nesdi Evrilyan Rozanda Universitas Islam Riau Indonesia
Andi Adriansyah Universitas Mercubuana Indonesia
A. Aulia, Universitas Andalas Indonesia
Trias Andromeda Universitas Diponegoro Indonesia

2017 International Conference on Electrical Engineering and Computer Science (ICECOS)

Invited Speaker

<i>Serious Games Discover Game Refinement Measure</i> Hiroyuki Iida (Japan Advanced Institute of Science and Technology, Japan)	1
<i>Radio Spectrum Maps for Emerging IoT and 5G Networks: Applications to Smart Buildings</i> Eryk Dutkiewicz (University of Technology Sydney, Australia), Beeshanga Abewardana Jayawickrama (University of Technology Sydney, Australia), Ying He (University of Technology Sydney, Australia)	7
<i>Generation of a Homogeneous Glow Discharge Using Perforated Aluminium Electrode</i> Zolkafle Buntat (Universiti Teknologi Malaysia, Malaysia)	10

Communications and Vehicular Technology

<i>Android-based Application Using Mobile Adhoc Network for Search and Rescue Operation During Disaster</i> Vitri Tundjungsari (Yarsi University, Indonesia), Ahmad Sabiq (YARSI University, Indonesia)	16
<i>Approaches for Improving VoIP QoS in WMNs</i> Mohammad Tariq Meeran (Tallinn University & Kabul University, Estonia), Paul Annus (TTU, Estonia), Yannick Le Moullec (TTU, Estonia)	22
<i>On the Reduction of Interference Effect Using Power Control for Device-to-Device Communication Underlying Cellular Communication Network</i> Misfa Susanto (University of Lampung & University of Lampung, Indonesia), Helmy Fitriawan (Lampung University, Indonesia), Herlinawati Herlinawati (University of Lampung, Indonesia), Andri Abadi (University of Lampung, Indonesia)	28
<i>A Novel Three-Tier SQLi Detection and Mitigation Scheme for Cloud Environments</i> Wahid Rajeh (Huazhong University of Science and Technology & University of Tabuk, P.R. China), Abed Alshreef (Wuhan University of Technology, P.R. China)	33
<i>Improved Bundle Pricing Model on Wireless Internet Pricing Scheme in Serving Multiple QoS Network Based on Quasi-Linear Utility Function</i> Fitri Maya Puspita (University of Sriwijaya, Indonesia), Maijance Oktaryna (Universitas Sriwijaya, Indonesia)	38

Electronics, Circuits, and Systems

<i>Formation Control of Leader-Follower Robot Using Interval Type-2 Fuzzy Logic Controller</i> Gita Fadila Fitriana (Computer Science Faculty, Universitas Sriwijaya, Indonesia), Husnawati Husnawati (Computer Science Faculty, Universitas Sriwijaya, Indonesia), Siti Nurmaini (University of Sriwijaya, Indonesia)	44
---	----

<i>Differential Drive Mobile Robot Control Using Variable Fuzzy Universe of Discourse</i> Siti Nurmaini (University of Sriwijaya, Indonesia), Chusniah Chusniah (Universitas Sriwijaya, Indonesia)	50
<i>Smart Monitoring Apps for Salvaging Neolissochillus Thienemanni Sumateranus (Batak Heritage) from Extinction</i> Richad Harijanja (Del Institute of Technology, Indonesia), Pandapotan Siagian (Del Institute Of Technology, Indonesia), Nickholas Pangaribuan (Del Institute of Technology, Indonesia), Lambok Sinaga (Del Institute of Technology, Indonesia), Baktiar Gultom (Del Institute of Technology, Indonesia), Evita Sembiring (Del Institute of Technology, Indonesia), Kisno Shinoda (Kisno Shinoda, Indonesia)	56
<i>Optimization of PID Control Parameters with Genetic Algorithm plus Fuzzy Logic in Stirred Tank Heater Temperature Control Process</i> Nurul Ikhlas Septiani (Sriwijaya University, Indonesia), Ike Bayusari (Sriwijaya University, Indonesia), Caroline Herry (Sriwijaya University, Indonesia), Triya Haiyunnisa (Indonesian Institut of Sciences, Indonesia), Bhakti Yudho Suprpto (University of Sriwijaya, Indonesia)	61
<i>Vision-Based Multi-Point Sensing for Corridor Navigation of Autonomous Indoor Vehicle</i> Djoko Purwanto (Institut Teknologi Sepuluh Nopember, Indonesia), Muhammad Rivai (Institut Teknologi Sepuluh Nopember, Indonesia), Hendawan Soebhakti (Politeknik Negeri Batam, Indonesia)	67
<i>Odor Classification Using Support Vector Machine</i> Nyayu Latifah Husni (Sriwijaya University & Polytechnic of Sriwijaya, Indonesia), Ade Handayani (Polytechnic of Sriwijaya, Indonesia), Siti Nurmaini (University of Sriwijaya, Indonesia), Irsyadi Yani (Sriwijaya University, Indonesia)	71
<i>Formation Control Design for Real Swarm Robot Using Fuzzy Logic</i> Ade Handayani, ASH (Politeknik Negeri Sriwijaya & Engineering Electrical, Indonesia), Nyayu Husni (Politeknik Negeri Sriwijaya, Indonesia), Siti Nurmaini (University of Sriwijaya, Indonesia), Irsyadi Yani (University of Sriwijaya, Indonesia)	77
<i>Tracking Control Enhancement on Non-Holonomic Leader-Follower Robot</i> Bambang Tutuko (Sriwijaya University, Indonesia), Siti Nurmaini (University of Sriwijaya, Indonesia), Gita Fadila Fitriana (Computer Science Faculty, Universitas Sriwijaya, Indonesia)	83
<i>Mobile-Robot Positioning for Wi-Fi Signal Strength Measurement</i> Ade Handayani, ASH (Politeknik Negeri Sriwijaya & Engineering Electrical, Indonesia), Nyayu Latifah Husni (Sriwijaya University & Polytechnic of Sriwijaya, Indonesia), Siti Nurmaini (University of Sriwijaya, Indonesia), Deby Putri (Polytechnic of Sriwijaya, Indonesia)	87
<i>Cooperative Searching Strategy for Swarm Robot</i> Nyayu Husni (Politeknik Negeri Sriwijaya, Indonesia), Ade Handayani (Polytechnic of Sriwijaya, Indonesia), Siti Nurmaini (University of Sriwijaya, Indonesia), Irsyadi Yani (University of Sriwijaya, Indonesia)	92

Information Technology

<i>An Experimental Study for Detecting Speech</i> Punnoose Kuriakose (Private, India), Ravi Shanker (ABV-IIITM GWALIOR, India)	98
<i>Car Model Recognition from Frontal Image Using BRISK</i> Malisa Huzaifa (Bandung Institute of Technology, Indonesia), Iping Supriana Suwardi (Bandung Institute of Technology, Indonesia)	104

<i>A Critical Review of Blockchain and Its Current Applications</i>	
Bayu Adhi Tama (Pukyong National University (PKNU), Korea), Bruno Joachim Kweka (Pukyong National University, Korea), Youngho Park (Pukyong National University, Korea), Kyung Hyune Rhee (Pukyong National University, Korea)	109
<i>Image Enhancement Using the Image Sharpening, Contrast Enhancement, and Standard Median Filter: Noise Removal with Pixel-Based and Human Visual System-Based Measurements</i>	
Erwin Erwin (Universitas Sriwijaya, Indonesia), Adam Nevriyanto (Universitas Sriwijaya, Indonesia), Purnamasari Diah (Universitas Sriwijaya, Indonesia)	114
<i>A Hybrid Cuckoo Search and K-Means for Clustering Problem</i>	
Abba Suganda Girsang (Bina Nusantara University, Indonesia), Ardian Yunanto (Bina Nusantara University, Indonesia), Ayu Aslamiah (Bina Nusantara University, Indonesia)	120
<i>Designing Gamification Framework to Support Social Media Application Based on Game Elements and Cutting-edge Technology</i>	
Meyhart Sitorus (Gadjah Mada University, Indonesia), Ridi Ferdiana (Universitas Gadjah Mada, Indonesia), Teguh Bharata Adji (Gadjah Mada University, Indonesia)	125
<i>Quality Driven Architectural Solutions Selection Approach Through Measuring Impact Factors</i>	
Md Abdullah Al Imran (University of Malaya, Malaysia), Sai Peck Lee (University Malaya, Malaysia), M A Manazir Ahsan (University of Malaya, Malaysia)	131
<i>Aesthetics of Interaction Design on the Mobile-Based University Website</i>	
Andhika Giri Persada (Universitas Islam Indonesia, Indonesia), Mohamad Waskita Adi Pranata (Universitas Islam Indonesia, Indonesia), Afina Anfa Ana (Universitas Islam Indonesia, Indonesia)	137
<i>A Review on Conditional Random Fields as a Sequential Classifier in Machine Learning</i>	
Dewi Yanti Liliana (Universitas Indonesia, Indonesia), Chan Basaruddin (Universitas Indonesia, Indonesia)	143
<i>Haze Trajectory Clusters in South Sumatra in 2015</i>	
Imas Sukaesih Sitanggung (Bogor Agricultural University, Indonesia), Ajeng Dwi Asti (Bogor Agricultural University, Indonesia), Lailan Syaufina (Bogor Agricultural University, Indonesia), Husnul Khotimah (Bogor Agricultural University, Indonesia)	149
<i>Shape Analysis Using Generalized Procrustes Analysis on Active Appearance Model for Facial Expression Recognition</i>	
Desy Komalasari (Universitas Indonesia & Universitas Indonesia, Indonesia), Chan Basaruddin (Universitas Indonesia, Indonesia), M Rahmad Widyanto (Universitas Indonesia, Indonesia), Dewi Yanti Liliana (Universitas Indonesia, Indonesia)	154
<i>Geofencing Based Technology Towards Child Abuse Prevention</i>	
Sarifah Putri Raflesia (Universitas Sriwijaya, Indonesia), Dinda Lestarini (Bandung Institute of Technology, Indonesia), Taufiqurrahman Taufiqurrahman (Universitas Sriwijaya, Indonesia), Firdaus Firdaus, F (Universitas Sriwijaya & Unsri, Indonesia)	160
<i>The Detection of 3D Object Using a Method of a Harris Corner Detector and Lucas-Kanade Tracker Based on Stereo Image</i>	
Winal Prawira (University of Lampung, Indonesia), Emir Nasrullah (University of Lampung, Indonesia), Sri Ratna Sulistiyanti (University of Lampung, Indonesia), Arinto Setyawan (University of Lampung, Indonesia)	163

<i>Integration of Spatial Online Analytical Processing for Agricultural Commodities with OpenLayers</i>	
Imas Sukaesih Sitanggung (Bogor Agricultural University, Indonesia), Muhamad Syukur (Bogor Agricultural University, Indonesia), Asep Ginanjar (Bogor Agricultural University, Indonesia), Rina Trisminingsih (Bogor Agricultural University, Indonesia), Husnul Khotimah (Bogor Agricultural University, Indonesia)	167
<i>Design of Pick and Place Robot With Identification and Classification Object Based on RFID Using STM32VLDISCOVERY</i>	
Munawar A Riyadi (Diponegoro University, Indonesia), Norman Sudira (Diponegoro University, Indonesia), Aris Triwiyatno (Diponegoro University, Indonesia), M Harisuddin Hanif (Diponegoro University, Indonesia)	171
<i>Denial of Service Attack Visualization with Clustering Using K-Means Algorithm</i>	
Napsiah Amelia Putri (Universitas Sriwijaya, Indonesia), Deris Stiawan (University of Sriwijaya, Indonesia), Ahmad Heryanto (Sriwijaya University, Indonesia), Tri Wanda Septian (University of Sriwijaya, Indonesia), Lelyzar Siregar (Universitas Sumatera Utara, Indonesia), Rahmat Budiarto (Al Baha University, Saudi Arabia)	177
<i>The User Engagement Impact Along Information Technology of Infrastructure Library (ITIL) Adoption</i>	
Sarifah Putri Raflesia (Universitas Sriwijaya & Institut Teknologi Bandung, Indonesia), Kridanto Surendro (Bandung Institute of Technology, Indonesia), Rossi Passarella (Universitas Sriwijaya, Indonesia)	184
<i>Fuzzy Knuth Moris Pratt Algorithm for Knowledge Management System Model on Knowledge Heavy Metal Content in Oil Plants</i>	
Ermatita Ermatita (Sriwijaya University & Computer Science Faculty, Indonesia), Dedik Budianta (Universitas Sriwijaya, Indonesia)	188
<i>Multi-Object Face Recognition Using Content Based Image Retrieval</i>	
Muhammad Fachrurrozi (University of Sriwijaya & Computer Science Faculty, Indonesia), S Saparudin (Fakultas Ilmu Komputer, Universitas Sriwijaya, Indonesia), Erwin Erwin (Universitas Sriwijaya, Indonesia), Anggina Primanita (Universitas Sriwijaya, Indonesia)	193
<i>Spatio-temporal Analysis of South Sumatera Hotspot Distribution</i>	
Firdaus Firdaus, F (Universitas Sriwijaya & Unsri, Indonesia), Septriani Septriani (Universitas Sriwijaya, Indonesia), Alsella Meiriza (Universitas Sriwijaya, Indonesia), Reza Firsandaya Malik (University of Sriwijaya & Faculty of Computer Science, Indonesia), Siti Nurmaini (University of Sriwijaya, Indonesia)	198
<i>Comparison of a* and Iterative Deepening a* Algorithms for Non-Player Character in Role Playing Game</i>	
Anggina Primanita (Universitas Sriwijaya, Indonesia), Rusdi Effendi (Universitas Sriwijaya, Indonesia), Wahyu Hidayat (Universitas Sriwijaya, Indonesia)	202

Pervasive Computing and Internet of Thing

<i>Economic Denial of Sustainability (EDoS) Mitigation Approaches in Cloud: Analysis and Open Challenges</i>	
Fahad Zaman Chowdhury (University of Malaya, Malaysia), Mohd Yamani Idna Idris (University of Malaya, Malaysia), Miss Laiha Mat Kiah (Universiti Malaya, Malaysia), M A Manazir Ahsan (University of Malaya, Malaysia)	206

<i>Smart IoT Automatic Water Sprinkle and Monitoring System for Chili Plant</i> Judika Herianto Gultom (Surya University, Indonesia), Maruf Harsono (Surya University, Indonesia), Tubagus Dhika Khameswara (Surya University, Indonesia), Handri Santoso (Surya University, Indonesia)	212
<i>An Intelligent Smartphone Based Approach Using IoT for Ensuring Safe Driving</i> Mohd Abdullah Al Mamun (East West University, Bangladesh), Jinat Afroj Puspo (East West University, Bangladesh), Amit Kumar Das (East West University, Bangladesh)	217
<i>Enhancing the Capabilities of IoT Based Fog and Cloud Infrastructures for Time Sensitive Events</i> Fatema Tuz Zohora (East West University, Bangladesh), Md. Rezwannur Rahman Khan (East West University, Bangladesh), Md. Fazla Rabbi Bhuiyan (East West University, Bangladesh), Amit Kumar Das (East West University, Bangladesh)	224
<i>Automation Control and Monitoring of Public Street Lighting System Based on Internet of Things</i> Andi Adriansyah (Universitas Mercu Buana, Indonesia), Akhmad Wahyu Dani (Universitas Mercu Buana, Indonesia), Gerri Irman Nugraha (Universitas Sriwijaya, Indonesia)	231

Power Systems

<i>Transformer Paper Condition Assessment Using Adaptive Neuro-Fuzzy Inference System Model</i> Rahman Prasojo (Institut Teknologi Bandung, Indonesia), Karunika Diwyacitta (Institut Teknologi Bandung, Indonesia), Suwarno Suwarno (Institut Teknologi Bandung, P.R. China), Harry Gumilang (PLN, Indonesia)	237
<i>Effects of Lifetime and Loading Factor on Dissolved Gases in Power Transformers</i> Karunika Diwyacitta (Institut Teknologi Bandung, Indonesia), Rahman Prasojo (Institut Teknologi Bandung, Indonesia), Suwarno Suwarno (Institut Teknologi Bandung, P.R. China), Harry Gumilang (PLN, Indonesia)	243
<i>Effect of the Presence of Metal Box on Partial Discharge Detected by Internal Loop Antenna</i> Mukhlisah Yunus (Bandung Institute of Technology, Indonesia), Fendi Fatoni (Bandung Institute of Technology, Indonesia), Umar Khayam (Institut Teknologi Bandung, Indonesia)	248
<i>Monitoring System of Stand Alone Solar Photovoltaic Data</i> Harmini Harmini (Semarang University, Indonesia), Titik Nurhayati (Semarang University, Indonesia)	254
<i>Study on Leakage Current Characteristics of Naturally Aged Silicon Rubber Coated Ceramic Insulator</i> Heldi Alfiadi (Institut Teknologi Bandung, Indonesia), Dini Fauziah (Institut Teknologi Bandung, Indonesia), Suwarno Suwarno (Institut Teknologi Bandung, P.R. China)	259
<i>Comparison of the Effect of Fixed Metallic Defects in Coaxial Gas Insulated Switch-gear Condition Monitoring</i> Visa Musa Ibrahim (FKE UTM JOHOR BAHRU, Malaysia), Zulkurnain Abdul-Malek (University Technology Malaysia, Malaysia), Nor Asiah Muhamad (Universiti Sains Malaysia, Malaysia), Mohammed Imran Mousa (University Technology Malaysia, Malaysia), Zainuddin Nawawi (Universitas Sriwijaya, Indonesia), Muhammad Abu Bakar Sidik (Faculty of Engineering, Universitas Sriwijaya Ogan Ilir, Indonesia), Muhammad Irfan Jambak (Faculty of Engineering, Universitas Sriwijaya Ogan Ilir, Malaysia)	264

<i>Sulphur Hexafluoride Gas Decomposition Products of Fixed Metallic Defect in Coaxial Gas Insulated Switchgear</i>	
Visa Musa Ibrahim (FKE UTM JOHOR BAHRU, Malaysia), Zulkurnain Abdul-Malek (University Technology Malaysia, Malaysia), Nor Asiah Muhamad (Universiti Sains Malaysia, Malaysia), Mohammed Imran Mousa (University Technology Malaysia, Malaysia), Zainuddin Nawawi (Universitas Sriwijaya, Indonesia), Muhammad Abu Bakar Sidik (Faculty of Engineering, Universitas Sriwijaya Ogan Ilir, Indonesia), Muhammad Irfan Jambak (Faculty of Engineering, Universitas Sriwijaya Ogan Ilir, Malaysia)	270
<i>Evaluation and Mitigation of Underground Gas Pipeline Coating Stress Due to Nearby Lightning Stroke</i>	
Mohammed Imran Mousa (University Technology Malaysia, Malaysia), Zulkurnain Abdul-Malek (University Technology Malaysia, Malaysia), Visa Musa Ibrahim (FKE UTM JOHOR BAHRU, Malaysia), Ali I Elgayar (UTM, University Teknologi Malaysia, Malaysia & College of Electrical and Electronics Technology-Benghazi-Libya, Libya), Zainuddin Nawawi (Universitas Sriwijaya, Indonesia), Muhammad Abu Bakar Sidik (Faculty of Engineering, Universitas Sriwijaya Ogan Ilir, Indonesia), Muhammad Irfan Jambak (Faculty of Engineering, Universitas Sriwijaya Ogan Ilir, Malaysia)	275
<i>Wavelet Analysis of Narrow Bipolar Pulses in Tropical Region</i>	
Zaini Zakaria (Universiti Teknologi Malaysia, Malaysia), Noor Azlinda Ahmad (Universiti Teknologi Malaysia, Malaysia), Mona Riza Mohd Esa (Universiti Teknologi Malaysia, Malaysia), Zuraimy Adzis (Institute of High Voltage & High Current, Universiti Teknologi Malaysia, Malaysia), Muhammad Abu Bakar Sidik (Faculty of Engineering, Universitas Sriwijaya Ogan Ilir, Indonesia), Zainuddin Nawawi (Universitas Sriwijaya, Indonesia), Muhammad Irfan Jambak (Faculty of Engineering, Universitas Sriwijaya Ogan Ilir, Malaysia)	280
<i>Recovery Voltage Study of Capacitor Bank Switching for 150kV Electrical System in Indonesia</i>	
Putu Agus Aditya Pramana (PLN Research Institute, Indonesia), Buyung Sofiarto Munir (Bina Nusantara University & PT PLN (PERSERO), Indonesia), Aristo Adi Kusuma (PLN Research Institute, Indonesia)	285
<i>AC Breakdown Strength Enhancement of LDPE Nanocomposites Using Atmospheric Pressure Plasma</i>	
Noor 'Aliaa Awang (Universiti Teknologi Malaysia, Malaysia), Mohd Hafizi Ahmad (Universiti Teknologi Malaysia, Malaysia), Zulkurnain Abdul-Malek (University Technology Malaysia, Malaysia), Muhammad Abu Bakar Sidik (Faculty of Engineering, Universitas Sriwijaya Ogan Ilir, Indonesia), Zainuddin Nawawi (Universitas Sriwijaya, Indonesia), Muhammad Irfan Jambak (Faculty of Engineering, Universitas Sriwijaya Ogan Ilir, Malaysia), Eka Waldi (Andalas University, Indonesia), Aulia Aulia (Universiti Andalas, Indonesia)	290
<i>Effect of Traction Substation for High Speed Railway in Indonesia</i>	
Aristo Adi Kusuma (PLN Research Institute, Indonesia), Buyung Sofiarto Munir (Bina Nusantara University & PT PLN (PERSERO), Indonesia), Putu Agus Aditya Pramana (PLN Research Institute, Indonesia)	295
<i>Lightning Data Mapping of West Java Province</i>	
Brian Bramantyo Harsono (PLN Indonesia, Indonesia), Buyung Sofiarto Munir (Bina Nusantara University & PT PLN (PERSERO), Indonesia), Nur Widi Priambodo (PLN Research Institute, Indonesia)	300

<i>Emission Heights of Narrow Bipolar Events in a Tropical Storm over the Malacca Strait</i> Mohd Riduan Ahmad (Universiti Teknikal Malaysia Melaka, Malaysia), Dinesh Periannan (Universiti Teknikal Malaysia Melaka, Malaysia), Muhammad Haziq Mohammad Sabri (Universiti Teknikal Malaysia Melaka, Malaysia), Mohamad Zoinol Abidin Bin Abd Aziz (Universiti Teknikal Malaysia Melaka & Hang Tuah Jaya, Malaysia), Mona Riza Mohd Esa (Universiti Teknologi Malaysia, Malaysia), Gaopeng Lu (Chinese Academy of Sciences & Institute of Atmospheric Physics, P.R. China), Zhang Hongbo (Institute of Atmospheric Physics, Chinese Academy of Sciences, P.R. China), Vernon Cooray (Uppsala University, Sweden)	305
<i>On the Interaction of 132 kV Transmission System with Communication Line: Street Cabinet Resistivity Evaluation</i> Zainuddin Nawawi (Universitas Sriwijaya, Indonesia), Hussein Ahmad (Universiti Tun Hussein Onn Malaysia, Malaysia), David Caulker (Universiti Teknologi Malaysia, Malaysia), Annuar Ramli (TM R&D SDN BHD, Malaysia), Muhammad Abu Bakar Sidik (Faculty of Engineering, Universitas Sriwijaya Ogan Ilir, Indonesia), Samsul Haimi Dahlan (Universiti Tun Hussien Onn Malaysia, Malaysia)	310
<i>Small Scale Test Model to Study Impulse Flashover and Attachment Pattern of Protected Building Structures</i> Muhammad Abu Bakar Sidik (Faculty of Engineering, Universitas Sriwijaya Ogan Ilir, Indonesia), Hussein Ahmad (Universiti Tun Hussein Onn Malaysia, Malaysia), Irshad Ullah (Universiti Tun Hussein Onn Malaysia, Malaysia), Md Ramdon Baharom (UTHM, Malaysia), Luqman Hakim (Universiti Tun Hussein Onn Malaysia, Malaysia), Zainab Zainal (UTHM, Malaysia)	316
<i>Evaluation of Grounding System for AC Substation Using Sub-Ground(SG) Software for Novice Professionals: Interpretation Based on IEEE Std. 80-1986</i> Muhammad Irfan Jambak (Faculty of Engineering, Universitas Sriwijaya Ogan Ilir, Malaysia), Hussein Ahmad (Universiti Tun Hussein Onn Malaysia, Malaysia), Mohamad Amirul Hafiz Mohammed (Universiti Tun Hussein Onn Malaysia, Malaysia), Siti Amely Jumaat (Universiti Tun Hussein Onn Malaysia, Malaysia), Muhammad Abu Bakar Sidik (Faculty of Engineering, Universitas Sriwijaya Ogan Ilir, Indonesia)	321
<i>Modelling and Optimization of Simultaneous AC-DC Transmission to Enhance Power Transfer Capacity of the Existing Transmission Lines</i> Uvais Mustafa (Aligarh Muslim University, India), M Saad Bin Arif (Universiti Teknologi Malaysia, Malaysia), H. Rahman (Aligarh Muslim University, India), Muhammad Abu Bakar Sidik (Faculty of Engineering, Universitas Sriwijaya Ogan Ilir, Indonesia)	328
<i>AC Breakdown Strength Performance of Plasma Treated Mineral Oil-Based Nanofluids</i> Izzah Zakaria (Universiti Teknologi Malaysia, Malaysia), Mohd Hafizi Ahmad (Universiti Teknologi Malaysia, Malaysia), Zulkurnain Abdul-Malek (University Technology Malaysia, Malaysia), Muhammad Abu Bakar Sidik (Faculty of Engineering, Universitas Sriwijaya Ogan Ilir, Indonesia), Zainuddin Nawawi (Universitas Sriwijaya, Indonesia), Muhammad Irfan Jambak (Faculty of Engineering, Universitas Sriwijaya Ogan Ilir, Malaysia)	333
<i>Wireless Electrical Source for Mobile Application</i> Tresna Dewi (Politeknik Negeri Sriwijaya, Indonesia), Pola Risma (Sriwijaya Polytechnic, Indonesia), Yurni Oktarina (Polytechnic Sriwijaya Palembang-Indonesia, Indonesia), Ahmad Taqwa (State Polytechnic of Sriwijaya, Indonesia)	338

Odor Classification Using Support Vector Machine

Nyayu Latifah Husni, Ade Silvia Handayani
Electrical Department,
State Polytechnic of Sriwijaya,
Palembang, Indonesia
nyayu_latifah@polsri.ac.id
ade_silvia@polsri.ac.id

Siti Nurmaini
Robotic and Control Research
Lab, Faculty of Computer
Science, University of Sriwijaya,
Palembang, Indonesia
siti_nurmaini@unsri.ac.id

Irsyadi Yani
Mechanical Engineering Department,
Faculty of Engineering,
University of Sriwijaya,
Palembang, Indonesia
yani_irs@yahoo.com

Abstract—This paper discusses about the process of classifying odor using Support Vector Machine. The training data was taken using a robot that ran in indoor room. The odor was sensed by 3 gas sensors, namely: TGS 2600, TGS 2602, and TGS 2620. The experimental environment was controlled and conditioned. The temperature was kept between 27.5 °C to 30.5 °C and humidity was in the range of 65% -75 %. After simulation testing in Matlab, the classification was then done in real experiment using one versus others technique. The result shows that the classification can be achieved using simulation and real experiment.

Keywords—odor; SVM; classification; TGS

I. INTRODUCTION

The mechanisms of human olfactory system inspired the researchers to develop imitating noses (called as electronic noses). The inventory of these noses gives a lot of changes in life. The human works can be easier and more quickly due to the amazing help of these e-noses. They are applied in many areas for variety of applications, i.e., military as warfare agents [1]-[2]; agriculture for post harvest management [3]-[4]; food sectors for determining the red wines [5] or olive oil [6]; health in detecting the cancer [7] or wound inspection [8], and air quality monitoring either in indoor [9] or outdoor [10].

As human beings fresh air is a main need. Human can live without food and water for some hours but they will die quickly without the supply of air. Poisonous air suddenly occurs in the surrounding of human accidentally. Some of them have no smell, no color and no sound. Thus, unconsciously, the human inhale them. Air quality monitoring gives some benefits for human being [11]-[13]. It can prevent dangers and decrease the victims due to poisonous air.

Some of dangerous pollutants exposure, such as CO, NO₂, SO₂, O₃ can impair cognitive function, degrade function in producing the heredity, influence social behavior [14]. Some negative syndromes also appear due to those pollutants, such as sick building syndrome (SBS), toxic mold syndrome, and multiple chemical sensitivity [15]. Therefore, it is better to protect our body from them. The National Ambient Air Quality Standard (<http://www.epa.gov/air/criteria.html>) established the limit exposure of some dangerous gases.

Some researchers nowadays tried to minimize the dangers of the dangerous pollutant. They made researches on localizing the odor [16], fire fighter assistance [17], gas leak

detection [18], and classify the odor [19]. Odor classifying was widely investigated for many purposes with different point of view [20]. The classification of odor using simple equipment is really useful for industry and also domestic application [21]. It can be easily substitute the role of human, for instance in classifying odor in perfumes and in food industries [22], [23]. Using electronic nose that can classify the type of odor precisely can increase the performance of industrial production. For environment monitoring, classifying odor can also give advantage human. Using a system that is able to classify the odor can give advantage to the human, such as giving the information and a warning to the human when the odor that the human inhales is danger and poisonous.

In classifying and identifying the odor, previous researchers used ANN [24] and SVM algorithm [25], [26], [27], [28], [29]. The classification of odor substances can be achieved using NN, however, it needs more time in order to get convergence condition. It is contrary to SVM. In SVM, the convergences can be got more quickly than NN. It's due to the data that should be generated will be divided into some parts by the SVM. It can separate the datasets by searching for an optimal separating hyper-plane between them [30].

SVM can work using a restricted amount of training data. By exploiting optimal hyper-plane, the largest distance or margin from the separating hyper-plane to the closest training vector can be provided. The maximizing of that linear discriminant margin can minimize the generalization errors. Thus, better generalization with high probability can be got [31]. These facts are contradictive with NN that cannot run well using a limited training data. Therefore, SVM are widely used in overcoming pattern recognizing problems [25], [26], [27], [28], [29]. The success of SVM application has been proved by Marcela [32] who compared 3 classification techniques, i.e. 1. Statistical Classifier (LDA); 2. Multi Layer Perceptron (MLP) using NN; and 3. Support Vector Machine (SVM). Marcela stated that SVM was better than two other classification techniques. Weizhen Lu also stated that SVM was better than NN [33]. There were three reasons introduced by Weizhen in order to state SVM power, such as: 1. It contains less number of free parameters than the conventional NN models; 2. SVM method provides better predicting results than neural network does; 3. The typical drawbacks of neural network models, e.g., "over-fitting" training and local minima, can be eliminated in SVM method. These 3 reasons were proved using research in [33]. In this research, 3 gas sources

were investigated, namely: ethanol, methanol, and acetone. These 3 gases were introduced to electronic nose in order to analyze the robustness of the robots in determining what type of gas that it has sensed.

II. ODOR CLASSIFICATION

In determining the success of odor classification, some aspects should be paid attentions, such as, the sensors and machine learning. A brief explanation of them is given as follows:

A. Electronic Nose

Electronic nose consists of 3 major parts, i.e., 1. Sensor Arrays, 2. Signal Transducer, and 3. Pattern Recognition. Sensor arrays are the first part of the olfactory system that has function to detect or sense the input of the system. The input of the system is usually in the form of odorant molecules. In the second part, there is signal transducer that has function to transduce the conductivity of material into electrical signal. That signal will be pre-processed and conditioned in the signal transducer. At the end part of the olfactory system, signal will be analyzed using pattern recognition in order to determine the concentration of the odor being measured [34]. The similarity of human olfactory system and electronic nose is described in Fig. 1. Support Vector Machine

Support Vector Machine (SVM) is one of learning machines. It was first introduced by Vapnik in 1979 [35] The method in this technique uses a hyper-plane that separates the dataset. Zhu and Blumberg, 2002 in [36] classified the terms used in SVM hyper-plane into 2 categories, i.e. optimal and learning. Optimal means that the separation hyper-plane obtained can minimize the misclassifications of training data, while learning means the iterative process of finding the classifier.

For getting optimal hyper-plane, assume that a training data $(x_1, y_1), \dots, (x_l, y_l), x \in R^n, y \in \{+1, -1\}$ can be separated by a hyper-plane as in equation (1):

$$(w \cdot x) - b = 0 \quad (1)$$

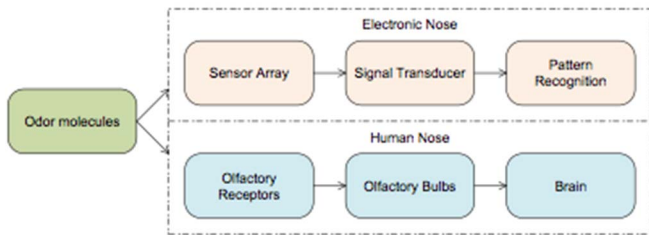


Fig. 1. Human olfactory system versus electronic nose

See Fig. 2 for the hyper-plane position. In this case, the set of vectors is separated by optimal hyper-plane (or maximal margin of hyper-plane) if it is separated without error and the

distance between the closest vector to the hyper-plane is maximal [35].

Use these 2 conditions in order to describe the separating hyper-plane:

$$(w - x_i) - b \geq 1 \quad \text{if } y_i = 1$$

and

$$(w - x_i) - b \leq -1 \quad \text{if } y_i = -1.$$

The compact notation for those inequalities is:

$$y_i[(w - x_i) - b \geq 1], \quad i = 1, \dots, l \quad (2)$$

For optimal solution, some non linear problems in SVM can be solved using α value of Lagrange multiplier as stated by S. Lee [37], as follow:

$$Q(\alpha) = \sum_{i=1}^N \alpha_k - \frac{1}{2} \sum_{i=1}^N \sum_{j=1}^N \alpha_i \alpha_j y_i y_j K(x_i, x_j) \quad (3)$$

If it subjects to the constraints, the equation will be:

$$\sum_{i=1}^N \alpha_i y_i = 0$$

where: $0 \leq \alpha_i \leq C, i = 1, \dots, l$

In non linear case, the function of $K(x_i, x_j)$ can be solved by using kernels, such as polynomial, gaussian, radial basis function, and multi layer perceptron [37]. The solution of equation (3), will be :

$$\alpha^* = (\alpha_1, \dots, \alpha_l)^T \quad (4)$$

The decision function can be counted using equation [38]:

$$f(x) = \text{sign}(\sum_{i \in SV} \alpha_i y_i K(x_i, x) + \alpha_i y_i \lambda^2) \quad (5)$$

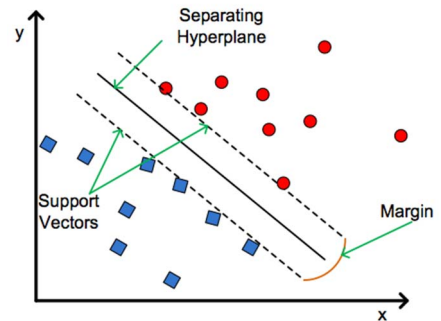


Fig. 2. Hyperplane

where α_i is the support vector value, x_i for the data that has correlation to support vector, x as testing sample data, y as target class and λ as constant.

Most of odor classification that used static sensors extracted the information of the sensor's steady state response. Thus, the input of the SVM algorithm is the comparison between the baseline and the steady state [39]. Amy Loutfi in [39] tried another method in classifying the odor. The training data of the SVM was got from the transient response of the sensors, not from the steady state response. Discrete Wave Transform (DWT) was used to improve the classification of the odor. DWT has function to decompose input signals of the training algorithm. The wavelett coefficients of the DWT were then inputted to the Principle Component analysis (PCA) to be extracted and finally classified by the SVM.

Marco Trincavelli in [40] tried to make a classification of odor in continuous monitoring application. The transient responses of the signals were used. The signals were collected using three-phase sampling technique, namely rise, steady state, and decay. The sensors mounted on the robot got samples continuously although the robot was not in the stopping condition. However, the steady state phase could not be reached although the speed of the robot in moving from one place to another place was constant. That is all was due to sensors was not exposed to the sources for long enough time. Therefore, Marco proposed a segmentation method to identify each phases of the output of the sensors. This method became one of important researches in reaching reliable e-nose application.

Alexander Vergara in [41] introduced Inhibitory Support Vector Machine (ISVM) to train a sensor array and evaluate its ability in detecting and indentifying odor in complex environment. Vergara's proposed method was a valuable tool in guiding to a decision which training condition should be chosen. It also became an important basic in understanding the degradation of the sensor to the change of the environmental condition.

Frank Michael Schleif in [42] proposed Generative Topographic Mapping Through Time (GTM-TT) to overcome some limitation occur in classical classification methods such as high dimensionality characterization. To evaluate the robustness and sustainability of proposed technique, it was compared to 3 other different classical algorithms, i.e. SVM, NN (Nearest Neighbor), and RTK (Reservoir ComputingTime- series Kernel). However, The GTM-TT is still under evaluation and reserach. It still needed to be developed and analyzed.

In paper [43], the SVM was used to recognize the source in a complex environment. The odor localization in that research was done using visual aid. The SVM was used to make segmentation of color image. Then, the feature candidates got from SVM (color, shape, and orientation) were extracted so that the robot can move to search the target by analyzing the characteristic of the areas. Besides to be used in odor classification for plume tracking/tracing or plume finding, SVM was also used in plume declaration [43].

The sensor output will be different when it is applied in mobile robot. The movement of the robot will produce inconsistency of the collected data. Therefore, it needed a special method to manage instability of odor concentration. In this paper, a basic experiment to the classification of odor is introduced. Due to its complexity, in this paper, it only shows the simulation and the classification of gas using a static robot. For the next research, a mobile one will be considered.

III. EXPERIMENTAL SETUP

A. Preparation

The first step in odor classification is to prepare the training data for the machine learning. A robot equipped with 3 odor sensors was set up (Fig. 3). The 3 sensors used were TGS 2600, TGS 2602, and TGS 2620. The block diagram process of the robot can be seen in Fig. 4 and Fig. 5.

The sources used were Ethanol, methanol, and acetone. These three sources are safer to be used in the real experiment. The array of sensors (TGS 2600, TGS 2602, and TGS 2620) sensed and detected the source and produced a signal response that formed a pattern. This pattern was used in the array sensors data processing. In this research, 2 controllers were used, namely: Arduino Mega and Raspberry. The use of raspberry was intended to process the classification in the robot itself, not using external processor, such as computer or other processors.

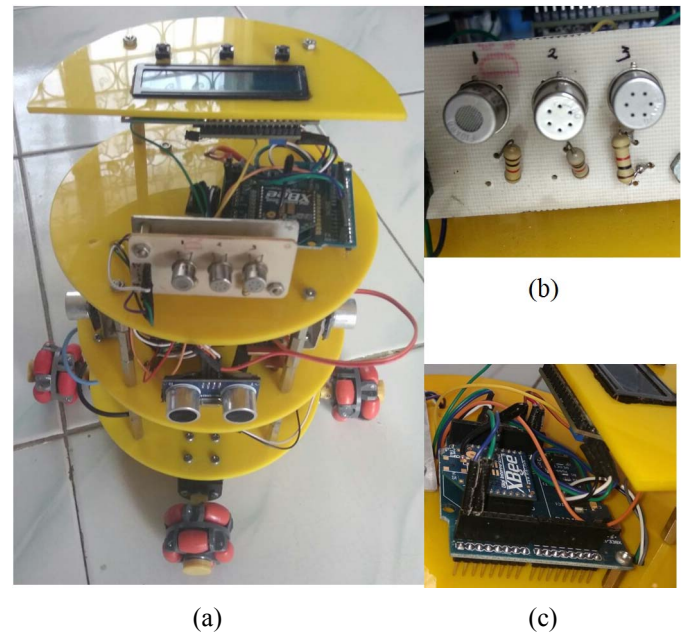


Fig. 3. Odor classification robot (a) Physical robots (b) three TGS sensors arranged from left to right: TGS 2620, TGS 2600, and TGS 2602. (c) X-bee transmitter module.

From Fig. 4, it can be seen that the signal sensed by the sensor array was first sent to the Arduino Mega. The signal

was then converted to digital signal in the arduino. The next, the digital signal was then sent to Raspberry. In this controller, the SVM process was conducted. The training data and testing were processed in this raspberry. An algorithm using one versus others technique was used (See Fig. 6) to identify and classify the gas. The process of the classification can be summarized in some steps, as follows:

1. Training Data

- a. Determine the number of classes in SVM process
- b. Map the data from input space to feature space using Kernel Radial Basis Function using the equation (6).

$$K(\vec{x}, \vec{y}) = \exp(-\gamma\gamma\|\vec{x} - \vec{y}\|^2) \quad (6)$$

- c. Determine support vector value $\alpha \neq 0$ by counting the value of $\alpha_1, \alpha_2, \dots, \alpha_n$ (where n is the amount of training data) from quadrating programming in equation (3). The correlation data x_i that correlates to $\alpha \neq 0$ as support vector can be achieved by using this programming.

2. Testing process

- a. Determine the number of classes in SVM process
- b. Map the data from input space to feature space using Kernel Radial Basis Function using the equation (6)
- c. Count decision function using equation (5).

The data base (training data) used in this experiment was taken in indoor environment of 4 m x 9 m. The robot was run under controlled and conditioned environment. The temperature was kept between 27.5 °C - 30.5 °C and humidity 65 % - 75 %.

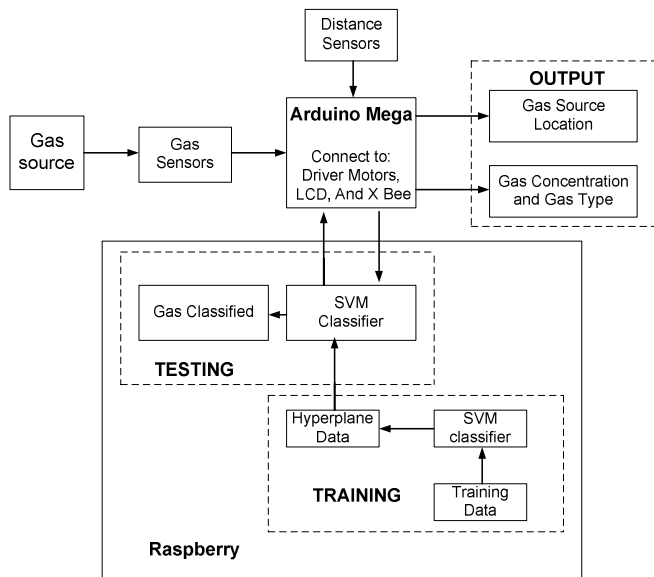


Fig. 4. Block Diagram Process

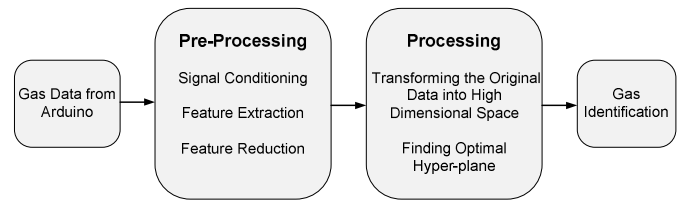


Fig. 5. Block diagram process in SVM

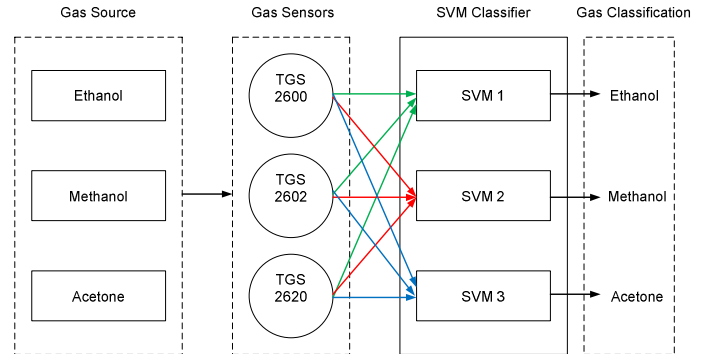


Fig. 6. One versus Other Technique

For the simulation and real experiment importance, at the beginning, the data training was got using these steps: The robot used as validation of the experiments was accomplished with wireless communication modules (X-bee communication). The transmitter was attached in the robot while the receiver was connected to the server. The data from the sensors can be easily monitored in the server. The choice of using X-bee communication was based on its superiorities (low cost, low power consumption, simple protocol, greater useful range and global implementation). It is suitable for this experiment due to the research used low data rate applications with limited battery power

B. Data Preprocessing

The continuous data sent to the server was then sampled, mined and processed. The final output data was then supplied as the training data of the SVM. For the simulation process, the pattern recognition or the classification simulation was then processed using Matlab. For real experiment, the training data was supplied to raspberry. In this part, the SVM process followed the block diagram process in Fig. 5.

IV. RESULT AND DISCUSSION

A. Training data

The data got from the real experiment in preparation process that was sampled, mined and processed as mentioned above was then supplied to the matlab to be simulated and raspberry for the real eksperiment. The data has been divided into two classes -1 and +1. See Sub Chapter III. A. point 1 for the detail.

B. Classification in Simulation

After the training data got, the next step was to construct the simulation. The simulation was done using GUI in matlab program. The experimental result was shown in Fig. 5. of some dangerous gases.

The simulation has a high percentage of success. From the experiment, it had more than 90% success (see Table II). Its success depends on the situation and condition of the environment to be tested. It is a must for the user to pay attention on the surrounding condition. It should be in the same condition with the training data prepared at the beginning.

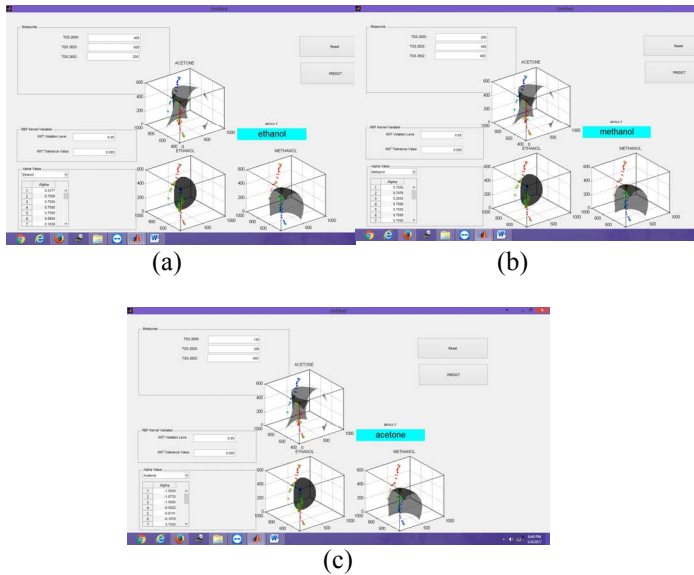


Fig. 7. Simulation of SVM when detected different sources (a) Ethanol (b) Methanol (c) Acetone

C. Classification in Real Experiment

For the real experiment, the data got can be seen in Fig. 8 and Table 2.

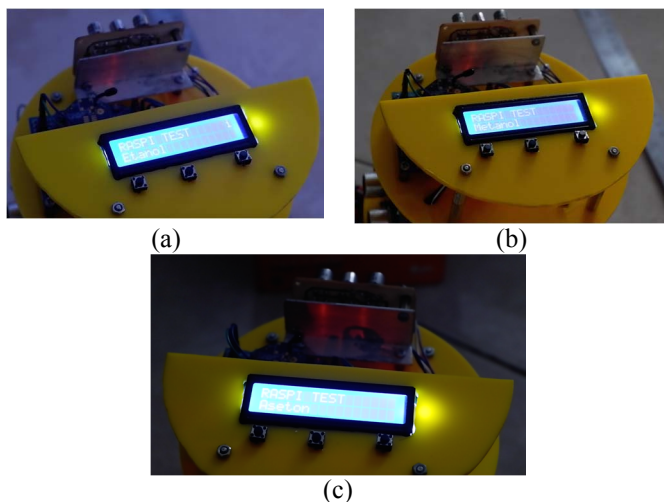


Fig. 8. Real experiment of SVM when detected different sources (a) Ethanol (b) Methanol (c) Acetone

TABLE I. SUCCESS RATE OF REAL EXPERIMENT

No.	Gas Source	Tested Output	Success Rate (%)
1.	Ethanol	Ethanol	95
2.	Methanol	Methanol	95
3.	Acetone	Acetone	90

V. CONCLUSION

The experiments on gas are really difficult. It is due to the gases are really sensitive. They can spread and dilute easily in the air. Therefore, the concentrate of the gas in one position will be different with other position although they are in the same room or area. The robustness of the gas sensor also affected the success of the experiment. It is better to be conditioned as already recommended by the data sheet of the sensors. For TGS series, especially TGS 26xx series, they should be conditioned for 7 days before they are used. When it was not conditioned in correct rules, the sensor will not work efficiently, some times the reading become false. Thus, the experiments will come to fail. The experiments done here was already successful. However, it is still far from the real one. Therefore, for the next experiments, we will try to conduct a real experiment using mobile robot, not static one..

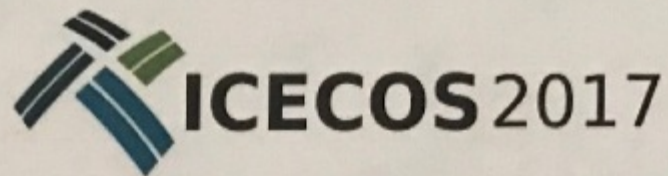
ACKNOWLEDGMENT

Authors thank to the Indonesian Ministry of Research, Technology and National Education (RISTEKDIKTI) and State Polytechnic of Sriwijaya under Research Collaboration for their financial supports in Competitive Grants Project. This paper is also one of our Ph.D. projects. Our earnest gratitude also goes to all researchers in Signal Processing and Control Laboratory, Electrical Engineering, State Polytechnic of Sriwijaya who provided companionship and sharing of their knowledge

REFERENCES

- [1] V. B. Raj, H. Singh, A. T. Nimal, M. U. Sharma, and V. Gupta, "Sensors and Actuators B : Chemical Oxide thin films (ZnO , TeO 2 , SnO 2 , and TiO 2) based surface acoustic wave (SAW) E-nose for the detection of chemical warfare agents," vol. 178, pp. 636–647, 2013.
- [2] C. Olgu??n, N. Laguarda-Mir??, L. Pascual, E. Garc??a-Breijo, R. Mart??nez-Ma??ez, and J. Soto, "An electronic nose for the detection of Sarin, Soman and Tabun mimics and interfering agents," *Sensors Actuators, B Chem.*, vol. 202, no. April 1972, pp. 31–37, 2014.
- [3] A. D. Wilson, "Diverse applications of electronic-nose technologies in agriculture and forestry," *Sensors (Switzerland)*, vol. 13, no. 2, pp. 2295–2348, 2013.
- [4] J. Gruber, H. M. Nascimento, E. Y. Yamauchi, R. W. C. Li, C. H. A. Esteves, G. P. Rehder, C. C. Gaylarde, and M. A. Shirakawa, "A conductive polymer based electronic nose for early detection of *Penicillium digitatum* in post-harvest oranges," *Mater. Sci. Eng. C*, vol. 33, no. 5, pp. 2766–2769, 2013.
- [5] M. L. Rodriguez-Mendez, C. Apetrei, M. Gay, C. Medina-Plaza, J. A. De Saja, S. Vidal, O. Aagaard, M. Ugliano, J. Wirth, and V. Cheyner, "Evaluation of oxygen exposure levels and polyphenolic content of red wines using an electronic panel formed by an electronic nose and an electronic tongue," *Food Chem.*, vol. 155, pp. 91–97, 2014.
- [6] D. Melucci, A. Bendini, F. Tesini, S. Barbieri, A. Zappi, S. Vichi,

- L. Conte, and T. Gallina Toschi, "Rapid direct analysis to discriminate geographic origin of extra virgin olive oils by flash gas chromatography electronic nose and chemometrics," *Food Chem.*, vol. 204, pp. 263–273, 2016.
- [7] E. Westenbrink, R. P. Arasaradnam, N. O'Connell, C. Bailey, C. Nwokolo, K. D. Bardhan, and J. A. Covington, "Development and application of a new electronic nose instrument for the detection of colorectal cancer," *Biosens. Bioelectron.*, vol. 67, pp. 733–738, 2015.
- [8] P. Jia, F. Tian, Q. He, S. Fan, J. Liu, and S. X. Yang, "Feature extraction of wound infection data for electronic nose based on a novel weighted KPCA," *Sensors Actuators, B Chem.*, vol. 201, pp. 555–556, 2014.
- [9] S. Zampolli, I. Elmi, F. Ahmed, M. Passini, G. C. Cardinali, S. Nicoletti, and L. Dori, "An electronic nose based on solid state sensor arrays for low-cost indoor air quality monitoring applications," *Sensors Actuators, B Chem.*, vol. 101, no. 1–2, pp. 39–46, 2004.
- [10] A. C. Romain and J. Nicolas, "Long term stability of metal oxide-based gas sensors for e-nose environmental applications: An overview," *Sensors and Actuators, B: Chemical*, vol. 146, no. 2, pp. 502–506, 2010.
- [11] N. Castell, M. Kobernus, H. Y. Liu, P. Schneider, W. Lahoz, A. J. Berre, and J. Noll, "Mobile technologies and services for environmental monitoring: The Citi-Sense-MOB approach," *Urban Clim.*, vol. 14, pp. 370–382, 2015.
- [12] S. Devarakonda, P. Sevusu, H. Liu, R. Liu, L. Iftode, and B. Nath, "Real-time air quality monitoring through mobile sensing in metropolitan areas," *Proc. 2nd ACM SIGKDD Int. Work. Urban Comput. - UrbComp '13*, p. 1, 2013.
- [13] A. Marjovi, A. Arfire, and A. Martinoli, "High Resolution Air Pollution Maps in Urban Environments Using Mobile Sensor Networks," *11th Int. Conf. Distrib. Comput. Sens. Syst. (DCOSS 2015)*, 2015.
- [14] C. Lin, S. Yang, K. Lin, W. Ho, and W. Hsieh, "Multilevel Analysis of Air Pollution and Early Childhood Neurobehavioral Development," no. 2, pp. 6827–6841, 2014.
- [15] J. A. Bernstein, N. Alexis, H. Bacchus, I. L. Bernstein, P. Fritz, E. Horner, N. Li, S. Mason, A. Nel, J. Oullette, K. Reijula, T. Reponen, J. Seltzer, A. Smith, and S. M. Tarlo, "The health effects of nonindustrial indoor air pollution," *J. Allergy Clin. Immunol.*, vol. 121, no. 3, pp. 585–591, 2008.
- [16] Z. Yuli, M. A. Xiaoping, and M. Yanzi, "Localization of Multiple Odor Sources Using Modified Glowworm Swarm Optimization with Collective Robots," pp. 1899–1904, 2011.
- [17] A. Marjovi, L. Marques, and J. Penders, "Guardians robot swarm exploration and firefighter assistance," ... *Conf. Intell. Robot.*, 2009.
- [18] J. Wan, Y. Yu, Y. Wu, R. Feng, and N. Yu, "Hierarchical Leak Detection and Localization Method in Natural Gas Pipeline Monitoring Sensor Networks," *Sensors*, vol. 12, no. 1, pp. 189–214, 2011.
- [19] J. G. Monroy and J. Gonzalez-jimenez, "Sensors and Actuators B: Chemical Gas classification in motion: An experimental analysis," *Sensors Actuators B. Chem.*, vol. 240, pp. 1205–1215, 2017.
- [20] S. Omatu, T. Wada, S. Rodríguez, P. Chamoso, and J. M. Corchado, "Multi-agent Technology to Perform Odor Classification Case Study: Development of a VO for Odor Classification," pp. 241–252, 2014.
- [21] F. Hossein-babaei and A. Amini, "Sensors and Actuators B: Chemical Recognition of complex odors with a single generic tin oxide gas sensor," *Sensors Actuators B. Chem.*, vol. 194, pp. 156–163, 2014.
- [22] Z. Xiao, D. Yu, Y. Niu, F. Chen, S. Song, J. Zhu, and G. Zhu, "Characterization of aroma compounds of Chinese famous liquors by gas chromatography – mass spectrometry and flash GC electronic-nose," *J. Chromatogr. B*, vol. 945–946, pp. 92–100, 2014.
- [23] A. Loutfi, S. Coradeschi, G. Kumar, P. Shankar, J. Bosco, and B. Rayappan, "Electronic noses for food quality: A review," *J. Food Eng.*, vol. 144, pp. 103–111, 2015.
- [24] L. Marques, U. Nunes, and A. Dealmeida, "Olfaction-based mobile robot navigation," *Thin Solid Films*, vol. 418, no. 1, pp. 51–58, 2002.
- [25] C. Distante, N. Ancona, and P. Siciliano, "Support vector machines for olfactory signals recognition," *Sensors Actuators, B Chem.*, vol. 88, no. 1, pp. 30–39, 2003.
- [26] F. J. Acevedo, S. Maldonado, E. Domínguez, a. Narváez, and F. López, "Probabilistic support vector machines for multi-class alcohol identification," *Sensors Actuators, B Chem.*, vol. 122, no. 1, pp. 227–235, 2007.
- [27] I. Conference, A. Technologies, and I. Processing, "Gases Identification with Support Vector Machines Technique (SVMs)," pp. 271–276, 2014.
- [28] L. Zhang, F. Tian, L. Dang, G. Li, X. Peng, and X. Yin, "Sensors and Actuators A: Physical A novel background interferences elimination method in electronic nose using pattern recognition," *Sensors Actuators A. Phys.*, vol. 201, pp. 254–263, 2013.
- [29] K. Brudzewski, S. Osowski, and A. Dwulit, "Recognition of coffee using differential electronic nose," *IEEE Trans. Instrum. Meas.*, vol. 61, no. 6, pp. 1803–1810, 2012.
- [30] L. Dang, F. Tian, L. Zhang, C. Kadri, and X. Yin, "Sensors and Actuators A: Physical A novel classifier ensemble for recognition of multiple indoor air contaminants by an electronic nose," *Sensors Actuators A. Phys.*, vol. 207, pp. 67–74, 2014.
- [31] A. Bermak, S. B. Belhouari, M. Shi, and D. Martinez, "Pattern Recognition Techniques for Odor Discrimination in Gas Sensor Array," vol. X, 2006.
- [32] M. A. Vizcay, M. A. Duarte-Mermoud, and M. de la L. Aylwin, "Odorant recognition using biological responses recorded in olfactory bulb of rats," *Comput. Biol. Med.*, vol. 56, pp. 192–199, 2015.
- [33] W. Lu, W. Wang, A. Y. T. Leung, R. K. K. Yuen, Z. Xu, and H. Fan, "Air Pollutant Parameter Forecasting Using Support Vector Machines," pp. 0–5, 2002.
- [34] S. Güney and A. Atasoy, "Sensors and Actuators B: Chemical Multiclass classification of n -butanol concentrations with k -nearest neighbor algorithm and support vector machine in an electronic nose," *Sensors Actuators B. Chem.*, vol. 166–167, pp. 721–725, 2012.
- [35] V. N. Vapnik, "The Nature of Statistical Learning Theory(2ed)." .
- [36] G. Mountrakis, J. Im, and C. Ogole, "Support vector machines in remote sensing: A review," *ISPRS J. Photogramm. Remote Sens.*, vol. 66, no. 3, pp. 247–259, 2011.
- [37] S. Lee, "A survey on pattern recognition applications of support vector machines," vol. 17, no. 3, pp. 459–486, 2003.
- [38] S. Vijayakumar and S. Wu, "Sequent Vector Classifier and Regression," *Proc. Int. Conf. Soft Comput.*, no. 610–619, 1999.
- [39] A. Loutfi, S. Coradeschi, A. Lilienthal, and J. Gonzalez, "Gas Distribution Mapping of Multiple Odour Sources using a Mobile Robot," pp. 1–15.
- [40] M. Trincavelli, S. Coradeschi, and A. Loutfi, "Odour classification system for continuous monitoring applications," *Sensors Actuators, B Chem.*, vol. 139, no. 2, pp. 265–273, 2009.
- [41] A. Vergara, J. Fonollosa, J. Mahiques, M. Trincavelli, N. Rulkov, and R. Huerta, "On the performance of gas sensor arrays in open sampling systems using Inhibitory Support Vector Machines," *Sensors Actuators, B Chem.*, vol. 185, pp. 462–477, 2013.
- [42] F. M. Schleif, B. Hammer, J. G. Monroy, J. G. Jimenez, J. L. Blanco-Claraco, M. Biehl, and N. Petkov, "Odor recognition in robotics applications by discriminative time-series modeling," *Pattern Anal. Appl.*, 2015.
- [43] P. Jiang, M. Zeng, Q. Meng, F. Li, and Y. Li, "A Novel Object Recognition Method for Mobile Robot Localizing a Single Odor / Gas Source in Complex Environments," pp. 2–6, 2008.



**INTERNATIONAL CONFERENCE
ON ELECTRICAL ENGINEERING AND COMPUTER SCIENCE 2017**

August 22-23, 2017

PALEMBANG, INDONESIA

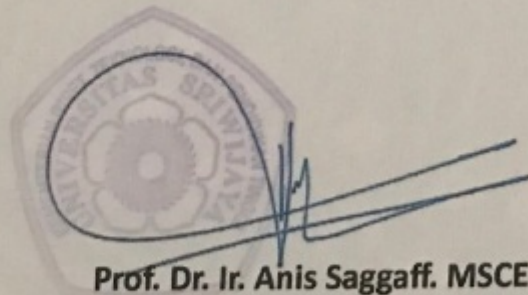
CERTIFICATE OF APPRECIATION

present to

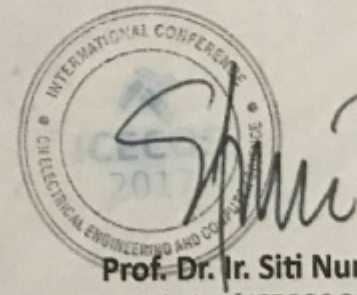
Nyayu Latifah Husni

In recognition and appreciation of your contribution as

PRESENTER



Prof. Dr. Ir. Anis Saggaff. MSCE
Rector of Universitas Sriwijaya

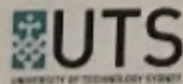


Prof. Dr. Ir. Siti Nurmaini
Chair of ICECOS 2017

Organized by :



Co-Organized by :



Technical co-Sponsored by:



Supported by:

