

The 8<sup>th</sup> International Conference on Information Communication and Technology (ICoICT)

24-26 June 2020

Yogyakarta, Indonesia

[Home](#) [Program](#) [TPC](#) [Committees](#) [Authors](#) [Other reviewers](#)

## Homepage

It is our great pleasure to announce that the 8th International Conference on Information and Communication Technology (ICoICT 2020) will be held in Yogyakarta, Indonesia on June 24 - 26, 2020.

Yogyakarta is the capital city of Indonesia as well as the largest city in the country. It is the cultural and economic hub of Indonesia with widely recognized landmarks including the iconic Borobudur Temple, Prambanan Temple.

ICoICT 2020 will be jointly organized by Telkom University Indonesia, Multimedia University Malaysia, and Universitas Gadjah Mada Indonesia.

The conference offers a good opportunity to enhance international academic exchange on ICT related topics and to provide a platform for researchers to discuss new problems and solutions.

ICoICT 2020 will feature traditional paper presentations, poster presentations, tutorials, demos, as well as keynote speech by renowned educational experts and industrials.

Papers from the previous ICoICT 2013 until 2019 have been published in **IEEE Xplore** and indexed in **Scopus**:

ICoICT 2013: <https://ieeexplore.ieee.org/xpl/conhome/6569393/proceeding>

ICoICT 2014: <https://ieeexplore.ieee.org/xpl/conhome/6908150/proceeding>

ICoICT 2015: <https://ieeexplore.ieee.org/xpl/conhome/7203317/proceeding>

ICoICT 2016: <https://ieeexplore.ieee.org/xpl/conhome/7565234/proceeding>

ICoICT 2017: <https://ieeexplore.ieee.org/xpl/conhome/8054654/proceeding>

ICoICT 2018: <https://ieeexplore.ieee.org/xpl/conhome/8509820/proceeding>

ICoICT 2019: <https://ieeexplore.ieee.org/xpl/conhome/8825728/proceeding>

The previous ICoICT conferences have successfully served a forum to bring together a diverse group of people from academics and industrial to share and present the latest issues and recent developments in the area of ICT.

2020 8th International Conference on Information and Communication Technology (ICoICT)  
Important Dates:

Call for Paper

OCTOBER 1, 2019

Paper Submission Deadline	FEBRUARY 1, 2020
Extended Paper Submission Deadline	FEBRUARY 29, 2020
Notification of Papes Acceptance	MARCH 15, 2020
Submission of Camera Ready Papers and Author Registration Deadline	APRIL 30, 2020
Conference Date	JUNE 24-26, 2020

The previous ICoICT conferences have successfully served a forum to bring together a diverse group of people from academics and industrial to share and present the latest issues and recent developments in the area of ICT. ICoICT 2020 is co-sponsored by IEEE Indonesia Section and IEEE Signal Processing Society Indonesia Chapter. All accepted papers in ICoICT 2020 will be published in the conference proceedings and will be submitted for publication.

We look forward to seeing you in Yogyakarta!



[2020 8th International Conference on Information and Communication Technology \(ICoICT\)](#)

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[Home](#) [Program](#) [TPC](#) [Committees](#) [Authors](#) [Other reviewers](#)

## Program

**Greetings and Video Presentation**

**Welcoming Speech by General Chair of ICoICT 2020**

**Speech by Universitas Gadjah Mada**

**Speech by Multimedia University**

**Opening Speech by Rector of Telkom University**

**Performance by Tel-U Virtual Choir**

**Keynote Speech #1**

Image Recognition for Driving Assistance of Intelligent Vehicles

The driver assistance system through image recognition has become important, as the traffic accident rate of the elderly driver increases in Japan. This may also occur in other countries. On the other hand, the accuracy of image recognition has been improved by the development of deep neural networks or other machine learning technologies. However, a large size of learning data is necessary for these methods. First, I will present an efficient enhancement of learning data for in-vehicle camera images. Then, I will introduce several image recognition methods for driving assistance that we have developed so far, such as the recognition of traffic signs, the recognition of walking pedestrian while operating a smartphone, the recognition of the driver's visibility, the weather recognition, and other research topics. In addition, I will talk about the human pose estimation using a super-low-resolution infrared sensor array for the purpose of watching the elderly people at home.

**Keynote Speech #2**

Principle of Precise GNSS Positioning and Its Applications to Disaster Monitoring Systems in Japan

Recently, a lot of services are provided based on location information based on GNSS (Global



Navigation Satellite Systems). In this presentation, the principle of satellite positioning is reviewed. There exist many methods and algorithms for satellite positioning, very simple and fundamental method as well as precise positioning methods are focused on. In the latter half of the presentation, as case studies of the application of precise satellite positioning, two systems for disaster monitoring and mitigation operated in Japan are introduced. One is the GNSS reference station network (GEONET), and another is the GPS ocean and tsunami monitoring system.

### **Keynote Speech #3**

Dr. Ardhasena is the deputy director for climate and air quality research in the Indonesian Agency for Meteorology Climatology and Geophysics (BMKG). He is an applied mathematician with wide interest of modelling phenomena in nature, such as water waves, optical waves in photonic devices, and climate. He is internationally active in the field of climate related activities under the World Meteorological Organization (WMO) from climate policy related, climate services and standards developments: presently serving as the chair of the working group on Climate Service of Regional Association - V South West Pasific, co-chair of the Expert Team on Global Climate Statement (responsible for the annual global climate statement for the World's policy reference), and a member of the Interprogramme Task Team on Cataloging Extreme Weather Water and Climate Events (IPTT-CWWCE) of the WMO, where within this team, he contributes to the development of a global framework and standardized approach for systematic cataloging of extreme weather and climate events and their unique identification system, which will be useful for the purpose of attribution of disaster losses and damages due to extreme hydrometeorological events.

### **1B: Climate Change Monitoring**

#### **Prediction of Sea Level by Using Autoregressive Integrated Moving Average (ARIMA): Case Study in Tanjung Intan Harbour Cilacap, Indonesia**

Yehezkiel Kevin Purba and Deni Saepudin (Telkom University, Indonesia); Didit Adytia (School of Computing, Telkom University, Indonesia)

#### **Wave Prediction by using Support Vector Regression, Study Case in Jakarta Bay**

Elizabeth Manurung and Didit Adytia (School of Computing, Telkom University, Indonesia); Nugrahinggil Subasita (NeXT Waves-ID, Indonesia)

#### **Sea Level Prediction by Using Seasonal Autoregressive Integrated Moving Average Model, Case Study in Semarang, Indonesia**

Ronald Tulus and Didit Adytia (School of Computing, Telkom University, Indonesia); Nugrahinggil Subasita (NeXT Waves-ID, Indonesia); Dede Tarwidi (Telkom University, Indonesia)

#### **Utilization of Internet of Thing and Social Media in Designing a Smart System for Identification Pollution Quality of Air, Water, and Temperature**

Muhardi Saputra, Wahjoe Witjaksono and Warih Puspitasari (Telkom University, Indonesia)

**Wave Height Prediction based on Wind Information by using General Regression Neural Network, study case in Jakarta Bay**

Vita Juliani and Didit Adytia (School of Computing, Telkom University, Indonesia); A Adiwijaya (Telkom University, Indonesia)

**1C: Emerging Trends - Social Media**

**Recognizing Personality from Social Media Linguistic Cues: A Case Study of Brand Ambassador Personality**

Andry Alamsyah, Rafa Bastikarana, Alya Rysda Ramadhanti and Sri Widiyanesti (Telkom University, Indonesia)

**Brand Awareness using Network Modeling Method**

Muhamad Fulki Firdaus, Z. k. a. Baizal and Kevin Bratawisnu, Made (Telkom University, Indonesia); Hanafi Abdullah Gusman (Telkom Universtiy, Indonesia)

**Measuring the effectiveness of social media owned by local government leaders in communicating smart city programs Case study on the Mayor's Bandung Instagram**

Grisna Anggadwita (Telkom University, Indonesia); Brady Rikumahu (School of Economics and Business, Telkom University, Indonesia); Ratih Hendayani and Rayhan Raka Putra (Telkom University, Indonesia)

**Classifying the Polarity of Online Media on the Indonesian Presidential Election 2019 Using Artificial Neural Network**

Muhammad Afif Farisi and Kemas Lhaksmana (Telkom University, Indonesia)

**Ensemble Learning in Predicting Financial Distress of Indonesian Public Company**

Dyah Sulistyowati Rahayu (University of Pancasila & University of Indonesia, Indonesia); Heru Suhartanto (Universitas Indonesia, Indonesia)

**1D: Emerging Trends - Health**

**ECG Based Biometric Identification System using EEMD, VMD and Renyi Entropy**

Sugondo Hadiyoso (Telkom University & Institut Teknologi Bandung, Indonesia); Inung Wijayanto (Telkom University & Universitas Gadjah Mada, Indonesia); Tugas Bme (Politeknik Negeri Bandung, Indonesia)

**EEG Signal Classification for Alcoholic and Non-Alcoholic Person using Multilevel Wavelet Packet Entropy and Support Vector Machine**

Cahyantari Ekaputri (Telkom University, Indonesia); Rahmat Widadi (Institut Teknologi Telkom Purwokerto, Indonesia); Achmad Rizal (Telkom University, Indonesia)

**QSAR Study of Fusidic Acid Derivative as Anti- Malaria Agents by using Artificial Neural Network- Genetic Algorithm**

Hamzah Azmi, Kemas Lhaksmana and Isman Kurniawan (Telkom University, Indonesia)

### **Leveraging Textural Features for Mammogram Classification**

Sri Frenzilino Mahayyu Akbarisena, Ema Rachmawati and D Utama (Telkom University, Indonesia)

### **1E: Emerging Trends - NLP/Language Model**

#### **Knowing Opposing Arguments in Persuasive Essays Using Random Forest Classifier**

Daulat Rachmanto, Ibnu Asror and Anisa Herdiani (Telkom University, Indonesia)

#### **End-to-End Speech Recognition Models for a Low-Resourced Indonesian Language**

Suyanto Suyanto (Telkom University, Indonesia); Anditya Arifianto (Telkom University & Artificial Intelligence Laboratory, ICM Research Group, Indonesia); Anis Sirwan (Divisi Digital Service (DDS) PT Telkom, Indonesia); Angga P. Rizaendra (Divisi IT, PT Telkom Akses, Indonesia)

#### **Syllable-Based Indonesian Lip Reading Model**

Adriana Kurniawan and Suyanto Suyanto (Telkom University, Indonesia)

#### **Language Modeling for Journalistic Robot based on Generative Pretrained Transformer 2**

Raihan Hamid Suraperwata and Suyanto Suyanto (Telkom University, Indonesia)

#### **Academic Expert Finding in Indonesia using Word Embedding and Document Embedding: A Case Study of Fasilkom UI**

Theresia V. Rampisela and Evi Yulianti (Universitas Indonesia, Indonesia)

### **1F: Emerging Trends - IoT**

#### **IoT Object Security towards the Sybil Attack Using the Trustworthiness Management**

Ridwan Hadiansyah (Telkom University, Indonesia); Vera Suryani (Universitas Telkom, Indonesia); Aulia Arif Wardana (Telkom University, Indonesia)

#### **IoT Object Security towards On-off Attack Using Trustworthiness Management**

Anggi Pratama Nasution (Telkom University, Indonesia); Vera Suryani (Universitas Telkom, Indonesia); Aulia Arif Wardana (Telkom University, Indonesia)

#### **Sustainable Internet of Things: Alignment approach using enterprise architecture**

Nunung Nurul Qomariyah (Bina Nusantara University Jakarta, Indonesia); Anjar Priandoyo (University of York, United Kingdom (Great Britain))

#### **LoRaWAN Internet of Things Network Planning for Smart Metering Services in Dense Urban Scenario**

Alvin Yusri and Muhammad Imam Nashiruddin (Telkom University, Indonesia)

#### **Designing NB-IoT (Internet of Things) Network for Public IoT in Batam Island**

Shelasih Winalisa and Muhammad Imam Nashiruddin (Telkom University, Indonesia)

## **TS1: Tutorial Session #1**

The Fourth Industrial Revolution- A Global Revolution in Science, Technology and Society towards a better life by Assoc.Prof.Dr.MD Shohel Sayeed (Multimedia University, Malaysia)

His core research interest is in the area of Biometrics, big data, cloud computing, artificial intelligence, information security, image and signal processing, pattern recognition and classification. He has published over 60 research papers in international peer-reviewed journals and international conference proceedings as a result of his research work. His research works have been published by high ranked peer- reviewed journals such as IEEE Transactions on Pattern Analysis and Machine Intelligence (TPAMI), International Journal of Pattern Recognition and Artificial Intelligence (IJPRI), Expert Systems with Applications, Discrete Dynamics in Nature and Society (DDNS) as well as several peer- reviewed International journals. Several of his findings have been presented in a number of well recognized IEEE conferences as well. He has been appointed technical paper reviewer for Journal of Pattern Recognition Letters, IEEE Transaction on Neural Networks, IEEE Transactions on Automation Science and Engineering, Journal of Computer Methods and Programs in Biomedicine and International Journal of Computer Theory and Engineering. He has also been invited to review technical papers for several international conferences. In recognition of his professional contribution, he has obtained recognition as a Senior member of IEEE Computer Society, IEEE Communication Society and International Association of Computer Science and Information Technology (IACSIT).

Dr. Shohel has invited as a Chief Guest and keynote speaker at the second International Conference on Advanced Computing (ICAC 2019). Apart from the ICAC 2019, Dr. Shohel was also invited as the keynote speaker for several international conferences such as the International Conference on Recent Trends and Challenges in Healthcare Informatics (RCHI- 2019), International Conference on Recent Trends in Advanced Computing (ICRTAC 2019) and International Conference on Computational Intelligence and Applications (ICCIA 2019). Furthermore, Dr. Shohel was also invited as the keynote speaker for the International Conference on Modern Research (Multidisciplinary) 2019, International Conference on Advanced Computing (ICAC 2015), International Symposium Innovative Management, Information & Production (IMIP 2015) and International Conference on Innovations in Computer Science and Technology (ICICST 2016), respectively.

## **2B: Disaster Data Science and Management**

### **Automatic First Arrival Picking on P-Wave Seismic Signal Using Support Vector Machine Method**

Muhammad Wahyu Putra Indi, Astri Novianty and Anggunmeka Luhur Prasasti (Telkom University, Indonesia)

### **Implementation of Automatic First Arrival Picking on P-Wave Seismic Signal Using Logistic Regression Method**

Yusuf Azam Sya'bani, Astri Novianty and Anggunmeka Luhur Prasasti (Telkom University, Indonesia)

### **Sentiment Analysis during Jakarta Flood for Emergency Responses and Situational Awareness in Disaster Management**

Warrah Maharani (Telkom University, Indonesia)

### **Impact Analysis on Disaster Data for Disaster Risk Reduction from Multiple Stakeholders Perspective**

Syamil Zayid, Nur Azaliah Abu Bakar, Mageshwari Valachamy and Nur Shuhada Abdul Malek (Universiti Teknologi Malaysia, Malaysia); Mohd bin Mahrin (Universiti Teknologi Malaysia, Malaysia); Khamarrul Azahari Razak (Universiti Teknologi Malaysia, Malaysia)

### **Data-Driven of Time Series Decomposition on Estimating Geodetic Secular Motion Around Palu- Koro Fault Zone**

Cecep Pratama (Universitas Gadjah Mada, Indonesia); Irwan Meilano (ITB, Indonesia); Euis Sunarti (IPB University, Indonesia); Setya Haksama (Universitas Airlangga, Indonesia); Mahmud Dwi Sulistiyo (Telkom University, Indonesia)

## **2C: ICT for Agriculture + Emerging Trends**

### **Micro-Climate Control for Hydroponics in Greenhouses**

Bayu Erfianto (TELKOM University & School of Computing, Indonesia); Andrian Rakhmatsyah (School of Computing - Telkom University, Indonesia); Endro Ariyanto (Telkom University, Indonesia)

### **Macroscopic Wood Blurred Image Analysis to Determine The Factors of Causing Blur**

Dandi Trianta Barus (School of Computing, Telkom University, Indonesia); Putu Harry Gunawan (Telkom University, Indonesia); Esa Prakasa (Indonesian Institute of Sciences, Indonesia)

### **IoT Products Adoption for Smart Living in Indonesia: Technology Challenges and Prospects**

Rahmat Yasirandi, Alvin Lander, Hana Rifdah Sakinah and Isa Insan (Telkom University, Indonesia)

### **Deep Learning Detected Nutrient Deficiency In Chili Plant**

Arief Rais Bahtiar, Pranowo Pranowo and Albertus Joko Santoso (Universitas Atma Jaya Yogyakarta, Indonesia); Jujuk Juhariah (Universitas Boyolali, Indonesia)

### **How Can Fingerprint Improves The Payment Experience of a Drink Vending Machine?**

Satria Hutomo, Parman Sukarno and Rahmat Yasirandi (Telkom University, Indonesia)

## **2D: Emerging Trends - Image**

### **Image Retrieval using Multi Texton Co-occurrence Descriptor and Discrete Wavelet Transform**

Agus Eko Minarno (Universitas Muhammadiyah Malang, Indonesia); Fauzi Dwi Setiawan Sumadi (University of Muhammadiyah Malang, Indonesia); Yufis Azhar, Wayan Alviansyah and Yuda Munarko (Universitas Muhammadiyah Malang, Indonesia)

### **Adaptive Attention Generation for Indonesian Image Captioning**

Made Raharja Surya Mahadi (Telkom University, Indonesia); Anditya Arifianto (Telkom University & Artificial Intelligence Laboratory, ICM Research Group, Indonesia); Kurniawan Nur Ramadhani (Telkom University, Indonesia)

### **EDGAN: Disguising Text as Image using Generative Adversarial Network**

Anditya Arifianto (Telkom University & Artificial Intelligence Laboratory, ICM Research Group, Indonesia); Made Raharja Surya Mahadi, Adriansyah Dwi Rendragraha, Malik Anhar Maulana, Triwidyastuti Jamaluddin, Muhammad Ferianda Satya and Rajabandaru Subhi (Telkom University, Indonesia)

### **The Concave n-Square Salient Wood Image-based Quality Assessment**

Risnandar Risnandar (Research Center for Informatics, Indonesian Institute of Sciences, Indonesia); Esa Prakasa (Indonesian Institute of Sciences, Indonesia); Iwan Erwin (Research Center for Informatics, Indonesia)

### **Object Tracking with Raspberry Pi using Histogram of Oriented Gradients (HOG) and Support Vector Machine (SVM)**

Lukman Rosyidi (University of Indonesia, Indonesia); Adrianto Prasetyo (STT Terpadu Nurul Fikri, Indonesia); Muh Syaiful Romadhon (Nurul Fikri College of Technology, Indonesia)

## **2E: Emerging Trends - Social Media**

### **Hate Code Detection in Indonesian Tweets using Machine Learning Approach: A Dataset and Preliminary Study**

Damayanti Elisabeth (Universitas Indonesia, Indonesia); Indra Budi (Faculty of Computer Science & Universitas Indonesia, Indonesia); Muhammad Okky Ibrohim (University of Indonesia, Indonesia)

### **A Simplified Method to Identify the Sarcastic Elements of Bahasa Indonesia in Youtube Comments**

Willbert Wijaya, I Made Murwantara and Aditya R Mitra (Universitas Pelita Harapan, Indonesia)

### **Synonyms-Based Augmentation to Improve Fake News Detection using Bidirectional LSTM**

Ghinadya Ghinadya and Suyanto Suyanto (Telkom University, Indonesia)

### **On The Feature Extraction For Sentiment Analysis of Movie Reviews Based on SVM**

Fitri Eka Cahyanti, A Adiwijaya and Said Al Faraby (Telkom University, Indonesia)

### **Opinion Mining Model System For Indonesian Non Profit Organization Using Multinomial Naive Bayes Algorithm**

Cut Fiarni (ITHB, Indonesia); Herastia Maharani and Gabriella Wisastra (Institut Teknologi Harapan Bangsa, Indonesia)

## **2F: Emerging Trends - Prediction**

### **Implementation Of Data Mining For Drop-Out Prediction Using Random Forest Method**

Meylani Utari, Budi Warsito and Retno Kusumaningrum (Diponegoro University, Indonesia)

### **Time Series Prediction on College Graduation Using KNN Algorithm**

Alfin Salim, Kusuma Ayu Laksitowening and Ibnu Asror (Telkom University, Indonesia)

### **Analyzing TF-IDF and Word Embedding for Implementing Automation in Job Interview Grading**

Annalisa Wahyu Romadon, Kemas Lhaksmana and Isman Kurniawan (Telkom University, Indonesia); Donni Richasdy (Telkom University & Bandung Techno Park, Indonesia)

### **Determination of Annual Employee Salary Increase and Best Employee Reward Using the Fuzzy-TOPSIS Method**

Fikri Kafabih and Utomo Budiyanto (Budi Luhur University, Indonesia)

### **Parallel Programming of Churn Prediction Using Gaussian Naive Bayes**

Dandi Trianta Barus, Rafanzhani Elfarizy and Fikhri Masri (School of Computing, Telkom University, Indonesia); Putu Harry Gunawan (Telkom University, Indonesia)

## **TS2: Tutorial Session #2**

What can Natural Language Processing do in a disaster? by Yunita Sari, Ph.D (Universitas Gadjah Mada, Indonesia)

In the disaster situation, social media can play an important role for propagating information among people. While most communication channels are unavailable, Twitter emerges as an alternative media for reporting problems and aid messages. However, with the massive amounts of information that have been produced by users, it is very challenging to identify the right and relevant information. In this tutorial, we are going to discuss on how Natural Language Processing can help addressing the problems. The talk will be focusing on the current state of the

art methods in this area, challenges and research directions to be explored.

### **3B: Disaster Risk Science and Engineering**

#### **Numerical Simulation of Tsunami Evacuation Route Planning in Padang Using Linear Programming**

Rizal Dwi Prayogo (Institut Teknologi Bandung, Indonesia); Siti Amatullah Karimah (Telkom University, Indonesia)

#### **A Blockchain-based Assistance Digital Model for First Responders and Emergency Volunteers in Disaster Response and Recovery**

Pg. Hj. Asmali Pg. Badarudin, Au Thien Wan and Somnuk Phon-Amnuaisuk (Universiti Teknologi Brunei, Brunei Darussalam)

#### **Nonlinear SWE and Experimental Observation for Wave Simulation due to Bottom Motion**

Astrid Velia Themba, Putu Harry Gunawan and Annisa Aditsania (Telkom University, Indonesia)

#### **Experimental and Simulation Approach for Water Bed Movements**

Alya Alifia Anwar Jaya, Putu Harry Gunawan and Annisa Aditsania (Telkom University, Indonesia)

### **3C: Natural Disaster Risk Reduction**

#### **A Fire Detection System Using Multi-Sensor Networks Based on Fuzzy Logic in Indoor Scenarios**

Fathur Zaini Rachman (Institut Teknologi Sepuluh Nopember & State Polytechnic of Balikpapan, Indonesia); Gamantyo Hendrantoro and Iwan Wirawan (Institut Teknologi Sepuluh Nopember, Indonesia)

#### **Implicit aspect extraction in product reviews using FIN algorithm**

Diah Hevyka Maylawati, Warih Maharani and Ibnu Asror (Telkom University, Indonesia)

#### **Performance Boost of Attribute-aware Semantic Segmentation via Data Augmentation for Driver Assistance**

Mahmud Dwi Sulistiyo (Telkom University, Indonesia & Nagoya University, Japan); Yasutomo Kawanishi, Daisuke Deguchi, Ichiro Ide, Takatsugu Hirayama and Hiroshi Murase (Nagoya University, Japan)

#### **Design and Characterization of Mobile Landslide Monitoring System**

Suryadi Suryadi (Universitas Indonesia, Indonesia); Adrin Tohari and Edi Kurniawan (Indonesian Institute of Sciences, Indonesia); Purnomo Sidi Priambodo (Universitas Indonesia, Indonesia)



### **3D: Emerging Trends - Health**

#### **Classification of subjects of Mild Cognitive Impairment and Alzheimer's Disease through Neuroimaging modalities and Convolutional Neural Networks**

Ahsan Tufail and Yongkui Ma (Harbin Institute of Technology, China); Qiu-Na Zhang (Harbin Institute of Technology, Harbin, China)

#### **Blood Detection in Infusion Hose Using Fuzzy System**

Rizqillah Zahra Lestari, Siti Amatullah Karimah and Maman Abdurohman (Telkom University, Indonesia); Rizal Dwi Prayogo (Institut Teknologi Bandung, Indonesia)

#### **Thymun: Smart Mobile Health Platform for The Autoimmune Community to Improve the Health and Well-being of Autoimmune Sufferers in Indonesia**

Yasmin Salamah, Rahma Dany Asyifa, Tsonya Yumna Afifah and Fajar Maulana (IPB University, Indonesia); Auzi Asfarian (Bogor Agricultural University, Indonesia)

#### **Foot Plantar Pressure to Detect Obesity**

Yulistia Nursida (School of Computing Telkom University, Indonesia); Bayu Erfianto (TELKOM University & School of Computing, Indonesia); Andrian Rakhmatsyah (School of Computing - Telkom University, Indonesia)

#### **Human-Like Constrained-Mating to Make Genetic Algorithm More Explorative**

Achmad Choirul Rizal and Suyanto Suyanto (Telkom University, Indonesia)

### **3E: Emerging Trends - Security**

#### **The Influence of Website-Based and Company-Based Quality toward Loyalty with Perceived Website Trust as Antecedents**

Indrawati Indrawati and Arlinda Shabila (Telkom University, Indonesia)

#### **Can Information Security, Privacy and Satisfaction Influence the E-Commerce Consumer Trust?**

Manuel Jesnico, Candiwan Candiwan and Ratih Hendayani (Telkom University, Indonesia); Yuvaraj Ganesan (Universiti Sains Malaysia (USM), Malaysia)

#### **Investigating the Influence of Information Quality, Information Seeking, and Familiarity with Purchase Intentions: A Perspective of Instagram Users in Indonesia**

Yekti Wirani, Latifa Diniputri and Muh Syaiful Romadhon (Nurul Fikri College of Technology, Indonesia)

#### **A Comparative Study of Internet Architecture and Applications of Online Music Streaming Services: The Impact on The Global Music Industry Growth**

Ramy A. Rahimi and Kyung-Hye Park (Chungnam National University, Korea (South))

#### **Biometric Identification Based on EEG Signal with Photo Stimuli Using Hjorth Descriptor**

Inung Wijayanto (Telkom University & Universitas Gadjah Mada, Indonesia); Sugondo

Hadiyoso (Telkom University & Institut Teknologi Bandung, Indonesia); Fauzia Sekarningrum (Telkom University, Indonesia)

### **3F: Emerging Trends - e-commerce**

#### **Security Functional Requirements for The Development of a Biometrics Attendance System**

Rahmat Yasirandi, Parman Sukarno and Emiya Fefayosa Br Tarigan (Telkom University, Indonesia)

#### **Comparative Analysis of K-Nearest Neighbor and Decision Tree in Detecting Distributed Denial of Service**

Ilham Ramadhan, Parman Sukarno and Muhammad Arief Nugroho (Telkom University, Indonesia)

#### **Parallelizing Polarization Plate Design for Automating Quantum Key Distribution Device based on EDU-QCRY1**

Rizka Khairunnisa, Dion Ogi, Anang Permana, Dian Sasetya, Agil MA, Izdihar Fakhriyah, Aulia Azizah, Jabang Saputro, Bintang Wahyudono and Yoga Pratama (Sekolah Tinggi Sandi Negara, Indonesia)

#### **Design and Implementation of NIDS Notification System Using WhatsApp and Telegram**

Arif Rahman Hakim and Julio Rinaldi (Sekolah Tinggi Sandi Negara, Indonesia); Muhammad Yusuf Setiadji (National Crypto Institute of Indonesia, Indonesia)

#### **Performance Comparison of Yolo-Lite and YoloV3 Using Raspberry Pi and MotionEyeOS**

Pertiwang Sismananda, Maman Abdurohman and Aji Gautama Putra (Telkom University, Indonesia)

### **TS3: Tutorial Session #3**

Toward Autonomous Robot for Disaster Mitigation Support using Deep Reinforcement Learning by Idham Ananta Timur, S.T., M. Kom (Universitas Gadjah Mada, Indonesia)

Disaster usually leads to uncertainty. Natural disaster, like earthquake, tsunami, landslides, volcanoes, floods usually change the landscape on earth. The rescue missions afterward, depending on the destruction level, will involve searching for survivors, deploying logistics and mapping the area to for a better mitigation management. However, doing all those actions might need more expensive vehicles, gasolines, and manpower. In this area, a smart autonomous robot might help.

However, developing a smart autonomous robot is also a challenging problem. Training an autonomous car to follow the lane in a known and well-defined road is already difficult let alone exploring unexpected, unseen aftermath of disaster landscape with so many kinds of unidentified objects. This tutorial will introduce the ideas and demonstrate how an end-to-end deep learning

and deep reinforcement learning might be able to help developing autonomous vehicle and discuss the issues surrounding such approaches to tackle the aforementioned challenge.

#### **4B: Disaster Risk Science and Engineering**

##### **An Optimization Model of Vertical Evacuation Scenario on Tsunami Disaster Mitigation**

Rizal Dwi Prayogo (Institut Teknologi Bandung, Indonesia); Nurul Ikhsan (Telkom University, Indonesia)

##### **Simulation of transport problem with clustering velocity-density function**

Ferdian Akbar Daniswara and Putu Harry Gunawan (Telkom University, Indonesia)

##### **Mobile-Based Hospital Recommendation According To Patient Needs Using SAW Method (Case Study: Banda Aceh)**

Raedi Isril, Danang Junaedi and Anisa Herdiani (Telkom University, Indonesia)

##### **Methods for Determining Nitrogen, Phosphorus, and Potassium (NPK) Nutrient Content Using Scale-Invariant Feature Transform (SIFT)**

Raden Sumiharto, Ristya Putra and Samuel Demetouw (Universitas Gadjah Mada, Indonesia)

#### **4C: Emerging Trends - Classification**

##### **Computational Parallel of K-Nearest Neighbor on Page Blocks Classification Dataset**

Damar Zaky and Putu Harry Gunawan (Telkom University, Indonesia)

##### **Comparative Analysis of Decision Tree Algorithm for Learning Ordinal Data Expressed as Pairwise Comparisons**

Nunung Nurul Qomariyah and Eileen Heriyanni (Bina Nusantara University Jakarta, Indonesia)

##### **Experimental Exploratory of Temporal Sampling Forest in Forest Fire Regression and Classification**

Yee Jian Chew, Shih Yin Ooi and Ying Han Pang (Multimedia University, Malaysia)

##### **Learning Content Recommendations on Personalized Learning Environment Using Collaborative Filtering Method**

Adhyfa Fahmy Hidayat, Dawam Dwi Jatmiko Suwawi and Kusuma Ayu Laksitowening (Telkom University, Indonesia)

##### **Fulfillment and Responsiveness on Online Travel Agencies Using Multiclass Classification**

Nadya Putri, Andry Alamsyah and Sri Widiyanesti (Telkom University, Indonesia)

#### **4D: Emerging Trends - Scheduling/Controller**

##### **MSOF-DT Strategy and Its Impact on Real-Time Systems Scheduling**

Fazmah Arif Yulianto (Telkom University, Indonesia); Kuspriyanto Kuspriyanto and Richard Mengko (Institut Teknologi Bandung, Indonesia)

##### **Comparison of Earliest Deadline First and Rate Monotonic Scheduling in Polling Server**

Zeyhan Aliyah, Muhammad Pambudhi and Abdan Ahnafi (Telkom University, Indonesia); Hilal H. Nuha (Telkom University, Indonesia & King Fahd University of Petroleum and Minerals, Saudi Arabia); Sidik Prabowo (Telkom University, Indonesia)

##### **A Distributed Fuzzy Logic with Consensus for Exhaust Fan Controller**

Misbakhul Munir (Telkom University, Indonesia); Bayu Erfianto (TELKOM University & School of Computing, Indonesia)

##### **Smart Controlling System for Green Centralized Air Conditioner based on System Engineering Approach**

Muhardi Saputra, Edi Sutoyo and Ahmad Almaarif (Telkom University, Indonesia)

#### **4E: Emerging Trends - Audio**

##### **Music Source Separation Using Generative Adversarial Network and U-Net**

Muhammad Ferianda Satya and Suyanto Suyanto (Telkom University, Indonesia)

##### **Analysis of Feature Correlation for Music Genre Classification**

Manuel Theodore Leleuly and Putu Harry Gunawan (Telkom University, Indonesia)

##### **Chord Recognition using FFT Based Segment Averaging and Subsampling Feature Extraction**

Linggo Sumarno (Sanata Dharma University, Indonesia)

##### **Improving the Capacity of Data Hiding by Modifying the Interpolation of Audio Samples**

Ryan Setiawan (Institut Teknologi Sepuluh Nopember, Indonesia); Tohari Ahmad (Institut Teknologi Sepuluh Nopember (ITS), Indonesia)

##### **Indonesian Graphemic Syllabification Using n-gram Tagger with State-Elimination**

Rezza Nafi Ismail and Suyanto Suyanto (Telkom University, Indonesia)

#### **TS4: Tutorial Session #4**

Deep Representation Learning for Recognizing Human and Object Interactions by Thomhert Suprpto Siadari (University of Science & Technology, Republic of Korea)

Human-object interaction (HOI) detection aims to detect human and object locations and classify their interactions at the instance level (e.g., a person riding a bike, carrying a backpack, and

throwing a Frisbee), which can be formulated as detecting a triplet (human, action, and object). This task is beneficial to many applications that require a deeper understanding of semantic scenes, such as video surveillance and visual question answering.

## **5B: ICT for Agriculture**

### **WSN Based Agricultural Bird Pest Control with Buzzer and a Mesh Network**

Achmad Ramadhan, Maman Abdurohman and Aji Gautama Putrada (Telkom University, Indonesia)

### **Method of Systematic Literature Review for Internet of Things in ZigBee Smart Agriculture**

Taufik Hidayat (Universitas Wiralodra, Indonesia); Rahutomo Mahardiko (Platinumetrix Pte. Ltd, Indonesia); Sianturi Tigor Franky D (Universitas Mercu Buana & Danon Digital Nusantara, Indonesia)

### **Radial Basis Function Neural Network in Identifying the Types of Mangoes**

Faisal Thaib, Golda Tomasila, Goldy Valendria Nivaan and Albertus Joko Santoso (Universitas Atma Jaya Yogyakarta, Indonesia)

### **IoT Based Smart Poultry Farm in Brunei**

Muhammad Hambali (Universiti Teknologi Brunei, Indonesia); Ravi Kumar Patchmuthu and Au Thien Wan (Universiti Teknologi Brunei, Brunei Darussalam)

### **E-Initiative for Food Security: Design of Mobile Crowdfunding Platform to Reduce Food Insecurity in Indonesia**

Auzi Asfarian (Bogor Agricultural University, Indonesia); Renardi Purnama Putra (IPB University, Indonesia); Arga Putra Panatagama (Bogor Agricultural University, Indonesia); Yani Nurhadryani (Nuhardryani, Indonesia); Dean Apriana Ramadhan (IPB University, Indonesia)

### **Designing Green Procurement based on ERP for Leather Tanning Industry**

Mahsyia Fajriani, Ari Yanuar Ridwan and Muhardi Saputra (Telkom University, Indonesia)

## **5C: Emerging Trends - Image**

### **Discriminative Spectral Regression Metric Learning in Unconstrained Face Verification**

Siew Chin Chong, Ong Thian Song and Lee Ying Chong (Multimedia University, Malaysia)

### **Face Recognition In Low Lighting Conditions Using Fisherface Method And CLAHE Techniques**

Fauzan Rahman and Febryanti Stehvanie (Telkom University, Indonesia); Kurniawan Nur Ramadhani (Universitas Telkom, Indonesia)

### **Fractal Batik Motifs Generation Using Variations of Parameters in Julia Set Function**

R Rizal Isnanto, Achmad Hidayatno and Ajub Ajulian Zahra (Diponegoro University, Indonesia)

### **Bone Scan Image Segmentation based on Active Shape Model for Cancer Metastasis Detection**

Ema Rachmawati, Fazrian Ramadlan Sumarna and Jondri Jondri (Telkom University, Indonesia); Achmad Hussein S Kartamihardja, Arifudin Achmad and Rini Shintawati (Universitas Padjadjaran, Indonesia)

### **Melanoma Classification Using Combination of Color and Shape Feature**

Dimas Agusta Wiranata, Ema Rachmawati and D Utama (Telkom University, Indonesia)

## **5D: Emerging Trends - Sensor Vehicle**

### **Accuracy Improvement on Learning Vector Quantization (LVQ) Using Exponential Smoothing for Driving Activity Classification**

Pitaloka Fortuna Dewi Setyorini (Electronic Engineering Polytechnic Institute of Surabaya (EEPIS), Indonesia); Haniah Mahmudah (EEPIS, Indonesia); Okkie Puspitorini (Politeknik Elektronika Negeri Surabaya, Indonesia); Nur Siswandari (EEPIS, Indonesia); Ari Wijayanti (Politeknik Elektronika Negeri Surabaya, Indonesia)

### **Single Triaxial Accelerometer-Gyroscope Classification for Human Activity Recognition**

Agus Eko Minarno, Wahyu Andhyka Kusuma, WAK, Hardianto Wibowo and Denar Akbi (Universitas Muhammadiyah Malang, Indonesia); Naser Jawas (University of Warwick, Indonesia)

### **A Review of Routing Protocols for Vehicular Ad-Hoc Networks (VANETs)**

Sumendra Yogarayan (Multimedia University (MMU), Malaysia); Siti Fatimah Abdul Razak (Multimedia University, Malaysia); Afizan Azman (Melaka International College of Science and Technology Malaysia, Malaysia); Mohd Fikri Azli Abdullah (Multimedia University, Malaysia); Siti Zainab Ibrahim and Kirbana Jai Raman (Multimedia University (MMU), Malaysia)

### **Tracking, Arrival Time Estimator, and Passenger Information System on Bus Rapid Transit (BRT)**

Hafiih Nur M. A (Telkom University, Indonesia); Sugondo Hadiyoso (Telkom University & Institut Teknologi Bandung, Indonesia); Fefa Belladina and Dadan Nur Ramadan (Telkom University, Indonesia); Inung Wijayanto (Telkom University & Universitas Gadjah Mada, Indonesia)

### **A Data Anonymization Method to Mitigate Identity Attack in Transactional Database Publishing**

Dedi Gunawan (Universitas Muhammadiyah Surakarta, Indonesia)

## **5E: Emerging Trends - Web/e-learning**

### **Analysis of Web Content Quality Information on the Koseeker Website Using the Web Content Audit Method and ParseHub Tools**

Deandra Abiantoro and Dana Sulisty Kusumo (Telkom University, Indonesia)

### **Analysis of the Generator and Consistency of General Web Page Layout Structure Using Matching Algorithm Based on Set Difference**

Agniya Noor Ilhamiati, Dana Sulisty Kusumo and Indra Lukmana Sardi (Telkom University, Indonesia)

### **Personalized E-learning Content Based On Felder-Silverman Learning Style Model**

Jeremiah Hasudungan Sihombing, Kusuma Ayu Laksitowening and Eko Darwiyanto (Telkom University, Indonesia)

### **Analysis of Learning Management System Features based on Indonesian Higher Education National Standards using the Feature-Oriented Domain Analysis**

Galih Wasis Wicaksono and Ghina Juliani (Universitas Muhammadiyah Malang, Indonesia); Evi Wahyuni, EDW (University of Muhammadiyah Malang, Indonesia); Yus Cholily, Hari Asrini and Budiono Budiono (Universitas Muhammadiyah Malang, Indonesia)

### **Optimizing Data Storage in Handling Dynamic Input Fields with JSON String Compression**

Irfan Darmawan (Telkom University, Indonesia); Alam Rahmatulloh, Iqbal Muhammad Fajar Nuralam, Rianto Rianto and Rohmat Gunawan (Siliwangi University, Indonesia)

## **TS5: Tutorial Session #5**

New Trends in Image/Video Restoration and Enhancement by Dr. Eng. Muhammad Haris (Bukalapak, Indonesia)

Muhammad Haris works as AI Research Manager at BukaLapak. He received S. Kom (Bachelor of Computer Science) from the Faculty of Computer Science, University of Indonesia, Depok, Indonesia, in 2009. Then, he received the M. Eng and Dr. Eng degree from Department of Intelligent Interaction Technologies, University of Tsukuba, Japan, in 2014 and 2017, respectively, under the supervision of Dr. Hajime Nobuhara. He worked as postdoctoral fellow in Intelligent Information Media Laboratory, Toyota Technological Institute with Prof. Norimichi Ukita. He also serves as reviewer for several journal and conferences such as IEEE TPAMI, IEEE TIP, IEEE TNNLS, and CVIU.

## **6B: Emerging Trends - IoT**

### **NB-IoT Network Planning for Advanced Metering Infrastructure in Surabaya, Sidoarjo, and Gresik**

Muhammad Imam Nashiruddin and Arrizky Ayu Faradila Purnama (Telkom University,

Indonesia)

**SigFox Network Planning for Smart Metering Based on Internet of Things for Dense Urban Scenario**

Muhammad Imam Nashiruddin and Alvin Yusri (Telkom University, Indonesia)

**Designing LoRaWAN Internet of Things Network for Smart Manufacture in Batam Island**

Muhammad Imam Nashiruddin and Shelasih Winalisa (Telkom University, Indonesia)

**IoT-Based Road Vehicle Counter Using Ultrasound Sensor and Cross-Correlation Algorithm**

Deta Soundra, Maman Abdurohman and Aji Gautama Putrada (Telkom University, Indonesia)

**Applied Internet of Things (IoT): The Prototype Bus Passenger Monitoring System Using PIR Sensor**

Alam Rahmatulloh (Siliwangi University, Indonesia); Firmansyah Maulana Sugiartana Nursuwars (University of Siliwangi & UNSIL, Indonesia); Irfan Darmawan (Telkom University, Indonesia); Galih Febrizki (Erajaya Group, Indonesia)

**6C: Emerging Trends - ERP**

**Parallel Construction of Information Technology Value Model: Design-Science Research Methodology**

Lukman Abdurrahman and Tatang Mulyana (Telkom University, Indonesia)

**A Strategy Framework For Incorporating Sustainability Into Enterprise Architecture**

Erda Guslinar Perdana (Telkom University, Indonesia); Benhard Sitohang (Institut Teknologi Bandung, Indonesia); Husni Sastramihardja (Universitas Esa Unggul, Indonesia); Muhammad Zuhri Catur Candra (Institut Teknologi Bandung, Indonesia)

**Green Production Using ERP: Case Study in The Leather Tanning Industry**

Ihwanul Ikhsan, Ari Yanuar Ridwan and Muhardi Saputra (Telkom University, Indonesia)

**Inventory Budgeting and Purchasing Optimization in ERP System for Health Industry: Conceptual Model for Accounts Payable**

Hafida Noor Azizah, Warih Puspitasari and Muhardi Saputra (Telkom University, Indonesia)

**Fintech Growth Impact on Government Banking Business Model: Case Study of Bank XYZ**

Rizki Perdana Rangkuti, Muhammad Amrullah, Hafidz Januar, Aditya Rahman and Cristin Kaunang (University of Indonesia, Indonesia); Muhammad Rifki Shihab (Faculty of Computer Science, Universitas Indonesia, Indonesia); Benny Ranti (University of Indonesia, Indonesia)



## **6D: Emerging Trends - UX**

### **User Interface Design Of Learning Applications For Balinese Traditional Dance using Goal-Directed Design**

Ni Nyoman Sri Ayu Asvini Dyatmika, Danang Junaedi and Veronikha Effendy (Telkom University, Indonesia)

### **Predicting Users' Revisitation Behaviour Based on Web Access Contextual Clusters**

Hapnes Toba, Christopher Starry Jomei and Lotanto Setiawan (Maranatha Christian University, Indonesia); Oscar Karnalim (University of Newcastle, Australia & Maranatha Christian University, Indonesia); Hui Li (Guizhou University, China)

### **Deep Analysis for Smartphone-based Human Activity Recognition**

Chew Yong Shan, Ying Han Pang and Shih Yin Ooi (Multimedia University, Malaysia)

### **The Analysis of User Intention Detection Related to Conventional Poster Advertisement by Using The Features of Face and Eye(s)**

Yolanda Modesty and Dodi Wisaksono Sudiharto (Telkom University, Indonesia); Catur Wirawan Wijiutomo (Telkom University & Institut Teknologi Bandung, Indonesia)

### **Impact Evaluation of Procedurally Content Generated Against Immersion Games Using ANOVA**

Hardianto Wibowo, Dimas Nurpratama, Wildan Suharso, Agus Eko Minarno and Galih Wasis Wicaksono (Universitas Muhammadiyah Malang, Indonesia); Dani Harmanto (De Montfort University, United Kingdom (Great Britain))

## **6E: Emerging Trends - Telecommunication Network**

### **Outdoor to Indoor Propagation Model of Glass Material Building at 26 GHz for 5G Mobile Technology**

Trivia Anggita (University Indonesia, Indonesia); Muhammad Suryanegara (Universitas Indonesia, Indonesia)

### **Optimizing BTS Placement Using Hybrid Evolutionary Firefly Algorithm**

Dzakyta Afuzagani and Suyanto Suyanto (Telkom University, Indonesia)

### **Deterministic Approach of Indoor Room THz Multipath Channel Model**

Dwi Cahyono (AKKA EMC / Mercedes Benz Technology (MBTech) GmbH, Germany); Fawad Sheikh (Universität Duisburg-Essen & The Mobile Terahertz Company UG, ID4US GmbH, Germany); Thomas Kaiser (Universität Duisburg-Essen, Germany)

### **A Comprehensive Survey of Cellular Network Performance from User's Perspective: A Case Study in 0-km Spot of Yogyakarta**

Widyasmoro Widyasmoro and Indar Surahmat (Department of Electrical Engineering, Universitas Muhammadiyah Yogyakarta, Yogyakarta, Indonesia)

## **An Evidence-Based Technical Process for OpenFlow-Based SDN Forensics**

Satria Akbar Mugitama, Niken Cahyani and Parman Sukarno (Telkom University, Indonesia)

### **TS6: Tutorial Session #6**

Deep Learning and Its Applications in Video Analytics by Dr. Lim Kian Ming (Multimedia University, Malaysia)

Deep learning has recently achieved very promising results in a wide range of areas such as computer vision, natural language processing and speech recognition. In contrast to hand-crafted methods, deep learning aims to learn hierarchical representations from large-scale data (e.g. images and videos) via deep architecture models with multiple layers of non-linear transformations. As compared to hand-crafted features, it is easier to achieve higher performance using the learned hierarchical representations. The principle behind the success of deep learning is that it is able to extract different levels of abstractions embedded in the data by carefully design the layer's depth and width. Then, the features that are beneficial for the learning tasks are properly selected.

In recent years, video analytics has attracted increasing interests from both academic and industry. The main goal of video analytics is to automatically recognize the temporal and spatial events in videos. Thanks to the enormous advancements achieved in deep learning, recent improvements in video analytics, ranging from the applications of object tracking, object detection, human-computer interaction, and video surveillance; has automated many tasks in the industries.

This tutorial commences with the concept of deep learning and followed by its applications in video analytics.

### **Greetings**

### **ICoICT 2021 presentation**

### **Closing by Dean of School of Computing, Telkom University**

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## Chord Recognition using FFT Based Segment Averaging and Subsampling Feature Extraction

(Conference Paper)

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### Abstract

This paper proposes a feature extraction subsystem for a chord recognition system, which gives a fewer number of feature extraction coefficients than the previous ones. The method of the proposed feature extraction is FFT (Fast Fourier Transform) based segment averaging and subsampling. Guitar chords were used in developing the proposed feature extraction. In general, the method of the proposed feature extraction is as follows. Firstly, the input signal is transformed using FFT. Secondly, the left half portion of the transformed signal is processed in succession using SHPS (Simplified Harmonic Product Spectrum), logarithmic scaling, segment averaging, and subsampling. The output of subsampling is the result of the proposed feature extraction. Based on the test results, the proposed feature extraction was quite efficient for use in a chord recognition system. For the recognition rate category above 98%, the chord recognition system only required a number of seven feature extraction coefficients. In addition, for the recognition rate category above 90%, the chord recognition system only required a number of six feature extraction coefficients.  
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[^ Top of page](#)

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# Chord Recognition using FFT Based Segment Averaging and Subsampling Feature Extraction

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**Abstract**—This paper proposes a feature extraction subsystem for a chord recognition system, which gives a fewer number of feature extraction coefficients than the previous ones. The method of the proposed feature extraction is FFT (Fast Fourier Transform) based segment averaging and subsampling. Guitar chords were used in developing the proposed feature extraction. In general, the method of the proposed feature extraction is as follows. Firstly, the input signal is transformed using FFT. Secondly, the left half portion of the transformed signal is processed in succession using SHPS (Simplified Harmonic Product Spectrum), logarithmic scaling, segment averaging, and subsampling. The output of subsampling is the result of the proposed feature extraction. Based on the test results, the proposed feature extraction was quite efficient for use in a chord recognition system. For the recognition rate category above 98%, the chord recognition system only required a number of seven feature extraction coefficients. In addition, for the recognition rate category above 90%, the chord recognition system only required a number of six feature extraction coefficients.

**Keywords**—chord recognition, FFT, feature extraction, segment averaging, subsampling

## I. INTRODUCTION

A chord will be generated if two or more notes are played at the same time. The naming of a chord is based on the origin of the notes being played. For example, if the origin of the notes are the first, third, and fifth notes on a major scale, then the chord is included in the major chord. There are many kinds of chord variations. This variation depends on the scale and the order of the notes on the scale [1].

Nowadays computers can be developed to be able to recognize the chords that are being played. Based on the previous works on chord recognition, the topic of chord recognition, which is using chroma features, is a popular topic. PCP (Pitch Class Profile) is a feature extraction that uses chroma features. PCP was introduced by Fujishima [2]. PCP produced a number of 12 feature extraction coefficients. Each feature extraction coefficient from PCP represents the power of the fundamental frequencies that exist in a chord. The original PCP from Fujishima, is still popular today. Recent studies still use the original PCP [3] [4].

In addition to the original PCP from Fujishima above, there were also a number of derivatives from the PCP. A number of PCP derivatives include, PCP that used statistical features [5], PCP that used logarithmic compression [6], Enhanced PCP [7], Improved Chromagram [8], CRP (Chroma DCT-Reduced log Pitch) Enhanced PCP [9], and

Improved PCP [10]. A number of PCP derivatives also produced a number of 12 feature extraction coefficients.

Based on a previous work also, there was a topic of a chord recognition whose feature extraction did not use chroma features. Sumarno [11] introduced a chord recognition whose feature extraction used FFT (Fast Fourier Transform)-based segment averaging. This kind of feature extraction gave a number eight feature extraction coefficients. If we look at the number of feature extraction coefficients, we can see that the research of chord recognition for reducing the number of feature extraction coefficients is still open.

This work developed further a chord recognition whose feature extraction used the above the FFT-based segment averaging [11], by adding a process called the subsampling process. The aim of adding this process was to give even a smaller number of the feature extraction coefficients, which was less than eight coefficients. As a note, this work used the guitar chords.

## II. RESEARCH METHODOLOGY

### A. Development of the chord recognition system and the feature extraction subsystem

The first step in the research methodology was the development of a chord recognition system, which was focused on the feature extraction subsystem. The block

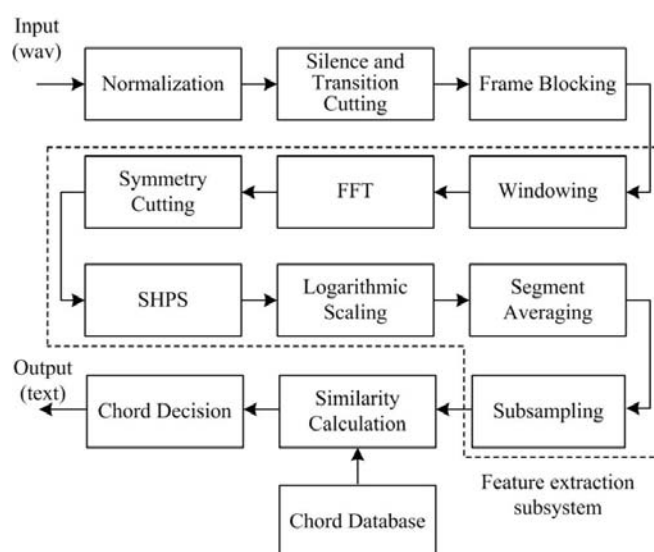


Fig. 1. The block diagram of the developed chord recognition system and its feature extraction subsystem.

diagram of the chord recognition system and its feature extraction subsystem are shown in Fig. 1. As shown in Fig. 1, the input system is a chord signal. This signal is an isolated chord signal recorded in wav format. The system output is a text, which indicates a recognized chord signal.

As a first note, if we look at each process in the feature extraction subsystem, it is the common process. However if we look at as a whole, there is a novelty in the feature extraction subsystem compares with the previous one [11]. As a second note, the implementation of the chord recognition system was carried out using Python software. In a more detail, the input and the function of each block in Fig. 1 are described as follow.

1) *Input*: The input of the chord recognition system is a chord signal. This chord signal came from the Yamaha CPX 500-II acoustic-electric guitar, as shown in Fig. 2. This chord signal is an isolated chord signal, which recorded in wav format. There are seven chord signals from the major chords of C, D, E, F, G, A, and B [11]. Chord signals recording was carried out using a sampling frequency that met Shannon's sampling theorem [12]:

$$f_s \geq 2 f_{max} \quad (1)$$

where  $f_s$  is the sampling frequency, and the  $f_{max}$  is the highest frequency component of the chord signal to be sampled. This study used a sampling frequency of 5000 Hz. According to the Shannon's sampling theorem above, the sampling frequency had exceeded the highest frequency component of 392 Hz (G4 tone) of the G chord [11].

The duration of the chord signals recording was two seconds. Based on the results of visual evaluations of the amplitude of the chord signal, the choice of two seconds duration was enough to get more than half of the chord signal that already in a steady state condition. As a note, the accurate chord information was available in this steady state condition.

2) *Normalization*: Normalization is a process for equalizing the maximum value of the sequence of signal data input. In this case, the maximum value is -1 or 1. Normalization is formulated as below.

$$\mathbf{x}_{out} = \mathbf{x}_{in} / \max(|\mathbf{x}_{in}|) \quad (2)$$

where  $\mathbf{x}_{in}$  and  $\mathbf{x}_{out}$  are the input and output signal data sequences of the normalization process, respectively. The normalization process is needed because the input signal data sequences have different maximum values.

3) *Silence and transition cutting*: Silence and transition cutting is a process for removing the silence and transition region of a signal data sequence. This region is on the left side of a signal data sequence. Silence and transition cutting is carried out as follows. Firstly, based on the visual observations, in order to remove the silence region, this



Fig. 2. The guitar for this work.

work needed the data threshold [0.5]. Starting from the leftmost data of the signal data sequence, if the data was less than [0.5] then the data was removed. Secondly, based on the visual observations also, in order to remove the transition region, this work needed a duration of 200 milliseconds at the leftmost region of the signal data sequence to be removed [11].

4) *Frame blocking*: Frame blocking is a process for acquiring a short signal data sequence, which called a signal frame, from a long signal data sequence [13]. Frame blocking is carried out by acquiring a signal frame at the leftmost region of the long signal data sequence. The purpose of using the frame blocking process is to reduce the number of signal data to be processed further. The effect of reducing the number of signal data is the reduction in computational time needed for signal data processing. This work used 256 points of blocking frame length [11].

5) *Windowing*: In the time domain, windowing is a process for decreasing the discontinuities that appear at the left and the right edges of the signal data sequence [13]. In the frequency domain, this reduction will eliminate the emergence of spectral leakage at the output the FFT process. This work used Hamming window [14] for windowing process. This kind of window has been widely used in the digital signal processing field [15]. The width of the window was the same as the frame blocking length.

6) *FFT*: FFT is a process for transforming a signal data sequence from the time domain to the frequency domain. This work used FFT radix-2. This kind of FFT has been widely used in the digital signal processing field [15]. The length of the FFT was the same as the frame blocking length. In addition, there were additional calculations of absolute values for the FFT results. This was necessary because the subsequence process, namely SHPS, required positive values.

7) *Symmetry cutting*: Symmetry cutting is a process for removing the right half portion of the FFT result. As a note, the left and the right half portion of the FFT result show a symmetry property. Therefore, it was sufficient if this work used only the left portion of the FFT result.

8) *SHPS*: SHPS (Simplified Harmonic Product Spectrum) is a process for reducing the harmonic signal data. The reduction of these harmonic signal data, visually, will show a clearer difference, between a signal data sequence and the other signal data sequences [11]. This work used the SHPS that was introduced by Sumarno [11]. This SHPS is a derivative of HPS (Harmonic Product Spectrum) that was introduced by Noll [16].

9) *Logarithmic scaling*: Logarithmic scaling is a process for increasing the number of significant local peaks. Based on the previous research [11], in the chord recognition that using segment averaging, if we increase the number of significant local peaks, it can increase the recognition rate. Logarithmic scaling is formulated as below.

$$\mathbf{X}_{out} = \log(\alpha \mathbf{X}_{out} + 1) \quad (3)$$

where  $\mathbf{X}_{in}$  and  $\mathbf{X}_{out}$  are respectively the input and the output signal data sequences, from the logarithmic scaling process. The  $\alpha$  value is the logarithmic scale factor. Adding the value '1' to the logarithmic scale factor formula is to avoid the zero

value logarithm, which will give an infinite value. This work used a logarithmic scale factor of 50 [11].

10) *Segment averaging*: Segment averaging is a process for obtaining a short signal data sequence from a long signal data sequence. The segment averaging was initially inspired from Setiawan [17]. Next, the segment averaging was developed by Sumarno [18]. Algorithmically, the segment averaging process is shown below.

1. Suppose  $\mathbf{Y}_{in}$  is an input signal data sequence in the segment averaging process.  $\mathbf{Y}_{in}$  has positive values and has a length  $N$ , with  $N = 2^q$  for  $q \geq 0$  which is a positive integer.
2. Set the segment length  $L$  points, with  $L = 2^p$  for  $0 \leq p \leq q$  which is also a positive integer.
3. Cut  $\mathbf{Y}_{in}$  uniformly using the segment length  $L$  points. This cutting will give a number of  $M$  segments namely  $\mathbf{S}_1, \mathbf{S}_2, \dots, \mathbf{S}_M$  with

$$M = N / L \quad (4)$$

As a note, each segment has a data sequence with the length  $L$  points.

4. Calculate the average value of the data sequence in each segment, and then arrange it into the following  $\mathbf{Y}_{out}$  data sequence.

$$\mathbf{Y}_{out} = \{ \text{avg}(\mathbf{S}_1), \text{avg}(\mathbf{S}_2), \dots, \text{avg}(\mathbf{S}_M) \}$$

The  $\mathbf{Y}_{out}$  data sequence is the output signal data sequence in the segment averaging process. This  $\mathbf{Y}_{out}$  data sequence has the length  $M$  points. Based on equation (4), the output of the segment averaging has a length of  $2^n$  points, with  $n = q - p$ . This work used the segment averaging output length 4, 8, 16, and 32 points.

11) *Subsampling*: Subsampling is an advanced process of the segment averaging process above, in order to get the signal data sequences that are even shorter. In this work, the output of subsampling process is also called the result of the feature extraction data. The effect of obtaining the shorter feature extraction data is the reduction in storage that needed to store a number of the feature extraction data. Interpolation is a way to do the subsampling process. An interpolation method that has been widely used is spline interpolation [19]. In this work evaluated linear, quadratic, and cubic spline interpolation methods [20]. In addition, this work also evaluated the subsampling output of 1-8 coefficients.

12) *Chord database*: Chord database is a collection of a number of chords reference feature extraction (C, D, E, F, G, A, and B). The development of the chord database was carried out as follows. The first one was recording a number of 10 training chord samples for each chord (C, D, E, F, G, A, and B). It was assumed that by using a number of 10 training chord samples, all variations of each chord signal from a guitar musical instrument have been obtained. The second one was processing the feature extraction of all the training chord samples by carrying out the normalization process up to subsampling process that are shown in Fig. 1. For each chord (C, D, E, F, G, A, and B), the feature extraction of 10 training chord samples will produce 10

feature extraction data sequence. The third one was carrying out the averaging calculation for each chord as follows.

$$\mathbf{Z}_T = \frac{1}{10} \sum_{i=1}^{10} \mathbf{Y}_{T,i} \quad (5)$$

where  $T$  is a chord (C, D, E, F, G, A, or B),  $\{\mathbf{Y}_{T,i} \mid 1 \leq i \leq 10\}$  are 10 feature extraction of a  $T$  chord, and  $\mathbf{Z}_T$  is a reference feature extraction from the average of 10 feature extractions of a  $T$  chord. The last one was collecting a number of seven reference feature extractions namely  $\mathbf{Z}_C, \mathbf{Z}_D, \mathbf{Z}_E, \mathbf{Z}_F, \mathbf{Z}_G, \mathbf{Z}_A$ , and  $\mathbf{Z}_B$  in the chord database.

13) *Similarity calculation*: Similarity calculation is a process for calculating the similarity values between a chord feature extraction of an input signal, and a number of chords reference feature extraction (C, D, E, F, G, A, and B) stored in a chord database. Thus, at the output of the similarity calculation process, there are a number of seven similarity values. This work used cosine similarity. This kind of similarity has been popularly used [21].

14) *Chord decision*: Chord decision is a process for determining the output text (C, D, E, F, G, A, or B), which indicates a chord that is recognized. The chord decision process was carried out as follows. The first one was finding the largest similarity value out of a total of seven similarity values, which are the outputs of the similarity calculation process. The second one was determining a recognized chord. A chord (C, D, E, F, G, A, or B) associated with the largest similarity value is determined as a recognized chord. As a note, an output process that is determined based on the largest similarity value indicating that it uses the template matching method [22] [23].

## B. Developing Test Chords

The second step in the research methodology is the developing of the test chords, which were used for testing the chord recognition system. This work recorded 20 test chord samples for each chord (C, D, E, F, G, A, and B). Therefore, there were a number of 140 test chord samples.

## C. Testing and Recognition Rate Calculation

The final step in the research methodology is testing and calculating the recognition rate. Testing was carried out using 140 test chord samples, for the segment averaging outputs 4, 8, 16, and 32 points, the number of feature extraction coefficients 1-8, and the methods of subsampling namely linear, quadratic, and cubic spline interpolation. The recognition rate calculation is the calculation of the ratio (expressed in percent), between the number of correctly recognized chords, and a number of 140 test chord samples.

# III. RESULTS AND DISCUSSIONS

## A. Results

The chord recognition system shown in Fig. 1 has been tested for the chords of a guitar shown in Fig. 2. This test was carried out for the segment averaging outputs 4, 8, 16, and 32 points, the number of feature extraction coefficients 1-8, and the methods of subsampling namely linear, quadratic, and cubic spline interpolation. The results are shown in TABLE I. As a note, the number of feature extraction coefficients are correspond with the subsampling outputs.



TABLE I. TEST RESULTS OF THE DEVELOPED CHORD RECOGNITION SYSTEM.  
RESULTS SHOWN: RECOGNITION RATE (%)

Subsampling method	Number of feature extraction coefficients (coefficients)							
	1	2	3	4	5	6	7	8
<b>Segment averaging output = 4 points</b>								
Linear spline interpolation	14.29	25.71	60.00	68.57	-	-	-	-
Quadratic spline interpolation	14.29	37.14	60.00	68.57	-	-	-	-
Cubic spline interpolation	14.29	37.14	61.43	68.57	-	-	-	-
<b>Segment averaging output = 8 points</b>								
Linear spline interpolation	14.29	45.71	61.43	62.86	88.57	<b>91.43</b>	<b>98.57</b>	100
Quadratic spline interpolation	14.29	47.14	65.71	68.57	87.14	84.29	90.00	100
Cubic spline interpolation	14.29	51.43	65.71	70.00	87.14	88.57	92.86	100
<b>Segment averaging output = 16 points</b>								
Linear spline interpolation	14.29	51.43	64.29	80.00	87.14	85.71	88.57	98.57
Quadratic spline interpolation	14.29	35.71	67.14	77.14	84.29	82.86	84.29	95.71
Cubic spline interpolation	14.29	25.71	67.14	77.14	85.71	84.29	87.14	97.14
<b>Segment averaging output = 32 points</b>								
Linear spline interpolation	14.29	50.00	60.00	82.86	82.86	91.43	94.29	97.14
Quadratic spline interpolation	14.29	42.86	44.29	71.43	78.57	90.00	92.86	95.71
Cubic spline interpolation	14.29	38.57	34.29	71.43	78.57	88.57	94.29	92.86

### B. Discussions

From the point of view of the optimal results, TABLE I indicates that the use of seven and six feature extraction coefficients can give the highest recognition rates of up to 98.57% and 91.43% respectively. These results were achieved by using the segment averaging output eight points, and the subsampling method with linear spline interpolation.

From the point of view of the number of feature extraction coefficients, TABLE I indicates that in general, if the number of feature extraction coefficients is increasing, the recognition rate will increase. This is due, if the number of feature extraction coefficients is increasing, the more dimensions will be used to distinguish one chord pattern from other chord patterns. This one will increase the discrimination level of the feature extraction. Finally, the increase of the discrimination level will lead to an increase of the recognition rate.

From the point of view of segment averaging output, TABLE I indicates that the optimal number of the segment averaging output is eight points. If the number of segment averaging output is less than eight points or even more than 8 points, it will decrease the recognition rate. These cases can be explained as follows. Firstly, if the segment averaging output is less than eight points, it will cause the input of the subsampling process to be rougher. Consequently, this input will cause the output of the subsampling process (which is the result of feature extraction) also to be rougher. This case will decrease the discrimination level of the feature extraction. Secondly, if the segment averaging output is more than eight points, it will cause the input of the subsampling process to be more detail. However, since the subsampling output (which is the result of feature extraction) are less than eight coefficients, it will cause the comparison between the output and the input of the subsampling process will be getting away from the value of 1. This case will also decrease the discrimination level of the feature extraction. Finally, the decrease of the

discrimination level will lead to a decrease of the recognition rate.

From the point of view of the subsampling method, TABLE I indicates that for each number of feature extraction coefficient and each number of segment averaging output, out of a total of 28 events, there are a total of 15 events where the use of linear spline interpolation gives the highest recognition rate. This means, in the majority, the use of linear spline interpolation is superior to quadratic and cubic spline interpolation. In addition, this also means that in the majority, the use of 2 evaluation points for each piece of spline interpolation is sufficient to get the highest discrimination level of the feature extraction. As a first note, each piece of linear, quadratic and cubic spline interpolation, requires 2, 3, and 4 evaluation points [20]. As a second note, in line with what has been described above, the highest discrimination level of the feature extraction will give the highest recognition rate.

### C. Comparison with the other feature extractions

A comparison of some chord recognition rates for several feature extraction methods is shown in TABLE II. As a first note, TABLE II only compare the number of feature extraction coefficients that have been achieved by the author with previous researchers. As a second note, whatever the test chords used, the previous methods [8] [9] [10] always give a number of 12 feature extraction coefficients.

As seen in TABLE II, the proposed feature extraction method can be considered the most efficient based on the two categories of recognition rate. The first one, for the recognition rate category above 98%, the chord recognition system only requires a number of seven feature extraction coefficients. The second one, for the recognition rate category above 90%, the chord recognition system only requires a number of six feature extraction coefficients.

## IV. CONCLUSIONS AND FUTURE WORKS

This work proposes a feature extraction subsystem, which can be used in a chord recognition system. The

TABLE II. THE PERFORMANCE COMPARISON OF SOME FEATURE EXTRACTIONS FOR CHORD RECOGNITION.

Feature Extraction	Number of Feature Extraction Coefficients	Recognition Rate (%)	Test Chords
Improved Chromagram [8]	12	94	1440 test chords from 360 recorded guitar chords
Improved PCP [10]	12	95.83	192 test chords from 192 generated guitar chords
CRP (Chroma DCT-Reduced log Pitch) Enhanced PCP [9]	12	99.96	4608 test chords from 576 generated guitar chords
Segment averaging with SHPS and logarithmic scaling [11]	8	100	140 test chords from 140 recorded guitar chords
Segment averaging and subsampling (this work)	7	<b>98.57</b>	140 test chords from 140 recorded guitar chords
	6	<b>91.43</b>	

feature extraction subsystem is FFT based segment averaging and subsampling.

Based on experiments, for guitar musical instrument, the optimal results can be viewed from the two categories of recognition rate. The first one, for the recognition rate category above 98%, the chord recognition system only requires a number of seven feature extraction coefficients. The second one, for the recognition rate category above 90%, the chord recognition system only requires a number of six feature extraction coefficients. These results were achieved by using the segment averaging output eight points, and the subsampling method with linear spline interpolation.

For further works, it can be explored the use of other subsampling methods besides spline interpolation. In addition, it can also be explored the other variants of the segment averaging feature extraction.

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