

HOME ABOUT LOGIN REGISTER SEARCH CURRENT ARCHIVES
 ANNOUNCEMENTS

Home > About the Journal > **Editorial Team**

Editorial Team

Editor-in-Chief

[Assoc. Prof. Dr. Tole Sutikno](#), Universitas Ahmad Dahlan, Indonesia

Area Editor for Electrical Power Engineering

[Assoc. Prof. Dr. Ahmet Teke](#), Cukurova University, Turkey

Area Editor for Electronics Engineering

[Prof. Ing. Mario Versaci](#), Università degli Studi di Reggio Calabria, Italy

Area Editor for Power Electronics and Drives

[Prof. Dr. Yang Han](#), University of Electronic Science and Technology of China, China

Area Editor for Instrumentation and Control Engineering

[Prof. Dr. Paolo Visconti](#), University of Salento, Italy

Area Editor for Signal, Image and Video Processing

[Prof. Dr. Nidhal Carla Bouaynaya](#), Rowan University, United States

Area Editor for Communication System Engineering

[Prof. Dr. Zahriladha Zakaria](#), Universiti Teknikal Malaysia Melaka, Malaysia

Area Editor for Computer Network and System Engineering

[Assoc. Prof. Dr. Muhammad Nadzir Marsono](#), Universiti Teknologi Malaysia, Malaysia

Area Editor for Computer Science and Information System

[Assoc. Prof. Dr. Wanguan Liu](#), Curtin University of Technology, Australia

Area Editor for Machine Learning, AI and Soft Computing

[Prof. Dr. Luis Paulo Reis](#), Universidade do Porto, Portugal

Area Editor for Internet of Things

[Assoc. Prof. Dr. Chau Yuen](#), Singapore University of Technology and Design, Singapore

Associate Editors

[Prof. Viranjay Mohan Srivastava](#), University of KwaZulu-Natal, South Africa
[Prof. Dr. Media Anugerah Ayu](#), Sampoerna University, Indonesia
[Prof. Dr. Simon X. Yang](#), University of Guelph, Canada
[Prof. Dr. Ahmad Saudi Samosir](#), Lampung University, Indonesia
[Prof. Dr. Alex Pappachen James](#), Indian Institute of Information Technology and Management-Kerala, India
[Prof. Dr. Antonios Gasteratos](#), Democritus University of Thrace, Greece
[Prof. Dr. Badrul Hisham Ahmad](#), Universiti Teknikal Malaysia Melaka, Malaysia
[Prof. Dr. Chi-Hua Chen](#), Fuzhou University, China
[Prof. Dr. Emilio Jimenez-Macias](#), University of La Rioja, Spain
[Prof. Dr. Francis C. M. Lau](#), Hong Kong Polytechnic University, Hong Kong
[Prof. Franco Frattolillo, Ph.D.](#), University of Sannio, Italy
[Prof. Dr. George A. Papakostas](#), International Hellenic University, Greece
[Prof. Dr. Huchang Liao](#), Sichuan University, China
[Prof. Longquan Yong](#), Shaanxi University of Technology, China
[Prof. Dr. Mahmoud Moghavvemi](#), University of Malaya, Malaysia
[Prof. Ing. Mario Versaci](#), Università degli Studi di Reggio Calabria, Italy
[Prof. Dr. Melchior Pierre](#), University of Bordeaux, France
[Prof. Dr. Pascal Lorenz](#), University of Haute Alsace, France
[Prof. Dr. Qiang Yang](#), Zhejiang University, China
[Prof. Dr. Sanjay Misra](#), Covenant University, Nigeria
[Prof. Dr. Surinder Singh](#), SLIET Longowal, India
[Prof. Dr. Teddy Surya Gunawan](#), International Islamic University of Malaysia, Malaysia
[Prof. Dr. Zhenyu Zhou](#), North China Electric Power University, China
[Prof. Dr. Zita Vale](#), Instituto Politécnico do Porto, Portugal
[Dr. Kennedy O. Okokpujie](#), Covenant University, Nigeria
[Assoc. Prof. Dr. D. Jude Hemanth](#), Karunya University, India
[Assoc. Prof. Dr. Hamed Mojallali](#), The University of Guilan, Iran, Islamic Republic of
[Assoc. Prof. Dr. Imran Sarwar Bajwa](#), Islamia University, Pakistan
[Assoc. Prof. Dr. Jumril Yunus](#), Universiti Kebangsaan Malaysia, Malaysia
[Assoc. Prof. Dr. Peng Zhang](#), University of Connecticut, United States
[Assoc. Prof. Dr. Shahrin Md Ayob](#), Universiti Teknologi Malaysia, Malaysia
[Asst. Prof. Dr. Andrea Francesco Morabito](#), University of Reggio Calabria, Italy
[Asst. Prof. Dr. Domenico Ciunzio](#), University of Naples Federico II, Italy
[Dr. Abdullah M. Ilyasu](#), Tokyo Institute of Technology, Japan
[Dr. Adamu I. Abubakar](#), International Islamic University Malaysia, Malaysia
[Dr. Anh-Huy Phan](#), Skolkovo Institute of Science and Technology (Skoltech), Russian Federation
[Dr. Arafat Al-Dweik](#), Khalifa University, United Arab Emirates
[Dr. Arcangelo Castiglione](#), University of Salerno, Italy
[Dr. Arianna Mencattini](#), University of Rome "Tor Vergata", Italy
[Dr. Athanasios Kakarountas](#), University of Thessaly, Greece
[Dr. Aniello Castiglione](#), University of Naples Parthenope, Italy
[Dr. Griengorai Rajchakit](#), Maejo University, Thailand
[Dr. Javed Iqbal](#), Sarhad University of Science and Information Technology, Pakistan
[Dr. Khader Shameer](#), Mount Sinai Health System, United States

USER

Username
 Password
☐ Remember me

TEMPLATE



ONLINE SUBMISSION

Submit Paper

QUICK LINKS

- Author Guideline
- Editorial Boards
- Reviewers
- **Online Submission**
- Abstracting and Indexing
- Scopus: Add missing document
- Publication Ethics
- Visitor Statistics
- Contact Us

JOURNAL CONTENT

Search
 Search Scope

Browse

- By Issue
- By Author
- By Title
- Other Journals

[Dr. Lai Khin Wee](#), Universiti Malaya, Malaysia
[Asst. Prof. Dr. Makram A. Fakhri](#), University of Technology, Iraq
[Mark S. Hooper](#), IEEE Consultants' Network of Silicon Valley, United States
[Dr. Paolo Crippa](#), Universita'Politecnica delle Marche, Italy
[Dr. Qammer Hussain Abbasi](#), University of Glasgow, United Kingdom
[Dr. Saleem Abdullah](#), Abdul Wali Khan University Mardan, Pakistan
[Dr. Santhanakrishnan V. R. Anand](#), New York Institute of Technology, United States
[Dr. Sudhanshu Tyagi](#), Thapar Institute of Engineering and Technology, India
[Dr. Winal Jaikla](#), King Mongkut's Institute of Technology Ladkrabang, Thailand

TELKOMNIKA Telecommunication, Computing, Electronics and Control

ISSN: 1693-6930, e-ISSN: 2302-9293

Universitas Ahmad Dahlan, 4th Campus

Jl. Ringroad Selatan, Kragilan, Tamanan, Banguntapan, Bantul, Yogyakarta, Indonesia 55191

Phone: +62 (274) 563515, 511830, 379418, 371120 ext. 4902, Fax: +62 274 564604

02723765[View TELKOMNIKA Stats](#)

HOME ABOUT LOGIN REGISTER SEARCH CURRENT ARCHIVES
ANNOUNCEMENTS

[Home](#) > [Archives](#) > **Vol 18, No 2**

Vol 18, No 2

April 2020

DOI: <http://dx.doi.org/10.12928/telkomnika.v18i2>

Table of Contents

Outage and throughput performance of cognitive radio based power domain based multiple access	PDF
<i>Dinh-Thuan Do, Chi-Bao Le</i>	579-586
Enabling relay selection in non-orthogonal multiple access networks: direct and relaying mode	PDF
<i>Dinh-Thuan Do, Minh-Sang V. Nguyen</i>	587-594
Compact reconfigurable PIFA antenna for wireless applications	PDF
<i>Abdullah Ali Jabber, Ali Khalid Jassim, Raad Hamdan Taher</i>	595-602
An optimum dynamic priority-based call admission control scheme for universal mobile telecommunications system	PDF
<i>Anike Uchenna, Ajibo Chinenye Augustine, Chinaeke-Ogbuka Ifeanyi Maryrose, Odo Chinedu Matthew, Amoke Amobi Douglas, Ani Cosmas</i>	603-612
Dynamic multiagent method to avoid duplicated information at intersections in VANETs	PDF
<i>Mohammed I. Habelalmateen, A. H. Abbas, L. Audah, N. A. M. Alduais</i>	613-621
A compact UWB monopole antenna with penta band notched characteristics	PDF
<i>Majed O. Al-Dwairi, Amjad Y. Hindi, Mohamed S. Soliman, Mohammad F. Aljafari</i>	622-630
Development of triangular array eight patches antennas for circularly-polarized synthetic aperture radar sensor	PDF
<i>Muhammad Fauzan Edy Purnomo, Vita Kusumasari, Edi Supriana, Rusmi Ambarwati, Akio Kitagawa</i>	631-639
Integration of IoT and chatbot for aquaculture with natural language processing	PDF
<i>M. Udin Harun Al-Rasyid, Sritrusta Sukaridhoto, Muhammad Iskandar Dzulkornain, Ahmad Rifai</i>	640-648
A performance of radio frequency and signal strength of LoRa with BME280 sensor	PDF
<i>Puput Dani Prasetyo Adi, Akio Kitagawa</i>	649-660
Patterns of sidemount four-bay FM antenna system	PDF
<i>Gerino Mappatao</i>	661-668
Failed handoffs in collaborative Wi-Fi networks	PDF
<i>Cesar Hernandez, Diego Giral, C. Salgado</i>	669-675
Technology readiness and usability of office automation system in suburban areas	PDF
<i>Dwi Yuniarto, A'ang Subiyakto, Aedah Abd. Rahman</i>	676-684
A new multi-level key block cypher based on the Blowfish algorithm	PDF
<i>Suhad Muhajer Kareem, Abdul Monem S. Rahma</i>	685-694
New approach to the identification of the easy expression recognition system by robust techniques (SIFT, PCA-SIFT, ASIFT and SURF)	PDF
<i>Ahmed Chater, Abdelali Lasfar</i>	695-704
Benchmark and comparison between hyperledger and MySQL	PDF
<i>Onno W. Purbo, Sriyanto Sriyanto, Suhendro Suhendro, Rz Abd. Aziz, Riko Herwanto</i>	705-715
Technology organization environment framework in cloud computing	PDF
<i>Iqbal Ahmed</i>	716-725

USER

Username
Password
☐ Remember me

TEMPLATE



ONLINE SUBMISSION

Submit Paper

QUICK LINKS

- Author Guideline
- Editorial Boards
- Reviewers
- **Online Submission**
- Abstracting and Indexing
- Scopus: Add missing document
- Publication Ethics
- Visitor Statistics
- Contact Us

JOURNAL CONTENT

Search
Search Scope

Browse

- By Issue
- By Author
- By Title
- Other Journals

Plant species identification based on leaf venation features using SVM <i>Agus Ambarwari, Qadhli Jafar Adrian, Yeni Herdiyeni, Irman Hermadi</i>	PDF 726-732
Face recognition based on curvelets, invariant moments features and SVM <i>Mohammed Talal Ghazal, Karam Abdullah</i>	PDF 733-739
Feature extraction of Jabon (<i>Anthocephalus</i> sp) leaf disease using discrete wavelet transform <i>Felliks Feiters Tampinongkol, Yeni Herdiyeni, Elis Nina Herliyana</i>	PDF 740-751
Sentiment analysis by deep learning approaches <i>Sreevidya P., O. V. Ramana Murthy, S. Veni</i>	PDF 752-760
A robust method for VR-based hand gesture recognition using density-based CNN <i>Liliana Liliana, Ji-Hun Chae, Joon-Jae Lee, Byung-Gook Lee</i>	PDF 761-769
Combined scaled manhattan distance and mean of horner's rules for keystroke dynamic authentication <i>Didih Rizki Chandranegara, Hardianto Wibowo, Agus Eko Minarno</i>	PDF 770-775
PSO optimization on backpropagation for fish catch production prediction <i>Yuslena Sari, Eka Setya Wijaya, Andreyan Rizky Baskara, Rico Silas Dwi Kasanda</i>	PDF 776-782
Genomic repeats detection using Boyer-Moore algorithm on Apache Spark Streaming <i>Lala Septem Riza, Farhan Dhiyaa Pratama, Erna Plantari, Mahmoud Fahsi</i>	PDF 783-791
Indoor positioning system using BLE beacon to improve knowledge about museum visitors <i>Andreas Handojo, Tanti Octavia, Resmana Lim, Jonathan Kurnia Anggita</i>	PDF 792-798
Hoax classification and sentiment analysis of Indonesian news using Naive Bayes optimization <i>Heru Agus Santoso, Eko Hari Rachmawanto, Adhitya Nugraha, Akbar Aji Nugroho, De Rosal Ignatius Moses Setiadi, Ruri Suko Basuki</i>	PDF 799-806
Evaluation of deep neural network architectures in the identification of bone fissures <i>Fredy Martinez, César Hernández, Fernando Martínez</i>	PDF 807-814
Comparing random forest and support vector machines for breast cancer classification <i>Chelvian Aroef, Yuda Rivan, Zuherman Rustam</i>	PDF 815-821
HAR-MI method for multi-class imbalanced datasets <i>H. Hartono, Yeni Risyani, Erianto Ongko, Dahlan Abdullah</i>	PDF 822-829
Single object detection to support requirements modeling using faster R-CNN <i>Nathanael Gilbert, Andre Rusli</i>	PDF 830-838
Bersha: bringing chatbot into hotel industry in Indonesia <i>Dennis Gunawan, Farica Perdana Putri, Hira Meidia</i>	PDF 839-845
MILA: Low-cost BCI framework for acquiring EEG data with IoT <i>Rolly Maulana Awangga, Syafrial Fachri Pane, Dzikri Ahmad Ghifari, Tri Angga Dio Simamora, Mochamad Yusuf Asyhari</i>	PDF 846-852
Benchmarking level interactivity of Indonesia government university websites <i>Nurdin Nurdin, Zana Chobita Aratusa</i>	PDF 853-859
Readiness measurement of IT implementation in Higher Education Institutions in Indonesia <i>Mohamad Irfan, Syopiansyah Jaya Putra</i>	PDF 860-869
Multicore development environment for embedded processor in arduino IDE <i>Stefanus Kurniawan, Dareen K. Halim, Dicky H., Tang C. M.</i>	PDF 870-878
Fisher-Yates and fuzzy Sugeno in game for children with special needs <i>Diena Rauda Ramdania, Mohamad Irfan, Salma Nuralisa Habsah, Cepy Slamet, Wisnu Uriawan, Khaerul Manaf</i>	PDF 879-889
User stories collection via interactive chatbot to support requirements gathering <i>Ferliana Dwitama, Andre Rusli</i>	PDF 890-898
P-D controller computer vision and robotics integration based for student's programming comprehension improvement <i>Nova Eka Budiayanta, Catherine Olivia Sereati, Lukas Lukas</i>	PDF 899-906
The prediction of mobile data traffic based on the ARIMA model and disruptive formula in industry 4.0: A case study in Jakarta, Indonesia	PDF

<i>Ajib Setyo Arifin, Muhammad Idham Habibie</i>	907-918
Brain computer interface based smart keyboard using neurosky mindwave headset	PDF
<i>Thair A. Salih, Yasir M. Abdal</i>	919-927
Qualitative assessment of image enhancement algorithms for mammograms based on minimum EDV	PDF
<i>Mazin N. Farhan, Mohammed G. Ayoub, Hassan M. Qassim, Abdulrahman K. Eesee</i>	928-935
Artifact elimination in ECG signal using wavelet transform	PDF
<i>Thanh-Nghia Nguyen, Thanh-Hai Nguyen, Van-Thuyen Ngo</i>	936-944
Glasses for the blind using ping ultrasonic, ATMEGA8535 and ISD25120	PDF
<i>Hartono Siswono, Widyastuti Widyastuti</i>	945-952
Low-cost and open-source anthropomorphic prosthetics hand using linear actuators	PDF
<i>Triwiyanto Triwiyanto, I Putu Alit Pawana, Torib Hamzah, Sari Luthfiyah</i>	953-960
Various and multilevel of wavelet transform for classification misalignment on induction motor with quadratic discriminant analysis	PDF
<i>Pressa Perdana Surya Saputra, Misbah Misbah, Hendra Ariwinarno, F. D. Mudianto</i>	961-969
Water bath sonicator integrated with PID-based temperature controller for flavonoid extraction	PDF
<i>Zainul Abidin, M. Aziz Muslim, Muhammad Muqorrobin, Warsito Warsito</i>	970-976
Three-level modified sine wave inverter equipped with online temperature monitoring system	PDF
<i>Suroso Suroso, Ahmad Khafidz, Winasis Winasis, Hari Siswanto</i>	977-984
An improved electricity efficiency method based on microcontroller and IoT with infrared sensor	PDF
<i>Arif Ainur Rafiq, Sugeng Dwi Riyanto, Ratna Wardani</i>	985-993
An optimal control for complete synchronization of 4D Rabinovich hyperchaotic systems	PDF
<i>Shaymaa Y. Al-Hayali, Saad Fawzi Al-Azzawi</i>	994-1000
PID controller for microsatellite yaw-axis attitude control system using ITAE method	PDF
<i>Ajiboye A. T., Popoola J. O., Oniyide O., Ayinla S. L.</i>	1001-1011
Projective and hybrid projective synchronization of 4-D hyperchaotic system via nonlinear controller strategy	PDF
<i>Zaidoon Sh. Al-Talib, Saad Fawzi Al-Azzawi</i>	1012-1020
Joint control of a robotic arm using particle swarm optimization based H2/H_∞ robust control on arduino	PDF
<i>Petrus Sutyasadi, Martinus Bagus Wicaksono</i>	1021-1029
Scheme for motion estimation based on adaptive fuzzy neural network	PDF
<i>Fredy Martinez, Cristian Penagos, Luis Pacheco</i>	1030-1037
Mobile-based monitoring system for an automatic cat feeder using Raspberry Pi	PDF
<i>Nenny Anggraini, Dzul Fadli Rahman, Luh Kesuma Wardhani, Nashrul Hakiem</i>	1038-1046
Controlling a knee CPM machine using PID and iterative learning control algorithm	PDF
<i>Dechrit Maneetham, Petrus Sutyasadi</i>	1047-1053
Combined ILC and PI regulator for wastewater treatment plants	PDF
<i>Lanh Van Nguyen, Nam Van Bach, Hai Trung Do, Minh Tuan Nguyen</i>	1054-1061
Rogowski coil sensor in the digitization process to detect partial discharge	PDF
<i>Eka Putra Walid, Asri Indah Lestari, Rudy Fernandez, Syaifa Mulyadi, Yoshinobu Murakami, Naohiro Hozumi</i>	1062-1071
Physical security with power beacon assisted in half-duplex relaying networks over Rayleigh fading channel: performance analysis	PDF
<i>Phu Tran Tin, Duy-Hung Ha, Luu Gia Thien, Tran Thanh Trang</i>	1072-1078
Robust audio watermarking based on transform domain and SVD with compressive sampling framework	PDF
<i>Ledya Novamizanti, Gelar Budiman, Elsa Nur Fitri Astuti</i>	1079-1088
Short-term photovoltaics power forecasting using Jordan recurrent neural network in Surabaya	PDF
<i>Aji Akbar Firdaus, Riky Tri Yunardi, Eva Inaiyah Agustin, Tesa Eranti Putri, Dimas Okky Anggriawan</i>	1089-1094
DWT-SMM-based audio steganography with RSA encryption and compressive	PDF

sampling

Fikri Adhanadi, Ledy Novamizanti, Gelar Budiman

1095-1104

Matching algorithm performance analysis for autocalibration method of stereo vision

[PDF](#)

Raden Arief Setyawan, Rudy Soenoko, Moch Agus Choiron, Panca Mudjirahardjo

1105-1112

MPPT control of PV array based on PSO and adaptive controller

[PDF](#)

Totok Winarno, Lucky Nindya Palupi, Agus Pracoyo, Lunde Ardhenta

1113-1121

Adaptive threshold for moving objects detection using gaussian mixture model

[PDF](#)

Moch Arief Soeleman, Aris Nurhindarto, Muslih Muslih, Karis W., Muljono Muljono, Farikh Al Zami, R. Anggi Pramunendar

1122-1129

Fuzzy transform for high-resolution satellite images compression

[PDF](#)

Donna Monica, Ayom Widipaminto

1130-1136

TELKOMNIKA Telecommunication, Computing, Electronics and Control

ISSN: 1693-6930, e-ISSN: 2302-9293

Universitas Ahmad Dahlan, 4th Campus

Jl. Ringroad Selatan, Kragilan, Tamanan, Banguntapan, Bantul, Yogyakarta, Indonesia 55191

Phone: +62 (274) 563515, 511830, 379418, 371120 ext. 4902, Fax: +62 274 564604

02723760

[View TELKOMNIKA Stats](#)



SJR

Scimago Journal & Country Rank

Enter Journal Title, ISSN or Publisher Name

[Home](#)[Journal Rankings](#)[Country Rankings](#)[Viz Tools](#)[Help](#)[About Us](#)

Write With Confidence

Check your grammar, spelling, and punctuation instantly with Grammarly

Grammarly

[Learn More](#)

Telkomnika

COUNTRY

[Indonesia](#)Universities and research
institutions in Indonesia

SUBJECT AREA AND CATEGORY

[Engineering](#)
[Electrical](#)
[and](#)
[Electronic](#)
[Engineering](#)

PUBLISHER

[Institute of
Advanced
Engineering and
Science \(IAES\)](#)

H-INDEX

23

PUBLICATION TYPE

[Journals](#)

ISSN

16936930,
2087278X

COVERAGE

2011-2020

INFORMATION

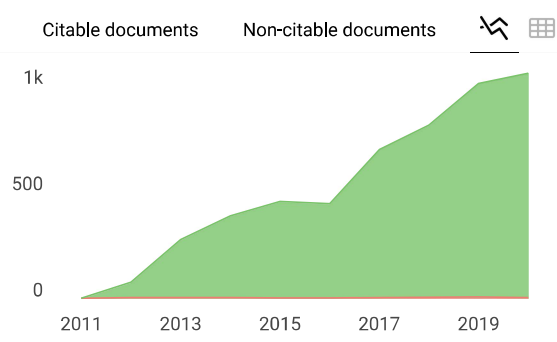
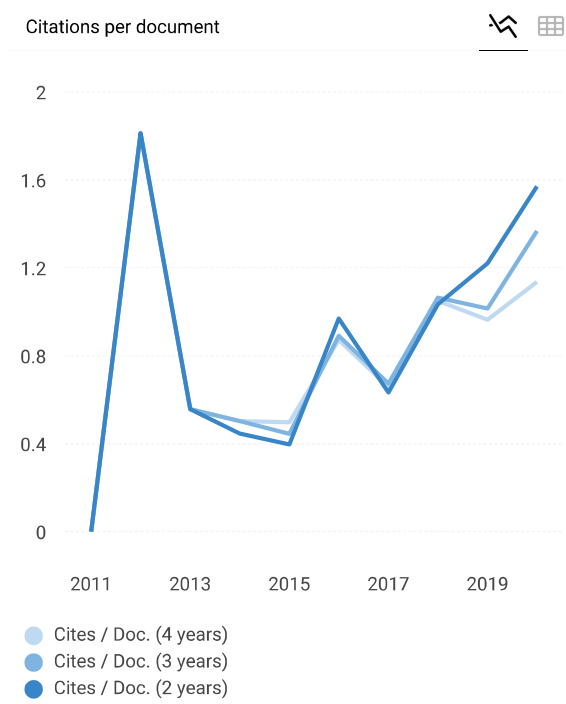
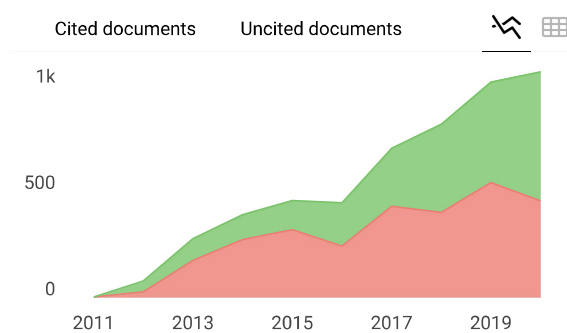
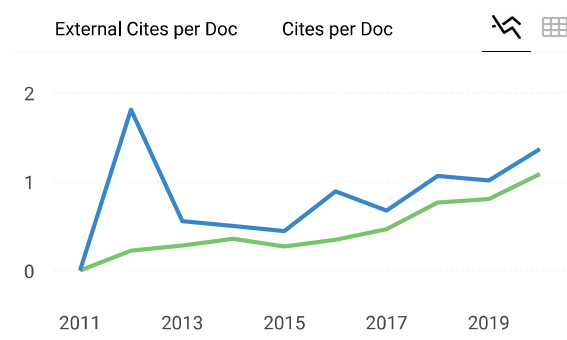
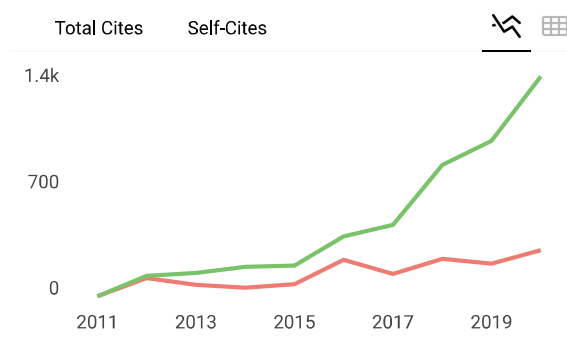
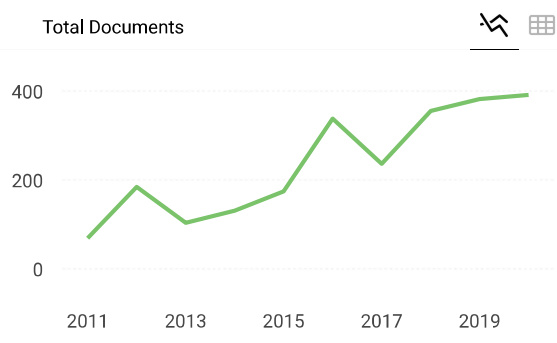
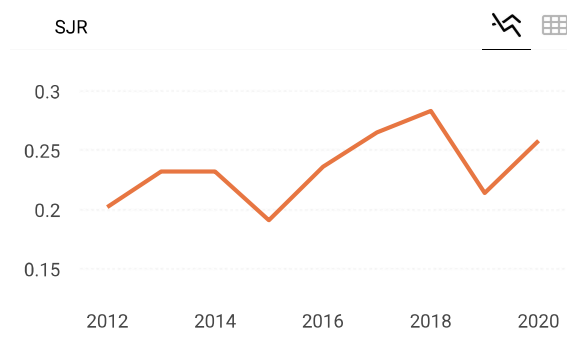
[Homepage](#)[How to publish
in this journal](#)[telkomnika@uad
.ac.id](mailto:telkomnika@uad.ac.id)

Support - Scopus journal

Fast Publication | Q1 Q2 Q3 Q4

One of the easiest ways to ensuring that your
published quicky by well-recognizedijrdo.org[OPEN](#)

SCOPE



← Show this widget in your own website

Just copy the code below and paste within your html code:

```
<a href="https://www.scimagojr.com" style="color: #000000; text-decoration: none; font-family: sans-serif; font-size: 12px;">

```





Document details - Indoor positioning system using BLE beacon to improve knowledge about museum visitors

1 of 1

[Export](#) [Download](#) [More...](#)

Telkomnika (Telecommunication Computing Electronics and Control)

Volume 18, Issue 2, 1 April 2020, Pages 792-798

Indoor positioning system using BLE beacon to improve knowledge about museum visitors(Article)([Open Access](#))

Handojo, A., Octavia, T., Lim, R., Anggita, J.K.

^aInformatics Department, Faculty of Industrial Engineering, Petra Christian University, Indonesia^bIndustrial Engineering Department, Faculty of Industrial Engineering, Petra Christian University, Indonesia^cElectrical Engineering Department, Faculty of Industrial Engineering, Petra Christian University, Indonesia

Abstract

Generally, a museum has many locations and artifacts collection that display for visitors. Museum manager often have difficulty in obtaining information on visitors behavior such as, is there are particular locations/artifacts in the museum that are frequently/rarely visit by museum visitors, how long visitors spend their time in particular locations/artifacts, etc. The purpose of this study is try to build a suitable system in order to improve knowledge about the behavior of museum visitors by identifying the position of visitors in the museum. This study uses Bluetooth Low Energy (BLE) Beacon that place around the museum. The visitor mobile phone will detect BLE beacon signal, then the mobile phone application will calculated the visitor's mobile phone position using the signal strength from the BLE beacons that are detected. The application then sends it to the computer server to display it in as museum visitor heat map. From this information, the museum manager could find out the visitors behavior movement and know which areas/artifacts that frequently/rarely visit by museum visitors. According to distance error testing which compare real location and position of the calculation, it is show that the average of distance error is around 140 cm. So, it can be concluded that the information obtained is sufficient enough to represent the position of museum visitors. © 2019 Universitas Ahmad Dahlan. All rights reserved.

SciVal Topic Prominence

Topic: Indoor Positioning Systems | Received Signal Strength | Wi-Fi

Prominence percentile: 99.559

Author keywords

[Bluetooth low energy](#) [Indoor positioning system](#) [Mobile phone](#) [Museum](#) [Visitor experience](#)

Funding details

Funding sponsor	Funding number	Acronym
	002/SP2H/P/K7/KM/2019	

Funding text

This research was supported by Indonesia Directorate Research and Technology of Higher Education under grant 002/SP2H/P/K7/KM/2019. This research also support by Petra Christian University Mobile Computing Research Group.

Cited by 0 documents

Inform me when this document is cited in Scopus:

[Set citation alert >](#)[Set citation feed >](#)

Related documents

Find more related documents in Scopus based on:

[Authors >](#) [Keywords >](#)

About Scopus

[What is Scopus](#)
[Content coverage](#)
[Scopus blog](#)
[Scopus API](#)
[Privacy matters](#)

Language

[日本語に切り替える](#)
[切换到简体中文](#)
[切换到繁體中文](#)
[Русский язык](#)

Customer Service

[Help](#)
[Contact us](#)

ELSEVIER

[Terms and conditions ↗](#) [Privacy policy ↗](#)

Copyright © Elsevier B.V. All rights reserved. Scopus® is a registered trademark of Elsevier B.V.

We use cookies to help provide and enhance our service and tailor content. By continuing, you agree to the use of cookies.

RELX

Indoor positioning system using BLE beacon to improve knowledge about museum visitors

Andreas Handojo¹, Tanti Octavia², Resmana Lim³, Jonathan Kurnia Anggita⁴

^{1,4}Informatics Department, Faculty of Industrial Engineering, Petra Christian University, Indonesia

²Industrial Engineering Department, Faculty of Industrial Engineering, Petra Christian University, Indonesia

³Electrical Engineering Department, Faculty of Industrial Engineering, Petra Christian University, Indonesia

Article Info

Article history:

Received Jul 24, 2019

Revised Jan 16, 2020

Accepted Feb 9, 2020

Keywords:

Bluetooth low energy
Indoor positioning system
Mobile phone
Museum
Visitor experience

ABSTRACT

Generally, a museum has many locations and artifacts collection that display for visitors. Museum manager often have difficulty in obtaining information on visitors behavior such as, is there are particular locations/artifacts in the museum that are frequently/rarely visit by museum visitors, how long visitors spend their time in particular locations/artifacts, etc. The purpose of this study is try to build a suitable system in order to improve knowledge about the behavior of museum visitors by identifying the position of visitors in the museum. This study uses Bluetooth Low Energy (BLE) Beacon that place around the museum. The visitor mobile phone will detect BLE beacon signal, then the mobile phone application will calculated the visitor's mobile phone position using the signal strength from the BLE beacons that are detected. The application then sends it to the computer server to display it in as museum visitor heat map. From this information, the museum manager could find out the visitors behavior movement and know which areas/artifacts that frequently/rarely visit by museum visitors. According to distance error testing which compare real location and position of the calculation, it is show that the average of distance error is around 140 cm. So, it can be concluded that the information obtained is sufficient enough to represent the position of museum visitors.

This is an open access article under the [CC BY-SA](#) license.



Corresponding Author:

Andreas Handojo,
Informatics Department,
Faculty of Industrial Engineering,
Petra Christian University,
Sivallankerto 121-131, Surabaya, East Java, Indonesia.
Email: handojo@petra.ac.id

1. INTRODUCTION

Indonesia is a country that has a long history. Starting from the ancient kingdom history, the history of resistance to invaders, the history of fighting for independence, and others. This history left a lot of historic relics such as temples, statues, historic buildings, furnitures, weapons, metal equipment, and others. Most of this relics are located in the museums. Indonesia has approximately 400 museums scattered in various places throughout Indonesia [1]. Seeing the important role of the museum in preserving culture and becoming an educational medium for the future of the nation, the Indonesian government has carried out museums revitalization with the aim of creating attractive museums for visitors in accordance with international museum standards [2]. The government has also organized the "Visit Indonesia Museums" program on seven provinces

in Indonesia with the aim of increasing the public's visit to the museum which is expected to increase people's understanding and love of the nation's history.

In presenting the information, the museum presents historical heritage by using displays and showing media. The layout of historic relics is very important so that it can provide important and interesting information for visitors. Especially considering the number of artifacts in the museum that can reach thousands items, such as the National Museum Indonesia which has around 141.000 artifacts [3]. The problem that arises is how the museum administrator could find out which area and which artifact that interesting to the visitors. How long the visitors will spend their time to a particular area/artifacts. It's any change that needed to be done to improve visitors experience and interest in their visit to the museum [4].

First objective from this study is to build a museum visitors behavior information by constructing location mapping to provide an analysis which museum area that visit by visitors, how long they spend times in particular locations, which areas and artifacts that favorite to the visitors, etc. This information will displayed on the museum visitor's heat map that displays the visitor movement in particular times and locations. Another objective from this study is to apply Internet of Things (IoT) technology to Indonesia Museums. How to find suitable IoT technology for Indonesian museums. Considering that Indonesia museums consists of a wide variety of objectives, budget size, various display models, the level of museum manager's ability to adopt technology, etc.

To achieve this objectives, this study builds a visitor behaviour mapping using the Indoor Positioning System (IPS) by utilizing Bluetooth Low Energy (BLE) beacons. This BLE signal will be detected by Bluetooth that are already installed on the visitor's mobile phone. This study proposed to use BLE beacons because its size is very small so that it is easy to place on the shelf or museum artifacts without significant interference. BLE beacons also easy to install and only require low energy consumption so they only require a small battery and only need to be replaced in one or two years. BLE beacons also cheap so they can be bought by any level of Indonesia museum (small to large museum budgets). BLE beacons also have a medium range coverage signal so it can cover small to large spaces in the museum.

First, museum visitors are asked to install the museum information application (through Google Playstore) that was made in the previous study [5], through this application visitors can access any information about artifacts in the museum (in text, video, image, audio). After detecting bluetooth signal from BLE beacons, the mobile phone application will calculate the distance of the mobile phone location from each BLE beacon location using the signal strength from each BLE beacon that has been detected. This study use trilateration and kalman filter method [6, 7] to calculate the position of museum visitor. Information about visitor locations is sent to the server as visitor mapping data. The data is then managed as visitor mapping information starting from the location of the visitor at a particular time, the length time that visitor spend in particular location, and the number of visitors in the location.

2. RESEARCH METHOD

Research on the use of technology for tourism development (especially cultural heritage tourism) continues to grow as by Botturi et al. [8] that create mobile games for learning cultural heritage, Meiliana et al. [9] that build mobile smart travelling application on android for Indonesia tourism. Handojo et al. [10] that using mobile phone and GPS features to build interactive game and information city heritage on mobile phone. McGookin [11] that developed a mobile application for cultural heritage. Rolando and Scandiffio [12] that use mobile phone technology, QR code, Geographic Information System (GIS), and Global Positioning Systems (GPS) as interactive tools for tourists visiting various cultural heritage sites in the city. Handojo et al. [13] also used mobile phone and GPS technology to guide tourists in a visit in the city of Surabaya to follow the history of the battle for Indonesian independence.

Several attempts also have been made in order to create an interactive and interesting museum. Chivarov et al. [14] create an interactive presentation using mobile phone to create digital exhibits in the museum. Turan and Keser [15] created museum guide in classical car museum to create interactive information. Some modern museums have used technological tools to create a more attractive museum for visitors. For example, the Smithsonian American Art Museum uses virtual reality to create a virtual experiences for museum visitors [16]. Another example is the Cleveland Museum of Art which uses the augmented reality facility to provide facilities for visitors to enjoy the art offered [17]. From various research and implementation efforts, it can be concluded that it is very important to make museums more interesting, interesting to visit, and interactive information using various types of information technology.

It is a challenge to create a museum that suits the needs of visitors. Therefore, it is very important for the museum manager to be able to know what museum visitors need and what visitors learn while in the museum [18]. It is important for museum manager to find out the needs of their visitors which areas or exhibition that interesting to them [19]. Therefore, this study tries to help museum managers to see which areas

or museum artifacts that have seen by museum visitors, how long visitors spend their time there, etc. This study use Indoor Positioning System Technology to mapping user location on the museum at a certain time.

Research on Indoor Positioning System (IPS) in order to determine user location in a room (indoor) has been developed by many researchers. IPS uses received signal strength indicators (RSSI) that obtained by ultrasonic wave transmitters/beacons. The transmitters/beacons locations usually have been predetermined. Some studies use WiFi (access point), radio frequency identification device (RFID), ultra wideband (UWB), and bluetooth low energy (BLE) as transmitters/beacons. Each equipment has its own specifications. Some devices have a long range such as WiFi which has a distance of 100 meters to 1 kilometer [20, 21]. Some equipment also has short range such as common Bluetooth that have 7-10 meters range and RFID which has a range of only around few centimeters to 1 or 2 meters [22].

Some studies use WiFi as IPS transmitter devices, such as Narzullaev et al. [23] which uses WiFi fingerprint as IPS to track assets and equipment in companies such as warehouses, factories, and hospitals. Yeo et al. [24] use WiFi fingerprints at shopping malls in South of Kuala Lumpur, Malaysia. Firdaus et al. [25] which use WiFi fingerprints based on user orientation to improve IPS. Another studies used Bluetooth (BLE) as transmitter, such as in Handojo et al. [5], Asmus [26], Davies [27], Skårberg and Sletten [28], and Setiawan et al. [29] that use it on the museum. Huh and Seo [30] and Thamm [31] that use Bluetooth on department store.

Every transmitter will have their own advantages and disadvantages ranging from price, size, range, energy consumption, installation difficulties, etc. This study chose to use BLE beacons (WEMOS LOLIN32 Lite) because (low) price consideration. So it's suitable to be implemented in various museums (small/big funds) without large cost necessity, considering not every museum has large funds. BLE beacons Figure 1 also have a small size (13x5 cm) so that they can easily be placed in various places in the museum space without disturbing the artifacts on display. In addition, BLE beacons also have easy installation so they are easily duplicated when needed [32]. In terms of energy consumption, BLE beacons have used Bluetooth 4.0 technology so that it only requires low energy. So, it is requires minimal battery maintenance can last up to more than 1 year). Meanwhile, to do location calculations, this study using the Trilateration method Figure 2 and Kalman Filter.



Figure 1. Bluetooth Low Energy Beacon

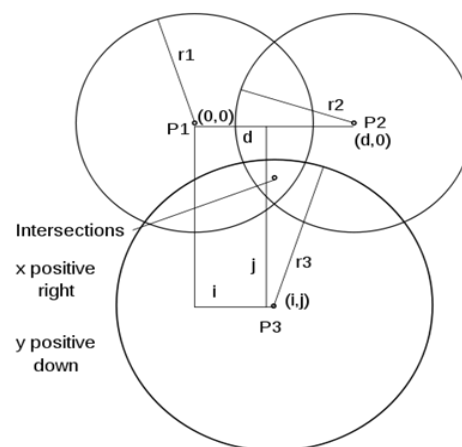


Figure 2. Trilateration

The research method of this study can be described as follows Figure 3. Some BLE beacons are placed in certain locations in the museum rooms. The coordinates of each BLE beacon are stored on the server.

- Each BLE beacons will broadcast their identification (UUID) using bluetooth signal. The museum application on user mobile phone will detect the beacon id that's around it
- Then, the application will then send the beacon id to the server. The server will send the location of the beacon on the museum.
- Based on this information, the application will calculate the user's location by calculating the BLE beacon strength signal (RSSI) using Trilateration dan Kalman Filter.
- The user location then sent to the server periodicaly

This data will be stored in a database on the server. The server will use this data collection to mapping the visitor's heat map. This visitor's heat map then could be use to improve knowledge about museum visitor's

interests. Where museum visitors spend their time in the museum, how long the museum visitors stay in the particular locations/artifacts. Using this information the museum manager could find out the patterns of visitors when visiting the museum. Then, the museum manager could reorganize the placement of museum artifacts or the layout of the museum to provide interesting display information for museum visitors.

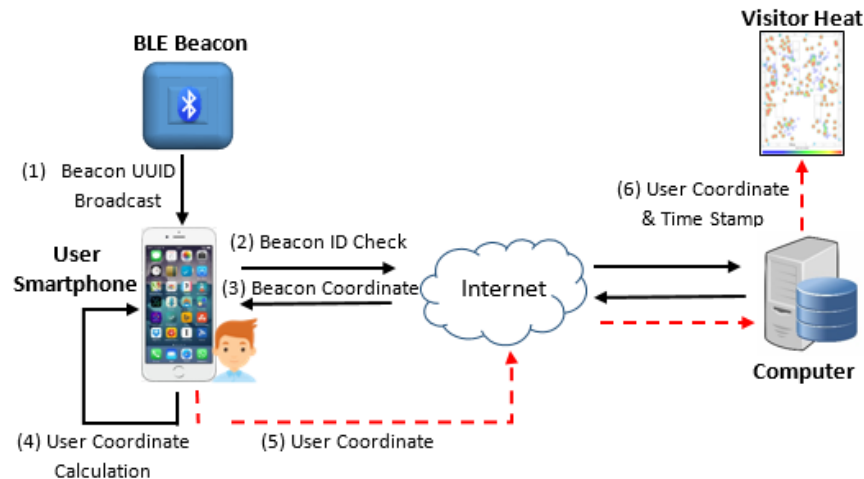


Figure 3. Bluetooth Low Energy Beacon

3. RESULTS AND ANALYSIS

As a place for testing, this study uses Trowulan Museum that located in the city of Mojokerto, East Java, Indonesia. Trowulan Museum is a museum that stores the relics of the Majapahit Kingdom (1293-1500 AD). Majapahit Kingdom was one of the largest ancient country that rule most of Indonesia, Singapore, and parts of Malaysia. The museum holds such as statues, war equipment, glassware, daily live tools, and others. This study try to cover 3 rooms in Trowulan Museum, namely the Metal Room (metal equipment, arms, etc), the Terracotta Room (contains glassware, jars, roof tile, etc), and the Sculpture Room (contains statue, sculpture, etc). Each room has a different area of 5x12 meters, 17x12 meters, and 21x21 meters. The Metal Room and the Terracotta room are both surrounded by walls, but the Sculpture Room is an open space room with a roof.

This study places a number of BLE beacons in each room. This BLE will provide a signal to detect the movement of museum visitors in the museum and detect how long they spend their time on each location. For implementation, this study place around 25 BLE beacons and records their location coordinates on computer server. This study also build a feature on the application that facilitate museum manager to simulate coverage range for each BLE beacon Figure 4. This will help the museum manager to find a suitable location for the beacon to cover all areas in the museum (using trilateration method).

The results of visitor mapping can be seen on the visitor's heat map Figure 5. Museum managers can find out the movements of museum visitors in the museum and how long they spend at each location. The red color means that many visitors are in a certain location and spend time there in a long period of time. With this data, the museum manager can analyze how many visitors come to visit a particular room or particular exhibits and how long they spend there. Using that knowledge, museum manager can conclude which room/artifact is rarely/frequently visited by museum visitors.

This study also tested the accuracy of location calculations for museum visitors. The test is done by comparing the real location data with the calculation position and taking 3 data of the highest BLE beacon signal strength that was successfully detected from the user's mobile phone. As shown in Figure 6 and Table 1 this test is to estimate the pretinence in BLE beacons placement conducted in the terracotta room. Calculation of user location distance error is around 70-200 cm with average error distance of about 140 cm. From the tests conducted, it appears that the placement from the BLE beacons have a big influence on the accuracy of the user's location calculation. Where it emerged from testing number 1, 4, 5, and 8 Table 1 that have a low level of RSSI (around -100) also has a considerable error distance which is around 1.5 to 2 meters. Therefore, the application facilities for beacon laying simulation Figure 5 has an important role in estimating the range of each beacon and the coverage requirement for each room.

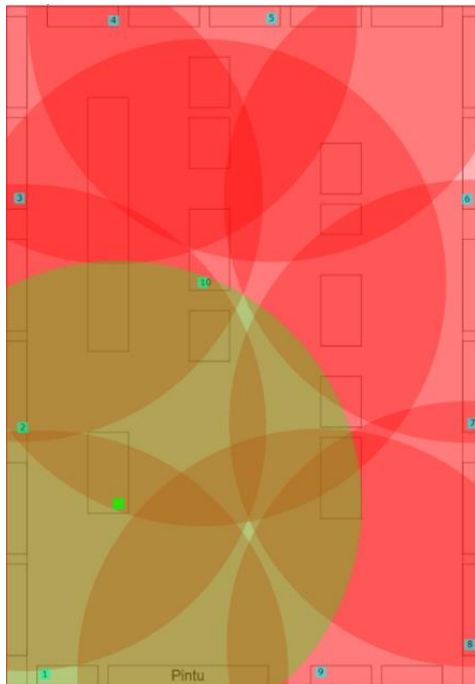


Figure 4. BLE Beacon coordinates map

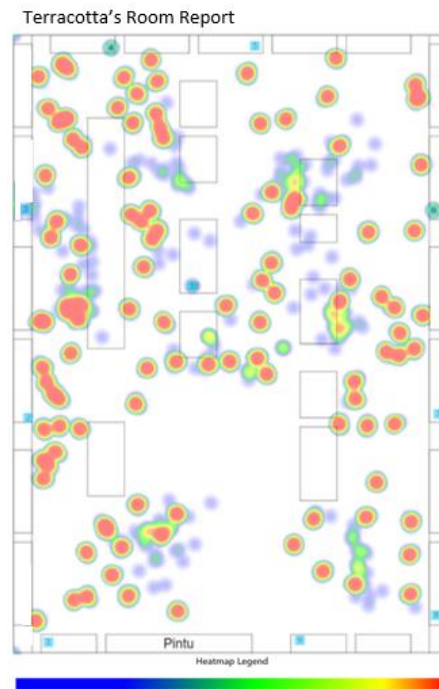


Figure 5. Museum visitors movement heatmap

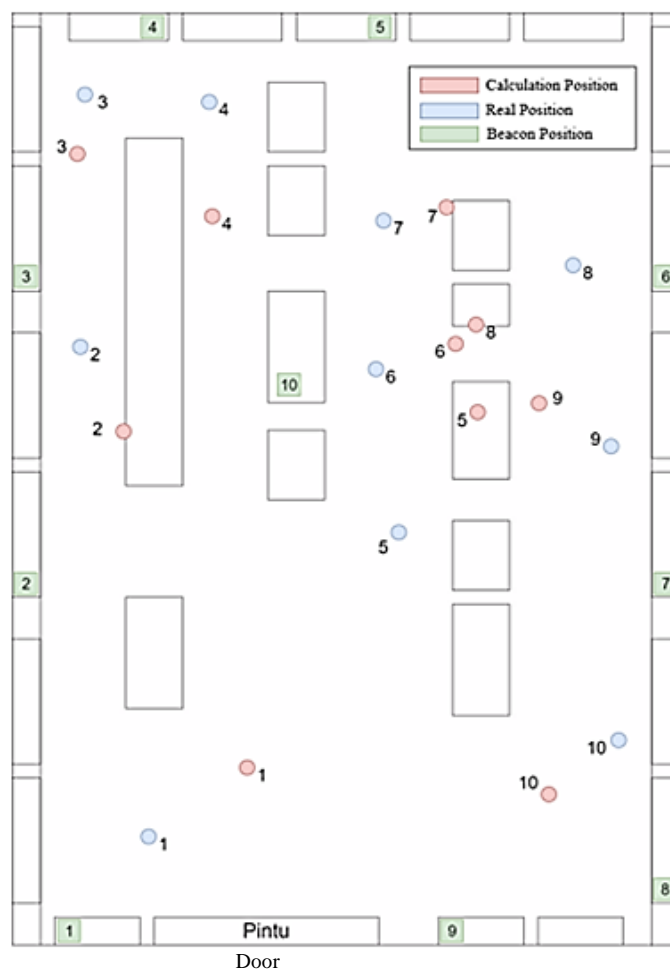


Figure 6. Visitor Position Calculation Testing

Table 1. Testing of position accuracy

No	Real Position		RSSI Beacon (Strongest Detected)			Calculation Position		Distance Error (cm)
	X	Y	1	2	3	X	Y	
1	226.67	1466.67	-95.87	-100.00	-100.48	400.00	1342.67	154.12
2	106.67	586.67	-84.23	-84.53	-91.59	182.67	738.67	130.94
3	114.67	133.33	-84.00	-89.07	-89.09	101.33	242.67	72.14
4	333.33	146.67	-100.07	-92.23	-102.00	338.67	352.00	195.40
5	666.67	920.00	-100.31	-103.88	-106.40	805.33	704.00	203.28
6	626.67	626.67	-100.84	-99.52	-108.53	766.67	581.33	147.16
7	640.00	360.00	-95.89	-92.00	-93.39	750.67	336.00	69.24
8	973.33	440.00	-92.48	-103.51	-108.24	802.67	546.67	185.26
9	1040.00	765.33	-99.35	-102.55	-98.33	913.33	688.00	138.41
10	1053.33	1293.33	-94.67	-98.47	-102.09	930.67	1390.67	106.59
Average								140.59

4. CONCLUSION

This study tries to mapping the visitor location in the museum and how long visitors are in a particular location in the museum. This mapping uses indoor positioning system using BLE beacons. BLE beacons are placed in particular places in the museum room. The signals emitted by beacons are detected by the application that installed on the museum visitor's mobile phone. The application will calculate the location of visitors using trilateration method and kalman filter. The application then sends this information to the server computer. The data is then mapped on the museum map using a website application to find out the location and how long visitors are at a particular location in the museum. This information is displayed in the form of a heat map. Based on this information, museum managers can find out which locations are often/rarely visited by visitors and how long visitors spend at that particular location. Using this visitor mapping information, the museum manager can analyze whether there are any particular locations in the museum that museum visitors rarely pass, how many visitors enter each museum area in a particular time, which museum areas/artifacts that often visited by visitors, how long they spend time in each area and which artifacts get a lot of attention and time from visitors, whether each artifacts display placement is suitable to the museum's needs. With this information, the museum manager can rearrange display artifacts, manage the flow of visitors' routes, etc. With this information, the museum manager is expected to be able to evaluate the layout of the items on display.

Based on the accuracy testing of visitor location information in real locations compared to the calculation of the visitor location using signal strength of BLE beacons. The results showed that the error distance is around 70-200 cm with an average of 140 cm. So it can be concluded that the information obtained is sufficient enough to represent the position of museum visitors. This error distance level is obtained at locations where RSSI beacon detection is not in good condition. So, it can be concluded that the laying of beacons is very decisive in getting the expected data accuracy. This accuracy could be improve by redeploy particular beacon to another place.

ACKNOWLEDGEMENTS

This research was supported by Indonesia Directorate Research and Technology of Higher Education under grant 002/SP2H/P/K7/KM/2019. This research also support by Petra Christian University Mobile Computing Research Group.

REFERENCES

- [1] UNESCO & Indonesia Tourism Ministry, "Practical Guide for Museum Revitalization in Indonesia," UNESCO. 2011.
- [2] Fopp M. A., "Managing Museums and Galleries. Routledge," USA and Canada: Taylor & Francis Ltd. 1997.
- [3] Jakarta Post, "Artifacts stolen from National Museum," 2013, [Online], Available: <https://www.thejakartapost.com/news/2013/09/13/artifacts-stolen-national-museum.html>, Januari 2019.
- [4] Nicholls A, Pereira M, Sani M., "New trends in museums of the 21st century." The Learning Museum Network Project, 2013.
- [5] Handojo A., Lim R., Octavia T., Anggita J. K., "Museum Interactive Information Broadcasting Using Indoor Positioning System and Bluetooth Low Energy: a Pilot Project on Trowulan Museum Indonesia." *Technology Innovation Management and Engineering Science International Conference*, Bangkok, pp 237-242, Desember 2018.
- [6] Wahid A., Kim S. M., Choi J., "Mobile Indoor Localization based on RSSI using Kalman Filter and Trilateration Technique," *International Conference on Machine Vision*, 2015.
- [7] Röbesaat J., Zhang P., Abdelaal M., Oliver, "An Improved BLE Indoor Localization with Kalman-Based Fusion: An Experimental Study," *Sensors*, vol. 17, 2017.

- [8] Botturi L, Inversini A, Maria AD, "City Treasure: Mobile Games For Learning Cultural Heritage," *Proceedings of Museum and the Web, Archives and Museums Information*, April 2009.
- [9] Meiliana, Irmanti D, Hidayat M, Amalina N, Suryani D, "Mobile Smart Travelling Application for Indonesia Tourism," *Procedia Computer Science*, vol. 116, pp. 556-563, 2017.
- [10] Handojo A, Lim R, Andjarwirawan J, Sunaryo S, "Games and multimedia implementation on heroic battle of Surabaya: An android based Mobile Device Application," *Proceedings of Second International Conference on Electrical Systems*, pp. 619-629, 2015.
- [11] McGookin D, Tahiroğlu K, Vaitinen T, Kytö M, Monastero B, Vasquez JC, "Investigating tangential access for location-based digital cultural heritage applications," *International Journal of Human-Computer Studies*, vol. 122, pp. 196-210, February 2019.
- [12] Rolando A, Scandiffio A, "Mobile Applications as Tool for Exploiting Cultural Heritage in the Region of Turin and Milan," *International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences*, vol. XL-5/W2, September 2013.
- [13] Handojo A, Andjarwirawan A, Sunaryo S, Lim R, "Heroic battle of Surabaya application based on android," *Journal of Engineering and Applied Sciences*, pp. 2396-2303, 2014.
- [14] Chivarov N, Ivanova V, D. Radev D, Buzov I. "Interactive presentation of the exhibits in the museums using mobile digital technologies," *IFAC Proceedings Volumes*, vol. 46, pp. 122-126, 2013.
- [15] Turan B, Keser H, "Museum Guide Mobile App: The Case of the Near East University Classical Car Museum," *Social and Behavioral Sciences*, vol. 131, pp. 278-285, May 2014.
- [16] Sara. "A Pocket-Sized Wonder in Virtual Reality, Media and Technology," 2016, [Online], Available: <https://americanart.si.edu/blog/eye-level/2016/04/301/pocket-sized-wonder-virtual-reality/>, Januari 2019.
- [17] Powell J. K., "Augmented Reality and Kinect Create Unique Art Experience at Cleveland Museum," 2016. [Online]. Available: <https://www.forbes.com/sites/jenniferhicks/2016/10/27/augmented-reality-and-kinect-create-unique-art-experience-at-cleveland-museum/#324db3e73771>, Januari 2019.
- [18] Falk J. H., "Museums Social Learning Spaces and Knowledge Producing Processes," Kulturstyrelsen, 2013
- [19] Ahmad S., Abbas M. Y., Yusof W. Z. M., Taib M. Z. M., "Adapting Museum Visitors as Participants Benefits their Learning Experience?" *Social and Behavioral Sciences*, pp.156-170, 2015.
- [20] M. Centenaro, L. Vangelista, A. Zanella and M. Zorzi, "Long-range communications in unlicensed bands: the rising stars in the IoT and smart city scenarios," *IEEE Wireless Communications*, vol. 23, no. 5, pp. 60-67, October 2016.
- [21] T. Adame, A. Bel, B. Bellalta, J. Barcelo and M. Oliver, "IEEE 802.11AH: the WiFi approach for M2M communications," *IEEE Wireless Communications*, vol. 21, no. 6, pp. 144-152, December 2014
- [22] M. Scherhäufl, M. Pichler, D. Müller, A. Ziroff and A. Stelzer, "Phase-of-arrival-based localization of passive UHF RFID tags," *2013 IEEE MTT-S International Microwave Symposium Digest (MTT)*, Seattle, WA, pp. 1-3, 2013.
- [23] Narzullaev A., Muminov Z., Ibragimov G., "Wi-Fi Signals Database Construction using Chebyshev Wavelets for Indoor Positioning Systems," *International Journal on Advanced Science Engineering Information Technology*, vol. 9, no. 1, 2019.
- [24] Yeo K. S., Ting A., Ng S. C., Chieng D., Anas N., "Wi-Fi Indoor Positioning Fingerprint Health Analysis for a Large Scale Deployment," *International Journal on Advanced Science Engineering Information Technology*, vol. 9, no. 4-2, 2018.
- [25] Firdaus, Ahmad N. Z., Sahibuddin S, "Fingerprint indoor positioning based on user orientations and minimum computation time," *TELKOMNIKA Telecommunication Computing Electronics and Control*, pp. 1740-1749, 2019.
- [26] Asmus K. N., "A System of Applications for the Integration of BLE Beacons in Museums," *Master Thesis. Massachusetts: Massachusetts Institute of Technology*, pp. 103-105, 2016.
- [27] Davies M, Furey E, Curran K, "Improving compliance with bluetooth device detection," *TELKOMNIKA Telecommunication Computing Electronics and Control*, vol 17, no. 5, pp. 2355-2369, 2019.
- [28] Skärberg J. R., Sletten K., "Using Bluetooth beacons in a Museum," *Master Thesis. Ohio: University of Ohio*, 2016.
- [29] Setiawan T., Irawan B., Osmond A. B., "Design Museum Guidance Application Based on Android Using Bluetooth Estimote," *e-Proceeding of Engineering*, vol.3, no. 2, pp. 2211, 2016.
- [30] Huh J. H., Seo K., "An Indoor Location-Based Control System Using Bluetooth Beacons for IoT Systems," *Sensors*, vol. 17, 2017.
- [31] Thamm A., Anke J., Haugk S., Radic D., "Towards the Omni-Channel: Beacon-Based Services in Retail," *International Conference on Business Information Systems*, pp. 181-192, June 2016.
- [32] F. Zafari, A. Gkelias and K. K. Leung, "A Survey of Indoor Localization Systems and Technologies," *IEEE Communications Surveys & Tutorials*, vol. 21, no. 3, pp. 2568-2599, 2019.