

RIBATS: RSSI-based adaptive tracking system with ASEKF for indoor WSN

Rafina Destiarti Ainul, Hendi Wicaksono Agung

Department of Electrical Engineering, Faculty of Engineering, University of Surabaya, Surabaya, Indonesia

Article Info

Article history:

Received Jul 9, 2024

Revised Feb 24, 2025

Accepted Mar 1, 2025

Keywords:

Adaptive tracking

ASEKF

RIBATS

RSSI

WSN

ABSTRACT

Wireless indoor tracking systems face challenges due to environmental conditions and signal attenuation, affecting location accuracy, crucial in wireless sensor network (WSN) applications. Many tracking techniques rely on specific path loss models proposed by previous researches, but these models are susceptible to changes in environmental conditions, impacting estimation outcomes. In order to solve these problems, this paper propose adaptive tracking system using received signal strength indicator (RSSI) measurement parameter called as RIBATS. Adaptive in this system refers to the reliability of an algorithm for obtaining the accurate location without any path loss modelling at dynamic indoor environments. The enhancement of weighted centroid localization (eWCL) scheme calculates the location estimation only using RSSI data measurement without propagation characteristic determination. However, estimation result from eWCL still have high error at certain area. Hence, by defining a multiplier factor as adaptive scaled to the covariance matrix of EKF can eliminate distortion effects from eWCL called as adaptive scaled extended Kalman filter (ASEKF) algorithm. An effective variance estimation algorithm for adaptive indoor tracking system using eWCL and ASEKF combination achieve 0.82 meters mean square error (MSE) value with 55.67% error reduction. Then, without using multiplier scale factor at EKF algorithm only reduce previous eWCL at 3.78% with 1.78 meters MSE value.

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



Corresponding Author:

Rafina Destiarti Ainul

Department of Electrical Engineering, Faculty of Engineering, University of Surabaya

Surabaya, 60293, Indonesia

Email: rafina@staff.ubaya.ac.id

1. INTRODUCTION

Wireless sensor networks (WSN) provide many applications equipping a large number of sensor nodes interconnected wirelessly such as environmental monitoring, military surveillance, medical monitoring, object tracking, and vehicle navigation. All of these applications require accurate location information [1], [2]. Nevertheless, the accuracy performance of global positioning system (GPS) as location-based technology is only capable for outdoor tracking system applications and it is deteriorate rapidly in complex indoor environments [3]. Therefore indoor location-based services are still the main concern for many researchers due to incapability from existing technologies for achieving precision location information.

Several enabling technologies of indoor location-based services have been expanded using mobile wireless communication system such as Wi-Fi, ultrasound signal, Zigbee, ultra-wide band (UWB), LoRA, Bluetooth low energy (BLE), and Radio frequency identification (RFID) [4]–[11]. These technologies depend on its quality of measurement parameter as well as received signal strength indicator (RSSI), time of arrival (TOA), time difference of arrival (TDOA), angle of arrival (AoA) and frequency difference of arrival

(FDOA) [12], [13]. Compared to wireless communication indicator, RSSI have various advantages: low power consumption, simple hardware, and easy in data measurement. However its advantages of RSSI are directly proportional to its disadvantages as high sensitivity to environment. RSSI data measurement depends on the propagation characteristics represented as path loss exponent value (PLE). Many factors are used to consider the specific PLE values including signal reflection, noise, multipath fading, scattering and interference effects. These factors can make inconsistent PLE values, while the specific PLE values are required for determining distance estimation between anchor nodes as the transmitter and unknown node (UN) as receiver or target nodes from RSSI data measurement. Hence, establishing an accurate distance estimation based on RSSI measurement and PLE value is difficult which can also affect to the performance of indoor location-based services [6], [10].

In order to solve the problem related to the indoor location-based services using RSSI, many researchers proposed robust methods for minimizing the influence from the external environment variability. RSSI-based adaptive scheme is an effective solution to gain accurate locations in high complexity environment. The enhancement of weighted centroid localization (eWCL) is one of adaptive scheme in positioning system. Using eWCL scheme, the distance estimation can automatically calculate by RSSI measurement without determine PLE values [7], [14]. However, these schemes still have high errors distance in practical deployment up to 1.85 meters [15]. Therefore, improved algorithm should be added for minimizing the error estimation. Extended Kalman filter (EKF) as a statistic approach algorithm is appropriate for non-linear systems as well as fluctuating condition of RSSI [15]. EKF as the derivative algorithm of Kalman filter (KF) can be used for predicting the position of target node that recursively work for obtaining the convergence value from the variance of error measurement [15]–[24].

The dynamic states from RSSI data measurements can be influenced to the performance of KF algorithm in calculating estimated positions [25], [26]. Many researchers have been tried to modify the KF algorithm as adaptive filter scheme. Nie and Zhang [15] proposed effective scaled with self-adaptive scaling parameters which was called as unscented Kalman filter (UKF). Determination of scaling parameter values for UKF was important due to the estimation results is not as good as the EKF algorithm. As well as [18]–[21], [23], [24] have been proposed scaling parameters for EKF algorithm. The various schemes for calculating its parameters directly influenced the performance of the EKF results. Then, in [17] have been tried for modifying EKF using adaptive adjustment at its noise covariance values with scaling parameters also. Several approaches for determining the scaling parameter have been proposed before in [17]–[24] such as Fuzzy, least square, residual based and weighted.

This paper extends the conference paper [14], where we only proposed the eWCL algorithm for the indoor localization system without any refinement algorithm. Therefore, in this paper, we adopted previous research in [17]–[24] for using scaling parameter values for the EKF, which can be used to improve the result from [14]. In this paper, the scaling value was calculated using the eWCL algorithm as the weighted value from RSSI measurement data and then multiplied by the covariance matrix of the EKF. The contributions of this paper are: (i) the development of adaptive scheme for estimating position from RSSI data measurements automatically without determining the PLE value of each environment condition which called as RSSI-based adaptive tracking system (RIBATS); (ii) this paper presents the formulation algorithm of tracking system in detail with the addition of new scheme using the adaptive scaled Extended Kalman Filter (ASEKF) algorithm as the refinement process from initial estimation using eWCL algorithm to achieve accuracy result; (iii) the proposed scheme performance is verified through the realistic scenario of RSSI data measurement from Xbee S2 Pro transmission which were installed at the 3rd floor of EEPIS postgraduate building as indoor environment location.

In order to guarantee the effectiveness of this proposed system, this paper is organized as follows: the research methodologies are discussed in section 2, which involve the proposed scheme of RIBATS, as well as RSSI-based adaptive tracking system. This system utilizes the eWCL algorithm for initial estimation, followed by improvement with the ASEKF algorithm for final estimation. The experimental results based on real measurement data have been evaluated using mean square error (MSE) and accuracy percentage parameters to verify the proposed system results in section 3. Finally, we draw the conclusion and discuss possibilities of future work in section 4.

2. RESEARCH METHOD

2.1. RSSI-based adaptive tracking system

In this section, we explain in detail the process used to obtain the estimated route result in RSSI-based adaptive tracking system (RIBATS) at Figure 1. This process begins with the deployment of several nodes in a realistic environment, followed by RSSI measurement for estimating position and eWCL calculation as the input data for determining the estimated route using ASEKF algorithm. Estimated positions

are obtained from RSSI measurements transmitted from XBee S2 Pro module, serving as the anchor node (AN) to the mobile UN. In this paper, we create a simulation that reflects a real-world scenario, implemented within the indoor environment of the EEPIS postgraduate building's 3rd floor. The simulations are performed using MATLAB software, and the relevant parameters for this system are provided in Table 1.

RSSI levels have been received by the UN using the Arduino Pro Micro module via the Xbee protocol. There are 18 anchor nodes deployed at the wall on the building walls at a height of 2.4 meters with 7 meters separations. The mobile UN moves to the 53 specified points at a height of 0.9 meters, as shown at Figure 2. The entire measurement process is conducted indoor area on the EEPIS campus, where several obstacles are present. The RSSI measurement phase starts at the first measurement point of the $UN_{S_j} (1,2,3... n)$, connecting to the nearest $AN_{S_i} (1,2,3...n)$ within a maximum serving distance of 10 meters. When the UN moves to the next point on its route and the distance is within 10 meters, the measurement process halts and shifts to measure the other ANs. This procedure repeats for each ANs located at the nearest point to the UNs route.

Table 1. Simulation parameter

Parameter	Value	Remarks
Operating frequency	2.4 GHz	
Transmit power	17 dBW	Xbee Pro (S2) module
Receiver sensitivity	-102 dBm	
Interval distance between anchor nodes (AN)	7 meters	Anchor nodes (AN) deployment
Calculating estimated position	2 meters	Unknown node (UN) movement

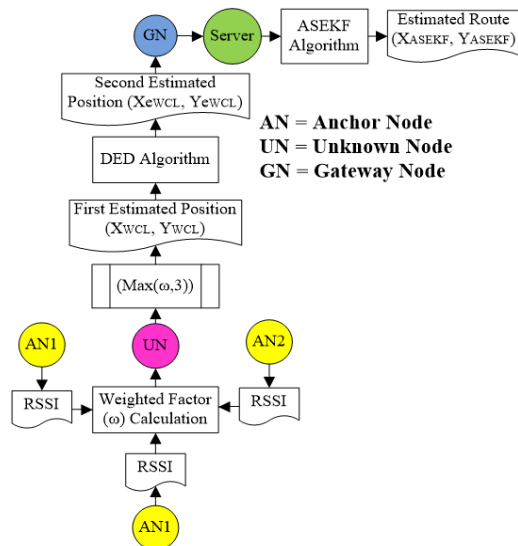


Figure 1. RSSI based adaptive tracking system methodology

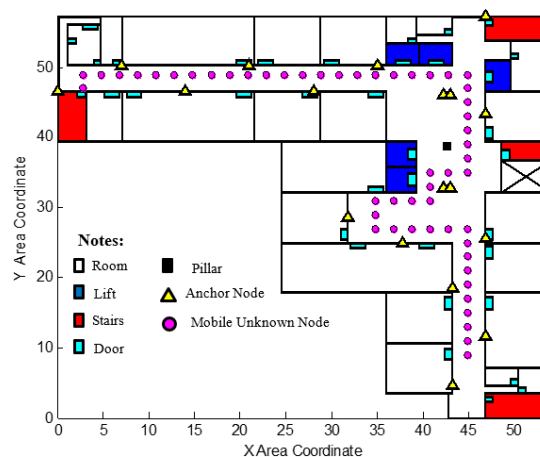


Figure 2. Assumed route scenario of mobile UN

Due to RSSI limitation and inconsistent data from Xbee transmission, the weighted factor value (ω) calculation is determined from three strongest RSSI level transmissions of ANs to the UNs. The weight factor based on RSSI can be express as [1], [14].

$$\omega_{ij} = \frac{\sqrt{(10^{RSSI_{ij}/10})^k}}{\sum_{i,j=1}^n \sqrt{(10^{RSSI_{ij}/10})^k}} \rightarrow \omega_{ij}' = \omega_{ij} \times N_{AN}^{2\omega_{ij}} \quad (1)$$

The weight value from (1) implies the influence in calculating the UNs estimated position. Therefore, previous weight factor value should be adjusted by k as the multiplier factor. The weight value is used to calculate the initial estimated position using the weighted centroid localization (WCL) algorithm, a refinement of the centroid localization (CL) method that enhances accuracy. The estimated position of UNs (x_j, y_j) based on WCL algorithm at (2) can be calculated using only the RSSI value and the coordinates of ANs, without the need for propagation value characteristics, as presented in [12], [15], [26]. This can be derived as [1], [14].

$$UN(x_{WCL}, y_{WCL}) = \frac{\sum_{i=1}^n (\omega_{ij}' \times (x_i, y_i))}{\sum_{i=1}^n \omega_{ij}'} \quad (2)$$

As illustrated in Figure 2, the next step involves using the weighted factor to reduce estimation errors without modifying the displacement positions of the UNs. To address this, the method from [23] was employed, incorporating the addition of the difference of estimated distance (DED) to achieve a uniform accuracy distribution across all UNs positions. The main requirement parameter of DED algorithm is distance, which is determined from estimated distance result of WCL algorithm, as shown in the (3).

$$d_{WCLAN_{i=1,2,3}} = \sqrt{(x_{WCL} - x_{AN_i})^2 + (y_{WCL} - y_{AN_i})^2} \quad (3)$$

The main idea of the DED algorithm is to determine the estimated position by calculating the difference in distances between the three nearest ANs and the position of the UNs. According to the distances of UNs to three nearest ANs, DED is multiplied with some weighted value as WCL algorithm (α, k). The weighted value of (k) can be adopted from adjusted result of WCL algorithm, while the (α) value should be adjusted again to obtain a better result for the DED algorithm. The (f) as the multiplication result between the weighted different distances to the three nearest coordinates of ANs can be calculated using (4-7).

$$f_{(x1,y1)} = (x_{AN1}, y_{AN1}) \times \left((d_{WCL2} - d_{WCL1})^k + (d_{WCL3} - d_{WCL1})^k + \frac{1}{d_{WCL1}^\alpha} + \frac{1}{d_{WCL2}^\alpha} \right) \quad (4)$$

$$f_{(x2,y2)} = (x_{AN2}, y_{AN2}) \times \left((d_{WCL2} - d_{WCL1})^k + (d_{WCL3} - d_{WCL2})^k + \frac{1}{d_{WCL2}^\alpha} + \frac{1}{d_{WCL3}^\alpha} \right) \quad (5)$$

$$f_{(x3,y3)} = (x_{AN3}, y_{AN3}) \times \left((d_{WCL3} - d_{WCL1})^k + (d_{WCL3} - d_{WCL2})^k + \frac{1}{d_{WCL1}^\alpha} + \frac{1}{d_{WCL3}^\alpha} \right) \quad (6)$$

$$F = 2 \times \left((d_{WCL2} - d_{WCL1})^k + (d_{WCL3} - d_{WCL1})^k + (d_{WCL3} - d_{WCL2})^k + \frac{1}{d_{WCL1}^\alpha} + \frac{1}{d_{WCL2}^\alpha} + \frac{1}{d_{WCL3}^\alpha} \right) \quad (7)$$

The combination process of the WCL and DED algorithms is called as the enhancement of WCL (eWCL) algorithm. Therefore, estimated position result from eWCL can be calculated as (8).

$$(x_{eWCL}, y_{eWCL}) = \frac{f_{(x1,y1)} + f_{(x2,y2)} + f_{(x3,y3)}}{F} \quad (8)$$

The estimated position obtained from the WCL algorithm serves as the initial estimation, while the second estimation, derived from the eWCL algorithm, is processed at the UN. Subsequently, the UN directs this result to the gateway node (GN), which then forwards the data to the server. All communication links between the UN and GN, as well as between GN and the server, utilize the Wi-Fi protocol. The GN hardware consists of a Raspberry Pi 3B, while the server employs a laptop. The estimated route of UNs is determined through the ASEKF algorithm at the server, as it demands relatively high computational time. The specific process and calculations involved in the ASEKF algorithm are elaborated upon in the following section.

$$Y_k = z_k - h(x_k) \rightarrow [d_{1_{wcl}} \quad d_{2_{wcl}} \quad d_{3_{wcl}}] - [d_{1_{ewcl}} \quad d_{2_{ewcl}} \quad d_{3_{ewcl}}] \quad (11)$$

Subsequently, the predicted state of ASEKF utilizes the EKF algorithm, incorporating an adjusted noise covariance value derived from the WCL and eWCL outputs, as illustrated by the (12 and 13).

$$P_0, Q_k = \begin{bmatrix} \sigma^2(x_{ewcl}) & 0 & 0 \\ 0 & \sigma^2(y_{ewcl}) & 0 \\ 0 & 0 & 0 \end{bmatrix}; F = \begin{bmatrix} 1 & 0 & 0 \\ 0 & 1 & 0 \\ 0 & 0 & 1 \end{bmatrix} \quad (12)$$

$$R_k = \text{diag} [\sigma^2 d_{1_{ewcl}} \quad \sigma^2 d_{2_{ewcl}} \quad \sigma^2 d_{3_{ewcl}}] \quad (13)$$

The covariance noise data parameters are processed into the Kalman gain (K_k) for determining the updated state during the correction process at ASEKF algorithm. Kalman gain is a key part of the Kalman filter which estimates the state of this system from the covariance noise data measurements as derived from (14).

$$H_k = \begin{bmatrix} x_{j_1} & y_{j_1} & 0 \\ x_{j_2} & y_{j_2} & 0 \\ x_{j_3} & y_{j_3} & 0 \end{bmatrix} \rightarrow x_{ji(1,2,3)} = \frac{x_{ewcl(1,2,3)} - x_{AN(1,2,3)}}{d_{(1,2,3)ewcl}}; y_{ji(1,2,3)} = \frac{y_{ewcl(1,2,3)} - y_{AN(1,2,3)}}{d_{(1,2,3)ewcl}} \quad (14)$$

Its main function is to determine the optimal balance between the predicted state and the new updated state, based on their respective uncertainties. Therefore, by giving more weight as the scale factor to the updated covariance, ASEKF ensures the best possible to minimize estimation errors and adaptively improve accuracy over time. As shown at Figure 3, the updated state and updated covariance error are multiplied with ω as the scale factor which is adjusted to the weighted factor value from (1). Then, the output data from ASEKF algorithm as the final estimation result can be derived as $X_{k|k-1}$ in the form of (X_{ASEKF} , Y_{ASEKF}) coordinate.

3. RESULTS AND DISCUSSION

3.1. Performance analysis of estimation results

The RIBATS system provides two position estimation results. The first is obtained using the eWCL algorithm as the secondary estimation, and the second uses the ASEKF algorithm for the final route estimation. The initial estimation, which employs the WCL algorithm, is not discussed in detail here because both WCL and eWCL were covered in our previous work [14]. As illustrated in Figure 4, the initial position estimation obtained from the eWCL algorithm is refined using several algorithms, including ASEKF, AEKF, and EKF. The results indicate that the ASEKF algorithm produces route estimates that closely approximate the actual route, as shown in Figure 4(a). This demonstrates that ASEKF offers superior route estimation accuracy, particularly when compared to AEKF and EKF.

In contrast, combining the eWCL algorithm with the conventional EKF algorithm results in significant positional errors, leading to route estimates that diverge considerably from the actual route, as shown in Figure 4(b). Similarly, the combination of eWCL with the adaptive EKF (AEKF) algorithm, as previously studied in [17], where a constant multiplier of 0.3 was used and subsequently increased by up to 100 times, also produces route estimation data that significantly deviates from the actual route. This discrepancy is attributed to the suboptimal multiplier, which fails to achieve a balanced condition between the predict state and the update state, thereby resulting in less accurate estimations. This indicates that using an appropriate multiplier as a weighting factor for the EKF algorithm is crucial for improving the position estimation results from the eWCL algorithm. The highly variable and fluctuating signal strength measurements necessitate the use of adaptive weighting values based on the current data conditions. This is evidenced by the combination of eWCL and ASEKF, which produces significantly better route estimation results compared to the EKF algorithm without a multiplier or the AEKF algorithm that uses a constant multiplier. The results highlight that the adaptability of the ASEKF algorithm allows it to better handle the inconsistencies in signal strength, leading to more precise estimations and improved overall performance. The specific values of estimated error and accuracy percentages are detailed in the discussion section.

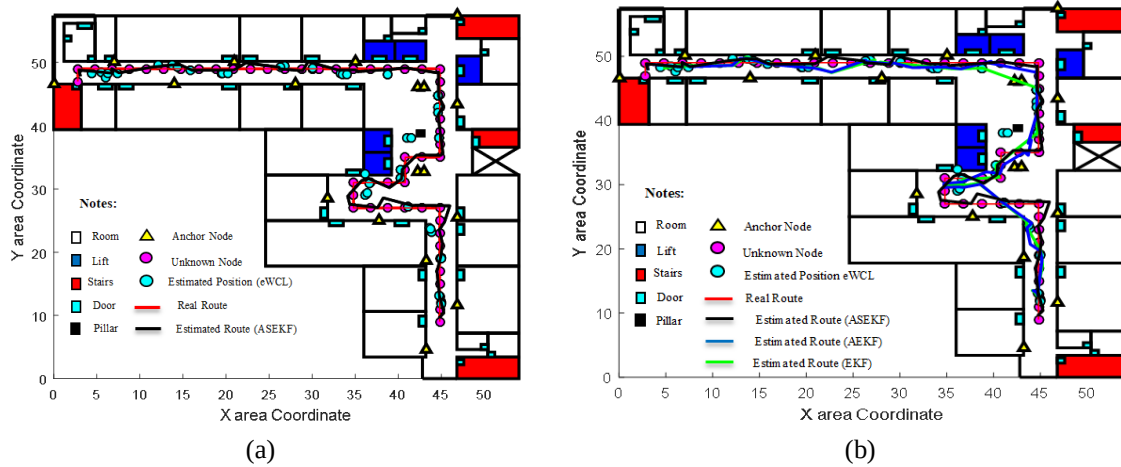


Figure 4. These figures are (a) estimated results from ASEKF algorithm and (b) comparison of estimated results from ASEKF, AEKF, and EKF algorithm

3.2. Discussion

In this paper, the primary evaluation focuses on position estimation, with the MSE being the key metric used to assess the performance of the algorithms. The MSE value reflects the accuracy of the position estimates, calculated as the average of the squares of the errors between the estimated and true positions, with lower values indicating better performance. This metric is derived from (15), which details the calculation process.

$$MSE = \sqrt{(x_{Real} - x_{estimated\ position_{ASEKF}})^2 + (y_{real} - y_{estimated\ position_{ASEKF}})^2} \quad (15)$$

Figure 5 illustrates these results, with Figure 5(a) displaying the cumulative density function (CDF)-based analysis, which facilitates the understanding of the distribution of MSE values across different algorithms. Figure 5(b) presents a Pareto chart that compares accuracy percentages and MSE values, further simplifying the comparison of estimation errors produced by each algorithm. This research compares several algorithms, including the conventional trilateration algorithm based on RSSI and path loss exponent for distance and position estimation, the original EKF algorithm combined with trilateration, eWCL alone as adopted from previous research, eWCL combined with the original EKF, AEKF combined with eWCL, and finally, all existing and previously proposed algorithms are compared with the proposed RIBATS scheme, which integrates ASEKF and eWCL algorithms.

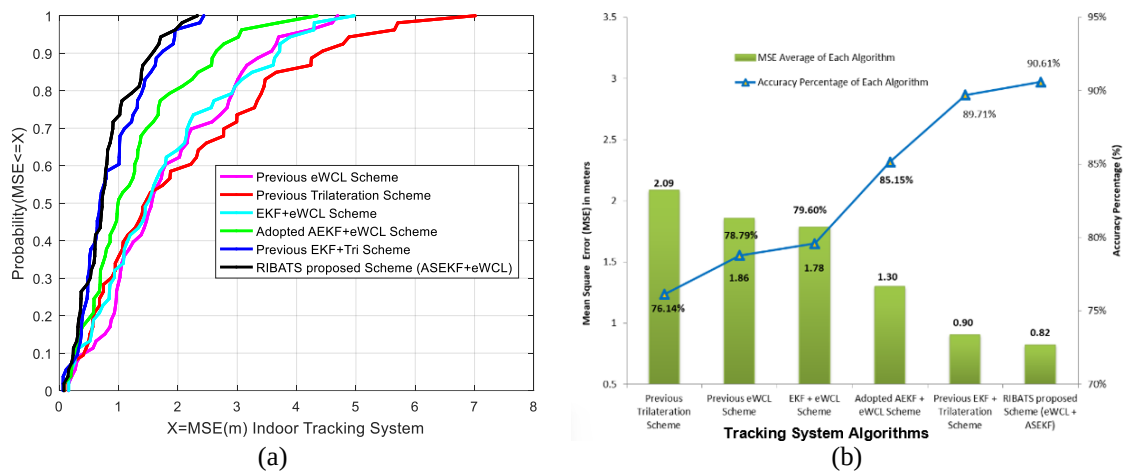


Figure 5. These figures are (a) CDF graph of RSSI-based adaptive tracking system and (b) Pareto chart of RSSI-based adaptive tracking system

According to the Figure 5(a), shows that the highest MSE value performance is using conventional trilateration achieved MSE value up to 7.01 meters. This highlights the substantial influence of the PLE on the effectiveness of conventional trilateration for position estimation. The reliance on PLE-based methods results in a static position estimation system, necessitating environmental propagation mapping for accurate RSSI-based estimates across varying locations. The next largest MSE result is obtained from using eWCL alone without improvements, and the combination of eWCL with the original EKF algorithm, where the estimated MSE error is 4.69 meters for eWCL alone and 4.97 meters for the EKF and eWCL combination. This indicates that the standalone use of eWCL still results in relatively high estimation errors. Even when improvements are made, the use of an inappropriate correction algorithm can lead to high estimation errors. For instance, the EKF requires a balance between the prediction state and the update state, affecting the effectiveness of the data error filtering process. The combination of the eWCL algorithm with AEKF demonstrates a significant improvement in performance. According to the CDF distribution analysis, for the range from 0 to 0.8, the maximum MSE value reaches 2 meters, while for the range from 0.8 to 1, the maximum value is 4.34 meters. These findings confirm that the concept of using AEKF, as proposed by the research [17], is highly effective in improving eWCL estimation by applying a multiplication factor to the updated state. However, the reduction in MSE achieved is still not optimal, as the combination of EKF and conventional trilateration exhibits superior performance with an MSE range of 0.06 to 2.43 meters.

Nonetheless, this combination of trilateration and EKF cannot yet be classified as an adaptive scheme, as the RSSI estimation process still requires a PLE value that cannot be arbitrarily determined; accurate propagation measurement and mapping are necessary for each estimation process. When compared based on the data distribution using CDF, the proposed algorithms ASEKF and eWCL exhibit nearly identical performance within the CDF distribution range of 0 to 0.6, with an MSE of less than 1 meter. In the CDF range from 0.6 to 1, although the MSE differences are minimal, the use of ASEKF and eWCL successfully reduces the MSE to 2.32 meters. According to the average MSE values shown in Figure 5(b), the combination of eWCL with the ASEKF correction algorithm also achieves an average MSE of 0.82 meters, which is the smallest value, with an accuracy rate of up to 90.61%. Using the proposed algorithm RIBATS as illustrated at Figure 5(b), the average difference in MSE produced is only 0.08 meters. However, using RIBATS successfully reduces the resulting MSE and increases accuracy, albeit not significantly. On the other hand, using the ASEKF and eWCL algorithms has managed to create an adaptive scenario in the RSSI-based tracking system. When the object moves and receives the 3 strongest RSSI signals from several reference transmitters, the object can automatically estimate its position without preprocessing to determine the PLE value, which is highly dependent on environmental conditions. If the RSSI-based estimation process includes PLE, then when moving the node installation location, initial measurements are needed to determine the correct PLE value. In contrast, using the RIBATS scheme, the estimation process can be done automatically even if the environmental conditions are different.

4. CONCLUSION AND FUTURE WORK

In this paper, we introduce RIBATS, an RSSI-based adaptive tracking system. RIBATS is currently utilized for indoor position estimation, starting with the eWCL algorithm for initial position estimation. The results are then refined and the traversed route is displayed using the ASEKF algorithm. Eighteen anchor nodes continuously transmit RSSI information and reference coordinates via Xbee S2 Pro to the UN for position estimation. The adaptive aspect of RIBATS allows this RSSI-based estimation process to be performed automatically without needing the environmental propagation factor PLE, which is typically required for RSSI-based positioning systems. The addition of an adaptive multiplier or weighted factor in the EKF algorithm, referred to as ASEKF in this paper, successfully reduces the MSE value by up to 2 times compared to using the eWCL algorithm alone, and decreases the average MSE value by 0.08 meters compared to the combination of trilateration and EKF algorithm. This demonstrates that the ASEKF algorithm effectively enhances the eWCL algorithm's adaptive estimation results without the need for PLE, and performs better compared to the trilateration and EKF algorithm that requires the PLE value.

In future work, we will utilize an RSSI-based adaptive multi-object tracking system through the LoRA protocol to expand coverage from indoor to outdoor environments. Additionally, we see several opportunities to use other non-linear algorithms to improve the accuracy of estimated positions and to enhance data privacy through security mechanisms.

ACKNOWLEDGEMENTS

The authors would like to thank Politeknik Elektronika Negeri Surabaya (PENS) and University of Surabaya for supporting this research.

FUNDING INFORMATION

The authors state that no funding was involved in the conduct or preparation of this research.

AUTHOR CONTRIBUTIONS STATEMENT

Name of Author	C	M	So	Va	Fo	I	R	D	O	E	Vi	Su	P	Fu
Rafina Destiarti Ainul	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓		✓	✓
Hendi Wicaksono		✓				✓				✓	✓	✓		
Agung														

C : **C**onceptualization

M : **M**ethodology

So : **S**oftware

Va : **V**alidation

Fo : **F**ormal analysis

I : **I**nvestigation

R : **R**esources

D : **D**ata Curation

O : Writing - **O**riginal Draft

E : Writing - Review & **E**diting

Vi : **V**isualization

Su : **S**upervision

P : **P**roject administration

Fu : **F**unding acquisition

CONFLICT OF INTEREST STATEMENT

The authors state no conflict of interest.

INFORMED CONSENT

This research does not involve human participants; therefore, informed consent was not required.

ETHICAL APPROVAL

This research does not involve human participants or animals; therefore, ethical approval was not required.

DATA AVAILABILITY

The data that support the findings of this research are available from the corresponding author upon reasonable request. The data consist of RSSI measurements collected using Zigbee S2 Pro modules and were used to evaluate the proposed algorithm.

REFERENCES

- [1] Q. Dong and X. Xu, "A novel weighted centroid localization algorithm based on RSSI for an outdoor environment," *Journal of Communications*, vol. 9, no. 3, pp. 279–285, 2014, doi: 10.12720/jcm.9.3.279-285.
- [2] M. Oda, O. Takyu, M. Ohta, T. Fujii and K. Adachi, "Position estimation of radio source based on fingerprinting with physical wireless parameter conversion sensor networks," in *IEEE Access*, vol. 11, pp. 12843–12857, 2023, doi: 10.1109/ACCESS.2023.3242611.
- [3] R. Xue and Z. Liang, "A simulated fusion localization algorithm with adaptive error covariance matrix for closed corridor seamless positioning," *Digital Signal Processing: A Review Journal*, vol. 149, p. 104495, Jun. 2024, doi: 10.1016/j.dsp.2024.104495.
- [4] N. F. N. A. Aziz, N. Jamil, and M. M. Din, "An improved indoor location technique using combination of kalman filter and centroid positioning," *Journal of Communications*, vol. 14, no. 1, pp. 17–25, 2019, doi: 10.12720/jcm.14.1.17-25.
- [5] A. Alhammadi, S. Alraih, F. Hashim, and M. F. A. Rasid, "Robust 3d indoor positioning system based on radio map using Bayesian network," in *IEEE 5th World Forum on Internet of Things, WF-IoT 2019 - Conference Proceedings*, Apr. 2019, pp. 107–110, doi: 10.1109/WF-IoT.2019.8767318.
- [6] B. T. Chhetri, A. Alsadoon, P. W. C. Prasad, H. S. Venkata, and A. Elchouemi, "Enhanced weighted centroid localization in RFID technology: patient movement tracking in Hospital," in *2019 5th International Conference on Advanced Computing and Communication Systems, ICACCS 2019*, Mar. 2019, pp. 910–915, doi: 10.1109/ICACCS.2019.8728552.
- [7] M. Chen, H. Zhao, C. Shi, X. Chen, and D. Niu, "Multi-scene LoRa positioning algorithm based on Kalman filter and its implementation on NS3," *Ad Hoc Networks*, vol. 141, p. 103097, Mar. 2023, doi: 10.1016/j.adhoc.2023.103097.
- [8] D. Konings, F. Alam, F. Noble, and E. M. K. Lai, "SpringLoc: a device-free localization technique for indoor positioning and tracking using adaptive RSSI spring relaxation," *IEEE Access*, vol. 7, pp. 56960–56973, 2019, doi: 10.1109/ACCESS.2019.2913910.
- [9] I. Javed, X. Tang, M. A. Saleem, A. Javed, M. A. Zia, and I. A. Shoukat, "Localization for V2X communication with noisy distance measurement," *International Journal of Intelligent Networks*, vol. 4, pp. 355–360, 2023, doi: 10.1016/j.ijin.2023.11.007.
- [10] Y. M. Chen, C. L. Tsai, and R. W. Fang, "TDOA/FDOA mobile target localization and tracking with adaptive extended Kalman filter," in *Proceedings - 2017 International Conference on Control, Artificial Intelligence, Robotics and Optimization, ICCAIRO 2017*, May 2017, vol. 2018-January, pp. 202–206, doi: 10.1109/ICCAIRO.2017.47.
- [11] Y. Li, J. Barthelemy, S. Sun, P. Perez and B. Moran, "Urban vehicle localization in public LoRaWan Network," in *IEEE Internet of Things Journal*, vol. 9, no. 12, pp. 10283–10294, 15 June 15, 2022, doi: 10.1109/JIOT.2021.3121778.

- [12] L. Qiang, M. Ying, B. Xiujun, L. Xiangning, L. Yan and H. Chunlei, "Research on localization techniques in occluded environments based on lora signals," *2024 IEEE 14th International Conference on Electronics Information and Emergency Communication (ICEIEC)*, Beijing, China, 2024, pp. 205-208, doi: 10.1109/ICEIEC61773.2024.10561742.
- [13] J. Du, J. F. Diouris, and Y. Wang, "A RSSI-based parameter tracking strategy for constrained position localization," *Eurasip Journal on Advances in Signal Processing*, vol. 2017, no. 1, p. 77, Dec. 2017, doi: 10.1186/s13634-017-0512-x.
- [14] R. D. Ainul, "Enhancement of weighted centroid algorithm for indoor mobile non-cooperative localization system," *International Conference on Informatics, Technology, and Engineering*, no. January, pp. 20–25, 2020.
- [15] Y. Nie and T. Zhang, "Scaling parameters selection principle for the scaled unscented Kalman filter," *Journal of Systems Engineering and Electronics*, vol. 29, no. 3, pp. 601–610, 2018, doi: 10.21629/JSEE.2018.03.17.
- [16] H. Li, G. Li, and T. Li, "Information gain-weighted multi-sensor arithmetic average fusion Kalman filtering," in *Proceedings - 12th IEEE International Conference on Control, Automation and Information Sciences, ICCAIS 2023*, Nov. 2023, pp. 230–235, doi: 10.1109/ICCAIS59597.2023.10382245.
- [17] S. Akhlaghi, N. Zhou, and Z. Huang, "Adaptive adjustment of noise covariance in Kalman filter for dynamic state estimation," in *IEEE Power and Energy Society General Meeting*, Jul. 2018, vol. 2018-January, pp. 1–5, doi: 10.1109/PESGM.2017.8273755.
- [18] A. Ismail and S. Vishnyakov, "Design a method for tracking moving object and predicting its trajectory in a noisy environment," in *2023 IEEE 6th International Conference on Pattern Recognition and Artificial Intelligence, PRAI 2023*, Aug. 2023, pp. 129–133, doi: 10.1109/PRAI59366.2023.10331956.
- [19] Y. Huang, Y. Zhang, B. Xu, Z. Wu, and J. A. Chambers, "A new adaptive extended Kalman filter for cooperative localization," *IEEE Transactions on Aerospace and Electronic Systems*, vol. 54, no. 1, pp. 353–368, Feb. 2018, doi: 10.1109/TAES.2017.2756763.
- [20] K. Liu and Z. Li, "Adaptive Kalman filtering for UWB positioning in following luggage," in *Proceedings - 2019 34rd Youth Academic Annual Conference of Chinese Association of Automation, YAC 2019*, Jun. 2019, pp. 574–578, doi: 10.1109/YAC.2019.8787599.
- [21] S. Shokri and M. R. Mosavi, "A fuzzy weighted Kalman filter for GPS positioning precision enhancement," in *2019 7th Iranian Joint Congress on Fuzzy and Intelligent Systems, CFIS 2019*, Jan. 2019, pp. 1–5, doi: 10.1109/CFIS.2019.8692157.
- [22] K. Arioka and Y. Sawada, "Improved Kalman filter and matching strategy for multi-object tracking system," in *2023 62nd Annual Conference of the Society of Instrument and Control Engineers, SICE 2023*, Sep. 2023, pp. 772–777, doi: 10.23919/SICE59929.2023.10354112.
- [23] H. Chen, X. Feng, Z. Huang, and Z. Zhuang, "Target tracking based on Kalman filtering techniques," in *Proceedings - 2022 International Symposium on Control Engineering and Robotics, ISCER 2022*, Feb. 2022, pp. 237–245, doi: 10.1109/ISCER55570.2022.00048.
- [24] J. Wang, X. Dong, Y. Xing, S. Lv, and P. Wan, "EFK localization method in NLOS environment based on residual discrimination," in *2023 IEEE/CIC International Conference on Communications in China, ICC3 2023*, Aug. 2023, pp. 1–5, doi: 10.1109/ICC357788.2023.10233641.
- [25] Y. Zhang *et al.*, "Clustering-based distributed fault-tolerant target tracking for sensors with decreased detection accuracy," in *IEEE Sensors Journal*, vol. 24, no. 11, pp. 18428–18443, 1 June 2024, doi: 10.1109/JSEN.2024.3382826.
- [26] P. Kanakaraja, S. K. Kotamraju, S. Nagulmeera, Y. D. Reddy and A. Divya, "LoRA based Indoor Localization using LPWAN Gateway and BLE Beacons," *2022 International Conference on Electronics and Renewable Systems (ICEARS)*, Tuticorin, India, 2022, pp. 683-687, doi: 10.1109/ICEARS53579.2022.9751724.
- [27] D. A. Rafina, P. Kristalina, and A. Sudarsono, "Modified iterated extended Kalman filter for mobile cooperative tracking system," *International Journal on Advanced Science, Engineering and Information Technology*, vol. 7, no. 3, pp. 980–992, Jun. 2017, doi: 10.18517/ijaseit.7.3.2657.

BIOGRAPHIES OF AUTHORS



Rafina Destiarti Ainul    earned a B.Eng. graduated in Telecommunication Engineering from Politeknik Elektronika Negeri Surabaya (PENS) in Indonesia, in 2015, and received her M.Eng. degree of Electrical Engineering also from PENS in 2017. She joined the University of Surabaya as a full-time faculty member in 2018. She is currently still an assistant lecturer in the Electrical Engineering Dept. Her research interests include IoT, mobile wireless communication system, and network security. She can be contacted at email: rafina@staff.ubaya.ac.id.



Hendi Wicaksono Agung    earned a B.Eng. graduated in Electrical Engineering from the University of Surabaya in Indonesia, in 2004, and received his M.Eng. degree in Electrical Engineering from the ITS University in Indonesia and Ph.D. in Electrical Engineering from SIIT, Thammasat University, Thailand in 2009 and 2022. He joined the University of Surabaya as a full-time faculty member in 2008. He is currently an assistant professor in the Electrical Engineering Dept. His research interests include robotics, mechatronics, multi-robots, autonomous vehicle, fuzzy logic systems, control systems, instrumentation, and industrial automation. He can be contacted at email: hendi@staff.ubaya.ac.id.

ISSN: 2502-4752 | e-ISSN: 2502-4760

INDONESIAN JOURNAL OF ELECTRICAL ENGINEERING AND COMPUTER SCIENCE



Our Subject Area:

- Control and Optimization
- Information System
- Electrical and Electronic Engineering
- Signal Processing
- Hardware and Architecture
- Computer Networks and Communications



Intelktual Pustaka
Media Utama



Institute of Advanced Engineering and Science

Find and Contact us:

✉ ijeecs.iaes@gmail.com

🌐 <https://ijeecs.iaescore.com>

[Home](#) > [About the Journal](#) > **[Editorial Team](#)**

Editorial Team

Advisory Editors

[Prof. Dr. Patricia Melin](#), Tijuana Institute of Technology, Mexico
[Prof. Neil Bergmann](#), The University of Queensland, Australia
[Dr. Argyrios Zolotas](#), Cranfield University, United Kingdom
[Prof. Daniel Thalmann](#), École Polytechnique Fédérale de Lausanne, Switzerland
[Prof. Ajith Abraham](#), VSB Technical University of Ostrava, Czech Republic

Past Editor-in-Chief (2016-2019)

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

Editor-in-Chief

[Prof. Dr. Seifedine Kadry](#), Lebanese American University, Lebanon

Managing Editors

[Prof. Dr. Leo P. Ligthart](#), Delft University of Technology, Netherlands
[Prof. Dr. Omar Lengerke](#), Universidad Autónoma de Bucaramanga, Colombia
[Prof. Dr. Tole Sutikno](#), Universitas Ahmad Dahlan, Indonesia
[Assoc. Prof. Dr. Wanguan Liu](#), Sun Yat-sen University, China
[Dr. Arianna Mencattini](#), University of Rome "Tor Vergata", Italy
[Mark S. Hooper](#), Analog/RF IC Design Engineer (Consultant) at Microsemi, United States

Associate Editors

[Prof. Dr. Ahmad Saudi Samosir](#), Universitas Lampung (UNILA), Indonesia
[Prof. Dr. Faycal Djeflal](#), University of Batna, Batna, Algeria
[Prof. Dr. Mouquan Shen](#), Nanjing Tech University, China
[Prof. Dr. Muhammad Irfan](#), Beijing Institute of Technology, China
[Prof. Dr. Nidhal Bouaynaya](#), Rowan University, United States
[Prof. Dr. Nik Rumzi Nik Idris](#), Universiti Teknologi Malaysia, Malaysia
[Prof. Dr. Luis Paulo Reis](#), University of Minho, Portugal
[Prof. Dr. Sanjay Kaul](#), Fitchburg State University, United States
[Prof. Dr. Srinivasan Alavandar](#), CK College of Engineering and Technology, India
[Prof. Dr. Vijayakumar Varadarajan](#), The University of New South Wales, Australia
[Prof. Dr. Maja Stula](#), University of Split, Croatia
[Prof. Anjan Kumar Ghosh](#), Tripura University, India
[Prof. Essam M. Rashad](#), Tanta University, Egypt
[Prof. Ezra Morris Gnanamuthu](#), Universiti Tunku Abdul Rahman, Malaysia
[Prof. João Crisóstomo Weyl](#), Universidade Federal do Pará, Brazil
[Prof. Mohammed Alghamdi](#), Al-Baha University, Saudi Arabia
[Assoc. Prof. Octavian Postolache](#), ISCTE-Lisbon University Institute, Portugal
[Prof. Ranathunga Arachchilage Ruwan Chandra Gopura](#), University of Moratuwa, Sri Lanka
[Assoc. Prof. Ahmed Nabih Zaki Rashed](#), Menoufia University, Egypt
[Assoc. Prof. Dr. Jumril Yunas](#), Universiti Kebangsaan Malaysia, Malaysia
[Assoc. Prof. Dr. Luchakorn Wuttisittikulki](#), Chulalongkorn University, Thailand
[Assoc. Prof. Dr. Mario Versaci](#), Università degli Studi di Reggio Calabria, Italy
[Assoc. Prof. Dr. Valentina Emilia Balas](#), Aurel Vlaicu University of Arad, Romania
[Asst. Prof. Dr. Ahmet Teke](#), Çukurova University, Turkey
[Asst. Prof. Dr. Dinh-Thuan Do](#), Ton Duc Thang University, Viet Nam
[Prof. Dr. Ehsan O. Sheybani](#), University of South Florida, United States
[Asst. Prof. Dr. Supavadee Aramvith](#), Chulalongkorn University, Thailand
[Assoc. Prof. Dr. Ljiljana Seric](#), University of Split, Croatia
[Dr. Abdalhossein Rezaei](#), University of Science and Culture, Iran
[Dr. Ahmed Boutejdar](#), German Research Foundation DFG Braunschweig-Bonn, Germany
[Dr. Anand Nayyar](#), Duy Tan University, Viet Nam
[Assoc. Prof. Aniruddha Chandra](#), National Institute of Technology, India
[Dr. Arafat Al-Dweik](#), Khalifa University, United Arab Emirates
[Assoc. Prof. Dr. Arcangelo Castiglione](#), University of Salerno, Italy
[Assoc. Prof. Chau Yuen](#), Singapore University of Technology and Design, Singapore
[Dr. Chinmay Chakraborty](#), Birla Institute of Technology, India
[Dr. Faqiang Wang](#), Xi'an Jiaotong University, China
[Dr. Harikumar Rajaguru](#), Bannari Amman Institute of Technology, India
[Dr. Imran Shafique Ansari](#), University of Glasgow, United Kingdom
[Assoc. Prof. Jinsong Wu](#), Universidad de Chile, Chile
[Dr. Makram Fakhry](#), University of Technology, Baghdad, Iraq
[Dr. Mohammed Dregham Zidan](#), Atomic Energy Commission of Syria, Syrian Arab Republic
[Dr. Mohd Khair Hassan](#), Universiti Putra Malaysia, Malaysia
[Dr. Munawar A Riyadi](#), Universiti Teknologi Malaysia, Malaysia
[Dr. N. Ramesh Babu](#), M Kumarasamy College of Engineering, India
[Dr. Nuno Rodrigues](#), Instituto Politécnico de Bragança, Portugal
[Asst. Prof. Dr. Praveen Malik](#), Dr. B. R. Ambedkar National Institute of Technology, India
[Asst. Prof. Dr. Rama Reddy](#), Kakatiya University, India
[Assoc. Prof. Shahrin Md. Ayob](#), Universiti Teknologi Malaysia, Malaysia
[Dr. Sudhanshu Shekhar Jha](#), Leipzig University, Germany
[Prof. Surinder Singh](#), Sant Longowal Institute of Engg. & Technology Longowal, India
[Dr. Tarek Djerafi](#), Institute of Energy, Materials and Telecommunications (INRS), Canada
[Dr. Tianhua Xu](#), Tianjin University, China
[Dr. Vassilis S. Kodogiannis](#), Emeritus Fellow at University of Westminster, United Kingdom
[Assoc. Prof. Dr. Wei Wang](#), Harbin Engineering University, China
[Prof. Wei Zhouchao](#), China University of Geosciences, China
[Dr. Yin Liu](#), Symantec Core Research Lab, United States
[Dr. Youssef Errami](#), Chouaib Doukkali University, Morocco
[Dr. Yuthapong Tuppapadung](#), Provincial Electricity Authority (PEA), Thailand

USER

Username
Password
☐ Remember me

JOURNAL CONTENT

Search
Search Scope
All

Browse

- By Issue
- By Author
- By Title

INFORMATION

- For Readers
- For Authors
- For Librarians

Editorial Board Members

[Prof. Abdelmadjid Recioui](#), University of Boumerdes, Algeria
[Prof. Ahmed El Oualkadi](#), Abdelmalek Essaadi University, Morocco
[Prof. Meerja Akhil Jabbar](#), Vardhaman College of Engineering, India
[Prof. Arthur Swart](#), Central University of Technology, South Africa
[Prof. Felix J. Garcia Clemente](#), University of Murcia, Spain
[Prof. Mohamed Habaebi](#), International Islamic University Malaysia, Malaysia
[Prof. Priya Ranjan](#), Bhubaneswar Institute of Technology, India
[Assoc. Prof. Murad Abusubaih](#), Palestine Polytechnic University, Palestinian Territory, Occupied
[Prof. Sattar B. Sadkhan](#), University of Babylon, Iraq
[Prof. Wajeb Gharibi](#), University of Missouri-Kansas City, United States
[Dr. Arun Sharma](#), Delhi Technological University, India
[Dr. Dimitri Papadimitriou](#), University of Antwerp, Belgium
[Dr. Duy Huynh](#), HUTECH University, Viet Nam
[Dr. Hamed Mojjallali](#), University of Guilan, Iran, Islamic Republic of
[Dr. Hasan Ali Khattak](#), National University of Sciences & Technology, Pakistan
[Asst. Prof. Dr. Jérôme Le Masson](#), CREC Saint Cyr, France
[Dr. Jitendra Mohan](#), Jaypee Institute of Information Technology, India
[Assoc. Prof. Jose Soler](#), Technical University of Denmark, Denmark
[Dr. Kamal Kant Sharma](#), Chandigarh University, India
[Dr. Kamil Dimililer](#), Yakın Doğu Üniversitesi, Cyprus
[Dr. Ke-Lin Du](#), Concordia University, Canada
[Dr. K.K. Thyagarajan](#), RMD Engineering College, India
[Dr. Maria Chiara Caschera](#), Istituto Di Ricerche Sulla Popolazione E Le Politiche Sociali, Italy
[Dr. Milica Petkovic](#), University of Novi Sad, Serbia
[Asst. Prof. Dr. Marwan Nafea](#), University of Nottingham Malaysia, Malaysia
[Dr. Salil Bhargava](#), Lovely Professional University, India
[Prof. Dr. Media A Ayu](#), Sampoerna University, Indonesia
[Dr. Mohammad Yazdani-Asrami](#), University of Glasgow, United Kingdom
[Dr. Mohd Syakirin Ramli](#), Universiti Malaysia Pahang, Malaysia
[Dr. Mritha Ramalingam](#), University Malaysia Pahang, Malaysia
[Assoc. Prof. Dr. Norliza Noor](#), Universiti Teknologi Malaysia, Malaysia
[Dr. Pratap Kumar Sahu](#), Foxconn, Taiwan
[Dr. Philipp Fechteler](#), Fraunhofer HHI, Germany
[Dr. Ratna Kalos Zakiah Sahbudin](#), Universiti Putra Malaysia, Malaysia
[Dr. Rupak Kharel](#), University of Central Lancashire, United Kingdom
[Prof. Dr. Sai Kiran Oruganti](#), Jiangxi University of Science and Technology Ganzhou, China
[Dr. Sanjaya Kumar Panda](#), National Institute of Technology, India
[Assoc. Prof. Dr. Santoso Wibowo](#), Central Queensland University, Australia
[Dr. Stylianos Basagiannis](#), United Technologies, Cork, Ireland
[Dr. Suneeta Suneeta](#), Vemana Institute of Technology, India
[Asst. Prof. Dr. Taghi Javdani Gandomani](#), Shahrekord University, Iran
[Asst. Prof. Dr. Tanmoy Maitra](#), Kalinga Institute of Industrial Technology, India
[Dr. Tianhua Xu](#), Tianjin University, China
[Assoc. Prof. Vasaka Visoottiviseth](#), Mahidol University, Thailand
[Dr. Vicente Ferreira De Lucena](#), Universidade Federal do Amazonas, Brazil
[Dr. Zhi-Xiang Zhang](#), Hefei University of Technology, China
[Dr. Yasin Kabalcı](#), Nigde Ömer Halisdemir University, Turkey
[Asst. Prof. Dr. Ying-Khai Teh](#), San Diego State University, United States
[Assoc. Prof. Dr. Zeashan Hameed Khan](#), Air University, Pakistan
[Mr. Abdelfatteh Haidine](#), National School of Applied Sciences, Morocco
[Prof. Dr. Mihai Gavrilas](#), Technical University of Iasi, Romania



This work is licensed under a [Creative Commons Attribution-ShareAlike 4.0 International License](https://creativecommons.org/licenses/by-sa/4.0/).

Indonesian Journal of Electrical Engineering and Computer Science (IJECS)

p-ISSN: 2502-4752, e-ISSN: 2502-4760

This journal is published by the [Institute of Advanced Engineering and Science \(IAES\)](https://iaescore.com/).



[IJECS visitor statistics](#)

[Home](#) > [Archives](#) > **Vol 39, No 1**

Vol 39, No 1

July 2025

DOI: <http://doi.org/10.11591/ijeecs.v39.i1>

Table of Contents

An approach for loss minimization and capacity savings in residential microgrid networks in Oman Sasidharan Sreedharan, Parmal Singh Solanki, Magdy S. Abdelfatah, I Made Wartana	PDF 1-10
Hybrid energy storage solutions through battery-supercapacitor integration in photovoltaic installations Abdelkader Yousfi, Fayçal Mehedi, Youcef Bot	PDF 11-22
Advanced generalized integrator based phase lock loop under complex grid condition: a comparative analysis Poonam Tripathy, Banishree Misra, Byamakesh Nayak	PDF 23-32
A comparative analysis of hybrid of traditional load flow methods for IEEE distributed power generation networks Muhammad Hafeez Mohamed Hariri, Noor Dzulaikha Daud, Nor Azizah Mohd Yusoff, Syed Muhammad Zakwan Syed Zaman, Mohd Khairunaz Mat Desa	PDF 33-44
A hybrid APSO-ANFIS optimization based load shifting technique for demand side management in smart grids Mohamed Faradji, Toufik Madani Layadi, Khaled Rouabah	PDF 45-61
Influences of the Sm³⁺-Eu³⁺ codoped Ba₂Gd(BO₃)₂Cl phosphors on the commercial white light emitting diodes Luu Hong Quan, My Hanh Nguyen Thi	PDF 62-69
Torque ripple minimization and performance enhancement of switched reluctance motor for electric vehicle application Yogesh B. Mandake, Deepak S. Bankar, Amit L. Nehete	PDF 70-78
Renewable energy conversion systems for global emission neutralization Suwarno Suwarno, Catra Indra Cahyadi, Pardamean Manurung, Abdul Rahim, Farhan Tanjung, Herman Birje, Fadly Syafni, Muhammad Ridho Kurnia, Ismail Faruqi	PDF 79-88
Predictive modelling of osteoporosis and effect of BMI on the risk of fracture in femur bone using COMSOL Multiphysics: a computational modelling approach Aleena Kamal, Minahil Kamal, Mashal Fatima, Syed Muddusir Hussain, Jawwad Sami Ur Rahman, Sathish Kumar Selvaperumal	PDF 89-100
Random forest method for predicting discharge current waveform and mode of dielectric barrier discharges Laladi Abdelhamid, Chentouf Abdellah, Ezziyyani Mostafa	PDF 101-109
Optimizing stress resistance in MEMS inertial sensors through material and thickness variations Miladina Rizka Aziza, Onny Setyawati, Jumiadi Jumiadi	PDF 110-117
Enhancing urban cyclist safety through integrated smart backpack system Sergio Gómez, Daniel Mejía, Fredy Martínez	PDF 118-130
Autonomous driving system and system hacking protection using V2X communication Eugene Rhee, Junhee Cho	PDF 131-138
Design and development of an automated spirulina (Arthrospira platensis) algae cultivator Miguel Q. Mariñas II, Mark Joseph B. Enojas, Daryll C. Balolong, Charissa Zandra B. Correa, Lemmuel Keith C. Roldan, Mark Lester Teves, Christian Mari Dela Cruz	PDF 139-147
Using ResNet architecture with MRI for classification of brain images Subramanian Dhanalakshmi, Subramanian Arulselvi	PDF 148-158
EMG-based hand gesture classification using Myo Armband with feedforward neural network Sofea Anastasia Mohd Said, Norashikin M. Thamrin, Megat Syahirul Amin Megat Ali, Mohamad Fahmi Hussin, Roslina Mohamad	PDF 159-166

USER

Username

Password

☐ Remember me

JOURNAL CONTENT

Search

Search Scope

Browse

- By Issue
- By Author
- By Title

INFORMATION

- For Readers
- For Authors
- For Librarians

Unraveling the relationships among essential oil compounds in Aquilaria species using GC-MS and GC-FID techniques	PDF 167-177
Nur Athirah Syafiqah Noramli, Noor Aida Syakira Ahmad Sabri, Muhammad Ikhsan Roslan, Nurlaila Ismail, Zakiah Mohd Yusoff, Mohd Nasir Taib	
Robust k-NN approach for classifying Aquilaria oil species by compounds	PDF 178-189
Noor Aida Syakira Ahmad Sabri, Nur Athirah Syafiqah Noramli, Nik Fasha Edora Nik Kamaruzaman, Nurlaila Ismail, Zakiah Mohd Yusoff, Ali Abd Almisreb, Saiful Nizam Tajuddin, Mohd Nasir Taib	
Benchmarking spectral handoff rate performance in cognitive wireless networks with real multi-user access	PDF 190-201
Cesar Hernández, Diego Giral, Fredy Martínez	
An efficient segmentation using adaptive radial basis function neural network for tomato and mango plant leaf images	PDF 202-213
Jolakula Asoka Smitha, Bichagal Shadaksharappa, Sheela Parvathy, Killingar Veena, Albert Jenifer, Baddala Vijaya Nirmala, Subbiah Murugan	
Enhanced performance and efficiency of robotic autonomous procedures through path planning algorithm	PDF 214-224
Raman Latha, Saravanan Sriram, Balu Bharathi, John Bennilo Fernandes, Ayalapogu Ratna Raju, Kannan Boopathy, Subbiah Murugan	
RIBATS: RSSI-based adaptive tracking system with ASEKF for indoor WSN	PDF 225-234
Rafina Destiarti Ainul, Hendi Wicaksono Agung	
The impact of coordinator failures on the performance of Zigbee networks in various topologies	PDF 235-246
Daulet Naubetov, Mubarak Yakubova, Bahodir Yakubov, Nurzhigit Smailov	
Evolution of the optical add/drop multiplexer in dense wavelength division multiplexing optical networks	PDF 247-257
Mnotho P. Mkhwanazi, Khumbulani Mpofu, Vusumuzi Malele	
Virtual learning environment on satisfaction and academic performance of students in institutions of higher learning	PDF 258-271
Odunayo Dauda Olanloye, Peter Adebayo Idowu, Abidemi Emmanuel Adeniyi, Afolake Afusat Badmus, Oluwasegun Julius Aroba	
Study on neuromorphic computation and its applications	PDF 272-282
Anjali Chature, A. Raganna, Venkateshappa Venkateshappa	
PRDTinyML: deep learning-based TinyML-based pedestrian detection model in autonomous vehicles for smart cities	PDF 283-309
Norah N. Alajlan, Abeer I. Alhujaylan, Dina M. Ibrahim	
Short-term recall comparison of iconic auditory and visual feedback stimuli in a memory game	PDF 310-321
György Wersényi, Ádám Csapó, József Tóllár	
High-accuracy classification of banana varieties using ResNet-50 and DenseNet-121 architectures	PDF 322-335
Suastika Yulia Riska, Danang Arbian Sulisty, Farah Shafiyah Siti Maharani	
An improved efficientnet-B5 for cucurbit leaf identification	PDF 336-344
Quang Hung Ha, Trong-Minh Hoang, Minh Trien Pham	
New technic of transfer learning for detecting epilepsy by EfficientNet and DarkNet models	PDF 345-352
Fatima Edderballi, Hamid El Malali, Elmaati Essoukaki, Mohammed Harmouchi	
Enhancing TV program success prediction using machine learning by integrating people meter audience metrics with digital engagement metrics	PDF 353-363
Khalid El Fayq, Said Tkatek, Lahcen Idougli	
A sentiment analysis on skewed product reviews: Ben & Jerry's ice cream	PDF 364-373
Nabilla Nurulita Dewi, Sekar Gesti Amalia Utami, Shalsabila Aura Adiar, Hasan Dwi Cahyono	
Seeking best performance: a comparative evaluation of machine learning models in the prediction of hepatitis C	PDF 374-386
Michael Cabanillas-Carbonell, Joselyn Zapata-Paulini	
Context dependent bidirectional deep learning and Bayesian gaussian auto-encoder for prediction of kidney disease	PDF 387-398
Jayashree M, Anitha N	
Optimization of 3D rendering algorithms for carbon reduction in virtual reality technology	PDF 399-409
Fendi Aji Purnomo, Fatchul Arifin, Herman Dwi Surjono	
Classification model for infectious lung diseases using convolutional neural networks on web and mobile applications	PDF 410-424
Kennedy Okokpujie, Alvin K. Agamah, Abidemi Orimogunje, Ijeh Princess Adaora, Olusanya Olamide Omolara, Samuel Adebayo Daramola, Morayo Emitha Awomoyi	
OPT-TMS: a transport management system based on unsupervised clustering algorithms	PDF 425-435
Soufiane Reguemali, Abdellatif Moussaid, Abdelmajid Elaoudi	

Internet of things based smart agriculture using K-nearest neighbor for enhancing the crop yield Kalyankumar Dasari, Mukund Ramdas Kharde, Kuruva Maddileti, Venkat Rao Pasupuleti, Mylavarapu Kalyan Ram, Challapalli Sujana, Govindu Komali, Shaik Baba Fariddin	PDF 436-445
Investigating the recall efficiency in abstractive summarization: an experimental based comparative study Surabhi Anuradha, Martha Sheshikala	PDF 446-454
Core methodological classes of text extraction and localization-a snapshot of approaches Dayananda Kodala Jayaram, Puttegowda Devegowda	PDF 455-465
Web-Based Attacks Detection Using Deep Learning Techniques: A Comprehensive Review Lujain Nasser Alghofaili, Dina M. Ibrahim	PDF 466-484
Geographic information system for marine ecotourism and rural lifestyle in Prachuap Khiri Khan Sompond Puengsom, Jakkapong Polpong, Phisit Pornpongtechavanich	PDF 485-496
BFT water color classification in tilapia aquaculture using computer vision Bondan Suwandi, Sakinah Puspa Anggraeni, Toto Bachtiar Palokoto, Budi Sulistya, Wisnu Sujatmiko, Reza Septiawan, Nashrullah Taufik, Arief Rufiyanto, Arif Rahmat Ardiansyah	PDF 497-508
Effective methods for employee performance assessment Agatha Beny Himawan, Rinta Kridalukmana, Toni Prahasto	PDF 509-522
Secure data transmission towards mitigating potentially unknown threats in wireless sensor network Chaya Puttaswamy, Nandini Prasad Kanakapura Shivaprasad	PDF 523-530
Web GIS-based postcode alternative system for resolving "last mile" problem in Jordan's home delivery Firas Omar, Ahmad Nabot, Bilal Sowan	PDF 531-544
HangeulVR: an immersive and interactive Korean alphabet learning on virtual reality Ahmad Nasikun, Muhammad Fadhil Mahendra, Achmad Rio Dessiar	PDF 545-553
Comparative study of deep learning approaches for cucumber disease classification Supreetha Shivaraj, Manjula Sunkadakatte Haladappa	PDF 554-563
Enhancing vocational computer engineering education with a GPT-driven speech recognition tool Putra Utama Eka Sakti, Alva Hendi Muhammad, Asro Nasiri	PDF 564-574
Predictive modeling for equity trading using sentiment analysis Chetan Gondaliya, Abhishek Parikh	PDF 575-584
A compact study on methodological insights on navigational systems in vehicular traffic system Prathibha Thimmappa, Mayuri Kundu	PDF 585-591
Real-time driver drowsiness detection based on integrative approach of deep learning and machine learning model Gowrishankar Shiva Shankara Chari, Jyothi Arcot Prashant	PDF 592-602
Word embedding and imbalanced learning impact on Indonesian Quran ontology population Fandy Setyo Utomo, Yuli Purwati, Mohd Sanusi Azmi, Lulu Shafira, Nikmah Trinarsih	PDF 603-613
Advancements in gas leakage detection and risk assessment: a comprehensive survey Y. Bhavani, Sanjusree Vodapally, Dinesh Bokka, Harshitha Varma Muddasani, Deepika Kasturi	PDF 614-624
Phasor measurement unit optimization in smart grids using artificial neural network Ashpana Shiralkar, Suchita Ingle, Haripriya Kulkarni, Poonam Mane, Shashikant Bakre	PDF 625-633
Low-resolution image quality enhancement using enhanced super-resolution convolutional network and super-resolution residual network Mohammad Faisal Riftiarysyid, Rico Halim, Andien Dwi Novika, Amalia Zahra	PDF 634-643
Advanced cervical cancer classification: enhancing pap smear images with hybrid PMD filter-CLAHE Ach Khozaimi, Isnani Darti, Syaiful Anam, Wuryansari Muharini Kusumawinahyu	PDF 644-655
Boosting real-time vehicle detection in urban traffic using a novel multi-augmentation Imam Ahmad Ashari, Wahyul Amien Syafei, Adi Wibowo	PDF 656-668
Non-contact breathing rate monitoring using infrared thermography and machine learning Anadya Ghina Salsabila, Rachmad Setiawan, Nada Fitriyatul Hikmah, Zain Budi Syulthoni	PDF 669-680

Smart enterprise architecture framework for developing patent office Yoga Prihastomo, Harjanto Prabowo, Agung Trisetyarso, Haryono Soeparno	PDF 681-690
Banking security and performance of islamic banks in middle east: the role of regulatory quality Mohammed Abd-Akarim Almomani, Adai Al-Momani	PDF 691-699
A novel (n, n) multi-secret image sharing scheme harnessing RNA cryptography and 1-D group cellular automata Yasmin Abdul, Venkatesan Ramasamy, Gaverchand Kukaram	PDF 700-709
An innovative image encryption scheme integrating chaotic maps, DNA encoding and cellular automata Gaverchand Kukaram, Venkatesan Ramasamy, Yasmin Abdul	PDF 710-719
An efficient DVHOP localization algorithm based on simulated annealing for wireless sensor network Omar Arroub, Anouar Darif, Rachid Saadane, My Driss Rahmani, Zineb Aarab	PDF 720-736



This work is licensed under a [Creative Commons Attribution-ShareAlike 4.0 International License](#).

Indonesian Journal of Electrical Engineering and Computer Science (IJEECS)

p-ISSN: 2502-4752, e-ISSN: 2502-4760

This journal is published by the [Institute of Advanced Engineering and Science \(IAES\)](#).



[IJEECS visitor statistics](#)

Get More with
SINTA Insight

Go to Insight



INDONESIAN JOURNAL OF ELECTRICAL ENGINEERING AND COMPUTER SCIENCE

INSTITUTE OF ADVANCED ENGINEERING AND SCIENCE (IAES)

P-ISSN : 25024752 < > E-ISSN : 25024760 Subject Area : Science, Engineering



10.7207
Impact



33622
Google Citations



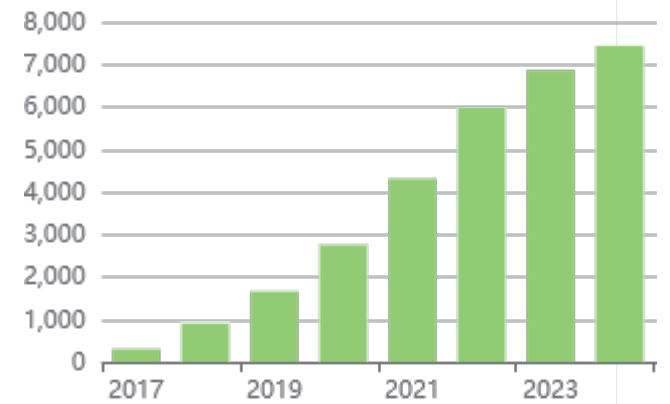
Sinta 1
Current
Accreditation

Google Scholar Garuda Website Editor URL

History Accreditation

2018 2019 2020 2021 2022

Citation Per Year By Google Scholar



Journal By Google Scholar

	All	Since 2020
Citation	33622	30463
h-index	64	61
i10-index	1095	998

Garuda Google Scholar

Enhanced vegetation encroachment detection along power transmission corridors using random forest algorithm

Institute of Advanced Engineering and Science Indonesian Journal of Electrical Engineering and Computer Science Vol 38, No 2: May 2025 1376-1382

2025 DOI: 10.11591/ijeecs.v38.i2.pp1376-1382 Accred : Unknown

End-user software engineering approach: improve spreadsheets capabilities using Python-based user-defined functions

Institute of Advanced Engineering and Science Indonesian Journal of Electrical Engineering and Computer Science Vol 38, No 2: May 2025 1024-1032

2025 DOI: 10.11591/ijeecs.v38.i2.pp1024-1032 Accred : Unknown

Deep learning-based cryptanalysis in recovering the secret key and plaintext on lightweight cryptography

Institute of Advanced Engineering and Science Indonesian Journal of Electrical Engineering and Computer Science Vol 38, No 2: May 2025 1115-1123

2025 DOI: 10.11591/ijeecs.v38.i2.pp1115-1123 Accred : Unknown

An embedded system for the classification of sleep disorders using ECG signals

Institute of Advanced Engineering and Science Indonesian Journal of Electrical Engineering and Computer Science Vol 38, No 2: May 2025 767-773

2025 DOI: 10.11591/ijeecs.v38.i2.pp767-773 Accred : Unknown

Emerging approaches of artificial intelligence tools for distance learning: a review

Institute of Advanced Engineering and Science Indonesian Journal of Electrical Engineering and Computer Science Vol 38, No 2: May 2025 1219-1230

📅 2025

🗨️ [DOI: 10.11591/ijeecs.v38.i2.pp1219-1230](#)

🏅 [Accred : Unknown](#)

[Performance evaluation of transdermal optical wireless communication using spatial diversity techniques](#)

[Institute of Advanced Engineering and Science](#) [Indonesian Journal of Electrical Engineering and Computer Science Vol 38, No 2: May 2025 865-875](#)

📅 2025

🗨️ [DOI: 10.11591/ijeecs.v38.i2.pp865-875](#)

🏅 [Accred : Unknown](#)

[A comparative analysis of GPUs, TPUs, DPUs, and QPUs for deep learning with python](#)

[Institute of Advanced Engineering and Science](#) [Indonesian Journal of Electrical Engineering and Computer Science Vol 38, No 2: May 2025 1324-1330](#)

📅 2025

🗨️ [DOI: 10.11591/ijeecs.v38.i2.pp1324-1330](#)

🏅 [Accred : Unknown](#)

[A tag-based recommender system for tourism using collaborative filtering](#)

[Institute of Advanced Engineering and Science](#) [Indonesian Journal of Electrical Engineering and Computer Science Vol 38, No 2: May 2025 960-974](#)

📅 2025

🗨️ [DOI: 10.11591/ijeecs.v38.i2.pp960-974](#)

🏅 [Accred : Unknown](#)

[Intelligent voice control system for UAV with mobile robot](#)

[Institute of Advanced Engineering and Science](#) [Indonesian Journal of Electrical Engineering and Computer Science Vol 38, No 2: May 2025 1061-1072](#)

📅 2025

🗨️ [DOI: 10.11591/ijeecs.v38.i2.pp1061-1072](#)

🏅 [Accred : Unknown](#)

[A review on power transformer failures: analysis of failure types and causative factors](#)

[Institute of Advanced Engineering and Science](#) [Indonesian Journal of Electrical Engineering and Computer Science Vol 38, No 2: May 2025 713-722](#)

📅 2025

🗨️ [DOI: 10.11591/ijeecs.v38.i2.pp713-722](#)

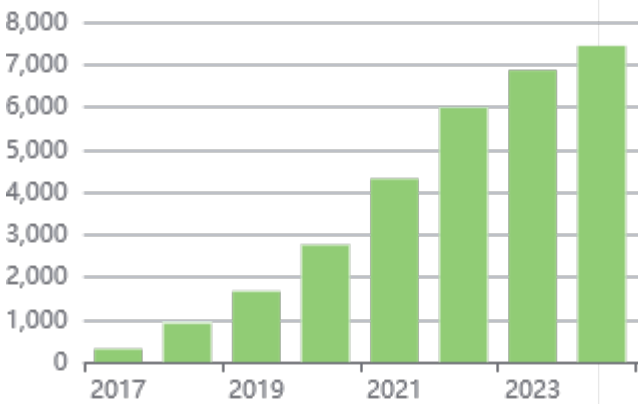
🏅 [Accred : Unknown](#)

View more ...

Get More with
SINTA Insight

Go to Insight

Citation Per Year By Google Scholar



Journal By Google Scholar

	All	Since 2020
Citation	33622	30463
h-index	64	61
i10-index	1095	998