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# SECURITY SYSTEM ON WIFI NETWORKS BASED ON RSS (RECEIVED SIGNAL STRENGTH) CORRELATION

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**ABSTRACT**

*Communication systems are always evolving, including data communication that occurs wirelessly, such as through WIFI networks. However, wireless communication inherently has a low level of security, making it vulnerable to attacks from unauthorized parties. In this research, a security system for WIFI networks was created based on the correlation of RSS (Received Signal Strength) values obtained through a channel probing process between two PCs by implementing several scenarios. The RSS data was quantized using Aono's method to obtain binary bits of 1 and 0. From the test results, it can be seen that the Key Generation Rate (KGR) produced was 16bit/s for a 50ms time interval, 8bit/s for 110ms, and 7bit/s for 120ms. The Key Disagreement Rate (KDR) was 30% for 50ms, 46.59% for 110ms, and 46.71% for 120ms, where the two PCs had a high bit difference. However, with Linear Block Code, the KDR value could be reduced to 0%. From the randomness results, it has met the randomness requirement for 50ms, which is 0.3712. From the identical bits between the two PCs, a symmetric key can be generated, meaning the key on PC1 and PC2 is the same.*

## INTRODUCTION

In the current modern era, communication using cables is gradually being replaced by communication without cables, commonly known as wireless network communication. An example is the WiFi (Wireless Fidelity) network, which operates using radio waves at specific frequencies. On a WiFi network, communication can occur between two or more devices, for instance, for data exchange. This data or information might be confidential. When confidential data or information is communicated on a wireless network, it is possible for this data to be accessed by unauthorized parties.

Currently, there are many ways to protect data communicated on wireless networks. One of them is through cryptographic techniques. Cryptography is the science of encoding data into a specific code that cannot be understood. In cryptography, there are two basic processes: Encryption and Decryption, where the original data (plaintext) is converted into encoded data (ciphertext) and then converted back into the original data using a specific agreed-upon key. There are two types of key methods used: symmetric keys and asymmetric keys. A symmetric key is a key where the same key is used by both the sender and the receiver, whereas an asymmetric key is a key where the key used by the sender and the receiver is not the same. The key implemented in this research is a symmetric key that will be used for communication between two PCs, where both PCs will measure the RSS value. When the RSS measurement value meets the requirements for key generation, the key can be generated, and the data transmission process can be carried out securely.

## RESEARCH METHOD

The system modeling in this research is generally illustrated in Figure 1.

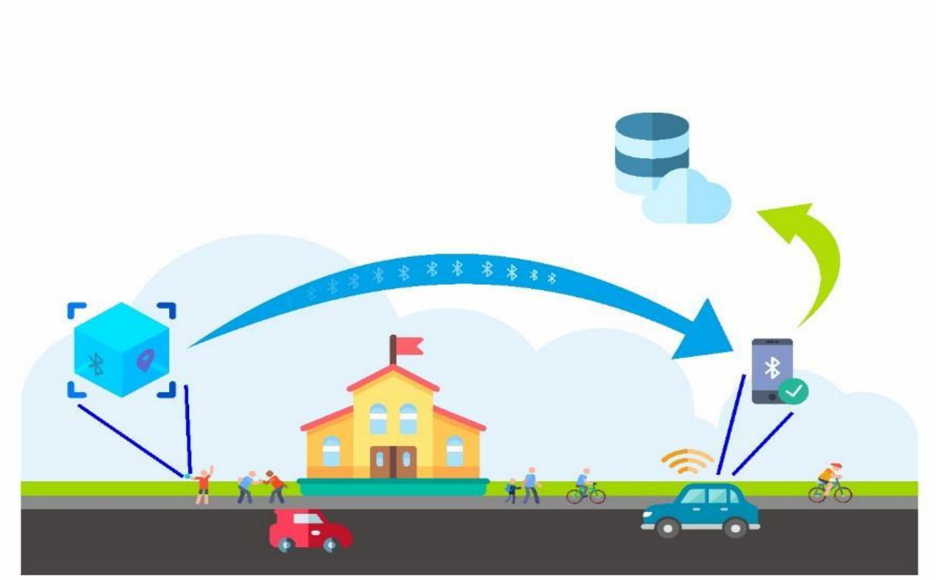

**Figure 1.** System illustration image

This system involves the flow of coordinate data communication from the hardware device (node) to a smartphone. This interaction is facilitated by Bluetooth HM 10 technology, which requires Bluetooth to be activated on both entities for the hardware's coordinate data transmission to occur. When the smartphone successfully receives the coordinate information in latitude and longitude format, the data is then visualized through the integrated Google Maps application. The purpose of this display is to simplify the process for the user to identify the actual location of the hardware device.

The next stage is the transmission of coordinate data from the smartphone to a central database. Within the database, the coordinate information will be further processed and then permanently stored on the server. It is important to understand that the effectiveness of this pickup system is influenced by the limited range of the Bluetooth technology used, which operationally has a maximum range of 15 to 20 meters if not supported by an external antenna as a signal booster. Therefore, the entire data communication process, from data acquisition by the hardware to storage on the server, is highly dependent on the central role of the smartphone. In this system, the smartphone not only functions to display the pickup target location through the available application but is also responsible for acting as an intermediary that forwards the location data to the database server.

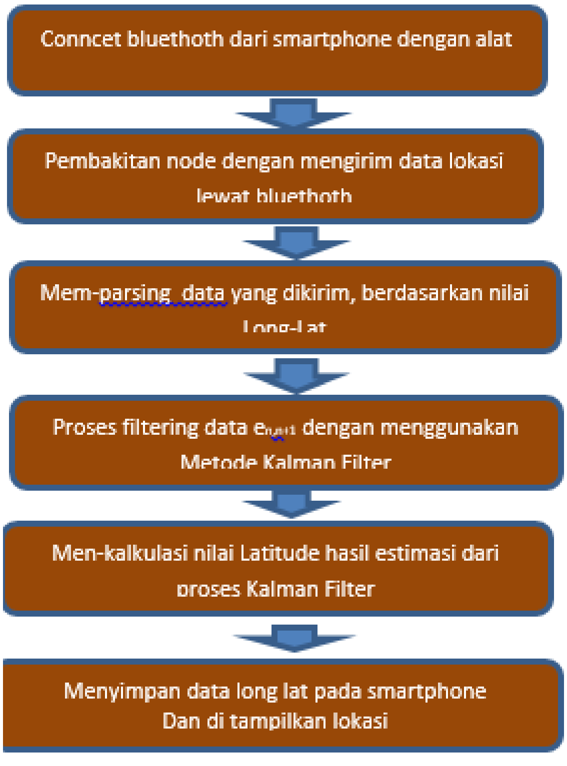


**Figure 2.** System block diagram

## RESULTS

**Table 1.** Kalman Filter Estimation Results with Variations of R and Q

| | | Measurement Noise Covariance (R) | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | $10^{-5}$ | | $10^{-4}$ | | $10^{-3}$ | | $10^{-2}$ | | $10^{-1}$ | |
| | | d | %Error | d | %Error | d | %Error | d | %Error | d | %Error |
| Process Noise Covariance (Q) | $10^{-5}$ | 5.78 | 35% | 4.92 | 14% | 3.6 | 8% | 2.92 | 16% | 2.79 | 18% |
| | $10^{-4}$ | 5.27 | 28% | 4.73 | 12% | 4.93 | 14% | 3.6 | 8% | 2.91 | 16% |
| | $10^{-3}$ | 5.23 | 25% | 5.27 | 28% | 3.73 | 4% | 4.92 | 11% | 3.6 | 8% |
| | $10^{-2}$ | 4.22 | 4% | 5.23 | 25% | 4.02 | 1% | 5.73 | 35% | 3.89 | 2.7% |
| | $10^{-1}$ | 4.22 | 4% | 5.22 | 4% | 3.23 | 11% | 5.82 | 42% | 5.73 | 31% |

From the table, it is observed that the lowest estimation error percentage is 1% at the parameters R=0.001 and Q=0.01. However, this optimal accuracy level is specific to measurements at a distance of 4 meters. When the same pair of parameters is applied to a measurement distance range of 2 to 14 meters, the highest recorded error percentage can reach

40.5%. A graphical illustration of the distance estimation in that range with various combinations of parameters (R) and (Q) tested in the field is presented further in the table. Based on the evaluation of covariance parameters, the combination of R=0.1 and Q=0.01 was identified as the most optimal, although it still produced a maximum measurement error percentage of 32.5% relative to the actual distance. Conversely, the use of parameters R=0.00001 and Q=0.00001 showed less satisfactory performance, characterized by the absence of a significant filtering effect and a measurement error that soared to 110%.

**Tabl.2. Distance Calculation Results with Kalman Filter**

| Percobaan | Jarak (m) | | | | | | |
|---|---|---|---|---|---|---|---|
| | 2 | 4 | 6 | 8 | 10 | 12 | 14 |
| 1 | 1.87 | 5.63 | 6.23 | 8.41 | 11.36 | 15.33 | 16.95 |
| 2 | 1.87 | 5.63 | 8.41 | 10.27 | 15.33 | 15.33 | 16.95 |
| 3 | 1.87 | 3.42 | 5.63 | 9.30 | 11.36 | 15.33 | 18.73 |
| 4 | 1.87 | 3.42 | 5.10 | 6.88 | 10.27 | 13.87 | 20.71 |
| 5 | 2.29 | 5.10 | 7.61 | 7.61 | 10.27 | 16.95 | 18.73 |
| 6 | 1.87 | 3.42 | 5.10 | 9.30 | 9.30 | 16.95 | 16.95 |
| 7 | 2.53 | 2.53 | 7.61 | 9.30 | 11.36 | 13.87 | 20.71 |
| 8 | 1.87 | 3.42 | 7.61 | 9.30 | 11.36 | 13.87 | 18.73 |
| 9 | 1.69 | 3.42 | 4.61 | 10.27 | 12.55 | 13.87 | 20.71 |
| 10 | 2.53 | 4.17 | 6.88 | 8.41 | 13.87 | 12.55 | 16.95 |
| Rata-rata | 2.01 | 3.89 | 6.35 | 8.84 | 11.59 | 14.73 | 18.55 |
| Error% | 0.5% | 2.7% | 5.9% | 10.5% | 15.9% | 22.8% | 32.5% |

Based on the distance table above, it can be seen that the error percentage continues to increase as the distance gets larger, with the smallest error percentage of 0.5% at a distance of 2 meters and the largest error percentage at a distance of 14 meters, or the largest distance measurement. The error percentage is 32.5%.

**Table.3** Distance Comparison

| Distance (meter) | Error Percentage % With Kalman Filter | Error Percentage % Without Kalman Filter |
|---|---|---|
| 2 | 0.5% | 7.3% |
| 4 | 2.7% | 12.9% |
| 6 | 5.9% | 17.0% |
| 8 | 10.5% | 31.0% |
| 10 | 15.9% | 50.3 % |
| 12 | 22.8% | 74.3% |
| 14 | 32.5% | 91.9% |

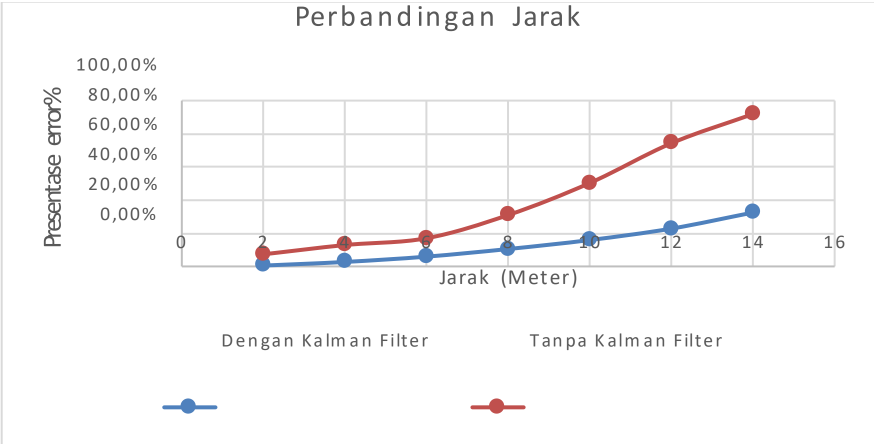


**Figure 3.** Distance Comparison Graph

**Graph Key** : Vertical axis is the error percentage (%) and Horizontal axis is the Distance.
It is evident from the graph that the comparison between using and not using the Kalman filter is quite significant. The error percentage without the Kalman filter at the furthest test distance of 14 meters reached 91.9%, a stark contrast to the result using the Kalman filter, where at the furthest test, the error percentage was only 32.5%. This proves that the Kalman filter process has a major influence.
Accuracy Testing of Latitude Values from Kalman Filter. After testing the best combination of R and Q values to be used in the estimation process with the Kalman filter on en,n+1 by applying the R and Q values of this research, which are R=0.1 and Q=0.01. The system will then generate a new en,n+1 value, and this will undergo a latitude value selection process. At this stage, a sample simulation for 20 test points has been conducted; the test was performed by tracking from Kenjeran Park to Taman Persahabatan Gubeng. A total of 20 points were used to determine the accuracy level of the Kalman filter implemented on the latitude.

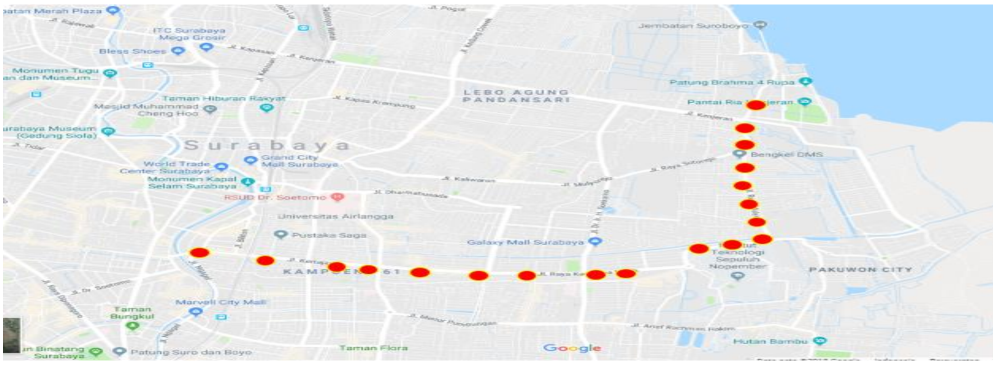


**Figure 4.** Latitude testing map using Kalman filter

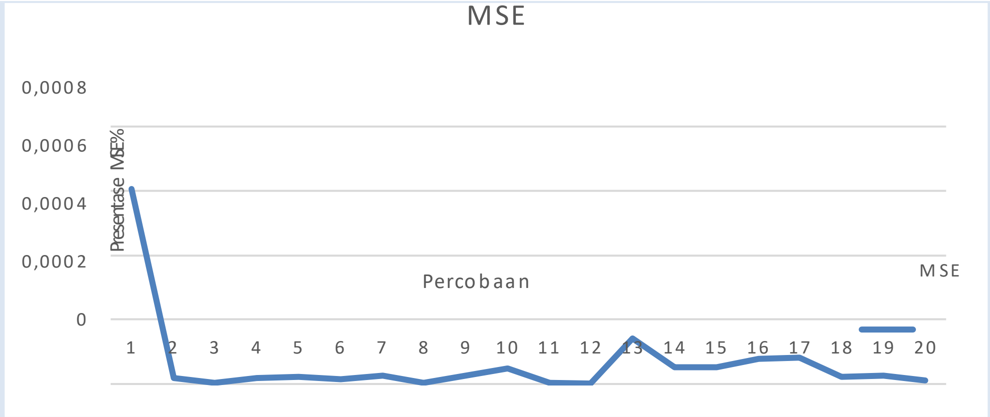


**Figure 5.** MSE (Mean Square Error) Graph

**Graph Key** : *Vertical axis is the MSE percentage and Horizontal axis is the number of coordinate points.*

From the data table and graph above, the calculation of the MSE (Mean Square Error) can be observed. The value closest to the measurement value is at latitude -7.274423, which is located in front of the Pakuwon roundabout police post, with an MSE value of 3.16176E-06. Meanwhile, the MSE (Mean Square Error) value that deviates furthest from the measurement value is at latitude -7.260700, located at Kenjeran Park. It can be seen here that when the location is strategic and has fewer obstacles, the MSE will be smaller, whereas in crowded places with many obstacles, the MSE will be larger.

**Table 4.** Latitude Coordinate Comparison

| No. | Nama | MSE | |
|---|---|---|---|
| | | Dengan Kalman Filter | Tanpa Kalman Filter |
| 1 | Kenjeran Park | 0.001156913 | 0.011157551 |
| 2 | Pasar Tempurejo | 1.73642E-05 | 4.49E-04 |
| 3 | Univ Widya Kartika | 5.37163E-06 | 3.71E-04 |
| 4 | ATM BRI Mulyosari | 1.84552E-05 | 0.000091553 |
| 5 | Bank Bukopin Mulyosari | 2.16118E-05 | 2.16E-05 |
| 6 | Giant Mulyosari | 1.30694E-05 | 1.31E-05 |
| 7 | SPBU Mulyosari | 2.7505E-05 | 0.00012656 |
| 8 | Pos Polisi Bundaran | 3.16176E-06 | 3.16E-05 |

| | | | |
|---|---|---|---|
| 9 | Halte PENS | 2.58391E-05 | 1.90E-04 |
| 10 | Gedung Graha ITS | 4.97501E-05 | 0.00014241 |
| 11 | Bundaran ITS | 4.39605E-06 | 4.40E-05 |
| 12 | Gerbang Utama ITS | 1.37372E-06 | 1.37E-04 |
| 13 | Super Indo Kertajaya | 0.000143394 | 0.000143494 |
| 14 | Rumah Makan Sederhana | 5.16436E-05 | 5.16E-05 |
| 15 | SPBU Pertamina Kertajaya | 5.16428E-05 | 0.000135097 |
| 16 | AHASS Manyar | 7.98075E-05 | 7.98E-05 |
| 17 | Gramedia Manyar | 8.36572E-05 | 8.37E-05 |
| 18 | Prima Buah | 2.22612E-05 | 0.000297091 |
| 19 | J&T Express Gubeng | 2.67968E-05 | 0.000248042 |
| 20 | Taman Persahabatan | 9.8945E-06 | 9.89E-06 |

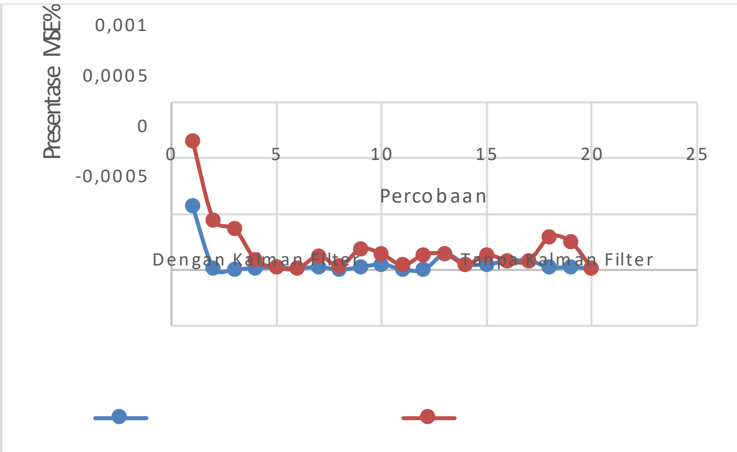


**Figure 6.** Latitude Comparison Graph

**Graph Key** : ertical axis is the MSE percentage and Horizontal axis is the number of coordinate points.

The graph above compares the latitude results between using and not using the Kalman filter. A significant difference is visible where the graph is more stable when using the Kalman filter, and its largest error percentage is still smaller than without the Kalman filter. As a result, when using the Kalman filter, the latitude coordinate estimation is more accurate and smoother than without the Kalman filter.

## CONCLUSSION

From the test results and analysis of the measurement results in the previous chapter, several conclusions can be drawn:

1. The performance of the child pickup system that was built is highly determined by the accuracy of the GPS module used.
2. The performance of the child pickup system from the hardware is greatly influenced by the Bluetooth connection range.
3. The Kalman Filter method is proven to minimize errors that occur in both distance and latitude coordinates.
4. Using the Bluetooth HM 10, the maximum distance is 15-20 meters.
5. The accuracy of the GPS on average is close to less than 0.1% error percentage; this proves that using the Kalman filter method is more precise.

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