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From: BEST (Beacon-based Evacuation System and Technology)

Bacon Beacon

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Summary

New beacon device arrived. Compared with ESP32, advertising interval of the beacons was faster and more accurate than ESP32 and accuracy was better. Also, iOS device and Android device can detect more signals. Therefore, ESP32s were replaced. Since the signal from the beacons is fluctuating, demo program has been developed in the foundation of Kalman Filter open source [2]. The program can filter the discontinuity. The data that comes from raw and filtered has been collected with the mobile devices. By analyzing it, the pattern has been found.

What “BEST” completed this week

- Improved the open source of Kalman filter [2]
 - Source of Kalman filter was developed in Python. When the program was started in the Raspberry Pi, fluctuation of the signal has been stabilized. Therefore, the code has been improved and changed to Swift and Kotlin to build in iOS device and Android device.

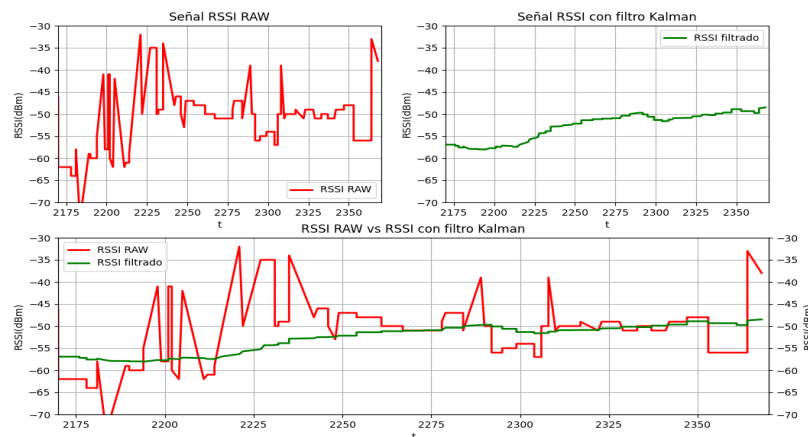


Fig. 1. Comparison between raw RSSI and filtered RSSI with Kalman filter

Fig. 1. Describes the stabilization of signal.

- Modifications of Overview
 - Access Point (AP)
 - As K-SW building area is large, Trilateration with beacons is not available. AP can cover larger space than a beacon, whereby Trilateration can work with one AP and two

beacons [1]. Therefore, the mobile devices can calculate the Received Signal Strength Indicator (RSSI) value from AP and beacons. They can take top two RSSI values that come from beacons [5] and from AP. With three RSSI values, they can estimate the location of themselves.

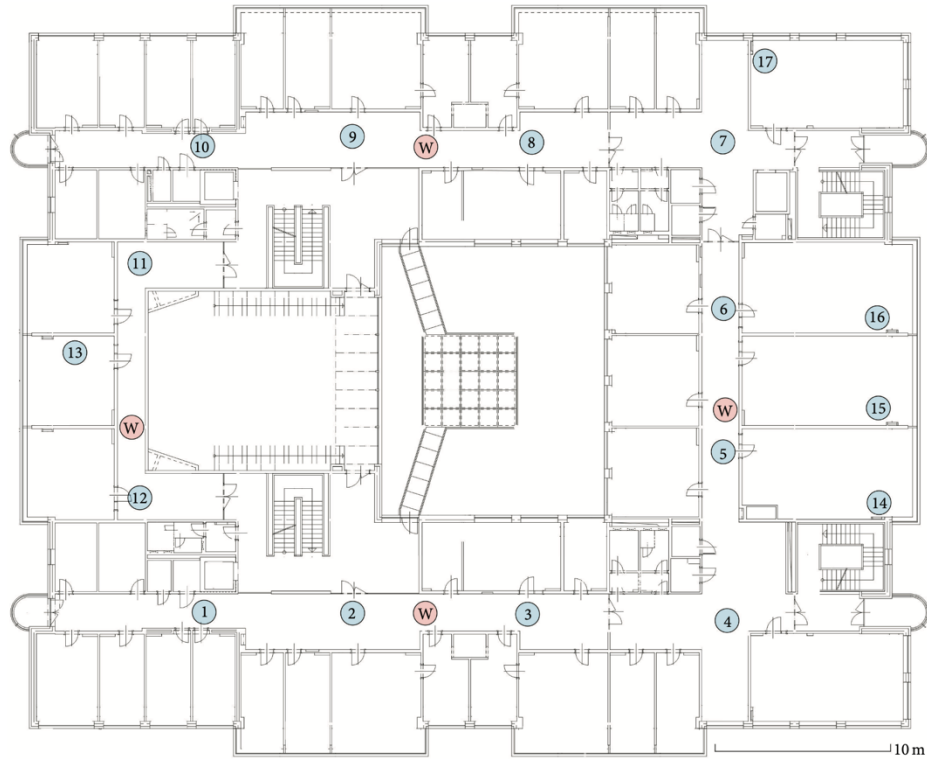


Fig. 2. Indoor Localization by Wi-Fi and Beacons [1]

Fig. 1. describes how to locate Access Points and Beacons to improve indoor localization.

- Experiments

To find out the relationship between raw RSSI, filtered RSSI with Kalman Filter and distance [5], an experiment was conducted. Experiment environment had been set with the new beacon, iOS device (iPhone12) and Android device (Galaxy A30). The distance between 0.5M to 5M was conducted on the floor. The beacon was placed at the fixed point. Two smartphones were used as receivers and moved during the experiment. They received signals for 5 minutes and moved 0.5M far from previous point. They collected raw RSSI, filtered RSSI, distance and Mean Squared Error (MSE) as a CSV file.

- Analysis of Data

Analysis of raw RSSI, filtered RSSI shows that Kalman filter reduces the fluctuation of signal. The goal of the analysis is how much Kalman filter can refine data. With Kalman filter value, the threshold of each distance would be determined by Support Vector Regression (SVR) model [5].

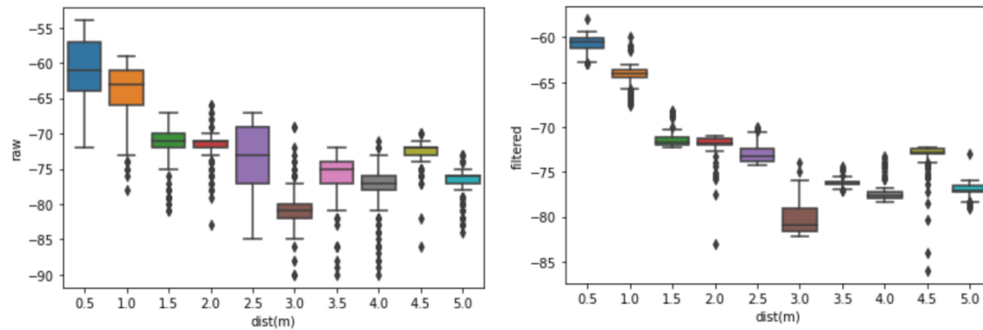


Fig. 3. Raw RSSI and filtered RSSI by the Kalman filter in iPhone 12

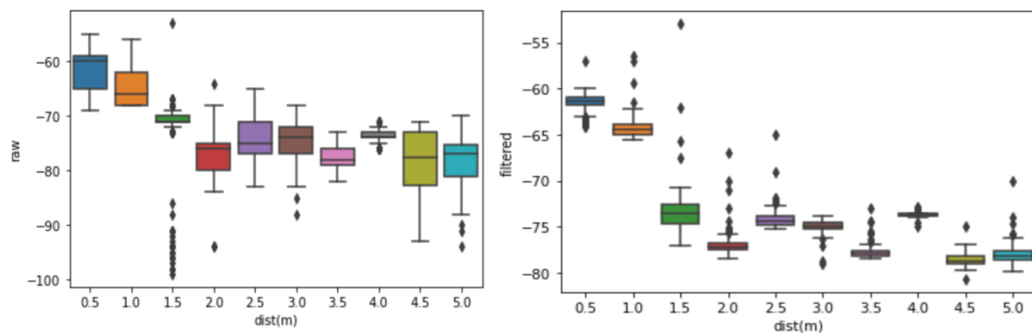


Fig. 4. Raw RSSI and filtered RSSI by the Kalman filter in Galaxy A30

Fig.3. and Fig.4. shows that raw RSSI has larger variance than the filtered value.

Things to do by next week

- Methodology for indoor localization
 - The experiment will be conducted with Trilateration by using new iBeacons and AP.
 - The experiment should be tested several times to get accurate indoor localization.
 - Data from mobile devices that include information from iBeacons will be collected and used to make Support Vector Regression (SVR) [6].
- Methodology for filtering Algorithms
 - Seminars for Unscented Kalman Filter since evacuees' behaviors are non-linear.
- Methodology for evacuation Algorithms
 - Seminars for A* Algorithms and Dijkstra Algorithms.
 - Seminars for multi-destinations shortest path Algorithms.

Problems or challenges:

- The pattern of evacuees' behavior is non-linear
 - The assumptions of Kalman Filter are that the object should move linearly, and the estimation of moving object should follow the Gaussian distribution [3]. However, the pattern of evacuees' behavior is non-linear which means that they do not only move forward in the same velocity. Thus, Unscented Kalman Filter should be studied and implemented in Swift and Kotlin.

References

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