ABSTRACT

Indoor localization systems play a crucial role in many modern applications, enabling object positioning and navigation in offices, libraries, hospitals, and more. However, the accuracy of positioning and tracking is often hindered by the complexity of indoor environments. One of the main challenges is the Non-Line of Sight (NLOS) condition, in which signals suffer from positive bias due to reflections or obstructions, significantly reducing the accuracy of position estimation. This research proposes the implementation of the Adaptive Kalman Filter (AKF) to improve the accuracy of position estimation under NLOS conditions. Unlike the standard Kalman Filter, the AKF can dynamically adjust parameters or measurements, allowing it to adapt to varying noise characteristics caused by NLOS. Prior to applying the AKF, distance measurements between tags and anchors are conducted using the Two-Way Ranging (TWR) method, while the Received Signal Power (Rx Power, in dBm) is used as an adaptive parameter to enhance tag positioning accuracy using the Ultra-Wideband (UWB) module. The tag's position coordinates are used as ground truth values for implementing both the standard Kalman Filter and the Adaptive Kalman Filter. The tag's position status is obtained through simulation experiments. The AKF provides more accurate position estimation compared to the standard Kalman Filter, as shown by lower RMSE and MAE values: RMSE of AKF is ~0.28 m and MAE is ~0.25 m, while RMSE of KF is ~0.52 m and MAE is ~0.49 m. Furthermore, the AKF improves accuracy closer to ground truth after being applied to varying Rx Power values, reducing average error by approximately 46% compared to the standard Kalman Filter. These findings demonstrate that the implementation of the Adaptive Kalman Filter significantly enhances positioning accuracy in NLOS indoor localization scenarios.

Keywords: Indoor Localization, Non-Line of Sight (NLOS), Kalman Filter (KF), Adaptive Kalman Filter (AKF), Ultra-Wideband (UWB), Positioning Accuracy.