Collaborative Indoor Localization System based on Angle of Arrival and RSSI

Graduate

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Objective: Localization in indoor environments tends to be significantly more difficult compared to its outdoor counterpart, due to factors, such as multipath occurring due to complex geometries of different rooms. As an attempt to improve the position of a device, this thesis sheds a light on a Collaborative Indoor Positioning System (CIPS) based on Received Signal Strength Indicator (RSSI) and Angle of Arrival (AoA) technology which was enabled by the Bluetooth 5.1 Protocol. The goal is to improve the position estimation of a Test Node (TN) by combining these two measurement parameters.

Approach / Technology: In a first step, the two localization methods based on RSSI and AoA were investigated separately and test environments with defined Anchor Nodes (AN) and TNs, shown in Fig. 1, are set up. For the positioning with RSSI a simple propagation model is used in combination with a trilateration algorithm to find the position of the TN geometrically. Additionally, the AoA system is used to find the angles of specific TNs by measuring the phase difference of an impinging signal on the antenna array at the ANs. As shown in Fig. 2, the two subsystems are then combined in a rectangular test environment, to form a CIPS. The peculiarity of CIPS is that it attempts to improve the position of TNs that can only use RSSI using ranging information to hybrid TNs whose positions are estimated using additional AoA information.

Result: As shown in Fig. 3, the accuracy of the estimated positions using only RSSI can be significantly improved by using a CIPS, based on implemented weighting algorithms and selective optimizations. Values like the estimated distances between the nodes, the standard deviation of a set of measurements or a defined trust factor are indicators to form the weight factors, which are then used in the trilateration process, to improve the position of the nodes only capable of measuring RSSI.

Fig. 1: Used hardware for measurements: RSSI node (a), AoA node (b), antenna array (c).
Own presentment

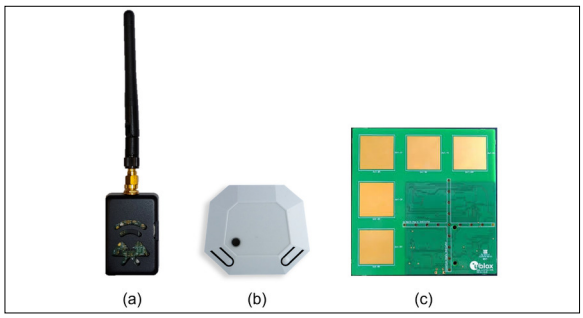


Fig. 2: The setup of the CIPS with the two used methods AoA and RSSI.
Own presentment

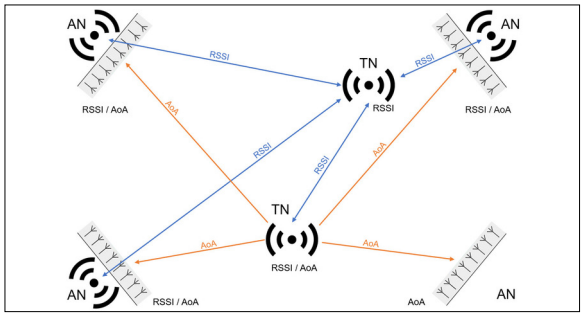
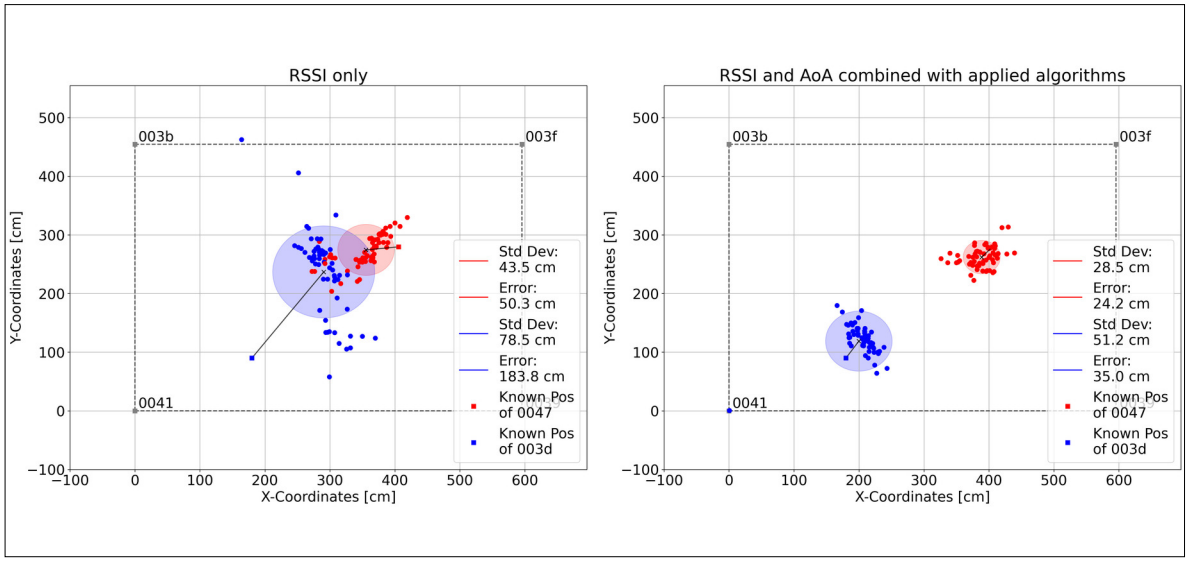


Fig. 3: Estimated positions based on RSSI only measurements (left), and combined RSSI and AoA measurements (right).
Own presentment



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