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Towards collaborative multi-agent positioning based on combined Wi-Fi RTT/ UWB/ IMU measurements

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The recent advances in Information Technology (IT) and Micro-Electromechanical Systems (MEMS) technologies and their global adoption in contemporary smartphone and PDA devices enables the introduction of novel approaches for indoor positioning applications that combine multi-sensor capabilities.

In this regard, Radio-frequency (RF), high accuracy ranging technologies operating in the Ultra-Wide Band (UWB) spectrum have recently been introduced in contemporary smartphone devices. Additionally, the adoption of Wi-Fi RTT technology in the most recent smartphone devices facilitates Peer-to-Infrastructure (P2I) medium level accuracy ranging in a widespread and seamless manner together with the standard web access functionality. Applications requiring absolute positioning of moderate to low accuracy may depend on Wi-Fi RTT-only systems, while high-accuracy UWB ranging would facilitate cases demanding safety-critical proximity reliant standards. Positioning architectures optimally utilizing these Two-Way Ranging (TWR) technologies may provide increased coverage and flexibility for indoor conditions in cases that a higher level of accuracy and availability is required.

This study aims at utilizing RF-based range measurements and to combine them optimally into a Pedestrian to Infrastructure (P2I), as well as, Pedestrian to Pedestrian (P2P) collaborative functional model aided by inertial measurements for indoor positioning. The implementation of the proposed approach utilizes simulation-based TWR data from four infrastructure nodes to four roving nodes, whereas operational elements for each technology, such as sampling rate, data formatting and communications scheduling are taken into account.

The distinct working scenarios examined in this study are as follows. Firstly, we examine separately the performance of the two technological approaches (i.e., Wi-Fi RTT and UWB) for P2I positioning scenarios. Secondly, we study the performance of the fuse the combined use of these technologies. For this purpose, we employ a scenario featuring a mixture of Wi-Fi RTT anchor and UWB static rover ranges. Finally, the potential (benefits and limitations) of the inclusion of IMU-based Azimuth information in the KF computation is evaluated for all scenarios. The results obtained from this investigation indicate a potential improvement in position accuracy of the order of 29% and 37% for Wi-Fi RTT/ UWB and Wi-Fi RTT/ UWB/ IMU solutions accordingly.