

**Enhancing Localization Scalability and Accuracy via Opportunistic Sensing**

**Abstract:**

Using a mobile phone for fine-grained indoor localization remains an open problem. Low-complexity approaches without infrastructure have not achieved accurate and reliable results due to various restrictions. Existing accurate solutions rely on dense anchor nodes for infrastructure and are therefore inconvenient and cumbersome. The problem of beacon signal blockage further reduces the effective coverage. In this paper, we investigate the problems associated with improving localization scalability and accuracy of a mobile phone via opportunistic anchor sensing, a new sensing paradigm which leverages opportunistically connected anchors. One key motivation is that the scalability of the infrastructure-based localization system can be improved by lifting the minimum requirement for anchor numbers or constellations in trilateration. At the same time, location accuracy under insufficient anchor coverage will be improved by exploring the opportunity of diverse data types rather than deploying more anchor nodes. To enable this highly scalable and accurate design, we leverage lowcoupling hybrid ranging using our low-cost anchor nodes with centimeter-level relative distance estimation. Activity patterns extracted in users’ smartphones are utilized for displacement compensation and direction estimation. The system also scales to finer location resolution when anchor access is improved. We introduce robust delay-constraint semidefinite programming in location estimation to realize optimized system scalability and resolution flexibility.We conduct extensive experiments in various scenarios. Compared with existing approaches, opportunistic sensing could improve the location accuracy and scalability, as well as robustness, under various anchor accessibilities.

**Existing System:**

Location information has infiltrated our everyday life in ways that we had not imagined before. The indoor location market will be more enormous than the

outdoor, since we spend more than 80% of our time indoors on our daily activities, e.g., working, shopping, eating, etc. Technologically speaking, outdoor localization techniques cannot be directly applied indoors. Satellites-based localization, i.e., GPS, has been one of the most important technological advances of the last half century. However, no matter how effective these systems are outdoors, their accuracy, coverage, and quality deteriorate significantly in small-scale indoor spaces. Over the past few years, a broad variety of location services has been targeted to revolutionize how people sense and interact with everyday objects and locations. For example, sensor networks help firefighters find the best route for search and rescue; GPS and WLAN systems provide coarse-grained way-finding and navigation services; RFID and short range communication devices provide proximity detection and awareness.

**Proposed System:**

We propose a highly accurate and scalable mobile phone localization system via opportunistic anchor access. This work narrows down to fine-grained localization techniques for future location-aware applications, for example, step-by-step indoor navigation for the blind, locating Virtual Reality (VR) headsets in gaming, and robotic indoor navigation, mapping, and autonomous driving. The key motivation of our design is originated from the problem associated with acoustic anchor-based solution with centimeter-level accuracy, i.e., the acoustic anchor can be easily blocked, and it is hard to access the minimum *three* anchors for trilateration in real environments. Deploying more anchor nodes is not economically practical. Furthermore, most finegrained solutions rely on high timing accuracy of entire anchor networks. Increasing the anchor number also increases the management burden of the timing accuracy. Leveraging multimodal opportunistic sensor data instead of deploying more nodes is a good step toward improving the efficiency and scalability. However, existing multi-modal solutions mainly focused on meter-level coarse-grained applications, for example, using motion data to improve the room-level or meterlevel WiFi localization accuracy. For fine-grained applications, such approaches are not well suited. One particular example is that combining meter-level results with centimeter-level results would downgrade the overall performance.