Abstract

Ahmed H. Salama

Investigation of the Benefits of Using Machine Learning Approaches in Wi-Fi Indoor Localization Systems

The rapid spreading of the smartphones market coupled with the advances in mobile computing technology which opened up fields of new services and applications. Some of these services require the knowledge of the exact location of their handsets. Therefore, the Global Navigation Satellite Systems (GNSS) is the best performed in the outdoor environment but it suffers from accuracy deterioration and outages in dense urban canyons and are almost unavailable for indoor environments. Nowadays, developing indoor positioning systems has become an attractive research topic due to the increasing demands on ubiquitous positioning. In this thesis, the wireless local area networks (WLAN)-based indoor positioning systems is focused on to act as Global Positioning System (GPS) counterpart indoors, where it has been studied for many years to provide indoor positioning services. The WiFi indoor localization systems based on machine learning approach are widely used in the literature. Fingerprinting approach has been widely used in indoor positioning based on WiFi technology. These systems attempt to find the perfect match between the user fingerprint and pre-defined set of grid points on the radio map. However, Fingerprints are duplicated from available Access Points (APs) and interference, which increase number of matched patterns with the user's fingerprint. In this research, the Principle Component Analysis (PCA) is utilized to improve the performance and to reduce the computation cost of the WiFi indoor localization systems based on machine learning approach. This could be done by utilizing the information contents of all the APs by transforming the Radio Signal Strength (RSS) fingerprints into its principle components (PCs). Furthermore, a graceful balance between positioning accuracy and system cost can be obtained by theoretically choosing a sufficient number of PCs. All proposed methods were developed and physically realized on Android-based smart phone using the IEEE 802.11 WLANs. The experimental setup was conducted in a real indoor environment in dynamic motion. The performance of the proposed method was tested using k-Nearest Neighbors, Decision Tree, Random Forest and Support Vector Machine classifiers. The results show that the performance of the proposed method outperforms other indoor localization reported in the literature.