A Thesis for the Degree of Ph.D. in Engineering

A Study on Co-Location of Mobile Users Using Ambient and iBeacon Radio Signals in Wireless Network

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Thesis Abstract

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Thesis Title

A Study on Co-Location of Mobile Users Using Ambient and iBeacon Radio Signals in Wireless Network

This dissertation provides a study on co-location system of mobile users. Co-location system combines methods of detecting nearby mobile users and providing them interesting and useful services or information within their respective groups. It has found several useful and real-world applications in proximity-based services. Aware of this new trend in our society and its impact in our daily life, we design two novel frameworks with the aiming at unleashing the potential of these proximity-based services.

We first devise a scheme that exploits the similarity of the environmental radio signals from multiple Wi-Fi access points when mobile users are in the same place, a room, for instance, to cluster them into the same group. The designed scheme is based on a nonparametric Bayesian method called infinite Gaussian mixture model that allows the model parameters to change with the observed input data. In addition, we apply a modified version of Gibbs sampling techniques with an average similarity threshold to better fit user's group. We evaluate the performance, in terms of clustering accuracy, of our proposal numerically and then experimentally. Through the experimental results we demonstrate the feasibility and the efficiency of this method. Results on experiment showed that it can even achieve a better accuracy when compared with the state-of-the-art community detection-based clustering method.

Then, we extend our first scheme to a new issue arising from the need to co-localize walking groups of people. That is, we give it now the ability of clustering groups of people even though their are walking together as part of the same group. This second devised framework is based on the analysis of the two key network properties, i.e., the edge betweenness and the shortest average path length among all pairs of mobile users in the wireless networks. It leverages Bluetooth low energy technology to achieve a high degree of co-location accuracy. From the collected radio signals, we construct a graph network in which the distance between pairwise vertices represents the connection strength between mobile users. Then, we apply a modified version of the edge betweenness techniques to cluster walking groups of mobile users into the same group. We assess our method with both computer-generated and experimental data sets. Through obtained results, we have shown that our method can be successfully applied to co-localize people walking as part of the same group in wireless networks.