ACCURATE INDOOR POSITION ESTIMATION TECHNIQUE USING FINGERPRINTING AND LATERATION-BASED APPROACH IN BLUETOOTH TECHNOLOGY

by

FAZLI SUBHAN

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BANDAR SRI ISKANDAR

PERAK

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ABSTRACT

With the rapid developments in wireless communication and mobile technologies, position estimation in outdoor environments has received considerable attention. Global Positioning System, GPS, is a well known outdoor position estimation technique which has been successfully implemented in various industrial and home applications. However, GPS is not suitable for indoor position estimation because GPS employs microwave signals, which are attenuated and scattered by roofs, walls and other objects present in indoor environments. This distortion of microwave signals significantly reduces the accuracy of GPS devices. Hence, there is a dire need to develop indoor position estimation techniques, which can enhance accuracy compared to GPS.

Indoor environments are totally different than outdoor environments due to the presence of obstacles, furniture, human bodies and other wireless communication devices, which may cause interference and sometimes experience disruptions due to disconnections. This disconnection occurs due to various factors such as noise, moving out of the coverage zone and device problems such as delays in the inquiry process, which also produces communication holes. The presence of communication holes has a negative effect on the accuracy of estimated position.

This thesis proposes a technique to estimate the position of an object in indoor environments in the presence of communication holes. The wireless technology which is considered for communication is Bluetooth. Currently, Bluetooth specifications do not provide a problem for indoor position estimation. However, the specifications provide two kinds of signal parameters which can be classified as connection-based and inquiry-based signal parameters. The connection-based parameters include Received Signal Strength Indicator (RSSI), Link Quality (LQ), and Transmitted Power (TPL). The inquiry-based signal parameter includes inquiry-based Received Signal Strength (RSS). The major contribution of this thesis can be divided into three

main parts. The first part consists of experimental analysis of Bluetooth signal parameters in order to select the best suitable parameter for position estimation.
This part also presents a comprehensive experimental analysis to observe the relationship between signal parameters and distance, so that the main source of distance estimation error can be identified. After selecting the best suitable parameter for position estimation, the next issue is to address the distance estimation error and identify its causes. This is handled in the second part of the thesis, which addresses the problem of communication holes. It presents an extended Gradient RSS predictor and filter, which is used to predict and filter RSS measurements in communication holes. The prediction and filtering process is based on the selected signal parameter based on our experimental observations. The refined output measurements are then given to the position estimation algorithm, which is handled in the third part of thesis. The third part of this thesis presents a new filter based hybrid position estimation technique, which integrates the features of fingerprinting and lateration approach. The novel approach used in the proposed hybrid approach is the use of Euclidian distance formula for distance estimation instead of propagation model. Simulation and experimental results validate the performance of proposed hybrid technique and improve the accuracy up to 53.64 % and 25.58 % compared to Lateration and fingerprinting approach, respectively. In summary, this thesis presents a complete framework for indoor position estimation using Bluetooth networks.