Navision Indoor Positioning System

Ahmed Wael, Ahmed Hossam, Mennallah Hatem
Supervised by Dr.Sameh Salem and Eng. Radwa Samy

4,October 2017

Abstract

There has been an upward trend in the requirement of indoor positioning systems as people spend a lot of time in indoor places, its a concern now for people and service providers to get exact indoor positioning information. Nowadays location predicated techniques are utilized in various fields such as traffic navigation, map accommodations, health-care ,manufacturing, and airports.There are many technologies to get indoor location information like Wifi,Bluetooth,Radio Frequency Identification,etc. Regardless the importance of IPS there is no a standard principle for IPS techniques.Thus,this proposed project will focus on improving the performance of indoor positioning systems by enhancing its accuracy and which can be integrated with many various fields that are mentioned above.

1 Introduction

1.1 background

The Bluetooth and Wi-Fi devices has become of extreme benefit when it comes to Indoor Positioning System (IPS). IPS may be used in malls, universities and hypermarkets maps, so it is commercially wanted[5]. Many people spend most of their time in indoor places, so service related indoor environment become increasingly important and global LBS market also grow [8]..most of the recent IPS systems have problem issues with accuracy. As GPS is used outdoor and gives high accuracy however its not suitable to be used indoor due to the strength of satellite signals is very poor.IPS generally needs two components, The hardware that produces signals and a device(user) which needs to know the location.As GPS can't be reliable due to low precision, IPSes used Bluetooth and WIFI.Many approaches are used in indoor localization such as Time of arrival (TOA) , Received signal strength(RSS),Angle of arrival (AOA) and fingerprint.In this project we will work on improving the accuracy of IPS that can be combined with many market applications that can provide a smooth user experience indoor and provide many services to the client to determine the

indoor location precisely and support their users with services making it easier for them to perform any required task in a matter of no time.

1.2 Motivation

The main goal of our system is to raise the accuracy of indoor positioning systems by using BLE beacons.Challenges that are taken into consideration along with the accuracy is minimizing the cost of such a system. Some of the implemented similar systems to our proposed project have faced challenges while implementing such as identifying the exact location, deflection of accuracy due to some obstacles.These obstacles are represented in walls inside the room and some human behaviour that influence the propagation path of the real signal of APs, which cause the received signal strength indicator(RSSI) increasing/decreasing instantly[13].

SURVEY

1.3 Problem Definitions

Enhancing the accuracy of Indoor localization that can be integrated with many market applications to offer several services to world-wide clients and users.

2 Project Description

Developing an indoor positioning system with the aid of external hardware and several algorithms to achieve best locating results and improve locating accuracy.

2.1 Objective

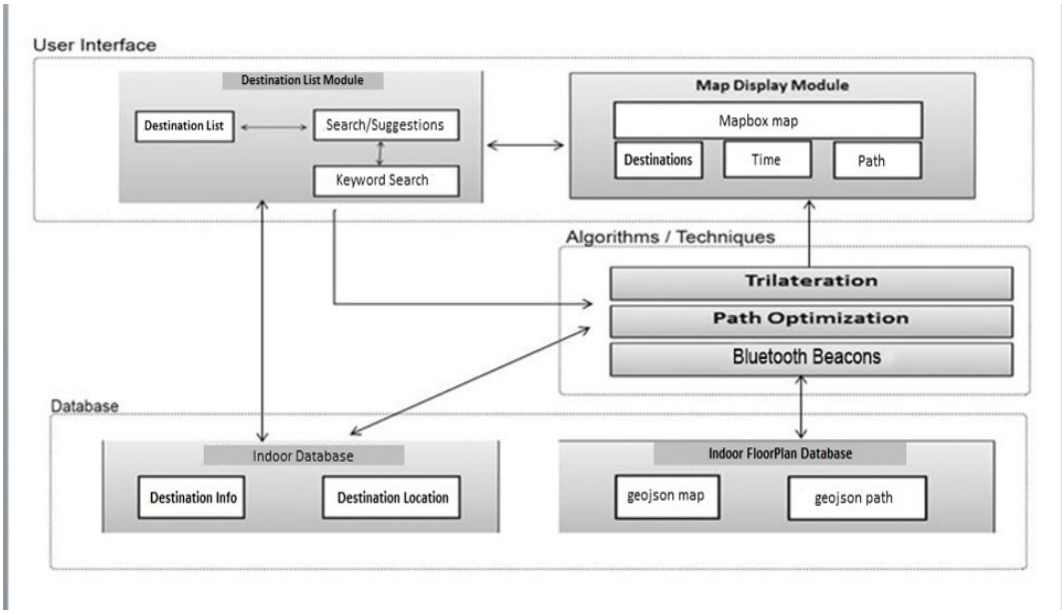
The aim is to reach the best accuracy results in IPS (Indoor positioning Systems). Indoor position system provides the positioning service to the indoor users, where the GPS coverage is not available. The challenges for most signal-based indoor positioning systems are the unpredictable signal propagation caused by the complex building interiors, and the dynamic of the environment caused by the peoples' movements. It faces noisy indoors the most which is crucial in such environment. Our main objective is to improve the accuracy of IPS facing the obstacles in intelligence way by using multiple techniques and algorithms.

2.2 scope

1. System will be able to scan for WIFI AP's and BLE Beacons.
2. System will be able to collect fingerprint RSSI values from both AP's and Beacons.

3. System will include Google maps to show the buildings in which beacons are set to be provided by IPS system.
4. The user will be able to draw the buildings floor-plan within the system.
5. User mark POI's in floor-plans.
6. System will show notifications based on the user certain location.
7. System will show configuration details of beacons AP's.
8. System can track people inside a certain building.
9. System will integrate between both WIFI and Bluetooth to achieve high accuracy.

2.3 project overview



The proposed system is an indoor positioning system.Our system consists of three components:
The user interface,algorithms, techniques, and database. The user interface consists of a destination list module and a map module which allows the user to input or search for his desired destinations and view the map respectively.The search results access the trilateration technique in order to locate the user indoor location then allow him to put his desired destination and this data is processed by path optimization algorithms in order to give a shortest path to the user from his indoor location to the destination. The database component contains destination information and Indoor floor plan modules. The saved info modules interact with the keyword search by gathering the destination information and

their respective location. The Indoor floor plan modules provide information to the path optimization algorithm to generate maps and locations of products.

3 Similar system information

WLAN Based Real Time Indoor Positioning: Literature Survey and Experimental Investigations[3]. The motivation of this paper is to reduce the cost of developing IPS. The paper shows that several technologies were developed for only indoor localization purposes. However, currently, they are not commonly used due to their cost and performance. So if a low-cost and relatively high-performance location determination technology is developed; it will have the potential to be used widely and it can become a popular way of localization. So compared to the other indoor positioning techniques, wireless systems are easier and cheaper taking into account that many buildings and structures have an existing WLAN infrastructure. The problem is achieving high accuracy and low coast are hard to be combined together. The researchers solved the problem by introducing wireless localization techniques. The main result they reached is combining wireless Localization Techniques, Localization Methods Using WLAN, Fingerprinting Approach, K-Nearest Neighbors, Bayesian Classification, RF Propagation Loss Models, Multilateration and The Kalman Filter. Reading this was important to me as it shows how to balance between accuracy and low coast while considering the complexity and robustness.

Indoor Positioning Based on Experimental Space Segmentation Method [6]. The motivation of this paper is developing an easy and simple approach without any additional hardware. The problem is reaching satisfying accuracy results. The researchers solved this problem by presenting a kind of segmentation method, named experimental space segmentation. The main results they reached that they proposed an experiment in real WLAN environment indicate that the proposed methods lead to improvement in the accuracy. This paper was useful because it is simple, easy to implement and doesn't require any hardware.

Design and Implementation of Indoor Postioning System Based on IBeacon[10] With increase in data and multimedia services, demand for locating has increased in complex indoor surroundings, which needs to determine the location information of the mobile terminal. The goal of this paper is to design and implement a mobile-based indoor location system.The lack of accuracy and the weak signals from I-Beacon devices in current indoor positioning system.They design and implements an indoor positioning system based on I-Beacon with the algorithm based on Euclidean geometry distance with combination of Gaussian function and unscented Kalman filter, these two are used to determine the maximum value at the RSSI, it can efficiently solve the problem of signal propagation, affected by interference.The results the researchers reach. Among these, the ratio between the drawings and the actual distance, the actual av-

erage error is 2.5 times then average measurement error. The average location error of the indoor location algorithm was only within 4 meters, the walls and barriers in the tracking surroundings might affect this result, the algorithm has strong real-time positioning and robustness.The combination of euclidean distance, Gaussian function and Kalman filter helped to lower the accuracy rate only within 4 meters. The System is dependable enough to locate the current location of the user and can overcome the constraints indoor positioning system environment the algorithm has strong real-time positioning and robustness.

A Mobile Indoor Positioning System Based on iBeacon Technology[11] The goal of this research is to implement a mobile-based indoor positioning system using mobile applications (APP) with the iBeacon solution based on the Bluetooth Low Energy (BLE) technology.The system is developed for the need for medical stuff to track the locations of their patients.the hospital emergency room overcrowding is common in countries around the world Because of the limitation of human resources and beds, patients will undoubtedly spend a lot of time waiting. While the patients are waiting, their locations are always not fixed as they might move around in the hospital, so the medical staff might spend much time to find them.An application is installed on the patients mobile device after they are registered. The application automatically recognizes in the background the BLE signal then these RSSI is utilized by the mobile application and selects the nearest beacon and uploads the beacon information on the system server. Furthermore, the patient's real-time location is estimated on the based on the detected Ibeacon signal and the beacon location mapping table stored on the server side. The medical staff, which are the monitoring side, can access patients' locations through web browsers or mobile devices. Thus the medical stuff can track the locations of their patients.The proposed system achieved 97.22 accuracy of the locations classification. The error prediction is estimated to the adjacent subarea within 5 meters that might be affected by the obstacles and walls in the tracking areas.This paper helped us to understand more about localization systems that uses Bluetooth low energy to enhance indoor positioning systems which is cost effective and easy-to-deploy solution.

Indoor Wi-Fi Positioning System for Android-based Smart phone[1] To propose a a personal indoor/outdoor WPS system on the smart phone using RSS(received signal strength) of signals from dense Wi-Fi access points dedicated for localization.The Wi-Fi signals provide a low precision for tracking the locations. Therefore in order to to acquire more accurate location of the target, Wi-Fi Aps dedicated for localization should be installed in the target area.RSS from each AP is measured three times and the mean value of three RSSs is calculated. We use the difference between the mean value and each training value. If the difference is below a threshold (T), the training value is withdrawn and then the mean of filtered training values is calculated again. Finally, the mean value is compared with the value of database and a proper location on the map is found.When displaying the smart phone at a certain cell, the color of cell is changed to white. The number indicated in the cell means the cell ID. Installed

APs dedicated for localization at specific locations can improve the positioning accuracy .New algorithms such as Kalman is used to filter errors and noise from signals .A proper scan time and threshold is required to yield a lower error rate.

Indoor Bluetooth Positioning using RSSI and Triangulation Methods[12] To analyze general wireless technologies and RSS based Bluetooth positioning using mathematical models to analysis the relation between the RSS and the distance between two Bluetooth devices.Developing low cost and easy-to-deploy location aware applications. These applications can be used in many scenarios such as assets management, staff tracking, indoor tourist guiding in museums, train stations and airports.Three distance based algorithms are used for Bluetooth positioning: Least square Estimation, Three-border and Centroid method.These algorithms were analyzed to improve the positioning accuracy. Result analyses show that the RSS based triangulation positioning yields very good results.This paper helped us to compare between the different indoor positioning systems techniques such as WIFI and Bluetooth and to compare between the three algorithms Least Square estimation,Three-border and centroid and compare their different results when tested.

This paper[7] studies the indoor positioning system by using wireless Ethernet IEEE 802.11 (Wi-Fi). The aim of this study is to examine several aspects of location fingerprinting based indoor positioning that affect positioning accuracy. The main problem of this paper is to discover the aspects of the location and the impacts of human behavior on RSSI distribution that could affect the positioning accuracy. In this system, the software operates in two separated location-fingerprinting phases; the first phase is calibration phase (offline phase) and positioning phase (online phase). In calibration phase, the software has the following functionality: 1) load and view map of the building; 2) view list of all available APs and their current RSS in the current position; 3) perform fingerprinting by tapping on the current position in the map. Functionality in the positioning phase: 1) load and view map of the building; 2) estimate position (inform of coordinates as well as a point on the loaded map). Then uses the weighted k-Nearest Neighbors algothrim to indicate nearest points by Calculate the Euclidean distance in the signal space, the estimated location q considered as average coordinates value of k nearest neighbors, which have minimum Euclidean distance. They applied a new algorithm to filter error signals and find the location of the smart phone. It acquires a proper scan time; the positioning accuracy achieved in the performed experiments is 2.0 to 2.5 meters. This paper is important because it is using the Wi-Fi signals which is easy to implement and requires low cost than other indoor positioning system.//

Beacon applications in information services[2]. The motivation of this paper; Beacon is regarded as an important development is that its micro-positioning function is more precise than GPS. The problem is, the acquisition of user location through the built-in GPS of the App is a common occurrence, but this positioning method puts the device's battery duration time on the line. When the user opens Google map to navigate, the user will notice the battery

drops fast. The researchers solved this problem with the emergence of Beacon technology; users can continue to navigate without consuming too much energy. The main results is Beacon indoor positioning technology, applied in physical stores in the past could only obtain purchase records after checking out rather than purchase records during the purchase process. This paper was important to us as it shows the importance of beacons in indoor positioning system.//

Indoor Positioning System Using Wi-Fi Bluetooth Low Energy Technology,[9] Exploiting the feature of Wi-Fi signal detection from android smartphones, they built an app for user positioning in indoor environment. For testing purposes, we use pre-installed Wi-Fi access points and Beacon devices based on Bluetooth Low Energy (BLE) technology for indoor positioning at the department by using the classical RSSI based trilateration algorithm. They have developed an Android app for indoor positioning, which is based on RSSI measurements of Wi-Fi access points pre-installed in the department. They intend to export the system to BLE based technology using Estimote beacon devices (or Eddystones) in the similar way, and perform a comparative study between Wi-Fi and BLE technology for indoor positioning. They found that by using Wi-Fi: the accuracy comes out to be around 77.59 percent for x-coordinate and 88.41 percent for y-coordinate, and by using BLE technology: they got two coordinates in different scans first result, accuracy was 96.61 percent for x-coordinate and 66.10 percent for y-coordinate and for second result, accuracy was 81.5 percent for x-coordinate and 80.5 percent for y-coordinate. After averaging, accuracy is 89.10 percent for x-coordinate and 73.3 percent for y-coordinate.//

Applying Kriging Interpolation for Wi-Fi Fingerprinting based Indoor Positioning Systems [4] This paper focuses on the Wi-Fi fingerprinting method, and reports an improved IPS by combining spatial interpolation, k-nearest neighbor (KNN) and naive Bayes classifier (NBC). To be specific, the proposed IPS improves the fingerprint database, based on the site survey, an interpolation operation is included to automatically generate a certain number of interpolation points and associated fingerprints.in the offline phase. In the online phase, given real-time RSS measurements between a target and a fixed number of Wi-Fi APs, the target location is estimated by using the fingerprint database, NBC and WKNN. Extensive experiments are carried out in our lab, and show that the proposed IPS with 28 observation points is able to achieve the average positioning error of 1.265m, which is less by 46.6 percent than the counterparts of the traditional IPS with 28 observation points and is even comparable to the traditional IPS with 112 observation points

3.1 Similar System Description

Over the last years, indoor localization and navigation is becoming a hot topic. With the increasing number of buildings, there are many indoor positioning systems nowadays and each of them have a different accuracy, we aim to develop and get better accuracy. As mentioned in [10] their main problem was the lack of accuracy and the weak signals from the I-Beacon, they implement their

system based on Euclidean geometry distance with combination of Gaussian function and unscented kalman filter, these algorithms determine the maximum value at the RSSI and solve the problem of the weak signals. This research will assist us in our proposed system to get clear and strong signals and ends the problem of signal propagation. Android Application for Wi-Fi based Indoor Position: System Design and Performance Analysis[7] is also an research studies the indoor positioning system but depend on Wireless Ethernet IEEE 802.11 (Wi-Fi) standard, their problem was to discover the aspects of the location and the impacts of human behavior on RSSI distribution that could affect the positioning accuracy, they divided the tested area by 20 cells with some Aps were installed. They uses location-fingerprinting phases; the first phase is calibration phase (offline phase) and positioning phase (online phase). In addition, the weighted k-Nearest Neighbors algothrim to indicate nearest points. They found that when increasing the number of AP expected accuracy rate increase remarkably. Applying Kriging Interpolation for Wi-Fi Fingerprinting based Indoor Positioning Systems[4], this paper, improves the Wi-Fi fingerprinting based IPS by efficiently combining the universal Kriging (UK) interpolation method, K nearest neighbor (KNN) and naïve Bayes classifier (NBC). Specially, the proposed IPS takes into account the comprehensive features of received signal strengths (RSSs) by adopting the UK method and area partitioning, the average positioning error of 1.265m

3.2 Comparison with proposed project

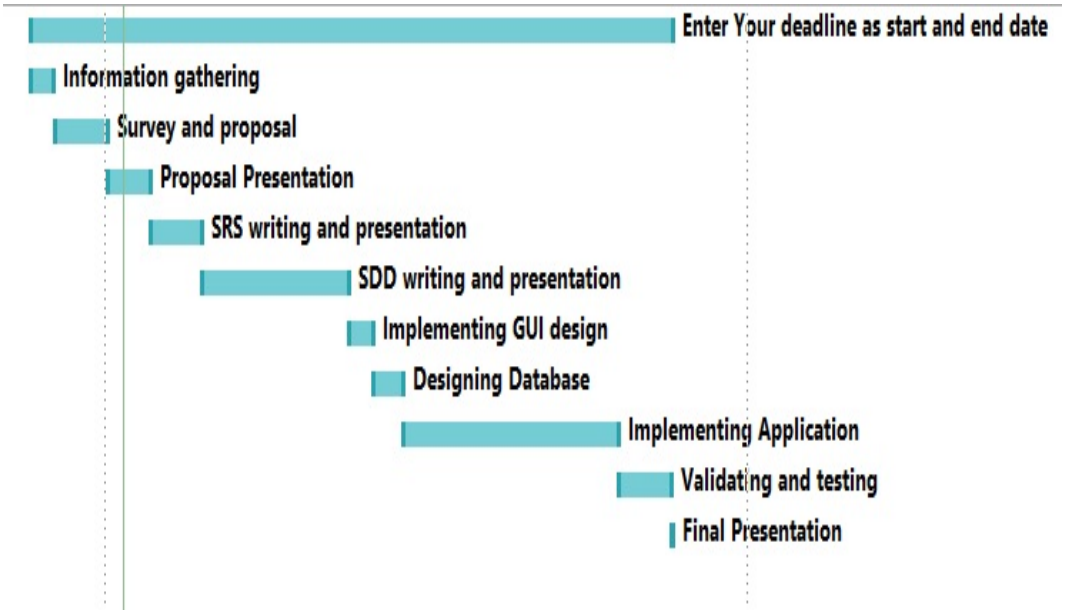
Point of comparison	Algorithm used	Device used	Accuracy achieved	Average location error	Test points
DESIGN AND IMPLEMENTATION OF INDOOR POSITIONING SYSTEM BASED ON IBEACON	Euclidean geometry distance, and combined with Gaussian function and Unscented Kalman filter.	Bluetooth Low Energy technology based on the I-Beacon	Not mentioned	Within 1- 4 meters	15 different test points
Android Application for Wi-Fi based Indoor Position: System Design and Performance Analysis	K-NN and Euclidean geometry Distance	Wireless Ethernet IEEE 802.11 (Wi-Fi) standard	Not mentioned	2.0 to 2.5 meters.	The area is divided by 20 cells With some APs were installed
Proposed Project	Euclidean geometry distance, Gaussian function, Unscented Kalman filter.	Bluetooth Low Energy technology based on the I-Beacon	-	-	-

4 Project Management And Deliverable

4.1 Tasks and Time Plan

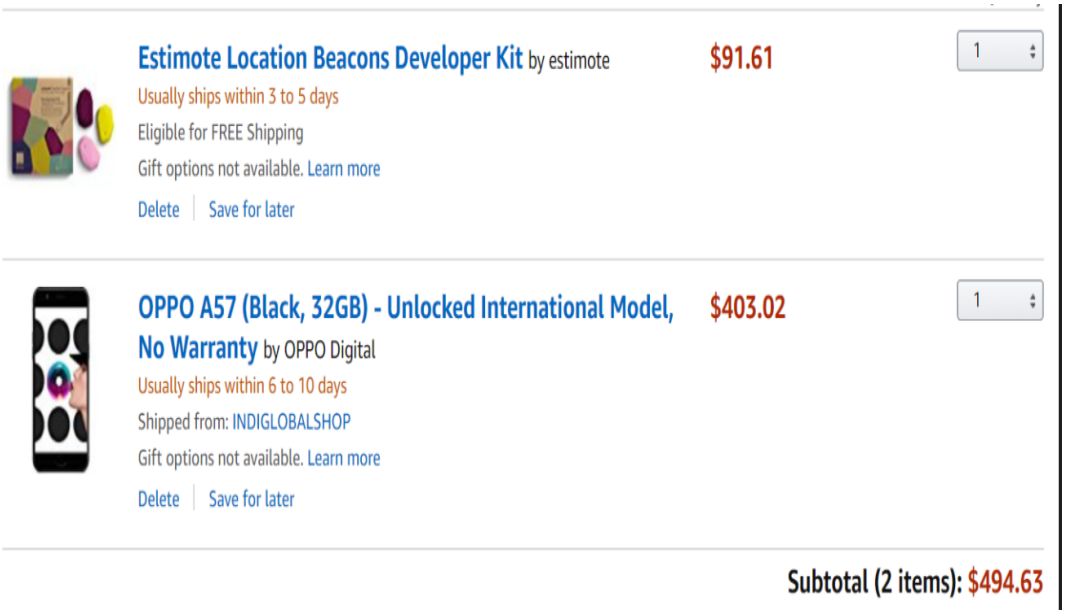
	Enter Your deadline as start and end date	20/08/17	26/06/18
	Information gathering	20/08/17	30/08/17
	Survey and proposal	01/09/17	25/09/17
	Proposal Presentation	26/09/17	16/10/17
	SRS writing and presentation	17/10/17	10/11/17
	SDD writing and presentation	11/11/17	20/01/18
	Implementing GUI design	21/01/18	01/02/18
	Designing Database	02/02/18	15/02/18
	Implementing Application	16/02/18	31/05/18
	Validating and testing	01/06/18	25/06/18
	Final Presentation	26/06/18	26/06/18

Time plan Table.



Gantt Chart.

4.2 Budget and Resource Costs



References

[1] Sun-Ho Choi Joo-Yeon Kim Woo Jin Lee Beom-Ju Shin Kwang-Won Lee and Hyung Seok Kim. "Indoor Wi-Fi Positioning System for Android-based Smart phone". In: (2010).

[2] Chia-Sui Wang Ding-Yu Liu and Kuei-Shu Hsu. "Beacon applications in information services". In: *IEEE* (2016).

[3] Tansel Ozyer Bulent Tavlib Gokhan Kula. "IEEE 802.11 WLAN Based Real Time Indoor Positioning: Literature Survey and Experimental Investigations". In: *IEEE* (2014).

[4] Bing Jia Hailong Zhao Baoqi Huang. "Applying Kriging Interpolation for WiFi Fingerprinting based Indoor Positioning Systems". In: *IEEE* (2016).

[5] Chunyan Liu Jian Wang Andong Hu and Xin Li. "A Floor-Map-Aided WiFi/Pseudo-Odometry Integration Algorithm for an Indoor Positioning System Körper. (China) [On IBEACONS and indoor positoning systems]". In: *ISSN* (2015).

[6] Nikola Stojkovic Mirjana Simic. "Indoor Positioning Based on Experimental Space Segmentation Method". In: *IEEE* (2014).

[7] Dinh-Thuan Do Phan Van Hieu Dao Tang Loc Nguyen Trong Thuong Hoac Thieu Phong. "Android Application for WiFi based Indoor Position: System Design and Performance Analysis". In: (2016).

[8] ALSHIHRI SAAD JuHo Kim SungIl Kim SunHwa Ha. “Indoor Positioning System Techniques and Security Körper. (Seoul, Korea) [On IPS and security]”. In: (2015).

[9] Mohammed Abdul Qadeer Vibhu Varshney Rajat Kant Goel. “Indoor Positioning System Using Wi-Fi Bluetooth Low Energy Technology”. In: *IEEE* (2016).

[10] Xuzhi Wang Rizwan Muhammad Xiangjie Li Dan Xu. “DESIGN AND IMPLEMENTATION OF INDOOR POSITIONING SYSTEM BASED ON IBEACON Körper. (China) [On IBEACONS and indoor positoning systems]”. In: *IEEE* (2016).

[11] Cheng-Chung Fang4 Zui-Shen Yen4 Bey-Jing Yang4 Feipei Lai123 Xin-Yu Lin1 Te-Wei Ho1. “A Mobile Indoor Positioning System Based on iBeacon Technology”. In: (2015).

[12] Yutian Zhao Yue Liu Laurie Cuthbert Yapeng Wang Xu Yang. “Bluetooth Positioning using RSSI and Triangulation Methods”. In: (2013).

[13] Yutian Zhao. “Bluetooth Positioning using RSSI and Triangulation Methods Körper. (GBeijing, China) [On IPS]”. In: *IEEE* (2013).