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Shopping Mall Directory: A Detailed-Guide Application for Android-Based Mobile Devices

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ABSTRACT

The purpose of this paper is to describe the development of mobile application for shopping mall directory. The Location Based Wi-Fi (Wireless Fidelity) Mall Indoor Directory (LBWMID) aims to provide information for consumers to enhance their experience in the shopping mall. The features that were included in this proposed work are Wi-Fi based indoor Positioning System to locate consumer's current location, directions from current location to another location, shops' information and map module. Current location of consumers could be located using two or more access points that are in the range. Strongest signal will be compared to get accurate readings of the current location. Directions are provided from the current location using a search function to enable consumers to search for shops they wish to visit. A simple directions statement will be provided to guide consumers. Shops information such as shop names, categories, locations, descriptions and floor layout are also provided in this mobile application. Floor layouts are provided with multi-touch and scalable functions that enable consumers to get the accurate readings of the map. Our main contribution here is providing technical details which may be used as a guide for students, developers, and researchers. As a second contribution, we have explained the current solutions for the indoor navigation problems.

Keywords: *Indoor navigator, mall directory, android shopping application*

1. INTRODUCTION

Wi-Fi access point fingerprinting is desirable because it does not necessitate the installation of additional transmitters; it makes use of existing Wi-Fi access points [1]. Our proposed LBWMID mobile application is a location-based Wi-Fi mall indoor directory that helps the consumers to know their current locations in huge shopping mall buildings. By using this application on their mobile devices, they can identify their current location in a shopping mall, what are the shops near to them; they can get directions to another location(s) in the building and viewing the floor layouts of the shopping mall as well [2]. This mobile application is a Wi-Fi location-for indoor positioning systems.

In this paper, we are dealing with the problem of indoor navigation. Estimating consumer's location can be done in several different ways, because Global Positioning System (GPS) is not always available particularly for the indoor environment where the satellite coverage is veiled [3] [4]. Besides, mall navigation directories are difficult to find inside malls. Currently many shopping malls do have their own mobile application directories that support only the indoor layout building, but it is not a location-based system which means they do not provide the service for defining the current locations, other mobile application directories also couldn't provide the directions from the consumer's current location to another location.

To overcome the above mentioned problems, our proposed work uses the shopping mall's particular pattern of Wi-Fi access point's fingerprint. In order for LBWMID to provide accurate estimates of position, a few calibration scans must be completed in known spots. These calibration scans are the references that LBWMID uses to position Wi-Fi capable devices accurately in a particular environment. It simply matches locations (i.e., floor level, shops) with the Wi-Fi fingerprint of a particular location. Therefore, there is no need to know the location of the Wi-Fi access points. A Wi-Fi fingerprint is the pattern of signal strengths of a collection of Wi-Fi access points visible in a particular area. This signal strength pattern tends to vary from place to place, that is how LBWMID can attach different XML layouts to different locations even when they are covered by the same group of Wi-Fi access points.

There are a big variety of solutions of the indoor positioning systems on the market so far. With increasing demand of location-based services, more solutions of positioning will be realized. This paper describes in technical details the problem of indoor-navigation and explains the available techniques in the market nowadays.

Because abilities of devices differ significantly, one positioning method is useful for one, but useless on other devices. Thus, there are many techniques of indoor locating solutions that are presented on section 2 in this paper, while section 3 is discussing the developing process

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of our application. The application overview and the conclusion on section 4. In section 5, future work is presented.

2. LITERATURE REVIEW

The proliferation of mobile devices and the growing demand for location aware systems that filter information based on current device location have led to an increase in research and product development in this field [5]. In this section, we are highlighted the related techniques and products in which their main features, strength, and limitations are discussed.

A. Navigation Radio Technologies

1. Satellite global coverage

It is been using on a Global Positioning System (GPS) providing a combination of territory-spatial positioning and navigation system that requires line of sight (LOS) in order to be functioning. Presently there are several global navigation satellite systems dedicated to civil positioning including the US NAVSTAR Global Positioning System, the Russian GLONASS, and the European Union's Galileo [6]. The usefulness of satellite systems is that receivers can estimate latitude, longitude, and altitude to a high degree of accuracy. Due to the GPS characteristic of LOS, it is inoperable for the indoor environments where the LOS is invisible by ceilings and roofs.

2. Cellular Networks

A Cellular Communication Network is a system that allows mobile phones within a particular cellular range to wirelessly communicate with each other through large cell towers [7][8]. This type of communication is based on the capability of the network to determine the position of a cell phone by identifying the cell tower that the device is connected at a given time. The advantage of this technique is its ubiquitous distribution, easy implementation and the fact that all mobile cell phones support it. On the other side accuracy of this technique is very low due to the fact that cell towers can support ranges of 35 kilometers or more. In urban environments cell towers are distributed more densely.

3.Wi-Fi

Wi-Fi stands for Wireless Fidelity that complies with the IEEE 802.11 standard. Nowadays, wireless connectivity is more prevalent than ever in our everyday lives [9] [1]. Each wireless Access point (AP) broadcasts a signal that can be heard by all devices within its range. Wireless devices have the capability to measure the strength of this signal. This strength is converted to a number, known as Received Signal Strength Indicator (RSSI).

4. Bluetooth

Bluetooth is a wireless communication that complies with IEEE 802.15 standard, similar to Wi-Fi except it is over short distances [10]. The devices can send a maximum of 3Mb/s. Implementation can be highly expensive.

5. Infrared

Infrared (IR) is a wireless networking specialized for the indoor positioning for limited range [5]. IR has several technical limitations such as requires line of sight, the receiver affectivity by sunlight of a window room, in addition to its pricey installation and maintenance.

6. Ultra Wide Band

Ultra Wide Band (UWB) has been pioneered for the use of a very low energy level for short range and high bandwidth communications using a large portion of the radio frequencies [11]. The natural strength of the UWB lies in its use of highly wide transmission bandwidths, which results in preferable capabilities which include accurate position location and ranging, lack of distinguished fading, high multiple accessibility, and easier material penetration[12].

Table 1: Shows the General Comparison of Popular Kinds of Signals Based on the Usage of Indoor And/Or Outdoor Positioning Systems.

Radio Signal	Characteristics	
	Indoor	Outdoor
Satellite global coverage	• Inapplicable for indoors.	• High availability and accuracy.
Cellular Networks	• Available but inaccurate.	• Available but inaccurate.
Wi-Fi	• Readily exist throughout most buildings. • Cheap to implement and maintenance.	• Very short network range for outdoors.
Bluetooth	• Very cheap to implement. • Limited range.	• Cannot be covered.
Infrared	• Very short range • Expensive. • Can be affected by sunlight streams.	• Impossible to implement.
UWB	• Accurate positioning information • Very expensive to implement so not commonly used.	• Accurate positioning information • Very expensive to implement.

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B. Positioning Techniques

Different techniques of signal based metrics are being in use for localization (device position determination). [13] [14] and have categorized the localization methods generally into five main methods:

1) With Cell Identification (Cell-ID), in this method, transmitters or access points are partitioning a particular area into cells within these cells, the receiver can be detected and positioned based on cell ID. However, this method is inaccurate, because it is hardly to determine where in the cell the receiver is located.

2) The Angle Of Arrival (AOA), it determines the position of the device by calculating the angle towards the receiver from the transmitter using a directional antenna [14] [15]. This method requires a line of sight to spot the receiver, which is unreasonable to be implemented on indoor environments.

3) Time Of Arrival (TOA), it determines the position of a device by calculating the distance from the transmitter to the receiver using the following formula: D = time x speed, where speed is a constant [15]. However, this method requires synchronization between the two imitated devices for a better accuracy.

4) Time Difference Of Arrival (TDOA) requires synchronization of the receivers [13]. This method based on trilateration technique meaning it determines the receiver's position based on calculating the intersection of the radii of the transmitters [15].

5) Finally, the Received Signal Strength (RSS), also known as fingerprinting, where a radio map is being created. It composes of two phases, the offline (training) and online (tracking) phase. The offline phase of fingerprinting is determining the signal characteristics at a given point and storing it in a database, following up the online phase by picking up the signal characteristics and compares it with the database to examine the place. Ordinarily, a filter is needed from the reflections, distortion and absorbance of the signals to increase the positional accuracy [13] [14].

C. Related Systems

This section includes the review of some of the existed mobile-directory systems for indoor environment within Malaysia, which can be obtained at the play store of any mobile device. We have chosen the most four popular systems.

1Utama Mobile Application

The 1 Utama is a mobile application for One Utama Shopping Centre located in Bandar Utama City Centre in Selangor [16]. This mobile application has the following functions: the directory link function is to locate the address or the location of the shops. There is no search function therefore consumers have to search for the shops one by one on the given list. The Where Am I link function is to locate the consumer's current location. The floor plans will pop-up once you have selected the Floor Plan link.

Setia City Mall Mobile Application

The Setia City Mall Mobile Application is developed for Setia City Mall Centre located in Bandar Setia Alam, Shah Alam, Selangor (http://www.convep.com/malls.html). The Directory link function is to locate the address and location for the shops. The shops are divided into categories automatically. Consumers can use the search function on top of the screen to fasten the search process. The Layout link function is use to show the entire floor plans of the shopping mall. Other than these two main functions, there are other interactive links such as Favorites, Events, Promotions, E-Coupons, Concierge, Getting Here and Feedback.

MyMall Pavillion Application

Convep is the company who developed this mobile application in 2010. MyMall Pavillion is located on Jalan Bukit Bintang in Kuala Lumpur. The mobile applications have the following functions which are Inbox, Directory, Floor Plan, Event, Promotion, E-Coupon, Mall- Info, Find – Mall and Feedback. The Directory link function is to locate the address and location for the shops. The shops were divided into categories automatically. Consumers can use the search function on top of the screen to fasten the search process. The Layout link function is use to show the entire floor plans of the shopping mall.

Mobile SACC Mall Indoor Directory and Map

Mobile SACC Mall Indoor Directory and Map is a standalone mobile application. The main application interface includes the floor plan of the building, list of shops and a search function to search for the shops in the shopping mall.

3. PROPOSED WORK

In this section, we discuss the technical details of our proposed solution. This description aims to help students, researchers, and Android developers to understand in deep the developing steps of our proposed product. In the following, in the first sub section, we have explained our design steps which include the System Requirement

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Specification (SRS), use case diagram, Activity diagram, and flowchart of user interface. In the second subsection, we have presented some screen shots of our product during its run time.

A. Design Phase

In table II, we concluded and presented the System Requirement Specification. These SRS have been collected from the same products that are available in the market. In the collection process for the SRS we have chosen more than one product and collected these SRS from them. These 14 SRS represent the standard functions that any location based Wi-Fi Mall Indoor directory should have.

Table 2: System Requirement Specification

No	Requirement	Use Case
1	To locate user's current location	Current Location
2	To display user's current location information	Display Current Location
3	To display error when couldn't locate location	Error Displaying Locations
4	To provide a search function for user to search for direction to another location	Search Direction
5	To display user's desired location direction	Display Direction
6	To provide user the floor plans of the building	Floor Layout
7	To provide the list of floor layout for user to select	Select Floor
8	To display the selected floor layout by the user	Display Floor Layout
9	To provide user all the stores information in the building	Store List
10	To provide the list of store categories for user to select	Select Category
11	To display the list of stores under the selected	Select Store
12	To display the selected store information	Display Store Information
13	To display the first interface of the application	Home
14	To end application	Exit

A use case diagram is to capture the requirements of the system by means of communicating with users and other stakeholders what the system is intended to do. Figure 1 shows the use case diagram of our proposed mobile application. There are 14 use cases all of them work together to satisfy the SRS.

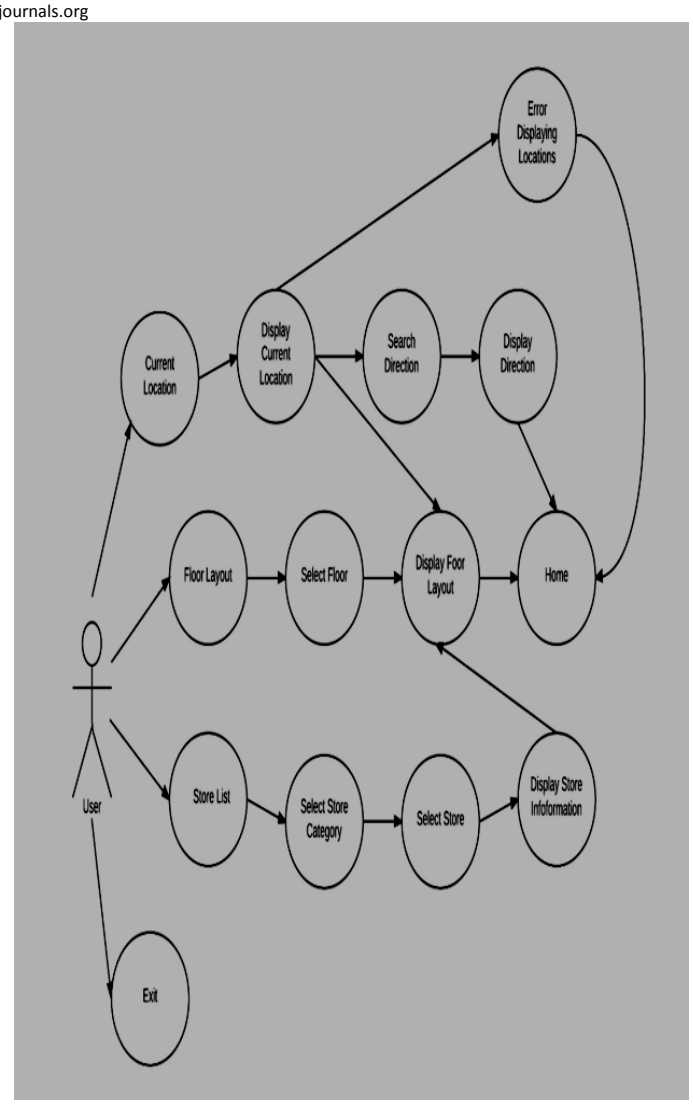

Figure 1: Use Case Diagram

Activity diagram is used to display the sequence of activities. It shows the workflow from a start point to the finish point detailing the many decision paths that exist in the progression of events contained in the activity. Figure 2 shows the activity diagram of our proposed mobile application. Figure 3 shows flowchart for our proposed application's user interface.

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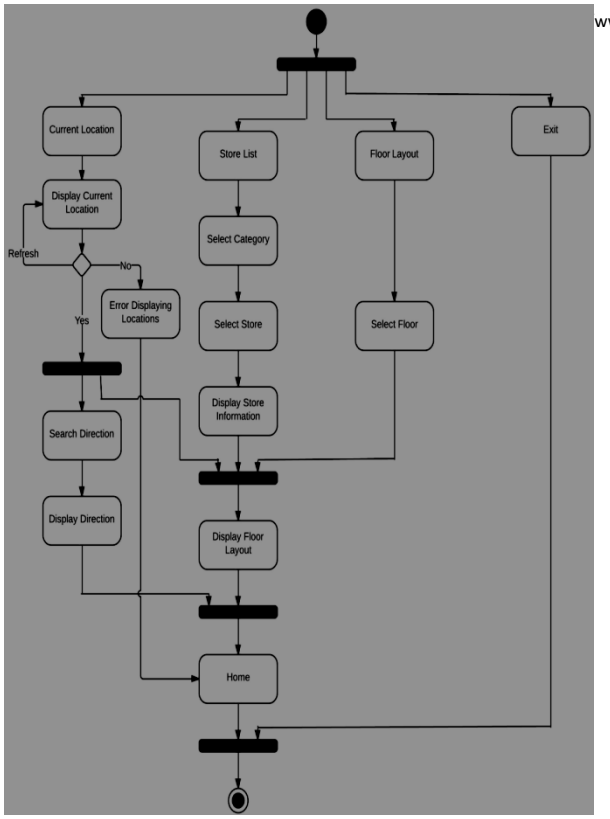

Figure 2: Activity Diagram

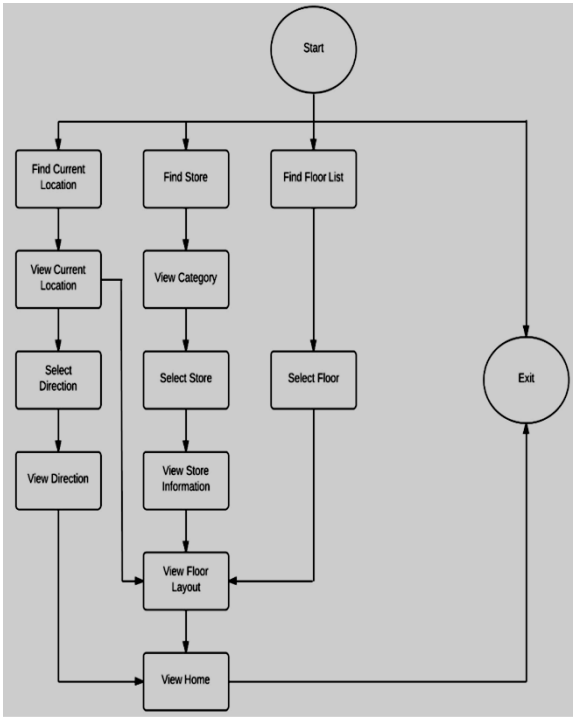

Figure 3: Flow Chart for User Interface Design

Screen Shots for our mobile application

In this subsection, we presented some of our product's screen during the runtime. The aim of this subsection is to provide a real implementation view of our mobile application which may help to compare our product with the similar products and show our contribution.

Figure 4: Screen shot for main application functions

Figure 4 shows the application main user interface which consist of three main functions as following, the "store list", is to view all the available shops of a particular mall in a categorized manner. While, "where am I" is to tell the exact location of the user, and from the current location interface, the user has a further option to navigate to a next destination as illustrated in figures 5 and 6. When the destination is set, the system will show the user the directions to the next point as a text message as depicted in figure 7.

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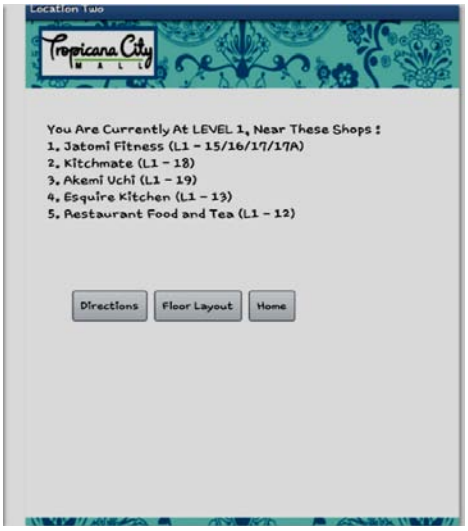

Figure 5: User current location

Figure 6: Search for a place text box

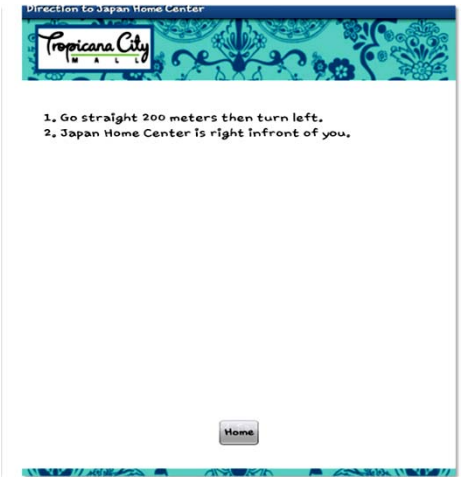

Figure 7: Navigation directions

4. CONCLUSION

As the saying goes, "Time is gold". The Location-based Wi-Fi Mall Indoor Directory: Mobile Application will assist consumers once they step into the mall. Instead of having to waste their time and energy navigating through the mall, with this sophisticated but user-friendly mobile application, it will help enhance their experience in the shopping mall.

Moreover, this mobile application provides consumers their current locations, directions, floor plans and shops information. Consumers will also get detailed direction statement from their location to where they choose to go with this mobile application's search functionality. Table III summarizes our contribution with compare to the other similar products. Our LBWMID is the only application that satisfies the five main functions, i.e., store details, search by name categories, floor plans, directions, and current location.

Table 3: System Summarization

Mobile Applications	Store Details	Search by Name / Categories	Floor Plans	Directions	Current Location
1 Utama	Yes	No	Yes	No	No
Setia City Mall	Yes	Yes	Yes	No	No
Pavillion	Yes	Yes	Yes	No	No
Mobile SACC Mall	Yes	Yes	Yes	No	No
LBWMID	Yes	Yes	Yes	Yes	Yes

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5. FUTURE WORKS

This work can be further enhanced and developed for providing a higher service quality to the user through several suggestions. Firstly, by applying triangulation techniques on the Wi-Fi Positioning System for the user's current location method to get more accurate readings of the surrounding locations. And adding an interactive map with voice based turn-by-turn navigation system or animated map navigation system for a more friendly use will give an advantage. Finally, have a favorite list to store and edit shops information, locations, directions and access points (BSSID) for future use.

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