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A SYSTEM FOR FINE-GRAINED ZONE-BASED POSITIONING USING BLUETOOTH (FGZPUB)

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ABSTRACT

Systems of location have had a growing trend of becoming one of the most important applications used in computing. This paper presents a mobile application, which shows the location of a user and demonstrates how location can be accurately identified. We have used Bluetooth technology with helpful of algorithms for fine-grained zone-based positioning using multiple Bluetooth sensors and implementing of positioning system using JavaME.

1.0 INTRODUCTION

In recent years, location systems have become one of the most promising areas in mobile computing. The speedy development in communications technology has been strong, as well as the emergence of some features which are contributing to the development of location systems. However, some of the new technology has not yet been implemented. According to Bhagwat (2002) one of the location systems favors using Bluetooth technology because it uses short-range frequencies.

Location systems consist of a number of sensors deployed in an area. The location systems are able to identify the current location within the coverage area by comparing the signal received with a database. According to Ahuja et al. (2007) it links to the signals sent from transmitters with a specific location. The location of the user, as well as the device, is extremely useful for a number of applications. Moreover, as we know that Bluetooth uses a short-range radio signal, and in order to locate the user, many communication services are needed in his/her vicinity. These communication services are referred to as “call zones”.

King (2009) state that Bluetooth is composed of 79 slots, and a subset of 32 is used to determine the location of device. Two different rates of movement make sure that two devices find each other fairly quickly. In total, the connection needs to be completed in less than 10.24 seconds, and during this time any information connection is made possible.

Global Positioning System (GPS) is a technology designed to display information in any position Chakraborty et al. (2014). GPS sends the radio signals in order to detect locations, which uses radio signals to electromagnetic signals allows the user to define the location by using a triangulation method. However, the GPS must be directly related to the satellite, making it almost useless at home and in dense urban areas. To obtain good results in an indoor environment, Kelly et al. (2018). there should be many sensors. According to Mir et al. (2017) Bluetooth devices can communicate with the network via an access point. Therefore, Bluetooth stations are able to exchange location information with each other. Moreover, if one of the Bluetooth devices is equipped with another location, it will be able to exchange information with these other devices in the piconet. According to lee et al. (2017) the position of the user should be updated when the user moves from one point to another. In order to achieve the best connectivity, the master in the piconet should be allowed to choose the best channel of mobile nodes that provide the highest possible bandwidth. There are two types of mobile nodes, the master and slave. If the mobile nodes are masters, they can control several piconets and limit the bandwidth accordingly. If there is no synchronization between mobile devices, this will

make the implementation of the processes of transformation and the sharing of channels difficult.

According to Kansal et al. (2012) Each access point has a security method called pairing, which allows access to authorized users only, and it allows the piconet a degree of protection. This is achieved with an encryption key, known as "PIN". The access point sends a pairing request to the master device. To do this, the access point in the zone covered sends an association request from the master device. Most of the time, this makes the user enter the PIN in the access point. If the PIN received from the user is true, then connection is allowed.

In recent years, much research has been carried out to establish positioning systems This paper has created a base for further development in these systems. Of these systems, the most popular is the positioning system. According to Hallberg et al. (2013) the Global position system (GPS) has the characteristic of determining one's location in the outside environment, but this is not the best solution in indoor environments. There are many technologies that have contributed to the development of systems to locate the user in the indoor environment, for example Bluetooth technology became a solution to these systems.

There are many systems that have been implemented in the past. However, some of these systems are based on operation in outdoor environments, in the long term and include communications, satellite, cellular, and sensing systems. On the other hand, the advantage of other systems that based on the work in indoor environments to include a shorter range, and wireless networking and Bluetooth. In this paper will be discussing in these systems, in addition, this system will be working under the indoor environments in identifying positions.

The remainder of the paper focuses on a system for fine-grained zone-based positioning using Bluetooth. Section 1 introduces a running example and a more detailed overview of the position system and explores the background of (FGZPUB) System. Section 2 focuses on the related work are presented while. Section 3 describes the Concept and Architecture of (FGZPUB) System. Section 4 shows the prototype implementation and Evaluation of (FGZPUB) System. In Section 5, shows the overview of (FGZPUB) System. Section 6 detailed evaluation of a real-world case study. Finally, Section 7 provides the conclusions and identifies directions of future work.

1.1 Aims and contributions of the research

This research aims to investigate fine-grained zone-based positioning using Bluetooth technology and investigate the minimum size of zones that can be achieved by Bluetooth overlapping, and will clarify the shape of Bluetooth zones, and the speed at which a user can be positioned within a zone. It will also develop algorithms for fine-grained zone-based positioning using multiple Bluetooth sensors.

The contributions of this research are as follows:

It highlights the minimum size of the zone that can be achieved by using a stationary reference Bluetooth device to create overlaps.
The developed application will play a key role in Bluetooth technology by Highlighting the shape and extent of Bluetooth zones.

1.2 System components

Below is the list of equipment used in this research for this prototype.

- One Mobile phone which has a Bluetooth module.
- Four laptops, each equipped with Bluetooth Protocol Stack

1.3 Background

In today's world, location-based services have become more important because of their many applications in this area. Anacleto et al. (2014) there used to provide location information for the user, for example, an advertisement in a shopping centre to identify the user's location Mobile location servers assist users to determine where they are within the shopping center. Kelly et al. (2018) there are many technologies to support positioning systems such as GMS, GPS, and Bluetooth that are available today as a result, these applications have developed their own location system. According to McDermott-Wells (2015) Bluetooth is a wireless network technology that has been invented as an alternative to cable systems used to connect devices. Since 1999, expansion of this technique to communicate between electronic devices such as (printers, faxes, speakers, etc) has been ever increasing.
The next table will show briefly the characteristics of Bluetooth that enable it by using low-cost transceiver microchips to provide a relatively cheap and short range method of communication. These vary in power consumption and physical range and are organized by three classes as shown in table 1.

Table. 1. Key features in Bluetooth design.

Class	Maximum Permitted Power mW (dBm)	Range (approximate)
Class 1	100 mW (20 dBm)	100 meters
Class 2	2.5 mW (4 dBm)	10 meters
Class 3	1 mW (0 dBm)	1 meter

The Application group consists of actual applications that use Bluetooth's links. Bluetooth devices that perform a search to discover any device or other contact with them is called "an inquiry procedure". According to Bargh et al. (2018) There are two types of inquiries in Bluetooth. These are limited and general. The general inquiry is used for

discovering all Bluetooth devices in its range, while the limited inquiry is used for discovering all Bluetooth devices around it. This discovery has to be achieved within a limited time. Devices that are discovered within the range of 10 meters are to respond to a query device. The user can select the device that he/she can connect to from a list of devices which have been discovered. According to the Bluetooth specification. Bhagwat (2012) "the inquiry substrate may have to last for 10.24 seconds unless the inquirer collects enough responses and determines to abort the inquiry substrate earlier".

According to Synnes et al. (2012) Bluetooth standard has been based upon a master and slave operational mode. The piconet is used to refer to the network formed by one device or all devices that are discovered within its range. More than 10 piconets can be coexisting within a single coverage area. A master can, at the same time, connect to as many as 7 active slave devices. The logical address of 3 bits, consisting of 0s and 1s, can be used by a piconet, for a maximum of up to 8 devices. According to Bandara et al. (2014) The connection time for Bluetooth technology is split into slots of time which are 625μs (micro seconds) in length. Devices in this time slot are made at 1600 hops each second.

One of the most important design requirements of Bluetooth SDP (Service Discovery Protocol) is interoperability with existing protocols for service discovery. This led to attempts to set the existing protocols for service discovery of Bluetooth (SDP). According to Bahl et al. (2010) it can apply to a client on the device to discover information about the services on other Bluetooth devices. Bluetooth is a set of protocols that work with each other. The new version of the specification would identify the service discovery protocols (SDP), Logical Link Control and Adaptation Protocol, (L2CAP) Host Controller Interface (HCI), Link Manager Protocol (LMP), and Baseband and Radio (RF) as shown in Figure 1.

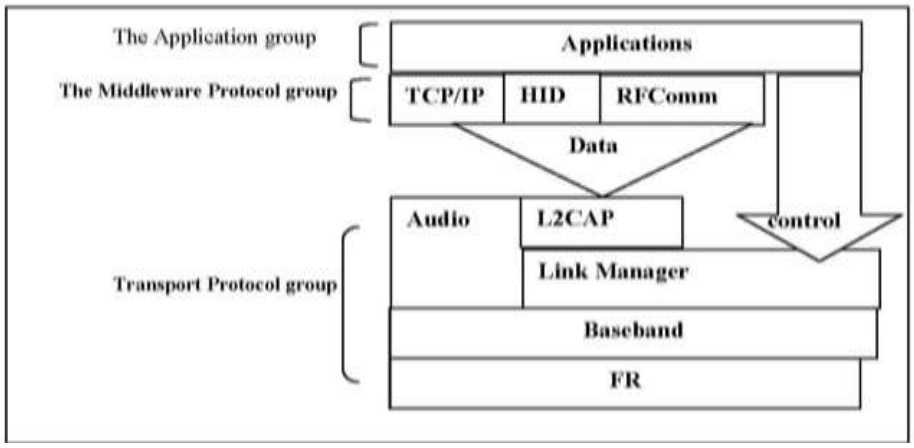

Figure 1. A Bluetooth protocol stock.

The following is a brief description of each protocol.

The Bluetooth protocol is the set of rules by which all Bluetooth devices must abide in order to establish communication links with other devices in the vicinity. According to Barahim et al. (2017) the Host Controller Interface or HCI is integrated into every Bluetooth chip. The HCI is a standard language of communication between software and hardware. Because of the portability of HCI, it is easy to establish communication protocols between Bluetooth chips thus making it easy for information to travel from one device to the next. Therefore, using HCI makes it possible to link information which is device dependent without interfering with other devices which do not possess HCI commands.

The logical link control and adaptation protocol or L2CAP Bahl et al. (2010) is Bluetooth's link layer. Both this layer and the layers above it are implemented within the software. Packets sent from higher layers are received by L2CAP and sent to the other end of links. As soon as an L2CAP connection becomes within range, Bluetooth devices are able to link up together Kansal et al. (2012) a client device then needs to discover the services provided by the server device.

The service discovery protocol or SDP provides a method for applications on a device to discover services and their attributes (Cotroneo, 2014). Bluetooth SDP has been efficiently and effectively designed for discovering services on resource constrained devices. The assumption of this design is that Bluetooth networks are resource constrained in terms of computing power and memory. Therefore, Bluetooth SDP provides a simple method of a matching scheme using 128-bit UUIDs (Universally Unique Identifier). Client applications on devices trying to discover services need to provide the correct service UUID through discovery requests sent to peer devices .The Bluetooth SDP server embedded into each Bluetooth device providing service information matches the UUID in incoming discovery requests against existing service UUIDs McDermott-Wells, (2014)Therefore, the server tries to match against attribute UUIDs as shown in Figure 2.

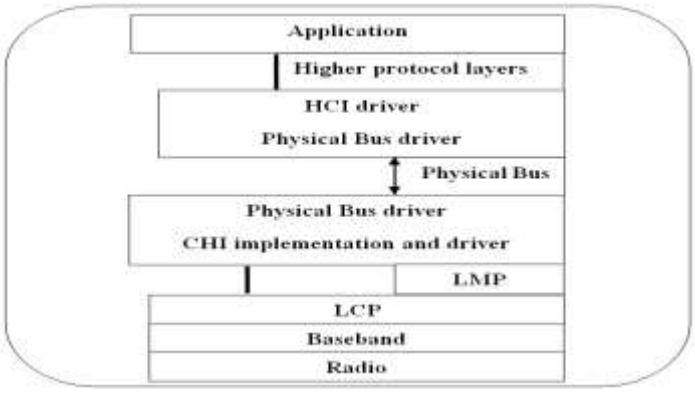

Figure 2. The Service Discovery Protocols

2.0. Related Work

2.1. *Bluetooth positioning*

There are many Bluetooth-based positioning systems that have been proposed over the past few years. These applications have generally assisted in creating a well developed positioning system, but it requires an extensively deployed infrastructure, which will allow any Bluetooth device to be used to determine the location. Furthermore, there are still many of these are still applications available today, which can be developed and applied. Positioning systems, by nature, are required to determine the location of the user.

Bluetooth is a technology of specifications, which has assisted in the development of the quality of wireless communications. Li et al. (2016) provide a promising development to determine the location of the user. Rodriguez et al. (2015), called the "local positioning working group", are developing a description of Bluetooth technology, as well as the format of the information which helps Bluetooth devices exchange location information.

Characteristics of Bluetooth short-range radio signals make it useful for location-based services. Bandara et al. (2014) The Bluetooth station is connected to an access point which determines the location of the device. This will cover an area of 10 meters without any other localization mechanism and requires the existence of multiple access points. The use of Bluetooth technology has made a considerable contribution to the development of systems to locate the user. It has also helped the creation of low-cost infrastructure for these systems. The use of Bluetooth to be able to locate the device completely within the specifications requires that the request relates to the other device. This allows the use of any Bluetooth device to determine the location of the remote machine. This can be done without requiring advanced preparations.

Mainetto (2013) Bluetooth technology has been developed by a special interest group (SIG). It has become the standard for low power usage, being a short-range device that uses radio technology. Guérin et al. (2012) Bluetooth radio frequency operates between 2.4000 -2.4835 GHz which means devices can communicate by using radio waves at a distance of around 10 meters. Communication in Bluetooth technology devices can be point-to-point or point to multipoint. Bluetooth devices (Masumoto et al. 2019) share a common channel called a piconet, which means the device at the center is a master and other device around it are slaves. The main features of Bluetooth that makes it suitable for use with mobile application:

- Minimal hardware dimensions.
- Low price of Bluetooth components.
- Low power consumption for Bluetooth connections.
- Medium range.

There are many methods that can be used in positioning systems such as Angle of Arrival (AOA), Cell Identity (CI), Time Difference of Arrival (TDOA), and Time of Arrival (TOA). The AOA method is based on detecting the direction of signal arrival in the zone covered. This is defined by a fixed angle using a mobile device. In the CI method, the network is divided into smaller cells so that they can facilitate the identification of the device. Each cell corresponds to a unique stationary device. Smaller cells tend to improve accuracy. In the TOA, a device sends a signal to reach the station, and in turn, the station sends the signal back to the phone. TOA however, requires very accurate clocks to prevent deviation of master packets during transmission of signal.

2.2. *Zone based positioning*

This section will present some of the systems performed in the field of zone-based positioning for identifying position. This means a user can be located via Bluetooth sensors which are located in different zones. However, many Bluetooth sensors can cover areas and these sensors can overlap in area coverage.

Many scientists have researched location systems for a long time, and many of these systems use different methods and technology. One of the technological systems used to

identify location is known as the ParcTab by Bahl and Padmanabhan (2010) which provides a special hardware to assist in determining the user's location. Furthermore, this system can also locate the zone of the device and its user. This concept operates using the principles of locating user information in order to determine his/her position. In addition, it also used a simple method in determining the identity of the zone where the user is located.
There is another system that has been developed by Avancha (2012) that uses ultrasonic technology to locate the user. This system is characterized by employing mathematical equations and the user has to use special hardware to determine his position.

Previous research into systems usage can be related to our system that uses Bluetooth technology in order to determine the user's location. Ahuja et at. (2007) used building zones based on further identifying the position. In addition, this system investigated strategies aimed at reducing noise to receive the signal of the user. This helped identify the server in the user area in addition to identifying the form of the wide area covered by the sensing Bluetooth. The advantage of this system is that each zone has no influence on the behavior of another zone. Many of the existing systems in the field of position location need to continue to develop and to avoid mistakes in them and increase accuracy.
One of the systems that has been developed by Chakraborty et al.(2012) have deal with frequent updates of position. Therefore, it is dependent on the server to detect new devices connected to it. Furthermore, many systems based on this method require expensive infrastructure or a complex calculation to determine the position. What distinguishes this system's accuracy is information about the quality of location. This is a requirement to help determine the accuracy of where the user is situated. On the other hand, the user has to know how to integrate the existing infrastructure and wireless LAN access point with Bluetooth and sensors to determine the location of the device.

Despite many systems being used for Wi-Fi technology such as the positioning systems, some are unsuitable for indoor environments because of these are influenced by the engineering of the position, however, Bluetooth technology is used in positioning systems when the RSSI method can be used to identify the device's location. Kotanen et al. (2013)
One of the most popular systems in determining the position is the RADAR. This is a radio frequency (RF) based system for location. This system works by recording the device information and processing signal strength. Overlapping may occur within the centers of the coverage area. The main feature that distinguishes this radar system is that it uses mobility within the area through the signal strength information to identify and track users. This requires a small number of base stations and uses the same infrastructure that provides public wireless networks in the building.
The concept of the system on the basis of Zone-based location service (ZLS). Thompson etal.(2018) provide a way for nodes to record the location information of all mobile nodes within the vicinity. This is referred to as a location update zone. The location update zone can be through access points deployed in the location.
According to Misra and Enge (2019) have system which is It consists of three floors and is equipped with 9 access points (APs) on each floor. The MAC address of each AP with its corresponding physical location was recorded in the server's database. The system was also extended to identify categories of users based on various parameters. A typical application of the proposed system is to track students at universities. The system can be integrated to allow people to track their friend's locations. Users can locate specific users by providing the user ID. Also, users can also locate a group of users based on their categories.

2.3. Point based positioning

In this section, we will introduce some regimes that have been created to locate the user within the area covered. It will introduce systems which are based on the determined users coordinates, in particular, within the area covered by the Bluetooth sensors.
Location-based services allow mobile users to know where they are. This makes it easy to provide them with the ability to connect to each other. In addition, many of the applications available in this area based on location are available in this area to identify the user. Mobile Service location has become one of the critical tools to provide the user's location at the right time and in the right location. There are many regulations that contributed to the provision of location information to the user. It uses local data in determining the location, when the Bluetooth stations networks connect to 3G mobiles through Bluetooth access points.
Thongthammacharl and Olesen (2012) outlined the concept of a system that enables the identification of the user's location within an indoor environment by Bluetooth technology. This system determines the user's point within the zone by providing more detail of the area. It is also characterized by the ability to track user movement within the area. The server system requires the composition of a map of the location to be able to provide the service. This requires many access points to provide automatic updates on location, because the user moves from one point to another.

According to Schilit et al. (2011) there are systems that have been introduced in this field. They introduced a new system in the indoor environment of a mobile device based on Bluetooth technology. This system uses Bluetooth access points of a network to identify the location. Location is determined by the power of the signal sent from access points in the zone covered by the Bluetooth sensors. In addition, the signal energy is measured by the mobile device, and then this signal is forwarded to a central server in order to specify the location. This system distinguishes the response time, which enables Bluetooth to search for

Bluetooth devices in the zones, and then record the information of the location within seven to eight seconds.

One of the simplest systems to use Bluetooth sensors to identify the user's location is based on proximity. Anastasias et al. (2013) used the radio to cover the Bluetooth access points to determine the area where the user is located. Their approach is to estimate the distance between the device to be detected and reference points such as Bluetooth access points deployed in the region. These are estimated through using the multilateration.

3.0 Concept and Architecture of (FGZPUB) System

This section will discuss the concept behind this application and give an overview of its architecture. This application is based on the identification of the reference area by the stationary reference Bluetooth device, which could contribute to the application identifying a zone using Bluetooth technology.

The architecture depicted in Figure 3 divides the system into various components that seamlessly interact providing a practical solution to the positioning problem in indoor campuses. The system follows typical client/server architecture, with the client (mobile) running an application specifically built for this project, and the server, which is stationary reference Bluetooth device. The mobile application can be installed on any mobile phone, which supports java application.

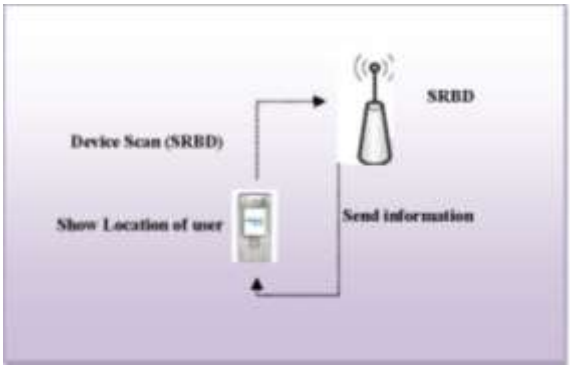

Figure 3. System architecture

The next section will show how the application will be realized with more detail. The application is installed on the mobile. When the user enters within the reference area which is covered by some or all of the stationary reference Bluetooth device, as shown in Figure 4, this application will scan for the stationary reference Bluetooth device. The users will then get a message to show them where their location is. If the users want an update, they can press the update button to get a new message. The application will provide the location of the user by using the stationary reference Bluetooth device which the reference area covers.

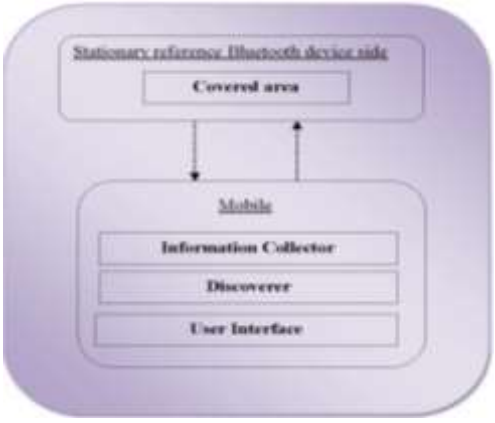

Figure 4. System architecture

The proposed application is based on the identification of the reference area by a stationary reference Bluetooth device,

which contributes to the application identifying a zone using Bluetooth technology. The architecture divides the system into various components that seamlessly interact providing a practical solution to the positioning problem in indoor campuses. The system follows typical client/server architecture, with the client (mobile) running an application specifically built for this project, and the server, which is a stationary reference Bluetooth device. The application can be installed on any mobile phone, which supports a Java application.

Some of the terminologies used in the application are:

- Stationary Reference Bluetooth Device (SRBD) is a device used to create an area where mobile devices can be located
- Reference Area is the area covered by a stationary reference Bluetooth device.
- Zone which might comprise one reference area or an overlapping of reference areas

Recently, different types of communication have contributed to the identification of places by using 3G or using Wi-Fi especially outdoors.

4.0 Prototype Implementation and Evaluation

4.1 Set up

This application developed by using Java ME to implement the mobile MIDlet. The stationary reference Bluetooth devices should develop this application were four laptops: Toshiba Satellite L500-21T, Dell Latitude D500, Toshiba Satellite U405 and Asus A42J. The mobile used in this application was a Nokia (N70).

4.2 *The mobile device*

A mobile device must have Bluetooth functionality. This Bluetooth-enabled mobile phone is able to discover the stationary reference Bluetooth device by using a Bluetooth protocol (Service Discovery Protocol) stack which is required. Four laptops (S1, S2, S3 and S4) were used as stationary reference Bluetooth devices. The phone used must be:

- Programmable;
- Bluetooth-enabled;
- Enable API to have access to Bluetooth functionality.

4.3 *The place of experimentation*

This application will investigate Bluetooth positioning in two setting: first, within the indoor environment (Figure 5);

and second in the outdoor environment (Figure 6). The reason for these two different approaches is to obtain different results, which can then be compared in order to help us understand how the zone positioning technique is different between indoor and outdoor environments.

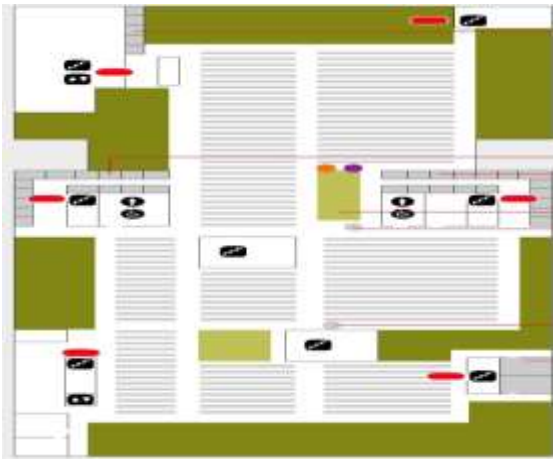

Figure 5. Indoor environment for experimentation.

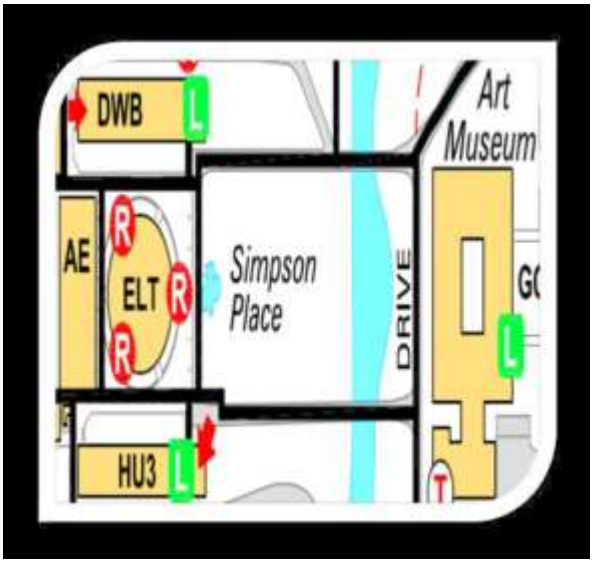

Figure 6. Outdoor environment for experimentation.

4.4 *System overview*

The system consists of two main elements; the first is a Mobile application and the second is the stationary reference Bluetooth device. The following section will explain the sequence of the components of the system and how they interact with each other.

4.5 Stationary Reference Bluetooth Device

A stationary reference Bluetooth device is a device used to create an area that has Bluetooth technology using four stationary reference Bluetooth devices (Figure 7).

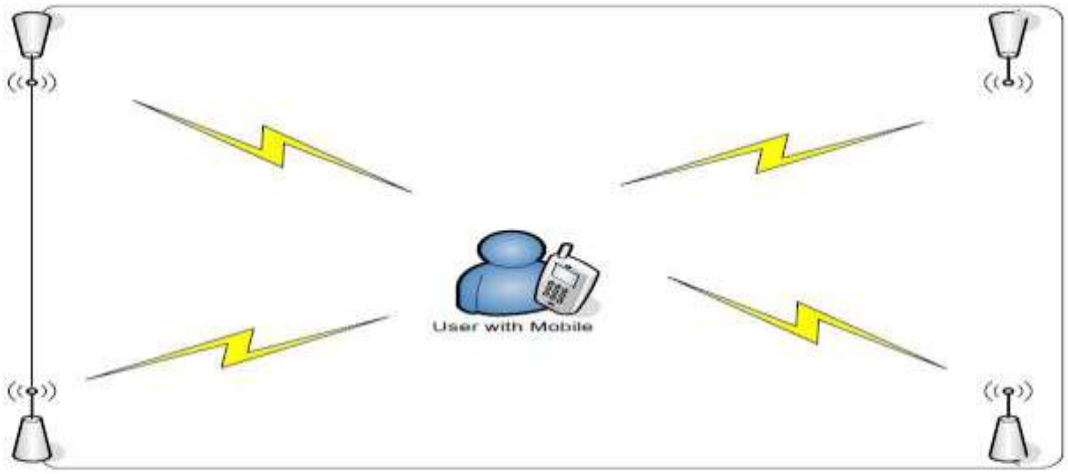

Figure 7. Distribution of a stationary reference Bluetooth device.

4.6 *Mobile application*

The mobile application is responsible for initiating Bluetooth discovery and maintaining user inputs. The following diagram illustrates the lifecycle of the user interface flow as shown in Figure 8.

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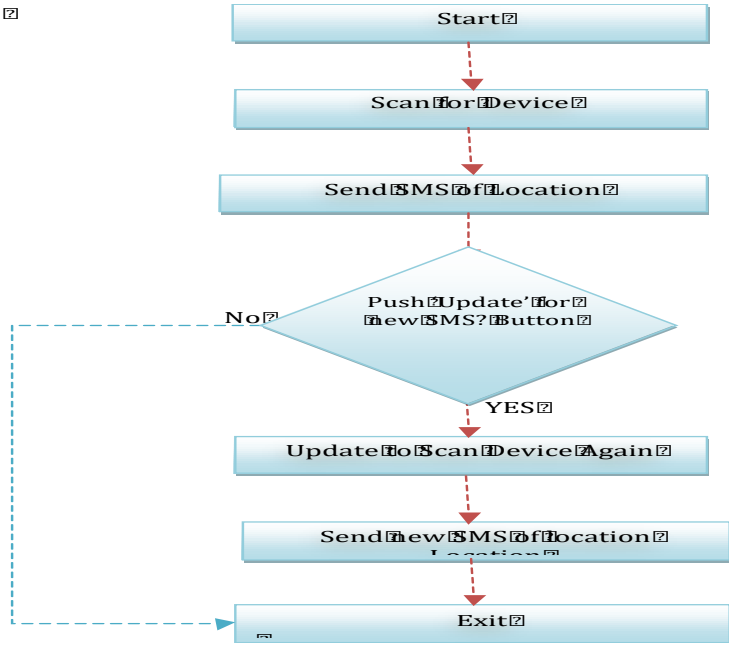

Figure 8. Mobile application lifecycle

This application has two main screens. The first screen has two choices, which are located at the bottom of screen. The first choice allows the user to run the application and the second choice is to exit, as shown in Figure 9. The second screen also has two choices at the bottom of the screen, the first of which is to update the application, and the second allowing the user to exit, as shown in Figure 9. When the application starts, it searches for all possible stationary reference Bluetooth devices in the reference area. When this application is running, the user will be shown their location

will as shown in Figure 9. However, if the Mobile user does not discover any possible stationary reference Bluetooth devices or is outside reference area, they will receive a message, as shown in Figure 9.

Figure 9. The screen of application

5.0 USING BLUETOOTH FOR ZONE BASED POSITIONING.

The simplest method to use Bluetooth as a positioning system is by using the signal coverage of a Bluetooth as a zone, and therefore any overlap between any two or more stationary reference Bluetooth devices will create additional zones. This application can determine which zone the user is standing in. A set of rules will help the application determine the user position by identifying how many stationary reference Bluetooth devices can discover the user mobile. The following section will demonstrate the process used in the case of four stationary references Bluetooth devices.

The following Figure 10 and 11 will show that how is a difference in the range and scope of the Bluetooth signal of the stationary reference Bluetooth Devices, depending on the environment. The reason behind this fact is that the environment has an influence on the stationary reference Bluetooth Device. Since the implementation took place in an indoor environment (La Trobe University Library), the status signal from one stationary reference Bluetooth Device to another was weakened by physical barriers; in this case the library bookshelves.

As demonstrated in Figure 10, there is a difference in the scope of the stationary reference Bluetooth devices when compared to those of Figure 11. This is due to the fact that in Figure 11, the implementation was carried out in an outdoor environment, which contributed to the clarity and sharpness of the signal of the stationary reference Bluetooth devices, as it is an open area with no physical barriers.

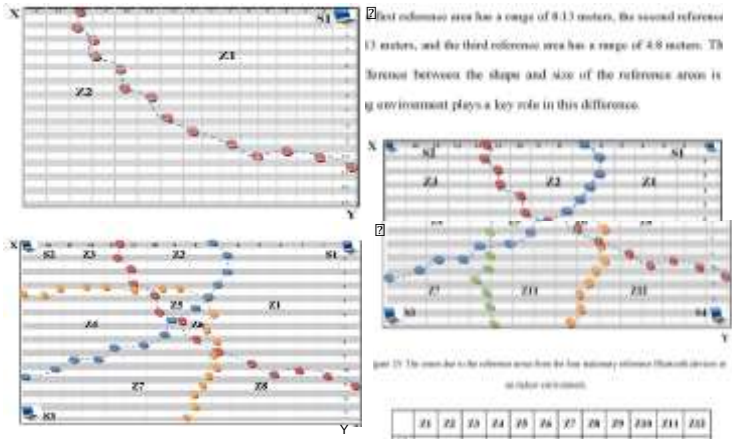

Figure 10. Different references area created by many stationary reference Bluetooth device in an indoor environment.

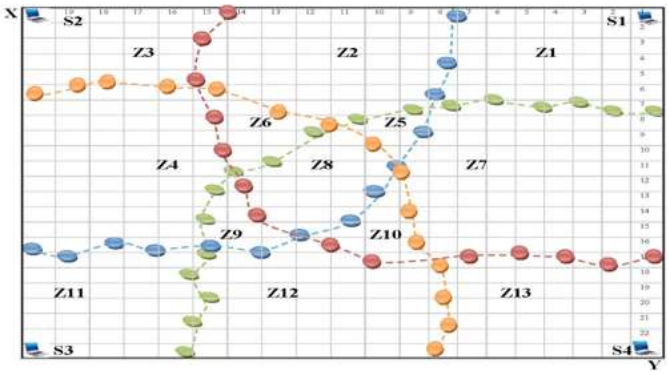

Figure 11. Shows the possibility of detection of devices by four stationary reference Bluetooth devices in an outdoor environment.

The different possibilities of overlap created by the different stationary references Bluetooth devices in both indoor and outdoor environments. There is a very clear difference in signal strength between stationary reference Bluetooth devices in an indoor and an outdoor environment. There will clearly show the overlap between stationary reference Bluetooth devices and displays the shape and size of each zone which is covered by stationary reference Bluetooth devices. Also, shows clearly highlights the overlap between areas by stationary reference Bluetooth devices, and displays zones where a user can be located.

5.1 PERFORMANCE STUDY

The application began by scanning one stationary reference Bluetooth device, which it scanned ten times, in order to determine the average time, it takes to find the location. The average time it took the application to discover one stationary reference Bluetooth device was 10.76 seconds as shown in Figure 12. The time taken to discover that the mobile device is in the zone due to the overlap of the reference areas of two stationary reference Bluetooth devices was 10.75 seconds. The average time taken by the application to discover that it is in zone found by four overlapping reference areas, which were 10.87 seconds and 10.89 seconds respectively. Table 2 illustrates these findings clearly.

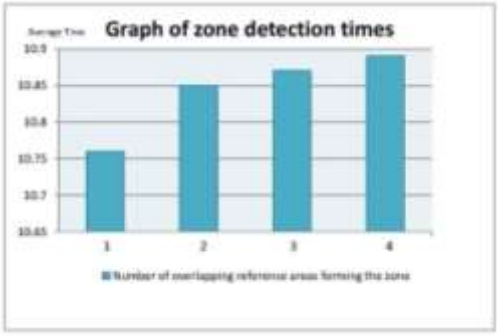

Figure 12. Average time to detect overlap.

Table 2. The values of the 10 test times

Test Number	Overlap 1	Overlap 2	Overlap 3	Overlap 4
Test 1	10.7.	10.8	10.9	10.8
Test 2	10.8	10.9	10.8	10.9
Test 3	10.7	10.8	10.9	10.9
Test 4	10.7	10.9	10.8	10.8
Test 5	10.8	10.9	10.9	10.8
Test 6	10.8	10.8	10.9	11.00
Test7	10.7	10.8	10.8	10.9
Test 8	10.8	10.9	10.9	10.9
Test 9	10.8	10.8	10-9	10.9
Test 10	10.8	10.8	10.8	10.9
Average time	10.76	10.85	10.87	10.89

There are differences in the shapes of the zones. Zones in the indoor environment were much closer, and also the small size of each zone made them more meaningful and visible compared to the outdoor environment. The indoor limitations of mobility of overlap between areas by stationary reference Bluetooth devices have affecting by the buildings structures.

6.0 CONCLUSION AND FUTURE WORK.

This paper has described how Bluetooth technology can be used to provide and identify a user's location. It has also highlighted the benefits of Bluetooth technology. It also proposed a method to solve some of the deficiencies prevalent in previous Bluetooth systems and explained how to implement them. This paper has discussed some of the characteristics of Bluetooth technology and the various types of protocols, concept and architecture. Future improvements to this application may increase its effectiveness by reducing the amount of time it requires to determine the location of a user. Speed at which a user enters and leaves a Bluetooth zone can also play a key role in Bluetooth positioning

systems. Developing algorithms for fine-grained zone-based positioning, using multiple Bluetooth sensors and addition of intelligence will improve the application.

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