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Indoor Navigation for Android Devices

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Abstract-This paper represents Indoor navigation using android device with Bluetooth capabilities to navigate the feasibility of range for indoor positioning. In Indoor navigation system, each android device scans the nearby Bluetooth enabled devices and sends the results to the server. The server collects the scanning results from android devices and fined their location via shortest path algorithms.

Index Terms-Indoor positioning, Bluetooth, Android devices

I. INTRODUCTION

Most of the commercial application is based on global navigation satellite systems .In this each node should able to access the location information and be aware of its geographical locations. However, this concept cannot function for indoor positioning where the satellites signals are blocked due to natural disasters. Thus, alternative positioning techniques have been introduced that is using Wi-Fi network or Bluetooth for indoor positioning. The technique includes the solution that will locate the position of a person inside a campus or any public environment like Malls, Hospitals, corporate offices, hotels etc. Positioning accuracy is to be within several feet's. And the position will be uploaded to server from where the localization server will guide the user to navigate throughout the campus. This application works on the android smartphone devices. Using WAP (Wi-Fi Access Point) or Bluetooth access point it calculates the position of user within the campuses.

Fig 1:- Indoor Navigation using Android device.

II. POTENTIAL TECHNOLOGIES

2.1. Wi-Fi

It is a common name for IEEE 802.11x standards. Each wireless router broadcasts a signal that is received by devices in that area. Wireless devices can easily measure the strength of this signal. This strength is converted to a number which is called as received signal strength indicator (RSSI). A

user's device can detect the RSSI and MAC address of multiple routers at one time. Used by systems to compare the strength of signals from multiple access points. There is no standard conversion between RSSI and the actual received signal strength (RSS); many manufacturers have their own conversation scheme.

Pros:-

- Readily available in most of campus
- Wide Range.

Cons:-

- Less security.

2.2. Bluetooth –

Bluetooth is the IEEE 802.15 standard and is similar to Wi-Fi. Bluetooth is a standard wire-replacement communications protocol primarily designed for consumption of low power, with a short range depended on low-cost transceiver microchips in each device. Because the devices use a radio (broadcast) communications system. Range is power-class dependent, but effective ranges vary through practice. But most of the android devices use class 2 Bluetooth devices.

Table 1: Ranges of Bluetooth

Class	Max. permitted power		Type. range[] (m)
	(mW)	(dBm)	
1	100	20	~100
2	2.5	4	~10
3	1	0	~1

Pros:-

- The maximum range of Bluetooth is 100 meters, but this range is not the same for all same type of connections. It depends on a version of the device they are using.
- Low cost.

2.3. Infrared –

Infrared wireless networking was a first technology in the field of indoor positioning. However, this system has several drawbacks and problems. The primary challenge is the limited range of a network. Also, there is no such method for providing data networking services. An early implementation of an IR technique is the Active Badge System. This is a remote positioning system in which the location of a person is determined from the unique IR signal emitted every ten seconds by a badge they are wearing. The signals are captured by sensors placed at various locations inside a building and relay information to a central location manager system. The accuracy achieved from this system is fairly high in indoor environments. However, the system suffers from several limitations such as the sensor installation cost due to the limited range of IR, maintenance cost, and the receiver's sensitivity to sunlight, which often occurs in rooms with windows.

Pros:-

- Accurate,
- Low cost
- User friendly to use wireless communication technology

Cons:-

- Requires line of sight

III. SYSTEM COMPONENTS

3.1. Use of Bluetooth on mobile phone:-

All the persons in the network own a Bluetooth enabled cell phone through which they connect to the network. Usually cell phone contain BT Class 2 device with a range of around 10 meters, called as Bluetooth transceiver. This is also called as reader node, which they use to make a request to track others and also for themselves to be located by others. By doing this they will get all the notification of the respective place.

3.2. Bluetooth (BT) Access Points:-

These access points are needed to incorporate the core Bluetooth protocols (mandatorily present in all BT devices) like Link Management Protocol (LMP), Logical Link Control and Adaptation Protocol (L2CAP) and Service Discovery Protocol (SDP). Additionally, there is need of Radio Frequency Communications (RFCOMM) protocol which provides for binary data transport by creating a virtual serial data link.

3.3. Wi-Fi:-

They allow us to provide the application, called indoor positioning through they acquire tracking information from other devices and sent it to the server and vice versa.

3.4. Server:-

The Server in our system apart from performing various network functions also stores information of the Bluetooth devices i.e. their Bluetooth addresses or device names. Moreover it also contains a list of different Bluetooth access points with their address and corresponding physical location.

IV. POSITIONING TECHNOLOGIES

There are various indoor positioning techniques that are appropriate for Bluetooth devices. In order to navigate within a campus, one must first determine one's current location. Two important factors are taken into consideration i.e. accuracy and convergence time.
Below are some well know techniques used in positioning.

4.1. Location Finger Printing –

Location fingerprinting is a technique in which a location is identified by a record of radio signals. The main advantage of this technique is that, it avoids cost of installing new infrastructure by reusing the radio infrastructure which is already placed positioning system is deployed. As stated in the literature review, techniques which determine a distance directly from the signal strength are susceptible errors due to the fact that there is no direct relationship between the signal strength and the distance. Such methods include triangulation, among others. The fingerprinting technique completely avoids this problem, as this problem is not at all concerned with the distance, but rather tries to obtain unique combinations of RSSIs that distinguishes a location from all other locations. The fingerprinting technique is based on a radio map, which is express as a collection of fingerprints. A fingerprint consist a set of radio signals measured at a particular location, in which each signal is associated with the device from which it was emitted.

4.2. Time of arrival- The distance is derived from the absolute time of travel of a wave between a transmitter and a receiver. The propagation time can be directly converted to distance but requires the receiver to know the exact time of transmission.
Accuracy is subject to propagation delay errors and the accuracy of timing measurements.

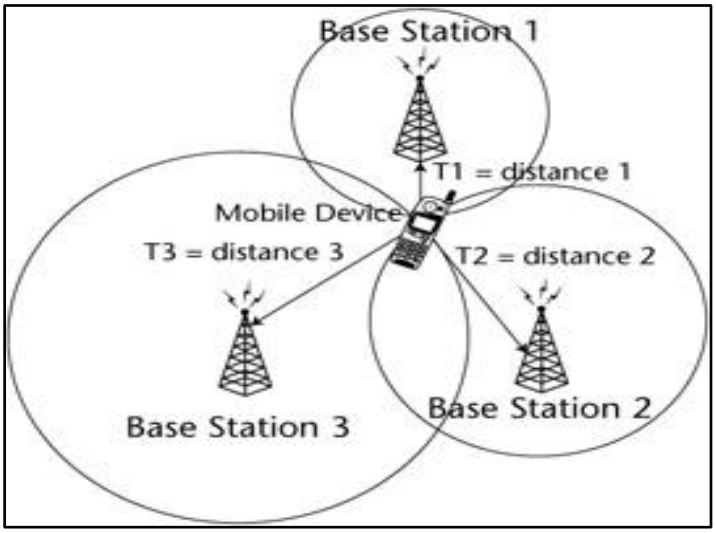


Fig2:-Arrival of time Centroids.

V. ROUTING ALGORITHM

5.1. Dijkstra's Algorithm –
Scientist Edsger Dijkstra invented the algorithm and it is most widely used routing algorithm. The algorithm works by advancing a single node at a time, starting from the source node. At each iteration in the loop, the algorithm chooses a node having the minimum cost from the source node. This node has been visited from the source but not yet been optimized. This node is then marked as an optimized and the cost to all the adjacent nodes will be evaluated. The Dijkstra algorithm is mathematically proven to find the shortest path.

5.2. Bellman-Ford Algorithm –
It is basically used to find shortest path in a graph containing negative weight edges. It addresses the incapability of Dijkstra to work with negative edges by adding a protection that prevents the path from passing through a negative cycle. Its run time complexity is worse than the Dijkstra algorithm because it has to update all possible edges in the graph instead of just edges adjacent to the minimum cost node.

Table 2: Summary of algorithm

Algorithm	Advantages	Disadvantages
Dijkstra's	□ High Speed □ Optimal	□ Doesn't works With negative edge Graph
Bellman-Ford	□ Optimal □ Works with negative edge graph	□ Low speed

VI. WORKING THEORY

In this project the development, implementation, and testing of a smart-phone based indoor navigation system is proposed. Moreover the architecture shall be kept as generic and adaptable as possible. Hence anyone could use the system to deploy the navigation system for their premises. The end user won't have to get a new mobile application designed every time for a new premise. The system will allow even a novice user to do the same.

The project has several parts.

Desktop Module: The desktop module that will be used by administrator to do the following:

- Set map information
- Save/Load map information to/from files
- Set Bluetooth device information
- Set paths
- Find optimum paths
- Auto compiles mobile application.
- Upload mobile application to dedicated website for public download access.

Bluetooth Modules: These are ultra-low cost Bluetooth devices that will be setup in premises at regular intervals. These devices will transmit their Device-ID to all Bluetooth devices in range. This is the only purpose these devices shall serve. These devices can also simultaneously be used for other purposes without affecting the navigation system at all.

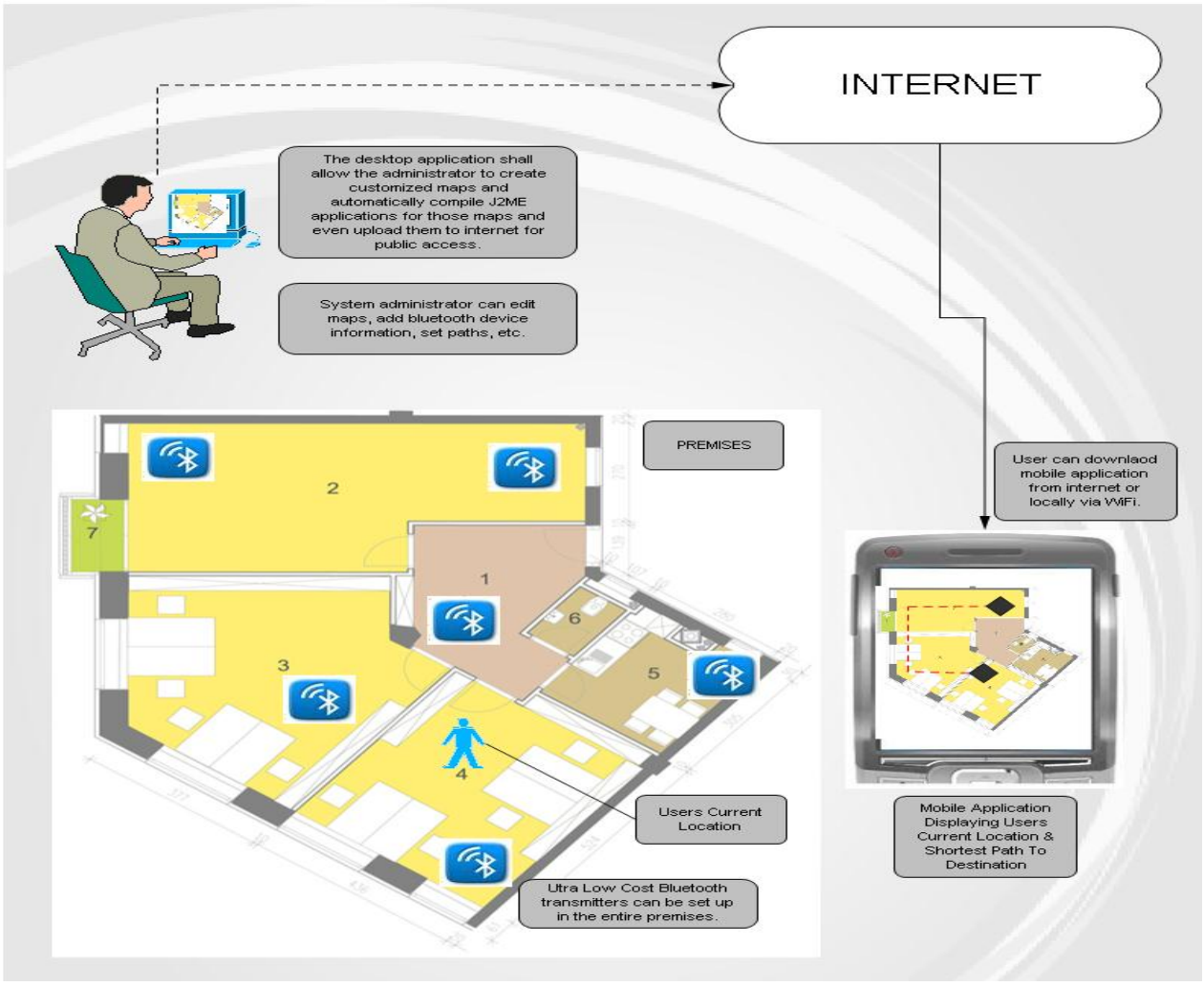


Fig 3: Architectural Block Diagram of Indoor Navigation System

Mobile Module: The mobile application that can be downloaded from internet by any user on a smart phone will show the user overall map of the premise. Besides this, the application will allow the user to

- See his current location
- Select source point
- Select destination point
- Show all paths from source to destination.
- Show optimum path from source to destination
- Update current location at regular intervals
- Graphically show the path overlay on premise map
- Navigate through premise map for additional information
- Save the application for future reference use
- Transmit the application to fellow member using Bluetooth.
- Triangulate the user position based on multiple Bluetooth devices in range for even more accurate positioning.

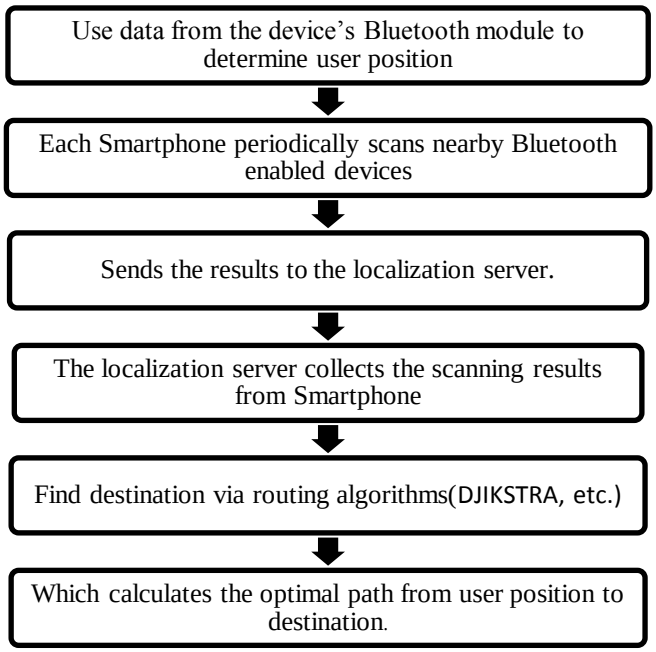
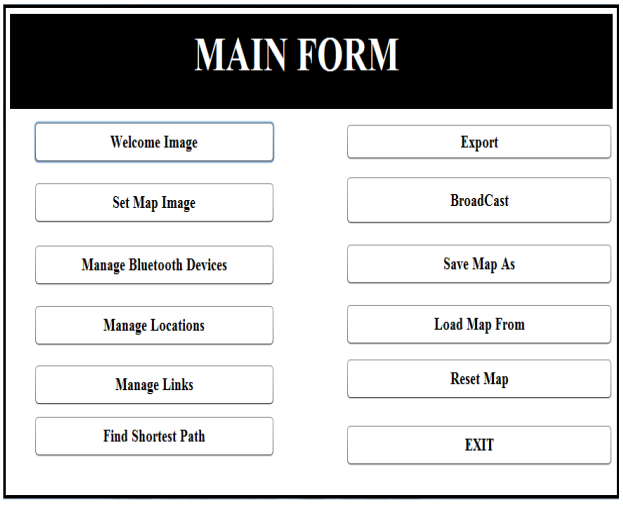


Fig4:-Flow of indoor positioning system.

VIII. EXPERIMENTAL RESULT AND ANALYASIS

Admin side:-

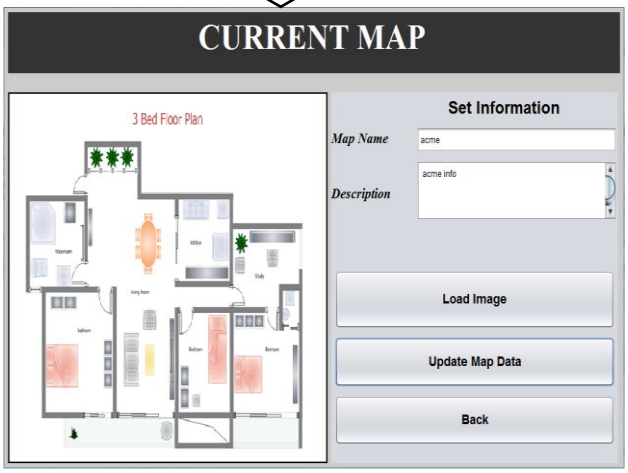


- Set map Image
- Manage Bluetooth devices
- Manage locations
- Manage links etc.

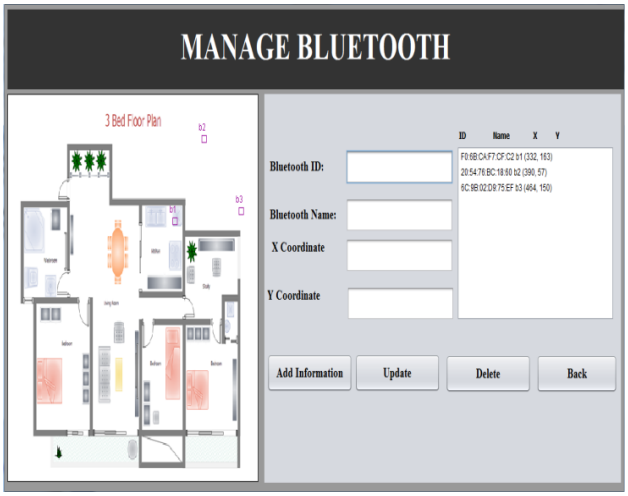
In set map Image: We load the maps.

In manage Bluetooth device: We locate the Bluetooth access point and so on.

Admin part contains following option:-

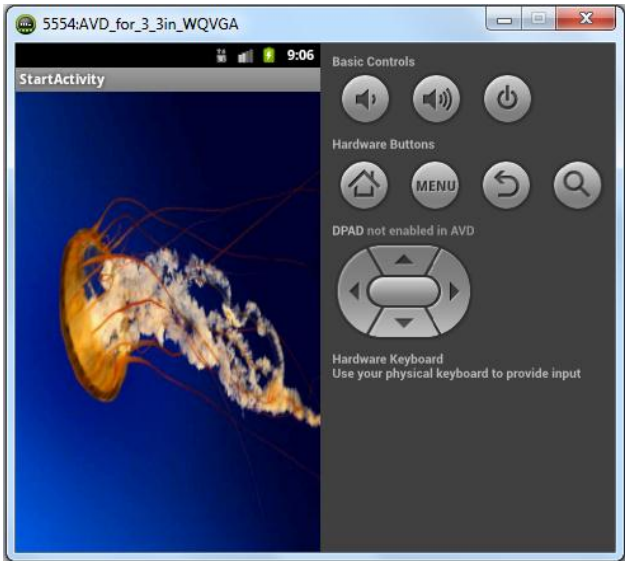


- In this we can see there are 3 options, i.e. load map, update map, and back option.
- In load map-we can add number of maps as our project is dynamic.
- Update map-according to different premises we can upload map by this option.

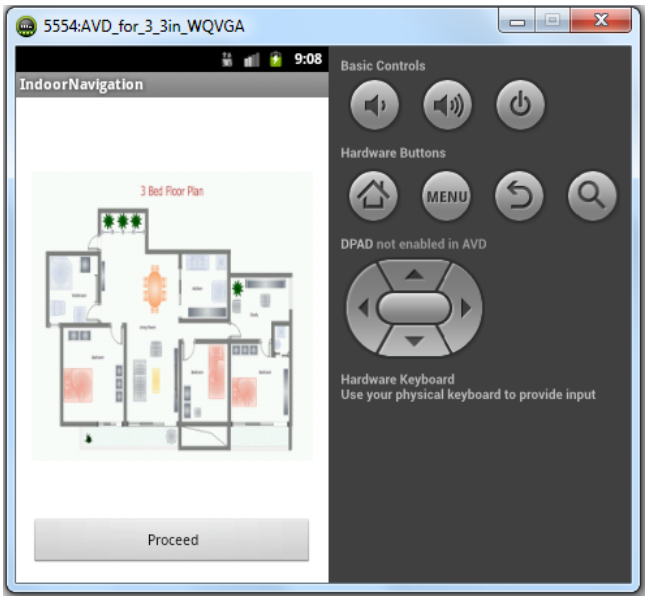


- All the information of the BT access point which is stationary is loaded in database i.e. BT id, BT name.
- In this we also calculate X and Y co-ordinate of all BT access point.

User Side:-



- These are the user side output.
- In which we can see the starting welcome image after that we will get the loaded maps.



- These is the map with updated data, where all its contain i.e. BT id and BT name is stored in database.
- It will also highlight active BT access point.

Fig5: Snapshot of Admin and User side

IX. CONCLUSION

In this paper we have introduced a conceptual model for localization of indoor mobile using Bluetooth devices. This mapped the position on digital blueprints to navigate inside the building. With development of mobile phone apps in all platforms on a large scale, there is a lot of scope of adding new capabilities and features to this system. Our proposed system presents an uncomplicated and cost effective approach for its users to navigate through indoor infrastructures. We also determine the shortest path using Dijkstra's algorithm from source to destination and use Bluetooth for navigating and determining the user's current

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