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An Indoor Shop Localization and Navigation System for Malls Using Bluetooth Beacons

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Abstract*: *Indoor navigation and location-awareness are important and growing research areas due to the interest of mobile users in location-based services [3]. The location sensing methods such as Global Positioning System or Inertial Measurement Unit may not be feasible to use Indoor [2]. We preferred Bluetooth device for indoor navigation which have advantage of being low cost and being widely available. We Implemented Navigation System using java, this implementation is adaptable to whatever indoor environment (Mall, Colleges, Commercial center, Offices, Museums etc.). In this System we also find the Shortest Path by using Dijkstra's Algorithm.

Keywords*: *Bluetooth Low Energy, Shortest distance, Route, RSSI, Dijkstra's Algorithm.

I. INTRODUCTION

With development of intelligent mobile phone and its Sensor inside it, navigation and positioning technology based on the mobile phone becomes an important in the field of navigation. There are various navigation algorithms are available (like Wi-Fi, Global Positioning System, Bluetooth, PDR etc.) WI -Fi and ZigBee are also suitable for indoor localization but Bluetooth is easier to use and has advantage of being widely available [1]. On the basis of power consumption and range criteria Bluetooth is best option for mobile application [7]. Bluetooth uses the frequency band between 2400 MHz and 2480 MHz [1]. We implement the indoor navigation system using Bluetooth Beacon. There are various algorithms to find the shortest path (like Prims, Kruskal, and Dijkstra's). We preferred Dijkstra's algorithm to find a minimum path from source to destination as the time Complexity of Dijkstra's Algorithm O (V^2) [5]. The Mall, colleges, museum has very big area so user can't easily find particular location. So we provide the map to easily find the location.

The remaining paper divided as follows the section 2 includes Exiting systems, section 3 includes Implemented System, section 4 includes Implementation and results, section 5 includes Advantages and section 6 includes Conclusion.

II. EXISTING SYSTEMS

In the previous projects indoor navigation system application based on Wi-Fi, ZigBee etc. In the previous indoor navigation system the application is only used for that specific shopping center, museum and building. Some of the techniques based on the mobile sensors, image processing. But they do not give the exact indoor navigation and there is no such application to recover these problems. Some of the existing systems only contain the visual displays and walking can be dangerous on those small screens [4]. So with the visual displays we added audio part for navigation. So we proposed the new system to overcome the problem in existing system.

There are various methods for indoor navigation used previously which are using Wi-Fi, Bluetooth, ZigBee, mobile phone sensors or using image processing. But developed system which work on Bluetooth is more reliable and energy efficient.

III. IMPLEMENTED SYSTEM

This system gives the indoor shop localization and navigation using Bluetooth. There are two parts in this system first is desktop application for an admin (i.e., for shopping mall management) and the second is end user android application for positioning and navigation [6]. This system is designed for creating navigation and localization for any shopping mall or other big buildings. For this admin part has to add their separate mall maps location in it. In the admin part the functionalities like adding map, adding Bluetooth beacon location which were pre-installed in the mall, adding locations or shops with their offers, linking Bluetooth beacon with these locations have been added. These functionalities are with user friendly GUI so that admin can create the database for their mall's android application.

On the other side android application get created using the data provided by admin application. As the user downloads and opens the android application he/she will get first welcome image of that mall. Then the map of the mall will get displayed. Using the Bluetooth technology the available Bluetooth beacons get searched and using linking in the database, the location displayed to user

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with offers. The functionality of adding source and destination has also been added so that user can get the shortest path. For finding out the shortest path Dijkstra's algorithm is used [6]. Using this shortest path user can navigate within the mall.

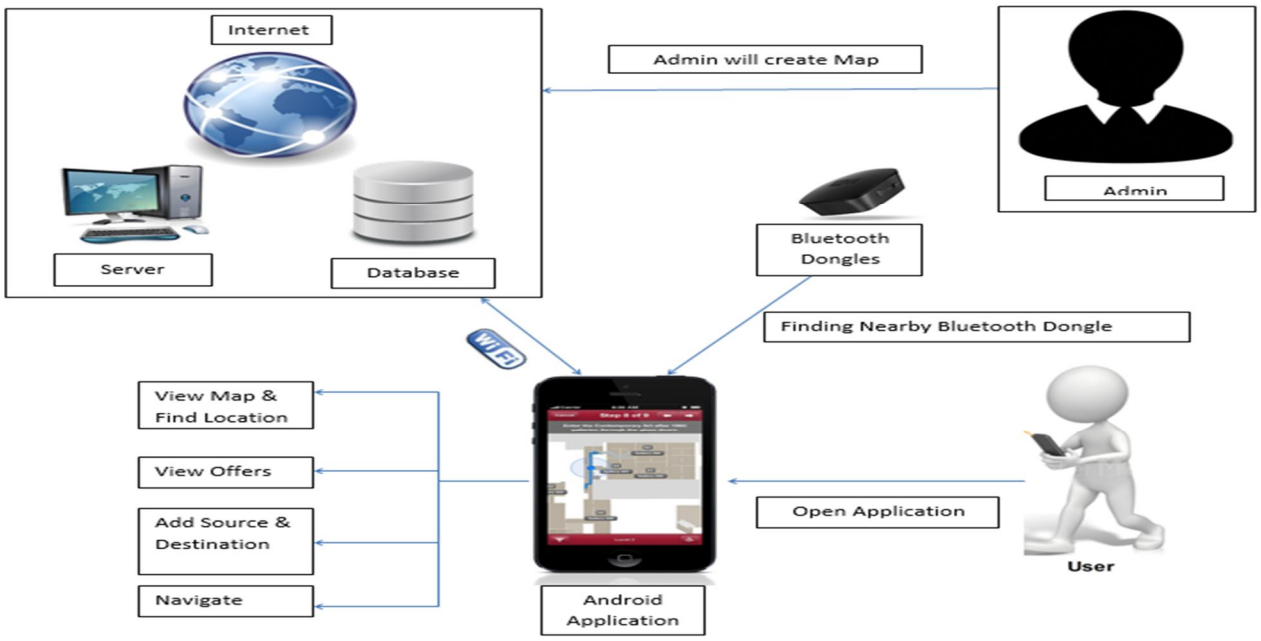


Fig. 1 Architecture Diagram of Indoor Navigation System for Mall

IV. IMPLEMENTATION AND RESULTS

A. *Results*

1) *Admin Application:* Admin application have successful implementation of managing Bluetooth devices, adding location, linking location, finding the shortest path and exporting data for android application. Every Bluetooth beacon has specific mac address with it. This mac address has been inserted in admin application using that the system can identify the Bluetooth beacon. Using this mac address as Bluetooth ID and pointing the location on the map the Bluetooth beacon get added in the database. Here for the reference the map of one floor of college has been taken.

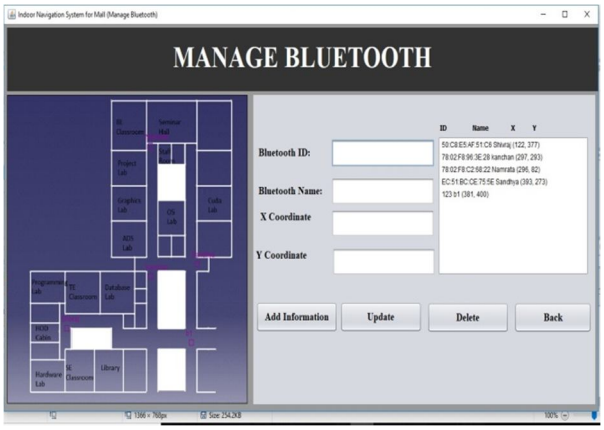


Fig. 2 Adding Bluetooth device location on map

Location on the map also been added using admin application with the specific offers. And these locations get link with the Bluetooth beacons so for finding that location the range of that specific beacon is must. Again this added location get linked with each other successfully so that a graph of locations can be formed which is useful for path finding. In admin application the shortest path also found out with the help of source and destination using Dijkstra's algorithm. It gives the exact shortest path too at all the trials.

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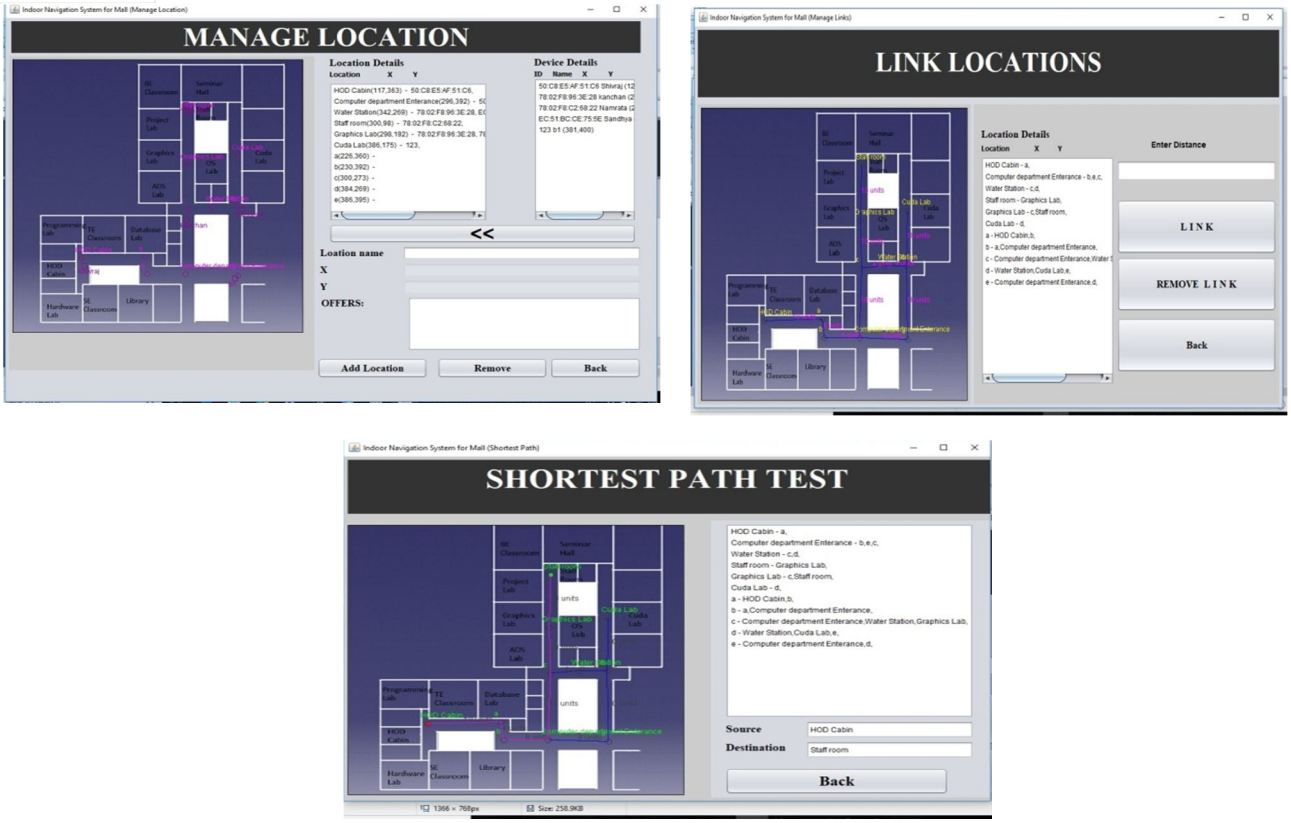


Fig. 3 Screenshots of location management and shortest path on system

2) *Android Application:* In android application user get an application specific for a single mall which gives the shop finding using Bluetooth and shortest path for navigation. After opening the application, system start finding nearby Bluetooth beacons and using the data from the database it shows the nearest shop or location. It also shows the offer of that nearest shop too.



Fig. 4 Screenshots of Shop localizing and offer displaying on android system

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User can add source and destination by clicking on the locations on map and the exact shortest way for navigation is shown on the screen. We tested system for many cases of finding shortest way and every time it found out to be correct.

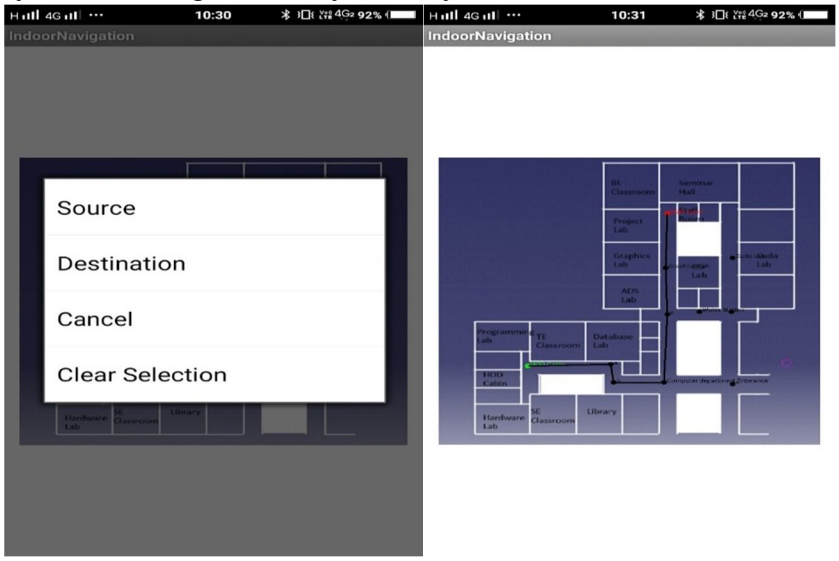


Fig. 5 Screenshots of Execution of shortest path display on android application

V. ADVANTAGES

A. Cost-effective.
B. Unremarkable hardware (it does not require any additional hardware).
C. Low energy consumption.
D. Flexible integration into the existing infrastructure.
E. Do not require any charge i.e. free of charge.
F. Bluetooth use wireless signal which having low power.
G. Bluetooth device setup Personal Area Network(PAN) i.e. Piconets

VI. CONCLUSION

We have implemented the system successfully using Bluetooth technology. This system can be used for shop localization and navigation of any mall. This system gives an energy efficient and cost effective system which helps you to enhance your shopping experience in the mall. The shopping experience gets enhanced by localizing your favorite shop and taking glance through its offers. The main advantage of using this system is that same system can be used by many malls without any change in software. We can extend this system for any other commercial buildings, museums, hospitals and many more.

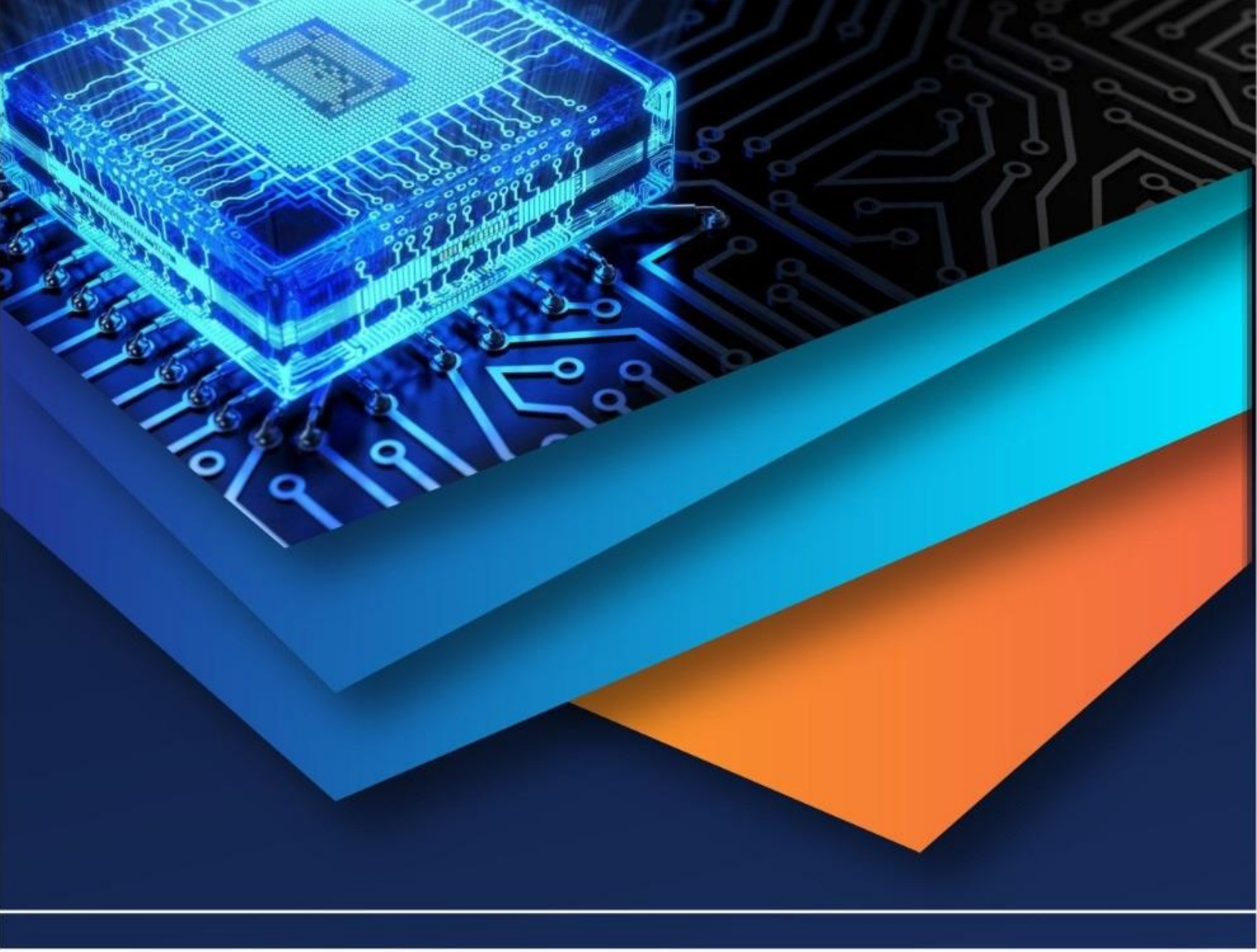
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