A Project Based Seminar Report

On

"Indoor Navigation System"

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By

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CERTIFICATE

This is to certify that the project based seminar report entitled "**Indoor Navigation System**" being submitted by **Manvi Pandya (71828960)** is a record as bonafide work carried out by him/her under the supervision and guidance of **Prof. R. R. Chhajed** in partial fulfillment of the requirement for **TE (Information Technology Engineering) − 2015 course** of Savitribai Phule Pune University, Pune in the academic year 2019-20.

Date: /   /2020

Place: Pune

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This Project Based Seminar report has been examined by us as per the Savitribai Phule Pune University, Pune requirements at Pune Institute of Computer Technology, Pune - 411043 on ....

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Abstract

Today the navigation systems are highly accurate with help of Global Positioning System (GPS) for outdoor navigation process. However, the lack of GPS signal reception inside the buildings makes indoor navigation process an interesting challenge. Most systems that have been developed so far lack the adaptability to changes that our system provides to the user.

The idea presents the design of an indoor space representation technique and an interface that will provide navigation feature for that indoor environment using a WebApp. The user is alerted with a link that directs him to our WebApp as soon as he enters the zone. Here, the user's role is to enter start and end location and the application provides the user with the optimized path. To find the shortest path Dijkstra's or A* algorithms will be used. For the implementation purpose Bluetooth Low Energy(BLE), iBeacons will be used. These devices emit continuous radio packets and were conventionally modelled for advertisements, and these signals can be used for positioning.

All that a user need is a smartphone. This system will be used especially in big industries, offices, shopping mall or college campus.

Keywords

Abreviations

Sr. No.	Abbreviations	Full form
1	GPS	Global Positioning System
2	BLE	Bluetooth Low Energy
3	IPS	Indoor Positioning System
4	GPSL	Google Play Services Location
5	RSSI	Received Signal Strength indication
6	PDR	Pedestrian Dead Reckoning
7	MAC	Media access control

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1   INTRODUCTION

1.1   Introduction to Indoor Navigation System

An indoor navigation system is a system that provides navigation within buildings. Nowadays, the majority of people use the Global Positioning System (GPS) for outdoor navigation processes. However, the lack of GPS signal reception inside the buildings cannot provide accurate navigation within a building and that is where an indoor positioning system (IPS) comes in. An indoor positioning system acts as a GPS, but specifically for buildings.

1.2   Motivation behind project topic

This project is motivated by the following challenges which we do not believe can be addressed by current approaches . It includes locating gate ,check-in counters at airports ,Helping patients find labs/doctors rooms ,Providing shortest path for patients and doctors during emergency situations ,Identifying location of all fork-lifts in the warehouse on a real-time basis,Remembering parking lot,locating and navigating to conference rooms in an enterprise,Helping with emergency exit during crisis and so many more.

1.3   Aim and Objective(s) of the work

Infrastructure items, such as hosts, can be broken into by a competing company to attain confidential information about its users and other data that is stored on the machine. This in turn allows workflows to be changed, i.e. by breaking in a system and patching the code-base or the platform itself, or simply by reverse engineering workflows and creating rogue clients.

Objective is to detect the position of the user automatically when in online mode ,to provide an application which will guide the user inside the building and show their progress while they navigate ,to provide the user with the shortest path to reach to the destination along with all the feasible paths ,to provide an admin panel to the owner of the premises, in order to enter the floorplan of the location and is also responsible for plotting points of features and possible paths,to help the user locate their friends if they are nearby/in the same building (Find a friend) and to provide users with paths to emergency exit in case of an emergency.

1.4   Introduction to Positioning Techniques

Positioning techniques is the most important aspect of the project. As the application's main aim is to detect the position of the user and provide appropriate path to the user. There are various positioning techniques used for the detection of the user's position. There is a requirement of a technique which is accurate, easy to install and which can be used by the user very easily.

2 LITERATURE SURVEY

2.1 An Indoor Positioning and Navigation Application for Visually Impaired People using Public Transport

This paper describes the results of a project setup at NAWI Graz Graz University of Technology Graz, Austria and was an indoor positioning and indoor navigation system for use in public transport systems, and especially for use by visually impaired people.An application was developed for outdoor indoor positioning and navigation between different modes and vehicles. It allows the user to request a navigation route and to compute all possible transportation routes for all available modes of transport.

Positioning is graph-based PDR approach that uses the tactile paths, is used with Bluetooth Low Energy (BLE) beacons, and combined with the default location provided by the smartphone(For Android devices, this default location is provided via Google Play Services).It requires three estimations including:Attitude Estimation , Graph-based PDR and Bluetooth Combination and Positioning service In Navigation ,Given start and target nodes, the shortest path is computed using Dijkstra's algorithm.

ADVANTAGES

1. It was made for both indoor and outdoor navigation and automatically switches between technologies (GPSL or beacons).

2. Since it was made specially for blind people,its results are accurate.

3. No additional infrastructure was installed and no additional electricity was used, an indoor positioning system was created that operates independent of additional infrastructure.

4. Voice Navigation feature is present.

DISADVANTAGES:

1. No admin panel.

2. Since it focuses more on accuracy it is very slow and thus can not be used by the general public.

3. It requires a tactile path, which is not there in developing countries like india.

4. A malfunction of the algorithm was observed if the smartphone flipped over .

5. Application is required to be installed (So users unaware of the app can not use it).

6. Application is only in regional language(German) which makes it difficult for people from outside to use the service.

This paper focuses more on accuracy than efficiency and is thus not useful for the general public who are visually paired where lack in accuracy will be managed (by a few meters) but optimised solution is required.

2.2 A Smart Indoor Navigation System over BLE

The proposed indoor navigation system is launched on the third floor, building 8, Faculty of Engineering, Cairo University In this paper, a smart indoor navigation system over BLE is demonstrated. It uses a Raspberry Pi board as a scanner. While using iBeacons for floor planning the scanned area. Then navigation is based on A* algorithm. Finally, a low-power consumption is achieved usingiBeacons with a good navigation accuracy using A* algorithm.Working Include 3 steps as follows:

- Trilateration: Trilateration uses the distances from each of the known locations to determine the coordinate of the unknown location .

- Particle Filter: The particle filter is a way of implementing the recursive Bayesian filter(compute estimates based on random samples).

- A* Algorithm: A* algorithm is an extension of the Dijkstra's algorithm.

Hardware used were Bluetooth Low Energy(BLE) , Estimote Beacons ,RaspberryPi.
Software used were Backend(LAMP Platform) , Frontend(Web page).
ADVANTAGES

1. It provides positioning with low power requirements.

2. It provides high accuracy by using A* algorithm.

3. User-friendly Interface.

4. Use of LAMP platform make it platform independent.

DISADVANTAGES

1. For positioning it uses triangulation method which is not very accurate so to increase it's accuracy particle filters are used which add up to the cost and complexities.

2. No Admin Panel .

3. It was designed for single floor.

4. Application is required to be installed (So users unaware of the app can not use it).

5. No additional features for users.

This paper provides high accuracy in positioning using Beacons and optimised navigation using A* algorithm which gives much better results than previous discussed technologies.But positioning using triangulation can be improved by using some different computation which further reduces need of particle filters.

2.3 Improved indoor position estimation algorithm based on geo-magnetism

In this paper , Positioning is based on the geomagnetic field . Most of the similar projects make use of particle filters .The particle filter improved the accuracy of location positioning. However,calculation cost can be high for multiple particles and can take longer time to estimate the accurate locations of users.Users also need to move a certain distance before determining their locations. In this paper, they introduced an algorithm that can decrease processing loads of the particle filter and can detect user locations more quickly

The experiment took place on the third floor of the electronic building of Yeungnam University The corridor was square-shaped, 67m wide, and 12m tall. The surroundings included spaces such as lab, office, and library.
Positioning includes 4 steps as follows:

- Measurement step, measures magnetic intensity of the current location using the magnetometer.

- Prediction step, generates N number of particles which are calculated for weight values via prior probability of previously generated particles with a number N.

- Weight update step, Gaussian density function is used for updating weight values.

- Resampling step, with a probability proportional to the weight value particles that are to be included in the new particle group

NN algorithm, pre-existing particle filter, and modified particle filter all three are implemented.

RESULT

- Particles are generated only in a few candidate locations using Euclidean distance.

- Since few particles are generated for weight value calculation, there are fewer numbers of particles that consume processing power causing less overhead issues.

- Locations can be estimated more quickly.

ADVANTAGES

1. High Accuracy is achieved with particle filter in less amount and time.

2. Geomagnetic field removes the need for additional infrastructure.

3. Algorithm introduced showed better results than previous results.

DISADVANTAGES

1. Using Particle Filter is still costly and complex.

2. It is suitable for ideal situations only(no noise or disturbances).

3. Real-time use is very difficult.

4. No Admin Panel

5. No additional features

This method provides accuracy but for a smaller and already known area which do not have much disturbances and noise which is practically not possible with any public place .Thus implementation in real-time scenario is not possible .

Table no. 1 Summary of other papers

Topic		Advantages	Disadvantages
Time-Efficient Indoor Navigation and Evacuation With Fastest Path Planning Based on Internet of Things Technologies	2019 IEEE TRANSACTIONS ON SYSTEMS, MAN, AND CYBERNETICS: SYSTEMS	1. Finds the fastest path and shortest path based on congestion 2. In case of emergency, provides closest exit without congestion 3. Friend's location can be detected	No admin panel
Mobile Indoor Navigation System in iOS Platform Using Augmented Reality		Augmented reality is more accurate	1. Starting point should be entered manually 2. Not feasible in new places 3. For accuracy purpose, gender and height is required of user (user specific)
Indoor Navigation System using BLE Beacons	2019 International Conference on Nascent Technologies in Engineering (ICNTE 2019)	1. Uses web app rather than traditional apps 2. Has admin panel 3. Dynamic interaction and adaptability to changes	1. Need internet connection 2. Fastest path is not provided

Topic		Advantages	Disadvantages
An Indoor Positioning and Navigation Application for Visually Impaired People using Public Transport	2018 International Conference on Indoor Positioning and Indoor Navigation (IPIN), 24-27 September 2018, Nantes, France	1. Both outdoor(GPS) and indoor(PDR) navigation system 2. Different modes are also shown including railway (Graz main railway station) to reach target point	1. Uses PDR algorithm which is very complex 2. PDR is not accurate as beacons 3. Uses tactile paths which is difficult to follow 4. Useful only for visually impaired people
Smart Indoor Navigation System over BLE	2019 8th International Conference on Modern Circuits and Systems Technologies (MOCAST)	1. A* algorithm 2. Beacon (accuracy upto 1m)	1. Need internet connection 2. No admin panel (Blueprint is a pre-requisite)
Indoor pedestrian navigation algorithm based on smartphone mode recognition	2019 IEEE 3rd Information Technology, Networking, Electronic and Automation Control Conference (ITNEC 2019)	1. Neural networks are used (accuracy 99.45%) 2. Heading correction method is used 3. Step length method is used to improve accuracy	Inertial sensors are required for positioning which is not practically possible (first aspect)

Topic		Advantages	Disadvantages
Using A* algorithm to find shortest path in Indoor positioning system	2017,International Research Journal of Engineering and Technology (IRJET), June -2017	1. A* gives a faster and efficient result. 2. A* uses heuristic to achieve better performance.	A* algorithm is hard to apply on 3D floor plan so 2D plan was used.
BLE Beacons for Internet of Things Applications: Survey, Challenges and Opportunities	IEEE Internet of Things Journal, Vol. A, No. B, Month 2018	1. Beacons have more accuracy than GPS. 2. Advertising is done using beacons which is of great use.	1. Beacons' batteries are need to be changes after almost every 5 to 8 years. 2. Also, there are some security issues with beacons.
Application of Augmented Reality in Campus Navigation	International Conference on Precision Machining, Non-Traditional Machining and Intelligent Manufacturing, 2019	1. It is a less time consuming process 2. Improved framework so that more users interacted in a synchronize manner.	1. It is very expensive to implement and develop. 2. Lack of security in as issue. 3. Low performance level.
A Survey of Positioning Systems Using Visible LED Lights	IEEE Communications Surveys and Tutorials, Vol. 20, No. 3, Third Quarter 2018	1. It is easy to install. 2. It is not affected with Radio Frequency systems	1. Data decoding is difficult. 2. It has low accuracy for positioning in corners or edges.

Topic		Advantages	Disadvantages
Improved indoor position estimation algorithm based on geo-magnetism intensity	2018 International Conference on Indoor Positioning and Indoor Navigation, 27th-30th October 2018	1. High Accuracy is achieved with particle filter in less amount and time. 2. Geomagnetic field removes the need of additional infrastructure. 3. Algorithm introduced showed better results than previous results.	1. Using Particle Filter is still costly and complex. 2. It is suitable for ideal situations only(no noise or disturbances). 3. Real-time use is very difficult. 4. No Admin Panel 5. No additional features
Indoor Navigation Using A* Algorithm	2016,Springer International Publishing AG 2017 T. Herawan et al. (eds.)	1. This application uses A* algorithm which is more efficient than Dijkstra. 2. The application displays the user's progress along the route and issues instructions for each turn.	1. The application is unable to locate the user; it can only know which floor the user currently locates through the input by the user. 2. The application only provides navigation in two-dimension (2D).

Topic		Advantages	Disadvantages
			3. The floor plan shown in the application cannot be zoom in or zoom out. 4. A* algorithm is hard to apply on 3D floor plan so 2D plan was used.
Indoor Navigation based on Linked Data at Honvéd Hospital, Budapest	2018,IEEE 12th International Symposium on Applied Computational Intelligence and Informatics.	1. The Linked Open Data technology is a form of the Semantic Web which exploits the advantages of data on the internet. 2. RDF is designed to store information in a flexible fashion	1. The challenge during the development was to migrate the data from RDF datatype into Neo4j database. 2. RDF database exposed some limitations considering the shortest path algorithm. 3. Neo4j is optimized for graph traversals and finding the shortest paths and spanning trees which is the disadvantage of Neo4j over RDF.

3 ABOUT PROJECT

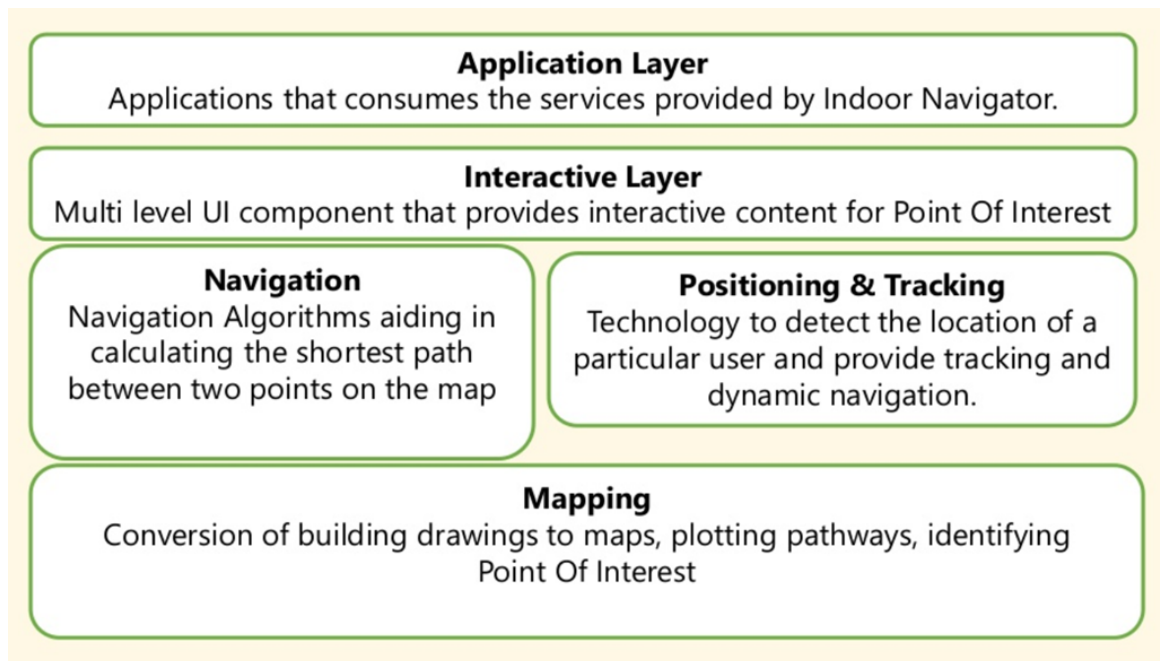## 3.1 TECHNOLOGY STACK

Figure 1: Technology stack

1. **Mapping**

   Mapping tools provides 3 Features including:

   - **Map Creation** Converts the floor plan image into suitable format and Identify details at different levels.
   - **Allowable Path**Allow admin to mark the paths , Provides Flexibility to user to choose among different paths
   - **Point of Interest** It includes conference rooms , elevators and other amenities like water-coolers.

2. **Positioning and Navigation**

   - **Positioning** We will use Beacon technology for Positioning of user.
   - **Navigation**We will be using A* algorithm for Navigation.

3. **Interactive Layer**

   - This layer helps user to interact with Point-of-Interest(presented as overlay above the map at specific location.)
   - Custom Interactive definitions are possible where another applications can be launched within the map.

- Example: To book a movie ticket.

4. **Application Layer**

   - All the services of Indoor-Navigation – Mapping, Navigation , Positioning and Interaction are exposed as Web-App Service that can be consumed by Application Layer.

   - This helps in having one common SDK for all platforms – iOS , Android , Laptop ,Desktop etc.
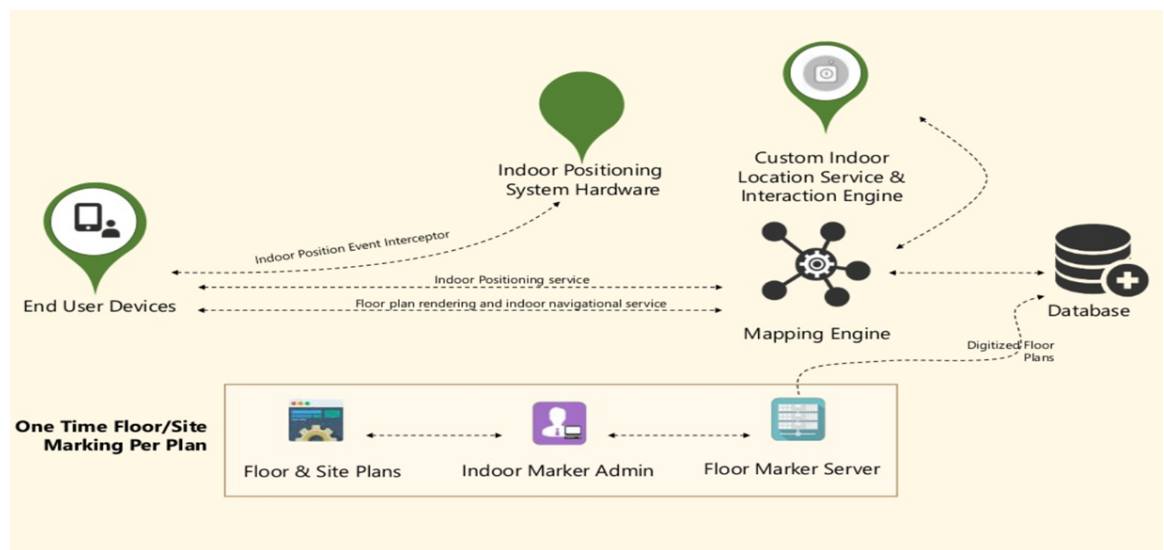
3.2   WORKFLOW

Figure 2: Workflow

1. Bottom most part of the diagram works as a mapping layer , this includes the floor plan of the premises which are used by the admin and stored in a database with the help of servers.

2. As soon as End user enters the circumference of the beacon a trigger is fired and an URL is sent to the user.

3. Clicking onto the URL takes the user to the web-app.

4. Position detected is first sent to the database via mapper.

5. Now users have to enter the destination.

6. Once done it is also sent to the database

7. Both the starting and ending position along with all possible paths are sent to interaction engine where A* algorithm works.And the most optimised path is sent back to End user device.

4 Applications of Indoor Navigation

4.1 Application

As the name suggests, its main application is finding the positioning of the user and then navigating him/her to the desired destination. Other Applications includes following :

- Indoor Marker Admin Allows Admin to Locate paths and points of interest.

- Share Location This feature will share your current location in building to other contact.

- Emergency Evacuation It finds the closest Emergency exit during a crisis.

- Find a FriendA friend gets a notification if other is in same locality.

- Location Based FeaturesProvides Indoor Local Information

4.2 Advantages

- This application can be used online as well as offline. So, internet connection is not a mandatory aspect.

- No need to install an application,it is a web-app as soon as the user enters the premises an URL will be sent.

- There is no need to enter the starting point manually. Users' location will be fetched automatically.

- Fastest and Shortest path is provided in this application.

- Admin panel is provided for the owner of the premises, in order to enter the floorplan of the location and is also responsible for plotting points of features and possible paths .

- During any emergency, the application provides users with paths to emergency exit.

- It also provides a feature to find a friend. It gives a path from user to the friend if the friend is present in the same campus.

4.3 Disadvantages

- The main drawback of this application is that it requires installation of multiple beacons in the campus.

- Maintenance of beacons is required. Every 5 to 8 years beacons' batteries need to be changed.

- Also, if some floorplan is added into the premises, more beacons are needed to install.

- If the floorplan provided by the owner is not accurate than it may lead in detection of wrong position.

5 CONCLUSION

Our indoor navigation system will consist of backend applications and client applications. Backend application will handle user authentication, persisting data and location data exchange between users. Client applications will be developed for Android and iOS mobile devices. It will provide functionalities of automatically locating users,navigating them to desired destinations via most optimised route, sharing their locations and showing their friends on indoor maps.

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