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Secured Wi-Fi based Indoor Path Traversal –IOT

Rubeena P.P[1], Prof. Manjunatha Reddy G[2]

[1]*M.Tech Student, Dept of CSE, BTL Institute of Technology, Karnataka, India*
[2]*Assistant Professor, Dept. Of CSE, BTL Institute of Technology, Karnataka, India*

Abstract - *To make navigation simpler an application has been proposed that helps us with the path to the desired destination within the campus, multi-storey building or an apartment for a legitimate user. It allows the user to find a location as quickly as possible with minimum effort and collaborate with other application users to benefit the experience of route planning. The GPS method for positioning works great outdoors but it is not suitable for indoors (secured buildings like star hotels, service apartments, college block etc.).The Proposed system helps in keeping the campus safe from intruders and it also reduces the time to search a person manually by going to their chalet. The accurate indoor location can be found out by using the DynoPath algorithm with the help of Received Signal Strength Indication (RSSI). The algorithm mainly focuses on calculating Actual distance, positions and accuracy to reach the desired location using bit transformation. It is bound to be secure as no data is going to be stored on cloud hence avoiding data breaches. It incurs some cost but at the price of high end security ,tracking of all the activities and most importantly the luxury of a user to get all the details regarding the person whom they want to meet at the fingertip. The effort is taken to provide routes that are as precise as an on-campus path would require.*

Key Words: Received Signal Strength Indication (RSSI), Path Traversal Tracking, DynoPath Algorithm.

1. INTRODUCTION

For a complex infrastructure like a campus or multi-storey building ,new students or people who are there for the first time have a hard time to find route to the place where they exactly want to go. Static maps are available at some points on the campus but users fail to get continuous help to get to their destination. Whereas it is very common to use navigation systems in personal vehicles to reach to designated locations, systems for pedestrian navigation are quite hard to find.

The Global Positioning System (GPS) is the leading technology to determine locations on mobile devices. Almost every Smartphone on the market has the capability to receive GPS signals. GPS is a freely accessible system based on satellites. While the GPS method for positioning works great outdoors it is not usable indoors, due to the fact that it needs a line of sight to at least four satellites. With an accuracy of 50 - 300 meters, the location tracking method using the mobile phone network is also not suitable. To determine a usable indoor location estimate, a different approach based on Wi-Fi technology is being used.

Our implementation of an android navigator application directs the user from his current location to the exact location he searches in the campus. It reduces the effort of the user to walk all over the campus. The user is authenticated by the security operator when he enters the premises of the campus there by providing the link to the application and the user has to register prior to using the application. Once he is done with the registration he can search for the person whom he wants to meet and if the person is available then he will be shown the shortest path to the destination and if not available he will get to know about the same at the entrance itself. These paths are represented using the bit values thus reducing any overhead and also misinterpretation of the data. We also make sure that the person traverses through the same path provided by the system by making sure that the security operator gets an alert in case the user chooses to deviate from the path provided to him. For this we use the Wi-Fi access points to know the exact location of the user while on transit. The easiest way to get a location estimate based on wireless networks is to use the nearest access point. This system is integrated into most of the access point management systems. It determines the access point to which a client is connected and based on the information of it, it computes how far the signal of this access point radiates. The client has to be in the range of this area.

The Received Signal Strength Indication (RSSI) is calculated using the newly proposed DynoPath algorithm by mainly focusing on calculating actual distance, positions and accuracy to reach the desired location using bit transformation. By bit transformation we mean that the path from the source to destination will be represented using 1's and 0's . For example we can provide the straight traversal as 1, right as 11 , left as 111, upstairs as 1111,downstairs as 11111 and backwards as 111111 and also for every 10m say we can represent the path with a 0 thus making sure that any third party can never make it out that it's representing any path.

Once the user is out of the campus, it will be made sure that the path he travelled will be automatically deleted in order to maintain any further security breaches. The main advantage of this application is that the routes are provided such that they are as precise as an on-campus path would require. Thus the user cannot use the application outside the campus area.

2. EXISTING SYSTEM

In this section, the already existing works on indoor and outdoor navigation methods are briefly discussed for comparison with our proposed method. The methods that can be used for the indoor and outdoor navigation are shown in Table 1.

	Outdoor	Indoor
Conventional maps	Yes	Yes
Global positioning system	Yes	No
Augmented Reality	Yes	Yes
Wi-Fi positioning system	Yes	Yes
Vision-based localization system	No	Yes

Table 1. Method for indoor and outdoor navigation

Map display contains some space or object and other elements in a certain area. Normal conventional map is a map that is printed on a paper. According to K. Salischev, map contains 3 basic components. The basic components are the content, mathematical base and legend of the map. The content shows the information of some natural and object in the map. The mathematical base shows the coordinate of a specific of object or etc. Besides that, distance of a block also specifies in the map. The third component which is the legend of map usually show more specific information of object in the map.

Global positioning system is a positioning method using the satellite as transmitter and GPS as the receiver. There are 24 satellites circling the earth and the system function by using at least 4 satellites. The satellite transmits signal to the receiver, time travel between transmitter and receiver also will be recorded to determine the position in three dimension east, north and altitude. Besides that, 2 types of data are needed by the GPS receivers which are the almanac and ephemeris. These 2 types of data ensure that the transmitter and receiver are connected to get the accurate positioning result.

Augmented reality is a method that applies live direct or indirect view of a physical, real-world environment whose elements are augmented by computer-generated sensory input such as sound, video, graphics or GPS data. This system requires the GPRS which obtains information about a particular geographical location which can be overlaid with tags etc. Images, videos etc. can be superimposed onto this location. In the navigation system, the system will show a virtual path that indicated at real world environment.

Vision base localization system is method for indoor navigation system. It uses QR code, bar code and other picture as marking for the location. Using scanner scan the marker can access the data based set by the developer where it will show the location of user in indoor. User may select the place need to go and it will start from the marker. The advantage is it simple does not require much hardware to establish connection between transmitter and receiver. The disadvantage is that it does not have real time navigation.

Wi-Fi positioning system is a type of method that can identify the location of the user in certain location. It can use for outdoor positioning and indoor positioning and location estimation performed by Wi-Fi is based on the following facts.

1. All Wi-Fi AP have a unique identification (ID) called Basic Services Set Identification (e.g. Medium Access Control (MAC) address).

2. Each Wi-Fi access point (AP) broadcasts its Basic Services Set Identification periodically.

3. Any Wi-Fi client can receive broadcasted Basic Services Set Identification from the Wi-Fi APs.

User location can be estimated by using Wi-fi AP location or using Data Slot Set Identification. There are several methods to estimate location and all commonly classed into 3 types that are proximity, triangulation, and scene analysis.

Two pass project methods are chosen for the proposed indoor and outdoor navigation which are the global positioning system and vision base localization system. Global positioning system is a method that position using satellite as transmitter and GPS receiver. The earliest function of GPS system only can navigate user to destination that user key in. As the GPS has been upgraded, new features are added such as the bookmark, time to travel to destination, etc.

According to the research paper by Krina Patel et al., they have created an application name UTour that navigate to tour create by the user. The application was build using android studio and it use Google map API to connect the application to Google map. The application is similar like Google map, using GPS build in the mobile phone to detect the location of user and when user search desire tour will show the routing to destination.

According to research paper by Claudia Barberis et al., they have tested the difference interfaces of the application such as 2D map and 3D map. For the navigation system, routes in a building are internally represented as a graph approximating the floor plans, where nodes are the turning points and edges are the path segments.

The route between two points is computed with a shortest path algorithm. However, from a user-cognitive point of view, this could not be the best option for large open areas, like those typically present in malls. The indication obtained from users is that when such spaces are transit area, they simply look for the shortest path between entry and exit “doors”. Routing algorithms was modified to change the application more suitable to use in specific location.

3. PROPOSED SYSTEM

We are proposing a system that allows the user to register and then get the routes that are as precise as an on-campus path would require. A user of our application enters the details of the person whom he wants to meet and if the person is available, he will be shown the shortest path to the destination and if not, he will get to know about the same at the entrance itself so he need not simply waste his time by manually searching the person.

Once he is out of the campus, the path he travelled will be automatically deleted in order to maintain any future security breaches. To determine a usable indoor location estimate, an approach based on Wi-Fi technology is being used. The easiest way to get a location estimate based on wireless networks is to use the nearest access point. DynoPath is a unique and an efficient algorithm being proposed here which is used for quick localization of target devices. DynoPath uses the fundamental rules of RSSI (Received Signal Strength Indication) that provides an accurate indoor location and environmental factor such as direction and distance instead of signal entries from access points. This help to guide the user to move gradually towards the direction of target.

DynoPath can be combined with either Wi-Fi to form a complete system for indoor tracking. Basic idea of DynoPath is to set the Smartphone as signal emitting source which send the signals and gradually draws the user in its own direction.

The main concern will be to improve the performance of our system than the existing ones with the use of existing resources, use of less frequency and use of simple encryption. It is also bound to be secure as no data is going to be stored on cloud hence avoiding data breaches.

4. SYSTEM ARCHITECTURE

Fig 1 gives a quick overview of all components of the system environment and shows how they interact with each other. Arrows indicate the communication direction.

The admin maintains an open directory, which provides any kind of address information regarding university staff (e.g. name, telephone numbers and offices). It is then accessed by the server. It also stores data such as Wi-Fi access point data. It is accessed by the server via JDBC. The admin updates and sets the path in the database periodically.

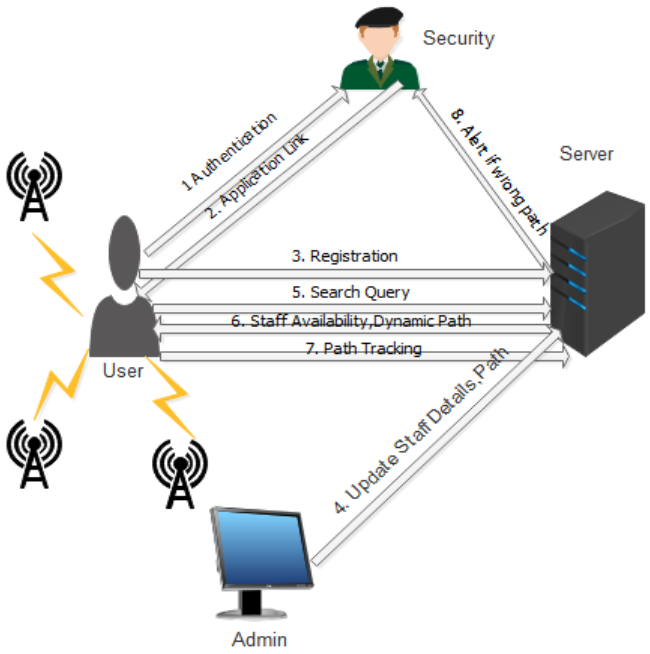

Fig 1 : System Architecture

The user on entering the premises will be authenticated by the security operator who then provides the user with the application link by email. Once the user registers himself, he will be provided with a unique id which will be used further for path tracking. On search he will be given the path to the destination which already exists in the database. In the application the path will be shown in the format of lines but the path is actually represented using the bit values so that it's difficult for the intruders to manipulate the data.

The main server is the central information source for the clients. It handles the computation of the indoor location based on the Wi-Fi signal strength provided by the admin. It also alerts the security in case it finds that the user is not traversing through the path in which he is asked to traverse.

Clients in this system are Smartphone. They consume the information of the servers and display it to the end user.

Security operator is the one who checks the authenticity of the user at the entrance using the available data at the server.

There are four main modules of this system. They are

User Module

The main user of the proposed application will be user. A user easily gets the access to the path to person whom he wants to meet by just installing the application.

The steps to be followed by the users of this system are

- Once security finds that the user is a valid person , the user will be sent a link from where the application can be downloaded.

- The user needs to then register with basic information.
- User will be asked whom to meet and once the person name is entered the user will get the details if the person is available or no. If available, the path to the destination will be showed else the reason why the person is not available will be displayed.

Admin Module

Supervisory powers are all handled by the admin.

Main functionalities of this module are

- Access to all the attendance details of the staff members so that if a user comes in searching of the staff they get the details of their availability.
- Block any type of user in case he feels they are not a valid user.
- Access to all the meetings held, appointments of the staff etc.

Employee Module

Employee is the staff who can also use this application.

Main functionalities of this module are

- Employee can download the application and update his status if he is not available.
- Employee can also use the application to get the path to any other person he wants to meet.

Security Module

Security module is the one who checks the authenticity of the user at the entrance.

Main functionalities of this module are

- Sends the link to the user once the user is authenticated.
- Will have the details of all the employee availability.

5. IMPLEMENTATION

The proposed system will have one web application for the admin and one application running on the smart mobile. The smart mobile user first downloads the application once the security identifies him as a legitimate user. With the desired employee or staff name a user can search for the desired employee or staff and can enable the navigation to reach to the destination. The system takes the assistance from the mobile sensors as the main concern is to look for low battery consumption and for the more accurate location of the smart mobile in indoor location. As the user behavior can't be guessed because the user might be at one position or he can take the turns but the speed variation of all these behaviors can be pointed out using the accelerometer and the orientation sensors in the Smartphone itself. These sensors send the location samples to the server and those are plotted on the map and the trajectory is made. The mobile sensors and the Wi-Fi routers can be used for the indoor localization because of the accuracy and the consumption of less mobile battery. DynoPath is a unique and an efficient algorithm being proposed here which is used for quick localization of target devices. DynoPath can be combined with Wi-Fi to form a complete system for indoor tracking. Basic idea of DynoPath is to set the Smartphone as signal emitting source which send the signals and gradually draws the user in its own direction.

It is mainly divided into two phases. The first phase is the user validation phase and the second one is the path traversal tracking phase.

In the User Validation Phase the following step occurs.

- The user upon entrance at the premises will be authenticated by the security personal and if he is a genuine person then he will be sent the email having the application link where he can download the application and install it followed by the registration using some of his basic information.
- The user will then be provided with an unique id which will be used to track the path he is travelling and also for passing this users information to the valid Wi-Fi's which comes under the range of the valid path in which he is supposed to travel.

In the Path Traversal Tracking Phase the following steps will take place.

- The path from the source to destination will be represented using bit values i.e 1's and 0's For example we can provide the straight traversal as 1, right as 11 , left as 111, upstairs as 1111,downstairs as 11111 and backwards as 111111 and also for every 10m say we can represent the path with a 0.
- The user is supposed to travel through this path else an alert will be sent to the security . For this path traversal tracking, DynoPath algorithm uses the fundamental rules of RSSI (Received Signal Strength Indication) that provides an accurate indoor location and environmental factor such as direction and distance instead of signal entries from access points. Each of the Wi-Fi access points that are in the range of the valid path will be sent the system generated unique id of the user so that if the user comes in any other Wi-Fi range an alert will be sent to the security.
- Unlike the existing systems we make sure that the user doesn't deviate from any position enroute the specified path thus enhancing security.

The below activity diagram shows how the entire process takes place.

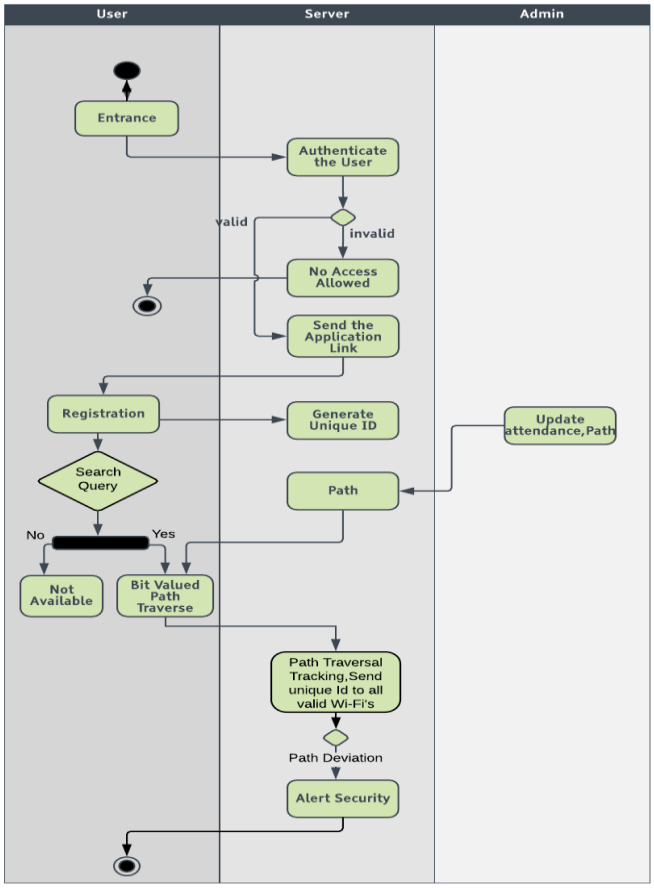

Fig 2 : Activity diagram

In short the pseudo code for Path Traversal Tracking algorithm is divided into four parts.

- Selecting the start point: - Choose the starting point of the target search manually.
- Get the path set by the admin from the server which is represented using bit values i.e the path from the source to destination will be represented using 1's and 0's . For example we can provide the straight traversal as 1, right as 11 , left as 111, upstairs as 1111,downstairs as 11111 and backwards as 111111 and also for every 10m say we can represent the path with a 0.
- Calculate the RSSI reading: - Place the receiver facing towards all four directions and calculate the distances once he has started travelling from the suggested path.
- Provide all the valid Wi-Fi's with the users unique id that comes in the range of the suggested path. The rest of the Wi-Fi's will not be having this id so that when a user comes in their range they can check if the user unique id was provided to them else the Wi-Fi can alert the server which will inturn alert the security. In this way the user can be tracked as he has deviated from the suggested path.

6. CONCLUSIONS

The navigation proposed here can be an effective application in wide areas such as college, hospitals, multi-storey buildings, apartments etc. The strength of this application is the easy to use navigation feature which is able to find paths on campus to user defined locations without much waste of time for manual searching. A new tracking system that relies on Wi-Fi and mobile device is being introduced. Thus making the best utilization of the existing infrastructure available in an organization and making the deployment of the system most commercially viable by using technologies that are already available to the consumers. The tracking of path travelled by user and then intimating it to the concerned personal is what has not been implemented till date which is taken care off in our implementation. Thus there is no security breach which is the most important issue to be considered in the current scenario.

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