Wi-Fi Assistant Triangulation and Navigation System for an Indoor Environment

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Abstract—*A navigation system allows a person to traverse a path from an initial to the final position such that it is most efficient and easy to use. Various technologies used for this purpose are RFID, Bluetooth, Infrared, GPS (geo positioning system), and Wi-Fi. Technologies like GPS work perfectly well in an outdoor environment but the signals are very weak inside a building or premises (like schools, mall, hospital etc.) and technologies like RFID and Bluetooth have the limitation in range where the signals can reach. Navigation assistant system (NAS) instead uses WIFI technology which when used with techniques like triangulation helps in tracking, positioning and navigation to fulfil user's need. This system allows user to download already plotted maps for the purpose of navigation. Triangulation method utilizes Wi-Fi routers which already exist inside the building infrastructure for the purpose of localization. User is provided automatically with the shortest and most efficient path to any destination for navigational purposes. The service of saving location is provided so that it can be used any time in the future to return to the required destination via the shortest path.*
A user of this system has the access to Calendar which consists of various events, offers held at the premises on some date in the future and user can also track their friends. It's a simple system which can be learned and used very easily by any smartphone user.

Index Terms: *Navigation, Position determination, Wireless sensors, Site Plotting*

1. INTRODUCTION

Wireless fidelity (Wi-Fi) another term for WLAN has the usability for networking various devices together through signals sent from various WIFI routers. WIFI works with the concept of received signal strength (RSS) which is utilized by navigation assistant system through smartphones which uses these signals for the purpose of localization and tracking. As mobile handheld devices has the capability to capture the Wi-Fi signal strength through Received signal strength (RSS).Wi-Fi routers detect (RSS) signal to locate the User's location. Localization of a system can be achieved through the Wi-Fi access point which is already installed in an indoor environment. When user entered in the premises includes mall, campus, hospital, etc. then this navigation system helps the user for turn by turn navigation and provides the exact location. Firstly a sensor called Wi-Fi is inbuilt sensor which

is already installed in the smartphones and secondly in the closed buildings the Wi-Fi is already available. Triangulation method is used which uses three or more WIFI routers to localize the user. Wi-Fi routers are used for signal strength as the signal strength is an important aspect of positioning the user in an accurate way. Therefore three routers are used with strong signal strength so that the exact position of user can be displayed. Navigation can be achieved by controlling and maintaining user orientation from one place i.e. source to the another place i.e. destination. To navigate the user inside the premises maps are required which are already stored in the database by the administrator. Site creation and site definition are the two responsibilities of an administrator who designs the custom maps. Site creation is a process of canvas creating on which map can be plotted. Now the image is uploaded on the canvas thus pixel of that image should match the canvas. If maps are not available or stored in database then the Creation and uploading of map is done by administrator. Site definition is another process where admin defines the north of the maps, specify the indoor objects like walls, rooms define the path and routes and then it is uploaded for the user.

When user visit a site various functionality is provided to the user by downloading maps user can navigate throughout the premises. User can download the site image as well as upload the maps which will be used by administrator. Administrator plotted the map on the canvas and then will be downloaded and used by user. By Navigation assisting system user find their exact location and if the current location is displayed then user needs to enter the require destination through shortest distance user navigate turn by turn along the path to their destination. If user want to save location then while navigation the user can save the outlet location and if they want to save parking spot then this can be easily saved and located.

User can also browse the offers, events or upcoming calendars and communicate with other person who already in the premises and installed this application in their devices.
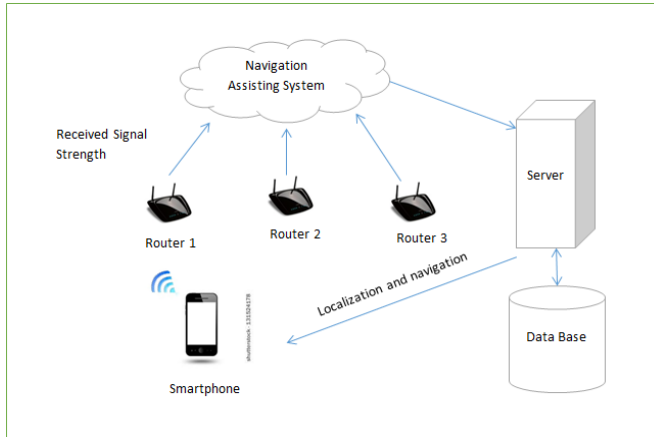
Fig. 1: Navigation assisting system

2. BACKGROUND

While presenting the Navigation assisting system approach, here first focused on the various approaches used for an indoor environment. Many potential techniques and approaches are developed to navigate and localize the user. As these potential techniques are Geo positioning system (GPS), Radio frequency identification (RFID), Bluetooth, Infrared, Cell tower and Wi-Fi. GPS is widely used for an outdoor environment as it is inadequate in an obstructed area. GPS is continuously improving for an outside areas it shows accurate position of user for navigation and localization. Bluetooth is a communication device which is used for few meters. The range of Bluetooth is inadequate for large distance communication and it is very expensive for implementation. RFID is very commonly used technology which is implemented to identify the tag id of users. The locator and identifier are the two entities which is costly but reliable and adequate. Locator captures the tag id which are attached in premises or entrance and tag id is given to the user through which locator identifies user presence. But hardware and other proprietary devices is very cost effective. Infrared is a pioneer technology which is limited to a short distance but its accuracy inside the building is very high. Due to its limited range of network it is not impressive for localization and navigation and the cost of sensors and hardware installation is very high. Cell tower uses communication network area where the range or strength of signal is determined. Cell tower has cell Id and cell of origin through which communication between mobile handheld devices occur. But the cell tower techniques are not used as it is very limited and it is unavailable in buildings or closed environment. Wi-Fi is widely used technology which is easily available everywhere nowadays. Range of Wi-Fi is relatively high as compared to other proprietary devices. Wi-Fi routers are used to localize the user in the closed environment and due to these routers the signal strength is measured. Wi-Fi is adequate technique for an indoor environment as it penetrates the closed area where GPS are unreachable. Wi-Fi is technology which is used in navigation assisting system.

There are various positioning approaches have been developed for localization and navigation system. Cell of origin which is used for cellular mobile communication is inaccurate in buildings. This technique is useful for outdoors. Other techniques are angle of arrival, Time of arrival, angle difference of arrival and time difference of arrival which is defined using signal strength and propagation time. The accuracy and performance is depending on the synchronization and propagation delay. These techniques require additional hardware i.e. base station for determining angle and orientation sensors to locate the user. Localization fingerprinting is another positioning technique which is used for sensors calibration and highly accurate but its complex implementation method is time consuming as it uses algorithm called matrix correlation which is used to locate the exact position. Triangulation is a method which requires three or more routers to locate the user.it requires wireless signal strength to estimate the location of user. As this method is easy to implement and simple to use.

3. SYSTEM DESIGN

In proposed system the various modules are integrated in a single unit which provides functionality for navigation assisting system. Starting of the system various features are as follows:

- Firstly the system provides the scanning functionality through which a list of sensor is displayed. The range of WIFI signal is detected in the smartphone.
- Site creation and definition are the main functionality done by administrator. Thus administrator uploads the image which is available to the user so that from the server user can download the map.
- To find the pinpoint location of the user, the Wi-Fi makes use of triangulation method which received signal from three routers available in the premises.
- When user specifies the destination then the system plots the route from source to destination and provides the efficient path to the user to go.
- The location where the user wants to go later would be saving so that the user can easily navigate.
- The facility of browsing offers events and upcoming calendar is provided to the user.
- The communication between friends who are inside the premises can be done and locate them in the premises.

The modules which are developed integrate to the system i.e. navigation assisting system is:

There are two users i.e. Administrator and smartphone user.

3.1. Admin application

3.1.1. Map creation. Admin is responsible for creating custom maps and uploading maps for the user if maps are not available. The canvas is created where the maps are uploaded and the image is mapped. It connects the point which is set by the admin i.e. XY coordinates of the rooms, corridor etc. All the points are connected to display the efficient path which available to the user to go along the routes.

3.1.2. Map definition. In this functionality administrator defines the rooms, set the path and set the north for the user. The definition of map defines the path between the locations, defines the scale of image which is to be mapped on the canvas. The pixels of image are converted into meters which are defined by the admin So that user location on the floor plan is displayed correctly. This map is uploaded on the dedicated server for the user.

3.2. User centered application

3.2.1. Map download. Map can be downloaded and provided to the user when he entered in an indoor environment or visit the site i.e. mall, campus, hospital etc. The maps are available on the server which is created by the administrator.

3.2.2. Scanning. The sensors are used i.e. accelerometer to help the user for performing tracking functionality.

3.2.3. Wi-Fi Positioning. This functionality allows user to find WIFI signal and reads them so that the position of user can be localize and track the exact location which is plotted on the canvas.

3.2.4. Navigation. Through the current location of the user, the dedicated path is to be defined and plotted thus from source to destination the user can easily navigate. Here the dedicated path is plotted along with user can travel correctly.

3.2.5. Save location. This function is provided to the user so that he can save the current location or any other spot where he want to go or thus bookmark the place to go. Like parking spot thus user save the parking place when he come back then through save location the spot is located easily.

3.2.6. Browse Offers and events. By using calendars and browsing them the user gets the information about the events and offers. Thus upcoming schedules are facilitating to the user and this function is utilized efficiently and actively.

3.2.7. Find friends. By using find friends the user track their friends who are inside the premises and using the same system in their smartphone. Thus this system enables users to communicate with each other.

3.2.8. Feedback. The utility of this function is to provide user the facility of reviewing or comment about the system.

4. ALGORITHM

4.1. Triangulation method

WIFI routers are used to localize (to find the exact position of the user) user through a concept called triangulation method.

Triangulation as the word indicates requires use of three WIFI hot spots for the localization purpose. It requires two main things:

* Signal strength
* Coordinates

Received signal strength based triangulation is used in this system. As it play a vital role to localize the user in the perimeter which was enclosed in certain environment. Even though using router there is always an issue of signal strength thus by using at least three routers the signal strength obtained is good and the user is easily located. For an outdoor environment it's not a big deal but for indoor environment it is required that the signal strength is measured and certainly used to determine the position of user on the floor plans.

4.2. Map matching Algorithm

The image is uploaded on the canvas, to load the image on it first the pixels are converted into meters and then set the rooms and paths, specify the north and distance between the two points are defined after performing these task the map is matched to the exact premises or floorplan. Thus to provide the pinpoint location to the user map matching algorithm is used.

4.3. Navigation Queries

Navigation queries is used which is in simplified manner and the stored procedures are created using dedicated SQL server. The queries make use of the user current location and thus provide the destination path which is already plotted by admin on floorplans. Navigational queries assemble all the utility of premises thus by plotting the XY coordinates on the map admin set he points. Admin facilitate the link between the two points and specify the distance among them using navigation queries. Optimizing the nearest point to move on the admin creates the path and thus efficient path is provided to the user. Navigation query uses the criteria on which the user moves along the shortest path to the target.

5. SYSTEM IMPLEMENTATION

Navigation assistant system (NAS) uses the WIFI technology and triangulation approach to locate the user. Android platform based programming and libraries are used. Eclipse SDK package and web services are used to provide the processing libraries and dataset. To calculate the pinpoint location of user, signal strength is measured through triangulation method which uses at least three routers, less than three routers drops the accuracy. Site creation and definition is introduced by administrator which is then uploaded on the canvas. Custom maps can be created using pixels rendered on the scale. The maps are uploaded on the canvas and then the pixels are converted into meters. By setting XY coordinates the rooms and corridors are defined. By map matching algorithm the system specify or match the

north, rooms and determine the location distance using sensors data on the floor plan. As map are uploaded and stored in database thus to track the user on the underlying floorplans map matching is done. Navigation Queries is used to navigate the user from source to desire destination. Navigational procedures are used through setting their points on the map user can easily navigate to their destination. The efficient and shortest path is provided to the user so that he can easily navigate in an efficient time. User can save location and browse offers and events through the server. By Find friend's functionality user can track friends and other members for communication. By Using functionality of feedback user send reviews and comment on the Navigation system.
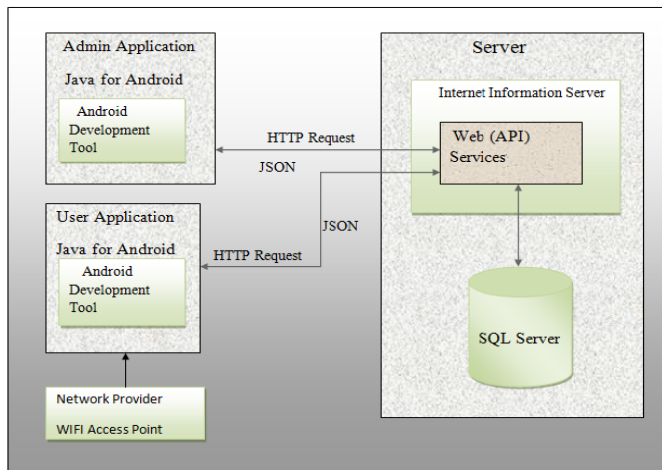

Fig. 2: System Implementation

6. EXPERIMENTAL ANALYSIS

This system is developed in Eclipse IDE (integrated development environment) with android. The measuring device is used called smartphone through which the following functionality is analyzed and the experiments are shown. The final outcomes for NAS (navigation assisting system) of various modules are as follows:
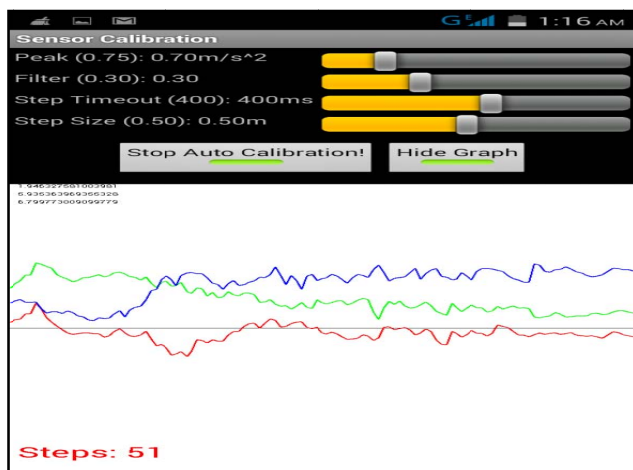

Fig. 3: Sensors calibration

Fig. 4: Navigation system

7. CONCLUSION

Navigation assisting system is a system which integrates all the functionality into one and provides the effective results to the user Administrator creates the site map for the premises providing XY coordinates to the rooms and corridors. Bitmap images are used where pixels are converted into meters. By setting north the direction is determined and the points are to be set from source to destination. The efficient path is provided to the user for navigation in this functionality administrator defines the points and marks the distance between the locations. The user can save the spot for where he willing to go later on. It provides the browse offers and events for upcoming calendar. Find friend is another functionality where user can track their friends their location is displayed in the system. The user can give feedback and their experience about the system. This paper provides all the functionality which is according to the user when they are inside the premises. This system works effectively and efficiently for the user by detecting WIFI signal in the smartphone.

8. ACKNOWLEDGEMENTS

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