ISSN No:-2456 –2165

Indoor Navigation System for Firefighters
(Fireguide System)

Bhavana Sangare[1], Sahil Mulla[2], Shailaja Mishra[3], Ajitkumar Khachane[4]
Department of Information Technololgy, Vidyalankar Institute of Technology, Vidyalankar College Marg, Wadala East, Mumbai, Maharashtra 400037

Abstract—A navigation system is a system that aids in navigation. Firefighting is an alarming job to perform as there can be several unpredictable threats while rescuing victims. Since the firefighters are not aware about the internal structure of the fire ridden building, they will not be able to find the location of the EXIT door, a fact that can prove to be catastrophic. We introduce an indoor navigation system (FIREGUIDE) using RFID technology.

Keywords—Indoor, Navigation System, Firefighters, RFID, Shortest Route Application, FIREGUIDE.

I. INTRODUCTION

Firefighters put their own lives in danger to save innocent people trapped inside a building encompassed by fire. The frame of mind of firefighters during a rescue operation is not completely steady due to loss of visibility, urgent condition of victims and many other environmental factors. In such a situation, if the firefighters get puzzled about the location of the nearest exit door, then lives of both firefighters and victims are imperiled.

To address these issues, we introduce the FIREGUIDE system which combines indoor localization using passive RFID technology implemented on an Android Smartphone. The firefighter will carry an Android Smartphone and a RFID glove. In the environment, we set up passive R-tags tags (RFID-tags) on the walls and along the baseboard. The system also includes a FIREGUIDE server that stores information about the building and calculates the directions to the closest exit. It is evident that the FIREGUIDE system will save a significant number of firefighters and victims lives. We envision that FIREGUIDE can be provided as a subscription service to the fire departments. For wide deployment of such a system, each commercial building will be required to deploy the proposed infrastructure and share the building blueprints and tag deployment with such a service provider.

II. FIREGUIDE SYSTEM

FIREGUIDE uses multiple wireless technologies, (RFID and Bluetooth module) to collect information required to calculate a firefighter's location and transmit this information to the FIREGUIDE application.

RFID: Radio frequency identification is an automatic ID system. An RFID tag provides a unique identification code that can be read by a scanning device, like a barcode or the magnetic strip on a credit card.

Scanning Range: An RFID reader can scan a tag as long as it is within frequency range. It does not have any line-of-sight limitations.

RFID Costs: RFID systems bring their own cost benefits, such as reduced labor costs and improved efficiency.

Speed and Convenience: RFID readers can scan tags in milliseconds and work automatically.

FIREGUIDE system includes two different applications to guide a firefighter towards the EXIT doors.

1. Shortest Route application
2. Audio Instruction database

III. FIREGUIDE SYSTEM ARCHITECTURE

The FIREGUIDE system architecture consists of the following components:

- Environment- Passive RFID tags (R-tags) deployed in the building.
- User Device–RFID glove and the Android based Smartphone.
- FIREGUIDE Server–FIREGUIDE server stores the unique ID (of deployed R-tags), corresponding images to the exit, respective audio instructions, and communicates with the user device.

A. Environment:

1.

The environment includes passive RFID tags (R-tags) providing very accurate location information.

Passive RFID tag (R-tag): R-tags are densely deployed in the building. They are located at baseboard level and at each door of the building at a 4ft height. Granularity was the main reason behind selecting this technology for our system. Proximity of 2-3 cm is required to transfer data from an RFID tag into the reader. Other reasons for selecting these R-tags were their cost and the fact that they do not need an active power source.

Fig.1

IV. FIREGUIDE CLIENT MODULE

This section describes the client software which includes the RFID glove and the Android Smartphone for visual representation.

A. RFID Glove:

The RFID Glove allows the user free use of his hand as well as the ability to scan an R-tag.

Fig 2: RFID Glove (back view) Scanning an R-Tag

Fig 3 Front view of RFID Glove

Fig 4: Picture of Surroundings of Room 312

The R-tag is scanned by placing the palm on top of R-tag. The glove communicates the unique ID represented by an R-tag using Bluetooth technology to the Android Smartphone. There are 2 buttons (Button A and B) present on the glove. Both buttons perform different functions implemented in Smartphone to guide the firefighters with the navigation. When R-tag is scanned by the firefighter, the shortest route leading to the nearest Exit door is displayed on the Android Screen (see Figure 4). If this shortest route is infeasible to reach, then the firefighter has another option to find an alternative Exit door. The firefighter can press Button A to switch to the Alternate view that will display the shortest route to alternate nearest exit, along with the audio instruction playing in the background. With the help of the shortest route, the firefighter will know how to reach the nearest Exit door in the smoky environment (where visibility is almost zero). that will display the shortest route to alternate nearest exit. The firefighter will be presented a picture of his surrounding (with clear visibility). This picture will include the Left side view, Right side view and/or the view behind the firefighter. Figure 4) shows the

surroundings of Room 312 assuming the firefighter is facing towards the R-tag deployed in the corridor near Room 312.The firefighter will press button B if he wants to repeat the audio instruction again.

B. Android Smartphone Applications:

Android Smartphone provides great features to build multiple applications in one single application. Android client module consists of Bluetooth module, Android basic Drawing APIs, OpenGL libraries, and shortest route applications.

V. FIREGUIDE CLIENT ARCHITECTURE

The description of each module is as follows-

A. Bluetooth Module –

V.

The UID of R-tag scanned by RFID glove needs to be transferred to the Smartphone hence Bluetooth Module is used. As soon as the main application starts, Bluetooth service is initiated as a background thread. Bluetooth service starts running as soon as the application is turned ON. There is a constant handshake between Bluetooth and RFID glove at short intervals. If handshake signals are not received for a time interval then it signifies that the Bluetooth is disconnected. A new connection is made as soon as it is acknowledged that the previous one is broken.

FIREGUIDE system uses multiple wireless technologies such as Bluetooth module and RFID.FIREGUIDE system includes Shortest Route application to guide a firefighter towards the EXIT doors.

VI. SHORTEST ROUTE APPLICATION

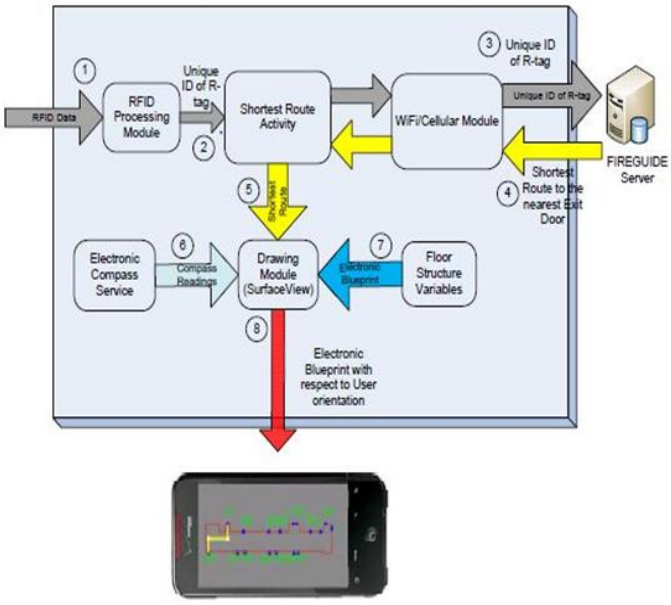

Fig.5: Shortest Route Path Application

A. RFID Processing Module:

Every R-tag has a unique identifier (UID). On scanning an R-tag, the RFID processing module extracts the UID and sends it to the server over a Bluetooth network.

B. Shortest Route Images:

For each R-tag corresponding images of shortest route to exit will be stored in the database along with the written instructions on the images which will guide the firefighter to the nearest exit. If in case the provided shortest route is blocked then alternate shortest path images will also be stored in the database and will be displayed when the firefighter presses button A for displaying alternate shortest route images.

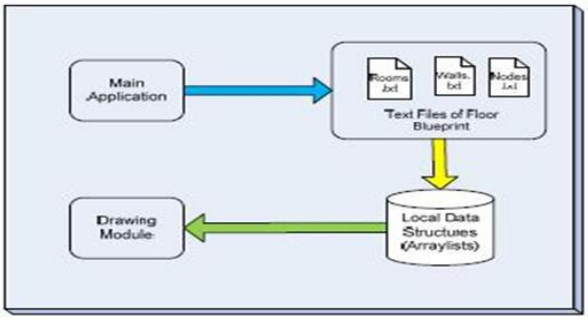

Fig. 6: Parsing of Floor Blueprint

C. Flow of events in the Shortest Route First is as follows:

1. Start
2. Firefighter scans the RFID tag using the RFID Glove.
3. Unique RFID number is read by the RFID receiver.
4. Bluetooth module transfers this ID to the Server.
5. Server accepts the ID and passes it as a parameter to the shortest route module.
6. After designing the shortest route path using the Dijkstra's algorithm, it retrieves the associated audio file and the clear images of the surrounding (left view, right view, front view) from the server.
7. Audio instruction starts playing and the shortest path is displayed on the FIREGUIDE application.
8. If Firefighter presses button A, alternate shortest path will be computed and will be displayed on the screen.
9. If firefighter presses button B, audio instruction is repeated.

VII. CONCLUSION

We are using java to develop the Android based client software and C# for the server application. Postgre SQL database with Post GIS libraries is used to answer each query. To avoid the cost of a cellular data plan, we will use a Bluetooth module between the Android Smartphone and the server. In a real environment a cellular data connection must be used. The R-

tags will be deployed at every door. User will carry a RFID glove and an Android Smartphone enabled with the Bluetooth.

A. Testing the correctness of instructions provided for navigation:

User will walk to each door and scan the R-tags deployed on the door the shortest route to the nearest exit will be displayed on Android Smartphone..

REFERENCES

[1]. Wireless sensor network, Wilson J., Bhargava V., Redfem A., Wright P, "A wireless sensor network and incident command interface for urban firefighting, Proceedings of the 4th Annual International Conference on Mobile and Ubiquitous Systems: Computing, Networking and Services, MobiQui-tous 2007 " https://dl.acm.org/citation.cfm?id=1549074

[2]. Wearable Computer Orientation System, D. Ross and B. Blasch, " Development of a Wearable Computer Orientation System, In Personal and Ubiquitous Computing, 6:1, pp. 49-63, 2002. "

[3]. Willis, S. Helal, " RFID Information Grid for Blind Navigation and Wayfinding, Proceedings of the 2005 Ninth IEEE International Symposium on Wearable Computers, 2005."

[4]. Indoor Navigation for the Visually-impaired, V. Kulyukin et al, " RFID in Robot-Assisted Indoor Navigation for the Visually-impaired, Proceedings of the IEEE International Conference on Intelli-gent Robots and Systems, October 2004. A.M. Ali, M.J. Nordin, Indoor navigation to support the blind person using weighted topological map, International Conference on Electrical Engineering and Informatics, 2009."

[5]. Sensing Surrounding, N. Bourbakis, " Sensing Surrounding 3-D Space for Navigation of the Blind, IEEE Engineering in Medicine and Biology Magazine, Volume: 27 , Issue: 1 pp 49 55, Jan.- Feb. 2008."

[6]. Audionav, N. Fallah,"AudioNav: a mixed reality navigation system for individuals who are visually impaired, ACM SIGACCESS Accessibility and Computing, Issue 96, pp. 24- 27, January 2010."

[7]. Blind navigation system, S. Chumkamon, P. Tuvaphanthaphiphat, P. Keeratiwintakorn, "A blind navigation system using RFID for indoor environments,5th International Conference on Electrical Engineering/Electronics, Computer, Telecommunications and Information Technology,. ECTI-CON 2008. vol.2, pp.765-768, May 2008. "

[8]. Indoor navigation, Carmine Ciavarella and Fabio Patern. 2004. , "The design of a handheld, location-aware guide for indoor environments. Personal Ubiquitous Comput. 8, 2 (May 2004), 82-91. DOI=10.1007/s00779-004-0265-z http://dx.doi.org/10.1007/s00779-004- 0265-z."

[9]. WiFi localization method, Dik Lun Lee and Qiuxia Chen. 2007," A model-based WiFi localization method. In Proceedings of the 2nd international conference on Scalable information systems (InfoScale '07). ICST (Institute for Engineering), ICST, Brussels, Belgium, Belgium, , Article 40 , 7 pages."

[10]. OpenGL, Beginning OpenGL game programming, "second edition, by luke benstead, Dave Astle and Kevin Hawkins"

[11]. Challenges faced by firefighters, http://work.chron.com/risks-being-fireman-8600.html