

RFID Based 3D Indoor Navigation System Integrated with Smart Phones

Y. Ortakci*, E. Demiral*, I. R. Karas*

* Karabuk University, Computer Engineering Department, Demir Celik Kampusu, 78050, Karabuk, Turkey
(yasinortakci, ismail.karas)@karabuk.edu.tr; emrullahdemiral@gmail.com

Abstract. Nowadays there are a lot of high rise, complex and huge buildings in the cities especially in metropolises. These building are almost like a small city with their tens of floors, hundreds of corridors and rooms and passages. Sometimes people lost their way in these huge buildings. Due to size and complexity of these buildings, people need guidance to find their way to the destination in these buildings. In this study, a mobile application is developed to visualize pedestrian's indoor position as 3D in their smart phone. This mobile application has the characteristics of a prototype for indoor navigation system. While the pedestrian is walking on his/her way on the route, smart phone will guide the pedestrian by displaying the photos of indoor environment on the route. As a future plan, an RFID (Radio-Frequency Identification) device will be integrated to the system. The pedestrian will carry the RFID device during his/her tour in the building. The RFID device will send the position data to the server directly in every three seconds periodically. On the other side, the pedestrian will just select the destination point in the mobile application on smart phone and sent the destination point to the server. The shortest path from the pedestrian position to the destination point is found out by the script on the server. This script also sends the environment photo of the first node on the acquired shortest path to the client as an indoor navigation module.

Keywords. Indoor Navigation, Smart Phone, Android, RFID, Mobil

1. Introduction

Nowadays there are a lot of high rise, complex and huge buildings in the cities especially in metropolises. These building are almost like a small city with their tens of floors, hundreds of corridors and rooms and passages.



Published in "Proceedings of the 11th International Symposium on Location-Based Services", edited by Georg Gartner and Haosheng Huang, LBS 2014, 26–28 November 2014, Vienna, Austria.

Sometimes people lost their way in these huge buildings. Due to size and complexity of these buildings, people need guidance to find their way to the destination in these buildings. Although there are a lot of studies about indoor navigation on 2D (two dimensional) maps, pedestrians need more realistic navigation system that routes pedestrians in buildings as 3D (three dimensional) (Musliman et al., 2009).

In this study, a mobile application is developed to visualize pedestrian's indoor position as 3D in their smart phone. This mobile application has the characteristics of a prototype for indoor navigation system. User will define the route on smart phone in advance, by selecting the nodes, which will be passed through along his or her tour, in order. This mobile application uses client server architecture, the client side is represented by smart phone and server side is represented by a web server, which holds a spatial database. Within the scope of this study, indoor environment is taken photo in three-meter intervals between all nodes and photo-frame library is established. Every photo is processed separately to decrease the storage size without losing much image quality due to making data transfer faster. The spatial database is designed by relating the nodes on 3D node networks with the photo frame library. Thus, this keeps the database information of photo frame library belonging to the indoor points. Client (smart phone) connects to the web server on a wireless network connection and sends user defined route to the server. When the route information arrives to the server, a web service is activated to query database. The query is retrieving operation of photos on the route from photo frame library. The result of the query consisting of a group of photos is sent back to application on the smart phone using the wireless network connection. While the pedestrian is walking on his/her way on the route, smart phone will guide the pedestrian by displaying the photos of indoor environment on the route.

2. Tools

The application is aimed at Android Mobile Operating System that has a widespread user and developer groups on the world (Dimarzio, 2008). Since the Android Application is generally developed based on Java programming language, Eclipse Interactive Development Environment (IDE) is used as a development environment. This mobile application is coded to able be run on all versions of Android from Android 2.2 (API Level 8) to Android 4.4 (API Level 19) <http://developer.android.com>. Script on the web server to query on the database is coded in PHP (Hypertext Preprocessor) web based programming language. Oracle Database 11g Database is used on the web server as database management system to keep all information (nodes, links, the paths of photos, extra definition about points and

so forth) about the mobile application. The results of query on the server is formatted as JSON (JavaScript Object Notation) to make a lightweight data transfer from the server to the smart phone www.json.org.

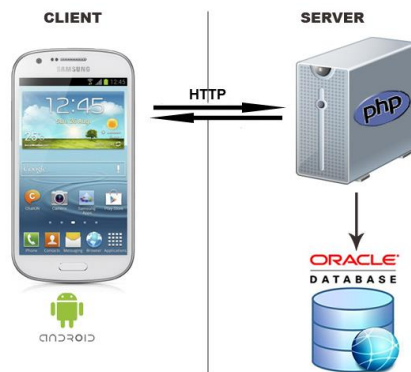


Figure 6. Architecture of the mobile application.

3. Mobile Application

This study is realized in three basic steps. In the first step, the database of the application is designed and provided a sample indoor environment's data. In the second step, the Android mobile application that works on client (smart phone) is developed. At the last step, a web based script is coded to connect to the database and to retrieve the photos on the route of pedestrian from the database on the server.

3.1. Database Design

In the database design, two different tables that are related to each others are created. The first table (link table) keeps the information of links between nodes in the building. In this table, every link has a specific identification number, a different start node and a different end node. The second table (photo table) keeps the name of the environment photo that belongs to each point in every link in the building. The second table also keeps extra information to specify the location of every points in the links. Therefore, every link in the first table has at least two related records (points) in the second table. The number of records that belongs to a link is calculated by considering the link length. If the link length is longer than three meters, then the link has more than two records in the second table for the reason that the indoor environment is taken photo in three-meter intervals between all nodes as mentioned before.



Figure 7. ER diagram of spatial database.

3.2. Development of Mobile Application

In the development of mobile application step, a graphical user interface is designed for pedestrian on the smart phone. There are two drop down boxes on the screen, one is for specifying the start node and another is for specifying end node. In this way, the pedestrian will define and add all links on his/her way. The pedestrian clicks on the send button on the screen just before he/she starts the tour. Then the mobile application sends the list of nodes, which pedestrian will visit along the tour, to the server in order. The application connects to the server by using http protocol. The script on the server will run and send the photo frames back to the smart phone. Thus, the indoor photos will be loaded to the smart phone in every three seconds, periodically. The period for loading the indoor photos to smart phone is defined as three seconds why a normal pedestrian would probably walk three meters in three seconds. Therefore, every point in the pedestrian's route will be displayed on the smart phone.

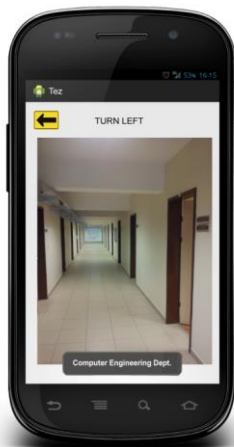


Figure 8. Mobile Application.

3.3. Development of Web Script

In the last step of the study, a PHP script is developed running on an Apache web server. The script takes the node list as argument coming from Android application. The script parses the node list and forms pairs of the

nodes. Every pair of nodes corresponds to a record in the link table. Thus, the script reveals the links on the pedestrian's route and retrieves all the photos of these links from photo table. The script converts the retrieved photos JSON format data uses http protocol to send it back to the client.

4. Future Plan

As a future plan, an RFID (Radio-Frequency Identification) device will be integrated to the system. The pedestrian will carry the RFID device during his/her tour in the building. RFID device will be used to determine the exact position of the pedestrian in indoor environments whose all floors, corridors, passages and rooms are equipped with RFID tags. The RFID device, handed by the pedestrian, will read the tags and find out pedestrian's 3D position in the building. The RFID device will send this position data to the server directly in every three seconds periodically. On the other side, the pedestrian will just select the destination point in the mobile application on smart phone and sent only the destination point to the server. As soon as the script on the server gets the position data from RFID device and destination points from the smart phone, then it will find out the shortest path from the pedestrian position to the destination point. The environment photo of the first node on the acquired shortest path will be sent to the client by the server script. The script will also send visual and voiced navigation information to the client to inform the pedestrian on his/her way. So the pedestrian will get a real indoor navigation module that is running on smart phone.

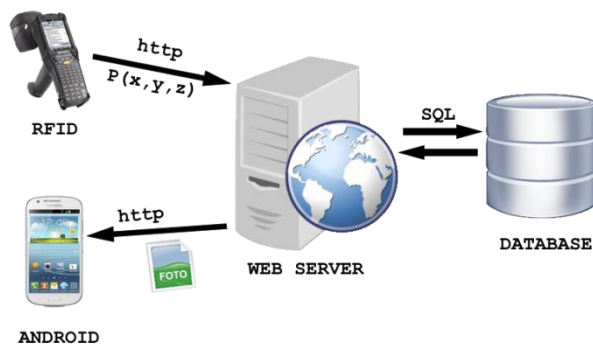


Figure 9. RFID device integrated navigation module.

5. Acknowledgement

This study was supported by TUBITAK - The Scientific and Technological Research Council of Turkey (Project No: 112Y050) research grant. We are indebted for its financial support.

References

Dimarzio J., (2008). Android A Programmer's Guide, Mc Graw Hill

Musliman I. A., Alizadehashrafi B., Chen T. K. and Abdul-Rahman A. (2009), Modeling Visibility through Visual Landmarks in 3D Navigation using Geo-DBMS, 3D Geoinfo Workshop, Belgium.

<http://developer.android.com>, (3 Mar 2014)

<http://www.json.org>, (1 Apr 2014)