Museum 360: Automated Guiding System For A Museum

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Abstract **-**During past few years Indoor navigation systems have been developed in many places such as Airports, Hospitals, Shopping malls, Companies and Museums. Museum 360 is a navigation system design specially for Museums. The system is developed based on Bluetooth Low Energy (BLE) Beacons technology instead of using Radio Frequency Identification (RFID), Near Field Communication (NFC) and Wireless Fidelity (Wi-Fi) technologies. Rather than traditional museum navigation systems, the implemented solution has a new narrating system for navigation, provide descriptions about the items verbally, providing suggestions to visitors what to visit by analyzing past history and also visitors can collect a soft copy of the tour. Museum 360 has two main components, Android application and the server. The system was developed according to the prototype life cycle methodology. When the system is completed it will benefits both of the visitors and museum staff. Visitors can be able to explore the museum as they wish with an efficient narrating navigation system, less time consuming and very descriptive portable tour guide.

Keywords - Museum, Indoor Navigation, Bluetooth Low Energy, Beacons, Android

INTRODUCTION

In present situation the museums all around the country have no automated guidance system. In the current situation most of the museums are giving human guidance (Museum Guides) for the visitors who visit the museums. Museums cannot provide a human guidance every time. Therefore, visitors have to find places that they want to visit. Furthermore, only the information that display near to the object can be got by visitor. It's not practical. Visitors have waste their time to find place and get less information. For this matter the research group has decided to provide a solution to make the museum guidance automated. That means a "Museum Guidance System" provided by the research group has made the tour easy for the visitors. The research group has developed the proposed system to the museum by using recommended, newly introduced mobile and wireless technologies in today's world. It is an application that will use Bluetooth 4.0, and runs in Android Platform.

The usages of android devices are high increasing. According to the recent research reports, there are about five billion mobile users in the world currently and approximately 1 billion among them are smart phone users. 36% of them are using Android Operating System. Asian countries including Sri Lanka have become the countries with most Android users in the world. That is why Android taken as the platform of the proposed system.

"Museum 360" is the application that will be developed by research team for above matter. When a visitor arrived to the museum, they will be guided to install application from android application market by the museum authority. There are two main task that are done by application. First, the application will give suggestions about some places that the visitor will interest to visit. That suggestions will be provided by using a statistical analysis algorithm. For that algorithm data will be gathered by the details which the visitor provided to the ticket counter. The recording details will be National or Passport ID Number, Name, Date of Birth, Occupation, Ambition, Time Duration, Country. In their ticketing office will record all these records and they are stored in a server. During the tour the visitor will get details of the things in an audio file and later he or she can download it if they are interested. After the end of the visit of a visitor, application has a history of this visitor, what are the places that visitor visited, Time duration spent on each place like vice. The application has this kind of past data that are

collected from the visitors. Hence, the application uses data mining techniques and algorithms to give the suggestions for the current visitor. Let's clarify it by using an example. When a visitor comes and if he or she is a 30 year old medical doctor from Sri Lanka, the application knows, what are the interest areas of that kind of a person by analyzing the old data that the application has gathered. Then application can give him or her a clear bunch of suggestions which he or she would like to visit in the museum with in an effective time duration to cover all the areas that they would interest to discover. Therefore, the visitor can manage their tour easily from the beginning. This proposed system will give the visitor voice narration when the visitor going across the museum to targeted area. The proposed system will provide suggestion to the visitor about the monuments that are next to their current location when the visitors are moving.

Then application shows them the shortest directions to the places that they most interested. While showing the directions the application tracks the position of the visitor by using the help of Beacons, a tracking device based on Bluetooth technology. We have used beacons because they are the latest technology and the most efficient technology to do tracking in indoor. When it's come to indoor tracking GPS cannot be used.

The application also provides a full description about the specific objects, monuments and other important places that included in the gallery according to the visitor's choice. In the end of the tour you can get the details of your visited areas as a PDF and the audio narration also can be get as an mp3 file.

LITERATURE REVIEW

In the literature review, the team discussed and searched about the existing deployed systems in the museums around the world and related solutions and researches have been done and developed by using BLE (Bluetooth Low Energy) Beacons also the literature review has covered about the Beacon Bluetooth technology and how to apply them and how has applied. The systems about that have been developed for navigation tasks and indoor positioning. Solutions and researches that have been done on same subject.

Hospix is a hospital exploring application for smart devices that developed by using Bluetooth Low Energy Beacons technology. The Pythagorian theorem has used to detect the positions of the Beacons. Hospix app has developed by using android technology which can be use by any person with simple knowledge of using smart devices to simplify exploring the hospital. It has an accurate navigation system than Global Positioning System (GPS), because using of GPS cannot detect the positions in an indoor area. Because of that the app has been used Beacons, a device that works with Bluetooth technology to detect positions. It has a real time notification system to give notifications [1].

The research (BeAMS) is about a robot which is choosing the path by using Beacons. In this research they used beacons in a lower range and the beacons are supposed to get signals from only one device but in "Museum 360", it handles multiple devices with Beacons in the same time [2].

"Beacons: Exploring location-Based technology in Museums" by Veronika Dolijenkova has used the beacon to reach their target because it gives a technology that addresses the need for a low-cost, easy-to-implement solution for indoor location-based services. Beacons have already been tested in diverse industries ranging from museums (Victoria and Albert Museum, Museum of Neon's), to retail (Shop kick, Carrefour), to the entertainment industry (Tulip land, Coachella, Tribeca Film Festival), and airports (London's Heathrow International Airport). Usingsuch promising case studies, the Met's Media Lab decided to test the potential of this technology for the Museum. The initial testing in the actual gallery spaces brought to the surface the host of important environmental factors to consider when working with beacons. These include gallery architecture, human traffic, and interference with metal objects, temperature changes, battery life, and the customization of app's interface. However they use the past version of beacon with low period of the battery life time but in "Museum 360" developersgoing to use the new version of the beacon to reach our project with success [3].

"Design and user acceptability testing of secure mobile phone authentication mechanism based on fingerprint sensing and geo fencing", focused on the security of the system and they have used finger print system and beacons. And they also used the technology of Near Field Communication (NFC). In this research the researchers have used beacons to track the locations but the researcher do not pay the

attention to the worst case scenario of such a system. That is when some beacons are crossing on some other beacons. In a place like museum we have to the attention to that scenario very carefully because in a place like museum lots of people cross each other at once. In “Museum 360”, paid our attention how to track that individual by using the beacon when number of people are there [4].

[ASK App]In this research they have created an iBeacon based positioning system for a museum. The iBeacon brand they have used is lack of battery strength but the one we are planning to use is more powerful than that one. They are also used the iBeacon in the lower part of the museum and then the signal strengths are been dropped down. But we are planning to use iBeacon in the middle part and from that we can get more strengthen signals from iBeacon and make the system more accurate [5].

“Observability-Based Beacon configuration Optimization for Mars Entry Navigation” is to compute the observable matrix. The quadratic approximation to the Lie derivatives is then used to recursively calculate the observable matrix efficiently. Next, the inverse of the condition number of the observable matrix is chosen as a metric to evaluate the observable quality. To verify the accuracy and effectiveness of the proposed approach, Mars navigation scenarios with ranging measurements from multiple ground-based beacons are considered in simulation examples, and the optimal beacon configurations are obtained using a genetic algorithm. This research is for outdoor navigation using Beacons. But our research using Beacons for indoor navigation system [6].

“An iBeacon- Based indoor positioning system for Hospitals” by Jingjing Yang, Zhihui Wang and Xiao Zhang has used the iBeacon technology to a positioning system that has developed for hospitals. In their research they have used an iBeacon technology that is somewhat old. In this developed Museum guidance system we are using the latest technology of iBeacon. In their research the Android versions that are compatible with the used iBeacon are old. In “Museum 360” researchers are using iBeacon that are compatible with the latest versions of Android and IOS [7].

“Bluetooth Smart Technology” by Eric Dahlgren and Hasan Mahmood has described about an indoor positioning system developed by using Bluetooth technology. They focused on indoor positioning and positioning techniques mainly. Instead of only positioning, from our solution we can show the shortest path to the position. There is always short description about specific detected items or places. Most importantly application navigates the place or item that want to explore [8].

“Sensoberg Beacon management system” is to a store using beacons. Set up the own Beacon infrastructure and protect it against unwanted usage .Transmit location-based services such as information on offers and products as well as use cases such as indoor navigation .Provide partners e.g. brand manufacturers with access to your Beacons and keep control over them. This means that partners, e.g. brands and couponing networks can use your Beacons through advertising subsidies are the benefits from the advantages. But they’re not going to suggest icons and specific areas for the goods. The research team is going to build an app with that qualities for the museum [9].

“Using Beacon for analytics in physical spaces “by AgarajNagabhushanam is for analyze the customer interest for item in stores. It shows a list of visitors who visited your stores. As an overview, can see their name (depending on the permissions your application has taken from them to collect this information), their last visited store location, their last visit, the number of visits, their Beaconstacsdk version and their device profile. The default time period for this list is 1 month. This system is useful only for store authority but the system proposed is useful for authority and as well as the customers [10].

METHODOLOGY

This project used the prototype methodology because the target was the end user’s satisfaction, which was accomplished in a lot of implementations of updated versions of the previous systems that were created. By prototype methodology developers show the user phase by phase their system development.

A. Planning

Main issues that came into consideration were financial problems, Database issues, Interface integration issues and Time management.

After a thorough look a final conclusion took place about the above mentioned economical and technical problems. To ensure that the project goes smoothly, techniques such as a Gantt chart and a work Brake

Down structure has been used to ease out the workload so that the application manages time, resources (Human Resources, Hardware etc.) and have a smoother control over the project.

B. Requirement Gathering and Analysis

Information and data required to the new system has been gathered through techniques such as research papers, interviews with visitors, questionnaires, analyzing reports and by conducting meetings with supervisors etc. The Documents related to research was collected and has been evaluated thoroughly. Questioning people on different levels who are currently involved with the system helped in finding requirements to build the new system. Simple questionnaire has been given out to visitors from different areas to obtain visitors opinions from them.

Finally, analyzing took place only after getting enough prospective on the problem thoroughly before the design phase. The team was able to recognize user expectations in this phase.

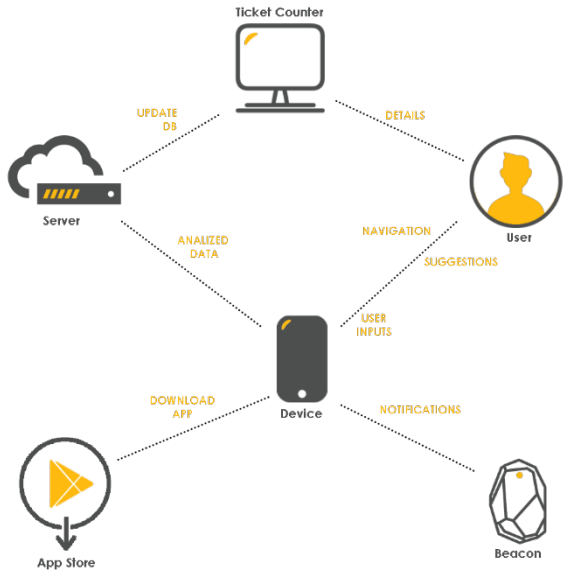

Figure 1 High Level Diagram

C. High Level Diagrams

D. Implementation

Since the system has two main components, Android application and the server, for implementation of the system has wanted two different platforms. Android studio will be used to develop the application with the aid of XML, JAVA and other android related languages and equipment. Beacons are also need to be programmed according to the requirements of the proposed system's objectives. Server will be developed based on languages that fulfill the requirements of the server that system wanted and it will be easy to make changes if there are problems on implementing the system because of using prototype model.

After completed the implementation of the web server and the android application ,Beacons want to be positioned in a perfect manner, both of systems need to be install on relevant devices like the android application need to be installed on an android smart device and the web server need to be hosted in a public server.

E. Testing

Testing has been divided into two main parts as functional testing and non – functional testing. Functional testing uses integration and system testing while non – functional testing used performance testing and security testing.

Unit testing examined and fixed the individual software modules or components that made the application or the system. Each module function was tested by a specific unit test features written in the same programming language as the module.

The system testing part of a testing methodology involves examining the entire system for errors and bugs. This test is carried out by checking the hardware and software components of the entire system (that have been previously unit tested and integration tested), and then testing it as a whole. Load testing was also used. It verified that the system can operate at the required response time when subjected to its expected load, and stress testing found out the failure point(s) in the system.

Security was tested after the implementation. Rise in cyber-crime and the awareness of the risks associated with software vulnerabilities, application security is now something that needs to be designed and developed at the same time as the desired business functionality. Security testing has inspected the software for confidentiality, integrity, authentication, availability, and non-repudiation. Individual tests have been conducted to prevent any unauthorized access to the software code.

RESULT AND DISCUSSIONS

F. Evidence

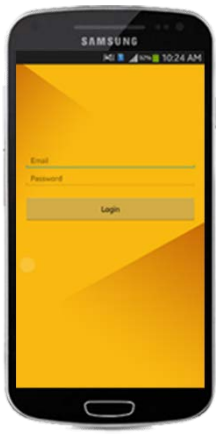

Figure 2 Login Interface

The discussion part is mainly focused on discuss about problems faced during the project design and implementation and how those issued are solved. This section also describes how the successful achievements are gained. Most of the software products consist of different kind of bugs. It is group members' responsibility to minimize the number of bugs before releasing the product to the end user.

Figure 3 Main Interface

Figure 4 Suggestion Interface

Figure 5 Play Interface

Museum 360 was carried out to provide solutions to overcome the problems that visitors face while visiting.

The research team discussed the problems faced by visitors while exploring places like museums and came up with the solution and those solutions were compared with the available solution through the literature survey. In analyzing the research problem, information were gathered from the questioners, interviews, web sites, blogs, journals and articles that are mentioned in references section of this dissertation. The Literature survey provided all the needed background on the research areas. The knowledge gained through the literature survey was the main source and main support to carry out this study. According to that literature survey group members, identified that there is no proper way to explore the museums without having any navigation problems.

In order to provide a solution, two technologies were used such as BLE Bluetooth and android mobile developing. After identifying the core components of the system we developed a system architecture diagram to support the implementation. Documentation is carried out throughout the duration of the project along with the problem analyzing and system designing.

Figure 6 Web Interface

However, for the implementation of Museum 360, the iBeacons get really interested and helpful to overcome the problems as you can do so many things with them, and the list keeps getting longer as people

imagine new uses. Currently some of the working uses include:

1) Positioning and navigation indoors;
2) Tracking of people or possessions;
3) Location based advertisements or messages;
4) Security and automatic locking/unlocking of a computer;
5) Trigger requests for things like payments (note payments cannot be contained in BLE itself as it isn't encrypted)

While building Museum 360 application those were the main problems and because of using iBeacons technology most of the issues were solved.

FUTURE WORKS AND CONCLUSION

With the limitations and difficulties faced and innovation of newly occurred ideas while implementing this software solution, several future improvements were identified in order to have a better software system in the future. Museum 360 application currently has a limitation since it can only be used by the users with android devices. Therefore, this mobile application is to be modified to IOS platform as a next step beyond this research.

The system currently uses 2D maps to view indoor floors of a building. Converting those maps to 3D, will be another better approach to be taken for guide users.

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