"Book Catcher": An Automated Navigation Application to help search and find books in a library

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Abstract- The purpose of this research is to help users navigate within libraries using an android application. Nowadays people visiting libraries has gone down. The reason is the traditional way of manually searching and finding a book. It takes a long time to search and find a book in a library, time and energy waste if the book is borrowed by someone else, should wait for the one to return, though the book is needed immediately, lack of choice of choosing a good book and lack of ways to share opinions about a book. The application will help users to search and find books so quickly and navigate them to reach the book's location using indoor navigational techniques such as Wi-Fi localization. It will also allow users to share their opinions among other readers through reviews and chats. The borrowers will be notified if the borrowed book is wanted by someone else too.

Index Terms- Android, Library, Indoor navigation, Wi-Fi localization, customized notifications

I. INTRODUCTION

In Sri Lanka, there are thousands of libraries and millions of readers. With the development of technology, the needs and wants of people have changed in searching and finding a book in a library. In daily life, people are spending much time and in finding things inside of huge buildings like shopping malls, libraries, museums and so on. To overcome these problems, many research teams have developed many smartphone applications using indoor navigation technologies like Wi-Fi technologies, iBeacon Technologies and radio based Technologies to navigate to the particular places.

The people now a days wish to do things in an efficient and productive way. They do not want to waste time and energy in carrying out their day to day activities. In the traditional way of library process, the user visits the library and search for the books they want shelf by shelf and row by row. At last, they borrow books by marking entry on the system by the librarian. It is inefficient searching and borrowing and if the book wanted is already borrowed by someone else, it is just a waste of time in searching them. The biggest issue is to find and locate the books in a library. The user might have to waste time unnecessarily, if the needed book is not available or lent out. The traditional way in libraries makes people unsatisfied and unwanted to visit library.

The readers might prefer visiting libraries to borrow the books they want as it would be more efficient but since GPS doesn't work well indoors and other forms of indoor navigation have to be looked into in order to allow a user to navigate within a library.

Sometimes, the user might find difficulties in trying to choose a book. The user would not have the option to get to know what others think about each book so that the user might be able to make decision on which book to borrow.

The librarian also faces difficulties in lending out books and provide certain information for the borrowers and members so that their resources are spent efficiently and members would not be annoyed by unnecessary and irrelevant information from the library.

The "Book Catcher" is an android application with an overall objective of improving the library experience by overcoming all of the mentioned problems. The application would allow user to search and find books in a library and based on the search results, the application should navigate the user within the library. The application would also suggest users based on the past borrowing patterns. The user would get notified, if the book borrowed by themselves needed by someone else too. The application would also allow the users to share the opinions about books through reviews and chat with other members of the library.

Figure 1: High Level Architecture Diagram

Figure1 illustrates the high-level architecture diagram of the system where the users can manage the data and borrowing details. As shown in the diagram the database that was chosen to store data was MySQL database and PHP was used to access that database. Wi-Fi access points would be placed around the library to enable indoor navigation. Signals received from these access points would help the system to decide user's location. There is a backend system for the librarian to maintain the books in future.

The research paper discusses about background and related work in the second chapter. Where the third chapter discuss the methodology that was used to develop a prototype system. Fourth chapter discuses about the implemented prototype system. Fifth chapter discusses about the issues faced during the development of the system. The conclusion that was derived and the limitations faced are discussed in the sixth chapter. Future work is discussed in the seventh chapter.

II.   BACKGROUND

With the development of technology, the needs and wants of people have changed in searching and finding a book in a library. In daily life, people are spending much time and in finding things inside of huge buildings like shopping malls, libraries, museums and so on. Many research teams have developed many smartphone applications using indoor navigation technologies like Wi-Fi technologies, iBeacon Technologies and radio based Technologies to navigate to the particular places. Smartphone applications can be used is to help search and find books in the library. Another way in which the smartphones can be used is to help the users navigate around.

There is no specific application which resembles "Book Catcher" directly but there are several applications that allow the users to navigate within library.

"Book Mark" is an android application which helps the user to have illustrated a technique by providing a detailed map to any desired book by simply scanning the barcode on the back of any other book in the library [1]. "iMoon" is another android application with a unique feature which provides Image-based Indoor Navigation is based on sensor-enriched 3D models   of indoor environment methodology [2]." Newman Project is another app which helps users to identify the location or direction of the resources within a library with the help of maps using handheld devices [9].

Wi-Fi-based Indoor Navigation with Mobile GIS and Speech Recognition Technique describes two positioning techniques based on WLAN: Triangulation and fingerprinting which associated with speech recognition and spatial data model is presented [3].

Wi-Fi Based Indoor Positioning System Using Smartphones research investigates other built-in sensors and develops methods for improving the accuracy of indoor positioning. it can be deployed with a minimal cost, as no specialized hardware is necessary for setting up the system[4].

A Secure Shopping Experience Based on Block chain and Beacon Technology   approach for a future shopping system. Customers' personal data are protected by a block chain based storage network. The system transacts encrypted data in a tamperproof way and is able to run secure   multiparty computations while no one but the data owner has access to the input data[6].

The research on Indoor Navigation System for Handheld Devices, they tested Bluetooth, Wi-Fi, and radio frequency according to their maximum ranges, but from this list they have decided to choose Wi-Fi because, Wi-Fi is, readily available throughout most buildings, minimal costs for implementation and medium range (100 meters) [7].

The research called 3D Model based Indoor Navigation System for Museum. Provide accurate descriptions of locations of indoor objects. This three-layer system with application, web service and database is developed to provide localization, navigation and visualization services. The network extraction method is smart and renewable [8].

Fingerprinting is another technique used for localization and Fingerprinting introduce some basic indoor positioning concepts and then focus on one method that relies on fingerprinting Bluetooth iBeacon signals using machine learning[3],[5].

The research done at 3RigaTechnicalUniversity examined several aspects of location fingerprinting based indoor positioning. This system can be relatively easily implemented for notebook computers, personal digital assistants (PDAs), smartphones, and other Wi-Fi enabled mobile devices and working in 5GHz frequency in the application[10].

Most of the currently available applications are mostly concerned on only providing basic features such as navigate the library, few applications offer few unique features but none of the applications offer features like locating and directing users to help find and search book in the library.

Therefore "Book Catcher" fills the all mentioned gap by creating a Book Catcher application which allows the users to find books with in the library and locate the particular book that the user want by using Wi-Fi technology. Reviews and ratings about the book will help other users to make borrowing decisions.

III.   METHODOLOGY

Prototype methodology was selected as the methodology in order to develop "Book Catcher". Analysis, Designing and Implementation phases were executed concurrently   and iteratively until all requirements were gathered and implemented in a manner where system fulfills all the functional and nonfunctional requirements of the system. The initial prototype was built with less number of features, where then it was developed upon and features were added in every prototype. This procedure helped the research group to be more accurate about requirements and was also helpful to figure out the defects and fine tune the functions which were developed.

A. Planning

Planning phase was started at the initiation of the project where the research group understood the system to be developed and how it can be built. Scope, problems and the objectives were discussed among group members in order to identify them accurately. A feasibility analysis was done to make sure that the project was feasible.

B. Requirement Gathering and Analysis

Analysis phase focused on gathering information and analyzing the difficulties faced by the members of library in modern days which paved the way to develop the requirements of the system. Data sources which were used to gather data were categorized as primary and secondary data sources. As primary data source, a questionnaire was created and distributed among public in order to obtain their opinions about borrowing books in a library and how it could be improved. The questionnaire contained only closed ended questions since most people preferred it. The gathered information from primary data source were more helpful to get a better understanding about the member's needs. Whereas secondary data are gathered from research journals, articles, book etc. The data gathered through research papers are discussed in detail in the previous section.

C. Design

The primary objective of the design phase was to create a design that satisfies the agreed application requirements. Initially overall design was done starting with the high-level architecture diagram (Figure 1). Thereafter the physical design of the system was done which included the actual input and output process of the system. The Wi-Fi signals are transmitted from access points and these will act as inputs to detect the location of the user. Data from the database would also act as input for certain processes and all the other input will be touch inputs. All the outputs will be displayed on the screen. Secondly the interface design was done which defined how the user interacts with the system including inputs and outputs of the system. The user interface was designed to be more understandable and easy to navigate. When designing UI, basic principles were followed such as the layout, aesthetics, content awareness, user experience, consistency and minimum user effort. Finally, the database design was done which defined how the data was to be stored in the database. Number of tables, relationships between each table, primary keys and foreign keys were decided in this process.

D. Implementation

Implementation is the fourth stage of the SDLC where the project team transformed the design into a working system. Android studio was the IDE which was used to build "Shopping Helper" and several libraries were used to add the functionalities required as well as to improve the performance of the system and ease the development of the application. Since, the member details have to be used the database had to be stored externally. MySQL database was chosen for this purpose. To Communicate and integrate with the database, PHP scripts were used and this along with the database was hosted on Amazon Web Services.

For indoor navigation, Wi-Fi access points which are readily available with in the building were used. The Software Development Kit (SDK) which was used to provide indoor navigation was Situm SDK. The Wi-Fi access points will transmit Wi-Fi signals continuously which will be read by the user's mobile device. Along with the Wi-Fi signals, GPS signals will be transmitted which will help the system to locate more accurately. The signals will be used to estimate the location of the user within the library.

E. Testing

During the testing phase, the following testing were performed in order to test the functionality as well as to identify defects of the system which would result in a system with better quality, performance and accuracy.

- Unit testing is where the smallest testable parts of an application called units, which are individually and independently analyzed for proper operation.
- Integration testing focuses on testing whether the set of modules functions together without errors. Data flow and the data exchange between modules is mainly focused on this testing.
- System testing is where the completed and integrated system is tested to verify that the system meets functional and non-functional requirements.

IV.   IV. RESULTS

The "Book Catcher" is an android application focusing on improving the library experience by providing several functionalities such as search books, indoor navigation within the library, customized notification, sharing reviews of books and chat.

"Book Catcher" which allows the user to share book details with their family members in order to make reading more efficient and effective. Figure 1 shows the implementation of this functionality.

Figure 1: Share Book Details

Book Catcher allows the user to search the particular book that the user wants. Figure 2 shows the implementation of this functionality.
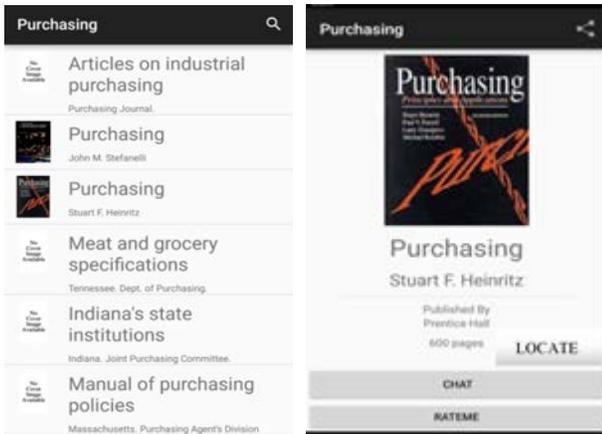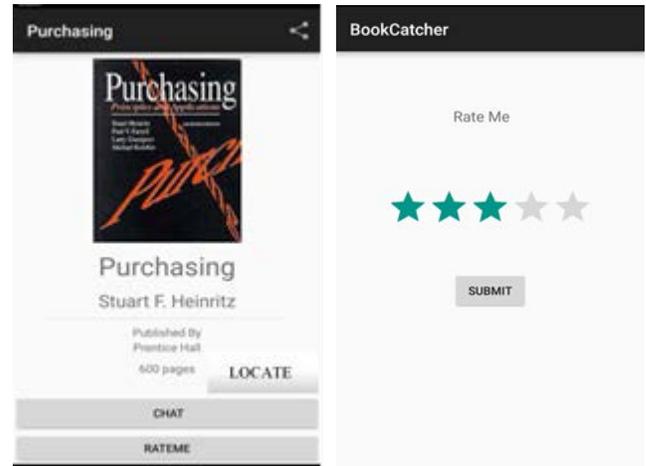
Figure 2: Search Book Interface

Indoor navigation functionality of "Book Catcher" allows the user to locate themselves within the library as well as to locate and navigate to the book's location. Figure 3 shows the implementation of this functionality. Situm SDK was used to implement the indoor navigation functionality.
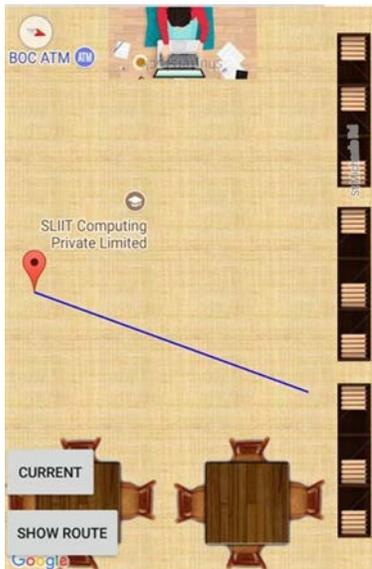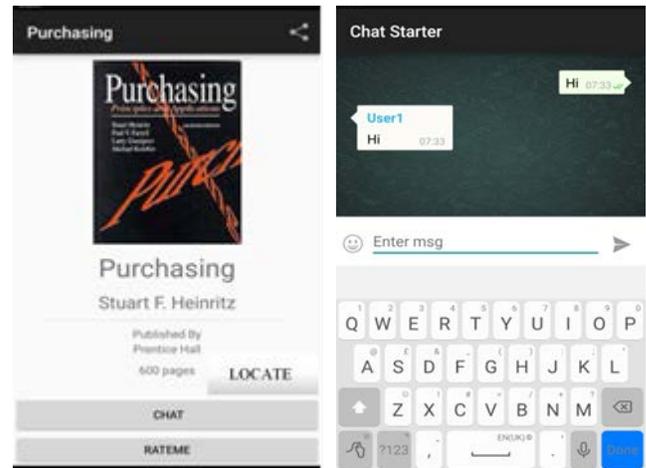

Figure 3: Indoor Navigation Interface

Previous readers should be able to rate the books this will help to future users to get an idea about that particular book. Figure 4 shows the implementation of this functionality.

Figure 4: Rate Book Interface

"Book Catcher" allows the users to chat with other members. Figure 5 shows the implementation of this functionality.

Figure 5: Chat Interface

"Book Catcher" developed a backend system for librarian which is help to add the books and view the books in the library. Figure 6 shows the implementation of login functionality in backend system.
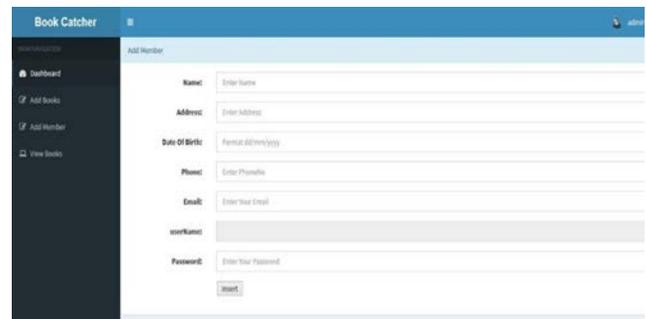

Figure 6: Back-End Login Interface

Figure 7 shows the implementation of Add member functionality in backend system
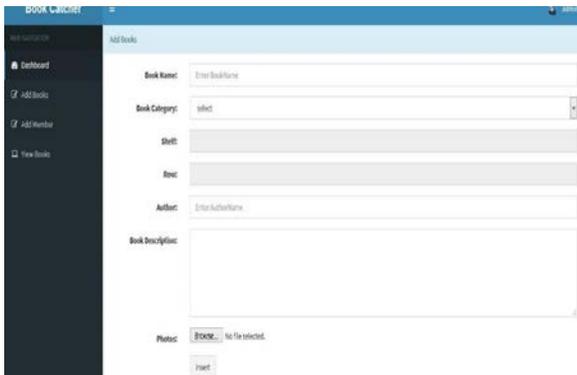
Figure 7: Add Member Interface

Figure 8 shows the implementation of Add book functionality in backend system

Figure 8: Add Book Interface

Figure 9 shows the implementation of View book functionality in backend system

Figure 9: View Book Interface

V.   DISCUSSION

The "Book Catcher" was developed with an overall objective to improve the library experience of members and through the implemented system; members can enjoy a more efficient and effective library experience.

While developing system, the team had to experience some technical issues and following are those issues along with how the team managed to overcome those issues.

The most important issue was the level of accuracy of indoor navigation using Wi-Fi access points. The reason for this issue is that the location of the user is measure based on the signal strength received from the Wi-Fi access points and when a user is at a particular location the signal strength from the Wi-Fi access point's signal kept on varying. Another cause for the issue was when the smartphone received Wi-Fi signals from too many Wi-Fi access points at the same time the system had trouble figuring out where exactly the user was. This was not an issue when user is walking along a straight path but only when the user was in an open area. In order to overcome this issue, the signal strength of the Wi-Fi access points was reduced and the transmitting interval of the signals was also reduced. This improved the accuracy up to a certain extent but did not eradicate the issue completely.

The assumptions made when developing the system are as follows,
• User has a basic knowledge of using android smartphone applications.
• User is within the mapped area when using indoor navigation
• User's phone is running on android version 4.4 to 5.1

When considering about the dependencies,
• The mobile should be always connected to internet via mobile data, Wi-Fi, hotspot and etc. to make use of all the functionalities of the system

VI.   CONCLUSION

Based on the statistical analysis results it can conclude as location of user, Accuracy of Wi-Fi access points, environmental factors and patterns/order affects the efficiency of navigating, locating and suggesting. Membership does not affect the efficiency that much however if there is an application which helps to find and locate books within a library the efficiency can be improved. There is a strong relationship between accuracy of Wi-Fi access points and efficiency of navigating, locating and suggesting. It is recommended considering the accuracy of Wi-Fi access points when assisting navigation. Overall this system should be able to improve efficiency in sharing and locating books.

Following are the limitations that were figured out about "Book Catcher" by the development team when developing the system.
• One of the main limitations is that if the user is outside the mapped area but still receive the Wi-Fi signals from the access points, the system will assume that the user is within the mapped area. The only solution for this would be to map every area that the user can reach which might be costly.
• Wi-Fi access points based navigation cannot be used on phones with android version below 4.3 as Wi-Fi access point support for android was only introduced with android version 4.3.
• Wi-Fi access points based navigation only has an average accuracy of 4-5 meters and this can sometimes become worse depending on the location of the user and the placement of the access points. The accuracy will be acceptable when the user is in a straight path and not when in an open area.

VII.   FUTURE WORK

- To use other indoor navigational techniques such as beacons and geomagnetic readings to improve the accuracy.
- The System could be made compatible with other operating systems such as IOS, Windows, Blackberry and etc.
- Add GPS support so that the app would allow the user to navigate even when outside the Library.
- Have an algorithm which would allow the user to go to the required libraries in a sequence so that they will be spending the least amount of time.
- Add further conditions to sort out the notifications for the users.

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