A Fully Functional Shopping Mall Application - SHOPPING EYE

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Abstract— **In the modern world, shopping has become an essential day to day activity for most of the people. However, their busy life style has lessened the time to do shopping. This has made them to look for quicker and easier ways to do their shopping. Some of the difficulties that people have to go through when they do shopping include having to travel a long distance without knowing the availability of the items, difficulty in finding relevant shops inside a shopping mall, forgetting to buy some items which they intended to buy. In order to overcome the above mentioned problems a fully functional shopping mall application is proposed in this paper. It contains details about all the shops inside a mall, available items, customer wish lists and a map. It consists of a mobile application developed using Android and a Server side module which act as a main database server for connecting with customers and shop owners. Both the modules communicate through web services. In this project wireless communication technique—Bluetooth is used to identify the vertical and horizontal position of the customer. Augmented reality based technique is used to tag the shops with its promotions, loyalty points etc.**

Keywords- ***Ibeacons; Augmented reality; Shopping application; Indoor navigation***

I. INTRODUCTION

Shopping-Eye is an innovative information technology (IT) solution developed to help and support the personals who have difficulties when they go on shopping. It allows users to locate appropriate shops inside a shopping mall, checks the availability of items, promotions and discounts of each shop without physically being present at shops, and enables them to maintain a wish list so that they will not forget to buy items which they intended to buy.

According to an online survey that was carried out with the participation of 100 shoppers from Sri Lanka, it was identified that around 23% people are dissatisfied with the salesperson's service and around 40% are lost inside the shopping mall at the first time while finding shops. Further it was identified that 42% forgets to buy items which they intended to buy and some are dissatisfied with the items they bought. It was also identified that around 81% of shoppers with smart phones are more than willing to use a fully functional mobile application to overcome the afore-mentioned problems [8]. Thus, it was decided to develop the proposed system.

Many knowledge areas and technical backgrounds were required to proceed with the proposed research project. It contains a mobile application developed using Android and a Server side module which act as a main database server for connecting with customers and shop owners. Both those modules communicate through web services. In this project wireless communication technique —Bluetooth was used to identify the vertical and horizontal position of the customer. Augmented reality based technique used to tag the shops with its promotions, loyalty points etc. Both shoppers and shop owners are equally benefited from Shopping-Eye. Following are the main objectives of the project:

- **Loyalty Management/Gift Cards (Excluded Plastic Cards)**
  Using the mobile app customers can add points for what they bought from the shopping mall. So later they can get advantages from those points like discounts which are usually given as loyalty card points nowadays

- **Augmented reality based shop details**
  Customers can view all the details of a particular shop by watching a particular shop through camera window. It will give details like shop category, customer loyalty points, promotions etc.

- **Keep customers updated about the latest deals, events and entertainment in the shopping center**
  Wi-Fi access is given inside the shopping mall to all customers to use their mobile application to check latest details like availability of goods, location of each shop with searched goods and related promotions. Customers can get those offers using mobile internet data too.

- **QR tags on items to get more information**
  QR readers added section-wise or individually in each shop inside the shopping mall to give information about the goods and their details. As an example if it is the cloths section, customers can get all the details of a particular cloth and its availability in terms of colors, sizes, price and discount.
  Users are also provided with the facility of sending a description about a particular cloth to another person through a mail. It will increase customer satisfaction whenever people buy goods for others without knowing their satisfaction.

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- **Help customers to find the best price for their favorite product**
  Customers can compare prizes with other market prizes and pay a fair price to the products that they buy.

- **Detect and give relevant offers in a particular floor**
  All the promotions and special offers are separately given for each floor whenever a user moves from one floor to another.

- **Fully functional server side to the shop owners**
  Shop owners can manage their shop details and item details via Shopping Eye website. The latest retail details will be reached to the customers through this application.

II. LITERATURE REVIEW

After an comprehensive background study the researchers came across some similar exsisting systems such as Fashion Bug and ODEL Magazine in the local market (Sri Lanka) and Eggert Shopping Center, MMM Shoping Lovers and Shopzy in the globle market [9], [10], [11], [12], [13]. However, they do not address most of the problems that the proposed system has addressed. Table I shows a comparison of the features between the existing products or applications and the proposed solution — Shopping Eye.

TABLE I. A COMPARISON OF EXSISTING SYSTEMS AND SHOPPING EYE

	The Shopping Eye	Fashion Bug	ODEL Magazine	Eggert shopping center	MMM Shopping Lovers	Shopzy
Category wise shop searching	Yes	Yes	No	No	Yes	Yes
Navigate to shops	Yes	No	No	No	Yes	Yes
Show promotions and discounts	Yes	No	Yes	Yes	Yes	Yes
Show Promotions and discounts through Augmented Reality	Yes	No	No	No	No	No
Loyalty Management	Yes	No	No	No	No	No
Maintain Wish Lists	Yes	No	No	No	Yes	No
Reminders of items to buy	Yes	No	No	No	Yes	No
Item Identification	Yes	Yes	No	Yes	No	No
Navigate to Shopping Malls	Yes	Yes	No	Yes	No	No
Checking Availability of items	Yes	No	No	No	No	No

III. METHODOLOGY

Shopping Eye consists of three major components: website, mobile application and inventory control system. The main users of the three components are shopping mall managers, shoppers and shop owners respectively. Figure 1 illustrates the interaction between the three end users. Web services were used to maintain the reliability of the data.

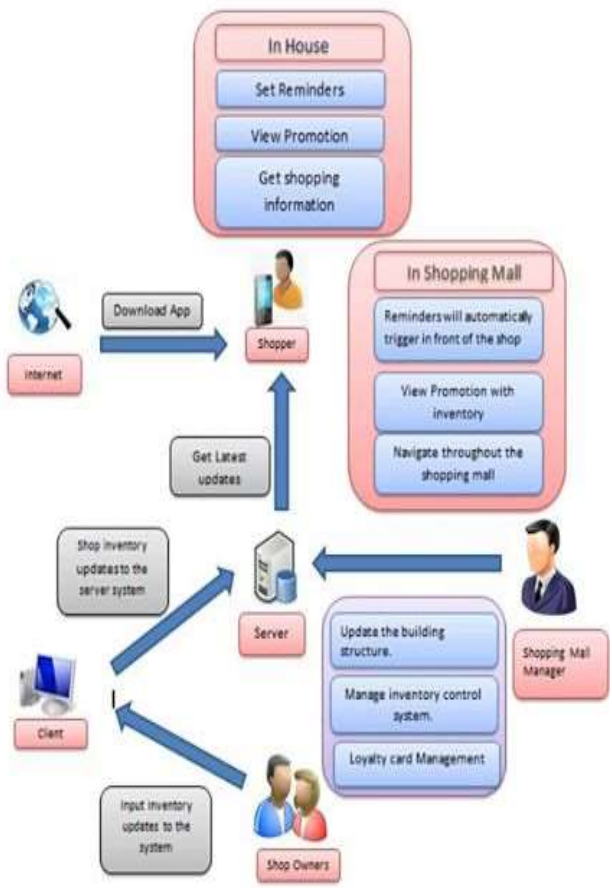

Figure 2. System Diagram.

A. Website

The first stage of the application development was implementing the 3d and 2d architecture of the building. For that ASP.NET, Unity tool and MY SQL were used. In this stage the application was designed to auto implement the building structure according to given inputs as parameters through the interface and store it in to the database. Those building structures were used for navigation and position identification. At the same time Inventory and loyalty card management system were implemented using ASP.NET, Web Service and JSON [3], [4]. It uses real time inventory updates and promotion notification function. A separate inventory control system was developed for shop owners inside the mall to update the inventory and promotion details, including assets management, but at the same time as a secondary option, web services, was given to update their new item details/ promotion details which can be embedded with the existing system. In loyalty card system shop owners are given separate user account for their shops and customers also can have the facility of individual user accounts to manage their loyalty point separately according to the shop.

B. Mobile Application

As soon as the server side implementation was finished, the mobile application implementation was started. It was started as three different modules. First one was mobile position and angle identification system using beacon technology [1], [2], [6]. Beacon is a Bluetooth transmitting device and beacon triangulation method was used to find indoor navigation.

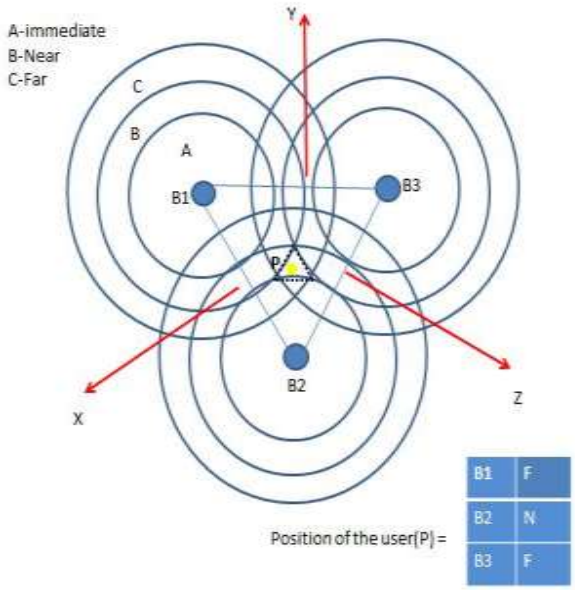

Figure 3. Beacon triangulation- I.

As shown in figure 2, beacons were located according to a triangular manner (B1, B2 and B3) and then an algorithm was written to identify whether a particular user is inside the beacon area (triangle) or not. The area of the triangle was obtained using the Heron's formula. Equation (1) and Figure 4 explains the Heron's formula and how it can be calculated to identify whether user is inside the beacon area or not.

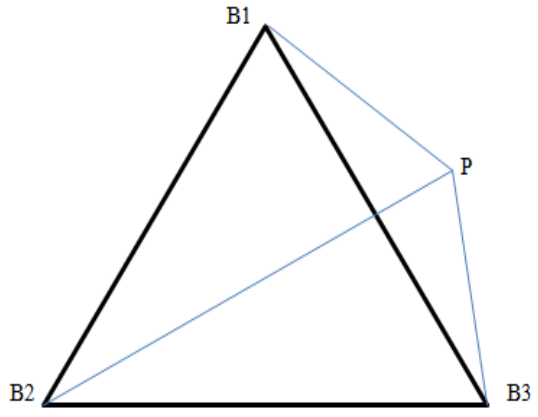

Figure 4. Beacon Triangulation II.

$$A = \sqrt{s(s-a)(s-b)(s-c)},$$

$$s = \frac{a+b+c}{2}.$$

Where a=B1B2 length, b=B2B3 length, c=B3B1 length

Equation 1 : Heron's Formula.

If area B1B2B3 = area B1B2P + area B2B3P + area B3B1P, then user is inside the triangle.

If area B1B2B3 < area B1B2P + area B2B3P + area B3B1P, then user is outside of the triangle.

Then the RSSI values were retrieved to the phone screen from the three beacons of the triangle. According to RSSI values that were retrieved, the exact square ID of the user was identified by getting coordinates from the 2D map of the shopping mall. Once the position of the user was found, identifying the angle and the direction of the phone was initiated. Using phone's inbuilt sensors the vertical and horizontal angle were captured. Since shop details should be tagged to the camera panel, the user is notified to keep the camera panel vertical. If the user changes it from vertical angle to any other angle notifications will be popped up automatically. Direction of the phone is captured using geographical positioning system and the compass of the phone. To connect with beacons, Bluetooth should be enabled in the user's phone.

Second part of the mobile app is to identify the objects that are displayed through the mobile camera.

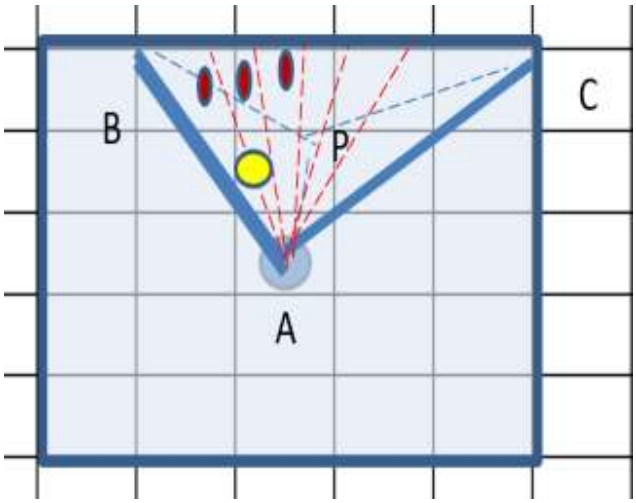

Figure 5. Approach 2.

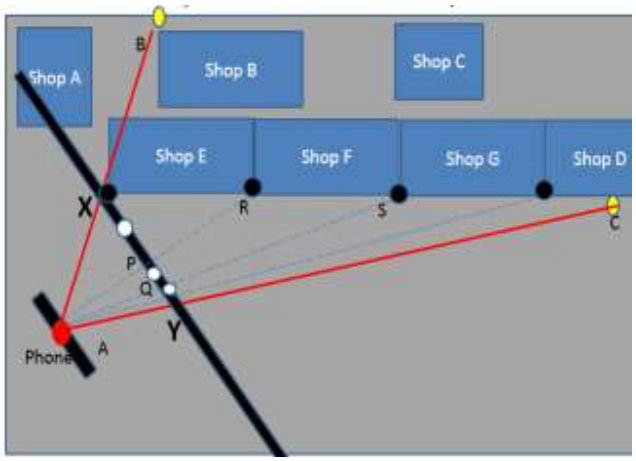

Figure 6. Approach 3.

Here the phone position and the angle of the phone were used as inputs and then the object was analyzed using a special algorithm.

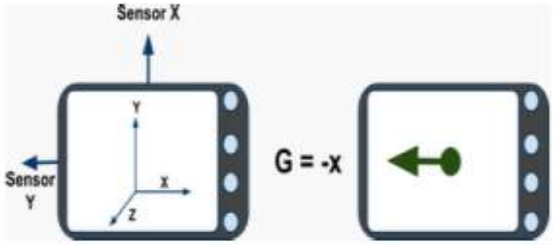

Figure 7. Phone Orientation.

Finally the application was developed using second part inputs and the objects were drawn in the screen at the right place. Here augmented reality features, which are widely used for virtual images processing [4], [16] were used. When those tagged labels are clicked, they display relevant information of each shop in the camera panel. For that implementation few libraries and the researchers' own algorithms were used.

C. *Inventory Control System*

Inventory control system is used to add large number of data to the database and to confirm all the CRUD operations with the performance. ICS has been implemented according to the existing systems architecture by learning existing industrial systems. C# and MySQL database were used for development, and ICS is connected with the main website using web services.

IV. RESULTS AND DISCUSSIONS

It was found out that for indoor micro location identification (user's position indoor) iBeacons, which is a very cheaper technology compared to other technologies such as RFID and Wi-Fi, can be used successfully. To successfully identify the user's position (indoor) the researchers came up with an algorithm which does Beacon triangulation using RSSI value provided by beacons according to the distance of the beacon and the phone. According to calculations 5 RSSI difference approximately makes a difference of 12-15cm.However RSSI values are subjected to environmental interferences therefore high accuracy can be obtained where there are less environmental inferences.

A technique to get the direction using compass was also implemented as part of this research. User has to place the phone horizontally before viewing the shops through camera panel, as at horizontal level compass works accurately. After around 30 seconds user has to move camera panel vertically and view shops through camera panel. It was decided to give notifications until the user keeps the phone in landscape mode. Once user placed it to landscape mode then the angle is taken using an inbuilt android method. Here the rotation of the camera panel was identified using the original angle of the camera.

2D map and 3D structure were generated successfully inside mobile phone using HTML5 context using several layers. Basic two layer were used for virtual map creation which is light weighted and it can be transferred to mobile device within a second (100KB). On top of that 2D map was created. User position in the 2D map was tagged using user position details. From 2D map 3D structure was generated successfully using our own algorithm. User position and shops which were requested by user were successfully tagged in 3D structure. Although unity is a good software to be used for above task, web application takes time when loading to mobile phones because of its complexity.

For identifying shops in front of the user and camera panel coordinates to tag them (augmented reality) researchers came up with their own algorithm which takes user position, phone direction and blue print details as inputs. Since an algorithm was used instead of image processing, the quality of the camera, distance, and obstacles between camera and shops didn't matter. Also it was observed that it gives much accurate results with a zero cost compare to RFID tags, Infrared LEDs, Ultra-Wide-Band and visual marker based tracking [1]. Even without image processing the system is capable of tracking shops in front of the user similar to the way how human eyes see it That is far away shops occupy small area in the camera panel where as nearby shops occupy large area accordingly. This was achieved by using physic theories of light beams behavior in air inside the algorithm that was proposed by the researchers. It was found that the algorithm's accuracy depends on the square size (in the blue print, floor area is divided into small squares) as well as the accuracy of its inputs. Much more accurate results can be obtained when square size is smaller. However it takes some time to process though it runs in the server which may create a delay. The proposed system has overcome that by storing the results of the algorithm with its corresponding input inside a database where results can be obtained much efficiently.

Tags for each visible shop were successfully displayed on the camera panel (augmented reality) using pure android development. Through web services and JSON the needed

information about each shop was retrieved when the user clicks on the phone panel. Some libraries such as Vuforia have used Image Processing in order to tag the objects in the camera panel. However, when Image Processing is used to tag objects there are lot of drawbacks as mentioned earlier.

The system was successfully tested for a building similar to a structure of a shopping mall. When testing, the beacons were placed on the ceiling to avoid interferences. All the common features including wish list reminders and other location based notifications, navigation inside shopping mall and item identification through QR scanning as well as the unique features such as displaying promotion and discount details through augmented reality, checking availability of items and loyalty points management were successfully tested using an android OS 4.3 version phone. The researchers of the project has been successful in producing a product which can be used by shoppers, shop owners and shopping mall managers to get their regular day to day tasks done in an easier and a cheaper way.

V. CONCLUSION AND FUTURE WORK

Analyzing the requirements, collecting the data, studying existing technologies to implement the system, gathering ideas from resourceful authorities and conducting literature reviews were done in order to achieve the objectives of the system. By conducting literature reviews different methodologies that were used to address the same problem was found out.

During the literature survey it was found that most of existing similar systems are only concern in basic functionalities. They do not provide any details regarding available items where shoppers can check at home. Also promotions and discounts details are given through augmented reality which has many disadvantages as they use image processing to identify shops. So they are not accurate enough to use inside a shopping mall. Loyalty card management facility is not provided by any available system and further discounts/ promotions are not related with loyalty points in the existing system.

The proposed research system have overcome all of the obstacles mentioned above and have implemented an interactive, less costly and an efficient package to shoppers, shop owners and shopping mall managers.

The shopping-EYE is developed mainly for android users. In the next stage of development, the researchers are hoping to move for IOS, windows phones and Blackberry using cross platform development.

Accuracy level of the proposed system can be increased by using upcoming technologies. Thus, in the future the system can be developed in a way to utilize those technologies.

As a future work, the researchers intend to optimize searching and analyzing algorithms for high performance and accurate results.

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