Smart Shopping Cart using a Product Navigation System

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Abstract— **In a view to streamline shopping system and facilitate access to required commodities among innumerable varieties in a super market, personalized service can be exploited in automated manner through interactive graphical user interface. Implementation of several touch screen modules with a database can provide easy, accurate and timely information in regards to query generated by the users.**
An item and its location with absolute identification are displayed on the screen to facilitate users to get access to it immediately. This not only saves valuable time and cumbersome manual procedure in finding desired products but also provides an easy-to-use interactive shopping experience without any effort.
Our proposed system includes mounting of these modules on every shopping cart of the super-market. Hence each individual user can access it easily without wasting time.
Also, along with giving location of the product required, the floor map will also show the user its location using an Indoor Positioning System (IPS).

***Index Terms*—Embedded Systems, Indoor Product Search, Shopping Assistance.**

I. Introduction

Shopping malls or supermarkets are ideal environments to explore new applications as they constantly update their technology to support customers. Moreover every week numerous shoppers enter supermarkets displaying so many distinct product choices, from which they will ultimately select a few items in a quick span of time.

Shoppers usually face difficulties in locating the products in the supermarket. This is either due to difference in the actual product appearance and what the user has in mind or due to changes in product's visual appearance or even due to lack of knowledge of the product location.

Most of the shops' physical layout encourages the customers to follow a U-shaped route, which demands the customers to go back to the same route again. All these factors make it difficult for them to efficiently move around the shop to locate the products. Shopping Assistance Unit is basically a touch screen based graphical user interface (GUI) module. The requirement of the touch screen interface is basically to provide easier, faster and interactive access of data to the users.

II. Methodology

We are trying to design and implement a location based shopping assistance service that allows shoppers to shop with ease and style. Along with product details, the system will also display the User's location based on a Indoor Positioning System(IPS).The Shopping Assistance Unit will be mounted on the Shopping carts to make it easily available for all the customers. Shopping assistance unit will help users in locating products, make their shopping experience faster and more pleasing.

To make shopping experience enjoyable an assistance module is provided in form of a touch screen which is mounted on each shopping cart. User will be able to find the product location along with his own location which will be displayed on the touch screen.

To find the object location, user will have to select the category of the product and the required brand from the available drop down menu. This Query will be processed and the section where the product is available will be highlighted. Also Section Name along with the rack number will be displayed on the pop up window.

User will also be able to see his own location which will help him to trace the path upto the section where the required product is placed.

The Product location will be retrieved from the database stored locally on the module. The user location will be determined by an Indoor Positioning System using passive RFID tags and readers.

The module will be constructed using an appropriate microcontroller which supports database storage as well as support for a GUI tool.

III. Related works

Reference [1] proposes a similar system, the Shopping Assistance Unit (SAU) with the following features and specifications.

A. Hardware

Shopping Assistance Unit [1] comprises of Mini2440 Development board. The Mini2440 Development Board is based on the Samsung S3C2440A (400 MHz) using ARM920T core. This ARM core acts as the heart of the system.

B. Software

As in [1], to facilitate the user interaction with SAU, implementation of a GUI (Graphical User Interface) is an added benefit. Embedded Linux provides support for development of GUI. They propose the use of GUI development tool Qt, which is an open source cross platform application framework.

C. Other features

A local database is maintained having information about the Products and their location (section and rack number). Whenever a customer queries a search for a product, the product information is retrieved from the database and displayed using a pop-up window. To ease the querying process, the customer is provided with various dropdown menus for category and brand. Based on the input given by the user, the product is searched for in the database and retrieved accordingly. The zone of the product location is then highlighted on the module screen and the Section name and Rack number is displayed in a pop up window.

The Shopping Assistance Unit [1] is a smart and useful module to assist shoppers and make the shopping experience more satisfactory. Although it has some limitations which can be worked upon to improve the system and its usability.

i. The paper in [1] proposes to mount the SAU modules at various places inside the store. With limited number of modules, their demand may exceed their availability leading to queues of customers wanting to use the module.
ii. The module does not provide any information regarding whether the requested product is actually available at the given location. Even if the customer reaches at the desired location, it may be possible that the product is not in stock.
iii. The SAU does not give any information about the user location. Even though the product location may be displayed, if the user does not know his/her own location, the information provided may be of little use as the user may be practically unaware of the path to follow to reach the required product location.

Thus, an effort should be made to overcome such limitations and further enhance the functionalities of the SAU.
In this process, however, one should ensure that the module's usage remains feasible in terms of cost and user-friendliness. Keeping in mind the current usefulness of the SAU, the changes made should not affect its main aim of easing the shopping experience. The simplicity of the SAU module is its essence.

IV. PROPOSED SYSTEM

A. Smart Shopping Cart

In view of increasing the availability of the SAU modules, we propose to mount these modules on the Shopping Carts of the store.

This ensures that every user is entitled to a module and can use it freely whenever needed. If such a method is not used, the customer may be forced to wait in queues to use the module.

This may lead to wastage of time and eventually the customers may be discouraged from using the system. Instead mounting these modules on the Shopping Cart makes them easily accessible and makes the shopping experience less frustrating.

B. Rechargeable Battery

The need of a rechargeable battery arises due to the fact that the modules have now become portable as they are mounted on the shopping carts. Thus we need to ensure that the battery life of the modules is sufficient to function throughout the working hours of the day.

Battery Specifications

The Mini2440 and 3.5" LCD screen utilize 0.6 A/h
Supposing we use a 5A supply battery ,
The battery life = 5A/(0.6A/h)
~ 8 hours.
This is sufficient for efficient working of the module

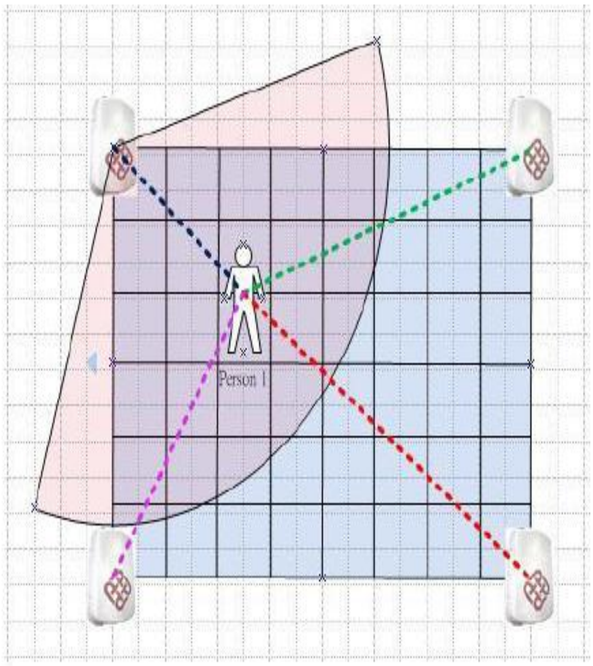

Figure 1. Example of an object in an RFID covered zone

C. User Location Using An Indoor Positioning System

The Shopping Assistance Unit (SAU) proposed by [1] gave the information regarding product location inside the shopping mall/store. As an addition, we propose to provide the User Location and display that too in order to ease the searching process for the user.

There are many ways to determine a location of an object inside a building. A satellite based Global Positioning System (GPS) does not work in such cases because these signals cannot penetrate concrete walls. Thus an Indoor Positioning System (IPS) can be termed as a mini, localized version of GPS. Many IPS have been developed using Wi-Fi as well as Mobile Context Aware System. But these systems have their drawbacks which hinders their use in the SAU. For e.g., in the Wi-Fi based IPS, the SAU module should also have modem functionalities which may increase the cost factor. Moreover it needs continuous Internet connectivity which cannot be guaranteed.

To overcome these drawbacks, another method to implement an IPS is proposed in [2]. This method makes use of Passive RFID tags and readers to locate an object within a given area.

RFID is the acronym for Radio Frequency Identification. RFID positioning system is real time and low cost system. It is an accurate positioning technology which can identify the movement and location of personnel and goods to provide real time information that supports Location- Based Services (LBS).

Radio-frequency identification (RFID) is the wireless non-contact use of radio-frequency electromagnetic fields to transfer data, for the purposes of automatically identifying and tracking tags attached to objects including people, vehicles, goods and assets without the need for direct contact (as required in magnetic stripe technology) or line of sight contact (as required in bar code technology). RFID technology can track the movements of objects through a network of radio enabled scanning devices over a distance of several meters. With such benefits, numerous researchers attempted to use RFID technology in positioning. To offer a low cost indoor positioning solution for locating large number of items, passive tags are chosen rather than active ones.

As stated in [2], the method consists of three phases that are required to accurately determine the indoor positioning of any object:

1. Evaluating the performance of passive tags
2. Design of the data collection model
3. Development of the location estimation model for the RFID positioning system by means of passive tags.

Following is the summary of steps required to determine indoor location of a person/object as described in [2].

Step 1: Place the object with passive tags at Cell 1 at 1m height.

Step 2: Record the corresponding RSSI of the tags to each of the four readers for 15 seconds. The data will be automatically stored in the database. Two conditions may occur when the data are collected:

- 2- 1: If the system can get 20 readings of RSSI of the object within 15 seconds, it will stop and show the result.
- 2- 2: If the system cannot get 20 readings of RSSI of the object within 15 seconds, it will continue to take data for another 15 seconds until 20 readings have been collected. The maximum time allowed for taking the data for Cell 1 is 1 minute. If the system cannot collect enough data, then this cell will not be available for position detection.

Step 3: Repeat STEP 2 for six times to obtain an average value that will be used as the fixed RSSI value of Cell 1 in the LUT.

Step 4: Repeat all the steps above for the remaining cells. Finally, six readings of RSSI for each of Cells will be stored in the database.

Step 5:Formation of LUT:

After collecting the six sets of data, the system will calculate the average RSSI for each cell. After the average RSSI values of each cell picked up by the four readers have been determined, they will be used to form the LUT.

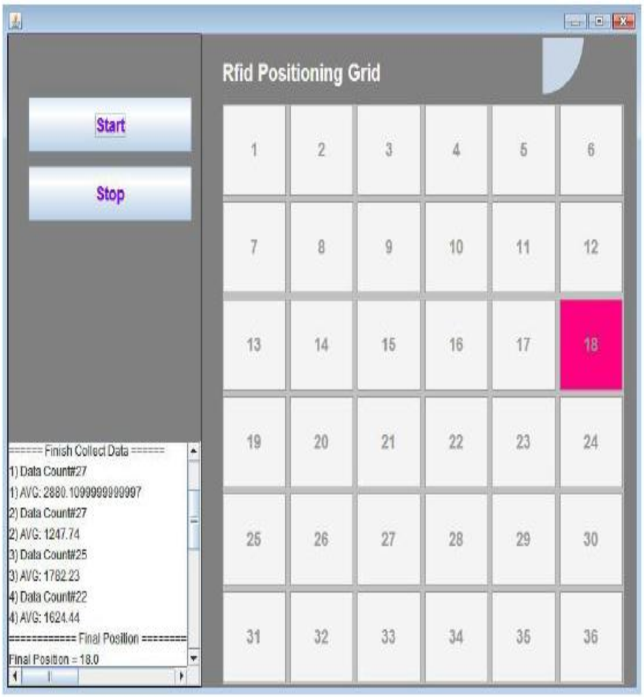

Figure 2. Screen capture of an RFID positioning system

*Step 6:*Location Estimation

When an object is placed inside one of the cells within the selected area, the RFID Positioning System will notify the RFID readers and then record the RSSI of the object picked up by the four readers. From the LUT, each cell has a fixed set of four average values of RSSI. The system will then calculate the Euclidean distance of that object to the readers.

$$\text{Euclidean distance} = \sqrt{\left(\sum_{d=1}^{k} |x_{id} - x_{jd}|^2\right)}$$

where x_i is the average RSSI of cell *i* read from LUT

x_j is the average RSSI of the detected object at an unknown cell the position of which is to be determined

d is an index that indicates the identity of a reader

The cell that has the smallest Euclidean distance would mean that it is nearest to the current position of the detected object and that cell is highlighted on the user screen.

In our proposed system, the SAU module and RFID tags are present on the shopping cart. The user can enter a query by using the available drop down menus. When user queries for the product required, the system first retrieves the product information from the database and highlights the product location section on the map. At the same time, using the RFID positioning system, the user location is also determined and displayed on the SAU screen. A pop-up window gives the section name and rack number of the queried product.

The flowchart in Figure 3 gives a precise and succinct description of the above procedure.

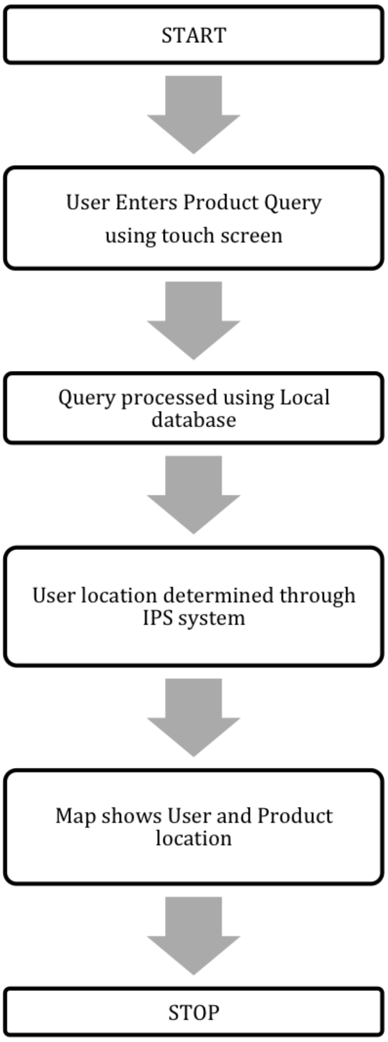

Figure 3. System Working Flowchart

V. CONCLUSION AND FUTURE SCOPE

Although our proposed system will be improved as compared to the earlier system proposed in [1], there is certainly some scope for further enhancements in the functionalities, which can be considered for future research.

i. Showing Product Availability:

Even though the system provides product location, there is no surety that the Product will be in stock and available at that time. Hence, the system can include the functionality of displaying the Product availability.

ii. Self Charging Battery:

Since the SAU modules will be mounted on the Shopping Cart, a method could be devised to charge batteries using the motion of the cart. This would definitely increase battery life and reduce the number of times the battery has to be charged externally.

iii. Determining the Navigation Route:

Since the system already provides User and Product location, it could go a step further and determine the route, which the user can take to reach the desired location. For this an algorithm should be made to determine the shortest and optimal route between the two end locations.

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