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Smart App based Shopping Trolley Assisted by RFID

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Abstract: In the recent years there has been enormous leap in online shopping technology but little has changed in the offline sector. We can still find people waiting for their turn at the billing counter of departmental stores. Many concepts has been put forward to employ RFID based shopping trolley, where in the shopper can just drop the items into the trolley which will be detected by the RFID reader and the data will be displayed on small screen in the trolley. Once done, shopper can check out quickly. But it has lots of limitations. The proposed system will use an APP on shopper's smart phones which will constantly communicate with the store's main database and the trolley will communicate to the database over WIFI using ESP-8266 module, also there will be an array of IR LEDs along aisle which helps detect the relative location of the trolley. The main system sends all information to phone app. This approach will also help promoting the concept of PRE-SHOPPING. Using the App provided, the customer can see all the items in the store from his home and make a rough list. Upon entering the store, he can just pull out a trolley, scan the QR code in the trolley using the app and the app will communicate with main system and link the trolley. The main system pulls out the pre-shopping list of the shopper and also keeps track on trolley's movement and alert the shopper when he pass across the item which is in the list.

Keywords: Smart phone, ESP-8266 wifi module, Radio frequency identification (RFID), App, Infrared (IR), Microcontroller, Database, Shopping Trolley, cart.

I. INTRODUCTION

There has been enormous development in the field of embedded system, RFID tags, android Apps and microcontrollers lately but little has it contributed in making shopping easier. While there has been massive advancement in the online shopping sector the enthusiasts and engineers have turned a blind eye to the offline sector but the fact remains that, the stake holders for offline sector is much greater. There has been many proposals to bring RFID based shopping cart for departmental stores where in when a user picks and drops a product into the trolley, the RFID reader reads it and sends it to microcontroller which along with inputs from some peripherals , looks up the data table stored in EEPROM and identifies the product and displays them. At the end of the shopping, at the Billing counter the data is transferred to the main computer. While this solves the problem of "Queue at the billing counter" it brings out new challenges. Every time a product is added to the shop's inventory, the table in every microcontroller has to be updated which is not easy and also there is no easy option to change price or other details of a product. To solve this there has been some attempts to bring in the concept of real time communication with the store database using ZIGBEE modules and to display the received information on a TFT display on the trolley which requires trolley to have other sophisticated peripherals to support the display which will in turn make it not affordable for an average departmental store owner.

Tracking position of the trolley and assisting shoppers to reach right section is another challenge, the present systems make use of GPS(global positioning system) based system which is not very effective because inside a closed building the potential of GPS is limited, the best accuracy might be 5 metres or so. But we are looking forward to get precision in terms of Centimetres to make tracking useful. Our proposed system will solve the above problems and also make it lot easier to put into operation, both in terms of complexity and also the cost. It has wider scope and potential than the existing or proposed system and will take the shopping experience to the next level. As we know the world has switched to an era of smart phones. It is already playing a great role in online shopping and other aspects of life. Our system will make use of these phones in offline shopping sector in a revolutionary way. The stores already have inventory database running on their local servers. The proposed system has a specially created App which communicates with the store's database and helps shoppers create a rough list of things to buy which we can call "PRE-SHOPPING". The trolleys in the store will be fixed with RFID reader, IR receivers which get signals emitted by IR transmitters along aisle. It will also have some IR Line break detectors to detect when we drop a product to cart or when we pull something back. The trolley will also have a QR (Quick response code) which will be unique to each trolley.

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The array of IR emitters placed along the aisle will emit unique signals. The IR receivers in the trolley will receive this signal and send it to the microcontroller which will send it further to the main system over wifi. Using this information the main system can detect the location and track movement of the trolley. In the main database we will all fine details like the location of each product in the inventory. The system will check the shopper's pre-shopping list and finds out if any product in the list is in the vicinity of trolley's current location and alerts the user via notifications in the App. The shopper can also ask assistance through app to reach a particular section. The system will find the shortest path using graph traversal algorithms and give him the full assistance to reach that product.

II. RELATED WORKS

The concept of RFID has become very popular in last few years and there have been attempts to employ it in many areas, one among them being shopping sector. In [3] RFID Based Automatic Billing Trolley is implemented using a similar approach. Considerable analysis was done. But the visible drawback is that the data regarding product details is stored in microcontroller's memory. Hence adding or modifying inventory is difficult also the interface for the user is a character LCD screen which is not very pleasing compared to present standards. The communication medium used to communicate with the main computer is RF, but if there are identical frequency RF devices working in the vicinity it's going to cause interference. In [2], RFID Based Smart Shopping and Billing, The problem has been clearly analysed and the solution to it is good. The concept used helps us to have real time communication with the main system and modifying inventory is easier and also it supports trolley tracking. But the problem here is that the interface used to communicate with the server or main system is Zigbee.

But as pointed in conclusion, another ZigBee module operating at the same frequency can easily intercept/interfere with the transmitted data. Also the interface used is a small size TFT display. It is going to increase the implementation cost, and also there won't be enough room to display all the information required. Handing too much data requires each trolley to have high end controllers which adds to the cost and complexity. In [8], RFID BASED SHOPPING CART, the implementation method is very close to the method used in [3]. But here instead of using Character LCD screen, a better touch screen module has been used and also instead of RF modules, Zigbee modules have been used. While this solves some of the problems the major problem still remains. The lookup table is stored in local memory of microcontroller and also the use of touch screen and display in each trolley will require high end hardware and processing ability which will increase the cost of implementation drastically.

III. PROPOSED SYSTEM DESIGN

A. E-Trolley

As shown in figure 1, the E-trolley system consist of PIC 18F4520 as its core which is an 8 bit microcontroller. It has dedicated USART support and 256 Bytes of EEPROM along with other features which we are not interested here. The communication to the store's main database is established using ESP 8266 module. The ESP8266 WiFi Module is a self contained SOC with integrated TCP/IP stack that can give microcontrollers an access to your WiFi network. It is interfaced to controller's USART port. ESP8266 module requires AT commands to work. The strategy followed here is a subroutine in the microcontroller's code has a collection of AT commands. The subroutine follows an algorithm to select and send AT commands as and when required.

The subroutine is coded such that it sends a command to ESP module to create a connection to a PHP webpage, this command is sent repeatedly each time with the current IR signal and RFID reader status. The use of the IR signal is discussed in following sections. A PHP page in the main server receives data send by ESP8266 module through PHP "GET" method and it then processes it.

When a product is dropped in to the cart, it passes through the RFID reader and also breaks IR Beam which is detected by the microcontroller. The RFID reader requires UART or USART connection with the microcontroller. But PIC18F4520 has only 1 hardware USART level which we used for connecting ESP8266. Hence interface to RFID reader is made using the concept of "SOFT UART" which is a technique of using microcontroller's general purpose IO pins as serial ports and managing them with software routines.

Another core part of the E-trolley is that it has IR receivers placed at some places. Along the aisle of the store we have an array of IR emitters, each emitting a specific data. The receivers in the trolley unit pick it up and send it to microcontroller which sends it further to the main database system. As the trolley moves it picks up the emitted rays of the next emitter hence effectively enabling tracking by the main system. Each trolley will have a unique identity which can be linked to the APP by using QR code. The App will then connect to the main system and link this id. So that the main system will know trolley ID a particular shopper is using.

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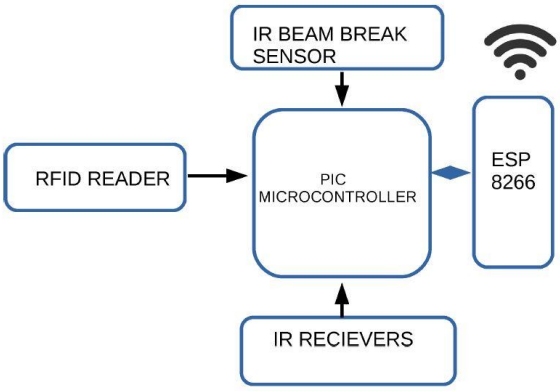
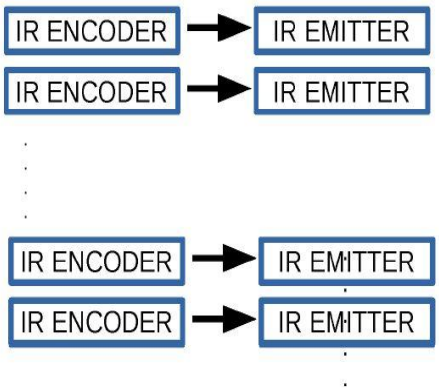


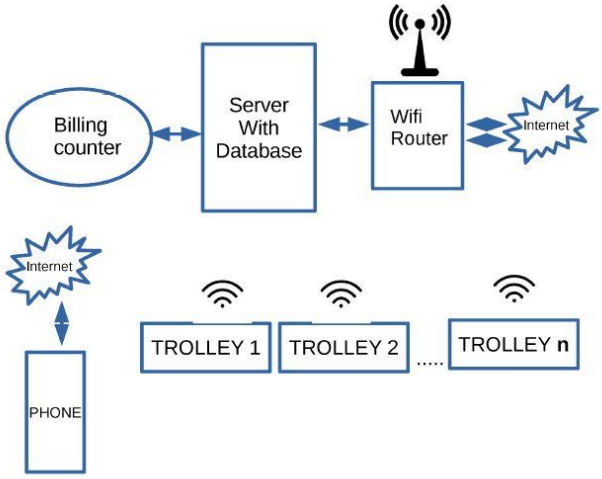
(Figure 1:-E-trolley components)



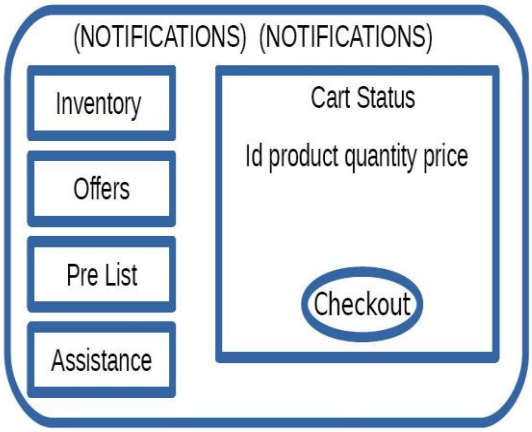
(Figure 2:-Tracker along aisle)

B. Tracker along aisle

Along the aisle we place an array of Infrared Emitters Each of them sends out a unique data which will be collected by the receivers in the E-trolley. Since each IR emitter gives out unique data, by looking at the data received by the trolley we can get the precise location of the trolley with less than metre accuracy. The accuracy and precision is directly dependent on number of Emitters we place along with aisle.



(Figure 3- Main system)



(Figure 4- Abstract of App)

C. Main system

The main system consists of an Apache server with mysql database. The billing counter/s is connected to the server via network or as a direct terminal. The server is connected to Wifi router which is linked to internet. The phone App will communicate with the server over internet. Also All the E-trolleys will communicate to the system over WIFI. Almost all departmental stores, now days have a computerised inventory management system up and running hence it will be easy to switch to the proposed concept.

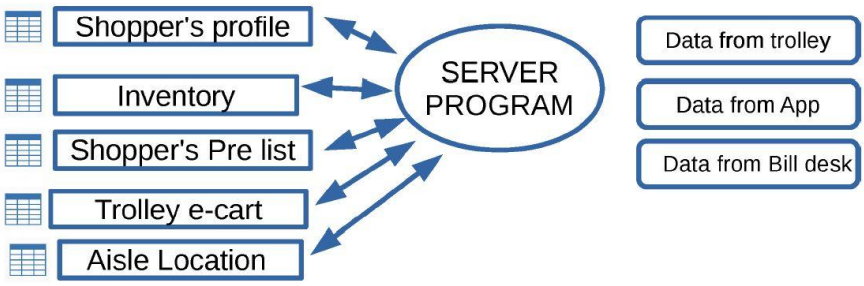


Figure 5- Server program

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C. Server program

The DBMS maintains data on Shoppers's user profiles, inventory, shopper's prelist, temporary purchase table of each trolley, present offers etc. It gets data from E-trolley, Phone App, bill desk, administrator's computer. The aisle locations are represented in the form of graphs. Programs running in the server will play a major role in making the proposed things possible. The important tasks are as follows.

1. Load shopper's pre list when the app sends intimation about the trolley being used
2. Track the location of the trolley.
3. Scan the location of each item in the Pre list and notify the app if any item is in the close vicinity
4. If user adds or removes anything to/from the trolley, update respective e-cart table and inventory.
5. 5) Check offers and user's past purchase history to predict the item user is likely to buy and suggest it through the app.
6. If user seeks assistance to go to any section, perform graph traversing algorithm to find node by node direction, each node being a unique IR signal and intimate the same to the user App
7. When the user hits checkout, provide payment. The shopper can pay cash at the counter or pay digitally through the app. When user pays from App, the same will be notified at bill desk's terminal.
8. When user checks out, empty the e-cart table and update user's history.

D. Mobile App

The abstract view of the app interface is shown in figure 4.The app is the most important component of the proposed system. Right from PRE-LISTING to check out, app has a role in it. A shopper can enter his credentials and log into the app and view the inventory and pre list items to buy. After entering the store, the QR code of the trolley is scanned and is sent to the main system which will link the trolley to the user's temporary shopping table. The app will also have room to display spontaneous offers and notifications like direction to an aisle, location of an item etc. Based on the live data, the Store supervisor or admin can give out spontaneous offers to the shoppers.

IV. CONCLUSION

The Smart App based shopping trolley assisted by RFID will be easy and inexpensive to implement compared to the existing systems. The App based smart concept proposed here is first of its kind. The existing systems have been properly analyzed and drawbacks identified and addressed in the proposed system. The use of ESP module for Microcontroller to network communication will make sure that there is no interference issue if there is another store in the vicinity running similar system. The potential of a system like this is huge; the store owners can analyze the trend or flavor of their customers in real time and offer them spontaneous offers and deals. The proposed system will put an end to the issue of long waits at checkout counters. Since we are living in a world where every second matters, the time saving technologies like this won't take much time to dominate.

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