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Follow Me Multifunctional Automated Trolley

L.S.Y. Dehigaspege, M. K. C. Liyanage, N. A. M. Liyanage, M. I. Marzook, and Dhishan Dhammearatchi
Sri Lanka Institute of Information Technology Computing (Pvt) Ltd.
Sri Lanka, Colombo

***Abstract* - Nowadays, supermarkets are almost developed with many technological advancements. People purchase different items from the supermarkets and put them into a trolley because it is the easiest method used in supermarkets to carry goods. However, throughout the whole process of shopping, customer must push the trolley manually by their own effort and when it comes to the billing process customers must wait in long queues to pay their bills. This is a time wasting process due to the busy schedule of people. To avoid these problems the research group have introduced an effective and highly advance system. Although there are some existing Smart Trolleys which includes some of the above mentioned aspects there is no proper multifunctional automated trolley to make shopping life easier. The research "Follow Me" has developed a multifunctional trolley which makes shopping life easier and convenient to customers. Follow Me consists of series of technologies such as automatic human guided travelling with use of an Arduino Mega, goods tracking and billing with the help of a Bar code reader and an android based tablet with extensive User Interface (UI) techniques. Furthermore, Follow Me consists of automatic parking to its slot and automatic charging while the trolley is parked in the slot. The research group has provided an accurate, user friendly smart shopping trolley to make customers shopping life more convenient and easier.**

Keywords: Supermarkets, Trolley, Billing, Multifunctional, Follow Me, User Interface (UI) techniques, Arduino card, Bar code reader, Automatic parking, Automatic charging

I. INTRODUCTION

Shopping carts in the supermarkets in day today shopping activities is now mostly visible. Customers are pushing trolleys around them to carry the items they purchased. The usual process of travelling the trolley is done manually by the human with the effort of his/her. Therefore, if a customer carries a baby while doing shopping it is a real burden to the customer to push the trolley or to a disabled person with one hand is almost impossible to push the trolley. People can see huge rush in supermarkets on holidays and weekends the rush is even more when there are special offers and discounts. The main purpose of the research project was to address the above issues by developing a multi-functional automated trolley.

Follow Me is an automated trolley that is capable of carrying goods while following the customer automatically without human effort, an android application has developed which gives suggestions about goods while purchasing, for this a tablet is fixed to the trolley with an android platform to function the above-mentioned task. Furthermore, the trolley is parking back to its slot automatically after the customer finishes his/her purchases, the trolley will be charged its battery automatically while the trolley is in the parking slot. Usage of this system will impact on modern day shopping market customers to do their shopping activities in an easy manner.

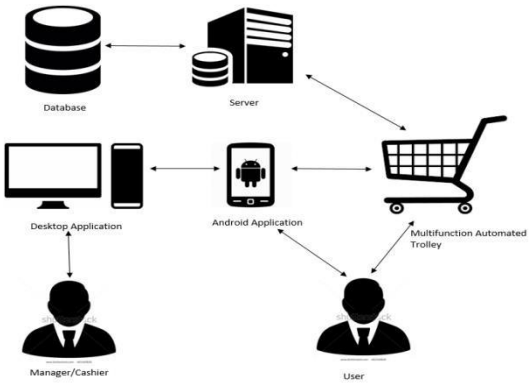

Figure 01: Architecture Diagram

According to the Figure 01, there are mainly two users who are interacting with the system. Customer will interact with the android system while using the trolley to get product details, prices and suggestions to the mobile device for the currently purchased items. The details are getting from the database where the details are being stored. Manager and the cashier is interacting with the desktop application as a helpmate to the customer to finalize the bill. All the above mentioned data are taken from a hosted database and a server.

II. LITREATURE REVIEW

An automatic line following trolley, this trolley is being guided behind the customer with use of traditional line following techniques. Considering the functional facts that they developed, the research group developed an automated trolley which follows the customer with use of an Arduino mega to ride the trolley the research group came up with the methodology sensors to track the path which the customers walks. Moreover, the developed research consists of a tablet which is fixed in front of the trolley to track the goods which the customers purchased and automatic billing system which is developed with use of Android operating system. Furthermore, the trolley to be developed is consisting of some multifunctional tasks of automatic parking to the slot and automatic charging while the trolley is being parked [1]. Electronic shopping cart based on Radio Frequency Identification (RFID) technology. This trolley contains a function to track the goods eg. Viewing the product name, expiry date and the cost, to display the items they have used a Liquid Crystal Display (LCD) screen. The drawback of the system is the trolley does only the functions that are mentioned above. Thus the trolley is electronic it does not cover the automatic travelling facility [3].

System designed to track the purchased items using a Quick Response (QR) code which developed a trolley to track the

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goods and do the automatic billing with the help of an electronic display. Through this system it does the billing process but the research is not completed with a fully automated trolley. However, the battery of the trolley must be charged manually. Considering these facts designed a trolley which saves man power is essential [4].

Multitasking shopping trolley with use of RFID technology. This is embedded with the aspect automatic product identification and billing. To track the products, it uses the technology RFID which contains readers and tags placed on the products. Though this identify the product through RFID the proposed system uses bar code reader to track the goods. Considering all the facts this trolley does not perform multitasks as it describes. The developed research is based on more functionalities that is more time consuming and easy to handle [5].

A system named Intelligent Shopping Cart developed using RFID technology in additionally this module consist of a technology Zigbee go get product details from the main server. This project improves the time consumption such as it reduces the time which waste on long queues to pay the bills. Although the system consumes the time, developed trolley which travels automatically saves more time and human power [6].

IOT Based Intelligent Trolley which is developed in India is tracking the purchases using RFID tags. When a customer puts any goods into the trolley the RFID tags will detect the product and will display the specifications of the product. A system with RFID tags are placed in all the trolleys. All the products in the mall are equipped with RFID tags. Therefore, there is no way to travel the trolley automatically but to put goods the trolley [7].

Shopping and automatic billing using RFID technology was developed by Vidyavardhaka College of Engineering in India. They have come up with an architecture with Radio frequency identification (RFID) and wireless technology to provide on spot billing in super markets. It uses the RFID based system application in the shopping trolley and the RFID tags which is used security of the products. A Liquid crystal display (LCD) that is fixed to the trolley displays the product name, cost and the total of all purchased products. The bill is transmitted to the server end through the ZigBee technology. There's no Automatic travelling system to the trolley. The research group has focused only in purchase tracking and billing only [8].

This research was developed for disabled customers. The research group implemented a trolley which follows the customer. To chase the customer accurately and measure the position a laser beam and laser range sensor is used. A gyro-sensor and a rotary encoder also used for fared chasing and have developed a mapping algorithm and an estimation method for searching the position of the customer. This trolley is capable of following the customer only [9].

Automated shopping trolley which can control using a remote. The structure of this trolley consist of robotic structure and a keypad which is used to navigate the trolley along the particular way. The Keypad has the inbuilt product code reader to read the bar codes and track the goods purchased. The wireless billing system is made up of the ZigBee communication module [10].

Smart shopping cart for automated billing purpose, this cart is using wireless sensors and image comparison algorithm to calculating the bill without involving a human. Customer does not need to waste their time staying in long queues to pay the bill. The cart cannot follow the human automatically. The developed research based on an automatic path finding trolley integrated with some functionalities such as an android performing tablet which is fixed to the trolley to keep track of purchased goods and automatic bill generating. Furthermore, the trolley is embedded with automatic parking and automatic charging while the trolley is parked in the slot [11].

Shopping trolley with smart shopping system to reduce the time wastage of customer and to make the shopping life easier for the customer. This automatic trolley is using Ultrasonic sensors to identify obstacle avoidance and android application to control. Moreover, this system helps users to find the products location which users RFID tags and readers for the identification phase [12].

Varsha Jalkote et al., developed a futuristic billing trolley with using RFID and ZIGBEE technologies. Whenever customer put a product into the trolley RFID scanner scanned it and product cost and the price bill displayed on the Liquid Crystal Display (LCD). By using ZIGBEE transmitter it takes product details which is stored in the main computer server of the supermarket. Thus the system is intelligent with the billing criteria it does not cover the aspects of the developed research “Follow Me” [13].

An automated patient cart navigation system to hospitals using active RFID technology, Arduino card and IR sensors. The purpose of the research is operating the patient cart without wasting human power. Navigation part is done by RFID tags and readers. Considering the above mentioned facts research group developed an automated trolley the main criteria that differs from the patient cart is that the system only navigates within the given path. The developed trolley follows the customer where ever the place he/she walks [14].

Automatic shopping cart to reduce the time consuming in supermarkets and malls. Whenever the customer puts a product to the trolley RFID reader scanned it and product price and cost displayed on LCD. ZIGBEE transmitter and receiver used to make a connection between trolley and main computer server. Considering the research done by Mr.Yathisha and the group they has focused mainly on billing aspect. The developed trolley can automatically follow the customer too [2].

Intelligent trolley for automatic billing in malls using
RFID technology and internet server. The methodology that they have used is when a customer puts a product into trolley RFID reader scanned it and connect with the internet server. Then the billing part is done in the trolley itself. Product name and cost displayed on a LCD. Thus the system is intelligent with the billing area it does not cover than the developed research “Follow Me” [15].

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A. RESEARCH GAP

Most developed trolleys are developed using traditional line following methodology. Since this some supermarkets have no way to use this technology it's difficult to use the line following technique in the whole supermarket. Furthermore, tracking the purchased goods in the trolley and billing system with help of android mobile device fixed to the trolley. Most of the researchers are developed to track the purchased goods but few trolleys perform both aspects goods tracking and automatic billing. After purchasing is done by the customer trolley parks to its slot automatically.

III. METHODOLOGY

According to the research papers that the research group went through no trolley performs automatic parking facility after the purchases are finished by the customers. Moreover, while the trolley is parked within the slot its battery will charge automatically. Since the research is based on an electronic device its battery must be charged to get work from it. According to the developed trolleys the battery is charged manually with help of a human to plug the device. Considering all the facts the research group came up with an intelligent trolley which performs multifunctional tasks to make shopping life easier.

The prototype methodology was used to achieve the project goals. Planning, Analysis, Designing and Implementation phases were executed concurrently and iterated until the project reached all the objectives and the users were satisfied with a final prototype.

First prototype was built with minimal amount of features and the rest of the features were added to each prototype produced.

A. Planning

The planning phase is the most critical and essential step in the software development life cycle (SDLC). As a starting point to the SDLC research problem was found and as a solution for the problem an automatic trolley with an android and a desktop application was proposed. In the planning phase the research team identified the project value and problems and divided the work among the members in the group.

Technology was chosen in order to build the project and a budget was calculated

B. Requirements Gathering and Analysis

During the requirements gathering phase the research group collected raw data of approximately 1500 goods which holds in the supermarket to extract the data mining terminology. These data contains the prices of the goods, item identification and the name of the goods. The stratified sampling method was used to prepare a questionnaire to gather information from supermarket customers. Individuals who are coming to the supermarkets daily were given the online questionnaire. While gathering the requirements the research group gathered information as primary and secondary data gathering which helped the group to identify the solutions. As discussed above the primary data gathering was done using the questionnaire which was given to the customers. Secondary data were gathered via the literature review done related to previous research which were similar products as the Follow Me research. With all the analysed factors Follow Me robot was developed with a combination of software and hardware components.

C. Designing

Designing phase was the place where the initial design of the project was planned. The sketch of the automated trolley was designed, how the hardware components are placed and how it will be connected to software. All the main functionalities such as automatic following, sensor fixing, line following methodology to park the trolley also the android and the desktop applications designs was planned. The application design contains tracking the purchased goods, suggestions for the currently purchased goods, bill generating, add goods and report generating. Finally the integration between the hardware and software was planned. As the final step of designing Arduino IDE (Integrated Development Environment) was finalized to develop the hardware programming, Android studio was finalized to develop the android application and Microsoft Visual Studio was finalized to develop the desktop application. Overall design for the project is stated in Chapter I Figure 01.

D. Implementation

The goal was the implement a user friendly system which works efficiently and effectively. Arduino IDE was used to implement the hardware programming of the system, Android Studio was used to implement the android application and Microsoft Visual Studio was used to implement the desktop application. As the very step the trolley was implemented to move automatically to follow an object Sharp IR sensors was used to implement the automatic following methodology and obstacle identification while travelling. As the implementation going on the research group developed the automatic parking methodology by reading the black line using IR sensors. Furthermore, the research group developed an android application for customers use. The application consist of major functionalities such as details of the goods to track this barcode scanner is used and the application consist of automatic suggestion for the goods that are currently purchased by the customer. Suggestion part was implemented using data mining methodology and the mined data is stored in a hosted web server so the android application pulls the data from the web server when customer requests for suggestions. All the data is stored to the database and for the billing process, add products and to view reports a desktop application was built. All the data which are taken from the android application are stored in the database and through web services all the details are taken to the desktop to print the final bill to the customer. Moreover through the desktop application the manager of the supermarket can view the reports of their sales and he/she can add products if needed.

E. Testing

"Follow Me" automated trolley was tested using two testing methods. In unit testing each and every function was tested individually. As per testing first the research group tested

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whether the trolley is following the customer automatically in a correct manner. In integration testing, whole trolley and the software applications were tested along with the functionalities to make sure that the whole system is working properly without any errors.

IV. FIGURES / CAPTIONS

"Follow Me" automated trolley was developed for supermarkets and this smart trolley connects to android application through web services. Interfaces related to the functionalities of trolley, android application, desktop application are described in this section.

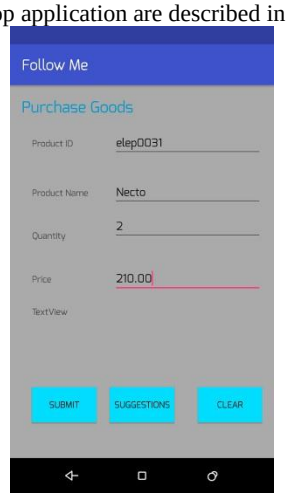

Figure 02: Mobile App Purchase Goods

The Figure 02 represents the Android Applications Purchase Goods Interface. In this place customers can purchase goods with the help of a barcode scanner and it will automatically fill the required fields and the customer can click on submit after purchasing.

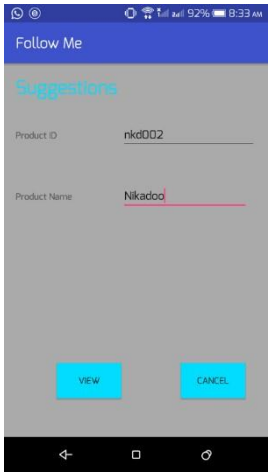

Figure 03: Mobile App Suggestions

The Figure 03 represents the Android Applications Suggestions Interface. Through this customers can view suggestions for the purchased goods.

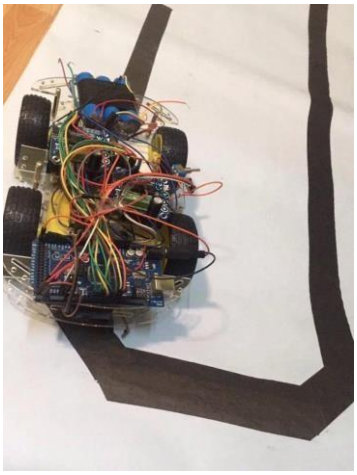

Figure 04: Robot Line Following

The Figure 04 represents the Follow Me trolley robot which follows the black line. This task is developed to park the trolley automatically to its parking slot.

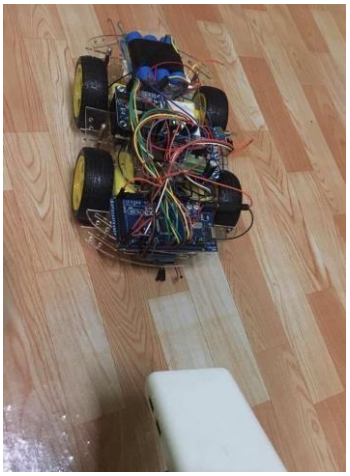

Figure 05: Robot Automatic Following

The Figure 05 represents the Automatic following Follow Me trolley which follows the customers automatically. Trolley will follow the customer automatically with the distance which is given by the developers.

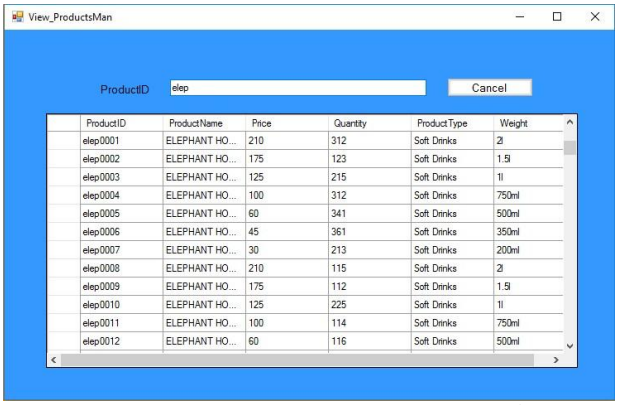

Figure 06: Desktop Application View Products Interface

The Figure 06 represents the view products interface in the desktop application. The supermarket staff can view the goods that are currently in the database.

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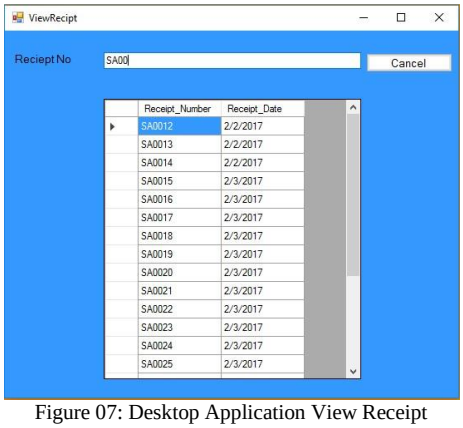

Figure 07: Desktop Application View Receipt

The Figure 07 represents the desktop application interface to view the receipt. Manager and the cashier of the supermarket can access this interface.

Figure 08: Desktop Application Calculate Bill Interface

The Figure 08 represents the calculate bill interface of the desktop application. The cashier can view the details which was send by the android application can calculate the final bill and print it to the customer.

V. DISCUSSION

Human Computer Interaction technology is very well developed in the current era. Follow Me robot was developed to follow the customer automatically while the customer performs shopping activities in the supermarket. When customer gets the trolley it follows the customer automatically with the help of Sharp IR sensors which is fixed to the Arduino Mega board. Through the sharp IR sensor the distance will be identified within the customer and the trolley. Moreover, to identify the obstacles again the Sharp IR sensors were used. Line following methodology was used to perform the automatic parking facility. To perform this task the research group used IR sensors in order to identify the black line. Arduino UNO was used to develop the line following methodology and all the sensors were fixed to the Arduino UNO board.

The research group developed an android application and a desktop application for the use of customers and staff. Android application was developed using Android Studio IDE and this application was developed for the use of the customer. Through this application customers can purchase goods with use of a bar code scanner and the android application is capable of showing the customers suggestion with regard to the goods that are currently purchased by the customer. To develop the suggestions the research group used Business Intelligent Studio IDE and the algorithm used to develop the suggestions was Decision Tree. All the data is stored in a hosted database and it was taken to the android application using Json. Desktop application was developed for the use of supermarket staff this was developed using Microsoft Visual Studio IDE and the language the research group used was C#, through this application the Manager can add goods to the store. Furthermore, this application is capable of storing all the details which was entered by the customer while purchasing goods. All the details is taken to the desktop application with use of web services. So that the staff can finally print the bill to the customer without wasting any time since the android application sends all the purchased item details to the desktop application via web services.

VI. CONCLUSION

Supermarkets in the world plays a major role when it comes for shopping and the supermarkets which exist in the market implement many things to compete with other supermarkets. “Follow Me” automated smart trolley provides some benefits to the supermarkets as well as to the customers.

“Follow Me” trolley consist of some multifunctional tasks such as it is able to follow the customers automatically so that the customer does not needs to push the trolley manually. “Follow Me” has an android application which helps the customers to track the goods details tasks which the android application perform has been described in section III part D. An important event that this trolley performs is the automatic parking. After the customer finished their purchases the trolley move back to its slot automatically without any helpmate. Line following methodology was used by the research group to implement the automatic parking technology. All the above mentioned functions and technologies were used to fulfil all the objectives of this “Follow Me” Multifunctional Automated Trolley and the research group hope the research would be a benefit for the developing supermarkets. Hope that this research study will be helpful for the researchers who interested in the automated systems as well as software building and will develop similar models with more advance technologies and features.

During the development of the project following are the limitations which were figured out:

a. Supermarket customers should be used to an automated environment;
b. “Follow Me” trolley detects only the closest object when travelling automatically;
c. Lithium battery life;
d. Trolley only detects the black and white path when it comes to automatic parking;
e. Server must work 24/7 accurately in order to access the developed android and desktop applications;

“Follow Me” Multifunctional Automated Trolley system have some limitations but the research group did some work to overcome the above mentioned issues.

a. Battery of the trolley must charge when it is parked in the slot;
b. Distance of the object identification has given a small distance so that the trolley identifies the only the customer who is near to the device;
c. Parking of the trolley only detects the black and white path so that the black and white must be drawn in supermarkets to work the automatic parking methodology;
d. Since the server is hosted the applications can perform their tasks 24/7;

VII. FUTURE WORK

Recommendations to those who are willing to develop this system further are as follows:

a. Setting up a navigation map to the application to identify the where the products are been stored.
b. Promoting the application to customer own mobile device.
c. Sending SMS or E-Mail after the purchasing is finished.
d. Add a payment method which is fixed to the trolley to pay using customers debit or credit card.
e. Developing a tag which uniquely identifies only the specific customer.

As the research was limited to a specific time period the group was able to focus only a limited amount of components. In the future

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the group is willing to do more researches and develop more methods that will be included to the hardware device as well as to the android application.

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