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An arduino based intelligent shopping system-mechatronics approach

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ABSTRACT

Internet of Things (IoT): Let devices and physical objects connect each other by their sensing, communicating and processing capabilities. This paper develops an intelligent shopping using the shopping cart system to provide IoT service in a hypermarket. The major instances are difficulty in finding the specified products and standing in a big queue in the billing section. This really takes a long time and creates customer un-satisfaction to the owner. Each cart is provided with an RFID based smart shopping system with an IoT enabled technology. It proposes the quick path finding schemes which help the customer to find the location of the product. The main facility that the proposed model provides the customer only needs to carry an RFID smart card. It also provides a centralized and automated billing system using RFID technology. The whole information will be sent to IoT cloud server through a GSM module. If the product is purchased the number of product availability is low. The IoT cloud server alerts the seller through SMS. The system facilitates faster billing and standing in a queue reduces the average time required for shopping.

Keywords— *Shopping, RFID tag, RFID reader, GSM, IoT*

1. INTRODUCTION

The grocery industry sector in nowadays extremely important in the worldwide economy, with its recent evolution in technological, political, social and economic terms making it one of the most convenient and diverse businesses across the globe. 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 main purpose of the research paper is to address the above issues by developing a multi-functional automated trolley. 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, the 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. 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.

This paper develops a multifunctional trolley which makes shopping life easier and convenient to the customer. It consists of a series of technologies such as automatic human guided travelling with use of an Arduino ATMEGA 328p, goods tracking and billing with the help of an RFID reader, Bluetooth Terminal HC-05 and thermal printer. This facilitates an accurate, user-friendly smart shopping trolley to make customers shopping life more convenient and easier.

This paper not only satisfies the customer and also satisfies the seller /owner in the hypermarket by developing the system with an IoT technology. This perhaps helps the owner to manage the goods and can access anywhere to view the status of the hypermarket through the internet. This IOT based Trolley has the following applications: Automatic billing at a shopping mall and Helps to owners to track the products.

2. LITERATURE REVIEW

2.1 Smart trolley using smartphone and Arduino, Journal of Electrical and Electronics Systems, November 2017

This paper proposes the smart trolley system whereas the customer scans the product in the trolley using barcode technology using RFID reader. Hence there is no need for the customer to wait in the queue having a membership card.

2.2 Automated Trolley for Shopping, International Journal of Innovative Research in Electrical, Electronics, Instrumentation and Control Engineering, Vol. 5, Issue 6, June 2017

This project report reviews and exploits the use of barcode technology which is used for product identification. We have also learned the architecture of the system that can be used in the shopping systems for intelligent and easy shopping in the malls to save time, energy and money of the consumers. There are a few challenges/drawbacks that can be resolved to make the proposed system more robust. This issue will have to be resolved specifically with respect to billing to promote con card to browse the offers, deals and facility of payment within the cart by using swapping card can be used to make cart more advance provide better consumer experience.

2.3 Smart Cart Using Arduino and RFID, International Research Journal of Engineering and Technology, Vol. 5, Issue 3, March 2018

This system is not only effective in eradicating the long queues but also manages the budget of the customer. With new technologies rapidly making every walk of life smart, shopping should be made smarter too.

2.4 The RFID Based Smart Shopping Cart", International Journal of Engineering Research and General Science, Volume 3, Issue 2, April 2015

The developed model has easy access, is economical and showcases an intelligent and easy shopping experience to reduce time, the energy of the consumers. There are a few challenges/drawbacks to being resolved to make the proposed system more robust, but there is also no doubt that with the RFID having a wide scope in supply chain management, the proposed model has the potential to improve and ease the basic retail experience to a great extent.

2.5 VatsalaVaibhaviet.al; in "wireless passive RFID based smart trolley with an app for billing solutions "published in international journal of Advance Research, Ideas and Innovations in technology

It proposed to develop an RFID active reader passive tag system in replacement of barcode, the mobile application is used for self –checkout.

2.6 Satish Kamble in "Developing a Multitasking Shopping Trolley Based on RFID Technology"

It proposed to develop a product to assist a person in everyday shopping in terms of reduced time spent while purchasing. The main aim of the proposed system is to provide a technology-oriented, low-cost, easily scalable, and rugged system for assisting shopping in person.

2.7 Automated Shopping Trolley for Super Market Billing System", International Journal of Computer Applications International Conference on Communication

The Automated Shopping cart system integrates a Shopping cart (trolley) with 2 sets of barcode scanners placed at 2 different checkpoints – the entry and exit points respectively. It facilitates the user to self-scan the barcode of the purchased products which he intends to purchase. Wrongful entries can be corrected by making use of a keypad that changes the functionality of the machine from the addition of products to the removal of products and activates the other barcode scanner at the opposite end.

3. TECHNOLOGY USED

3.1. IoT (Internet of Things)

The internet of things, or IoT, is a system of interrelated computing devices, mechanical and digital machines, objects, animals or people that are provided with Unique Identifiers (UIDs) and the ability to transfer data over a network without requiring human-to-human or human-to-computer interaction. An IoT ecosystem consists of web-enabled smart devices that use embedded processors, sensors and communication hardware to collect, send and act on data they acquire from their environments. IoT devices share the sensor data they collect by connecting to an IoT gateway or another edge device where data is either sent to the cloud to be analysed locally. Sometimes, these devices communicate with other related devices and act on the information they get from one another. The devices do most of the work without human intervention, although people can interact with the devices, for instance, to set them up, give them instructions or access the data.

3.2. RFID Technology

RFID stands for radio frequency identification. Reader (RFID reader) is a device used to gather information from an RFID tag, which is used to track individual objects. Radio waves are used to transfer data from the tag to a reader. RFID is a technology similar in theory to bar codes. Automatic identification technology which uses radiofrequency electromagnetic fields to identify objects carrying tags when they come close to a reader. RFID methods utilize radio waves to accomplish this. At a simple level, RFID systems consist of three components: an RFID tag or smart label, an RFID reader, and an antenna. RFID tags contain an integrated circuit and an antenna, which is used to transmit data to the RFID reader (also called an interrogator). The reader then converts the radio waves to a more usable form of data. Information collected from the tags is then transferred through a communications interface to a host computer system, where the data can be stored in a database and analysed at a later time.

An RFID tag consists of an integrated circuit and an antenna. The tag is also composed of a protective material that holds the pieces together and shields them from various environmental conditions. The protective material depends on the application. For example,

employee ID badges containing RFID tags are typically made from durable plastic, and the tag is embedded between the layers of plastic. RFID tags come in a variety of shapes and sizes and are either passive or active.

3.3. Arduino IDE platform
Arduino is an open-source computer hardware and software company, project, and user community that designs and manufacture single-board microcontrollers and microcontroller kits for building digital devices and interactive objects that can sense and control objects in the physical world. The Arduino project provides the Arduino integrated development environment (IDE), which is a cross-platform application written in the programming language Java. It contains code editor which includes features like text cutting and pasting, text searching and replacing, automatic indenting, brace matching, and syntax highlighting and compile and upload programs on Arduino board by one click mechanism. Additionally, it contains a message area, text console, a toolbar with buttons for various functions and operations menu. It supports c and c++ languages. The smallest Arduino c/c++ program consist of only two functions. They are:

- **Set up ():** This function is called only once whenever sketch starts either after power-up or reset. It initializes variables, input and output pin modes and other libraries that are used in the sketch.
- **Loop ():** This function is executed repeatedly after setup (). It is used to control the board until the board is either power off or is reset.

3.4. Bluetooth HC-05
The HC-05 module is a Bluetooth SPP (Serial port protocol) module which means that it communicates with the Arduino through serial communication. This module is designed for wireless serial communication and it is fully qualified Bluetooth V2.0+EDR (Enhanced Data Rate) 3Mbps Modulation with complete 2.4GHz radio transceiver and baseband. The maximum range for wireless communication for this module is 10 meters. The HC-05 Bluetooth module is different from the other modules like HC-06 in a way that the HC-06 module can only be set as a slave while the HC-05 module can be set as a master as well as a slave which can enable the communication between the two microcontrollers like two Arduino boards.

3.5 GSM
GSM (Global System for Mobile communications) is an open, digital cellular technology used for transmitting mobile voice and data services. GSM/GPRS Modem-RS232 is built with Dual-Band GSM/GPRS engine- SIM900A works on frequencies 900/ 1800 MHZ. The Modem is coming with RS232 interface, which allows you to connect PC as well as a microcontroller with RS232 Chip (MAX232). The baud rate is configurable from 9600-115200 through AT command.

The GSM/GPRS Modem is having internal TCP/IP stack to enable you to connect with internet via GPRS. It is suitable for SMS, Voice as well as DATA transfer application in M2M interface. The onboard Regulated Power supply allows you to connect a wide range of unregulated power supply. Using this modem, you can make audio calls, SMS, Read SMS; attend the incoming calls and internet through simple AT commands.

3.6 Materials used
Table 1: Components used and its specification

S. no	Components	Specification
1.	ATmega	328P
2.	RFID Reader	EM-18
3.	RFID Tag	Passive(13.56MHz)
4.	LCD Display	16*2
5.	Battery	SMF, 6v
6.	Transformer	12v
7.	Bluetooth module	HC-05
8.	Thermal printer	RP203
9.	GSM Module	800a
10.	Toggle switch	DPDT

4. EXISTING SYSTEM
In the existing system, IOT based intelligent cart for supermarket applied RFID Barcode technology for billing during purchase in the supermarket. The payment details will be sent to the server by which the central billing unit will deal with the customer's payment. The ESP module will be working as a short distance Wi-Fi chip for wireless communication. The main drawback of constraints includes such as distance and interference.

5. PROPOSED METHODOLOGY
In our proposed system an RFID based data analysis and an IoT enabled smart shopping system is designed to enhance the shopping experience. In our proposed system an RFID based data analysis and an IoT enabled smart shopping system is designed. The registered user will be given a smart card which can be recharged. The product in the rack is identified very easily using pathfinding technique which is displayed on the LCD located in the trolley. Each product is then scanned in a trolley through RFID reader.

Once the customer completes the shopping, the trolley will generate the bill automatically. The registered user will do payment by using a smart card and the non-registered user needs to pay the cash at the counter then the bill is generated within a few seconds. This ensures the process of scanning easy and precise.

If a customer wants to purchase any product then has to put the product in the cart. As soon as the product falls in the cart the RFID reader read the RFID Tag place on the product. This RFID reader is connected to the controller. Controller crosschecks the information gets from RFID reader and information in the memory of the controller. If the information gets a match then the cost of the product, the name of the product and the total bill display on the LCD.

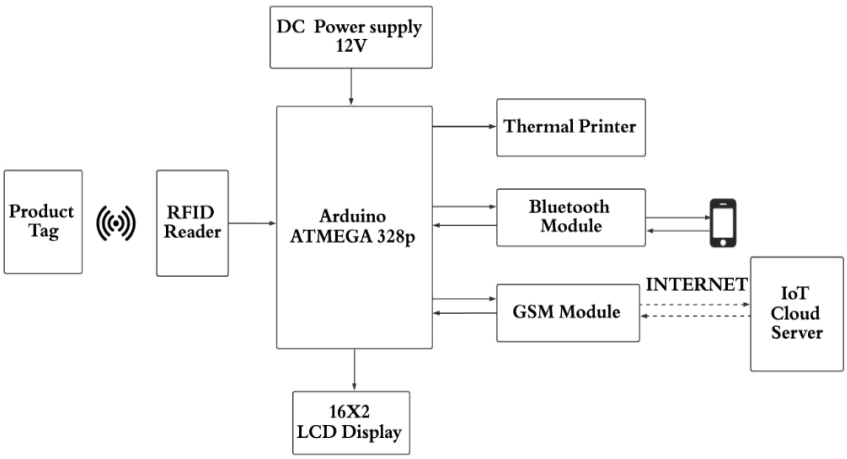

Fig. 1: Block diagram of the proposed system

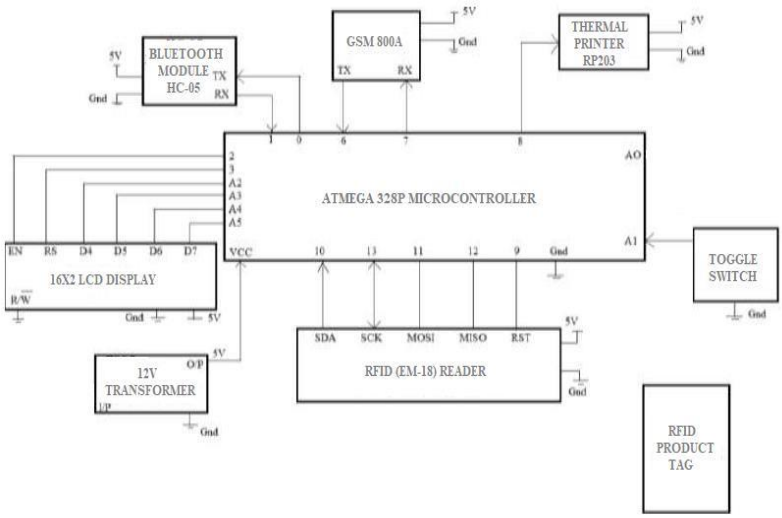

Fig. 2: Circuit diagram of the proposed system

5. RESULTS AND DISCUSSION

To begin with, the customer picks the smart cart to start shopping. Here each cart is designed with required smart system. The smart system is implemented with the above components in the block diagram.

Firstly the customer has to initialize power of the cart then it is ready to use .while shopping the customer are grouped into two: Registered user and non-registered user. If the customer is a registered user, she/he is provided with an RFID smart card as we have a membership card in all. Shopping is initiated when the customer flashes the card above the RFID reader. The registered user will be given a smart card which can be recharged. The non-register user presses the push button to initiate the shopping in the smart cart. After pressing the push button the led display shows that the shopping is initiated for the non-register also.

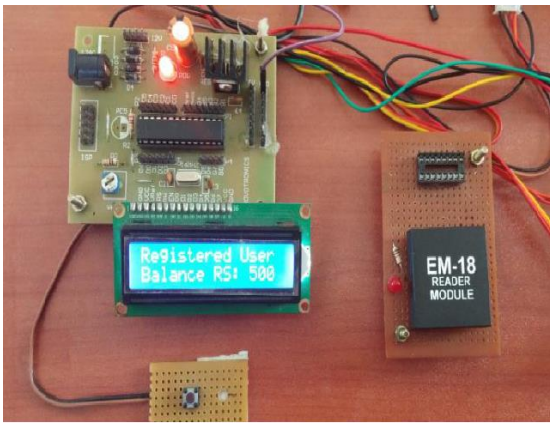

Fig. 3: Displaying balance amount for the registered user

Fig. 4: Alert to nonregistered user

Fig. 5: Shopping initiated for the nonregistered user

Fig. 6: LCD displaying product details

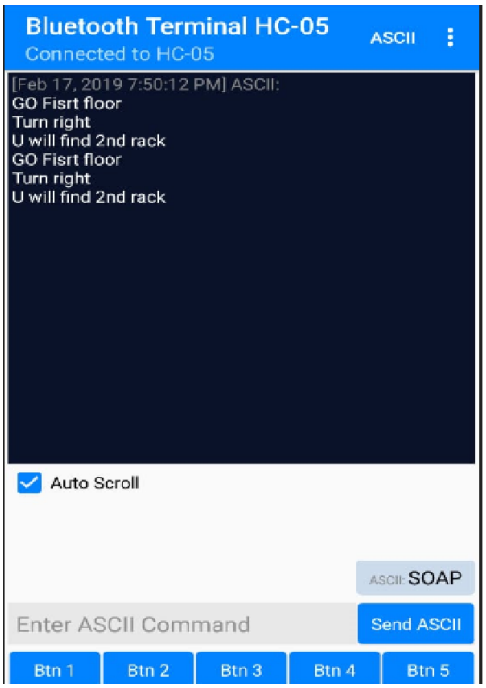

Fig. 7: Product route information via Bluetooth

Fig. 8: Product route information via LCD

Each product is then scanned in a trolley through RFID reader. If the customer faces any difficulty in finding the product, the customer can search the product by quick pathfinding schemes. They need to pair the devices and the default password of the HC-05 module is 1234. After pairing the devices, it shows the correct destination of the product. The trolley is provided with Bluetooth and GSM module which helps to find the location of the product. The user has to pair the mobile phone with a Bluetooth module in the trolley. And they have to type the name of the product in the search box of application. The instruction will be displayed on LCD. Once the customer completes the shopping, the trolley will generate the bill automatically. The registered user will do payment by using a smart card and the non - registered user need to pay the cash at the counter then the bill is generated within a few seconds with the help of a thermal printer.

Thus our proposed system is having an advantage where the registered user need not go to cash counter to pay the bill. The total shopping bill amount will be reduced from the recharge amount for the registered user. Only the non-registered user will be paying the bill in the cash counter. The user can also return the product, by scanning the product again above the RFID reader so that the product amount again added to the total amount.

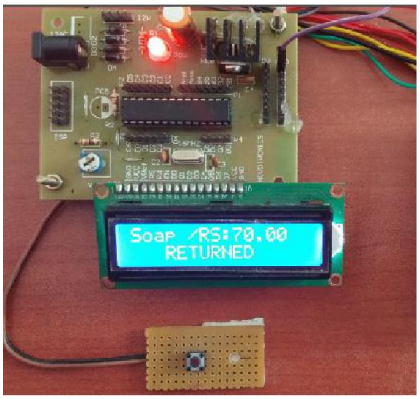

Fig. 9: LCD displaying returned product details

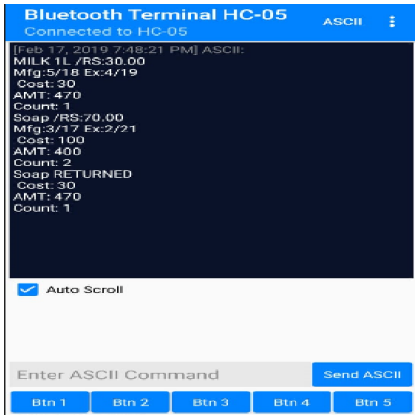

Fig. 10: Shopping list can be verified via Bluetooth

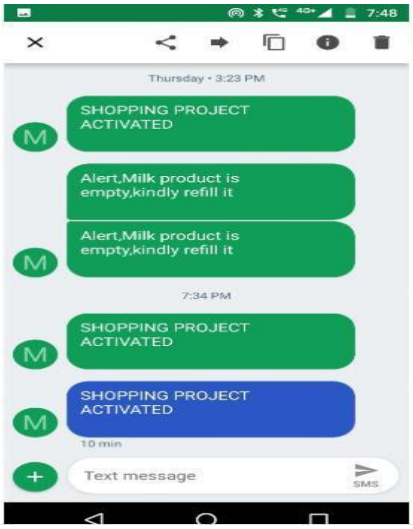

Fig. 11: SMS Alert to the owner at the real-time

Fig. 12: Empty stock alert SMS sent to the seller

Fig. 13: Thermal printer O/P for Registered user

Fig. 14: Thermal printer O/P Non-registered user

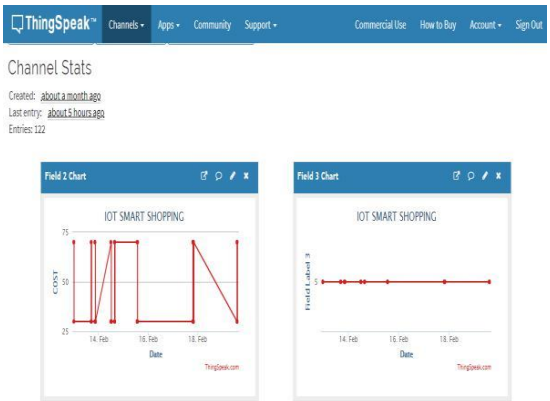

Fig. 16: MATLAB visualization for seller

	A	B	C	D	E	F
1	created_at	entry_id	field1	field2	field3	field4
2	2019-01-20 06:21:56 UTC	1	MILK	30	May-18	IN
3	2019-01-20 06:22:14 UTC	2	MILK	30	May-18	OUT
4	2019-01-20 06:22:35 UTC	3	MILK	30	May-18	IN
5	2019-01-20 06:22:55 UTC	4	MILK	30	May-18	OUT
6	2019-01-20 06:23:19 UTC	5	MILK	30	May-18	IN
7	2019-01-20 06:23:35 UTC	6	MILK	30	May-18	OUT
8	2019-01-20 06:24:41 UTC	7	SOAP	70	May-18	IN
9	2019-01-20 06:24:57 UTC	8	SOAP	70	May-18	OUT
10	2019-01-21 04:11:33 UTC	9	MILK	30	May-18	IN
11	2019-01-21 04:11:53 UTC	10	MILK	30	May-18	OUT

Fig. 17: Data analysis of the product details for seller verification

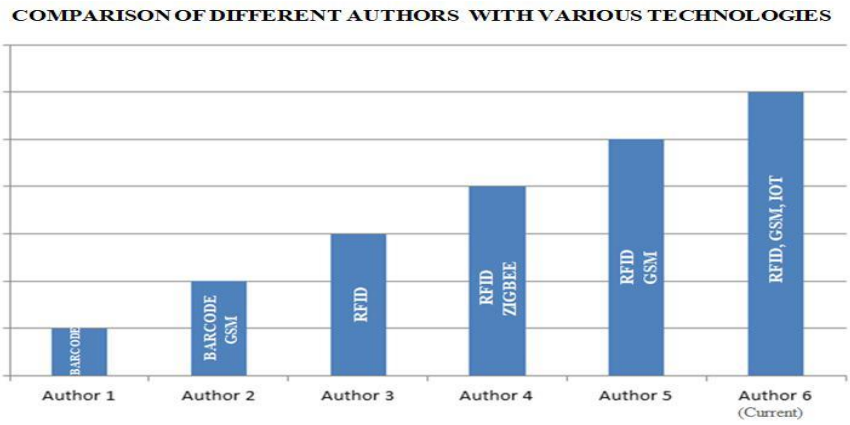

Fig. 18: Comparison with other authors

Thus our proposed system utilizes RFID; GSM & Bluetooth (HC-05) with an IoT enabled technology, the customer completes the shopping in the trolley itself by getting a real-time shopping bill using the thermal printer. Hence the overall time is reduced by eradicating the long queue in the bill counter and also the overall efficiency is improved.

6. CONCLUSION

The Smart Trolley was designed to function as a self-checkout system providing users flexibility and also it is designed to be highly efficient and fully synchronized with the retailer's current system. The developed model is easy to use, the trolley is user-friendly. The LCD displayed the name of the product, cost of the product and also creates an automated central billing system (ACBS) for supermarkets and malls. Using PID (product identification), customers will not have to wait near cash counters for their bill payment. Since their purchased product information is transferred to the central billing system. The smart shopping system proposed is highly dependable, authentic, trustworthy and time-effective.

7. FUTURE ENHANCEMENT

By implementing RFID technology in the hypermarket door end, theft is avoided and also it increases the security for commodities. Promoting the application to the mobile phones of the customer. Payment method can be modified through customer debit or credit card. In future, the trolley may be implemented with audio O/P so that customer can hear songs track while shopping. If the weight of the trolley increased then the corresponding torque and power may be improved with a suitable motor.

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