iJRASET
International Journal For Research in Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 9 **Issue:** IX **Month of publication:** September 2021

DOI: https://doi.org/10.22214/ijraset.2021.38159

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International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.429
Volume 9 Issue IX Sep 2021- Available at www.ijraset.com

IoT Based Smart Shopping Cart

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Abstract: Physically challenged and senior citizens find it difficult to push heavily loaded carts around the supermarket. To combat this, we have implemented an autonomous shopping cart that supersedes the existing shopping trolley. This autonomous cart can manoeuvre around without the need of pushing it by using multiple ultrasonic sensors. To avoid long queues at the billing counters and also to reduce the workload of the employees at the supermarket, we have implemented a billing system. Scanning is incorporated in the cart itself, thus reducing the time wasted by customers at the billing counter. This billing system uses RFID (Radio Frequency Identification) to scan products. Products scanned in the cart are sent to the computers installed in the supermarket using a Wi-Fi module. The Automated Shopping Cart thereby eases the shopping experience of customers and reduces the manpower employed in supermarkets. The significant benefit of using an automated cart is that customers can move swiftly through the cash counter and check out independently.

Keywords: Smart Cart, RFID, Arduino, Billing System, Autonomous Drive System

I. INTRODUCTION

Currently, the shopping system used in malls and supermarkets is based on the barcode system. This system replaced the previous manual billing system, but it has some limitations. Firstly, to scan the barcode in the products the scanner must be in the line of sight. Its scanning range is limited to a few inches. In addition to that, the barcode gets damaged easily when proper care is not taken when it is in use. So to finish scanning all the products, customers have to stand in long queues to generate their bills. Even though this method has a lot of disadvantages it is still widely used. A smart cart with advanced billing and manoeuvring capabilities helps to reduce the time wasted during shopping. This system not only truncates the queues at the billing counter but also saves a lot of money for customers. Here, scanning of products is done with the help of RFID tags and readers because they are more efficient and powerful than barcodes. When these RFID scanners are installed within the cart, customers themselves can scan the products while dropping the products into the basket. They can view purchased items on the LCD display attached to the cart. Hence, the time and money management of each customer can be taken care of easily. This paper is arranged into five sections. The first section gives an overview of the system. The second segment is about shopping systems and the study of existing systems. The third system is about the proposed solution to the existing system. The fourth segment is about hardware and software technologies required for building this system. The fifth segment is about the implementation of the system. The sixth segment presents the results obtained using Arduino and RFID devices. Finally, the conclusion provides a summary and future scope of the proposed system.

II. LITERATURE SURVEY

The literature survey is an important phase in the system development life cycle as we collect and acquire the necessary information to handle or develop a project during this phase. A literature review may be a description of the literature relevant to a specific field or topic. It gives an overview of what has been said, who the key writers are, what are the prevailing theories or hypotheses and what methodologies are appropriate and useful. In this chapter, research is done before taking up the projects and understanding the various methods that were used previously. A detailed analysis of the prevailing system was performed. This study helped to spot the advantages and disadvantages of the prevailing systems.

Suryaprasad J in "A Novel low-cost intelligent shopping cart" proposed to develop a low-cost intelligent shopping aid that assists the customers to search and select products and inform the customers on any special deals available on the products as they move around in the shopping complex. (2018)

Amine Karmouche in “Aisle-level scanning for pervasive RFID based shopping applications’’ proposed and developed a system that can scan dynamic and static products in the shopping space using RFID reader antennas. Instead of conducting the RFID observations at the level of individual carts, aisle-level scanning is performed. (2017)

P.Chandrasekar in “Smart shopping cart with automatic billing system through Zigbee “ proposed to develop a shopping cart with a product identification device which will contain a microcontroller, EPROM, Zigbee module etc., Purchasing product information is sent to the main pc. The (2019)

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III. HARDWARE AND TECHNOLOGY USED

A. Arduino Mega 2560

The Arduino Mega 2560 is a microcontroller board based on the ATmega2560. It has 54 digital input/output pins, 16 analog inputs, 4 UARTs, a 16 MHz crystal oscillator, a USB connection port, a power jack, an ICSP header, and a reset button. It contains everything needed to support the microcontroller. The coding for this microcontroller is done with the help of Arduino Integrated development environment software. It primarily uses C, C++ as the coding language, so it contains a vast amount of inbuilt functions and libraries which are useful while writing an Arduino code.

Simply by connecting it to a computer or an external power supply we can get it up and running. The Mega is compatible with most shields designed for the Arduino. The Mega 2560 is an update to the Arduino ADC, which it replaces. The Arduino Mega2560 has a resettable poly-fuse that protects the computer's USB ports from short circuits due to overcurrent.

Fig. 1 Arduino Mega 2560

B. RFID

RFID or Radio Frequency Identification uses radio waves to read or save information/data in an RFID based tag. The RFID tags consist of two major components, a microchip for processing and storing information and an antenna for transmitting as well as receiving the radio frequency signals. There are two kinds of tags: battery-powered RFID tags and passive RFID tags. The battery-powered tag has a small battery embedded inside it that gives the tag power to receive or transmit the information stored.

In the case of the passive tags, the interrogator uses its power to read the information present in the tags. RFID readers are used for retrieving the information that is stored inside the RFID tags. The reader consists of a transmitter that transmits the signal to the tag, requesting information and the receiver retrieves the information present in the tags.

Fig. 2 RFID representation

IV. SYSTEM ARCHITECTURE

The smart cart uses an Arduino to process the signal sent by the ultrasonic sensor and infrared sensor. Based on the signal sent, the motor gets actuated to follow the customer. Scanning and billing of the products are completed by using a NodeMCU, RFID reader, an LCD display, buttons and RFID tags.

The cart follows the customer when the signal received from the ultrasonic sensor is more than the predefined value. The RFID reader scans the RFID tags present on the products and sends the information to the NodeMCU module. The LCD display shows the details of the product. If a customer wants to remove a product, it is done by rescanning the product to remove it from memory. To delete all the data stored in NodeMCU, the reset button is pressed.

If a customer wants to see the total of their purchase, by scanning a master RFID tag they will be able to view it. The information about their purchase is sent to the server present in the supermarket via the Wi-Fi module present in NOdeMCU. So a customer's bill gets generated automatically in the admin's system to complete the payment process.

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The following block diagram gives an overview of the working of the cart movement and billing process.

Fig. 3 Block diagram for cart movement

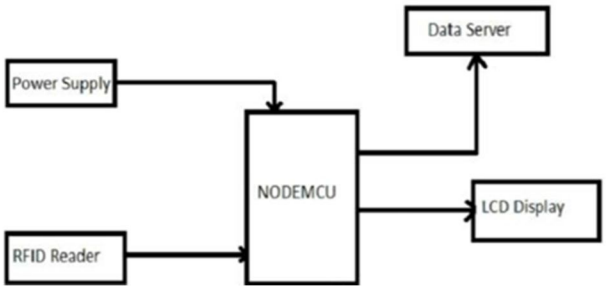

Fig. 4 Block diagram for billing

V. IMPLEMENTATION OF THE SYSTEM

A. Building The Cart

In this section, we shall discuss various steps involved in implementing the proposed system.

Initially, a power supply is given to the system via a DC power source, thereby the data is transferred to the ultrasonic sensor via Arduino mega. Here the ultrasonic sensor detects the distance between the person and the cart. After detecting the distance, data is transferred to the Arduino mega. The processed signal is transferred to the Motor Driver, which is a type of microcontroller used to control the DC motors connected to the cart. The actions performed by the DC motors are determined by the data which is given to the motor driver module. Then the cart follows the human by maintaining a specific distance between the cart and the human

1) Cart Movement

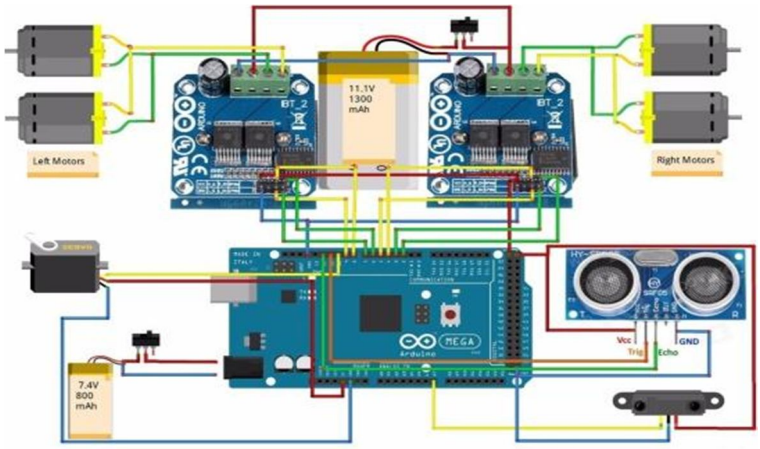

Fig. 5 Circuit Design for cart movement

The above circuit diagram is designed in designing software. The circuit shows the wiring connection for the system. This helps to make the cart follow a customer.

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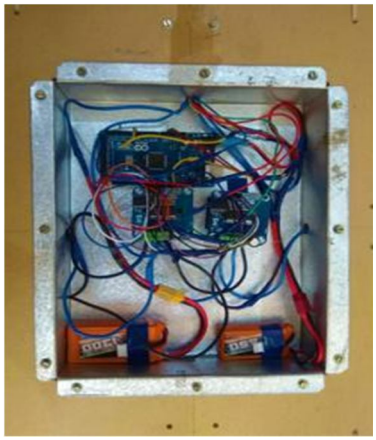

Fig. 6 Implementation of the circuit for movement

Fig. 7 Front view of the cart

2) *Billing Setup:* Here we have used RFID cards and RFID readers with NodeMCU to build this Smart Shopping Cart. The cart's information and the total value will be displayed on the webpage as well as on LCD. Each RFID card stores details of a specific product and an RFID reader installed in the cart reads the product price and sends them to NodeMCU ESP8266. Then NodeMCU processes the available items and total value in the cart and sends them to ESP8266. EM18 Reader is a very popular RFID module that can read the ID information stored in the RFID tags. The RFID tags store a 12-digit unique number which can be decoded by an EM18 reader module when the tag comes in a range of the Reader. This module has an inbuilt antenna that operates at a frequency of 125 kHz and a 5v DC power supply is required to power it up. It gives a serial data output and has a range of 8-12cm. The serial communication parameters are 8 data bits, 1 stop bit and 9600 baud rates. Here we use RFID cards and RFID readers with NodeMCU to complete the billing process. Then NodeMCU processes the available items and total value in the cart and sends them to ESP8266 Webserver, which can be monitored on a web browser from anywhere in the world.

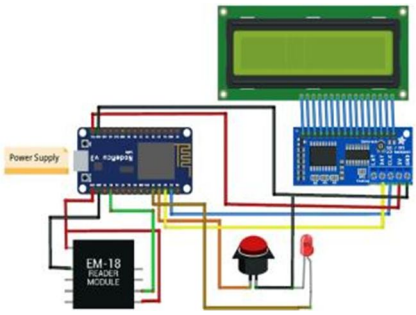

Fig. 8 Circuit design for billing

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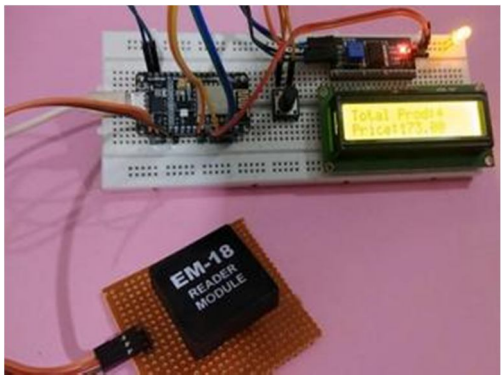

Fig. 9 Implementation of the circuit for billing

3) *Scanning a Product:* The product is scanned using the RFID scanner and items which are added to the cart gets displayed on the LCD screen.

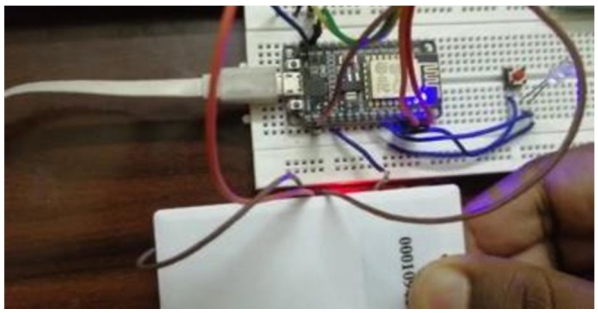
Fig. 10 Scanning a product

Fig. 11 After adding an item to the cart

4) *Deleting a Product:* A product can be deleted by simply pressing the delete button and rescanning the item you wish to delete. The bill total can be seen by using a MasterCard.

Fig. 12 Removing of a product

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Fig. 13 Displaying the total

5) *Completing the Purchase:* The bill is sent to the admin's system by pressing the bill button for the payment process.

Fig. 14 Finishing the purchase

VI. RESULT

A. Bill Generation at the Admin's Section

When the admin enters the cart's IP address in his system, the bill details get displayed in it. The changes that take place in the cart get updated on the web page in real-time. The payment process can be completed through the web page itself.

Smart Shopping Cart using IoT

ITEMS	QUANTITY	COST
Biscuit	1	35
Soap	1	38
Rice(1KG)	1	55
Tea(50g)	1	45
Grand Total	4	173.00

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Fig. 15 Bill details shown in admin's system

VII. CONCLUSION

The IoT based smart shopping cart has been successfully implemented. This system not only eradicates long queues at the billing counter but also helps the customers to save a considerable amount of money. The cart's ability to follow a customer independently and also advanced scanning capabilities makes this system better than the existing barcode systems.

With new technologies blooming every day, the shopping methodology should also be changed accordingly. By doing so, the billing process speed increases and becomes much simpler. The automatic following system makes the shoppers shop at ease. This project is beneficial for both shop owners and customers.

This objective is effectively attained through the model developed. And the system is of low cost, amiable to use and does not require any specific knowledge. Taking into account the changing trend in retail shopping, we can conclude that the Smart Shopping Cart will serve as a basic necessity for the Retail marketing industry to provide a faster and efficient billing process.

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VIII. FUTURE SCOPE

With the use of Artificial Intelligence and computer vision, we can make the cart follow a customer with a higher level of precision in any condition. Theft proof mechanisms can be utilised for protecting the items present inside the cart from burglars. Customized adverts can be shown to a customer based on their recent purchases helps in boosting sales. The payment process can also be done within the cart itself for creating fast and secure transactions. With the use of NVIDIA JETSON boards, we can control the motor actuation by using artificial intelligence embedded technology. This JETSON has a powerful computing board that can be used for easy smart movements of the trolley with greater accuracy and efficiency than an ultrasonic sensor.

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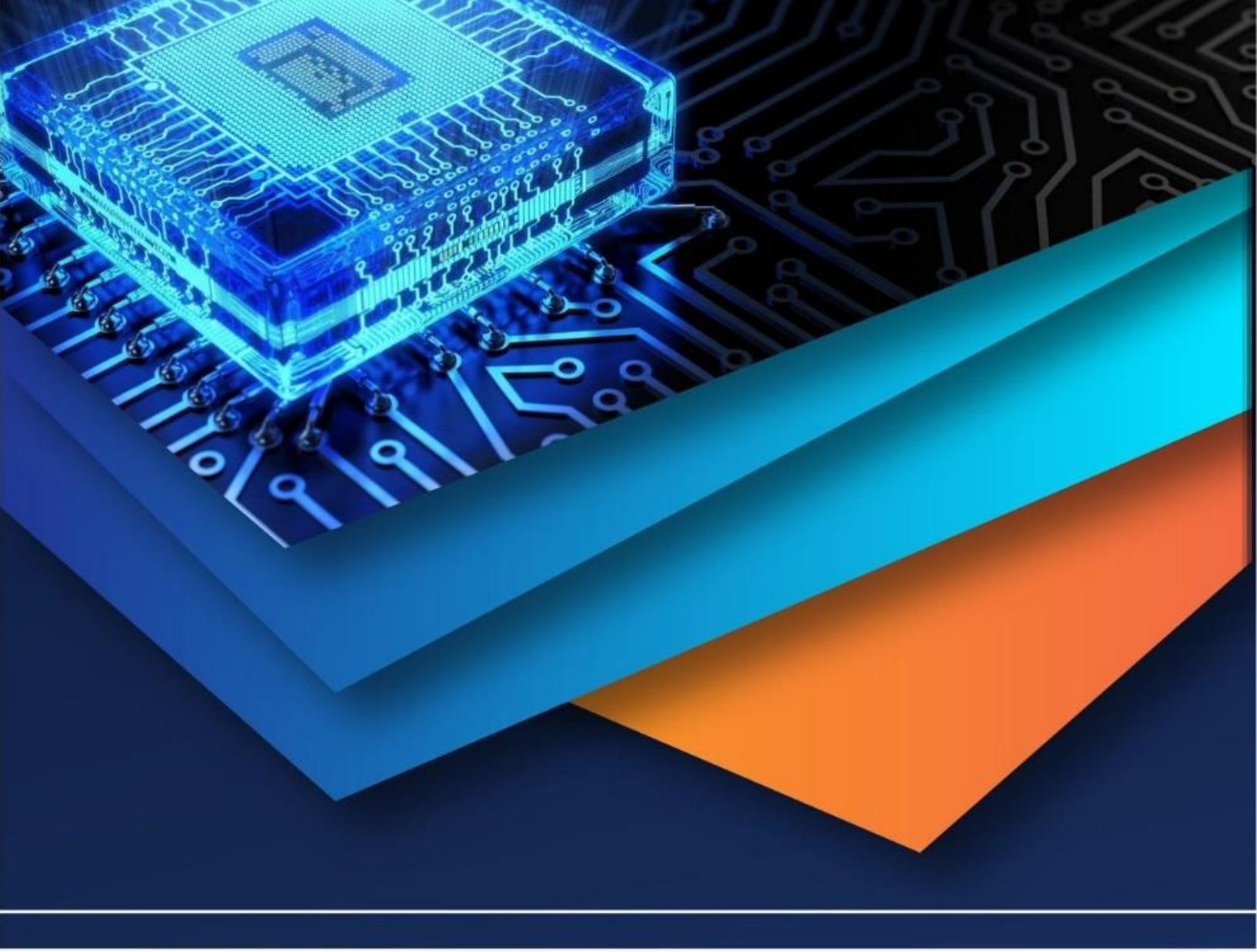

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