International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 05 Issue: 01 | Jan - 2021 ISSN: 2582-3930

IoT Based Smart Shopping Cart System for Customer Experience Optimization

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***Abstract*— The retail industry is observing a rapid transformation with Internet of things solutions taking the centre stage by improving customer loyalty & offering a wholesome experience. This paper addresses a robust, highly-efficient solution for making the shopping process elegant and comfortable for the users. With the aid of smart sensors & RFID techniques, retail stores will be able to provide a more streamlined and relevant shopping experience to shoppers. RFID tags can be attached to each product and RFID readers can autonomously scan the product details and display the information on a digital screen placed on the cart. Smart sensors can be deployed to detect & assist the new customer in their shopping without them having to push it manually. Further, after completion of the shopping, the system will connect to the Central server by the means of RF Transceiver for inventory updation and billing and will display the product details and the total cart amount and will allow you to pay the amount by scanning the QR code. The findings from this research can be applied to other industries as well.**

Keywords—customer experience, shopping cart, retail industry, smart sensors, RFID system, RF Transceiver, QR code

I. INTRODUCTION

Internet of Things (IoT) has received widespread acceptance in various real-life scenarios. IoT is capable of forming a network of items, each embedded with sensors, capable of communicating with each other in the network. IoT uses several technologies ranging from RFID & sensors to barcodes & GPS to monitor and manage physical assets in an organization. IoT Devices generate data to be stored & processed somewhere. For large-scale applications, tons of times of data is generated every second. This data can be handled by the cloud – a huge place for data with tools and applications ready to help with data pre-processing. There are numerous applications of IoT including smart city automation, e-health, fraud detection system to name a few.

The retail industry has been riding a wave lately. Since the past two decades, traditional retail landscape has dramatically changed, providing companies with innovative opportunities to collect & study data and accordingly ensure successful targeting across various channels. Amazon has over 197 million monthly visitors bringing in over $350 million in revenue. IoT use cases in retail are already enhancing the brick-and-mortar experience by gathering and implementing insights into customer's data. . Implementing IoT in retail provides numerous benefits to companies and innovative ways to interact with its customer. According to a research by Global Market Insight Inc, IoT in the retail market is predicted to reach over $30 Billion by 2024.

This paper proposes an architecture for automated human following smart cart system that eliminates the hassle of humans pulling the cart manually and waiting in long queues for bill payment. The design part includes an Arduino Micro-controller, connected to the Kinect sensors, DC motors, RF Transceiver. The RFID system consist of RFID tags attached to the products & the RFID readers mounted on the shopping cart to scan the products and send the product details to the Micro-controller which in-turn will fetch/update the inventory from the central server. Thus, providing a seamless shopping experience to the customer.

II. TECHNOLOGIES & COMPONENTS USED FOR SYSTEM

A. *Kinect Sensors*

A sensor is an element which can turn a physical outer stimulus into an output signal that can be used for further analysis, management or decision making. With the help of large arrays of sensors, information can be combined and correlated to infer conclusions about latent problems; for instance, in some cases, two sensor functions are available in one device.

Fig 1. Kinect Sensor

The system makes use of the Kinect Sensor, to detect and track movements of the target person. With the help of Kinect sensor, we can recognize a person's voice commands, provide skeletal tracking and depth analysis of the human.

B. *RFID Technology*

The vital component that constitutes IoT are RFID systems, that includes 'readers', which activates transmission of signals & tags, and are attached with unique identifiers in tags, sensors, and actuator. RFIDs can also help in improving tracking & visibility of items by increasing efficiency & the pace of the process. improving the template is used to format your paper and style the text. RFID systems depend on wireless communication. One aspect of the system is the RFID tag attached to each product and other aspect is the RFID reader that reads product details.

Fig 2.. RFID System

The RFID system in **Fig. 2**, shows the RFID reader with RFID card and Tag. The reader sends data to the tag using RF waves & in return receives a modulating echo simulating the information stored in the tag, which is then analysed by a real-time processing system for detection, authentication & tracking purposes.

C. DC Geared Motors

A DC geared motor is an all-in-one combination of motor and the gearbox. The inclusion of the gearhead to the motor helps in reducing the speed while increasing the torque output.

Fig 3. DC Geared Motors

With the aid of geared motors, we can provide the required torque for the trolley.

D. Motor driver

Motor driver acts as the interface between motor and the control circuits. The function of a motor driver is to convert lower-current signal to a higher-current signal that can drive a motor.

Fig 4. L293D Motor Driver IC

We use the L293D motor driver IC, which assists us to reverse the direction of rotation as well as to manage the speed of the DC motor.

E. RF Transceivers

RF Transceivers are wireless communication device. They include RF transmitter and RF receiver, where, RF transmitters are called as RF Up converter and RF receiver are called as RF Down converter. The circuit of RF Transceiver is typically designed for half-duplex operation, full duplex modes are available, although typically at a higher cost.

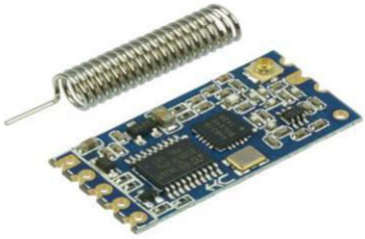

Fig 5. RF Transceiver

RF transceivers contain a built-in MCU (Micro-controller unit), to perform communication with external device through serial port. RF Transceiver is responsible to cover a wide range and provide quick and reliable communication.

F. Power Supply

For the power supply, four 1.5V AA batteries will provide power to Arduino, which is capable to output 3.3V and 5V voltage. Using eight 1.5V AA batteries, which altogether supply 12 V, we can provide power to the two DC motors.

G. Micro-controller

In the proposed system, Arduino Mega 2560 micro-controller is used to interface with all the components and sensors.

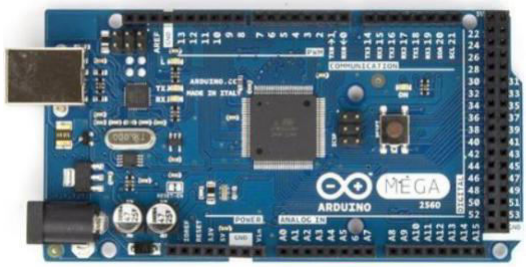

Fig 6. Arduino Mega 2560

Arduino Mega 2560 has a memory of 256 KB for storing codes, SRAM of 8 KB, EEPROM of 4 KB. All analog pins on this board can be utilized as digital I/O pins. This board offers more processive power that allows to work with different types of sensors without any delay.

III. PROPOSED SYSTEM

This system consists of the Arduino Mega 2560 connected to Kinect Sensor, Digital Screen, L293D motor driver IC, DC geared motors. Additionally, the Arduino Mega communicates with the Central Server through the RF Transceiver. Kinect Sensor is a motion-sensing input device which gives RGB characteristics and depth information of

each pixel. It selects a person who raises his two hands as the target to follow in the beginning. Consequently, the system then recognizes the person to follow, by skeletal tracking, identifying its location & understanding the RGB color characteristics of clothes. A threshold value is set between the shopping cart and the person. If the distance crosses the threshold value, the micro-controller pressures the motor to in the particular direction of the target customer. The L293D Motor driver IC is deployed to provide higher current signal to drive the motor and simultaneously control the motor speed by controlling the PWM speed. The two DC geared motors are driven by 12V DC Voltage. The sensors and the RF Transceivers require 5V DC Voltage. RFID tags can be placed on the products that can be scanned automatically using RFID readers and accordingly calculate the number of products purchased. RFID tags do not require a power source, the tag uses the energy of radio waves to power its operation. A digital screen will be placed on the shopping cart. Whenver the customer places a product in the cart, the RFID reader scans the tag, identifies and sends the product name to the micro-controller. The micro-controller fetches the product details from the Central Server using the RF Transceiver, the central server updates the inventory and provides the product details to the microcontroller. The micro-controller then updates the digital screen with the product details. To avoid time wastage, RFID system can help in smooth and advanced bill payment. After the customer indicates the completion of his shopping, the order is processed and the bill is generated by the central server, accordingly, after verification of the bill, a QR code scanner appears and the customer proceeds ahead to bill payment using the digital payment techniques. The proposed system allows the customer to shop in a more innovative and comfortable manner.

IV. METHODOLOGY

A. *Block Diagram*

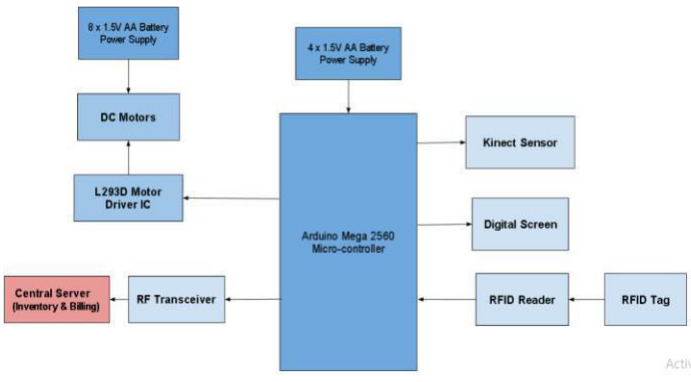

Fig 7. Block diagram of the system

B. *Working*

In this section, the interacing and working of the system will be discussed. The hardware part of the system consists of Arduino Mega interfaced with a Kinect Sensor, Digital Screen, RFID reader, L293D IC, Buzzer, RF Transceiver. The software part includes Arduino IDE to program the system.

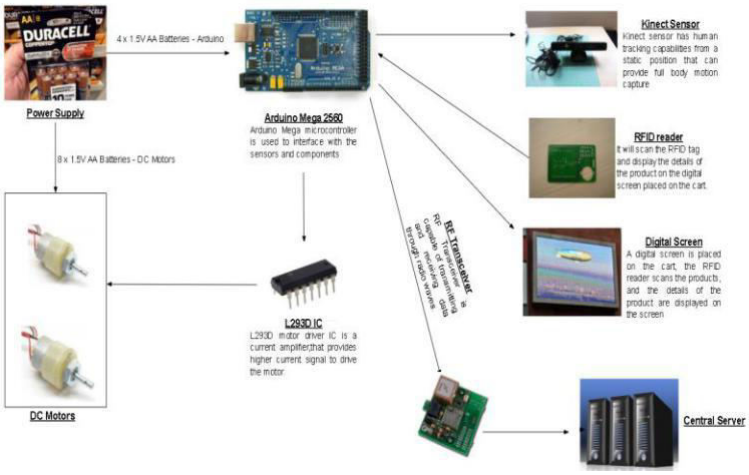

Fig 8.Architecture of the system

- Four 1.5V AA Batteries are required to supply power to the Micro-controller, which can output 3.3V and 5V voltage. Eight 1.5V AA Batteries, altogether 12V are connected to supply power to the DC motors.
- Kinect sensor is capable of tracking humans from a static position that can provide full-body motion capture. The system identifies the person who raises his two hands as the target. It follows the target person by identifying his location and capturing the RGB characteristics of the clothes of the customer.
- **Fig 8**. shows the connection from Arduino to L293D Motor driver IC which is used to drive both the motors simultaneously by providing a bidirectional current of upto 600mA . L293D consists of two H-bridge designed using 4 transistor circuit that helps to reverse direction of rotation and control the motor speed.
- RFID tags are used to identify and locate items usng radio signals. It contains a microchip and an antenna which transmit a signal to the 'reader'. RFID tags can be read at distances ranging from few centimetres to over 100 meters.
- When a product is placed in the shopping cart, RFID reader reads the tag information and conveys the name of that particular product to the micro-controller. The micro-controller communicates with the central server and receives the product details using RF Transceiver and then displays the details of the product on the Digital Screen. Simultaneously, the billing information gets updated, with the addition of every item in the cart.
- If the customer chooses to remove any product from his cart, the amount gets deducted from the bill too.
- After completing the shopping, customer has to select the "End Shopping" button on the digital screen.Simultaneously, the bill details and information are fetched from the central server to the Arduino Mega micro-controller which then displays it onto the digital screen. After confirmation from the customer about the bill, a QR code scanner appears, and the customer can complete his payment by scanning the QR code through digital payment methods
- The proposed system provides a seamless and elegant shopping experience to the customer

V. ADVANTAGES

This system has various benefits, for the customers as well as for the retailers:

- Efficient and care-free shopping experience given to the customers.
- Cost Optimization
- Minimizes shopping time.
- Eliminates the long queues for billing after shopping.
- Retailers can attract more customers with the proposed system.

VI. CONCLUSION

The proposed system is a good alternative on comparison with the conventional system being used in the supermarkets. The system offers a comfortable experience to the customers by eliminating the hassle of manually pushing the cart or standing in the queue for bill payment. The system communicates on real-time basis with respect to the inventory. Since the last few years, humans are investing more on the technology to ease their workload, therefore, the proposed system offers a innovative and elegant approach.

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