Iot-Based Smart Shopping Cart Using Radio Frequency Identification

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I. Abstract:
The modern age of technology in which most of the customer needs to wait in the supermarket for shopping because it is a highly time-consuming process. A huge crowd in the supermarket at the time of discount offers or weekends makes trouble to wait in long queues because of a barcode-based billing process. In this regard, the Internet of Things (IoT) based Smart Shopping Cart is proposed which consists of Radio Frequency Identification (RFID) sensors, Arduino microcontroller, Bluetooth module, and Mobile application. RFID sensors depend on wireless communication. One part is the RFID tag attached to each product and the other is RFID reader that reads the product information efficiently. After this, each product information shows in the Mobile application. The customer easily manages the shopping list in Mobile application according to preferences. Then shopping information sends to the server wirelessly and automatically generates billing. This experimental prototype is designed to eliminate time-consuming shopping process and quality of services issues. The proposed system can easily be implemented and tested at a commercial scale under the real scenario in the future. That is why the proposed model is more competitive as compared to others.

Keywords: IoT, RFID, Arduino, android application, Bluetooth, smart shopping cart, sensors

II. INTRODUCTION
Sensors are electronic devices [1] that can collect information from the surrounding environment [2]. Wireless Sensor Network (WSN) is used to interfacing of multiple sensors to work together and share collected information wirelessly [3]–[5]. Isolated systems are less valuable then networked systems [6] which generate more intelligent and autonomous applications [7]. A wide range of information can be collected, when the coupling of the wireless sensors with networked systems [8]. IoT is directly or indirectly tightly coupling of communication network and sensor network where the data management and data processing achieved by monitor-ing these processes intelligently [9], [10]. The sensors and actuators have an important role in IoT that enables us to range of reader it reads the stored information of object wire- lessly which is known as RFID technology [17]–[19]. RFID plays an integral role in the applications of IoT. It consists of three components such as RFID tags attached to the object that contain identity or data about an object, RFID reader that read the data from the tags and central processing system that perform communication in between RFID system to other electronic devices [20]. It emerging a revolutionary effect on a wide range of applications like aircraft maintenance, anti-counterfeiting, health care, baggage handling, and supply chain management [21].

III. PROPOSED SYSTEM:
The main focus of this study is to facilitate both supermarkets and customers. The proposed Architecture of this study provides the hardware and software solutions that help the supermarket
to improve the quality of service issues and eliminate the time-consuming process of the shopping. The retail industries invest further in exploring the potential of these technologies for the novel services for their customers [68]. These novel services attract a huge number of customers that increase revenue as well. The innovation of the proposed study is the architecture model and services that come together to provide eco-friendly services in cost-effective manners.

IV. Block diagram:

![Block diagram](image)

**V.I.HARDWARE COMPONENTS**

The electronic components needed to complete our proposed system

1) **RFID READER**

RFID modules can read and write Mifare’s tags and being sold at several web stores. The microcontroller and card reader use SPI for communication. The card reader and the tags communicate using a 13.56MHz electromagnetic field [55]. RFID Reader is working on the principle of induction of then induction produces flux. Due to this flux in coil power generates to the chip [41].

2) **ARDUINO UNO**

Arduino Uno is a Microcontroller board named Arduino Uno based on the ATmega328 series controller [57], [59]. You can control your board on what to do by sending a set of instructions to the microcontroller on the board. It facilitates the developers and programmers with the integrated development environment in which different operations can be performed easily. Like writing, compiling and uploading code to the microcontroller. Arduino Uno is an open-source prototyping platform based on easy to use hardware and software. It has 14 digital input and output pins and six analog inputs for communication with the electronic components such as sensors, switches, motors, and so on. It also has 16 MHz ceramic resonators, a USB connection jack, an external power supply jack, an In-Circuit Serial Programmer (ICSP) header, a reset button, GND pins used as a ground, and 5V pin used for supplying 5 voltages. Its operating voltage is 5V, with an input voltage of 7 to 12V. [60], [61].

2) **BLUETOOTH**

Bluetooth module [62] can easily achieve serial wireless data transmission. Its operating frequency is among the most

VI.FLOW CHART

![Flow chart](image)
A. SOFTWARE COMPONENTS
Software components control the electronic devices and data transmission from server to android mobile application and vice versa.

1) ANDROID MOBILE APPLICATION
An Android application is a software application, which will run only on the Android operating system because the Android operating system developed for mobile devices. A typical Android application is developed for a smart-phone or tablet, which operates on the Android operating system. That application is installed in the android supported device, which embedded with electronic circuits of the shop-ping cart.

2) WEB-BASED SUPERMARKET MANAGEMENT SYSTEM
A web-based application is also developed to control the data manipulation process at the cashier or admin side known as the Supermarket management system.

A. EXPERIMENTAL DESIGN
During shopping whenever, the customer puts a product in the shopping cart. Then embedded electronic circuit, which consists of the RFID reader, Arduino Uno and Bluetooth modules that get the details of the products from RFID tag and sends it to the android mobile application. Customers can easily interact with product details on mobile applications and complete their shopping in the mean time.

The circuit design of the electronic components of the Smart Shopping Cart presents in Figure 3. The electronic circuit consists of Arduino Uno, RFID reader, RFID tag, Bluetooth module, and Display device. First, connect the RFID reader with Arduino Uno. MOSI pin of the RFID reader is connected to D11 pin of the Arduino Uno, MISO pin is connected to the D12 in of Arduino Uno, RST connected to D9 of the Arduino Uno, SDA is connected to D10 of Arduino Uno, SCK is connected to D13 of Arduino Uno, 3.3 voltage power supply pin of RFID reader is connected to 3.3 voltage of Arduino Uno and GND pin is connected to negative terminal of the battery.

Second, connect the Bluetooth module with Arduino Uno. Data transmission pins TX and RX pins of Bluetooth module connected to D4 and D5 pins of Arduino Uno. GND pin connected to the negative terminal of the battery and VCC pin connected to the 5-voltage power supply pin of the Arduino Uno. Microcontroller ATmega328 of Arduino Uno needs to program efficiently to control connected sensors and handle data transmission processes in between sensors and android mobile applications.

Step 1: There is an electronic RFID passive tag attached to the product that has stored information about the product. When the product comes in the range of RFID reader module then it reads the RFID tag through electromagnetic waves. Electromagnetic waves produce induction and provide power to the RFID tag. In response, the RFID tag sends data to RFID reader wirelessly through radio waves. Step 2: Electronic MFRC522 RFID reader module that connected to Arduino Uno. After getting data from the RFID tag, the RFID reader sends the data to the Arduino.
Uno through its connected pins. Step 3: Arduino Uno is the intermediary module of the electronic circuit, which connects and controls the RFID reader and Bluetooth device. After getting data from the RFID reader, it sends towards the Bluetooth module. Step 4: Bluetooth module connects the electronic circuit to the android mobile application and helps to communicate with each other. When RFID reader reads the data from the RFID tag then it comes to Arduino. Arduino is responsible for the transfer of data between the android mobile application and Arduino Uno. The Bluetooth module provides a way to Arduino to communicate with the android mobile application.

Algorithm 1 RFID Data Transfer:

Initialization:
1: Call Bluetooth_connection
2: if Bluetooth_connected then
3: Call Wi Fi_connection
4: if Wi Fi_connected then
5: for Scanning_connected to disconnect do
6: Scanning_RFID_tag
7: if RFID_tag Detected then
8: RFID_Data CALL Transfer(RFID)
9: Display_RFID_Data in Mobile device
10: else
11: Show Error try to scan again
12: end if
13: end for
14: else
15: Error in Wi Fi_connection
16: end if
17: else
18: Error in Bluetooth connection
19: end if

Algorithm 2 Transfer(RFID):

Initialization:
1: RFID_received = RFID
2: if Mobile_device_WiFi_connected then
3: Call Server_database_connection
4: if Communication_is_established True then
5: for Scanning_connected to disconnect do
6: Search_Data_from_server
7: if RFID_tag_Found_in_database then
8: RFID_Data = Get_Data_according_to_RFID
9: else
10: RFID_Data = Invalid_RFID
11: end if
12: end for
13: else
14: Connection_Failed
15: end if
16: else
17: Error in connection. Wi Fi setup is Failed.
18: end if

Arduino Uno that provides wireless communication between the mobile device and Arduino Uno.
19: return $RFID_{data}$

The algorithms mention the communication processing of the shopping cart that how hardware communicates to each other to complete the shopping process successfully. Firstly, the algorithm "RFID Data Transfer" are presents the communication of the sensor that how they get the RFID by reading from the RFID reader and transfer it to the Android mobile application. Secondly, the algorithm "Transfer(RFID)" presents the communication of the mobile application to the server and retrieve the data according to the RFID. Then display this data to the customer on the android mobile application.

RESULTS AND DISCUSSION

Customers can login with two methods after the complete initialization of the android mobile application and RFID system. First, customers can enter the user name and password and second, customers can use the user RFID card. The user RFID card is the passive RFID tag as we discussed in the electronic component section that contains a unique customer id. The customer id is the eight-digit unique numeric value stored in the RFID tag.

When RFID reader reads the customer RFID card, it sends it to Arduino Uno, then Arduino sends it to the android mobile application through Bluetooth and then android mobile application gets the data from the server according to this customer id and verify it is a registered user or not. If the verification of customer are not successfully confirmed, then the customer can use the user name and password option to enter manually into the system. The customers can also use a customer RFID card to enter into the smart shopping cart system automatically. After login successfully, the customer became able to use different services in the dashboard discussed in the preceding section of the smart shopping cart to complete its shopping. The experimental prototype is shown in Figure 5. The serial monitor output shows the identification of the customer RFID card that ID depends on the seven-digit code as shown in Figure 6. When the RFID reader reads the RFID card value then it sends to Arduino Uno which displays on serial monitor output that RFID properly sends it to the Android mobile application or not.

Fig : experimental result

B. COMPARISON OF EXISTING AND PROPOSED SYSTEM

We use the Arduino Uno microcontroller, which helps to control the sensors of the electronic circuit that is controlled by the android mobile application. Different technologies like RFID sensors, Arduino Uno, Bluetooth, Wi-Fi, Supermarket management application and Android Mobile application embedded together to create an innovative automation shopping system. As shown in Table 3, these proposed model technologies never embedded together in related systems. Bar-code technologies are used in the most supermarket instead of RFID technologies that are very time consuming process to scan every single product in the line of sight position. RFID technologies are uses in related works but they are not provide a friendly environment to the customer. ZigBee modules are also used to trace the shopping carts and multiple shopping cart share shopping information with each other that increases the security risks and cost of the system. The Proposed system implemented on wireless communication and provide different software-based modules that make it more reliable and flexible to the
customer as well as to the supermarket.

CONCLUSION
In the aforementioned paper, the intended system design for automation of the shopping process by merging different technologies like Arduino Uno, RFID, and Android mobile application. That can be divided into two major categories: Electronic components and Software components. In Electronic Components, Arduino Uno operating as an intermediary microcontroller, which controls the RFID technology and Built, communication between RFID technology and software components like android mobile application through Bluetooth module. In software components, there is an android mobile application in which customers login to the proposed system by using different proposed methods that can secure customer privacy. Searching for the product in the shopping mall becomes easy because of the searching module based on product position allocation on the map. The proposed system prevents the customer to get an expired or undesired product by providing an android mobile application. Customer directly interacts with the product information. This information affects the preferences of the customer about the product and helps them to get the best quality product. Shopping products can be displayed in a current shopping list of the customer that helps the customer to maintain its shopping list according to need or budget. That also helps to remind the remaining products to purchase. Besides, there is a server as a data center of the supermarket, which also connected with the smart shopping cart. When an android mobile application needs to extract data from the server, according to the customer RFID card for verification of the customer login or extract information of the product according to the product RFID tags, then the mobile application can communicate with the server wirelessly. This feature of wireless information extraction helps the customer to move freely and can easily interact with information of products anywhere in the supermarket. Those technologies are programmed to work together to entertain the customer most efficiently. BY using proposed technology customers can search and effectively get the best quality product. As a lesson receive a proposed system can easily be implemented in real-life scenarios to support the shopping process by automation of shopping cart.

REFERENCES


