

Fully Automated Shopping Pushcart

Mohammed Ayub (3BR19EE047), Md Faizan Ahmed (3BR19EE048), Mohammed Irfan (3BR19EE049), P. Hyder Ali (3BR19EE056)

Department of Electrical and Electronics Engineering
Ballari Institute of Technology and Management, Ballari, Karnataka, India

ABSTRACT

Conventional shopping systems in supermarkets and malls require customers to wait at billing counters while products are individually scanned using barcode readers. During weekends and peak shopping periods, this process results in long queues and increased billing time. This paper presents a Fully Automated Shopping Pushcart based on Radio Frequency Identification (RFID) technology to simplify product identification and automate the billing process. The proposed system integrates an RFID reader, Arduino controller, LCD display, load cell, buzzer, driver circuitry, and associated communication and power-supply units. Each product is provided with a unique RFID tag that is detected when the product is placed in the shopping cart. The corresponding product information and price are processed by the controller and displayed on the LCD. When an item is removed, its price is deducted automatically from the running total. After shopping is completed, the accumulated product information is used to generate the final bill. The developed system reduces manual intervention, minimizes waiting time at billing counters, and provides a convenient and user-friendly shopping experience.

Keywords— RFID, Arduino Uno, Automated Billing, Smart Shopping Cart, RFID Reader, LCD Display, Retail Automation.

INTRODUCTION

Shopping in supermarkets and large retail malls has become a common activity, particularly in metropolitan areas. However, large numbers of customers during weekends and holidays create congestion at billing counters. In conventional systems, products are identified using barcode scanners and processed individually by a cashier. This procedure requires manual intervention and can result in considerable waiting time. RFID technology provides an alternative because tagged products can be identified automatically without the strict line-of-sight requirement associated with barcode systems.

Radio Frequency Identification is an automatic identification technology that uses radio waves for the identification, tracking, and transfer of information associated with objects. An RFID system generally consists of RFID tags and readers, with the tags providing unique identification information that can be retrieved wirelessly.

The technology has been adopted in applications including inventory management, supply chains, vehicle identification, access control, manufacturing, and retail systems. In supermarket applications, RFID can simplify product identification and support automatic inventory tracking and billing.

The proposed Fully Automated Shopping Pushcart integrates RFID technology directly into the shopping trolley. Whenever a tagged product is placed inside the cart, the RFID reader identifies it and the controller obtains the corresponding product information. The price is displayed and added to the running bill. Similarly, removal of an item causes its cost to be deducted. This approach provides continuous information about the shopping bill and reduces dependence on conventional checkout procedures.

LITERATURE SURVEY

Suryaprasad *et al.* [1] proposed a low-cost intelligent shopping cart designed to assist customers in searching and selecting products while providing information about special offers available during shopping. Karmouche and Salih-Alj [2] investigated aisle-level scanning for RFID-based shopping applications, where RFID reader antennas are employed to identify both static and dynamic products within the shopping environment. Rather than performing RFID observations only at individual shopping carts, their approach considers RFID scanning at the aisle level.

Chandrasekar and Sangeetha [3] presented a smart shopping cart with an automatic central billing system using RFID technology. Their system incorporates a microcontroller, LCD, RFID reader, memory, and communication arrangement for collecting product information and transferring shopping-cart data to a central billing system. Kamble *et al.* [4] developed a multitasking RFID-based shopping trolley intended to reduce the amount of time customers spend during shopping. Their work emphasized the development of a technology-oriented, low-cost, scalable, and robust shopping assistance system. These studies demonstrate the potential of RFID technology for reducing manual billing activities and improving the efficiency of retail shopping systems.

PROBLEM STATEMENT

Customers in large shopping malls frequently experience long waiting periods at billing counters, particularly during weekends and holidays. Conventional barcode-based billing requires each selected product to be individually presented to the cashier and scanned using a barcode reader. This process is time-consuming, requires human staff, and contributes to long checkout queues. Therefore, an automated shopping system is required to identify products as they are added to or removed from a shopping trolley, continuously calculate the total purchase amount, and reduce the time required for final billing.

OBJECTIVES

The main objectives of the proposed system are:

1. To design and implement an RFID-based automated shopping pushcart capable of identifying products and automatically updating the shopping bill whenever products are added to or removed from the trolley.
2. To reduce customer waiting time and manual billing requirements by integrating RFID identification, Arduino-based processing, LCD indication, product-data management, and automatic bill calculation into the shopping cart.
- 3.

PROPOSED SYSTEM

The proposed system uses an RFID-based electronic shopping cart to provide a low-cost and scalable solution for assisting customers during shopping. In contrast to conventional barcode-based billing, RFID tags are attached to products and identified using an RFID reader mounted on the shopping trolley. The RFID reader communicates the unique identification information of each product to the Arduino controller. The controller processes the received data and updates the product information and accumulated purchase amount.

The cart incorporates an LCD display to provide customers with information regarding the selected products and running bill. When a product is placed in the cart, its RFID tag is detected and the corresponding price is added to the total amount. If the customer removes the product, the associated amount is deducted. The system can communicate shopping information to the billing side for generation of the computerized bill. This arrangement minimizes

dependence on conventional manual checkout operations and provides customers with continuous information about their purchases.

BLOCK DIAGRAM

Fig. 2 shows the block diagram of the RFID-based automated shopping system, where the Arduino acts as the main controller interfaced with the RFID reader, load cell, switches, LCD, and NodeMCU. The system identifies products, measures their weight, displays billing information, and communicates the collected data through the NodeMCU for further processing.

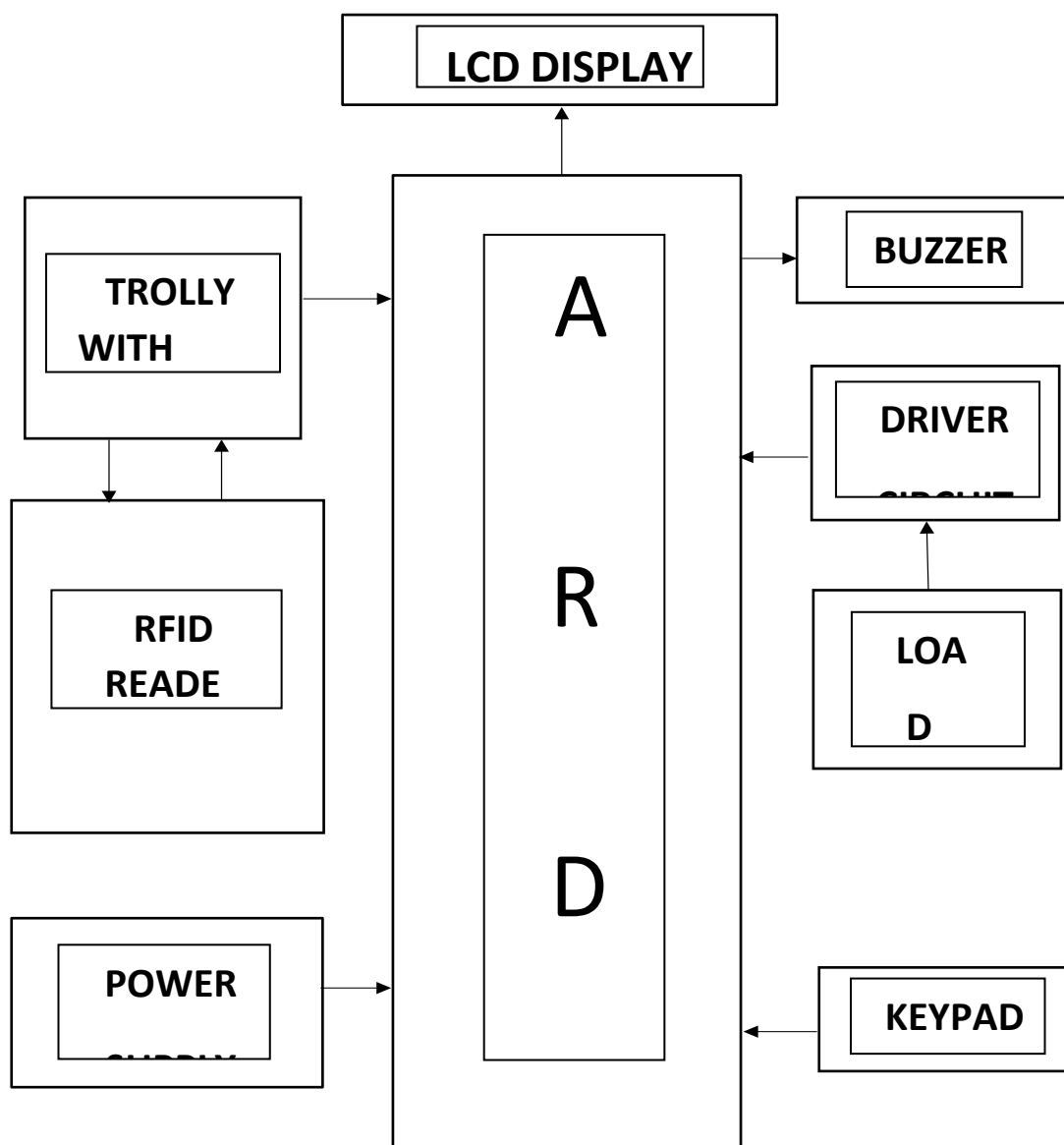


Fig 1 Block Diagram

CIRCUIT DIAGRAM

Fig. 3 shows the circuit diagram of the RFID-based automated shopping system, where the Arduino acts as the main controller interfaced with the RFID reader, load cell, switches, LCD, and NodeMCU. The system identifies products, measures their weight, displays billing information, and communicates the collected data through the NodeMCU for further processing.

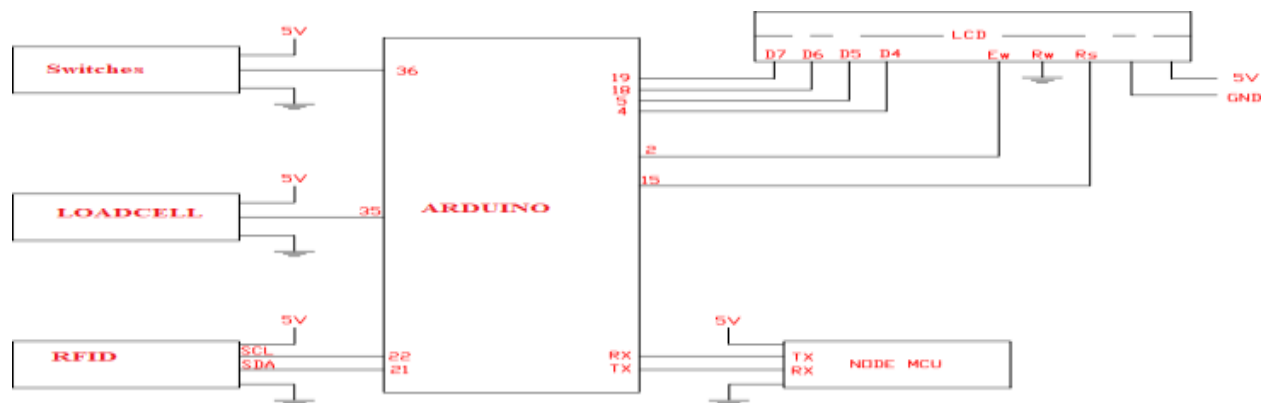


Fig 2 Circuit Diagram

METHODOLOGY

The operation begins when the shopping-cart system is initialized and the RFID reader, Arduino, display, and associated components are activated. RFID tags attached to individual products serve as unique product identifiers. When the customer places a product in the trolley, the RFID reader detects its tag and transfers the identification information to the controller. The corresponding product details are obtained and displayed on the LCD, while the product cost is added to the accumulated shopping amount.

The controller continuously monitors the addition and removal of products. If an item is removed from the trolley, its corresponding amount is subtracted from the total bill and the revised value is displayed. When shopping is complete, the customer initiates the completion operation and the accumulated product information is transferred for final billing. The generated bill represents the products confirmed in the shopping trolley, thereby reducing the need to scan every item again at a conventional checkout counter.

RESULTS AND DISCUSSION

As shown in **Fig. 3** and **Table I**, the developed automated shopping system was evaluated using unique RFID tags assigned to different products. When an RFID-tagged product was brought near the RFID reader, the system successfully identified the tag, retrieved the corresponding product information from the database, and displayed the relevant details on the display unit. The selected product data were temporarily stored and subsequently utilized for automatic billing. In addition, the system supported updating product information, enabling effective inventory management and maintaining accurate product records.

The integrated system was further tested to evaluate communication between the shopping cart and the server, RFID-based product identification, synchronization with the central database, automatic billing, product-information display, and inventory updating. The system also automatically modified the bill whenever products were added to or removed from the shopping cart and displayed the final payable amount. According to the experimental results presented in **Table I**, the integrated functions were successfully demonstrated. During functional testing of the RFID reader, five reading attempts were performed, of which four RFID tags were successfully detected while one tag failed to be read, demonstrating the overall effectiveness of the proposed identification mechanism.

Compared with conventional barcode-based shopping systems, the proposed RFID-based system provides several advantages. Barcode systems generally require the barcode to be clearly visible and depend on direct line-of-sight scanning, whereas RFID technology enables automatic product identification without requiring direct visual contact between the tag and reader. RFID tags can also be embedded or placed inside product packaging and are less affected by surface conditions such as dirt, scratches, or abrasion. Therefore, RFID technology provides a more flexible and efficient approach for automated product identification, billing, and inventory management, making the developed system suitable for smart shopping applications.

Table 1 Sample Database of product details.

ID	PName	PMrp	PEDate	Location
180089032EBC	PONDS	10.50	30-6-18	Row=1,Col=1
180089158B0F	LOCK	15.50	01-7-18	Row=1,Col=3
18008916F87F	RED LABEL	05.00	01-2-19	Row=2,Col=1
1800892ACF74	OIL	20.50	30-5-20	Row=1,Col=2



Fig 3 Unit Testing of LCD Display

CONCLUSION

The Fully Automated Shopping Pushcart demonstrates the application of RFID technology for automated product identification, billing, and inventory-related operations. The developed system integrates RFID tags and a reader with an Arduino-based controller and display to identify products and continuously update the customer's purchase information. Products added to the trolley contribute to the running total, while removed products can be deducted from the bill. The proposed model is designed to be user-friendly and does not require specialized training for customers. By reducing manual billing activities and checkout queues, the system can improve time efficiency and enable retailers to serve more customers within the same period. Further integration of advanced controllers, displays, communication systems, and electronic payment facilities can enhance the functionality of the smart shopping cart.

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