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High-Tech Based Grocery Store

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Abstract: ***Modern retail stores are adopting automation to improve customer convenience and security. The proposed system, Entry and Exit System with High-Tech Smart Trolley, is designed to create a fully automated and secure shopping experience using Arduino Uno, ultrasonic sensors, RFID, servo motors, and barcode scanning technology.***
At the entry gate, ultrasonic sensors detect the presence of a customer, and the Arduino Uno triggers a servo motor to open the gate automatically. Inside the store, the smart trolley allows customers to scan each product using a barcode scanner. The trolley's microcontroller adds the scanned item's name and price to the total bill displayed on an LCD screen. If a customer places an unscanned item inside the trolley, a buzzer rings immediately, indicating unauthorized addition.
Once shopping is complete, the trolley generates a QR code representing the final bill. After online payment or verification, the customer proceeds to the exit gate, where an RFID-based system authenticates the paid trolley and opens the servo-operated gate automatically. This approach enhances efficiency, prevents billing fraud, and minimizes manpower in retail environments.
Keywords: Smart Trolley, Arduino Uno, Ultrasonic Sensor, RFID, Servo Motor, Barcode Scanner, QR Code Billing

I. INTRODUCTION

Shopping in conventional supermarkets often requires customers to wait in long queues for billing, causing inconvenience. Additionally, manual verification of unscanned products is time-consuming. To overcome these challenges, this project presents a smart, automated shopping system that integrates entry, shopping, and exit control in one design.
The Entry Gate automatically detects approaching customers using an ultrasonic sensor and operates through a servo motor controlled by Arduino Uno.
The Smart Trolley uses a barcode scanner to register products, a buzzer to detect unauthorized additions, and an LCD display to show billing details.
After checkout, a QR code is generated for payment verification.
Finally, the Exit Gate includes an RFID reader that allows only paid trolleys to exit.
This integrated design reduces manpower, enhances billing security, and improves shopping efficiency.

II. OBJECTIVES

1) To automate entry and exit operations using sensors and RFID.
2) To develop a smart trolley that scans and monitors products in real time.
3) To detect unscanned items automatically using a buzzer alert.
4) To generate a digital QR bill for fast payment and verification.
5) To ensure that only paid trolleys can exit through RFID authentication.

III. LITERATURE REVIEW

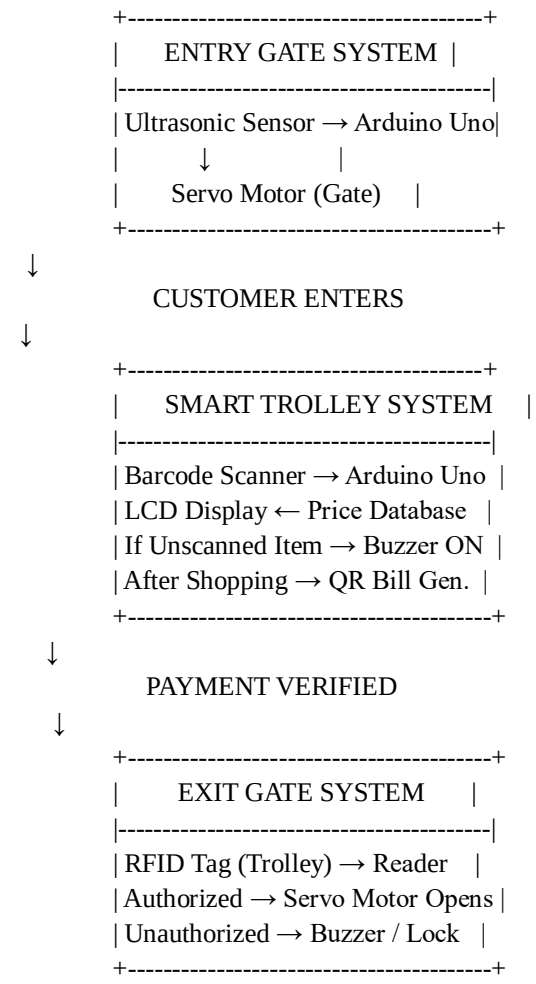
Existing smart shopping systems typically use barcodes for billing but rely on manual counters for final payment verification. Researchers such as Karthikeyan & Abirami (2020) implemented RFID-based carts, while Sharma & Singh (2021) developed ultrasonic-controlled gates for automation. However, most systems lacked integration between entry, billing, and exit control.
The proposed design combines these technologies — ultrasonic sensors, RFID, servo motors, and QR-based billing — into a unified model for a completely automated and secure shopping experience.

IV. PROPOSED SYSTEM

The system is divided into three major sections:
1) Entry Gate System – Ultrasonic sensor + Arduino Uno + Servo Motor
2) Smart Trolley System – Barcode Scanner + LCD + Buzzer + QR Generator
3) Exit Gate System – RFID Reader + RFID Tag + Servo Motor

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A. *Block Diagram*



V. WORKING PRINCIPLE

1) *Entry Gate Operation*

When a customer approaches, the ultrasonic sensor (HC-SR04) measures distance. If the detected distance is below a set threshold, the Arduino Uno triggers the servo motor to rotate and open the gate. Once the customer passes, the servo motor resets to its closed position automatically.

2) *Smart Trolley Operation*

Each trolley has:
A barcode scanner connected to Arduino to identify product codes.
An LCD display to show product name, price, and total bill.
A buzzer that activates if a product is placed inside without scanning, using a weight sensor or IR pair sensor for detection.
After shopping, a QR code representing the final bill is generated using a small display or printed slip.
Payment can be made via mobile scanning of this QR code.

3) *Exit Gate Operation*

At the exit, the trolley passes through an RFID reader system.
If the trolley's RFID tag corresponds to a "paid" status, the Arduino Uno activates the servo motor to open the gate.
If payment verification fails, a buzzer sounds, and the gate remains closed.

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VI. HARDWARE COMPONENTS

Component	Function
Arduino Uno	Controls all modules and processes sensor data.
Ultrasonic Sensor (HC-SR04)	Detects objects approaching the entry gate.
RFID Reader (RC522)	Reads RFID tag for exit gate authentication.
RFID Tag	Attached to trolley for exit verification.
Barcode Scanner	Used to scan product barcodes in the trolley.
LCD Display	Shows scanned products and total amount.
Buzzer	Alerts for unscanned or unauthorized products.

VII. SOFTWARE REQUIREMENTS

Software / Tool	Purpose
Arduino IDE	Coding, compiling, and uploading to Arduino Uno..
Embedded C / C++	Programming language for logic control.
Qr code Library	For generating payment QR code.
Serial Monitor	Used for testing and debugging

VIII. RESULTS AND DISCUSSION

The system was tested successfully under various conditions.

1) The ultrasonic sensor detected movement accurately up to 40 cm for gate operation.
2) The smart trolley correctly identified scanned products, and the buzzer effectively alerted when an unscanned item was placed inside.
3) The RFID reader authenticated the trolley within 1 second at the exit gate.
4) The QR payment system worked flawlessly through mobile scanning.

Parameter Manual System Proposed System Improvement
Billing Time10–12 min 2–3 min75% Faster
Product Misplacement Common Alerted Instantly Eliminated
Entry/Exit Time Manual Automated+100% Automation
Security Medium High Improved
(RFID & QR verified)

The prototype proved that automation improves both efficiency and transparency in the shopping process.

IX. ADVANTAGES

1) Fully automated entry, billing, and exit system.
2) Prevents theft and billing errors with buzzer alerts.
3) Saves customer time through self-checkout and digital payment.
4) Reduces manpower and operational costs.
5) Enhances security using RFID authorization.

X. FUTURE ENHANCEMENT

1) Integration of mobile app for customers to view bills digitally.
2) Use of wireless communication modules (Bluetooth/Wi-Fi) for data transfer.
3) Implementation of voice guidance for customer support.
4) Expansion into multi-counter networked systems.
5) Use of solar-powered units for energy efficiency.

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XI. CONCLUSION

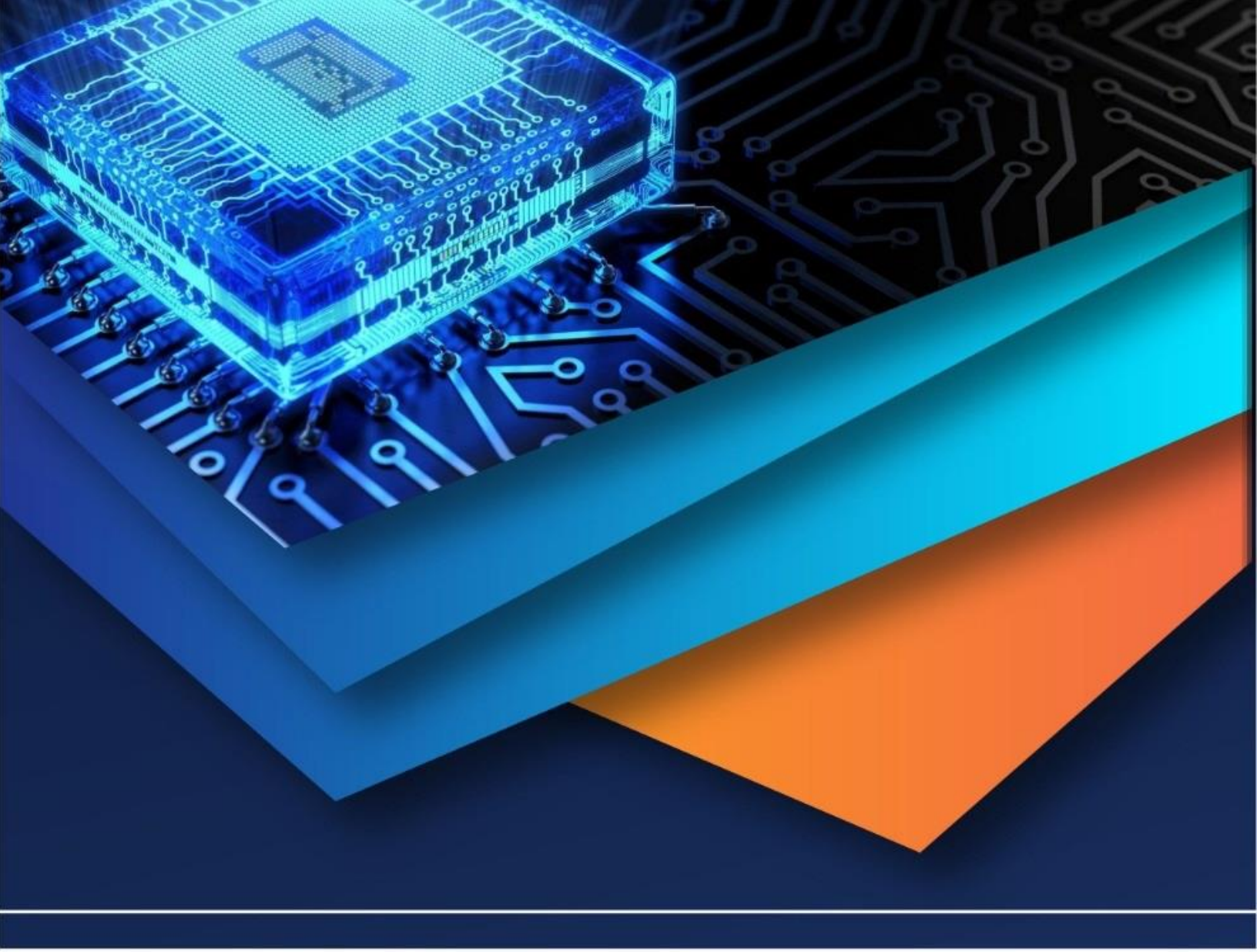
The High-Tech Based Grocery Shop successfully demonstrates how IoT and RFID can be combined with microcontrollers to create a simple, low-cost, and efficient smart store. The system eliminates manual billing, reduces human errors, and ensures faster checkout for customers.

By avoiding cloud and AI dependencies, it remains economical and easy to deploy in small grocery shops. This embedded-system-based automation approach represents an important step toward practical smart retail solutions suitable for developing regions.

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