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RFID Based Petrol Pump Automation System

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Abstract: ***The increasing demand for automation in fuel distribution systems has highlighted the need for efficient, secure, and transparent petrol pump operations. Conventional fuel dispensing methods rely heavily on manual processes, leading to inaccuracies, fuel theft, and time inefficiencies. This paper presents the design and implementation of an RFID-based petrol pump automation system that enables secure, cashless, and automated fuel dispensing. Each user is assigned a unique RFID tag linked to a centralized database containing account balance and transaction details. Upon scanning the RFID tag, the system authenticates the user and allows fuel dispensing based on available balance. The proposed system reduces human intervention, improves accuracy, and ensures real-time monitoring. Experimental results indicate improved efficiency, reduced waiting time, and enhanced security. The system provides a scalable solution for modern smart fuel stations.***
Keywords: RFID, Petrol Pump Automation, Fuel Management, Embedded Systems, Arduino, Cashless System.

I. INTRODUCTION

Petroleum is widely considered the cornerstone of modern industrial civilization, often referred to as "liquid gold" due to its immense economic value and versatility. As a non-renewable fossil fuel, its formation occurs over millions of years through the decomposition of marine organisms under intense heat and pressure. Because this natural process cannot be replicated within a human lifetime, it is vital to utilize this resource efficiently and conserve it.Fuel stations are essential infrastructure in modern transportation systems. However, most petrol pumps still operate manually, which leads to inefficiencies such as long queues, inaccurate fuel measurement, and fraudulent practices. The main aim of this paper is to deal with all stated problems by developing an automated petrol dispensing system using RFID technology. With the advancement of automation and digital payment systems, there is a growing need to modernize fuel dispensing systems. RFID (Radio Frequency Identification) technology provides a reliable solution for automatic identification and secure transactions. Whenever the userwants to fill the tank from the fuel dispenser, user has to scan the RFID cardfirst then Arduino UNO manages to read data from the RFID reader and perform action according to the customers' requirement.

II. LITERATURE SURVEY

A. Manual Control

In this, the control and automation are done by Manual Operation.

- Drawback:Human errors significantly impact the quality of the final output. Traditional hardwired control systems rely on contactors, relays, timers, and counters to achieve automation. However, these systems involve complex and bulky wiring, making modifications in control logic is difficult and time-consuming. Additionally, the system can only be implemented after complete planning, which increases overall project development time.

B. ElectronicsControl with Logic Gates

The control circuit was modernized by replacing electromechanical contactors, relays, and counters with solid-state logic gates and electronic timers.

- Advantage: Reduced spare requirement, energy saving, less maintenance and hence greater reliability.
- Drawback: Implementation of changes in the control logic as well as reducing project lead-time was not possible.

C. Programmable Logic Control

In this, instead of achieving desired control and automation through physical wiring of control devices, it achieving through program say software.

- Advantage: Energy Saving, Reduced Space.

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III. PROBLEM STATEMENT

With the rapid advancement of digital technologies, most modern petrol pump systems have incorporated electronic control units to manage key operations such as fuel dispensing, flow measurement, display control, and automatic shutdown of the pump. Despite this level of automation, human intervention is still required for payment collection, which introduces the possibility of errors, delays, and fraudulent activities. To address these limitations, the proposed petrol pump automation system utilizes RFID-based authentication for secure and contactless access to fuel services. In this system, users are provided with RFID cards that can be used across multiple petrol stations, irrespective of the operating company. This approach enables seamless, cashless transactions, reduces dependency on manual processes, and enhances overall system efficiency, security, and user convenience.

IV. IMPLEMENTATION DETAILS

A. Requirement

- RFID Module
- RFID cards
- Relay
- Arduino UNO
- Keypad array
- LCD display (16*2)
- DC Pump motor

B. Software Requirement

- Arduino UNO
- Express PCB (Circuit & Layout Design)

C. RFID Module

The RC 522 RFID Reader has a radio transponder that acts as an antenna and ranges 13.56MHZ that uses electromagnetic fields to identify the signals corresponding to the RFID tag.



Figure 1 RFID Module

D. RFID Cards

An RFID (Radio Frequency Identification) card is a contactless, portable device that uses radio waves to wirelessly communicate with a reader for identification or authentication.



Figure 2 RFID card

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E. Keypad Array

This keypad has 16 buttons, arranged in a telephone-line 4x4 grid. The keys are connected into a matrix, so you only need 8 microcontroller pins. This used to enter the password as well as amount and is connected with the Arduino uno as well as relay circuits.



Figure 3 Keypad Array

F. Relay

In an RFID-based petrol pump automation system, a relay functions as an electrically operated switch that controls the fuel dispensing motor. When the RFID reader scans a valid tag, the microcontroller verifies the user's credentials and available balance. Upon successful authentication, the microcontroller sends a control signal to the relay module, which activates and completes the circuit to power the fuel pump. This allows fuel dispensing for the specified amount. Once the preset limit is reached or the balance is exhausted, the microcontroller deactivates the relay, cutting off power to the pump. Thus, the relay ensures safe, precise, and automated control of fuel delivery.



Figure 4 Relay

G. Software Requirement:

The system software is developed using embedded programming (Arduino UNO).

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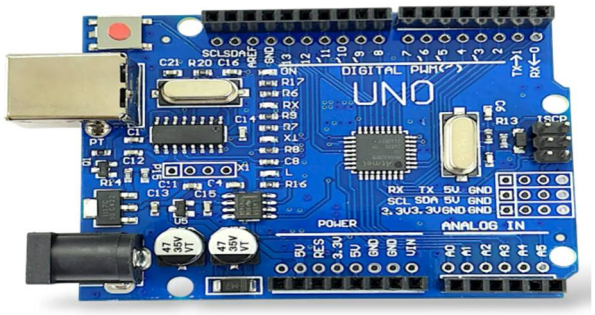


Figure 5 Arduino UNO

Function:

- Tag authentication
- Balance verification
- Fuel calculation
- Motor control
- Data logging

Algorithm:

- Initialize system
- Scan RFID tag
- Verify ID
- Check balance
- Accept user input
- Activate pump
- Deduct amount
- Update database

V. ACTUAL IMPLEMENTATION

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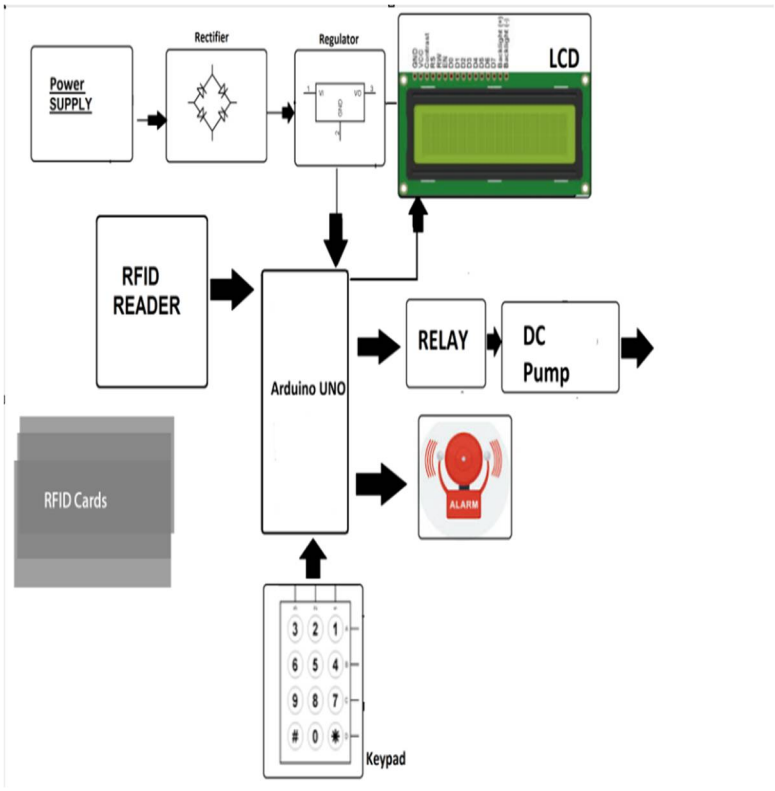


Figure 6 Block diagram

The complete prototype as developed was tested and verified results. It successfully fills the required quantity of fuel from smart card and operation of the project is clearly verified. RFID system is a versatile technology. This system is used in many application and real time application. In our application, RFID system dispenses the accurate amount of fuel which reduces the misuse of the fuel. And it also reduces the man power. And if the customer tries to swipe with the unauthorized card, the RFID system rejects the card. In this way the system is so secured. To obtain best performance the RFID readers and Tags must be in good quality is so secured.

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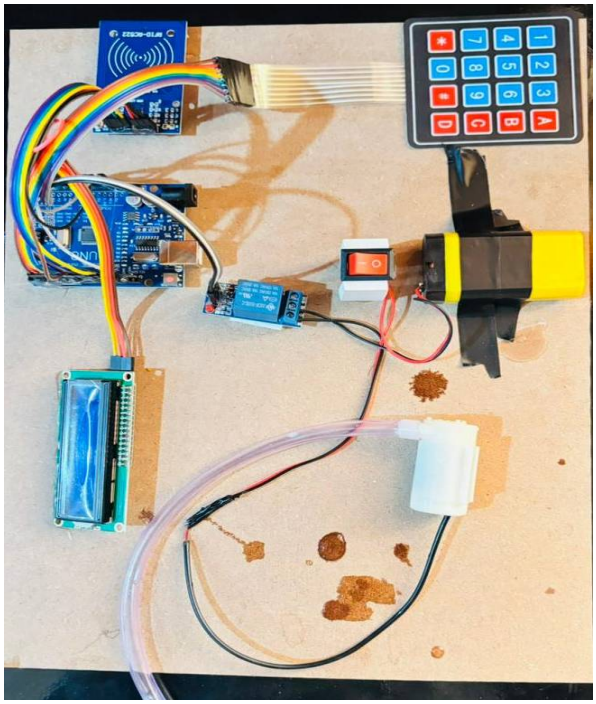


Figure 7 Implementation

VI. METHODOLGY

The proposed RFID-based petrol pump automation system is designed using a combination of identification, control, and actuation components to ensure secure and efficient fuel dispensing. The overall methodology is based on the interaction between hardware modules and embedded control logic.

1) Initially, each user is provided with a unique RFID card, which stores an identification number linked to a centralized database containing user details and account balance. When the user arrives at the petrol pump, the RFID reader scans the card and transmits the tag information to the Arduino Uno, which acts as the main control unit of the system.

2) The Arduino processes the received data and verifies the user's credentials. Upon successful authentication, the system prompts the user through the LCD display to enter the required amount or quantity of fuel using the keypad array. The entered data is processed, and the system checks whether sufficient balance is available.

3) If the validation is successful, the Arduino sends a signal to the relay module, which acts as a switching device to control the DC pump motor. The relay gets activated, allowing current to flow and turning ON the motor, thereby initiating fuel dispensing. The amount of fuel dispensed is controlled based on predefined calibration corresponding to the entered value.

4) Once the required fuel quantity is delivered or the transaction is complete, the Arduino deactivates the relay, which turns OFF the pump motor. Simultaneously, the system updates the user's balance and displays the transaction details on the LCD.

5) This methodology ensures automated operation, minimizes human intervention, and enhances accuracy, security, and efficiency in petrol pump management

VII. ADVANTAGES

1) Eliminates manual errors
2) Prevents fuel theft
3) Enables cashless transactions
4) Reduces waiting time
5) Provides accurate billing
6) Ensures real-time monitoring

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VIII. CONCLUSION

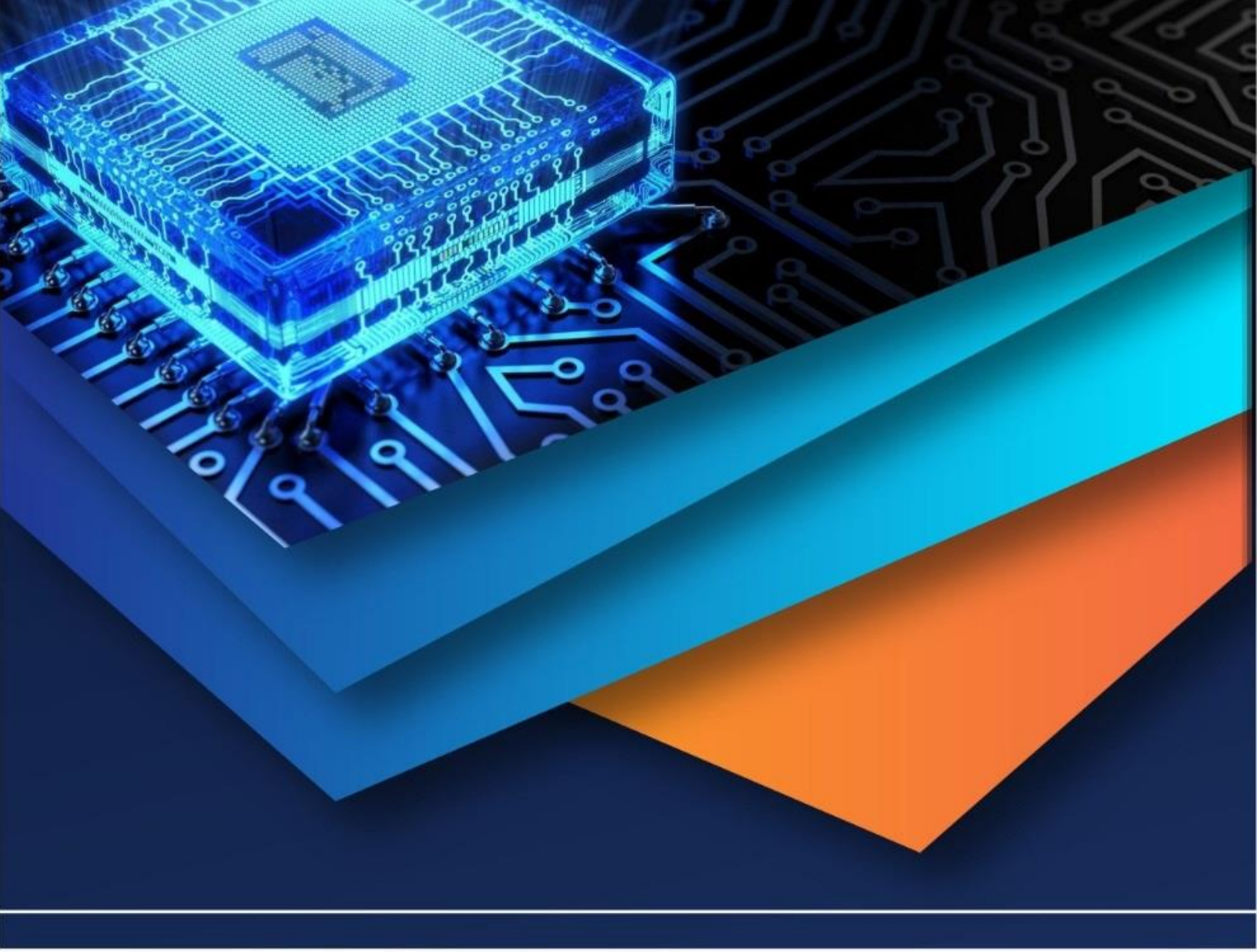
The RFID-based petrol pump automation system presents an efficient and reliable solution to the limitations of conventional fuel dispensing methods. By integrating RFID technology with embedded control systems, the proposed model enables secure, accurate, and contactless fuel transactions. It significantly reduces human intervention, thereby minimizing errors, fraudulent activities, and operational delays. The system also enhances transparency through automated billing and real-time transaction recording, ensuring better accountability and management. Furthermore, the adoption of cashless transactions improves user convenience and aligns with the growing trend of digitalization. The modular design of the system allows easy scalability and integration with advanced technologies such as IoT and cloud-based monitoring. Overall, the implementation of this system can modernize petrol pump operations, improve service efficiency, and provide a robust framework for future smart fuel management systems.

IX. FUTURE SCOPE

The proposed RFID-based petrol pump automation system can be further enhanced by integrating advanced technologies to improve functionality and scalability. Future developments may include the incorporation of IoT for real-time remote monitoring and control of fuel stations. Mobile application support can be added for user account management, transaction history, and digital payments. Integration with GPS can enable vehicle tracking and fuel usage analysis for fleet management. Additionally, implementing cloud-based databases will improve data storage, accessibility, and security. The use of artificial intelligence can help in demand prediction and fraud detection, making the system more intelligent, efficient, and adaptable to smart city infrastructure.

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