ISSN 2277-2685
IJESR/Jan-Mar. 2026/ Vol-16/Issue-1/610-618
Thati Ruchitha *et. al.*, / International Journal of Engineering & Science Research
Full Length Article

Smart Petro Card Management System

Ms. Radhika Ravikrindhi[1], Thati Ruchitha[2], Manadi Shivani[3], Cheguri Sree Harshini[4]
[1]Assistant Professor; Department Of Electronics And Communication Engineering Bhoj Reddy Engineering College For Women Hyderabad India
[2,3,4]B.Tech Students; Department Of Electronics And Communication Engineering Bhoj Reddy Engineering College For Women Hyderabad India
Mail Id ; ruchithathati2121@gmail.com[2], shivaniyadav3393@gmail.com[3], sree36999@gmail.com4
Accepted 28-03-2026

Abstract
The increasing adoption of automation and embedded technologies has highlighted the importance of secure and efficient fuel management solutions. Conventional fuel dispensing systems commonly depend on manual supervision, which may result in issues such as fuel pilferage, inaccurate dispensing, and inadequate transaction documentation. To address these challenges, this study proposes a Smart Petro Card Management System that automates and secures the fuel distribution process using embedded technologies.The proposed system is developed around an Arduino microcontroller that acts as the primary control unit. It integrates RFID-based user identification, biometric fingerprint authentication, wireless communication, and automated pump control. Each authorized user is assigned an RFID card containing a unique identification code. When the card is scanned by the RFID reader, the system retrieves the stored information and initiates a verification process. For enhanced security, fingerprint authentication is incorporated to validate the identity of the user before granting access to fuel dispensing.The implementation of the proposed system enhances transparency and security in fuel distribution by restricting access to authorized users only. It minimizes fuel theft, improves monitoring of fuel transactions, and ensures efficient fuel management. The system can be effectively applied in petrol stations, industrial fuel management systems, and fleet fuel monitoring applications.
Keywords
Smart Fuel Management, RFID Authentication, Fingerprint Verification, Arduino Microcontroller, IoT-based Monitoring, Automated Fuel Dispensing System, Embedded Systems, Petro Card System.

Introduction

Automation has become a fundamental component of modern technological systems. Industries, transportation networks, and service sectors are increasingly adopting automated solutions to improve operational efficiency, reliability, and security. Among these sectors, fuel distribution systems require effective monitoring and management to prevent misuse and ensure accurate fuel dispensing. However, many petrol stations still rely on manual supervision and conventional billing mechanisms, which may lead to issues such as fuel theft, inaccurate fuel measurement, and unauthorized usage.To address these challenges, the **Smart Petro Card Management System** has been proposed as an automated solution for fuel distribution. The system introduces advanced technologies such as RFID authentication, biometric verification, and microcontroller-based automation to ensure controlled access to fuel pumps. By integrating these technologies, the system enhances security while minimizing human intervention in fuel management processes.The proposed system operates by verifying the identity of users through an RFID card and fingerprint authentication. Once the user is authenticated, the Arduino microcontroller activates a relay module that controls the fuel pump motor. An LCD display is used to provide operational messages and transaction information to the user. Additionally, wireless communication enables the system to maintain records of fuel usage and allows remote monitoring of transactions.

Literature Survey

Automation in fuel dispensing systems has received considerable attention in recent years due to the increasing demand for secure and efficient fuel management solutions. Researchers have explored various technologies such as embedded systems, RFID identification, and wireless communication to improve the performance of fuel distribution systems.

Manual Control Systems

In traditional fuel dispensing systems, most operations were carried out manually by human operators. The pump operation, display monitoring, and billing procedures depended on manual supervision. Although this approach was simple, it had several disadvantages. Human errors could affect the accuracy of fuel measurement and billing. In addition, manual systems required higher manpower and made it difficult to maintain accurate records of fuel transactions.

Electronic Control Using Logic Gates

To improve the reliability of manual systems, electronic control circuits based on logic gates were

introduced. In these systems, relays, timers, and counters were implemented using electronic components to automate certain control operations. This approach improved reliability and reduced maintenance requirements. However, the system design lacked flexibility because any modification in the control logic required hardware changes, which increased development complexity.

Programmable Logic Control Systems

With technological advancements, programmable logic controllers (PLCs) were widely adopted in industrial automation systems. PLC-based control systems allowed operations to be programmed through software instead of fixed hardware circuits. This approach improved flexibility, reduced system complexity, and enhanced energy efficiency. Programmable controllers also enabled easy modification of system logic, which improved the adaptability of automated systems.

RFID-Based Fuel Management Systems

Recent developments in identification technologies have led to the introduction of RFID-based fuel management systems. RFID technology allows automatic identification of users through RFID tags and readers. In such systems, each user is assigned a unique RFID card that contains identification data. When the card is scanned by the reader, the system verifies the user and allows fuel dispensing after authentication. This method significantly reduces human intervention while improving security and transaction monitoring.Several studies have explored automated fuel management solutions using embedded technologies.Kulkarni Amruta M. and Tawar Sachin S. (2011) developed an embedded security system that utilized RFID and GSM modules. In their system, RFID technology was used to identify authorized users by reading the unique identification code stored in RFID tags. The GSM module enabled the system to send alerts and notifications to administrators through mobile communication, thereby improving system monitoring and security.Nang Khin, Su Yee, and Kyaw Thiha (2015) proposed an electronic fuel monitoring and control system designed to improve the management of fuel dispensers. Their research focused on enhancing fuel distribution monitoring through electronic control mechanisms. The proposed system ensured accurate fuel measurement, reduced the possibility of fuel misuse, and improved the operational efficiency of fuel stations.These studies demonstrate the potential of embedded systems and identification technologies in developing secure and automated fuel management solutions.

Hardware and Software

This chapter presents the hardware and software components required for the implementation of the **Smart Petro Card Management System**. The system integrates several electronic modules and programming tools to enable secure authentication, automated fuel dispensing, and efficient system monitoring. The hardware components include the Arduino microcontroller, RFID reader, fingerprint sensor, LCD display, keypad, relay module, buzzer, and pump motor. In addition, software tools such as the Arduino Integrated Development Environment (IDE) and Embedded C programming are used to develop and control the system functionality.

Hardware Requirements

The following hardware components are used in the development of the Smart Petro Card Management System.

Arduino Microcontroller

Figure1: Arduino UNO

The Arduino microcontroller acts as the central control unit of the system. It receives input signals from various modules such as the RFID reader, fingerprint sensor, and keypad, and processes them according to the programmed instructions. Based on the authentication results, the microcontroller controls the relay module that activates or deactivates the fuel pump motor. Due to its flexibility, ease of programming, and compatibility with multiple sensors, the Arduino platform is widely used in embedded automation applications.

RFID Reader Module

Figure 2: RFID reader Module

The RFID reader module is responsible for detecting and reading the data stored in RFID cards. Each user is assigned a unique RFID card containing an identification number. When the card is placed near the reader, radio frequency signals are used to transmit the stored information to the microcontroller. The system then verifies the card ID with the stored database before allowing access. RFID technology enables fast and contactless identification, making it suitable for automated access control systems.

RFID Card (Smart Petro Card)

Figure 3: RFID Card

The RFID card serves as the identification token for authorized users of the system. Each card contains a unique identification code embedded within a small chip and antenna. When the card is scanned by the RFID reader, the stored information is transmitted to the controller for verification. Only registered cards are permitted to access the fuel dispensing system. The RFID card is durable, reusable, and easy to operate, making it a practical solution for secure user authentication.

Fingerprint Sensor

Figure 4: Fingerprint sensor

The fingerprint sensor provides an additional layer of security by verifying the biometric identity of the user. The sensor captures the fingerprint pattern and compares it with previously stored templates in the system database. If the scanned fingerprint matches the stored record, the system proceeds with fuel dispensing. This biometric authentication prevents unauthorized access and significantly enhances system security.

LCD Display

Figure 5: LCD display

The LCD display is used to present system messages and operational information to the user. It displays notifications such as authentication success or failure, system status, and instructions during operation. The display enables users to understand the current state of the system and provides a simple interface for communication between the user and the embedded system.

Keypad (4×3 Matrix Keypad)

Figure 6: keypad (4x3 Matrix Keypad

The keypad serves as an input interface that allows users to enter commands or specify the fuel quantity. It consists of multiple buttons arranged in rows and columns. When a key is pressed, the microcontroller detects the corresponding signal and performs the required operation. The keypad enhances system usability by allowing direct user interaction with the fuel management system.

Relay Module

Figure 7: Relay module

The relay module functions as an electrically controlled switch that manages the operation of the pump motor. Since the microcontroller operates at low voltage levels, the relay module allows it to safely control higher voltage devices. When authentication is successful, the Arduino sends a signal to the relay module, which activates the pump motor for fuel dispensing.

Buzzer

Figure 8: Buzzer

The buzzer is used to generate audible alerts during system operation. It produces warning sounds in situations such as invalid authentication or unauthorized access attempts. The buzzer helps notify users and system operators about abnormal conditions, thereby improving the overall security and responsiveness of the system.

Pump Motor

Figure 9: Pump Motor

The pump motor is responsible for dispensing fuel from the storage tank. Once the authentication process is successfully completed, the Arduino microcontroller activates the relay module, which powers the pump motor. The motor operates for a specified duration or until the required fuel quantity is dispensed. This automated control ensures accurate and efficient fuel delivery.

Arduino IDE

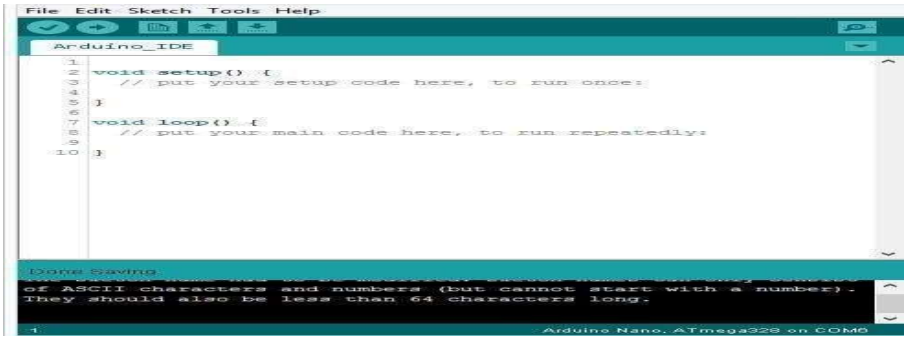

Figure 10: Arduino IDE

The Arduino Integrated Development Environment (IDE) is used for writing, compiling, and uploading the program code to the Arduino microcontroller. It supports programming in C and C++ languages and provides numerous libraries for interfacing with sensors, communication modules, and display devices. The Arduino IDE offers a simple interface that simplifies embedded system development.

Proposed System Architecture

The system architecture describes the structural arrangement of components used in the Smart Petro Card Management System and explains how these components interact to perform system operations. It provides a clear view of the functional flow of data and control signals between hardware modules. The architecture is designed to achieve key requirements such as enhanced security, automated operation, and efficient monitoring of fuel usage. By integrating embedded technology with authentication mechanisms, the system ensures that fuel dispensing is carried out in a controlled and reliable manner. The architecture is also flexible enough to support future enhancements, enabling additional features such as advanced monitoring, database integration, or cloud connectivity.

Existing System

In traditional fuel dispensing systems, most of the operational activities are performed manually. Petrol pumps generally rely on human operators to manage fuel distribution and maintain records of fuel transactions. The operator is responsible for identifying the user, initiating fuel dispensing, and recording the fuel consumption. Although this method is widely used, it is inefficient and susceptible to human errors.In many organizations such as transportation departments, industries, and government institutions, fuel is allocated to authorized vehicles. However, traditional systems often lack a proper automated mechanism to verify the identity of the user before dispensing fuel. The absence of an authentication system may lead to misuse of fuel resources, as unauthorized individuals may gain access to the pump and consume fuel without proper authorization.Therefore, an automated and intelligent system is required to ensure proper authentication, reduce manual intervention, and maintain accurate fuel transaction records.

Proposed System

The proposed Smart Petro Card Management System is designed to overcome the limitations associated with conventional fuel management systems. The system introduces automation and security by incorporating modern technologies such as RFID identification, biometric fingerprint authentication, and microcontroller-based control mechanisms.Once authentication is completed successfully, the Arduino microcontroller activates a relay module that controls the pump motor. The relay functions as an electronic switch, allowing the microcontroller to operate the pump motor safely. When the relay is triggered, the pump motor begins dispensing fuel to the vehicle.To enhance user interaction, an LCD display provides real-time system messages such as “Card Detected,” “Fingerprint Verified,” or “Access Denied.” A buzzer is also integrated into the system to generate alert signals during authentication failures or system errors. Additionally, a Wi-Fi module can be included to enable communication with a remote server, allowing administrators to monitor fuel usage and maintain digital records of fuel transactions.Overall, the proposed system offers improved security,

automation, and transparency compared with traditional fuel management systems. By integrating RFID technology, biometric authentication, and embedded automation, the system provides a reliable and intelligent solution for modern fuel management applications.

Block Diagram

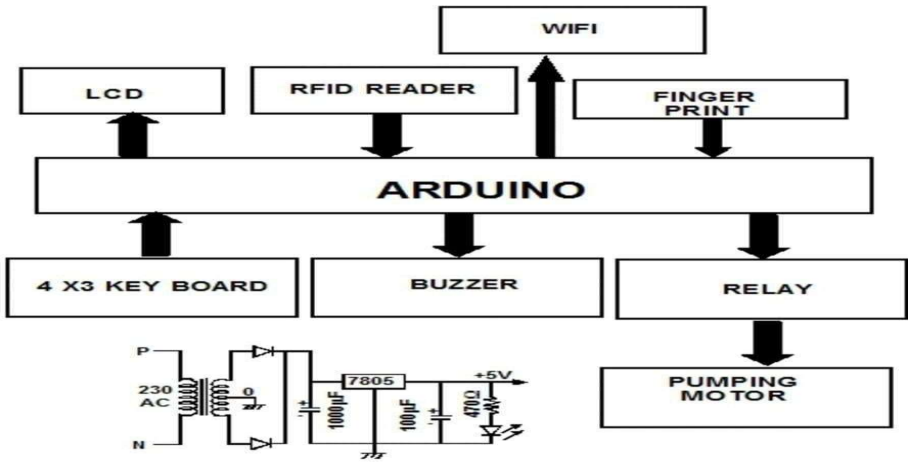

Figure 11: Block Diagram of Smart Petro card management system

The block diagram of the Smart Petro Card Management System illustrates the relationship between the main functional components of the system. It provides a simplified representation of how different modules are connected to the Arduino microcontroller and how information flows within the system. The diagram typically includes blocks such as the input unit, authentication unit, processing unit, control unit, output unit, and communication unit. Each block performs a specific function and contributes to the overall operation of the system.

Input Unit

The input unit consists of devices that collect information from the user and initiate the system operation. In this system, the RFID reader and keypad serve as the primary input devices. The RFID reader detects and reads the unique identification information stored in the Smart Petro Card when it is placed near the reader. This information is then transmitted to the Arduino microcontroller for further processing. The keypad allows users to enter additional inputs, such as fuel quantity or system commands. These input devices play a crucial role in initiating the authentication process and providing necessary data for system operation.

Authentication Unit

The authentication unit ensures system security by verifying the identity of the user. It employs a dual-authentication mechanism that includes RFID card verification and biometric fingerprint recognition. Initially, the system verifies whether the scanned RFID card is valid and registered in the database. After successful card verification, the fingerprint sensor captures the user's fingerprint and compares it with stored templates. This two-stage authentication process significantly reduces the possibility of unauthorized access and ensures that fuel is dispensed only to authorized individuals.

Processing Unit

The processing unit represents the core component of the system and is implemented using the Arduino microcontroller. It acts as the brain of the entire system by receiving data from the input and authentication modules, processing the information according to programmed instructions, and controlling the output devices. The Arduino coordinates the operation of all components including the LCD display, relay module, and buzzer, ensuring smooth and reliable system performance.

Control Unit

The control unit is responsible for managing the fuel dispensing mechanism. It primarily consists of the relay module that functions as an electronic switch. After successful authentication, the Arduino sends a control signal to the relay module, which activates the pump motor. The relay allows low-power control signals from the microcontroller to operate high-power devices safely. This unit ensures that fuel dispensing occurs only when authentication requirements are satisfied.

Output Unit

The output unit provides feedback to the user and executes the final actions of the system. It includes components such as the LCD display, buzzer, and pump motor. The LCD display shows messages related to system status and authentication results, helping users understand the operation of the system. The buzzer produces alert sounds in case of invalid authentication or system errors. The pump

motor performs the final task of dispensing fuel once access is granted.

Methodology

The methodology describes the operational procedure used to implement the Smart Petro Card Management System. It explains the sequential steps involved in user authentication and automated fuel dispensing. The methodology ensures that the system operates in a secure, efficient, and systematic manner by coordinating the interaction between hardware modules and software logic.

System Initialization

The process begins with system initialization when power is supplied to the system. At this stage, all hardware components including the Arduino microcontroller, RFID reader, fingerprint sensor, LCD display, keypad, relay module, buzzer, and Wi-Fi module are activated. The Arduino configures its input and output pins and places the system in standby mode. The LCD display shows a message such as "Scan Card," indicating that the system is ready to accept user input. This step ensures that all components are properly connected and functioning before the authentication process begins.

RFID Card Detection

Once the system is initialized, it waits for the user to present the Smart Petro Card near the RFID reader. When the card is detected, the RFID reader retrieves the unique identification number stored in the card and transmits this data to the Arduino microcontroller. This step represents the first level of interaction between the user and the system and initiates the authentication procedure.

Card Verification

After receiving the card identification data, the Arduino microcontroller compares the scanned ID with the list of registered users stored in the system database. If the card is valid, the system proceeds to the next stage of authentication. If the card is not recognized, the system denies access, displays an "Invalid Card" message on the LCD display, and activates the buzzer to notify the user. The system then returns to standby mode, waiting for another authentication attempt.

Fingerprint Authentication

Following successful RFID verification, the system performs biometric authentication using a fingerprint sensor. The user is prompted to place their finger on the sensor, which captures the fingerprint image and compares it with stored biometric templates. If the fingerprint matches the stored record, authentication is confirmed and the system allows the user to proceed. If the fingerprint does not match, access is denied and the buzzer generates an alert sound.

Results and Discussion

This chapter presents the results obtained from the implementation of the Smart Petro Card Management System and discusses the operational performance of the system. It explains how the system verifies authorized users and controls the fuel dispensing process using RFID technology and biometric authentication. The results demonstrate how the integration of embedded hardware components improves security, automation, and monitoring of fuel usage. The chapter also describes different stages of system operation observed during testing and evaluates the effectiveness of the proposed solution.

Working

The Smart Petro Card Management System operates by integrating RFID-based identification with biometric fingerprint verification to ensure secure fuel dispensing. Initially, the system remains in standby mode and waits for the user to present the Smart Petro Card near the RFID reader. When the card is scanned, the RFID reader retrieves the unique identification number embedded in the card and transmits this data to the Arduino microcontroller.During this stage, the LCD display provides real-time system messages such as "Access Granted" and "Fuel Dispensing," allowing the user to monitor the progress of the transaction. After the required amount of fuel is delivered, the microcontroller automatically stops the pump motor and the system returns to standby mode. This automated process ensures controlled fuel distribution while maintaining security and operational efficiency.

Results

The Smart Petro Card Management System was successfully implemented using various embedded hardware components including the Arduino Uno microcontroller, RFID reader, fingerprint sensor, keypad, LCD display, relay module, and communication modules. The complete hardware setup demonstrates effective integration of all system components, where the Arduino Uno acts as the central controller that coordinates authentication, user interaction, and pump control operations.

Full Setup

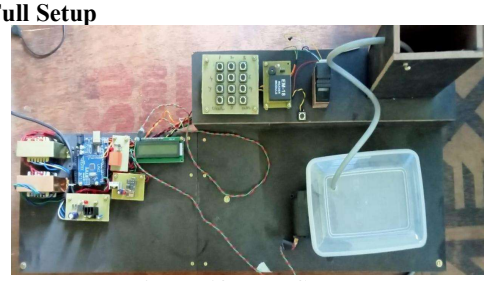

Figure 12: Full Set Up

The complete hardware configuration of the Smart Petro Card Management System is illustrated in the experimental setup. The setup consists of the Arduino Uno board connected to the RFID reader, keypad module, LCD display, relay module, and other supporting components through appropriate

wiring. The Arduino acts as the main processing unit responsible for controlling system functions. The LCD module displays operational messages and transaction information, while the keypad allows the user to enter commands such as fuel quantity. The relay module is connected to simulate the pump motor control mechanism used for fuel dispensing.

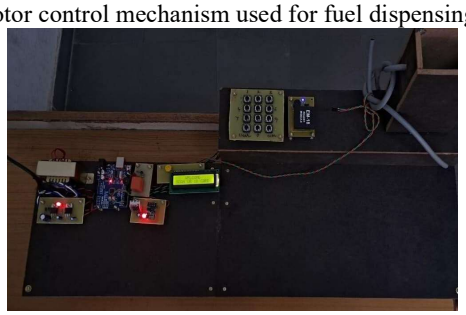

Figure 13: Before Scanning RFID

Before scanning the RFID card, the system remains in standby mode. At this stage, the LCD display indicates that the system is waiting for the user to scan the Smart Petro Card. This condition represents the initial operational state where the system is ready to receive user input.

RFID Card Scanning

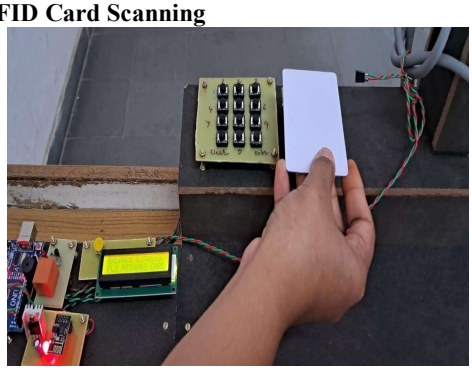

Figure 14: While Scanning

This stage illustrates the process in which the user places the Smart Petro Card near the RFID reader module. The RFID reader detects the card and retrieves the unique identification number stored in it. The retrieved data is then transmitted to the Arduino microcontroller for authentication. If the card is valid, the system allows the user to proceed with the next step of the authentication process.

Serial Terminal Output

Figure 15: Serial Terminal

The serial terminal output demonstrates the communication between the microcontroller and external modules. System messages such as card detection, authentication status, balance information, and transaction details are displayed through the serial monitor. This interface is useful for debugging and verifying that the system processes data correctly during different stages of operation.

Balance Display on LCD

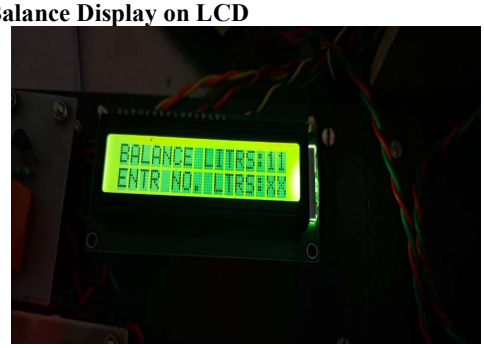

Figure 16: Balance Display on LCD

After successful authentication, the LCD display shows the available balance in the user's Smart Petro account. The LCD serves as an interface between the system and the user by providing real-time information such as balance details, instructions, and transaction updates.

Fingerprint Not Registered Message

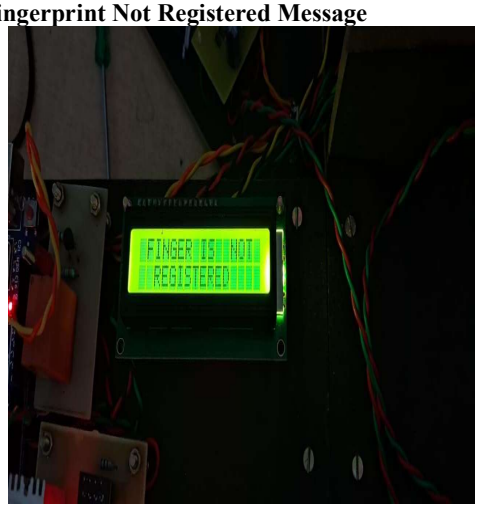

Figure 17 Fingerprint Not Registered Message

This stage represents a failed authentication scenario in which the fingerprint provided by the user does not match the stored biometric records. The LCD display shows an error message indicating that the fingerprint is not registered. The system restricts further access and may trigger a buzzer alert to notify the user. This mechanism ensures that unauthorized individuals cannot operate the fuel dispensing system.

Fingerprint Authentication

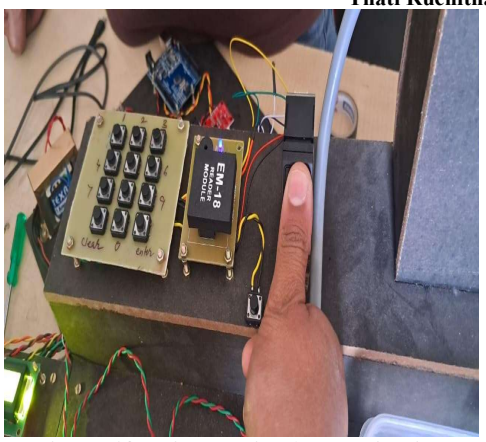

Figure 18 : Fingerprint Authentication

In this stage, the user places a finger on the fingerprint sensor for biometric verification. The sensor captures the fingerprint pattern and compares it with the stored templates in the database. If the fingerprint matches, the system confirms the user's identity and grants access to the fuel dispensing process. This step enhances system security by ensuring that the RFID card holder is the authorized individual.

Keypad Input Stage

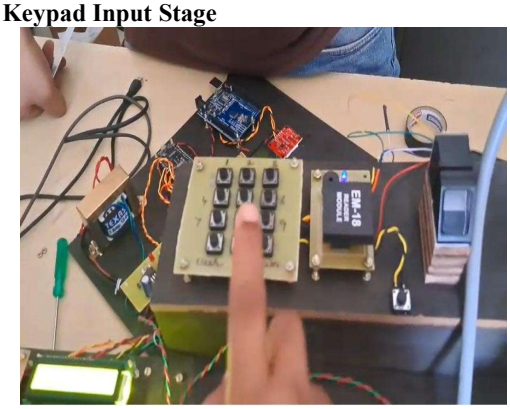

Figure 19: Keypad Input Stage

After successful authentication, the user can enter input values through the keypad module. The keypad is a 4×3 matrix interface that allows the user to specify fuel quantity or confirm transaction commands. The Arduino microcontroller reads the keypad inputs and processes them accordingly to perform the required system operation.

The experimental results confirm that the Smart Petro Card Management System operates effectively in different scenarios. During testing, the system responded correctly to both valid and invalid authentication attempts. When authorized credentials were provided, The LCD display played a significant role in improving user interaction by presenting system instructions and transaction updates in real time. Similarly, the keypad enabled convenient user input, while the fingerprint sensor and RFID reader ensured reliable authentication. The serial monitor output further confirmed that the microcontroller processed data accurately and maintained communication with connected modules.The successful implementation of the system indicates that it can be applied effectively in real-world environments such as petrol stations, industrial fuel distribution systems, and fleet management applications. By combining embedded system technology with secure authentication mechanisms, the proposed system provides a practical solution for modern automated fuel management.

Conclusion

The Smart Petro Card Management System presents an efficient and secure solution for improving fuel management and dispensing operations. Conventional fuel distribution methods primarily depend on manual supervision, which often results in operational inefficiencies, fuel misuse, lack of transparency, and possible human errors. The proposed system addresses these challenges by integrating automation and authentication technologies such as RFID identification, biometric fingerprint verification, and an Arduino-based embedded control system.In the developed system, RFID cards are used to identify registered users, while the fingerprint sensor provides an additional layer of biometric authentication. This dual authentication mechanism ensures that fuel dispensing is restricted to authorized users only, thereby preventing unauthorized access and minimizing fuel theft. The Arduino microcontroller functions as the central controller that coordinates the interaction between different hardware modules and manages the overall system operation.The system also provides real-time feedback to users through the LCD display, which shows operational messages and transaction information. The buzzer module serves as an alert mechanism to notify users in case of authentication failure or system errors. By automating the fuel dispensing process, the proposed system significantly reduces the need for manual supervision and improves operational efficiency.

Future Scope

Although the proposed system successfully demonstrates secure and automated fuel dispensing, several enhancements can be incorporated in future developments to further improve system performance and functionality. One possible improvement is the integration of cloud-based data storage and monitoring systems. By connecting the system to a cloud server, fuel transaction data can be stored securely and accessed remotely by administrators for real-time monitoring and analysis.The development of a mobile application is another potential enhancement. Such an application would allow users and administrators to track fuel

usage, check transaction records, and manage system settings conveniently through smartphones. This would increase system accessibility and improve overall user experience.Future versions of the system could also incorporate GPS technology to monitor the location of vehicles receiving fuel. This feature would be particularly beneficial for fleet management systems, as it would allow organizations to track vehicle movement along with fuel consumption data.Another promising area for future development is the use of data analytics to analyze fuel consumption patterns. By analyzing transaction data, organizations could identify trends, detect anomalies, and implement better fuel management strategies. With these enhancements, the Smart Petro Card Management System can evolve into a more intelligent, scalable, and efficient solution suitable for large-scale fuel stations, transportation networks, and smart city infrastructures.

References

[1] P. Lavanya, M. Bhavana Reddy, P. Greeshma, and T. Nandini, "Automated Petrol Pump System," *International Journal of Advanced Research in Computer and Communication Engineering (IJARCCE).*

[2] Sunil Sable, Naitik Surjuse, Prathamesh Hawale, Pratik Gargade, Rushikesh Ghodke, and Pranav Jadhav, "Automated Fuel System Using RFID Technology," *International Journal for Research in Applied Science and Engineering Technology (IJRASET).*

[3] Pavan Mankal, Mahesh, Md. Amer Ali, and Md. Nisar, "Fueling the Future: Securing Efficiency with RFID-Enhanced Pump Automation," *International Education and Research Journal.*

[4] T. N. L. Ruthvik, Prashanth S. K., Santosh Hegde, Vishalini Divakar, and Suhas M. Gowda, "Petrol Bunk Automation and Security Using RFID," *International Advanced Research Journal in Science, Engineering and Technology (IARJSET).*

[5] Naresh Jogi, Naresh Bille, Ramakanth Yadav Golla, Janardhan Naidu Gaduputi, Gowri Mahesh Raja Adigarla, and Manoj Sindhwani, "Smart Petrol Pump Using RFID and GSM Technology," *EasyChair Preprint.*

[6] Zahra'a M. Baqir and Hassan J. Motlak, "Design and Implementation of Smart Petrol Station Using Internet of Things," *IntechOpen.*

[7] Dr. Kaushika Patel, Trupti Baraiya, and Atman Shah, "Next Generation Automated Petrol Pump Using RFID Technology," *International Journal of Scientific Research in Engineering and Technology.*

[8] Naveen B., Rashmitha B. K., Parthasarathi K. S., Sandhya B. C., and Lohith S., "IoT-Based Petrol Bunk Management for Self Operation Using RFID and Raspberry Pi," *International Journal of Recent Technology and Engineering.*

[9] Sujatha S. Ari, Manoj J., Mokshith S., Jayanth M. R., and Kushal S., "Petrol Connect: An IoT Enabled Smart Card and QR Code Based Secure Fuel ATM," *International Journal of Advanced Research in Computer and Communication Engineering.*

[10] Sreelekshmi S., T. S. Shabanam, Preethi Presannan Nair, Neema George, and Sajana Saji, "RFID Based Smart Card for Campus Automation," *International Journal of Engineering Research and Technology (IJERT).*