Design and Implementation Of Fuel Dispenser Using RFID

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Abstract: The project proposes an RFID-based fuel dispenser system to modernize conventional systems, addressing inefficiencies, security vulnerabilities, and limitations in tracking and monitoring fuel transactions. The IoT program aims to integrate various equipment, such as sensors, gadgets, and hardware, with programming to create new gadgets. The petroleum pump currently operates physically, requiring a larger workforce and expensive fuel stations. To address these issues, an automatic fuel filling system using web technology is proposed. These systems aim to make fuel operation less difficult, more reliable, and safer, ensuring the same amount of fuel is provided to customers and preventing fraud at different fuel stations. The system uses human-software interaction through a web-enabled procedure, preventing errors made by people. The review paper surveys recent projects in designing prototypes of smart petrol pumps based on RFID as payment tools and remote control with high security levels, concluding with future potential directions in the design of smart petrol pump systems. The system uses user account information for fuel selection and dispensing, ensuring seamless fuel selection even without a constant internet connection. It maintains transaction logging and user account management, promoting transparency and accessibility. Periodic synchronization ensures real-time updates, enhancing the overall fueling experience. This innovative approach caters to diverse user needs and enhances the fueling experience.

Index Terms—RFID, RFID Reader, Micro-controller, Arduino, GSM.

I. INTRODUCTION

RFID technology has revolutionized fuel dispensing systems, making processes more efficient, secure, and convenient. It uses wireless communication to identify, track, and manage various objects, such as fuel stations. RFID tags are attached to vehicles, allowing for efficient and secure transactions at fuel stations. The proposed system is fully automated, eliminating the need for manual labor to maintain the pump. The system uses an LCD unit to display values entered through a keypad, while a microcontroller unit controls the pump operation for precise fuel stations. This system ensures ease of transaction, transparency, and safety for users, reducing working manpower and upgrading current fuel stations to a new level. The RFID cards are given to customers, allowing the entire process of fuel dispensing to be done by the user themselves. The system is well-programmed to automatically calculate the precise amount of fuel for entered amounts and run the pump for accurate time intervals, reducing cheating in fuel stations. Next-generation petrol bunk management uses a Raspberry Pi module as the central controller unit, coordinating with RFID cards, an electric motor, an LCD, and a Wi-Fi modem. One of the most notable features of this system is the automatic transmission of gasoline without human interference. Additionally, the system offers the facility to recharge RFID cards onsite. RFID in fuel dispensers helps businesses and fleet operators monitor and manage fuel consumption, track vehicle usage, and prevent fuel theft. It simplifies payment and billing processes, making transactions faster and more convenient for consumers. This technology also contributes to environmental sustainability by reducing the potential for fuel spillage and ensuring fuel is dispensed to the right vehicles and containers, minimizing waste and environmental harm.

II. LITERATURE SURVEY

In [1]. Fawzi M. Al-Naima1, et al said that RFID reader reads a vehicle's tag and if authorized, the system sends a signal to activate the fuel dispenser. A message with the available fuel amount is displayed on the LCD, allowing the customer to fuel. If the fueling exceeds the allowed amount, solenoid valves prevent exceeding. Keypad inputs ensure precision. If a valid tag is detected but fueling doesn't start, a ten-second timer is activated, preventing fraud or illegal use. The dispenser is deactivated at the end of the fueling operation, displaying the remaining balance on the LCD.
In [2]. Sanjay Ahuja RFID tags pose a security risk due to customers forgetting to remove them post-purchase, potentially allowing tracking. To prevent data leakage, EPC kill command can be used as a pro-privacy

technology. Cryptography can be used as a privacy measure, but it requires key management and encryption standards. Tag passwords, timer-based mechanisms, and blocker tags can also be used. Differentiating readers based on energy levels can be an effective solution, as criminals may maintain more distance.

In [3]. Shreedhar M.B, et al said that The Automated Petrol Dispensing System uses a Delta (14ss2) Programmable Logic Controller (PLC) to control the process in the petrol bunk. The PLC installation system allows for easy integration of PLC-based control units into the system configuration, facilitating the engineering process. The PLC uses various data, including user programs, I/O memory data, and commands, stored in the CPU unit's memory space. RFID technology uses radio frequency to automatically identify and track tags attached to objects, allowing for faster and more efficient fuel dispensing. The system operates automatically and takes less time to operate, reducing human work and allowing for self-operation. The system uses a Human Machine Interface (HMI) to interact with the system, allowing users to input amounts using RFID cards, similar to ATM cards. Fuel is dispensed based on the entered amount, reducing human labor and time.

In [4] Saptami T1.et al proposed that the petro-card is provided to customers, which is then scanned at a petrol pump. The system checks the balance and fills the fuel for the entered number of litres. The total amount charged is calculated based on the number of litres, and the motor pump starts running. Transaction details are displayed on the LCD and sent as SMS to the customer's smartphone. If the balance is insufficient, the system sends a message to recharge the card, and the customer can send the recharge amount via SMS. The system also includes a level sensor and smoke sensor for emergencies.

In [5]. Deepa.D et al suggested that Automated fueling stations use RFID readers at the entrance to open gates only when the tag ID is valid. GSM technology accesses user environment, allowing users to enter necessary details and confirm transactions using their pin numbers. A message is sent to the user's registered mobile number for confirmation, and all user information is added to the filling station owner's database. The RFID tag in each vehicle undergoes RSA-Rivets-Shamir-Adelman Asymmetric cryptography, using a unique id or key for encryption and decryption.

In [6]. Naveen B et al proposed an A customer's RFID card contains their details, which are read by a Raspberry Pi module. The user's details are displayed on an LCD display, and the amount of fuel required is entered through a keypad. The Raspberry Pi activates a relay drive, and the user receives a bill with transaction details via a mobile app.

In [7]. Zahra'a M. Baqir et al proposed that create a website that takes fuel level data from a fuel station and displays it on a website accessible to both admins and users. The system will provide sales and stock reports to the owner every hour, allowing customers to view the fuel station's status and stock upkeep. The system also includes a biotelemetry system for individual verification and a liquor sensor in petrol bunks to reduce drunk and drive accidents. The proposed framework uses GSM and AT mega 328 for programmed fuel filling, aiming to improve fuel procedures

In [8]. Mrs.V.Uma et al proposed that The proposed petrol pump automation system uses RFID cards to access petrol at petrol stations across the country. The system uses a microcontroller to analyze data from the RFID reader, determining the card's funds and filling the tank based on the number of taps. This system provides security by avoiding human involvement and reducing the risk of carrying cash. The total amount debited and consumed are sent to a cell phone.

In [9]. T. Murali Krishna et al suggested that the proposed petrol pump automation system uses RFID cards to access petrol at various petrol stations across the country. The system connects stations and performs actions based on customer requirements. This digital system provides security, reduces the risk of carrying money, and includes an Atmega328 microcontroller, RFID module, LCD display, Ac pump, and alarm.

In [10]. Battula Pranitha et al suggested that This chapter discusses a proposed system for postpaid cards. The system uses an RFID reader to read a consumer's card number, triggering a microcontroller to display the balance amount. A keypad is used to input petrol quantity, and the microcontroller activates a relay driver for specific time periods. The relay output is connected to a petrol pump, which senses fuel smell and activates a relay. The information is sent to the user's mobile using GSM technology.

In [11]. Naveen kumar P et al suggested that the This thesis focuses on a web application that allows users to access fuel station status and stock maintenance, reducing time and manpower. It also includes security features for the e-calibration unit in fuel pumps. The system reduces work and paper for entrepreneurs and pump mechanics, allowing them to perform repairs without regional officers' knowledge. The system requires valid mechanic credentials for calibration mode access.

In [12]. S. Chandana1et al suggested that the NodeMCU is an open-source hardware platform based on ESP8266, capable of Wi-Fi data transfer and object linking. It has a powerful processor, larger memory, and supports larger sketches. Android development aimed to create a platform-independent application environment, using Java for its superior performance and platform independence.

In [13]. Linda Castro et al suggested the Electronic Product Code (EPC) network is an RFID networking standard developed by the Auto-ID Center. It extends the first three components of a RFID system by adding unique product-item identification through the EPC code, local Object Name Service (ONS), and EPC-IS. The

network consists of five components: the EPC code, RFID reader, SAVANT, EPC-IS, and local ONS. The EPC code allows unique identification of any object throughout a supply chain, making the object "unique" in the world once incorporated into an RFID chip.
In [14]. Md. Badiuzzaman Pranto et al suggested that android application has been developed to simplify the monitoring process, supporting devices from Jelly Bean 4.1 and up. The app's back-end is in Java, while the UI is in XML. It allows users to monitor transactions, check balance, profile, and apply for new RFIDs. The MFRC522 RFID reader module is connected to the Arduino Mega board, requiring a 13.56 MHz frequency.
In [15]. K. Michael et al suggested that the RFID technology's ability to read through packaging materials like plastic wraps and cardboard containers is valuable, but metal and liquid can interfere with signals. Determining the best RFID tag position can be time-consuming, leading to "RF-friendly" and "RF-unfriendly" product categories. The high cost of RFID tags hinders widespread deployment in supply chain management.

III.EXISTING METHODOLOGY

Components of the Existing System

Fuel Pump Mechanisms

Traditional fuel dispensers utilize mechanical pumps to deliver fuel to vehicles. These systems require manual input from users. Once the user is authenticated, they can proceed to select the type and quantity of fuel through the dispenser's interface, which may include a keypad or touchscreen.

User Authentication

RFID technology enhances user identification by providing a contactless authentication process. Each user is assigned a unique RFID tag or card linked to their account information. When a user approaches a fuel dispenser, their RFID tag is recognized and verified, eliminating the need for manual input. This streamlines the fueling process and reduces transaction times. RFID tags are also more secure than traditional methods, making them more reliable.

Payment Methods

Automated RFID authentication improves security by providing a reliable and accurate method of user identification. It eliminates human error and unauthorized access risks, as each RFID tag is uniquely encoded and securely linked to the user's account. This enhanced security measures instill confidence in users and mitigates risks associated with traditional authentication methods.

User Experience

The current system has manual processes that cause inconvenience, leading to lengthy transaction times and potential payment delays. This results in frustration and dissatisfaction for users. Implementing automation and improved user interfaces can streamline authentication and payment processes, reducing wait times and minimizing user frustration.

Security Measures

The current system's security measures primarily focus on user authentication and payment processing. However, manual methods like PIN codes or card swiping may introduce vulnerabilities, potentially leading to unauthorized access or fraudulent activities. Limited payment options, mainly cash transactions or credit card payments, also pose security risks. While some safeguards are in place, manual user authentication leaves room for security gaps. The lack of diverse payment methods may increase risks. These concerns underscore the need for system enhancements to ensure fuel dispensing transactions' integrity and security.

IV.PROPOSED METHODOLOGY

Automated User Identification

RFID technology automates user identification at fuel dispensers by assigning unique tags to each user, reducing transaction times, and enhancing user convenience by eliminating the need for manual input.

Enhanced Security

Automated RFID authentication enhances security by encrypting and uniquely linking RFID tags to each user's account, minimizing unauthorized access and fraudulent activities, thus instilling trust and confidence in fuel dispensing transactions.

Offline Payment Technology

Offline payment technology is introduced to address connectivity issues by offering prepaid cards or tokens processed locally on fuel dispensers. This provides a reliable payment option, reducing dependency on network availability and transaction disruptions, even in areas with limited network connectivity.

Continuous Transactions
The system facilitates seamless fueling transactions, enabling users to initiate and complete transactions without interruption, even in areas with limited or no network coverage, ensuring a hassle-free fueling experience.

Automatic Synchronization

The system automatically synchronizes buffered transaction data with the central database after re-establishing network connectivity, ensuring accurate recording and reflection of all offline transactions and ensuring data integrity and completeness.

Flexible Payment Options
Prepaid cards are an innovative offline payment method that offers flexibility and reliability for users. These cards allow users to conveniently load funds and use them for fuel purchases, catering to diverse user preferences.

Hardware and Software Upgrades
The existing hardware and software systems have been upgraded to support RFID and offline payment technologies, ensuring compatibility and optimal functionality in fuel dispensing systems.

Compatible Hardware Integration
The integration of upgraded RFID readers and offline payment modules into fuel dispensing systems ensures seamless operation, with compatibility testing conducted to minimize disruption during the upgrade process.

User-Friendly Software Interface
The software interface has been enhanced to include RFID and offline payment functionalities, providing a user-friendly experience. Clear instructions and intuitive features are implemented, enhancing usability and satisfaction. Regular user feedback and usability testing are conducted for optimal efficiency.

Model Design

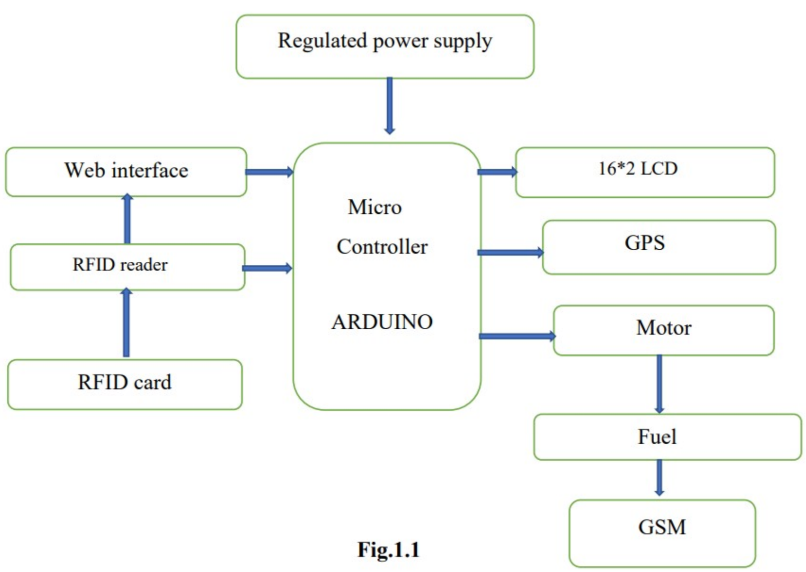

Fig.1.1

TABLE I

S.NO	DESCRIPTION	EXISTING SYSTEM	PROPOSED SYSTEM
1.	User Authentication	Manual input of credentials	RFID-based automatic authentication
2.	Payment Method	Traditional methods(cash/cards)	Introduction of offline payment using prepaid cards
3.	TransactionHandling	Real-time with online connectivity	Offline transaction supportwith buffered data and synchronization.
4.	Security Measures	Basic securityprotocols	Enhanced security, including encryption and continuous monitoring
5.	Hardware Upgrades	Standard hardwarecomponents	Upgraded RFID readers andfuel pump control systems
6.	Software Interface	Basic user interface	Improved user interface with RFID authentication and offline payment options
7.	TransactionFeedback	Standard display	Real-time feedback on RFID authentication and offline transactions

RESULT

RFID Technology Integration

The implementation of RFID technology resulted in swift and secure user identification. Manual input requirements were eliminated, reducing transaction times and streamlining the fuel process. Testing confirmed seamless RFID integration, ensuring a robust and reliable system for user authentication.

Offline Payment Technology

The integration of offline payment technology, particularly using prepaid cards, addressed connectivity issues effectively. Continuous transactions were achieved through a buffered data approach, allowing users to complete transactions seamlessly, even in areas with limited network connectivity. Rigorous testing verified the system's resilience to various scenarios, enhancing reliability.

Hardware and Software Upgrades

Hardware and software upgrades, including RFID readers and modifications to the software interface, were successfully implemented. The compatibility of existing hardware with the proposed enhancements was ensured, paving the way for a seamless integration process. User interfaces were enhanced to accommodate RFID authentication and offline payments, providing a user-friendly experience

Significance of Enhancements

The enhancements had a profound impact on the fuel dispensing system. User experience significantly improved with faster transactions and more convenient paymentoptions. Security was heightened through RFID-based automated user identification andthe additional layer of security provided by offline payment technology. Operational efficiency saw marked improvements with streamlined user interactions and reduced transaction times.

V.CONCLUSION

The integration of RFID technology in fuel dispensing has significantly improved user satisfaction and operational efficiency. This integration streamlines the authentication process, reduces transaction times, and ensures seamless transactions, even in limited network coverage areas. It also enhances security measures, reducing the risk of unauthorized access and fraudulent activities. These enhancements not only improve operational efficiency but also bolster security measures, minimizing the risk of unauthorized access and fraudulent activities. The successful implementation of these technologies demonstrates the industry's commitment to innovation and meeting evolving user needs. As technology evolves, fuel dispensing systems will continue to deliver enhanced user experiences and drive industry innovation.

REFERENCES

[1] Sanjay Ahuja, Pavan Potti "An Introduction to RFID Technology" School of Computing, University of North Florida, Jacksonville, Florida2088-8708, doi:10.4236/cn.2010.23026 Published Online August 2010.

[2] Fawzi M. Al-Naima1, Mohannad M. Hasan "Design and Implementation of RFID-based Fuel Dispensing System" Department of Computer Engineering, Al-Nahrain University, Baghdad, Iraq, ISSN 2210-1519.

[3] Shreedhar M.B, B.S. Shivashankara "PLC BASED AUTOMATIC FUEL DISPENSING SYSTEM USING RFID TECHNOLOGY" Vol. 4, Issue 1, ISSN No. 2455-2143, Pages 54-57.International Journal of Engineering Applied Sciences and Technology, 2019.

[4] Saptami T1, Seema D2, Snehal D3, Vidya A4, Sagar B5, "Multipurpose Self -Fuel Dispensing Automated Framework Utilizing RFID Prepaid Cards". Dept. of CS Engineering, Angadi Institute of Technology and Management, Belagavi, Karnataka, India. Aug 2020.

[5] Deepa.D, Deepashree.B, Deepu.N, Divya.R.P, "Multipurpose Self Fuel Dispensing Automated Framework Utilizing RFID prepaid cards.".International Conference on Design Innovations for 3Cs Compute Communicate Control,2018.

[6] Naveen B, Rashmitha B K, Parthasarathi K S, Sandhya B C,Lohith S, "IOT Based Petrol Bunk Management for Self-Operation using RFID and Raspberry PI". International Journal of Recent Technology and Engineering (IJRTE). ISSN: 2277-3878, Volume-8, Issue-1C, May 2019.

[7] Zahra'a M. Baqir, Hassan J. Motlak, "Smart automatic petrol pump system based on internet of things". Department of Electrical and Electronic Engineering, Babylon University, Iraq, ISSN: 2088-8708, DOI: 10.11591/ijece.v11i2.pp1804-1811.

[8] Mrs.V.Uma , M.Thanuja , N.Yashasree, P.Sai Thanmai, "RFID based Petrol Pump Automation System", Department of Electronics and Communication Engineering. ISSN 2582-7421.

[9] T. Murali Krishna, Kothagolla Sushmitha, Banoth Yashwanth, Marreddy Bhanu Prakash Reddy, Pathkula Mahendar," RFID BASED PETROL PUMP AUTOMATION SYSTEM", Department of Electrical and Electronics Engineering, ISSN:0377-9254, Vol 13 Issue 12,2022.

[10] BATTULA PRANITHA, RAKKASI DHARANI," RFID BASED UNMANNED PETROL PUMP", Electronics and Communication Engineering, MAY – 2022.

[11] Naveen kumar P, Kumaresan P and Babu Sundaresan Y,"IoT based retail automation of fuel station and alert system",School of Information Technology and Engineering, VIT University, Vellore-632014,doi:10.1088/1757-899X/263/4/042072.

[12] S. Chandana1, C. J. Dhanyashree1, K. L. Ashwini1, R. Harini1, M. Premkumar, Laith Abualigah, "Fuel automata: Smart fuel dispenser using RFID technology and IoT-based monitoring for automotive applications", Journal of Autonomous Intelligence (2023) Volume 6 Issue 1, doi:10.32629/jai.v6i1.682.

[13] Linda Castro & Samuel Fosso Wamba," AN INSIDE LOOK AT RFID TECHNOLOGY", J. Technol. Manag. Innov. 2007, Volume 2, Issue 1. January 2007.

[14] Md. Badiuzzaman Pranto ,Md. Mahidur Rahman ,Zunayeed-Bin-Zahir,"Vehicle Fuel Monitoring and Management using RFID authentication and Telematics Notification", 2019 IEEE.

[15] K. Michael, L. McCathie," The pros and cons of RFID in supply chain management", DOI: 10.1109/ICMB.2005.103 · Source: IEEE Xplore.