RFID Based Petrol Pump Automation System

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Abstract — In today's world, almost every sector and business has transitioned to automation. Gas stations are highly functional with microcontrollers to monitor gas flow and display the correct price to the customer. But customers need to collect personal payments, increasing the risk of human error when handling cash. That's why our program is designed so that our customers do not need to carry cash. Instead, they will be given a smart card with an RFID tag that will be connected to the RFID reader at the fuel pump and they will be able to make payments without the need for cash or human interaction. This reduces human error in calculations and increases work efficiency.

Keywords: Arduino Mega, GSM, Node MCU ESP8266 Wi-Fi SoC, 4*4 Keypad, 20*4 LCD Display, RFID Reader RC522, RFID Tag Submersible Motor, Relay Buzzer.

I. INTRODUCTION

In the ever-evolving landscape of technology, automation has become a key driver in enhancing efficiency, accuracy, and convenience across various sectors. One such sector that stands to benefit significantly from automation is the fuel retail industry. The RFID-based petrol pump automation system represents a significant advancement in this field, offering a streamlined, secure, and user-friendly approach to refueling vehicles. By leveraging Radio Frequency Identification (RFID) technology, this system enables wireless transfer of data between vehicles and fuel pumpsoptimizing the entire fueling process. One of the primary benefits of an RFID-based petrol pump automation system is enhanced security and fraud prevention. RFID tags embedded in vehicles are pre-registered with specific user accounts, ensuring that only authorized vehicles can access fuel. This mechanism significantly reduces the risk of fuel theft and unauthorized usage. Additionally, the system's capability to authenticate each vehicle provides an added layer of security, making it difficult for unauthorized entities to exploit the fueling system. Efficiency is another critical advantage of implementing RFID technology in petrol pumps. The automation of fuel dispensing processes significantly reduces the time taken to refuel vehicles. By eliminating manual intervention, the system minimizes human error, speeds up transactions, and ensures accurate fuel delivery. This is particularly beneficial in high-traffic fuel stations where time efficiency is crucial for maintaining customer satisfaction and operational flow. From a user perspective, the RFID-based system offers unparalleled convenience. Drivers can refuel their vehicles without needing to step out or handle payment transactions manually. The system automatically identifies the vehicle, dispenses the required amount of fuel, and processes the payment through a pre-linked account, providing a seamless and convenient refueling experience. This hands-free approach not only enhances user experience but also promotes a smoother and more efficient operation of the fuel station. Moreover, the RFID system allows for comprehensive data collection regarding fuel usage, transaction history, and vehicle details. This data is invaluable for various purposes, such as inventory management, predictive maintenance, and customerrelationship management. Fuel stations can analyze this data to improve their services, optimize operations, and enhance customer satisfaction. Effective data management can lead to better decision-making and more strategic business practices. Lastly, the adoption of RFID-based automation systems can result in significant cost savings for fuel station operators. By reducing the need for manual labor and minimizing fuel loss due to theft or inaccuracies, these systems can lower operational costs. Efficient management of fuel resources helps maintain optimal inventory levels and reduces wastage, contributing to overall cost efficiency.

II. BLOCK DIAGRAM

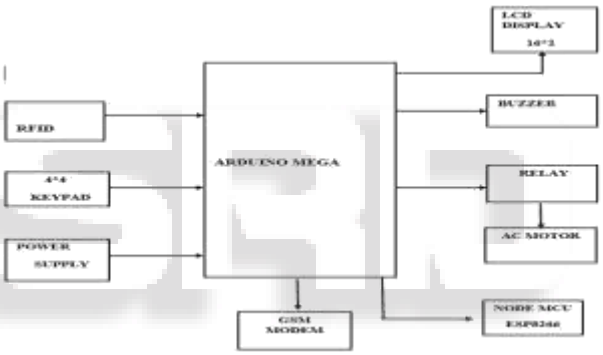

Fig. 1: Block Diagram of RFID Based Petrol Pump Automation System

A. *Arduino Mega:-*

- Working Principle: An RFID reader connected to the Arduino Mega scans RFID tags presented by users. Each RFID tag has a unique identifier. The Arduino Mega processes the unique identifier from the RFID tag to authenticate the user by comparing it with pre-stored valid IDs in its memory or an external database.
- Function: The Arduino Mega interfaces with the RFID reader to read and interpret the unique identifiers of RFID tags.t authenticates users by verifying RFID tags against a list of authorized IDs stored in its memory or an external database.

B. *RC522 RFID Reader Module:-*

- Working Principle: The RC522 RFID reader module operates on the principle of electromagnetic induction, generating an RF field that powers passive RFID tags within range. These tags transmit their unique data back to the reader through backscattering.
- Function: In an RFID-based petrol pump automation system, the RC522 RFID reader module plays several key roles. It authenticates users or vehicles by reading RFID tags to verify their authorization for fuel

dispensing. The system logs each transaction, including details like the tag ID, fuel amount, and timestamp, ensuring accurate record-keeping.

C. AC Motor:-

- Working Principle: The working principle of an AC motor involves the conversion of electrical energy into mechanical energy through electromagnetic induction. When an alternating current flows through the motor's stator windings, it creates a rotating magnetic field that induces a current in the rotor, causing it to turn and produce mechanical motion.
- Function: The AC motor powers the pump mechanism to transfer fuel from the storage tank to the vehicle's fuel tank. When an RFID tag is authenticated, the motor activates to begin the dispensing process.

D. NODE MCU:-

- Working principle: The NodeMCU plays a crucial role by facilitating communication between the RFID reader, the microcontroller, and the internet. The working principle involves the NodeMCU reading data from the RFID tags and then processing and transmitting this data to a server for authentication and transaction processing.
- Function: The NodeMCU interfaces with the RFID reader to capture the unique ID from the RFID tags attached to vehicles or users. It processes the captured RFID data, checking it against a database to verify the user's credentials and pre-loaded balance or fuel allowance.Using its built-in Wi-Fi module, the NodeMCU connects to the internet, sending and receiving data from a remote server to update transaction records and balances in real-time.

E. GSM MODEM:-

- Working Principle: The working principle of a GSM modem involves utilizing mobile network technology to send and receive data over GSM (Global System for Mobile Communications) networks. It operates by converting digital data from a microcontroller or computer into a format suitable for transmission over the GSM network, and vice versa.
- Function: It allows the system to send updates about fuel levels, transaction details, and operational status to a central server or an authorized user via SMS or GPRS. The modem can send immediate alerts and notifications in case of any anomalies, such as unauthorized access attempts or system malfunctions, ensuring timely intervention.It facilitates the exchange of transactional and operational data between the petrol pump system and remote servers, ensuring that records are updated in real-time for inventory management and billing purposes.

III. LITERATURE SURVEY

1) RFID Based Petrol Pump Automation System by PoojaMandhare ,RajwardhanAutade,VishalGutal, Dr. S. D. Shribahadurkar, Prof. P. Upadhye.

The system uses RFID technology to identify authorized vehicles and Arduino microcontrollers to control the fuel pump. the paper provides a well-researched and informative overview of the potential benefits of RFID-based automation for petrol pumps. The authors have successfully demonstrated the feasibility of such a system and have identified several areas for future improvement.

2) AUTOMATED PETROL PUMP USING RFID TECHNOLOGY by Rohith .S, Akilan .K, Murali Krishna. M, Dr.Kandasamy .

RFID systems dispenses accurate amount of fuel as required by the user. In this way the efficiency is maintained. Also as everything is automated, the labourpressure is reduced. Also as only authorized users may enter or leave the system, this system is more secure than present ones. To make this system more efficient, greater quality of RFID cards must be produced. Thus the design and simulation part of our project is complete in the first phase of the project. In the second phase, they aim to work on the hardware design of our project and implement everything they discussed in the report so far.

3) Fawzi Mohammed Munir Al-Naima and Mohannad M Hasan, "Design and implementation of RFID Based fuel dispensing system", Research gate publication, September 2015.

This paper presents a fuel dispensing system based on RFID technology. The system can improve the fueling process in order to make it much easier, secure and reliable. It prevents unauthorized fueling by assigning a specified amount of fuel for registered vehicles, depending on their types, within a specific period of time so that each vehicle will get a sufficient amount of fuel. It also provides efficient statistics about the various quantities of fuel at the stations.

IV. PROPOSED METHODOLOGY

1) Define requirements: The first step in implementing an RFIDbased petrol pump system is to define the requirements of the system. This includes identifying the specific needs of the petrol station, such as the types of fuel to be dispensed, the volume of fuel to be dispensed, and the security requirements.
2) Select hardware: Once the requirements have been defined, the next step is to select the appropriate hardware for the system. This includes the RFID tags, RFID readers, and control systems.
3) Install hardware: The RFID tags must be installed on the vehicles that will be using the system. The RFID readers must be installed at the petrol pumps. The control systems must be installed at a central location.
4) Develop software: The software for the system must be developed to manage the RFID tags, RFID readers, and control systems. The software must also be able to communicate with the petrol station's point-of-sale system.
5) Test system: The system must be thoroughly tested before it is put into operation. This includes testing the RFID tags, RFID readers, control systems, and software
6) Deploy system: The system can be deployed once it has been tested and deployed in the system for use.
7) Monitor and maintain system: The system must be monitored and maintained on an ongoing basis. This includes checking the RFID tags, RFID readers, and control systems for damage. It also includes updating the software as needed.

V. HARDWARE AND SOFTWARE DESCRIPTION

A. Hardware Description:

1) Arduino mega

The Arduino Mega is based on ATmega2560 Microcontroller. The ATmega2560 is an 8-bit microcontroller. We need a simple USB cable to connect to the computer and the AC to DC adapter or battery to get started with it. The functioning of the Arduino Mega is similar to other Arduino Boards. We need not require extra components for its working. The ATmega2560 Microcontroller is consistent with most of the shields of Arduino UNO.

Arduino Mega (8Kb SRAM) acquires more SRAM space than Arduino UNO (2Kb SRAM). The greater the SRAM space, the more space would the Arduino have to manipulate and create a variable when it runs. The Arduino Mega includes 54 I/O digital pins and 16 Analog Input/Output (I/O), ICSP header, a reset button, 4 UART (Universal Asynchronous Reciever/Transmitter) ports, USB connection, and a power jac.

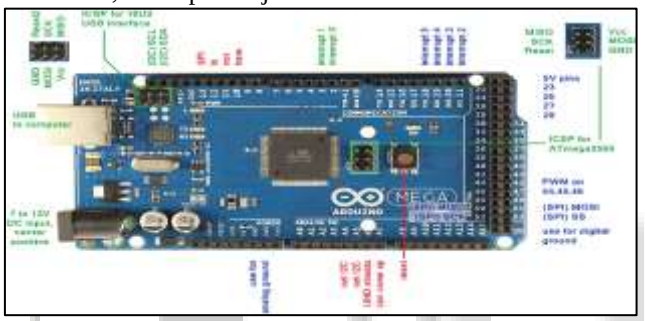

Fig. 1: ARDUNIO MEGA

2) RC522 READER MODULE

RC522 is the highly integrated RFID card reader which works on non-contact 13.56mhz communication, is designed by NXP as low power consumption, low cost and compact size read and write chip, is the best choice in the development of smart meters and portable hand-held devices.

Fig. 2: RC522 READER MODULE

3) NODE MCU

The NodeMCU (Node MicroController Unit) is an open-source software and hardware development environment built around an inexpensive System-on-a-Chip (SoC) called the ESP8266. The ESP8266, designed and manufactured by Espressif Systems, contains the crucial elements of a computer: CPU, RAM, networking (WiFi), and even a modern operating system and SDK.

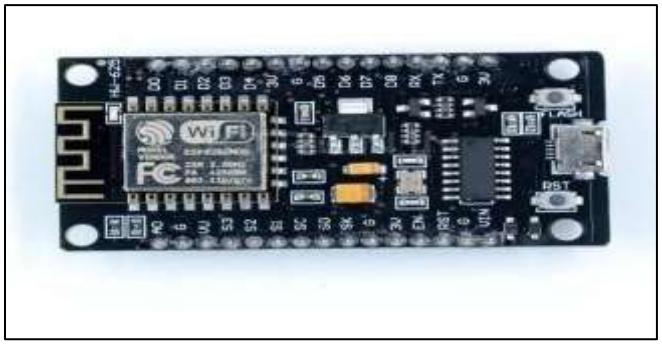

Fig. 3: NODE MCU ESP8266

4) GSM MODEM

The SIM800A modem has a SIM800A GSM chip and RS232 interface while enables easy connection with the computer or laptop using the USB to Serial connector or to the microcontroller using the RS232 to TTL converter. Once you connect the SIM800A modem using the USB to RS232 connector, you need to find the correct COM port from the Device Manger of the USB to Serial Adapter. Then you can open Putty or any other terminal software and open an connection to that COM port at 9600 baud rate, which is the default baud rate of this modem. Once a serial connection is open through the computer or your microcontroller you can start sending the AT commands. When you send AT commands for example: 'ATr' you should receive back a reply from the SIM800A modem saying 'OK' or other response depending on the command send.

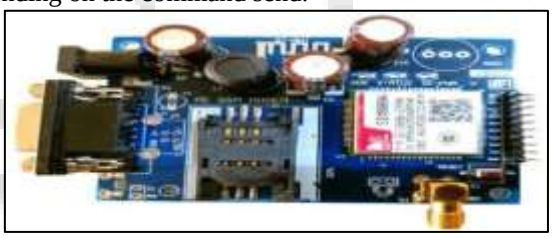

Fig. 4: GSM MODEM SIM800A

5) AC MOTOR

An AC motor operates by converting electrical energy into mechanical energy through the principle of electromagnetic induction. When an alternating current (AC) is supplied to the stator windings, it generates a rotating magnetic field. This rotating field induces an electromotive force (emf) in the rotor, causing current to flow within it. The interaction between the stator's rotating magnetic field and the rotor's induced current creates torque, causing the rotor to turn. In synchronous motors, the rotor speed matches the rotating magnetic field's speed, while in induction motors, the rotor lags slightly behind, creating slip necessary for induction.

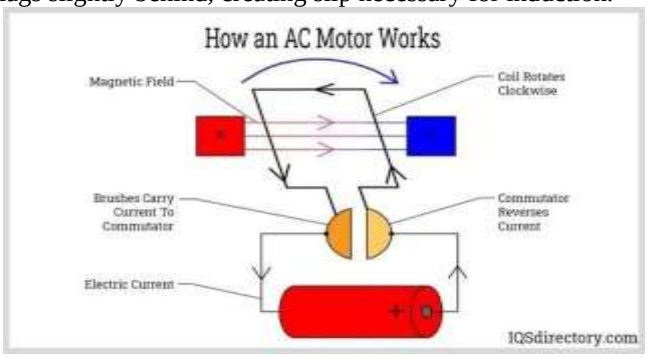

Fig. 5: AC MOTOR

B. Software Description

Arduino is a type of computer software and Hardware Company that offers open-source environment for user project and user community that intends and fabricates microcontroller based inventions for construction digital devices and interactive objects that can sense and manage the physical world. For programming the microcontrollers, the Arduino proposal provides a software application or IDE based on the Processing project, which includes C, C++ and Java programming software. It also support for embedded C, C++ and Java Programming software. Arduino is an opensource computer hardware and software company, project and user community that designs and manufactures microcontroller-based kits for building digital devices and interactive objects that can sense.

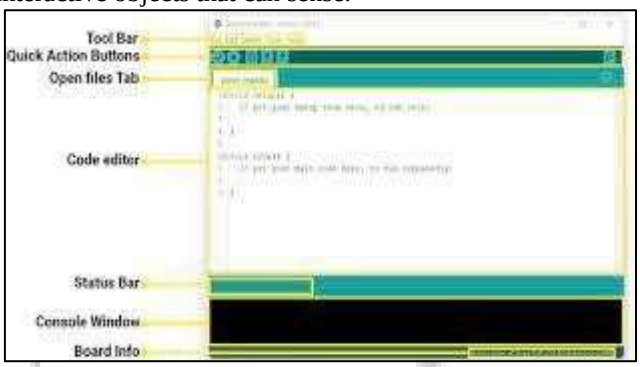

Fig. 6: ARDUINO IDE INTERFACE

VI. RESULT

The RFID-based petrol pump automation system significantly enhances security by ensuring only authorized users access fuel, reducing fraud and unauthorized access. It improves efficiency with faster service and reduced manual intervention, leading to shorter wait times and higher throughput. Users benefit from a seamless experience and transparent transactions, boosting satisfaction. Accurate data collection enables comprehensive records, insightful analytics, and better operational decisions. The system also reduces operational costs by minimizing losses and optimizing fuel management. Enhanced CRM capabilities facilitate loyalty programs and targeted marketing. Additionally, the system promotes environmental safety through controlled dispensing and real-time alerts for irregularities. Scalability and easy integration with other technologies ensure long-term adaptability and growth.

VII. FUTURE SCOPE

The future scope of RFID-based petroleum pump automation systems is vast and promising. As technology advances, these systems will enhance efficiency and security at fuel stations. They can streamline operations by enabling seamless, contactless transactions, reducing human error and fraud. Integration with vehicle identification systems will allow personalized services and real-time monitoring of fuel consumption. Moreover, these systems can support dynamic pricing models and loyalty programs, improving customer satisfaction. The integration with IoT and advanced analytics can provide valuable insights into consumer behavior and operational efficiency. With the growing emphasis on smart cities and automation, RFID-based solutions are likely to become standard in the industry, contributing to more sustainable and intelligent fuel management systems. The scalability of RFID technology also means it can be easily adapted to future advancements, ensuring long-term viability and continuous improvement.

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