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Fuel Flow: Streamlining Fuel Dispensing with RFID and ESP8266 Integration

Hrishikesh Barge[1,] *, Balaji Apet[1], Kunal Chavan[1], Prashant Dahale[2]

Abstract

The "Smart Automatic Petrol Pump System Based on RFID and ESP8266" project is a cutting-edge implementation of Internet of Things (IoT) technology designed to revolutionize the conventional petrol and diesel fuelling process. With the exponential growth of vehicular traffic in urban areas, fuel stations have encountered congestion and inefficiencies. This project addresses these challenges by introducing an intelligent and automated system that seamlessly integrates RFID technology, ultrasonic sensors, microcontrollers, and wireless communication. The "Smart Automatic Petrol Pump System Based on RFID and ESP8266" project is a cutting-edge implementation of Internet of Things (IoT) technology designed to revolutionize the conventional petrol and diesel fuelling process. With the exponential growth of vehicular traffic in urban areas, fuel stations have encountered congestion and inefficiencies. This project addresses these challenges by introducing an intelligent and automated system that seamlessly integrates RFID technology, ultrasonic sensors, microcontrollers, and wireless communication.

INTRODUCTION

The advent of the Internet of Things (IoT) has ushered in an era of interconnected devices, where digital technology seamlessly integrates with the physical world, transforming various aspects of our daily lives. Among the numerous domains touched by this technological revolution, the domain of fuel stations and their services has become a focal point of innovation. The "Smart Automatic Petrol Pump System," as presented in this report, represents a groundbreaking application of IoT technology to alleviate the challenges encountered in the fuelling process, particularly in urban areas [3-4]. The contemporary urban landscape has witnessed an unprecedented surge in vehicular traffic, leading to congestion and inefficiencies at traditional fuel stations. Long queues, manual payment systems, and the absence of Important Elements of Intelligent Automatic Fuel Pump Systems Two essential parts form the basis of a Smart Automatic Petrol Pump System:

EASE OF USE

The core objective of the "Smart Automatic Petrol Pump System" is to automate and optimize the fuelling process through a fusion of hardware and software components. The project employs a suite of cutting-edge hardware, including the ATmega328 microcontroller, SR04 ultrasonic sensor, RFID reader, keypad, relay, water pump, ESP8266 Wi-Fi module, and an LCD 16x2 display. These components collaborate to create an intelligent and efficient ecosystem that streamlines fuel dispensing while enhancing security and user in the subsequent sections of this report, we delve into the hardware and software components in greater detail, elucidate the practical applications of this innovative system, and present the results of our project's implementation. By leveraging the capabilities of IoT technology, our project underscores the

***Author for Correspondence**
Hrishikesh Barge
E-mail: hrishikeshbarge5@gmail.com

[1]Student, Department of Electronics & Telecommunication, Sinhgad College of Engineering, Pune, Maharashtra, India
[2]Associate Professor, Department of Electronics & Telecommunication, Sinhgad College of Engineering, Pune, Maharashtra, India

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potential for a more efficient, secure, and user-centric fuelling experience in an increasingly interconnected world [5].

ATmega328 Microcontroller

The ATmega328 (Figure 1) Microcontroller serves as the central processing unit and the brain of the "Smart Automatic Petrol Pump System" project. Its role is pivotal in coordinating and controlling the various hardware and software components to ensure the project's objectives are met. Here's how the ATmega328 Microcontroller is used in this project: Control Logic: The ATmega328 Microcontroller executes the control logic of the system, determining when to initiate fuel dispensing, manage user interactions through the keypad, and handle sensor inputs. Data Processing: It processes data collected from sensors, such as the SR04 Ultrasonic Sensor and RFID Reader, to make real-time decisions based on the inputs received. Acting as the fuel pump system's central processing unit, the ESP8266 microcontroller oversees interacting with RFID readers, managing dispensing systems, and establishing connections with cloud-based or backend services. The ESP8266, which has programmable logic and Wi-Fi connectivity, allows for remote monitoring, real-time data interchange, and predictive maintenance, all of which improve the fuel pump system's dependability and operating efficiency.

The SR04 Ultrasonic Sensor (Figure 2) is employed in the "Smart Automatic Petrol Pump System" to accurately measure the distance between the fuel pump and vehicles, allowing for vehicle detection. By initiating fuel dispensing when a vehicle is detected, the sensor enhances efficiency, minimizes wait times, and contributes to a seamless user experience, supporting the project's goal of automating and improving the fuelling process.

RFID Reader

The RFID Reader (Figure 3) in the project is instrumental in automating user and vehicle identification. It enhances security by reducing the risk of unauthorized access and fraudulent transactions. The system streamlines authentication, ensuring a faster and more convenient fuelling experience for users. RFID technology can be integrated with user accounts, facilitating efficient billing and transaction tracking, aligning with the project's aim to optimize fuelling processes and enhance security. RFID tags with unique IDs that allow for seamless and contactless identification are attached to cars or fuel cards. When a car with an RFID tag approaches the petrol pump, RFID readers placed there scan the tag for pertinent data, including the car's fuel choices, payment information, and history of filling. By doing away with the need for manual involvement, this automated authentication procedure lowers wait times and improves customer satisfaction all around [6-9].

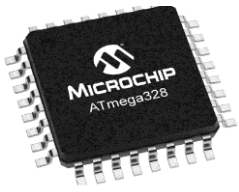

Figure 1. SR04 ultrasonic sensor.

Figure 2. SR04 ultrasonic sensor.

Figure 3. RFID reader.

LCD Display 16*2

The LCD 16x2 Display (Figure 4) serves as a critical visual feedback mechanism in the "Smart Automatic Petrol Pump System," providing real-time information, messages, and status updates to the user. It enhances the user experience by conveying important data related to the fuelling process, such as transaction details, confirmation messages, and status indicators, ensuring that users are well informed and comfortable during the entire fueling operation [10].

Keypad

The Keypad (Figure 5) in the "Smart Automatic Petrol Pump System" acts as the primary user interface, enabling customers to input crucial information like PINs, control commands, and transaction details. This input mechanism is essential for secure and user-friendly fuelling operations, as it allows users to authenticate themselves, make selections, and ensure error-free transactions. The Keypad's integration with the system's microcontroller facilitates efficient processing and decision-making during the fuelling process.

Relay

The Relay (Figure 6) in the "Smart Automatic Petrol Pump System" plays a pivotal role in managing high power devices, specifically the water pump. When the system decides to initiate fuel dispensing or other liquid-related tasks, the Relay serves as an electromechanical switch, providing the necessary power control. This ensures the precise and efficient operation of the pump, contributing to the automation and user-friendly experience of the fuelling process [8].

Water Pump

The water pump is employed to efficiently transfer fuel from the storage tank to the vehicle's fuel tank. This essential component is under precise control, operating only when authorized by the system's control logic. It can be initiated by the user through the system's interface, where the customer selects the desired fuel type and confirms the transaction. Alternatively, the system can automatically control the pump's operation based on sensor inputs, such as detecting the presence of a vehicle or user authentication. This automation not only reduces the need for manual intervention but also minimizes the likelihood of errors, making the fueling process more efficient and precise. Block diagram of RFID Based petrol pump is shown in Figure 7.

The block diagram shows in Figure 8. the main components of the system and how they are interconnected. The ESP32 microcontroller is the central processing unit of the system and controls all the other components. The RTC module provides the ESP32 with the current time and date, which is used to dispense medication at prescribed times. The servo motor controls the dispensing mechanism, and the stepper motor controls the dosage of medication. The LCD display provides information to the user, and the switch allows the user to manually dispense medication. The LDR detects if the medication compartment is empty, and the battery powers the system. The Blynk app connects to the ESP32 over the internet and allows the user to monitor and control the system remotely.

Figure 4. LCD Display 16*2.

Figure 5. Keypad

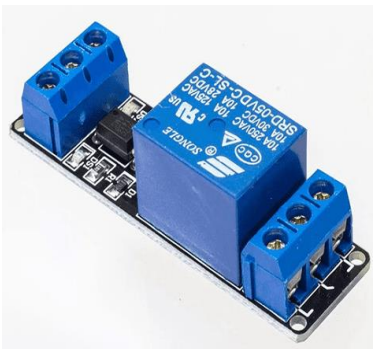

Figure 6. Relay.

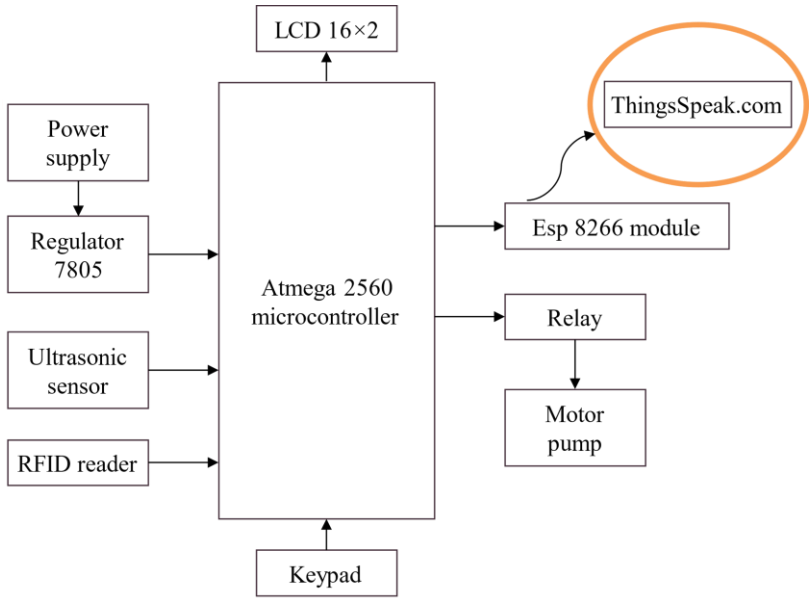

Figure 7. Block diagram of the RFID based petrol pump.

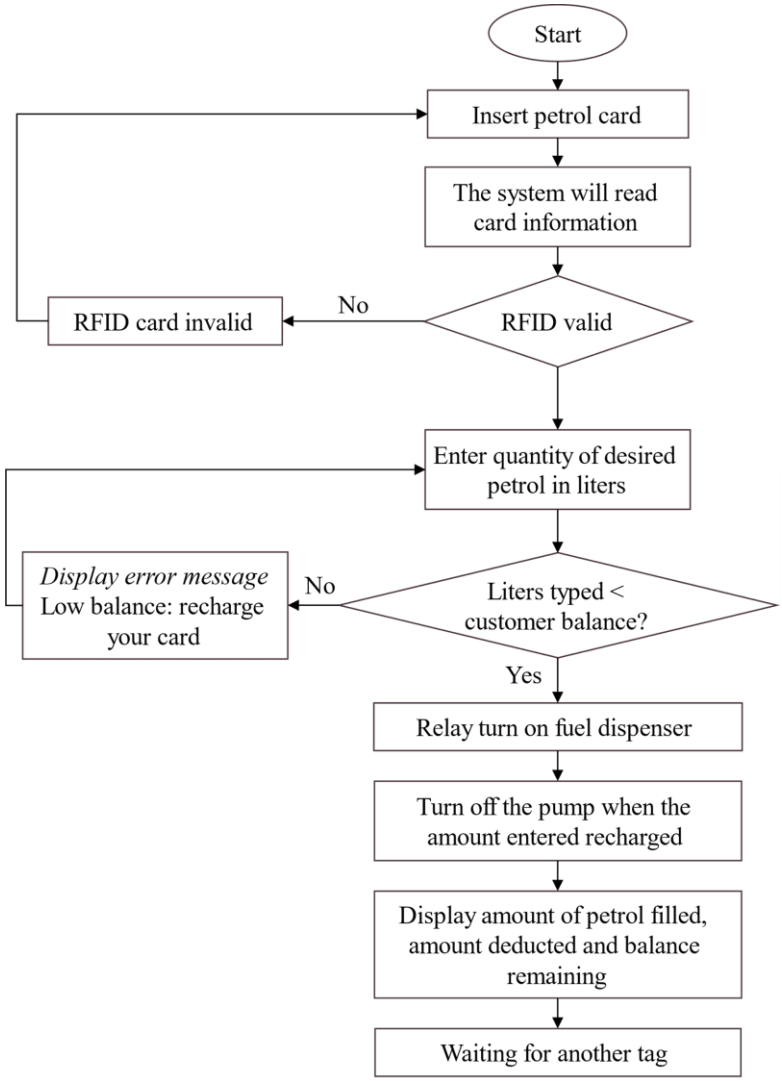

Figure 8. Flowchart of the RFID based petrol pump.

In this system the user has to insert the petrol card at the start. The system then reads the cards information now there are two cases to read the RFID: - CASE1: The RFID reader reads the RFID and if it is valid then the message to enter the quantity in litres is displayed. If the quantity of the litres is greater than the card balance, then the error message "Low balance: recharge your card" is displayed and the user is again redirected to the enter the petrol amount scareen. CASE2: The RFID reader reads the RFID and if it is invalid then the user is asked to enter the card again. If the litres typed are smaller than the customer balance, then the relay turns on the fuel dispenser and turns it off accordingly after the desired amount of petrol is filled in the tank.

LITERATURE REVIEW

This project delves into the realm of Internet of Things (IoT) applications and their relevance to the energy sector. This review seeks to establish a comprehensive understanding of the broader context within which the project operates, shedding light on key themes and challenges associated with IoT-enabled systems in similar domains. The literature encompasses diverse applications, including predictive maintenance for Industry 4.0, energy sector IoT applications, petroleum pipeline monitoring, and IoT implementations in oil fields. By examining these references, we aim to discern valuable insights that can inform the development and future scalability of our innovative fuelling station system. This review provides the necessary foundation to contextualize the project within the broader landscape of IoT technology adoption in the energy industry and infrastructure management, helping us draw upon relevant best practices and industry knowledge [1, 2].

RESULT

Implementing a smart automatic petrol pump system based on RFID and ESP8266 technology promises to revolutionize the fuelling experience. By integrating RFID tags with vehicles and utilizing ESP8266 microcontrollers, this system streamlines the fuelling process with efficiency, accuracy, and convenience. Drivers can quickly and securely identify themselves and their vehicles, reducing waiting times at the pump and minimizing errors associated with manual input. The hands-free operation ensures convenience for customers, while network connectivity enables real-time monitoring, data collection, and remote management of fuel levels and pump operations. Furthermore, the system enhances security with secure authentication and encryption protocols, mitigating the risk of fraud or unauthorized access. By offering personalized services and targeted promotions, this system not only enhances operational efficiency for fuel station operators but also improves the overall fuelling experience for customers. Overall, the integration of RFID and ESP8266 technology in petrol pump systems marks a significant step towards a more efficient, secure, and customer-centric fuelling ecosystem.

Advantages

1. *Automation:* Automates fuel dispensing process, reducing manual intervention, and improving efficiency.
2. *Enhanced security:* Utilizes RFID technology for secure user authentication and authorization, minimizing unauthorized access.
3. *Improved user experience:* Provides a user-friendly interface for easy interaction and seamless fueling experience.
4. *Real-time monitoring:* Enables real-time monitoring of fuel levels and transaction data for better management and decision-making.
5. *Efficiency:* Optimizes fueling operations, reducing queues and wait times at fuel stations, particularly in urban areas.

CONCLUSION

In conclusion, the "Smart Automatic Petrol Pump System" represents a significant leap in modernizing the fuelling experience. By leveraging IoT technology, RFID, and efficient automation, it not only enhances security, efficiency, and user convenience but also showcases adaptability for diverse

applications. This project serves as a foundation for the evolution of fuel stations, offering a glimpse into the future of fuelling, where technology meets sustainability and user-centric design, ultimately redefining the way we refuel our vehicles.

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