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RFID-Based Petrol Pump Automation with Solar Power System

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Abstract: -. Traditional fuel dispensing stations predominantly rely on manual operations, often resulting in human errors, fuel theft, and prolonged waiting times for customers. This project presents
an Automated Petrol Pump System integrated with RFID technology and powered by Solar Energy to provide a secure, cashless, and self-sufficient solution.
The system utilizes an Arduino microcontroller to manage the entire dispensing process. Users are issued unique RFID cards containing prepaid balance information. Upon swiping the card at the station, the RFID reader verifies credentials and displays the available balance on a 16x2 LCD. The user enters the desired fuel amount via a 4x4 keypad, and if sufficient funds are available, the microcontroller triggers a Relay Module to activate the pump. The pump automatically shuts off once the precise amount is dispensed, and the transaction value is deducted from the card in real-time.

1. INTRODUCTION

The RFID-Based Petrol Pump Automation system represents a significant shift toward digital infrastructure by integrating contactless identification with renewable energy.
Traditionally, fuel stations have relied heavily on manual lab or for dispensing fuel and handling cash, which often leads to inaccuracies, potential fraud, and operational delays. By implementing Radio Frequency Identification (RFID), the system creates a secure, cashless environment where a user's unique tag is verified against a database before any fuel is released. This ensures that only authorized users with sufficient balance can access the pump, effectively eliminating the risk of human error or unauthorized fuel withdrawal.
Beyond the automation of transactions, the inclusion of a Solar Power System addresses the critical issue of energy dependency. Conventional pumps are vulnerable to power outages and require expensive grid connectivity or diesel generators to stay operational. By
utilizing photovoltaic panels, the system generates its own electricity to power the microcontroller, sensors, and pump motors. This stored energy allows the station to function autonomously, making it an ideal solution for remote or rural areas where the power grid is unreliable or non-existent.
Ultimately, this integrated approach focuses on creating a sustainable and self-sufficient fuelling station. It combines the precision of embedded systems with the environmental benefits of green energy. The result is a highly efficient, 24/7 operational model that reduces overhead costs for owners while providing a transparent and rapid service for consumers. It is a step toward the future of smart cities and automated transport infrastructure, where technology minimizes human intervention and maximizes resource efficiency.

2. OBJECTIV OF THE PROJECT

Objective:

1 Automation & Accuracy

- To develop a fully automated fuel dispensing system using RFID technology.
- To eliminate manual measurement errors and ensure exact fuel quantity delivery.
- To control fuel flow automatically using a microcontroller and relay system.

2 Security & Authentication

- To provide secure user identification through unique RFID cards.
- To prevent unauthorized fuel access and reduce fuel theft.
- To maintain a secure database of users and transactions.

3 Efficiency & Transparency

- To reduce waiting time at petrol pumps.
- To ensure transparent fuel transactions with display confirmation.

- To minimize human intervention and operational mistakes.

4 Solar Energy Integration

- To integrate a solar panel system for eco-friendly power generation.
- To reduce dependency on conventional grid electricity.
- To ensure continuous system operation during power failures.
- To lower electricity costs and promote renewable energy usage.

5 Cost & Practical Implementation

- To design a low-cost and easily implementable system.
- To make the system suitable for rural and remote areas.
- To create a scalable model for future smart fuel stations.

6 Environmental & Safety Goals

- To reduce carbon footprint by using solar energy.
- To improve operational safety by reducing manual handling.
- To support sustainable and smart energy management systems

3. LITERATURE SURVEY

In simple terms, the RFID-Based Petrol Pump Automation with Solar Power is a project designed to make fuel stations smarter and more independent.

At its core, it solves two big problems: human error and power dependency. Instead of a person manually filling your tank and taking cash, you use a pre-loaded RFID card. When you tap this card, the system instantly identifies you and checks if you have enough money. Once you enter the amount you want, the pump's brain—usually an Arduino or microcontroller— automatically starts the motor and stops it at the exact millilitre. This makes the whole process faster, safer, and impossible to cheat.

What makes this system truly unique is the solar power part. Traditional petrol pumps need a constant supply of electricity from the city grid to work. If the power goes out, the pump stops. By adding solar panels, this system creates its own electricity from the sun. This power is stored in batteries, allowing the pump to work 24/7, even in remote areas where there are no power lines. It's an eco-friendly way to run a business while cutting down on expensive electricity bills.

Together, these technologies create an unmanned fuel station that doesn't need a staff member to stand there all day or a connection to the power grid to stay running. It's a cleaner, more efficient, and completely automated way to manage one of our most important resources.

3.1 Fundamental Concept

The core theory of this system is to replace the human-operated, cash-based refueling model with a **(M2M) interaction**. By using RFID (Radio Frequency Identification) technology, the system establishes a digital identity for every user. This allows for a "tap-and-go" experience where authentication, balance verification, and fuel dispensing happen in a synchronized loop controlled by a central microcontroller like an Arduino.

3.2 Working Mechanism

The theoretical operation follows a specific logical sequence:

- Authentication Phase: The RFID reader emits radio frequency waves. When a passive RFID tag (the user's card) enters this field, it powers up and transmits its unique ID. The microcontroller compares this ID against a pre-stored database.

- Transaction Phase: Once verified, the user interacts via a keypad and LCD. The system calculates the exact pulse duration required for the fuel pump motor to deliver the requested volume of fuel.

and it is the cyclical effect that occurs when alternating current passes through a load that contains a reactive component. The presence of reactive power causes the real power to be less than the apparent power, so the electric load has a power factor of less than one

- Execution Phase: A relay acts as an electronic switch, opening the fuel line only for the calculated duration. Simultaneously, the system updates the digital ledger to reflect the new balance.

4. PROBLEM STATEMENTS

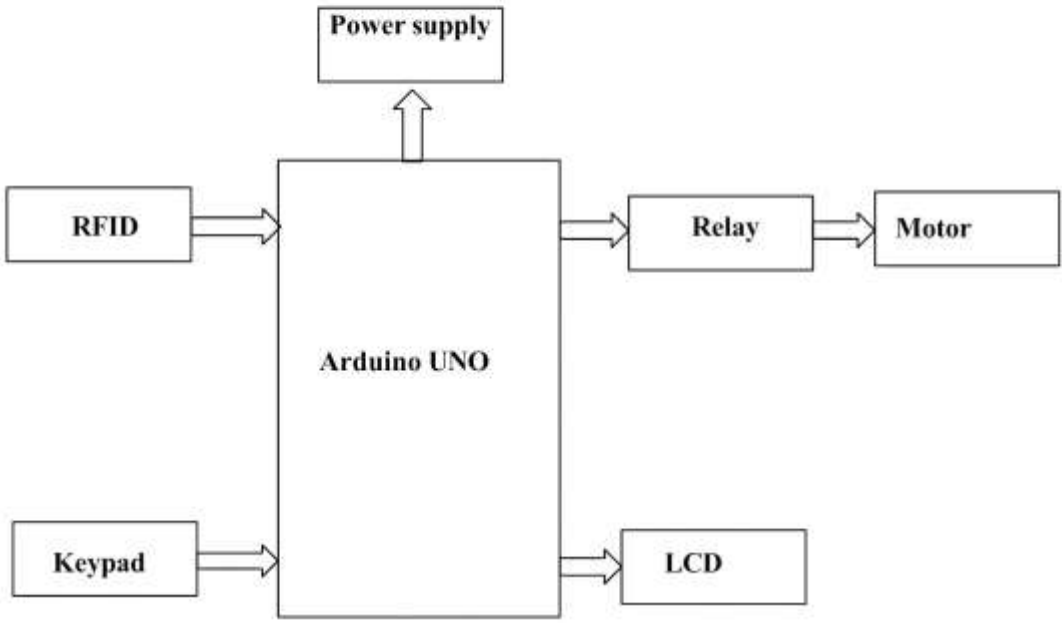
Traditional petrol pumps depend on manual operation, which can cause fuel inaccuracies, human errors, and lack of transparency. They also rely on grid electricity, which may be unreliable in some areas.

To solve this, an **RFID-based petrol pump automation system with solar power** is needed to ensure accurate fuel dispensing, secure user identification, reduced human effort, and continuous operation using renewable energy

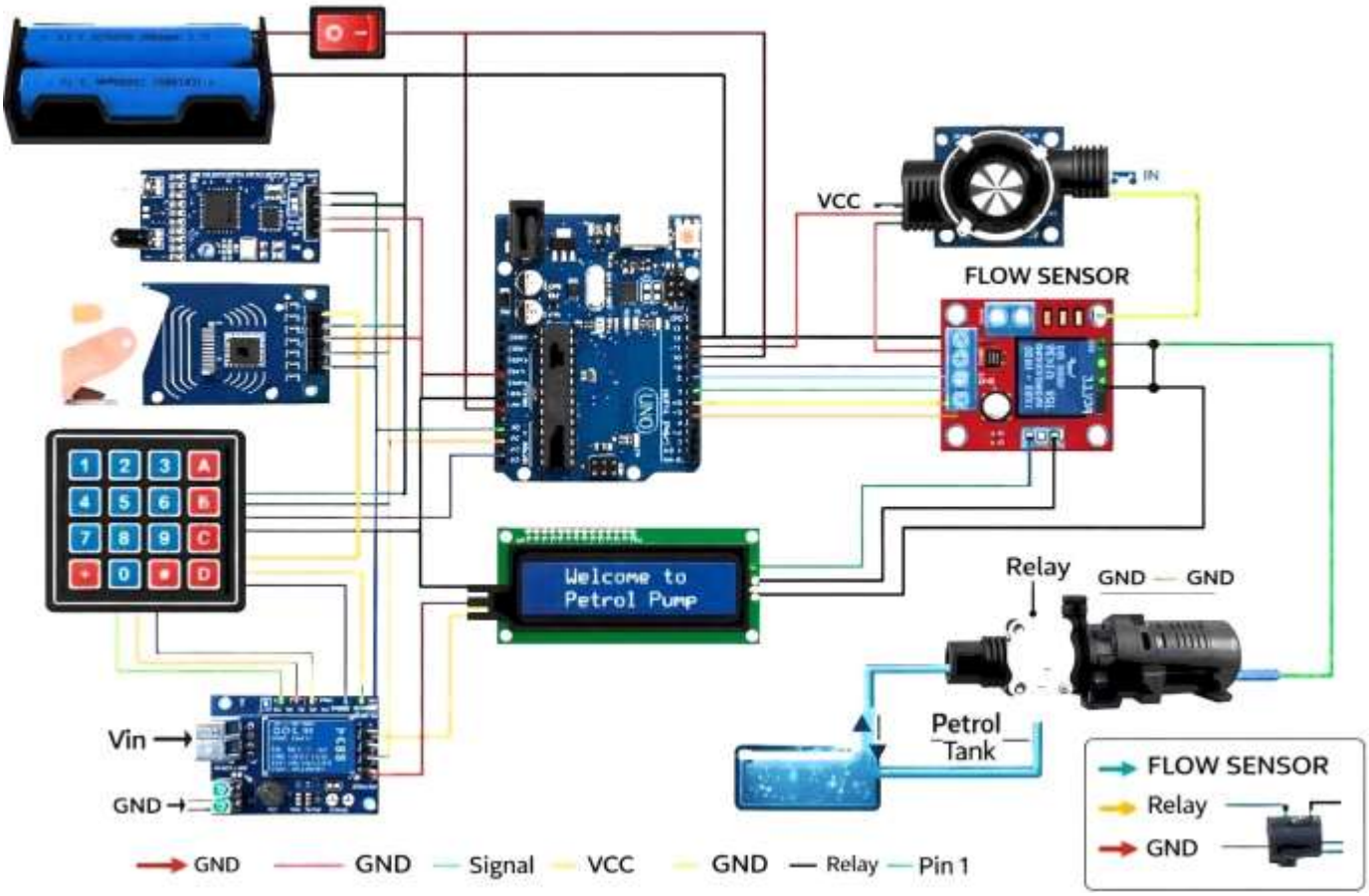
Key Objectives:

1. Manual system → chances of fuel fraud & human error
2. Inaccurate fuel dispensing
3. Long waiting time at petrol pumps
4. No secure user identification system
5. Dependence on electricity (power cuts issue)
6. High operational cost
7. Lack of automation and transparency

5. PROPOSED SYSTEM MODEL



6. CIRCUIT DIAGRAM



7. ADVANTAGES

1. Automatic Operation:
Water pump operates only when the user is authenticated, reducing manual effort.
2. Secure Access Control:
Only authorized users with an RFID card or correct keypad PIN can activate the pump.
3. Eco-Friendly Power:
Solar panel provides renewable energy, reducing dependency on the grid and saving electricity costs
4. Battery Backup:
System continues to operate even when sunlight is not available, ensuring uninterrupted water supply.
5. Prevents Water Wastage:
Pump runs only when needed, improving efficiency and conserving water.
6. User Feedback:
LCD and buzzer give real-time notifications, improving usability

8. CONCLUSION

The petrol pump system effectively demonstrates safe and efficient fuel dispensing to vehicles. It ensures accurate measurement of fuel using a flow meter and allows convenient refuelling for cars, motorcycles, trucks, and buses. The system combines storage, pumping, and dispensing mechanisms to provide reliable fuel supply while maintaining safety standards.

Key points:

Ensures accurate and controlled fuel delivery.
Can handle large volumes of fuel efficiently.
Designed to reduce manual errors and improve operational convenience.
Safety measures such as filters and proper storage prevent contamination and hazards.