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Study of Solar Powered Vending Machine

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Abstract

Over the past few years, there has been an emergence of vending machines that provide a wide range of products, including drinks, chocolates, and even medical supplies. However, access to first aid kits remains scarce in many public areas such as schools and transportation hubs. This paper proposes a solution in the form of a solar-powered, RFID-based vending machine aimed at dispensing essential first aid supplies and stationery items. The system combines an Arduino Uno microcontroller with an RFID reader to ensure secure and automated dispensing of items. By using renewable energy, this machine not only increases accessibility and efficiency but also reduces reliance on traditional power sources. Recent advancements highlight the growing trend toward automatic and solar-powered vending systems, reducing the need for manual operations while boosting energy efficiency (Kumar et al., 2020).

INTRODUCTION

Vending machines are automated systems designed to distribute products such as snacks, beverages, or lottery tickets. These machines are widely popular because they help reduce manual labor and save time. Vending machines can be categorized into two main types: IoT-based and non-IoT-based machines. Traditional vending machines generally rely on cash or credit transactions, controlled by microcontrollers. On the other hand, IoT-enabled vending machines support cashless payments, remote monitoring, and real-time inventory tracking (Haxhimehmeti & Besimi, 2020). The integration of IoT and machine learning technologies helps improve customer service and operational productivity. This study introduces a solar-powered vending machine that offers first aid kits and stationery, primarily designed for use in educational institutions and professional environments.

PROPOSED SYSTEM

The proposed system is centered around an Arduino Uno microcontroller, which serves as the core controller for the system. An RFID reader and tag system are integrated for secure user authentication. The vending process begins when a user scans an RFID card and selects an item, after which the corresponding product is dispensed using a motorized system. Due to the limited current capacity of the Arduino, an external motor driver circuit is utilized to power the motor, which is connected to a spiral ring to release the selected item smoothly (Chavan et al., 2020). This vending machine is powered by solar energy, utilizing stored power when needed to reduce dependence on conventional power sources.

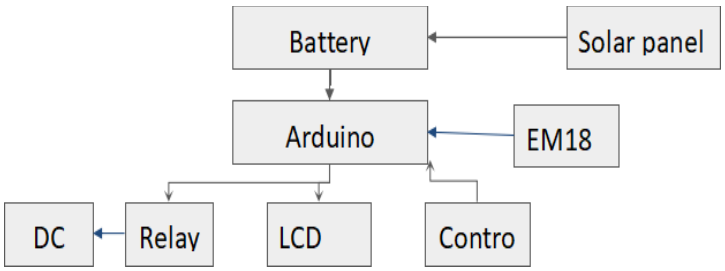

Fig.1 Block Diagram

EXISTING SYSTEM

Traditional vending machines usually operate with microcontrollers or processors and involve cash transactions through coin slots, creating potential security risks, such as the acceptance of counterfeit coins (Srihari & Sivakumar, 2020). Moreover, these systems often require complex programming and regular maintenance. The proposed vending machine resolves these issues by integrating RFID-based authentication for more secure and streamlined transactions. The incorporation of solar energy ensures continuous operation, even in areas with unreliable electrical supplies.

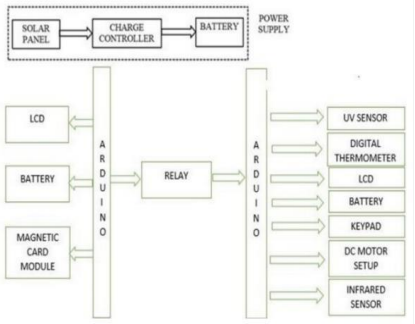

Fig.2 Existing System

ARDUINO

The Arduino Uno is an 8-bit microcontroller board built on the ATMega328P chip, offering 14 digital input/output pins, 6 analog inputs, and USB connectivity. The microcontroller processes inputs from the user interface and manages the motorized dispensing mechanism. In this system, a DSIBINO_V1 Arduino clone is employed, which operates on either AC or DC 12V power supply and features built-in LEDs for debugging purposes (Marques Ximenes et al., 2020). This choice ensures cost-effectiveness and stable performance.

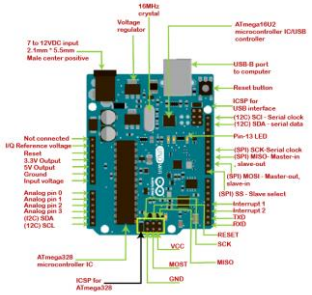

Fig.3 Arduino

RFID READER

An RFID reader is utilized to authenticate users by scanning RFID tags. The reader emits radio waves that interact with the tag, which then sends back its unique identification information. The range of the reader depends on several factors such as frequency, antenna characteristics, and tag positioning (Villarejo et al., 2020). In this system, an MDRC522 RFID module is used, interfaced with the Arduino via a level-shifting circuit to ensure compatibility. This system enables smooth user authentication and secure transaction logging.

Fig.4 RFID Reader

SYSTEM FRAMEWORK DESIGN

The vending machine is designed to dispense two categories of products: first aid items and stationery supplies. Users can select an item by pressing a button corresponding to their choice. Once the RFID card is scanned, the LCD screen displays the price and availability of the item.
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The microcontroller then activates the motor driver to dispense the product while updating the inventory status, and the remaining balance is shown on the LCD screen (Naveenraj et al., 2020). The integration of RFID authentication ensures secure transactions and prevents unauthorized access to the system

Fig.5 Circuit Diagram

ADVANTAGES

1. User-Friendly: The vending machine reduces the need for human involvement, allowing users to independently access the products.
2. Energy Efficiency: Solar energy integration reduces operational costs and supports sustainability.
3. Security: RFID-based authentication enhances transaction security and prevents unauthorized access.
4. Time Efficiency: Users can quickly access needed items, reducing waiting time.

CONCLUSION

This RFID-based vending machine offers an innovative solution for dispensing first aid and stationery supplies in public and institutional spaces. By using RFID technology for secure user authentication and a motorized system for item dispensing, the machine ensures smooth and efficient operation. The design is cost-effective, portable, and energy-efficient, making it a viable alternative to traditional vending systems. The integration of solar power contributes to its sustainability, and the use of RFID enhances security. Future improvements may incorporate machine learning algorithms to predict demand patterns and optimize inventory management (Mitrofanov et al., 2020).

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