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Smart Vending Machine System Using IOT

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Abstract - A smart vending machine system is proposed in this paper, utilizing IoT, UPI, RFID, product level detection, and GPS/GPRS notification to deliver a vending experience that is more convenient, secure, and efficient for both customers and operators. User authentication is achieved through RFID, and payment transactions are facilitated by UPI, allowing customers to make payments easily without the need for cash or cards. Product level detection ensures continuous availability of items, and when product levels drop below a predefined threshold, notifications are sent to the vending machine operator via GPS and GPRS, enabling prompt restocking.

Several advantages are offered to vending machine operators by the system. The real-time monitoring and management capabilities of the IoT platform enable operators to track inventory levels, sales data, and machine status remotely. This information can be utilized to optimize product mix and pricing, reduce operational costs, and enhance customer satisfaction. In summary, the potential of revolutionizing the vending machine industry lies in the proposed smart vending machine system. Through providing a more convenient and secure customer experience, lowering costs for operators, and offering valuable insights into customer behavior, IoT-enabled vending machines have the capability to boost sales and profitability.

Key Words: **S**mart vending machine, IoT, UPI, RFID, product level detection, GPS/GPRS notification.

1.INTRODUCTION

Vending machines have been around for many years, but they are still a popular way to purchase food and drinks. However, traditional vending machines have a number of limitations. For example, they can only accept cash payments, and they can be difficult to restock.

Smart vending machines using IoT address these limitations by offering a more convenient, secure, and efficient vending machine experience for both customers and operators. Smart vending machines use IoT sensors to collect data about the machine, such as inventory levels, temperature, and machine status. This data is then sent to the cloud, where it can be analyzed by vending machine operators. Vending machine operators can use the data collected from smart vending machines to track inventory levels, optimize the product mix and pricing, reduce costs, and improve customer satisfaction.

In addition, smart vending machines offer a more convenient and secure customer experience. For example, customers can use mobile apps to browse the machine's inventory, make payments, and even pre-order items. Smart vending machines can also be used to offer loyalty programs and other incentives to customers.

Overall, smart vending machines have the potential to revolutionize the vending machine industry. By offering a more convenient and secure customer experience, reducing costs for vending machine operators, and providing valuable insights into customer behavior, IoT-enabled vending machines can help to increase sales and profitability.

2. PROPOSED METHOD

The proposed method for the smart vending machine system project is to use a Raspberry Pi 3 Board to collect data from RFID tags and other sensors, and to send this data to the cloud for processing and analysis. The cloud-based system will then use this data to control the vending machine, such as by dispensing products, accepting payments, and sending notifications to operators.

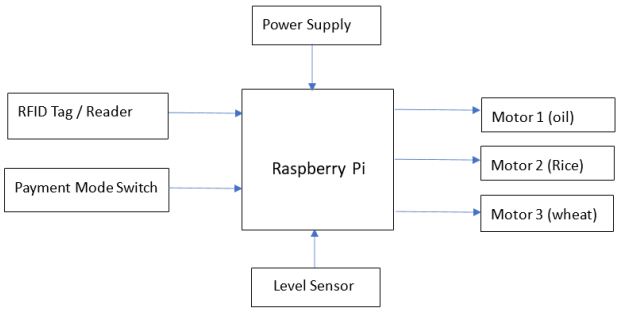


Fig 1. Block Diagram

2.1 Hardware

2.1.1 Raspberry Pi 3 Board

Pi is a credit-card sized computer that connects to a computer monitor TV and uses input devices like keyboard

and mouse. It is capable of performing various functionalities such as surveillance system, military applications, surfing internet, playing high-definition videos, live games and to make data bases. Raspberry Pi is the main controller in our project which gathers data from the input modules and transmits it to the output modules.

Specifications:

Microprocessor	Broadcom BCM2837 64bit Quad Core Processor
Processor Operating Voltage	3.3V
Raw Voltage input	5V, 2A power source
Maximum current through each I/O pin	16mA
GPU	Dual Core Video Core IV® Multimedia Co-Processor. Provides Open GLES 2.0, hardware-accelerated Open VG, and 1080p30 H.264 high- profile decode.
Internal RAM	1Gbytes DDR2
Clock Frequency	1.2GHz
Operating Temperature	-40ºC to +85ºC
Wireless Connectivity	BCM43143 (802.11 b/g/n Wireless LAN and Bluetooth 4.1)
Ethernet	10/100 Ethernet

Fig 2. Raspberry Pi

2.1.2 RFID

RFID stands for Radio-Frequency Identification, and an RFID tag is a small device that uses radio waves to store and transmit data. RFID tags consist of a microchip and an antenna. They are used for various purposes, including tracking and identifying objects, animals, or people.

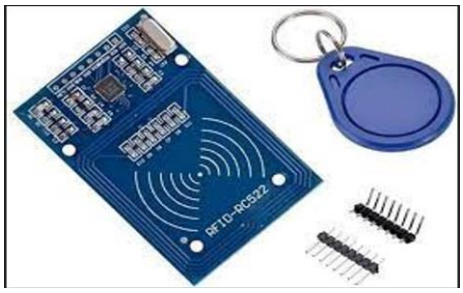


Fig 3. RFID

2.1.3 UPI

UPI, which stands for Unified Payments Interface, is a popular digital payment mode in India. It is a real-time payment system that enables people to send and receive money using their smartphones. UPI allows for interbank transactions and offers several benefits, including instant fund transfers, 24/7 availability, and simplified transactions. Here are some key points about UPI

Fig 4. UPI

2.1.4 Level Sensor

A level sensor is a device used to detect and measure the level of a substance, usually a liquid or granular material, in a container or a specific location. Level sensors are widely used in industrial, commercial, and residential applications to monitor and control the amount of a substance in a tank, silo, or other storage vessel. There are various types of level sensors, each with its own principles of operation and suitable applications.

2.1.5 DC Motor

A DC Motor is an electric motor that runs on direct current power. In any electric motor, operation is dependent upon simple electromagnetism. A current carrying conductor generates a magnetic field, when this then placed in an external magnetic field it will encounter a force proportional to current in the conductor and to strength of external magnetic field. A DC Motor provide excellent speed control for acceleration and deceleration. It is easy to understand, simple and has cheap drive design.

Specifications:

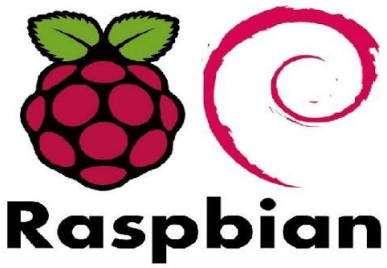
Standard	130 Type DC motor
Operating Voltage	4.5V to 9V
Recommended/Rated Voltage	6V
Current at No load	70mA (max)
No-load Speed	9000 rpm
Loaded current	250mA
Motor Size	27.5mm x 20mm x 15mm
Weight	17 grams

Fig 5.DC Motor

2.2 Software Components

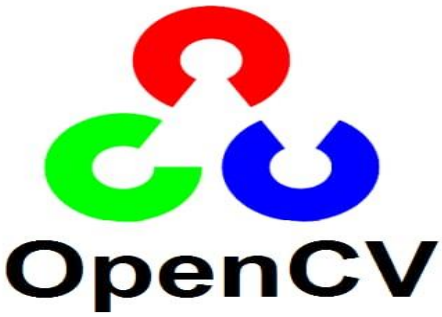
2.2.1 Raspbian OS

This provides significantly faster performance for applications that make heavy use of floating-point arithmetic operations. All other applications will also gain some performance through the use of advanced instructions of the ARMv6 CPU in Raspberry Pi. Although Raspbian is primarily the efforts of Mike Thompson (MP Thompson) and Peter Green (plug wash), it has also benefited greatly from the enthusiastic support of Raspberry Pi.



2.2.2 Open CV

Open CV (Open-Source Computer Vision) is a library of programming functions mainly aimed at real- time computer vision originally developed by Intel. The library is cross platform and free for use under the open-source BSD license OpenCV supports deep learning frameworks TensorFlow, Torch/PyTorch and Cafe.



3.METHODOLOGY

1. **Hardware Development**: The first step is to develop the hardware for the smart vending machine system. This will involve designing and prototyping the following components:
    - Vending machine hardware
    - IoT sensors
    - Communication modules

The vending machine hardware should be designed to be robust and withstand the demands of the vending machine environment. The IoT sensors should be able to accurately detect product levels and other environmental conditions. The communication modules should be able to transmit data to the cloud reliably and securely.

2. **Algorithms:** The following algorithms will be used in the smart vending machine system:

- **Product level detection algorithm**: This algorithm will use the data from the IoT sensors to detect product levels in the vending machine.
- **User authentication algorithm**: This algorithm will use the RFID tags to authenticate users.
- **Payment processing algorithm**: This algorithm will process contactless payments using UPI.

4. Literature Review

Title	Author	Methodology
RFID Technology: Beyond Cash-Based Methods in Vending Machine	Aneeqa Ramzan, Saad Rehman, Aqib Perwaiz	The methodology integrates passive RFID cards and Arduino Mega with SPI protocol for secure authentication, featuring keypad password protection, LCD consumer information display, GSM-based SMS notifications, and a mechanical structure with DC motors for efficient product-oriented vending.
Modeling and Optimization of Item Changes in Vending Machines	Gaku Nemoto, Kunihiko Hiraishi	This study focuses on optimizing item changes in Japanese beverage vending machines, with route men responsible for replenishment. Using an optimization model based on item utility values and vending machine state transitions, it achieves up to a 2.8% sales improvement compared to heuristic methods.
NuiVend - Next Generation Vending Machine	Robert Gruen, Erich Liang	In this paper, we will discuss NuiVend's use of a variety of technologies. Such as: Microsoft Kinect, various Microsoft Cognitive API services, relay and sensor boards, as well as the overall logic of the control software. Finally, we discuss potential improvements to NuiVend as well as Microsoft Language Understanding Intelligent Service (LUIS) techniques that can be applied to many other future NUI based projects.

5.APPLICATIONS

- **Retail Stores:** Offer smart vending solutions within retail spaces, providing a wide range of products and real-time inventory updates.
- **Corporate Offices:** Install intelligent vending machines in office buildings for snacks, beverages, and office supplies.
- **Manufacturing Facilities:** Offer employee access to snacks and personal protective equipment in industrial settings.

6. CONCLUSIONS

We utilised IOT technology in this article to create a sales mechanism for smart vending machines. It may comprehend vending machine purchasers and markets. Face recognition is used to analyse the vending machine's principal source in order to alter sales and so achieve a larger profit.

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