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Token-Based Vending Machine

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Abstract- **Token-based vending machines have become increasingly popular due to their convenience and security. These machines require the user to authenticate themselves before dispensing a product or service. In this project, we propose a token-based vending machine that uses an Arduino Uno microcontroller, three push buttons, three 5V DC motors, and an RFID RC522 module. The user initiates the authentication process by pressing a push button. If the authentication is successful, the respective motor is turned on to dispense the product. The use of RFID authentication makes the process more secure and efficient. The proposed vending machine provides a simple and reliable solution for dispensing products or services. This project can be further improved for various applications in transportation, retail, healthcare, and other industries. Overall, the proposed vending machine provides a promising solution for dispensing products or services in a secure and efficient manner. improve access to products and services while also promoting cashless payment options.**

KEYWORD- Token-based vending machine, Arduino Uno, RFID RC522, Authentication, Dispensing.

I. INTRODUCTION

Since the 18th century, vending machines have been in use. They have been used to dispense a variety of items, including soda cans, cigarettes, money, water, sweets, and toys. The ATM is a well-known example of a vending machine that makes use of engineering principles. The concept behind this initiative is to sell a set or predetermined number of papers in exchange for the insertion of a Rs. 10 coin. Reduced workloads for both customers and those working in stationery are the goal. This device also includes an integrated mechanism that easily guides users to their desired location.

Vending machines are widely used for dispensing products or services, such as beverages, snacks, tickets, etc. Traditional vending machines require the user to insert coins or bills to get the product or service. However, the advent of token-based vending machines has made the process more convenient and secure. In this project, we propose a token-based vending machine that uses RFID authentication to dispense products or services.

Can feeder stack columns or feeder trays are positioned inside the machine to store and dispense items. A substantial revolving wire spiral holds the goods in place on each tray. For simple maintenance and product replenishment, feeder trays slide in and out of the machine. The motor controls that physically move the items forward until they are released from the stack and fall to the access area are likewise housed in the feeder stacks and trays. A rotor moves a single item when a client picks a product, dumping cans or bottles one at a time. Similar spirals twist and push goods forward on snack food trays until they drop off the tray. Some vending machines, particularly those that sell cold drinks, locks, and hinges to deter theft and vandalism.

The earliest known reference to a vending machine is in the work of Hero of Alexandria, an engineer and mathematician in first-century Roman Egypt His machine accepted a coin and then dispensed holy water. The first modern coin-operated vending machines were introduced in London, England in the early 1880s, dispensing postcards.

The machine was invented by Percival Everitt in 1883 and soon became a widespread feature at railway stations and post offices, dispensing envelopes, postcards, and notepaper. The Sweetmeat Automatic Delivery Company was founded in 1887 in England as the first company to deal primarily with the installation and maintenance of vending machines. In 1893, Stoll, a German chocolate manufacturer, was selling its chocolate in 15,000 vending machines. It set up separate companies in various territories to manufacture vending machines to sell not just chocolate, but cigarettes, matches, chewing gum, and soap products. Internal communication in vending machines is typically based on the MDB standard, supported by National Automatic Merchandising Association (NAMA) and European Vending & Coffee Service Association (EVA).

II. PROBLEM STATEMENT

While using RFID (Radio Frequency Identification) technology in vending machines has many advantages, there are also some potential difficulties that need to be taken into consideration. The expense of installing RFID technology, which can be significant for small or medium-sized vending machine operators, is one of the key issues. In addition, the technology needs a lot of upkeep and care to perform well, which can be difficult for operators without the resources or technical know-how to handle the equipment well. Another problem is the potential for security lapses or system breakdowns, which might lead to lost sales or compromised client information. The use of RFID technology to track consumer behaviour and purchasing habits may also raise privacy concerns.As a result, it is crucial for vending machine owners to carefully analyse the potential difficulties and hazards involved with using RFID technology, and to take the necessary action to reduce these risks and guarantee a successful deployment.

III. OBJECTIVES

To increase the effectiveness and convenience of vending operations, RFID (Radio Frequency Identification) technology is increasingly being used in vending machines. RFID technology can assist vending machine owners in streamlining their operations and enhancing the overall consumer experience by facilitating speedier transactions, minimising cash handling, and boosting inventory management. Customers may quickly and simply buy things from vending machines using RFID-enabled payment cards or mobile wallets without having to deal with cash, while operators can keep an eye on inventory levels and track sales data to make the best choices for product placement and placement. Additionally, vending machine operators can remotely monitor and maintain their equipment, quickly identifying and resolving problems without having to physically visit every machine, thanks to RFID technology. RFID technology is gaining popularity among vending machine operators who want to streamline their operations and maintain market competitiveness since it improves operational efficiency and the entire consumer experience.

IV. METHODOLOGY

An RFID vending machine is a specific type of vending machine that enables cashless transactions using radio-frequency identification (RFID) technology. The following is the procedure for using an RFID vending machine:

1. Customers receive an RFID card or tag: Customers must first obtain an RFID card or tag in order to use an RFID vending machine. These can be purchased from the person who operates the vending machine or from a specific location.

2. Customers add money to the RFID card or tag: After purchasing an RFID card or tag, customers must add money to it. Either a specialised vending machine or an online gateway can be used for this.

3. Clients bring the RFID card or tag up to the scanner of the device: When customers are prepared to make a purchase, they place their RFID card or tag near the machine's reader. 3. Customers place the RFID card or tag near the machine's reader. The customer is then identified by the reader, along with any remaining funds on the card or tag.

4. Customers choose the desired product or service: Following recognition of the RFID card or tag, customers can choose the desired good or service via the vending machine's interface.

5. The machine dispenses the item: After the consumer has made their choice, the vending machine dispenses the item. The customer's RFID card or tag is automatically used to cover the cost of the purchase.

6.Customers may add additional funds: If a customer's RFID card or tag balance is low, they can add extra money via the same online portal or a specific vending machine.

In addition to other places, such as workplaces, public spaces, and schools, RFID vending machines are common. Customers can buy goods or services from them conveniently and without using cash, which also lessens the demand for actual money. Utilising RFID technology also makes sure that only legitimate transactions are acknowledged and helps to avoid fraud.

Sensors and Controllers

1. **Arduino Uno microcontroller**

The microcontroller used is Atmega 328.The Atmel 8-bit AVR RISC-based microcontroller combines:32 kB ISP flash memory with read-while-write capabilities 1 kB EEPROM, 2 kB SRAM,23 general purpose I/O lines, 32 general purpose working registers, 3 flexible, timer/counter with compare modes, internal and external interrupts, Serial programmable USART, A byte-oriented 2-wire serial interface, SPI serial port, 6-channel 10-bit A/D converter (8-channels in TQFP and QFN/MLF packages),programmable watchdog timer with internal oscillator, Five software selectable power saving modes, operating frequency of 20MHz.

Fig 1: Arduino Uno

2. DC Motor

A DC motor is any of a class of electrical machines that converts direct current electrical power into mechanical power. The most common types rely on the forces produced by magnetic fields. Nearly all types of DC motors have some internal mechanism, either electromechanical or electronic; to periodically change the direction of current flow in part of the motor. In this system, the DC Motor of operational voltage and Most types produce rotary motion; a linear motor directly produces force and motion in a straight line. Current: - 12V, 5A is used. The speed is 500rpm.

Fig 2: DC Motor

3. RFID RC522

This RC522 RFID Card Reader Module 13.56MHz is a low-cost MFRC522 based RFID Reader Module is easy to use and can be used in a wide range of applications. The MFRC522 is a highly integrated reader/writer IC for contactless communication at 13.56 MHz. 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 devices2 RFID RC522.

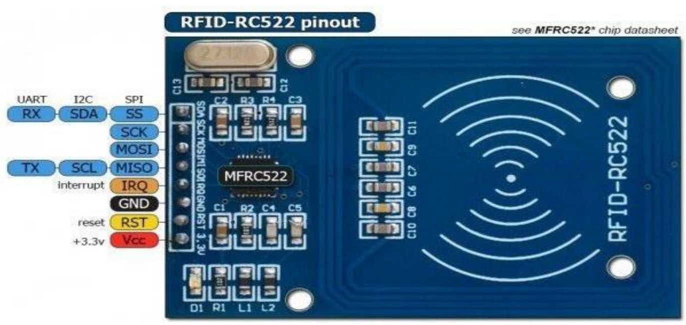

Fig 3: RFID RC522

4. L298N Motor Drive

At the center of the module is a big, black chip with a chunky heat sink – the L298N. The L298N chip contains two standard H-bridges capable of driving a pair of DC motors, making it ideal for building a two-wheeled robotic platform.The L298N motor driver has a supply range of 5V to 35V and is capable of 2A continuous current per channel, so it works very well with most of our DC motors.

Fig 4: L298N Motor Drive

5. LCD Monitor

Liquid Crystal Display (LCD) screen is an electronic display module and finds a wide range of applications. A 16 x 2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over other seven segments and other multi segment LEDs. The reason being LCDs are economical, easily programmable, have no limitation of displaying special and even custom characters(unlike 7 segments),animation and so on.

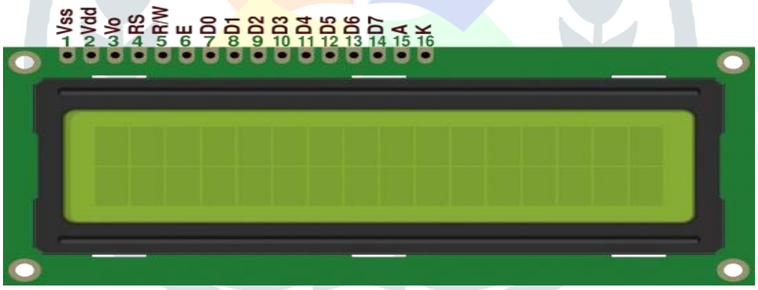

Fig 5: LCD Display

6. PCB Breadboard

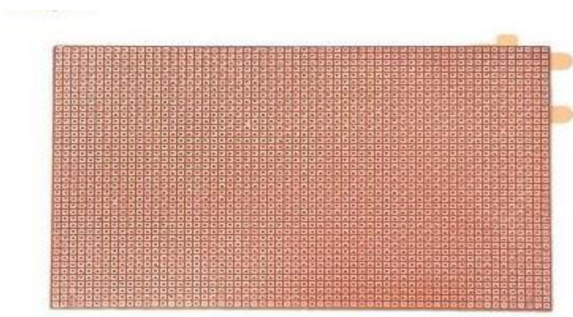

Fig 6: PCB Breadboard

Prototyping boards have holes to which you affix electronic components to build your desired circuit. These components can beattached with or without solder depending on the type of board. It is always recommended to test your circuit diagram first. There are many electronics prototyping boards available in the market.

V. Software Coding

```
#include <Wire.h>
#include <LiquidCrystal_I2C.h>
#include <SPI.h>
#include <MFRC522.h>

#define RST_PIN 9
#define SS_PIN 10

const int motor1EnablePin = 3;
const int motor1Input1Pin = 2;
const int motor1Input2Pin = 4;
const int motor2EnablePin = 5;
const int motor2Input1Pin = 7;
const int motor2Input2Pin = 8;
const int motor3EnablePin = 0;
const int motor3Input1Pin = 1;
const int motor3Input2Pin = 6

;
const int button1Pin = A0;
const int button2Pin = A1;
const int button3Pin = A2;

MFRC522 mfrc522(SS_PIN, RST_PIN);  // Create MFRC522 instance

LiquidCrystal_I2C lcd(0x27, 16, 2); // Set the LCD address to 0x27 for a 16x2 display

void setup() {
  pinMode(motor1EnablePin, OUTPUT);
  pinMode(motor1Input1Pin, OUTPUT);
  pinMode(motor1Input2Pin, OUTPUT);
  pinMode(motor2EnablePin, OUTPUT);
  pinMode(motor2Input1Pin, OUTPUT);
  pinMode(motor2Input2Pin, OUTPUT);
  pinMode(motor3EnablePin, OUTPUT);
  pinMode(motor3Input1Pin, OUTPUT);
  pinMode(motor3Input2Pin, OUTPUT);

  pinMode(button1Pin, INPUT_PULLUP);
```

```
  pinMode(button2Pin,  INPUT_PULLUP);
  pinMode(button3Pin, INPUT_PULLUP);

  Serial.begin(9600);
  SPI.begin();
  mfrc522.PCD_Init();              // Initialize MFRC522

  lcd.init();                    // Initialize the LCD
  lcd.backlight();                // Turn on the backlight
  lcd.setCursor(0, 0);
  lcd.print("VENDING MACHINE");
  // Display a message on the LCD

}

void loop() {
  bool authenticate(), allButtonsOff = digitalRead(button1Pin) && digitalRead(button2Pin) && digitalRead(button3Pin);

  if (allButtonsOff) {
    lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print("VENDING MACHINE");
    delay(150);


  }
  else {
    if (digitalRead(button1Pin) == LOW) {
    lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print("SCAN RFID");         // Show "SCAN RFID" on LCD
     // Wait for RFID tag to be presented
    while (!mfrc522.PICC_IsNewCardPresent() || !mfrc522.PICC_ReadCardSerial()) {
      delay(100);
    }
      if (authenticate()) {
        lcd.clear();
        lcd.setCursor(0, 0);
        lcd.print("Authentication");
```

```
      lcd.setCursor(0, 1);
      lcd.print("successful!");
      digitalWrite(motor2Input1Pin, HIGH);
      digitalWrite(motor2Input2Pin, LOW);
      analogWrite(motor2EnablePin, 500);
      delay(2000);
      analogWrite(motor2EnablePin, 0);
      delay(200);
      lcd.clear();
     lcd.setCursor(0, 0);
     lcd.print("KITKAT DISPENSED");
     delay(2000);
     lcd.clear();
     lcd.setCursor(0, 0);
     lcd.print("SUCESSFUL");
     delay(1000);
      lcd.clear();
      lcd.setCursor(0, 0);
      lcd.print("VENDING MACHINE");

      // Keep all other motors off
      digitalWrite(motor1EnablePin,LOW);
      digitalWrite(motor3EnablePin, LOW);
     } else {
      lcd.clear();
      lcd.setCursor(0, 0);
      lcd.print("RFID ERROR");
      lcd.setCursor(0, 1);
      lcd.print("ACCESS DENIED");
      delay(2000);
      }

    }
else if (digitalRead(button2Pin) == LOW) {
lcd.clear();
lcd.setCursor(0, 0);
 lcd.print("SCAN RFID");          // Show "SCAN RFID" on LCD
    // Wait for RFID tag to be presented
```

```
    while (!mfrc522.PICC_IsNewCardPresent() || !mfrc522.PICC_ReadCardSerial()) {
      delay(100);
    }
     if (authenticate()){
        lcd.clear();
        lcd.setCursor(0, 0);
        lcd.print("Authentication");
        lcd.setCursor(0, 1);
        lcd.print("successful!");
        digitalWrite(motor1Input1Pin, HIGH);
        digitalWrite(motor1Input2Pin, LOW);
        analogWrite(motor1EnablePin,500);
        delay(2000);
        analogWrite(motor1EnablePin, 0);
        delay(200);
        lcd.clear();
        lcd.setCursor(0, 0);
        lcd.print("OREO DISPENSED");
        delay(2000);
        lcd.clear();
        lcd.setCursor(0, 0);
        lcd.print("SUCESSFUL");
        delay(1000);
         // Keep all other motors off
        digitalWrite(motor2EnablePin, LOW);
        digitalWrite(motor3EnablePin, LOW);
  } else {
    lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print("RFID ERROR");
    lcd.setCursor(0, 1);
    lcd.print("ACCESS DENIED");
    delay(2000);
  }
}
else if (digitalRead(button3Pin) == LOW) {
  lcd.clear();
lcd.setCursor(0, 0);
```

```
lcd.print("SCAN RFID");          // Show "SCAN RFID" on LCD
    // Wait for RFID tag to be presented
   while (!mfrc522.PICC_IsNewCardPresent() || !mfrc522.PICC_ReadCardSerial()) {
     delay(100);
   }
    if (authenticate())
  {
   lcd.clear();
   lcd.setCursor(0, 0);
   lcd.print("Authentication");
   lcd.setCursor(0, 1);
   lcd.print("successful!");
   digitalWrite(motor3Input1Pin, HIGH);
   digitalWrite(motor3Input2Pin, LOW);
   analogWrite(motor3EnablePin, 500);
   delay(2000);
   analogWrite(motor3EnablePin, 0);
   delay(200);
   lcd.clear();
   lcd.setCursor(0, 0);
   lcd.print("ECLAIRS DISPENSED");
     delay(2000);
     lcd.clear();
     lcd.setCursor(0, 0);
     lcd.print("SUCESSFUL");
     delay(1000);
       lcd.clear();
       lcd.setCursor(0, 0);
       lcd.print("VENDING MACHINE");
   // Keep all other motors off
   digitalWrite(motor1EnablePin, LOW);
   digitalWrite(motor2EnablePin, LOW);
 }
 else {
   lcd.clear();
   lcd.setCursor(0, 0);
   lcd.print("RFID ERROR");
   lcd.setCursor(0, 1);
```

```
    lcd.print("ACCESS DENIED");
    delay(2000);
  }
}
}
}

// Function for authenticating RFID tag
bool authenticate() {
  // Define known RFID tag UID
  byte knownUid[] = {0x89, 0x22, 0x39, 0x8D};
  // Check if presented tag UID matches known UID
  if (memcmp(mfrc522.uid.uidByte, knownUid, mfrc522.uid.size) == 0) {
    // If UID matches, return true
    return true;
  }
  else {
    // If UID does not match, return false
    return false;
  }
}
```

VI. Conclusion

RFID vending machines provide customers a cutting-edge and effective option to conduct cashless transactions. These vending machines can identify clients and deduct the cost of their purchase from their account using RFID technology, doing away with the need for real money. This offers a more practical and safe means of payment and helps lessen theft and fraud. In a number of locations, such as businesses, public spaces, and schools, RFID vending machines are becoming more and more common, and this trend is only expected to continue. The vending experience is improved for both customers and operators thanks to RFID vending machines, which provide a streamlined and creative alternative to the conventional vending machine paradigm.

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