RFID BASED SMART DOOR LOCK SYSTEM

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***Abstract*-- The paper presents an RFID door lock system utilizing ESP8266 and Blynk app for remote management. It combines the ease of remote monitoring and control via the Blynk platform with RFID technology for access control. The system consists of a Wi-Fi module, servo motor, and ESP8266 interfaced with an RFID reader. RFID tags are used to provide users access, and Blynk is the mobile interface that allows for real-time control and monitoring. Secure authentication, remote access control, and event logging are important features. The Blynk app facilitates effortless conFiguration and control of the system thanks to its integration. It offers an affordable and expandable way to improve security in both home and business environments. Performance evaluation shows that access control is dependable and effective. All things considered, the solution provides increased security and ease of use by fusing RFID technology with remote accessibility.**

Keywords:- ESP8266, RFID technology, Blynk app, RFID Reader,WIFI-Module.

I. INTRODUCTION

Innovative access control system development is now essential in an era marked by rapid technological innovation and growing security concerns. An effective solution for safe and practical access control in a variety of settings, from homes to businesses, is radio-frequency identification, or RFID technology. In this regard, the combination of Internet of Things (IoT) platforms and RFID technology offers a chance to improve the scalability, flexibility, and efficiency of access control systems.

This study examines the conception, creation, and deployment of an RFID door lock system that makes use of the Blynk mobile application platform and the ESP8266 microcontroller. The system offers a complete solution for contemporary access control needs by combining RFID technology, microcontroller capabilities, and Internet of Things-based remote management.

The necessity to solve the shortcomings of traditional access control systems such as laborious manual processes, constrained scalability, and a deficiency in real-time monitoring capabilities is what spurred this research. The suggested system seeks to address these issues while offering a seamless user experience and strong security measures by utilising RFID technology.

The system's primary component, ESP8266 microcontroller, allows for integration with Wi-Fi connectivity, door locking mechanism servo motor control, and RFID tag identification. Users can remotely access the door lock system and perform functions such as real-time monitoring, access management, and event logging from any location with internet availability by using the Blynk mobile application.

The purpose of this research study is to present a thorough analysis of the architecture, design factors, implementation specifics, and performance assessment of the RFID Door Lock System. This study aims to add to the body of knowledge in the areas of RFID technology integration, IoT applications, and access control systems by exploring the technical elements of system development.

Furthermore, the implementation and evaluation of the system have yielded useful insights that might guide future research endeavours and enable the adoption of comparable systems in many practical scenarios.

II. WHAT IS RFID TECHNOLOGY?

Radio-Frequency Identification (RFID) is an automatic identification system that uses electromagnetic fields to transfer data between a reader and an RFID tag. This technology is based on contactless communication and allows the storage and retrieval of information from objects, animals or people equipped with RFID tags. Here are some key points regarding the operation and use of RFID:

1. **Principle of operation:**
   - An RFID system is composed of a reader (or interrogator) and one or more RFID tags.
   - The tag contains a chip that stores a ***unique code*** or other information.
   - When the tag is in the electromagnetic field of the reader, it receives energy and transmits the stored data to the reader.

2. **Operating frequencies:**
    - RFIDs operate at different frequencies, mainly divided into low frequency (LF), high frequency (HF), ultra high frequency (UHF), and very high frequency (VHF).
    - Different frequencies affect the reading distance and ability to penetrate through materials.
3. **Types of RFID tags:**
    - Tags can be active (with battery) or passive (without battery).
    - Passive tags are powered by the reader field and have a shorter read distance than active tags.
4. **Common applications:**
    - Access control: RFID badge for automatic opening or security authentication.
    - Logistics and traceability: monitoring goods in transit through warehouses and distribution chains.
    - Contactless payments: contactless payment systems such as contactless cards.
5. **Security and privacy:**
    - RFID can present security and privacy challenges, with the potential for data to be intercepted and cloned.
    - Various encryption techniques have been developed to protect the information exchanged between readers and tags.
6. **Implementation with ESP8266:**
    - The ESP8266 can be used as an RFID reader, interfacing with a compatible RFID module.
    - The information read from the RFID tag can be used to trigger specific actions or access resources.

The use of RFID offers an effective and cost-effective solution for multiple applications, enabling the automation of processes and improving operational efficiency.

III. DESCRIPTION OF OPERATION

Access denied: The relay stays inactive, making sure that the unauthorised user cannot enter the protected area, if the RFID code is not found in the dictionary or if the related permission is restricted. In delicate situations, security requires this degree of control.

Our ESP8266 and RFID module-based RFID access control solution provides intelligent and individualised access control. The gadget can distinguish between authorised and unauthorised users by using a vocabulary that links particular RFID codes to particular permissions. Upon the user's presentation of his RFID badge to the reader, the system accesses the dictionary and determines whether to activate or deactivate a relay based on the corresponding permission.

Authorised access: A door or gate may be opened if the RFID code and the permission in the dictionary match, activating the relay for a predetermined amount of time. Applications for this functionality are best found in settings like workplaces, warehouses, or designated regions.

Flexible customisation is made possible by the dictionary's flexible permission management feature, which lets the administrator add, edit, or remove a user's access as necessary.

IV. SYSTEM ARCHIETECTURE

A. ESP8266:- The widely used and incredibly adaptable ESP8266 microcontroller was created by Espressif Systems. It is a well-liked option for Internet of Things applications because to its well-known low cost, low power consumption, and integrated Wi-Fi capabilities. Clock speeds of up to 80 MHz are available on the ESP8266, which has a Tensilica Xtensa LX106 CPU and is suitable for many applications. Its small physical factor and interoperability with several development environments such as Arduino and MicroPython—make it accessible and simple to use for developers of all skill levels.

The ESP8266 has GPIO pins for interacting with sensors, actuators, and other peripherals. It also supports the TCP/IP protocol stack, facilitating smooth communication over Wi-Fi networks. The ESP8266 can store programme code and data in its onboard flash memory and RAM, allowing it to function independently without the need for external storage devices. Because of its popularity, there is a thriving developer community that supports rapid prototyping and development with a wealth of documentation, tutorials, and third-party libraries. All things considered, the ESP8266's price, connectivity, and adaptability have made it a mainstay in the Internet of Things ecosystem, enabling a wide range of applications from industrial monitoring systems to home automation.

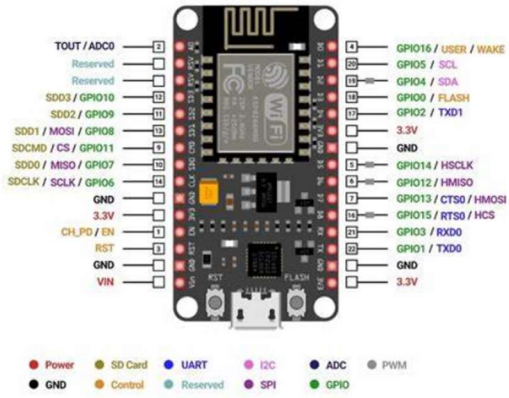

Fig. 1 PIN DIAGRAM OF ESP 8266[1]

B. RFID SENSOR:-

An essential part of asset tracking applications and access control systems is the RFID (Radio-Frequency Identification) sensor. In order to communicate with RFID tags, which have unique identifying information, it emits radio waves. These tags can be passive, relying on the sensor's radio waves for power, or active, containing their own power source for

longer-range communication. RFID sensors are made up of a reader module that decodes tag data and an antenna that sends and receives signals. They are perfect for areas demanding fast and accurate identification of objects or people since they provide benefits including non-line-of-sight functioning and speedy identification.

Fig. 2 IMAGE OF RFID SENSOR[3]

RFID technology finds applications in various industries, including retail, logistics, and security. The sensor's ability to read tags from a distance, coupled with its scalability and ease of integration with other systems, contributes to its widespread adoption in diverse contexts.

c. **Servo motor(sg70) :-** Compact and lightweight, the SG70 servo motor finds widespread application in robotics, automation, and amateur projects. Because of its compact form size, it can be used in applications where there is a shortage of space. The SG70, which has a normal rotation range of 0 to 180 degrees, is renowned for its accuracy and precision in controlling angular motion. It functions using a pulse-width modulation (PWM) signal, which is often produced by servo motor controllers or microcontrollers. For exact output shaft positioning, the motor combines a DC motor with gearing. With an approximate torque output range of 1.8 kg-cm, the SG70 can apply force that is adequate for a variety of jobs.

Because it usually runs at voltages between 4.8 and 6 volts, it can be used with a variety of power sources. Because of its cost, dependability, and longevity, the SG70 servo motor is well regarded by educators, DIY enthusiasts, and hobbyists. Because of its adaptability, it can be utilised in a wide range of applications, such as camera gimbals, robotic arms, and remote-controlled cars.

Fig. 3 IMAGE OF SERVO MOTOR[6]

V. BLOCK DIAGRAM

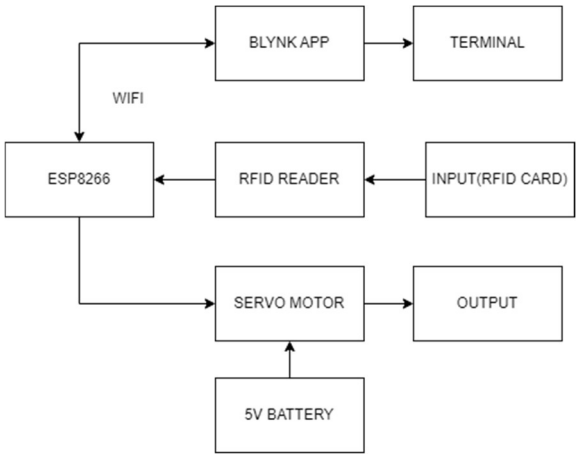

Fig. 4 BLOCK DIAGRAM OF SYSTEM[2]

The system consists of several components: an ESP8266 NodeMCU, an RFID/MFRC522 module, and servo motor and RFID key fobs. When a user taps an RFID tag on the reader, the reader retrieves the unique identifier (UID) from the tag. The ESP8266 compares this UID with predefined authorized UIDs.

VI. FUNCTIONALITY AND WORKING

A number of related parts and procedures enable the RFID door lock system with ESP8266 microcontroller, Blynk app, and servo motor to function:

RFID Authentication: Authorised users are allocated RFID tags at the start of the system. The RFID reader recognises the unique identifying information on an RFID tag when a user shows it to it.

ESP8266 Processing: The RFID reader provides the RFID tag data to the ESP8266 microcontroller, which functions as the central nervous system of the system. After processing this data, it decides if the user has permission to open the door.

Access Decision: The ESP8266 decides whether to allow or refuse access to the user based on the RFID tag data and preconFigured access permissions that are saved in the system.

Servo Motor Control: The ESP8266 signals the servo motor to activate the door lock mechanism in the event that entry is allowed. To unlock or lock the door, the servo motor spins its shaft to a predefined point.

Blynk Integration: The ESP8266 and the Blynk app communicate simultaneously over Wi-Fi. As a user interface, the Blynk app notifies the user in real time on the status of the door and the attempt at access.

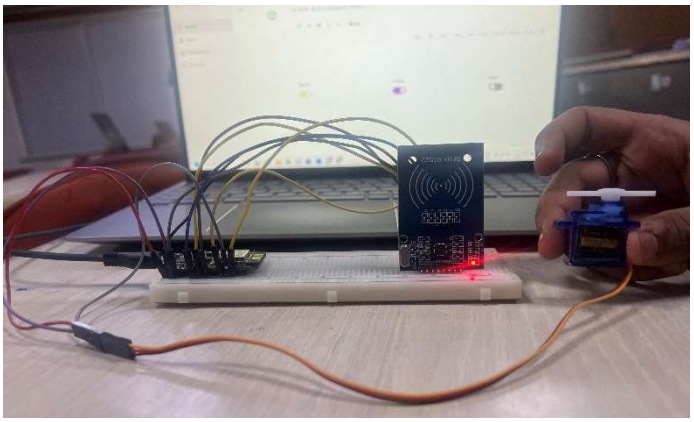

Fig. 5 HARDWARE IMPLEMENTATION [5]

Remote Control and Monitoring: Using the Blynk app, users can keep an eye on the condition of the door lock system from a distance. Regardless of where they are physically located, they can also operate the door lock, giving or removing access permissions as necessary.

Event Logging: The system has the ability to record information about access events, including the time and identity of persons who open the door. By giving administrators the ability to monitor access activities over time, this logging function improves security.

Feedback Mechanism: The Blynk app has the ability to notify the user of any unauthorized or authorized access attempts and confirm successful access.

In general, the RFID Door Lock System with ESP8266 on the Blynk app, coupled with a servo motor, provides an easy way to combine physical access control, Internet of Things connectivity, and RFID technology. It is appropriate for a variety of household and business applications since it improves security, convenience, and remote accessibility.

VII. RESULTS

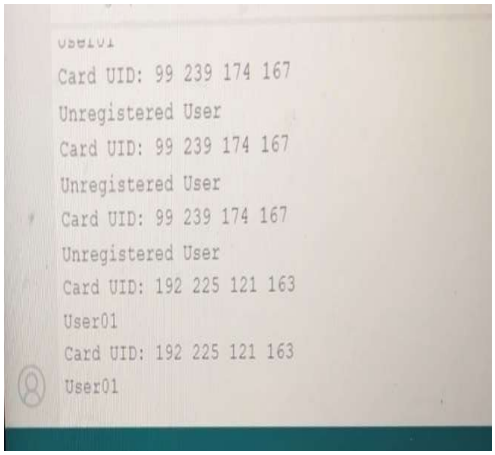

Fig. 6 SERIAL MONITOR WINDOW[4]

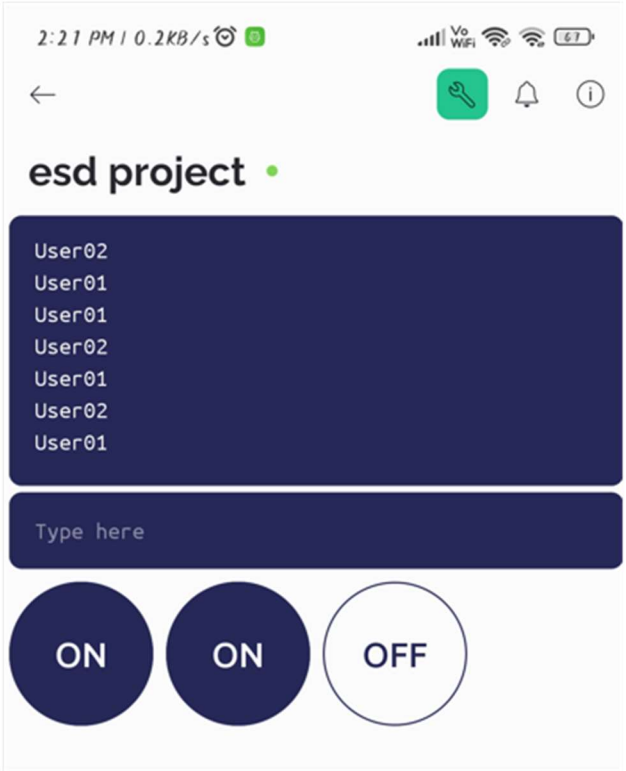

Fig. 7 BLYNK APP TERMINAL[4]

In this system, an ESP8266 NodeMCU is employed for RFID-based access control. During the initial scan, the system reads the unique identifier (UID) of each card and displays it on the serial monitor. Subsequently, when a user activates their Blynk app switch, the system identifies the user and presents their name in the terminal window of the Blynk app. This seamless integration of RFID technology and IoT ensures secure access while providing user-friendly interaction

If the switch in the Blynk app is turned off, attempting to access the system will result in denied access. The system ensures security by enforcing this restriction.

VIII. APPLICATIONS

There are numerous uses for the RFID door lock system in a variety of settings and industries, including:

1.Residential Security: Compared to conventional lock-and-key systems, RFID door lock systems provide better security in residential situations. Although they can still manage who enters their property, homeowners can allow trusted service providers, friends, and family members access.

2.Commercial Buildings: RFID door lock systems are useful for controlling entry for tenants, employees, and guests in offices, coworking spaces, and commercial buildings. By tracking access behaviour and limiting entry to authorised persons, these systems improve security.

3.Hotels and Hospitality: RFID door lock systems are commonly used in hotels and hospitality establishments to provide secure access to guest rooms and facilities. With RFID keycards, guests can conveniently access their rooms while hotel staff can easily manage access privileges.

4.Educational Institutions: Schools, colleges, and universities can use RFID door lock systems to control access to classrooms, laboratories, and administrative offices. These systems enhance campus security by preventing unauthorized entry and monitoring student and staff movements.

5.Healthcare Facilities: Hospitals, clinics, and medical offices utilize RFID door lock systems to restrict access to sensitive areas such as patient rooms, operating theaters, and medication storage areas. These systems help ensure patient privacy and safeguard medical supplies and equipment.

6.Industrial Facilities: Manufacturing plants, warehouses, and research facilities employ RFID door lock systems to control access to restricted areas containing valuable assets, machinery, and hazardous materials. These systems improve workplace safety and prevent unauthorized access to critical infrastructure.

7.Government Buildings: Government offices, embassies, and military installations rely on RFID door lock systems to secure classified information, sensitive documents, and restricted areas. These systems help enforce security protocols and protect national interests.

8.Retail Stores: Retailers use RFID door lock systems to secure backrooms, stockrooms, and storage areas containing merchandise and inventory. These systems prevent theft, minimize shrinkage, and ensure only authorized personnel can access valuable assets.

9.Data Centers and Server Rooms: Data centers and server rooms employ RFID door lock systems to control access to servers, networking equipment, and sensitive data. These systems enhance cybersecurity by restricting physical access to critical infrastructure.

10.Parking Facilities: RFID door lock systems are utilized in parking garages and gated communities to control vehicle access to designated areas. With RFID-enabled vehicle tags or key fobs, authorized vehicles can enter and exit the premises efficiently while unauthorized access is prevented.

Overall, the RFID door lock system offers versatile solutions for access control, security management, and asset protection in diverse environments, contributing to improved safety, efficiency, and peace of mind for individuals and organizations alike.

IX. CONCLUSION

The Blynk software, servo motor, ESP8266, and RFID Door Lock System seamlessly integrate RFID technology and Internet of Things connectivity to transform access control. It provides accurate door mechanism control, effective user verification via RFID tags, and remote monitoring via the Blynk app. The technology improves accessibility, convenience, and security and has applications in the commercial, industrial, and residential domains. It is appropriate for a variety of settings due to its adaptability, low cost, and user-friendly interface. All things considered, the system is a notable development in access control technology, offering a scalable and adaptable answer to contemporary security requirements.

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Appendix:

```
#define BLYNK_TEMPLATE_ID "TMPL3t_OaQfv3"
#define BLYNK_TEMPLATE_NAME "esd project"
#define BLYNK_AUTH_TOKEN "la6-qVkOmtsZYdsrwn-7hGarrAyMTPEC"
#include <SPI.h>
#include <MFRC522.h>
#include <ESP8266WiFi.h>
#include <BlynkSimpleEsp8266.h>
#include <Servo.h> // Include the Servo library

#define SS_PIN 4  // sda
#define RST_PIN 2
#define SERVO_PIN D3 // Servo pin

Servo servo; // Create a servo object

MFRC522 mfrc522(RST_PIN, SS_PIN);
char auth[] = "la6-qVkOmtsZYdsrwn-7hGarrAyMTPEC"; //Blynk Authentication Token -- sent via Email from Blynk

char ssid[] = "Redmi Note 10 Pro";   //Enter WiFi Name
char pass[] = "12345678";   //Enter Wifi Password      // Create MFRC522 instance.

SimpleTimer timer;
int fflag = 0;
int eflag = 0;
int jflag = 0;

void setup() {
  Serial.begin(9600);
  Blynk.begin(auth, ssid, pass);
  servo.attach(SERVO_PIN); // Attach the servo to the pin
  servo.write(90); // Initially set servo to the middle position
  SPI.begin();              // Init SPI bus
  mfrc522.PCD_Init();       // Init MFRC522 card
  timer.setInterval(1000L, iot_rfid);
}

void loop() {
  timer.run(); // Initiates SimpleTimer
  Blynk.run();
}

void iot_rfid() {
  // Prepare key - all keys are set to FFFFFFFFFFFFh at chip delivery from the factory.
  MFRC522::MIFARE_Key key;
  for (byte i = 0; i < 6; i++) {
    key.keyByte[i] = 0xFF;
  }
  // Look for new cards
  if (!mfrc522.PICC_IsNewCardPresent()) {
    return;
  }

  // Select one of the cards
  if (!mfrc522.PICC_ReadCardSerial()) {
    return;
  }
  // Now a card is selected. The UID and SAK is in mfrc522.uid.

  // Dump UID
  Serial.print("Card UID:");
  for (byte i = 0; i < mfrc522.uid.size; i++) {
    Serial.print(mfrc522.uid.uidByte[i] < 0x10 ? " 0" : " ");
    Serial.print(mfrc522.uid.uidByte[i], DEC);
  }
  Serial.println();

  // Dump PICC type
  byte piccType = mfrc522.PICC_GetType(mfrc522.uid.sak);
```

```
  if (piccType != MFRC522::PICC_TYPE_MIFARE_MINI &&
      piccType != MFRC522::PICC_TYPE_MIFARE_1K &&
      piccType != MFRC522::PICC_TYPE_MIFARE_4K) {
      return;
  }

  // Enter RFID Tag ID here
  if (((mfrc522.uid.uidByte[0] == 192) && (mfrc522.uid.uidByte[1] == 225) && (mfrc522.uid.uidByte[2] == 121) && (mfrc522.uid.uidByte[3] == 163)) && (fflag == 1)) {
      Serial.println("User01");   //Enter User1 Name
      Blynk.virtualWrite(V2, "harsh" );   //Enter User1 Name
      // Control the servo
      rotateServo();
  } else if (((mfrc522.uid.uidByte[0] == 99) && (mfrc522.uid.uidByte[1] == 239) && (mfrc522.uid.uidByte[2] == 174) && (mfrc522.uid.uidByte[3] == 167))&& (eflag == 1)) {
      Serial.println("User02");   //Enter User2 Name
      Blynk.virtualWrite(V2, "Mittal" );   //Enter User2 Name
      // Control the servo
      rotateServo();
  } else if (((mfrc522.uid.uidByte[0] == 21) && (mfrc522.uid.uidByte[1] == 22) && (mfrc522.uid.uidByte[2] == 23) && (mfrc522.uid.uidByte[3] == 24))&& (jflag == 1)) {
      Serial.println("User03");   //Enter User3 Name
      Blynk.virtualWrite(V2, "mark" );   //Enter User3 Name
      // Control the servo
      rotateServo();
  } else {
      Serial.println("Unregistered User");
  }
}

void rotateServo() {
  // Rotate the servo to a certain position
  servo.write(0); // Rotate to one direction
  delay(1000); // Wait for 1 second
  servo.write(90); // Return to the middle position
  delay(1000); // Wait for 1 second
}

// in Blynk app writes values to the Virtual Pin 3
BLYNK_WRITE(V3) {
  fflag = param.asInt(); // assigning incoming value from pin V3 to a variable
}

// in Blynk app writes values to the Virtual Pin 4
BLYNK_WRITE(V4) {
  eflag = param.asInt(); // assigning incoming value from pin V4 to a variable
}

BLYNK_WRITE(V5) {
  jflag = param.asInt(); // assigning incoming value from pin V5 to a variable
}
```