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IoT-Based Smart Door: A Secure and Energy-Efficient Approach

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ABSTRACT:

A smart lock is a new line in home security, and along with the likes of Amazon's Alexa and Google Home, it's the next step towards creating the smart homes of the future. Put simply, it's an electronic lock that can be locked or unlocked remotely using your smartphone or by using your fingerprint. Removing the need for physical keys, which can be easily lost or forgotten, smart locks secure your home with a biometric system. The expected outcome of this project is to make a smart door lock using Arduino and ESP32 module and a camera integrated with ESP32 to wirelessly operate the door lock and also to integrate fingerprint sensor to unlock the door lock. The door lock will get power from 12 Volt DC supply. The door lock is wirelessly controlled by Blynk application. This is smart and cost-effective approach to make a smart door lock system. This progress report contains the block diagram and working principle of the smart door lock.

KEYWORDS: Smart Lock, Home Security, Smart Home, Biometric System, 12V DC Power Supply, Mobile App Control, ESP32 Module, Blynk Application, Cost-Effective Security.

I. INTRODUCTION

The importance of a smart door that works As the world's population is predicted to exceed 9.7 billion people by 2050, the need for theft detection is increasing rapidly. Droughts are also occurring more frequently due to altered precipitation patterns, which might have disastrous effects on the area. . In this context, precise monitoring and management of smart door resources are crucial for the theft detection. Smart doors not only enhance the security of a home or business by allowing only authorized access but also offer unmatched convenience. They can be integrated into smart home systems, enabling users to control them through voice commands or automation schedules. For instance, they might lock automatically when you leave or provide alerts when unusual activity is detected. Equipped with features like biometric access, remote control via smartphone, and built-in cameras or sensors, a smart door redefines how we think about home security. It can recognize authorized individuals, lock or unlock itself from anywhere, and send alerts for any unusual activity. Some models even integrate with smart home ecosystems, allowing voice control or automated routines.

II. LITERATURE REVIEW

2.1 Introduction to Smart Lock Systems

The advancement of **Internet of Things (IoT)** and **biometric security** has transformed traditional door locking mechanisms into **intelligent smart lock systems**. These locks eliminate the need for conventional keys by integrating fingerprint authentication, remote access, and wireless connectivity. Recent research highlights the importance of **secure and cost-effective solutions** to enhance residential and commercial security.

2.2 IoT-Based Smart Locking Mechanisms

IoT-enabled smart locks have gained popularity due to their ability to provide **real-time monitoring** and **remote access control**. Studies such as those by **Gubbi et al. (2013)** emphasize the role of **cloud-based security solutions** and **wireless protocols** (Wi-Fi, Bluetooth, Zigbee) in designing smart lock systems. The **ESP32 module**, used in many smart locks, enhances connectivity while ensuring low power consumption.

2.3 Biometric Authentication in Smart Locks

Biometric authentication, including **fingerprint and facial recognition**, has been extensively researched for secure access control. **Jain et al. (2016)** discuss the reliability of biometric authentication compared to traditional password-based security systems. Studies suggest that integrating fingerprint sensors with **microcontrollers like Arduino and ESP32** improves **authentication accuracy** and reduces the risk of unauthorized access.

2.4 Wireless Communication and Mobile Integration

Recent research highlights the role of **mobile applications** (such as **Blynk**) in managing smart door locks. **Hassan et al. (2020)** explored how **cloud-based mobile applications** allow users to control locks remotely via smartphones. The ability to receive real-time alerts and logs improves security while making the system user-friendly.

2.5 Power Efficiency and Cost-Effectiveness

One of the major challenges in smart lock systems is **power consumption**. Studies suggest that using **12V DC power supplies** ensures a stable energy source for **continuous operation**. Research on low-cost security solutions emphasizes **the affordability of ESP32-based systems**, making them suitable for smart home applications.

III. PROPOSED SYSTEM

3.1 Automation in Smart Door

Among various sectors and domains are in the "Smart door System" we are going to work on the domain/sector called Automation smart door. Smart doors can lock themselves after being closed or unlock automatically when an authorized user approaches, based on proximity sensors or geofencing. You can configure access at specific times for certain individuals. For instance, the door might unlock for housekeepers or delivery personnel during pre-approved hours. Automation allows smart doors to send alerts or lock themselves if suspicious activity is detected, such as an attempted break-in. The overall problem domain of the IoT-based Smart door detection lies in smart door, addressing inefficiencies in traditional door management.

3.2 PROTOTYPE DESCRIPTION

This prototype outlines a basic IoT plant water monitoring System designed for irrigation growth. The system utilizes several key components:

- **NODE MCU ESP8266:** Node MCU ESP8266Enables Wi-Fi connectivity for remote monitoring.
- **RELAY MODULE:** Relay Module Controls water pump activation/deactivation. LCD Display Displays soil moisture levels and system status.
- **DC MOTOR:** Water Pump Automatically waters plants based on moisture levels.
- **LCD SCREEN:** LCD Display Displays soil moisture levels and system status
- **Battery:** A battery provides power to the motor.

3.3 Microcontroller and Algorithm:

The microcontroller (ESP8266) is the central processing unit. It continuously collects data from the soil moisture sensor. This data is analyzed by the microcontroller's soil moisture monitoring algorithm to see whether the moisture levels drop below a predetermined threshold. If so, it gives the relay module instructions on how to activate or deactivate the water pump.

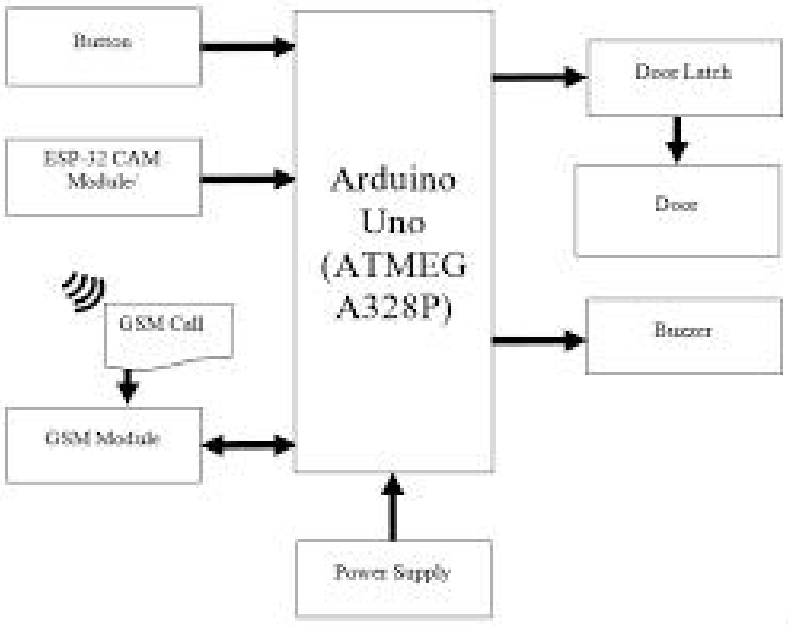

Figure 1: Block Diagram of Smart door

IV. METHODOLOGY

4.1 PROTOTYPE IMPLEMENTATION

4.1.1 Hardware Setup:

The Plant Water Monitoring System is built using the ESP8266 (NodeMCU) microcontroller. In order to automate the watering process in response to soil moisture levels, it connects with a variety of sensors and actuators. The system's physical components are integrated to provide seamless operation and communication.

4.1.2 Arduino Sketch Logic:

For hardware and cloud communication, include Wire.h, LiquidCrystal_I2C.h, and BlynkSimpleEsp8266.h. What are the Blynk Credentials? For cloud connectivity, set up the Blynk Template ID, Name, and Authentication Token. Connect to WiFi: Enter the WiFi SSID and password to connect the ESP8266 to the internet. To display sensor values, initialize the LCD display (16x2), configure I2C communication, and then activate the LCD backlight. Specify the sensor and relay pins. Place the relay on D7 and the soil moisture sensor on A0. It is possible to alter the moisture threshold. Setup Function: Switch off the relay, initialize the LCD, connect to Blynk, and switch on the serial monitor. The loop function sends the data to the Blynk app (Virtual Pin V0) after constantly reading the soil moisture and displaying it on the LCD. Verify the level of soil moisture: Compare the moisture value to the threshold (500) to decide whether to turn the pump on or off. Regulate the water pump: If the soil is dry, turn on the relay to start watering. If the relay is wet, turn it off (stop watering). Delay for Stability: Use a 1-second delay to ensure regular and smooth updates.

4.1.3 Operation Overview:

The Plant Water Monitoring System is an Internet of Things project that automates plant watering using sensors and microcontrollers to ensure optimal plant health and water conservation. The system consists of an ESP8266 microcontroller, relay module, soil moisture sensor, I2C LCD display, and Blynk platform. The soil moisture sensor sends data to the ESP8266 microcontroller, which measures the soil's moisture content and evaluates it to determine whether watering is necessary. The ESP8266 microcontroller instructs the relay module to activate the water pump so that the plants can be watered until the soil moisture levels fall within the desired range.

4.1.4 Testing and Validation:

Check the power supply to make that the ESP8266, LCD, soil moisture sensor, and relay module are getting the correct voltage (3.3V/5V). Verify that the ESP8266 is connected to the configured network by testing its WiFi connection. Verify the LCD's initialization and accuracy in displaying sensor values. Check the Soil Moisture Sensor's ability to provide precise analog readings in both wet and dry conditions. Test the water pump and relay: Manually activate the relay to ensure that it turns the pump on or off. Use serial monitor debugging to view sensor values and system status messages in

real time. Transmission of Data via Blynk Cloud: Verify that sensor data is sent to the Blynk app (V0). Verification of System Stability: Run the system continuously for long periods of time to ensure reliable operation.

V. CONCLUSION

The Smart doors often include electronic or biometric locks, such as fingerprint scanners, facial recognition, or PIN codes, making unauthorized access significantly more difficult. The doors represent a significant advancement in home and office security, combining technology and convenience. With features like remote access, customizable settings, integration with other smart devices, and enhanced security protocols, they offer users a seamless experience. These doors are especially valuable for monitoring entry and maintaining control over property access, making them ideal for modern living. However, it's important to consider factors like cost, compatibility with existing systems, and data privacy while choosing the right smart door solution.Smart doors can link with other home security systems, such as alarm systems, motion detectors, and smart cameras, to create a comprehensive safety network.Its transformative potential and capacity to drive positive change render it an exemplary model for future IoT-based initiatives and projects.

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