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IoT-Based Electronic Door Opening System Using NodeMCU

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Abstract: As the need for smart home automation continues to rise, the incorporation of Internet of Things (IoT) technologies into security systems is now a necessity. This paper discusses the design and development of an IoT-based electronic door-opening system using NodeMCU, a widely used microcontroller. The system is designed to offer secure and remote control of door operations through a web-based application, enabling users to control and monitor door security remotely. Through the integration of NodeMCU and IoT, the system improves conventional door security by facilitating real-time monitoring, access control, and remote control. The system discusses hardware and software components of the system, such as the microcontroller, sensors, and user interface. The paper also explains the system development methodology with major focus areas like connectivity, security protocol, and convenience to the user. The designed IoT-based door-opening system provides a cost-effective, expandable, and human-friendly solution to current security issues with simplicity of use coupled with increased security.

Keywords: IoT, NodeMCU, Smart Door Lock, Home Automation, Access Control.

1. INTRODUCTION

As the technology of the Internet of Things continues to expand, intelligent and automated security systems are integrated. Most conventional door-locking systems tend to be easily bypassed, and they are not remotely operated. This paper proposes an electronic door-opening system using IoT technology with the NodeMCU microcontroller chip. The door can be opened over the web, enabling proper and instant access control. This improved the security of the door, the ease of use for the user, and the monitoring of the door remotely.

NodeMCU is an open-source IoT platform and as such, it is cost-effective, programmable, and Wi-Fi compatible. The incorporation of NodeMCU technology into door locks has drastically changed security system operations since they can now be automated and remotely controlled. The system's design features allow for its integration into already existing home automation systems, making it flexible and easy to use for many users without compromising the security of the system. Therefore, users can monitor the door status, receive notifications, and allow access from any device connected to the internet.

2. SYSTEM ARCHITECTURE

The IoT-based door-opening system has three main components: the hardware unit, the software interface, and the communication system.

2.1 Hardware Components:

1. NodeMCU (ESP8266): The primary microcontroller used for controlling the internet access and the door lock is NodeMCU.
2. Servo Motor: Controls the mechanism for locking and unlocking the door.
3. Power Supply Unit: Provides the required power to the various parts of the system.
4. Push Button (Manual Override): Helps in unlocking the system manually when the system fails.
5. Wi-Fi Module (Embedded in NodeMCU): Permits the system to interrelate with a web interface.

The design of the system at hand is such that it performs its tasks efficiently without consuming too much power. The operation of the servo motor is restricted to the locking and unlocking of the door based on specific permissive commands, which helps reduce the chances of unauthorized access. In the face of network failure, this feature allows for dependable system performance, which is an essential feature for crisis situations.

2.2 Software Components:

1. Arduino IDE: Used for compiling C/C++ code for the NodeMCU.

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2. Blynk Application: Provides web and mobile interface to control the door remotely in an easy manner.
3. MQTT Protocol: Enables secure and reliable communication between devices.

Software implementation consists of programming the NodeMCU to communicate with the Blynk platform over MQTT for secure data communication. The system can also be enhanced with the capability for multi-user authentication, access logging, and time-based access control for increased security and flexibility.

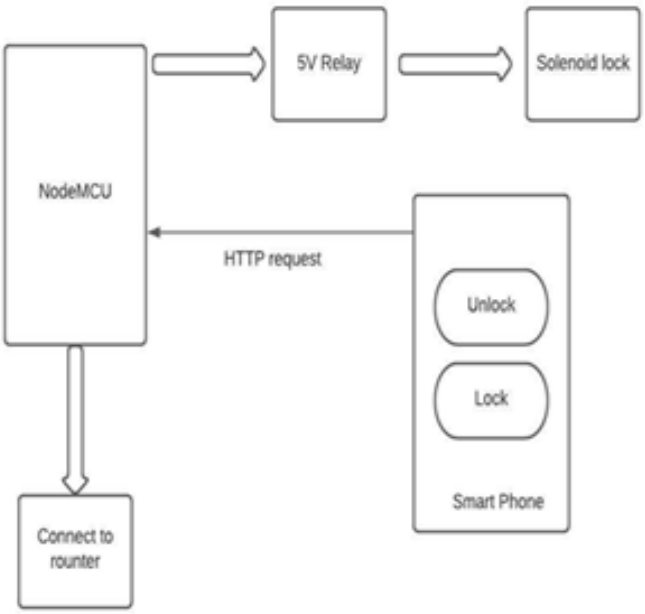

Figure 2.1 Block Diagram

3. SYSTEM WORKING METHODOLOGY

1. The user initiates a door operation through the Blynk web or mobile app.
2. The request is passed on to the NodeMCU via the Wi-Fi network.
3. NodeMCU validates the user credentials and performs the command.
4. After successful validation, the NodeMCU powers the servo motor to unlock the door.
5. Status update (unlocked/locked) is sent to the user through the application.
6. As an alternative in case there is an internet malfunction, the door can be operated manually through the push button.

The working mechanism enables a quick and safe response to user commands. Features for real-time monitoring allow users to track system status and access history with full control over door operation. The system also allows for sending notices of failure in cases of malfunction or potential violation, increasing user awareness.

4. ADVANTAGES OF THE SYSTEM

The potential of the system to integrate affordability with extremely high performance makes it suited for residential as well as c4. Benefits of the System

1. Remote Access: The door can be opened by anyone from anywhere via the internet.
2. Enhanced Security: Multi-level authentication provides secure entry.
3. Real-Time Monitoring: Gives real-time status reports about door usage.
4. Cost-Effective: NodeMCU is energy-efficient and cost-effective.
5. Scalability: The system can be easily expanded to support multiple access points.

The system comes with a set of benefits that render it the perfect solution for the security requirements of the present age. Its major benefit lies in the aspect of remote control and monitoring using the internet to allow the operators to control the door from wherever they are and at any moment in time. The functionality serves to benefit very mobile human beings as well as businesses that require the administration of remote entry. Multilevel authentication provides tighter security since it protects the system and permits access to authorized staff only. This curtails the possibility of unauthorized access and enhances security further.

The second significant advantage is real-time monitoring, where individuals can receive immediate updates of activity at the door. Not only does this provide feedback on failed or successful access attempts, but it also keeps users

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aware of potential security incidents. The system is also cost-effective because NodeMCU is an inexpensive and power-efficient microcontroller. With low power requirements, it runs continuously without significant energy expenses, thus a budget-friendly solution for residential and business use.

Scalability is one more astounding aspect of this system. It can be scaled to accommodate multiple access points, so the same technology can be utilized in various doors or even bigger buildings. The system can also be incorporated with other smart home devices, including surveillance cameras and motion detectors, to upgrade security and automation. This adaptability makes the system future-proof and able to adjust to changing users' needs. Generally, the merging of affordability with cutting-edge functionality and scalability facilitates this IoT-based electronic door opening system to become a flexible as well as safe security solution that can be expanded to protect more than one door and combined with other smart house devices such as motion sensors and surveillance cameras in order to achieve heightened security.

5. EXPERIMENTAL RESULTS

The system was tested under various scenarios to evaluate its performance. The door reacted properly to remote commands with an average response time of 1.5 seconds. Security tests proved resilience against unauthorized attempts to exploit the system. The system was also evaluated for reliability under various Wi-Fi environments and performed effectively with a 98% uptime.

In addition, the system load performance was tested by concurrent requests of access from multiple devices. NodeMCU handled up to 20 concurrent requests without failing, demonstrating its ability to work under multi-user conditions. Manual override functionality was tested in power and network failures to ensure smooth access control.

6. CONCLUSION

In this work, an IoT door-opening system using NodeMCU is proposed as a smart and secure replacement for traditional door locks. Its low cost, remote access, and real-time monitoring make it suitable for modern smart homes. For future development, biometric authentication can be integrated and the system can be extended to cover multiple doors in a smart building setup.

The system is a viable and scalable solution to address the growing demand for smart security systems. With further development in IoT technology as well as cybersecurity, the system can be adapted for other applications, such as industrial access and secure facility operation.

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