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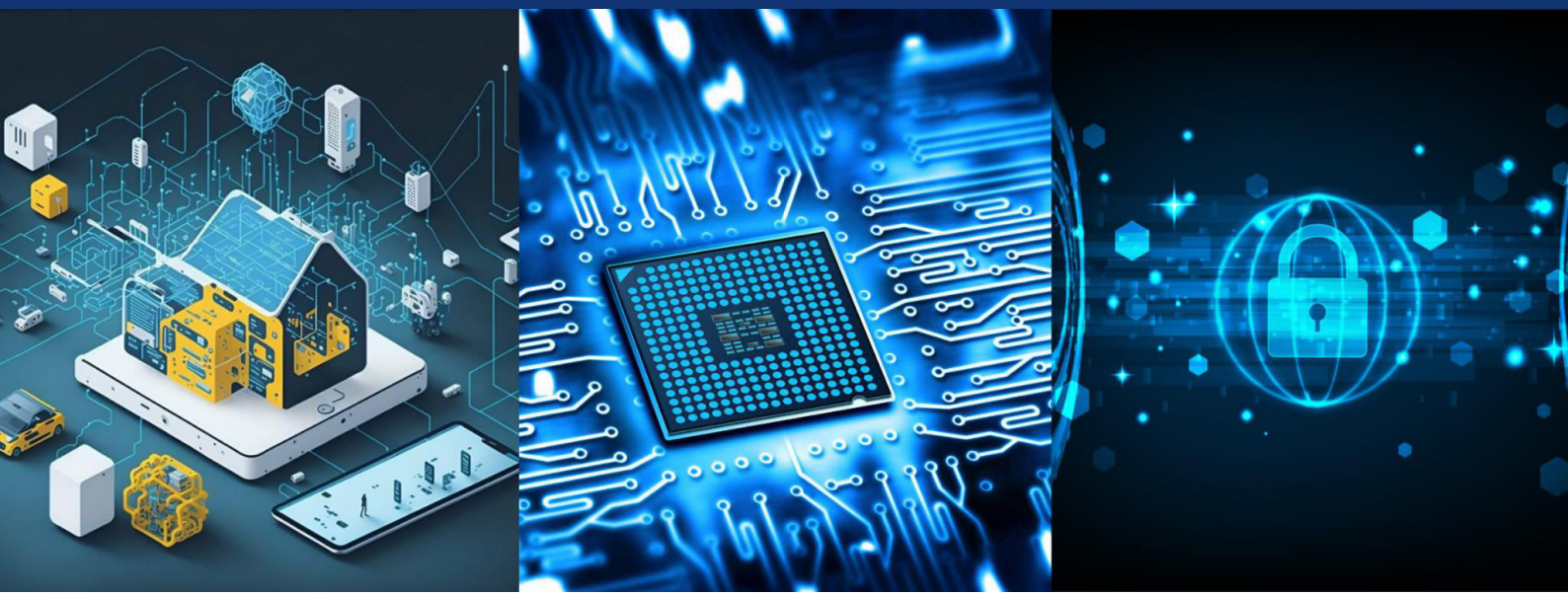

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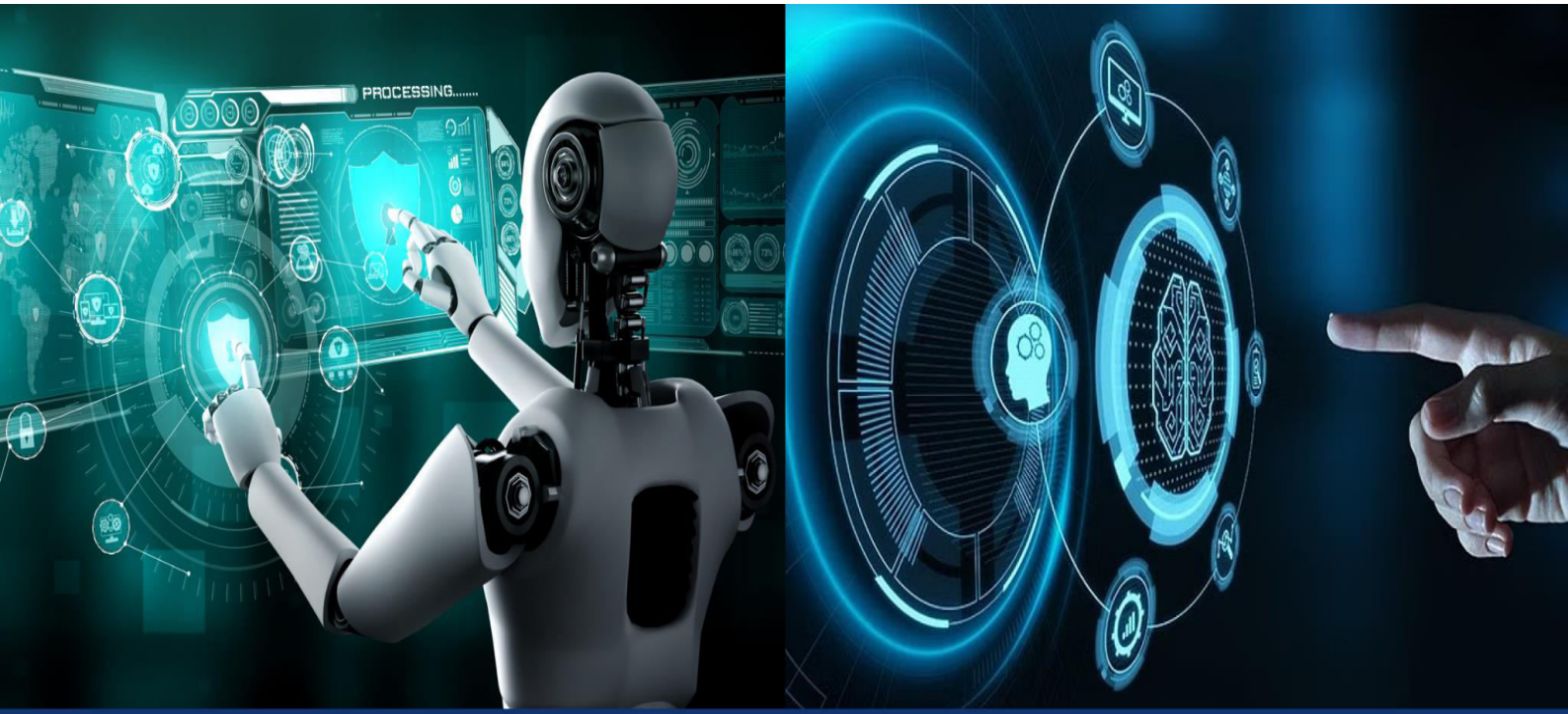

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OTP Based Smart Door Locking System

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ABSTRACT: An OTP-based door lock system is a modern security mechanism that utilizes unique One-Time Passwords for secure access. It comprises a microcontroller, GSM module, LCD display, keypad, and solenoid lock. The user enters their mobile number, receives an OTP, and upon successful verification, the door is unlocked. The system is cost-effective, easy to use, and can be installed in various applications for high-security levels. Overall, the OTP-based door lock system provides an efficient alternative to traditional lock-and-key mechanisms for securing access to restricted areas.

KEYWORDS: OTP, Smart Home, Security, Encryption

I. INTRODUCTION

An OTP (One-Time Password) based door lock system is a security system that utilizes a unique password that can only be used once to unlock the door. It provides an added layer of security compared to traditional lock systems. The system typically involves a door lock mechanism connected to a microcontroller that generates an OTP. The OTP is usually sent to the user's mobile device via SMS or a mobile app. The user then enters the OTP into the keypad or mobile app, which sends a signal to the microcontroller to unlock the door. The advantages of an OTP based door lock system are that it provides a higher level of security since the password can only be used once, and it is easy to use since the password is sent to the user's mobile device, eliminating the need for carrying physical keys. Additionally, the system can be easily integrated with other security systems such as CCTV cameras and alarm systems. Overall, an OTP based door lock system is a modern, convenient, and secure way to control access to your premises.

II. LITERATURE SURVEY

1. Security in Traditional Locking Systems

Traditional mechanical locks have been studied as the most widely used locking mechanism for decades. However, their vulnerabilities, such as key theft, duplication, or damage, have been well-documented (Smith et al.,2012). Studies indicate that while these locks are simple and affordable, they lack adaptability to modern security challenges.

2. Smart Locking Systems

Modern smart locking systems have evolved to address these limitations, offering features such as remote access, mobile integration, and dynamic password protection. Research by Kumar et al. (2019) highlights that smart locks using IoT (Internet of Things) often face security challenges, such as hacking through the internet. Bluetooth-based systems, like the one in this project, mitigate this by providing localized, secure communication, reducing external vulnerabilities.

3. Arduino-Based Control Mechanisms

The Arduino platform has been extensively explored for use in security and IoT applications. Arduino is particularly suitable for DIY and prototyping projects due to its open-source nature, low cost, and high compatibility with various sensors and actuators. This project leverages the Arduino Uno to control all system components, including the servo motor and Bluetooth module, offering a centralized and efficient processing unit.

4. Bluetooth-Based Communication

Bluetooth technology, specifically using modules like HC-05, has been extensively studied for short-range, secure communication. Research by Singh and Gupta (2018) emphasizes the reliability of Bluetooth in creating secure

connections without requiring internet access. This project integrates Bluetooth to connect the Arduino with a smartphone, ensuring real-time communication for OTP generation and lock control.

5. One-Time Password (OTP) Systems
The use of OTP in security systems is a well-documented strategy for enhancing authentication. OTP systems, as discussed by Shukla et al. (2017), generate unique passwords for each access attempt, making them highly secure against replay attacks or unauthorized access. This project integrates OTP functionality to dynamically authenticate users, reducing risks associated with static passwords.

6. App-Based Security Integration
Mobile applications have become an integral part of smart security systems. Studies, such as those by Tan and Lee (2021), demonstrate how platforms like MIT App Inventor enable non-programmers to design functional and secure apps for IoT and Arduino-based projects. This project utilizes MIT App Inventor to build a custom app that pairs with the Bluetooth module, enhancing user experience and functionality.

7. Servo Motors in Locking Mechanisms
The use of servo motors in locking systems has been explored for their precise control and high torque. Research by Ahmad and Ali (2020) highlights the suitability of servo motors for mechanical locking systems due to their programmability and reliability. In this project, the servo motor plays a key role in physically controlling the lock mechanism, ensuring a secure and responsive unlocking process.

8. Cost-Effective and DIY Smart Locks
Cost-effective solutions are a focus in academic and industrial research. This project aligns with studies by Gonzalez et al. (2019), which emphasize the value of low-cost, customizable security systems for domestic and small-scale use. By using off-the-shelf components such as Arduino and HC-05, this project offers an accessible and affordable alternative to commercial smart locks.

III. PROPOSED METHODOLOGY

The proposed system aims to enhance the security and accessibility of door locking mechanisms by utilizing a One-Time Password (OTP) based authentication approach. Traditional locking systems, including mechanical keys and static digital codes, are susceptible to theft, loss, or unauthorized duplication. In contrast, the proposed solution employs dynamically generated OTPs, ensuring that each access attempt is authenticated with a unique and temporary password, thereby significantly reducing the risk of unauthorized access.

The system architecture is centered around the **Arduino UNO** microcontroller, which orchestrates communication between the user interface, security modules, and the locking mechanism. The major components and functionalities of the system are as follows:

A. OTP Generation and Transmission
A four-digit random OTP is generated by the Arduino UNO upon initiation of an access request, typically triggered by an infrared (IR) proximity sensor. This OTP is transmitted to the registered mobile number of the user via a **GSM module (SIM900A)**. The transient nature of the OTP ensures it is valid for a limited time and for a single use, providing a secure form of authentication.

B. User Authentication
The user inputs the received OTP using a **4x4 matrix keypad** integrated into the system. The microcontroller compares the input with the stored OTP in its volatile memory (RAM). If the input matches the generated OTP, the door is unlocked by activating a **solenoid lock** through a digital control signal.

C. Feedback and Display
An **I2C-enabled LCD module** is used to provide real-time feedback to the user. The system displays messages such as “OTP Sent,” “Enter OTP,” “Access Granted,” or “Invalid OTP,” enhancing user interaction and usability.

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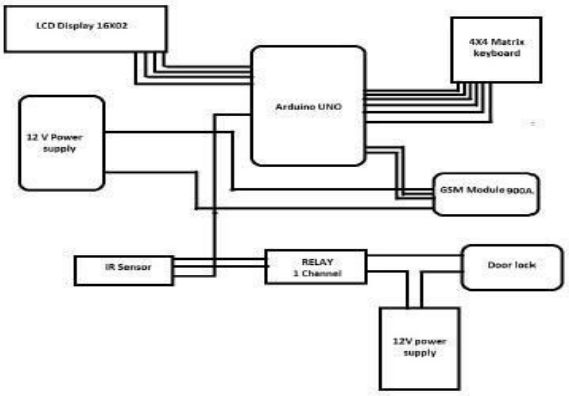
D. Expandability and Integration

The proposed design supports easy integration with other security systems such as CCTV cameras, fingerprint scanners, or RFID modules. Furthermore, the architecture can be extended to support multiple users and cloud-based OTP generation and logging, making it suitable for smart home, office, and industrial security applications.

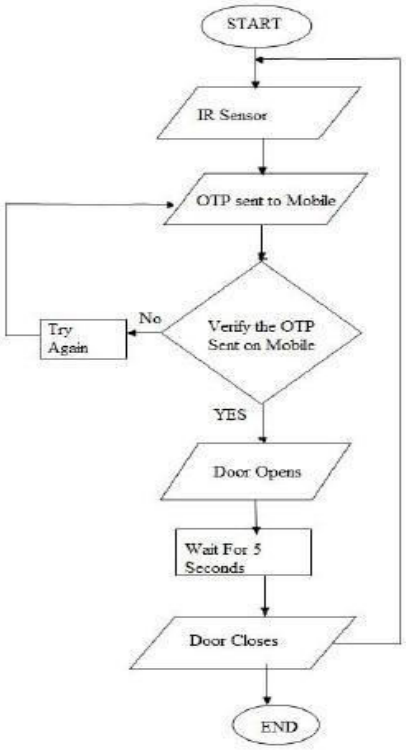
F. Cost and Implementation

The system uses readily available and low-cost hardware components, making it a cost-effective and scalable solution for enhanced door security. It is suitable for both residential and commercial applications where secure, flexible, and keyless access is desired.

IV. BLOCK DIAGRAM



V. FLOW CHART



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VI. FUTURE SCOPE

While the proposed OTP-based door lock system successfully addresses several security concerns associated with traditional locking mechanisms, there is significant potential for further enhancement and expansion. Future developments can focus on the following areas:

1. **Biometric Integration**
Incorporating biometric authentication methods such as fingerprint or facial recognition can provide multi-factor authentication (MFA), further strengthening the security of the system.

2. **IoT and Cloud Connectivity**
Integrating the system with Internet of Things (IoT) platforms can allow remote monitoring and control via smartphones or web applications. OTP generation and verification can also be managed through cloud-based services for greater flexibility and scalability.

3. **Mobile App Development**
A dedicated mobile application can be developed to manage user access, receive OTPs via push notifications, track entry logs, and provide alerts in real-time.

4. **Data Logging and Analytics**
Storing access logs on a local database or cloud server can be useful for auditing purposes and analyzing user behavior patterns for enhanced security management.

5. **Power Backup and Fail-Safe Mechanisms**
Adding a battery backup system or solar-powered module would ensure uninterrupted operation during power outages. Additionally, incorporating emergency override features can improve system reliability.

6. **Multiple User and Role-Based Access**
The system can be upgraded to support multiple users with varying levels of access rights (e.g., admin, guest), allowing more flexible control over restricted areas.

7. **Encryption and Secure Communication**
To prevent data interception, future versions can implement secure encryption protocols (e.g., AES, RSA) for OTP transmission and user data storage.

By integrating these advancements, the OTP-based door lock system can evolve into a comprehensive smart security solution capable of meeting the demands of both residential and industrial applications in an increasingly connected world.

VII. CONCLUSION

In this paper, a secure and cost-effective OTP-based door lock system has been proposed and implemented using Arduino UNO and GSM communication technology. The system enhances traditional access control methods by introducing dynamic password generation, eliminating the vulnerabilities associated with physical keys and static passwords. The integration of hardware components such as the GSM module, keypad, LCD display, and solenoid lock ensures reliable and real-time authentication, while maintaining user convenience.

The results demonstrate that the system provides a higher level of security, flexibility, and ease of use compared to conventional locking mechanisms. It is particularly suitable for smart homes, offices, and other restricted areas where secure access control is critical. The modularity of the system also allows for future enhancements such as biometric authentication, cloud connectivity, and multi-user access management.

Overall, the proposed OTP-based door lock system offers a practical solution for modern security challenges and presents a promising approach for advancing secure access technologies.

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