Report File

on

Door Automation System (Knock Lock)

Internet of Things Mini Project

(LPCIT-111)

July-December 2024

Bachelor of Technology (Information Technology)

Submitted by: -

Ekdeep Singh Gill (2203822)

Garv Singla (2203823)

Hardeep Singh (2203829)

Harish Kumar (2203830)

Himank Handa (2203836)

Submitted to: -

Prof. Himani Sharma

Department of Information Technology

Guru Nanak Dev Engineering College Ludhiana – 141006

Acknowledgment

We would like to express our sincere gratitude to all those who contributed to the completion of this report on Door Automation System (Knock Lock). First and foremost, we extend our thanks to Prof. Himani Sharma, our project supervisor, for their guidance, support, and valuable insights throughout the research process. Their expertise in the field of Internet of Things has been instrumental in shaping the direction of this report. Furthermore, we would like to acknowledge the contributions of our colleagues and peers who provided feedback, suggestions, and encouragement during various stages of this project. Their input has been invaluable in refining our analysis and enhancing the quality of this report.

Introduction

A **Door Automation System** (commonly referred to as a **Knock Lock**) is an innovative security solution that provides convenient access control and enhances safety for homes, offices, or other secure areas. It utilizes various electronic components and sensors to automate the process of locking and unlocking a door based on user input, such as a specific knock pattern, eliminating the need for traditional keys or physical touchpoints.

The system is powered by **Arduino**, a versatile open-source microcontroller platform, which acts as the brain of the project, managing inputs, processing data, and controlling outputs. The **Knock Lock** system typically uses a combination of sensors, actuators, and indicators like LEDs, LCD displays, piezo buzzers, and servo motors for its operation. Each of these components serves a specific purpose in ensuring the door unlocks in response to the correct knock pattern and provides feedback to the user.

Key Components of the Knock Lock System:

1. **Arduino Board (Microcontroller):** The Arduino board is at the core of the automation system. It is responsible for receiving inputs (e.g., knock pattern) through sensors, processing the data, and triggering the appropriate response (unlocking the door). Arduino's programmability allows for customization of the knock patterns and security protocols.
2. **LED Indicators:** LEDs are used as visual indicators to provide feedback to the user. For example, a green LED might light up when the correct knock pattern is detected, signalling that the door is unlocked. Red LEDs could indicate incorrect input or a failed attempt.
3. **LCD Display:** The LCD (Liquid Crystal Display) can be used to show messages, such as “Please Knock” or “Access Denied,” to inform the user of the system's status. It is an additional feedback mechanism that enhances the user experience and allows for dynamic display of instructions or error messages.

4. **Servo Motor:** The servo motor is used to physically unlock or lock the door based on the processed input from the knock pattern. It can rotate to disengage the locking mechanism, allowing the door to be opened once the correct pattern is recognized.
5. **Piezo Sensor:** The sensor detects the specific knock pattern made by the user. This could be a series of taps, such as a combination of short and long knocks, which the system recognizes and matches against a stored pattern.

This **Knock Lock** system not only provides a unique and secure way to automate door access but also adds a layer of convenience and novelty to everyday security solutions. With the flexibility and ease of use of the Arduino platform, the system can be customized to fit a wide variety of use cases, making it an ideal solution for home automation, office entry, and even innovative access control for other secured spaces.

Problem Formulation

In today's world, security and convenience are essential aspects of both residential and commercial spaces. Traditional lock systems, such as mechanical locks or keycards, can be easily lost, stolen, or forgotten, posing security risks. Moreover, physical access control methods require users to carry keys or cards, which can be inconvenient and vulnerable to unauthorized access.

While various automated security systems, such as keypad entry or RFID-based locks, offer some level of convenience, they still depend on physical devices (like keys, cards, or codes) that can be compromised. There is also a growing demand for touchless and more innovative solutions in the context of hygiene concerns and a desire for seamless entry experiences.

A **Knock Lock** system offers a unique solution by leveraging a simple, but secure, biometric-like method—recognizing a user's **knock pattern** as a form of authentication. This system would allow for door automation where the user can gain access simply by tapping on the door in a predefined sequence, without the need for keys, cards, or PINs. However, this technology introduces a series of challenges:

1. **Security:** The knock pattern must be unique enough to avoid being easily guessed or replicated, preventing unauthorized access.
2. **Accuracy of Knock Detection:** The system needs to accurately detect and differentiate between various knock patterns, even when external factors (such as background noise) might affect detection.
3. **Real-Time Feedback and User Interaction:** The system must provide clear and immediate feedback to the user, indicating whether the knock was successful or if access is denied, using visual (LEDs, LCD) and auditory (buzzer) feedback.
4. **Cost-Effectiveness and Simplicity:** The solution should be affordable and easy to implement using basic components, such as an **Arduino** board, **sensors**, and **actuators**.

5. **Customization:** The system should allow users to define and change knock patterns for different individuals, offering flexibility and scalability in access control.

Problem Definition

The main problem addressed by the **Knock Lock** system is to provide a **secure, convenient, and automated door access solution** that eliminates the need for traditional keys or security cards while ensuring that only authorized users can gain entry. The system must:

- Recognize a unique knock pattern to unlock the door.
- Prevent unauthorized access by rejecting incorrect knock patterns.
- Provide **feedback** to the user to confirm successful or failed access attempts.
- Be simple and cost-effective, leveraging easy-to-use components like **Arduino** and sensors.
- Be reliable and able to operate in varying environmental conditions with accurate knock detection.

Goals of the Problem:

- **Enhance Security** through a unique knock pattern that is difficult to replicate.
- **Automate Access Control** by using an Arduino-based system that can unlock the door when the correct knock pattern is detected.
- **Improve User Experience** with clear feedback (visual and auditory) to guide users during interaction with the system.
- **Offer a Simple, Cost-Effective Solution** that does not require expensive or complex hardware, making it suitable for DIY or small-scale applications.

By solving this problem, the **Knock Lock** system aims to provide a **novel and secure method of automating door access** that is user-friendly, hygienic, and resistant to common security vulnerabilities.

Objectives

The primary objective of the **Knock Lock** system is to create a secure, automated, and user-friendly access control solution for doors. By utilizing an Arduino-based system with sensors and actuators, the project aims to meet various functional and performance goals. Below are the key objectives of the **Door Automation System**:

1. **Secure Access Control:**
    - The system aims to provide an advanced and secure method for door entry through a **unique knock pattern**. The user can unlock the door by simply knocking in a predefined sequence, ensuring that only those who know the pattern can gain access.
2. **Automation of Door Locking and Unlocking:**
    - One of the main objectives is to automate the process of locking and unlocking the door. The system uses a **servo motor** to physically control the door lock, removing the need for manual intervention.
3. **User-Friendly Interface:**
    - The system should be easy to use and interact with. It aims to provide **visual and auditory feedback** to the user through **LED indicators**, a **LCD display**, and a **piezo buzzer**. This feedback informs the user of the system's status, such as whether the knock pattern is correct or if access is denied.
4. **Customizable Security Patterns:**
    - The system provides the ability to **program and customize knock patterns**. This means the door's security can be tailored to a specific user or group of users, allowing flexibility in how access is granted.
5. **Increased Convenience and Efficiency:**
    - The knock lock system aims to eliminate the need for traditional keys, keycards, or PINs, offering a **quick and efficient way** to unlock the door. This is especially useful in homes or offices where

people may often forget keys or want to avoid physical touchpoints for hygiene reasons.

6. **Low-Cost and Simple Implementation:**
    - Using readily available components such as **Arduino**, **LEDs**, **piezo buzzers**, and **servo motors**, the system should be **cost-effective** and easy to build, making it accessible for hobbyists, students, and DIY enthusiasts. The aim is to provide a low-cost yet functional solution to enhance security.
7. **Real-Time Feedback and Alerts:**
    - The system should be capable of providing **real-time feedback** to the user about the status of the lock (e.g., unlocked, locked, or error condition). The **LCD screen** will display messages such as "Access Granted" or "Incorrect Knock," while the **piezo buzzer** will sound alerts for both successful and failed attempts.

By achieving these objectives, the **Knock Lock** system provides a highly secure, customizable, and convenient solution for automating door locks while demonstrating the capabilities of the Arduino platform in creating practical, real-world applications.

Connections & Code

Components:

1. Arduino Board (e.g., Arduino Uno)
2. 3 LEDs (Green, Red, Yellow)
3. LCD (16x2)
4. Piezo Buzzer
5. Servo Motor

Hardware Connections:

- LEDs: Connect LEDs to pins 2, 3, and 4 (Green, Red, Yellow).
- LCD: Connect the LCD as per standard pinout (using Liquid Crystal library).
- Piezo Sensor: Connect to pin A0.
- Servo Motor: Connect to pin 9.

Code:

```
#include <LiquidCrystal.h>
#include <Servo.h>

// Pin Definitions
const int piezoPin = A0;       // Piezo sensor connected to analog pin A0 (as knock sensor)
const int piezoBuzzerPin = 6;  // Same piezo connected to digital pin 6 (as buzzer)
const int greenLedPin = 2;     // Green LED for success
const int redLedPin = 3;       // Red LED for failure
const int yellowLedPin = 4;    // Yellow LED for detecting tap
const int servoPin = 9;        // Servo motor to unlock door

// Knock pattern: 1 = tap, 0 = no tap
int knockPattern[4] = {1, 0, 1, 1}; // Example pattern: short tap, no tap, short tap, short tap
```

```
int detectedPattern[4];  // Array to store detected taps
int patternIndex = 0;    // Index for the detected pattern

// Servo object
Servo doorServo;

// LCD object using 4-bit mode
LiquidCrystal lcd(7, 8, 9, 10, 11, 12);  // RS, E, D4, D5, D6, D7 pins

int threshold = 500; // Threshold for detecting a knock (this value might need to be adjusted)

// Function to read the piezo sensor and detect knocks
int readKnockSensor() {
  int sensorValue = analogRead(piezoPin);  // Read the piezo sensor value
  return sensorValue;
}

void setup() {
  // Initialize pins
  pinMode(greenLedPin, OUTPUT);
  pinMode(redLedPin, OUTPUT);
  pinMode(yellowLedPin, OUTPUT);
  pinMode(piezoBuzzerPin, OUTPUT); // Piezo buzzer as output for feedback

  // Initialize servo
  doorServo.attach(servoPin);
```

```
  // Initialize LCD
  lcd.begin(16, 2);   // Set up the LCD for 16 columns and 2 rows
  lcd.setCursor(0, 0);
  lcd.print("Knock to unlock");

  // Initialize servo to locked position (0 degrees)
  doorServo.write(0); // Locked position
}

void loop() {
  int sensorValue = readKnockSensor();  // Read the piezo sensor

  // Detect knock (tap)
  if (sensorValue > threshold) {  // If the sensor value exceeds the threshold
    detectedPattern[patternIndex] = 1;  // Register a tap
    digitalWrite(yellowLedPin, HIGH);  // Yellow LED indicates a tap is detected
    tone(piezoBuzzerPin, 1000, 200); // Short beep on tap detection
    delay(300); // Wait a bit before resetting the detection
    digitalWrite(yellowLedPin, LOW);  // Turn off yellow LED
  } else {
    detectedPattern[patternIndex] = 0;  // No tap detected
  }

  // Update pattern index
  patternIndex++;

  // Once 4 knocks are detected, check if they match the pattern
  if (patternIndex >= 4) {
    patternIndex = 0;  // Reset pattern index
```

```
// Check if the detected pattern matches the stored knock pattern
bool correctPattern = true;
for (int i = 0; i < 4; i++) {
  if (detectedPattern[i] != knockPattern[i]) {
    correctPattern = false;
    break;
  }
}

// Provide feedback to the user
if (correctPattern) {
  digitalWrite(greenLedPin, HIGH);  // Green LED for success
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("Access Granted");
  doorServo.write(90); // Unlock the door (Servo moves to 90 degrees)
  tone(piezoBuzzerPin, 2000, 500); // Long beep on success
  delay(3000); // Keep the door unlocked for 3 seconds
  doorServo.write(0); // Lock the door (Servo back to 0 degrees)
} else {
  digitalWrite(redLedPin, HIGH);  // Red LED for failure
  lcd.clear();
  lcd.setCursor(0, 0);
  lcd.print("Access Denied");
  tone(piezoBuzzerPin, 500, 500); // Beep on failure
  delay(3000); // Wait for a while before resetting the system
}
```

```
    // Reset LEDs after 3 seconds
    digitalWrite(greenLedPin, LOW);
    digitalWrite(redLedPin, LOW);
    lcd.clear();
    lcd.setCursor(0, 0);
    lcd.print("Knock to unlock");
  }
}
```

How the Knock Lock System Works: The system is designed to work as follows:

1. The user taps on the door in a specific pattern.
2. The knock sensor detects the knocks and sends the data to the Arduino.
3. The Arduino processes the pattern and compares it with a predefined "authorized" knock pattern stored in memory.
4. If the pattern matches, the Arduino triggers the servo motor to unlock the door.
5. Visual and auditory feedback is provided via the LEDs and piezo buzzer, signalling the success or failure of the knock recognition.
6. If the knock pattern is incorrect, the system denies access and alerts the user with error messages on the LCD display and sound from the piezo buzzer.

This **Knock Lock** system not only provides a unique and secure way to automate door access but also adds a layer of convenience and novelty to everyday security solutions. With the flexibility and ease of use of the Arduino platform, the system can be customized to fit a wide variety of use cases, making it an ideal solution for home automation, office entry, and even innovative access control for other secured spaces.

Future Scope

The **Door Automation System** using **knock detection** (piezo sensor), **servo motor**, **LEDs**, **LCD**, and **piezo buzzer** has a promising future scope for enhancements and potential applications. As technology continues to evolve, there are several areas where this system could be expanded or improved for practical use. Below are some of the future scopes for this project:

1. Integration with Mobile App or Web Interface

- **Mobile App Control**: The system could be upgraded to include **Bluetooth** or **Wi-Fi** modules (such as **HC-05** for Bluetooth or **ESP8266/ESP32** for Wi-Fi) to allow users to control the lock remotely through a **mobile app** or **web interface**. This would enable users to unlock the door or check the status from anywhere.
- **Push Notifications**: Integrating with a mobile app could enable **push notifications** to alert the user when an incorrect knock pattern is entered or if someone is attempting unauthorized access.

2. Enhanced Security Features

- **Fingerprint or Face Recognition Integration**: To make the system more secure, you could integrate **biometric authentication** methods, such as a **fingerprint sensor** (e.g., **R305 Fingerprint sensor**) or a **camera module** with **face recognition** capabilities. The system could then combine **biometric authentication** and **knock pattern detection** to allow access, providing **multi-factor authentication**.

3. IoT Integration

- **Cloud-based Logging and Monitoring**: The system could be connected to the **cloud** (via **IoT** platforms like **ThingSpeak**, **Blynk**, or **Google**

Firebase) to store logs of access attempts, track time and date, and alert the user of any suspicious activity. This could provide a secure, accessible record for security purposes.

- **Smart Home Integration**: The system could be integrated into a larger **smart home ecosystem**, allowing it to work alongside other devices like **smart locks**, **security cameras**, and **home automation systems**. It could be controlled and monitored using a single interface such as **Google Home**, **Amazon Alexa**, or **Apple HomeKit**.

4. Biometric Hybrid System

- **Combined Authentication Methods**: For higher security, the system could be upgraded to require multiple methods of authentication:
  - **Knock + Password**: The system could require a specific knock pattern followed by a PIN code.
  - **Knock + Facial Recognition**: The system could detect a knock pattern and then use **face recognition** (with a camera module) for final access approval.

5. Multi-Door System

- **Centralized Management**: The knock-lock system could be adapted to control **multiple doors** in a building or home, each with its own lock mechanism, all controlled by a central unit. A user could manage multiple door access using their knock pattern or mobile app.

6. Accessibility and Customization

- **Sound and Vibration Feedback**: For users with hearing or mobility impairments, the system could incorporate **vibration feedback** or provide a **visual signal** when access is granted or denied.

- **Custom Knock Patterns**: The system could allow users to set their own knock patterns, making it more personalized and secure.

Conclusion

The **Door Automation System (Knock Lock)** based on **Arduino** has tremendous potential for future developments. With improvements in **security features**, **remote control**, **biometric integration**, **energy** and **smart home compatibility**, this system could become an integral part of modern home automation and security solutions. As technology advances, the system could evolve from a simple door lock to a comprehensive, multi-feature security solution that is smarter, more convenient, and more secure.

References

- WWW.WIKIPEDIA.COM
- WWW.ARDUINO.COM
- WWW.GEEKSFORGEEKS.ORG
- WWW.JAVATPOINT.COM