Product Design Practice - EC308P

Product Manual
Door Unlock System
(Knock To Unlock)

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About the product

A door unlocking system by knocking is a product that addresses the need for a simple, reliable, and discreet access control system for residential and small commercial settings. The traditional method of using physical keys can be cumbersome and inconvenient, especially when multiple people need access to the same door. Other types of access control systems, such as biometric or key card systems, can be expensive and complicated to install and maintain. A door unlocking system by knocking offers a cost-effective and easy-to-use alternative, as it requires only a specific knock pattern to unlock the door. This makes it a suitable option for situations where a high level of security is not required, and where the convenience and simplicity of the system are the main considerations. Door unlocking systems by knocking are typically used in residential or small commercial settings, where a high level of security is not required. They are generally less expensive than other types of access control systems, such as bio-metric or key card systems.

A door unlocking system by knocking typically consists of a sensor or microphone to detect the specific knock pattern, a micro controller to process the signal, and an actuator to trigger the unlocking mechanism. The system is usually programmed to recognize a specific knock pattern that has been pre-stored in its memory. When a user knocks on the door, the system records the sound or vibration pattern and compares it to the pre-stored pattern. If the pattern matches, the system unlocks the door and allows the user to enter. Door unlocking systems by knocking are generally less expensive than other types of access control systems, and they can be easily installed and maintained. They are also a discreet method of authentication, as the user does not need to input a code or use a device that may draw attention. However, they may be less secure than other methods of authentication, as the knock pattern can be mimicked or replicated by unauthorized individuals.

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Chapter 1

Introduction

A door unlocking system by knocking is a type of access control system that uses sound or vibration patterns to authenticate users and unlock a door. This type of system offers a simple, reliable, and discreet way to control access to a space. It is typically used in residential and small commercial settings where a high level of security is not required, but convenience and ease of use are important. The system is typically composed of a sensor or microphone to detect the specific knock pattern, a microcontroller to process the signal, and an actuator to trigger the unlocking mechanism. The system is programmed to recognize a specific knock pattern that has been pre-stored in its memory. When a user knocks on the door, the system records the sound or vibration pattern and compares it to the pre-stored pattern. If the pattern matches, the system unlocks the door and allows the user to enter.

In this way, a door unlocking system by knocking offers an alternative to traditional methods of access control, such as physical keys or key cards. It can be a cost-effective and easy-to-use option, especially in situations where multiple people need access to the same door or where a high level of security is not required. However, it is important to evaluate the security, usability, and practicality of the system for the specific use case before implementing it. Current locks and the locking framework are undeniably more perplexing and frequently utilize a specked component on the key which give a more noteworthy security. Yet, the significant drawback now days is that it's the equivalent 'lock and key' system, meaning, the key can continuously be reproduced with some work. One of the arrangements is to dispose of the 'lock and key' component itself totally. This paper plans to do likewise by laying out solid security basing on a 'Secret knocking pattern', hence the name, "Knock Based Security System". This framework eliminates the feeling of dread toward replication as there is no key required to be reproduced.

1.1 Aim

To provide a secure and convenient way to unlock a door using Knock method and to develop a knock pattern door unlocking system that is reliable, secure, and easy to use.

1.2 Objective

The objective of a door unlocking system by knocking is to provide a secure and convenient method for unlocking doors. The system should also be customizable, compatible, reliable, and cost-effective to meet user preferences and requirements. By meeting these objectives, the system can provide a secure and convenient alternative to traditional key-based locks, improving overall user experience and security.

1.3 Problem Statement

- How can security and reliability be achieved with the Knock to Unlock?
- How can the Knock to Unlock compete with other digital solutions available on the market?
- Existing electronic locking systems are often expensive, complex, and difficult to install and maintain?

1.4 Motivation

There are several reasons to be motivated to design a door unlocking system:

- **Security**: The primary motivation for a door unlocking system is to provide a secure way of controlling access to a secured area. The system should prevent unauthorized individuals from gaining access, which can help to keep the area and its contents safe.
- **Convenience**: A door unlocking system can provide a convenient way of accessing a secured area. Instead of having to carry physical keys, authorized individuals can simply use a code, card, or biometric identifier to unlock the door.
- **Access Control**: A door unlocking system can be used to manage different access levels for different individuals. For example, some users may only be able to access the area during certain times or on certain days.
- **Higher costs**: Traditional door locks can be costly to replace or rekey when keys are lost or stolen. A knock pattern-based door unlocking system can be cost-effective in the long run, as there is no need for costly key duplication or lock replacement.
- **Compatibility issues**: Traditional door locks may not be compatible with new technologies, such as smart home systems or security cameras. A knock pattern-based door unlocking system can be integrated with these technologies, providing a seamless and comprehensive security solution.

There are several door unlocking systems by knocking that are currently available in the market, such as the KNOCKI, KNOCKLOCK, these products use different technologies to detect the knock pattern, but all work on the same principle of using sound or vibration patterns to authenticate users and unlock the door.
There are some potential problems with these available products

- **Security concerns**: Some of these products may not be very secure, as the knock pattern can be easily replicated or mimicked by someone who knows the pattern. This can compromise the security of the system and allow unauthorized individuals to gain access to the space.
- **Compatibility**: Some of these products may not be compatible with all types of doors or locking mechanisms, which can limit their usefulness in certain situations. It is important to ensure that the product is compatible with the specific use case before purchasing it.

- **Usability**: Some users may find these products difficult to use or confusing, particularly if they are not familiar with the knock pattern. This can lead to delays or errors in accessing the space, which can be frustrating and time consuming.
- **Price**: Some of these products can be quite expensive, which may be a barrier to adoption for some users, particularly in small residential or commercial settings.

There are several potential solutions that can address the above-mentioned problems:

- **User education**: Providing clear and concise instructions on how to use the system can improve usability and reduce user errors. This can include providing visual aids, such as diagrams or videos, that demonstrate how to use the system.
- **Compatibility testing**: Thoroughly testing the system for compatibility with different types of doors and locking mechanisms can help ensure that it will work effectively in the specific use case.
- **Price optimization**: Developing cost-effective door unlocking systems by knocking that are affordable for small residential or commercial settings can encourage adoption and increase the popularity of the technology.
- **Advanced sound detection technology**: Using advanced sound detection technology, such as noise cancellation or frequency analysis, can improve the accuracy of the system in detecting the knock pattern, even in noisy environments or when the user knocks too softly or too loudly.
- **Low maintenance**: A knock pattern-based door unlocking system requires low maintenance compared to some other electronic locking systems. It does not require battery replacement or frequent card/fob replacement.

Overall, a knock pattern-based door unlocking system can provide a secure, convenient, low maintenance, compatible, and cost-effective solution to the problems faced by the existing products mentioned above.

Chapter 2

Design of Knock to Unlock

The design of a door unlocking system by knocking typically involves several modules, including a sound detection module, a microcontroller, a power supply module, and a locking mechanism. The sound detection module is responsible for detecting the sound of a knock and converting it into an electrical signal. The microcontroller then processes this signal and compares it to a predetermined knock pattern to determine if the correct sequence has been entered. If the correct sequence is detected, the microcontroller sends a signal to the locking mechanism to unlock the door.

The power supply module provides power to the system, and may include a backup battery to ensure the system remains operational during power outages. The locking mechanism can be an electric strike, magnetic lock, or other type of locking mechanism, and should be compatible with the door being secured.

Overall, the design of a door unlocking system by knocking should prioritize security, reliability, and convenience, while also being customizable and cost effective to meet user requirements.
This project can be divided into three parts:

Module -1: Design of software to record and analyze the knocks.
Module -2: Design of the mechanical system for turning the lock.
Module -3: Design for set up of sensors to communicate with a microcontroller. which controls the turning mechanism.
Module -4: Final Design of the product.

2.1 Design of Module-1 : Design of Software to record and analyze the knocks

The program running on the Arduino Uno is based upon a structure of different states, where each state completes a specific task. The program includes the following states:

- Listening for a knock
- Knock sequence recording
- Knock sequence analyzing
- Locking/unlocking of the door
- Recording of new secret knock sequence
- Calibration of piezo sensor thresholds

After a state has completed its task, the program jumps into another state, which one depending on the outcome of the completed task. If for example the state "Knock sequence analyzing" determines that the knock sequence was correct, the program will enter the state" Locking/unlocking of the door." To allow the user to manually lock/unlock the door with the lock turning knob or with its corresponding key, the servo motor is only receiving voltage from the Arduino Uno during the locking/unlocking sequence. This allows the motor to rotate freely without any resistance when it is not in use, thus allowing the door lock to be used as originally intended.

A key feature for the knock rhythm recognition to work properly was for it to be able to recognize knock patterns regardless of tempo. Therefore, the code analyzes the knock pattern by dividing all time periods in between the knocks with the longest time period. Thereby, all time periods become expressed as fractions of the longest one in the sequence. The classification of a knock rhythm as correct or incorrect is simply done by measuring the difference between the registered knock sequence and the secret knock sequence. If the largest difference between the two vectors is within a certain tolerance, the knock is classified as correct.

2.2 Design of Module-2 : Design of the mechanical system for turning the lock

The mechanical system for turning the lock in a door unlocking system using a **Solenoid lock** typically involves a solenoid, a linkage mechanism, and a mounting bracket. The solenoid is responsible for providing the linear force needed to actuate the lock mechanism, while the linkage mechanism converts this linear motion into rotational motion that can be used to turn the lock. The mounting bracket secures the solenoid and linkage mechanism to the door or door frame, ensuring that they remain in place during operation. The design of the mechanical system should consider factors such as the size and shape of the solenoid lock, the amount of force required to actuate it, and any potential interference with other components of the system. In addition, the mechanical system should be designed to be reliable, durable, and easy to install and maintain. It should also be compatible with the electrical components of the system, ensuring that the solenoid can be controlled by the microcontroller.

Overall, the design of the mechanical system for turning the lock using a **Solenoid lock** should prioritize functionality, compatibility, and ease of use, while also being robust and reliable enough to provide long-term operation. The solenoid lock should be selected based on its specifications, such as the required voltage, current, and stroke length, to ensure that it can provide the necessary force to actuate the lock mechanism.

In addition to the solenoid lock and linkage mechanism, the mechanical system for turning the lock in a door unlocking system may also include a relay. The relay is used to control the solenoid lock, allowing the microcontroller to switch the lock on and off as needed. The **Relay** typically consists of a coil that is connected to the microcontroller and a set of contacts that are used to switch the solenoid lock on and off. When the microcontroller energizes the coil, it causes the contacts to close, which in turn supplies power to the solenoid lock, causing it to actuate and turn the lock. The mechanical system should be designed to accommodate the relay, ensuring that it is securely mounted and properly wired to the microcontroller and solenoid lock. The wiring should be neat and organized, with proper insulation and strain relief to prevent damage or short circuits.

In addition, the mechanical system should be designed to provide sufficient force to actuate the lock, while also being compact and lightweight enough to be mounted on the door or door frame. The linkage mechanism should be carefully designed to ensure smooth and reliable operation, without binding or jamming. Overall, the design of the mechanical system for turning the lock using a solenoid lock and relay should consider factors such as compatibility, reliability, and ease of use, while also being cost-effective and practical to manufacture and install. With proper design and implementation, the system can provide secure and convenient access control for a variety of applications.

2.3 Design of Module-3 : Design for setting up of sensors to communicate with a microcontroller which controls the mechanism.

The design for setting up sensors to communicate with a microcontroller in a door unlocking system typically involves several key steps. The first step is to select the appropriate sensors for the system. In this case, sensors that detect the knocking sequence would be required. Commonly used sensors include **piezoelectric sensors**. These sensors can detect the unique frequency and pattern of the knocking sequence and provide an input signal to the microcontroller.

Once the sensors have been selected, the next step is to place them in a strategic location. The sensors must be placed in a location such as near the door or on the door frame, to ensure that they can detect the knocking sequence effectively. The placement must be such that the sensors are not affected by ambient noise or vibrations.

After the sensors have been placed, they need to be connected to the microcontroller. This is typically done using appropriate wiring and connectors. The microcontroller can then process the input signals from the sensors and determine if the knocking sequence matches the pre-programmed sequence. If the sequence is a match, the microcontroller can then send a signal to the turning mechanism to unlock or lock the door.

Finally, the system should be tested and calibrated to ensure that the sensors are accurately detecting the knocking sequence and that the microcontroller is responding correctly to the input signal. Any necessary adjustments can then be made to ensure optimal performance. Overall, the design for setting up sensors to communicate with a microcontroller in a door unlocking system involves careful consideration of the selection, placement, and connection of the sensors to ensure reliable and accurate detection of the knocking sequence.

The microcontroller can be connected to the **Relay** using appropriate wiring and connectors. The microcontroller can then send a signal to the relay to activate it, which will in turn send a signal to the solenoid lock to either lock or unlock the door. The **Relay** serves as a buffer between the microcontroller and the solenoid lock, ensuring that the microcontroller is not damaged by any high voltage or current surges that may occur during the locking or unlocking process.

The placement of the **Relay** will depend on the specific design of the door unlocking system. In some cases, it may be located near the solenoid lock, while in other cases it may be placed near the microcontroller. The wiring between the microcontroller, relay, and solenoid lock must be carefully planned and implemented to ensure reliable and safe operation of the system.

Overall, the inclusion of a **Relay** in the design for setting up sensors to communicate with a microcontroller in a door unlocking system provides an additional layer of safety and protection for the microcontroller and other electronic components. The sound detection module is connected to the microcontroller through a series of wires, which allow for the transmission of data. When the sound detection module detects the correct knocking pattern, it sends a signal to the microcontroller, which then activates the unlocking mechanism. The microcontroller is programmed to recognize the specific knocking pattern and initiate the unlocking mechanism only when the correct pattern is detected.

2.4 Design of Module-4 : Final Design

The final design of the door unlocking system by knocking consists of a sound detection module, microcontroller, turning mechanism, power supply, and a **solenoid lock**. The sound detection module detects the user's knocking pattern and sends the signal to the microcontroller, which recognizes the pattern and activates the turning mechanism using a **Relay** and **Solenoid lock**. A 12V battery powers the system through a voltage regulator. The solenoid lock, mounted on the door frame, extends a bolt to secure the door when activated. The system is secure, reliable, easy to use, and can be integrated into existing door locks with minimal modifications.

2.4.1 Hardware Requirements

- Arduino UNO
- Relay Module 5V
- Solenoid Lock
- Speaker
- LED
- Resistor 220,10k,1M
- Battery 12V
- Push Button
- Wires
- BreadBoard

Block Diagram

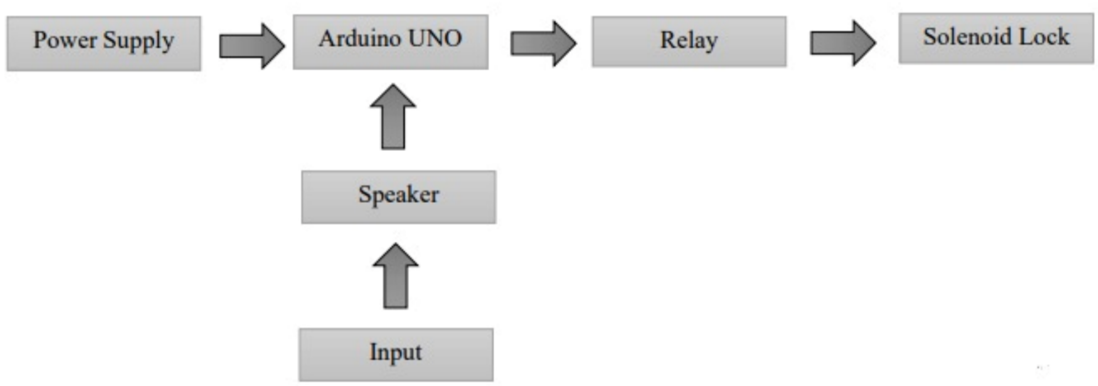

Fig.2.1 Block diagram

The block diagram of the Knock to Unlock system consists of four main components: the knock sensor module, the microcontroller unit (MCU), the solenoid lock, and the power supply. The knock sensor module detects the sound of a knock on the door and sends a signal to the MCU. The MCU processes the signal and compares it to a pre-programmed knock pattern. If the pattern matches, the MCU sends a signal to the solenoid lock, which unlocks the door. The power supply provides power to all the components in the system. Overall, the block diagram outlines the basic functionality and flow of the system, from the detection of the knock to the unlocking of the door.

Arduino UNO

Arduino Uno is a microcontroller board based on the ATmega328P microcontroller chip. It has 14 digital input/output pins, 6 analog inputs, a 16 MHz quartz crystal, a USB connection for programming and power, a power jack, an ICSP header, and a reset button. It is one of the most popular boards in the Arduino family and is widely used in the maker and DIY communities for prototyping and building various projects such as robots, sensors, and electronic devices.

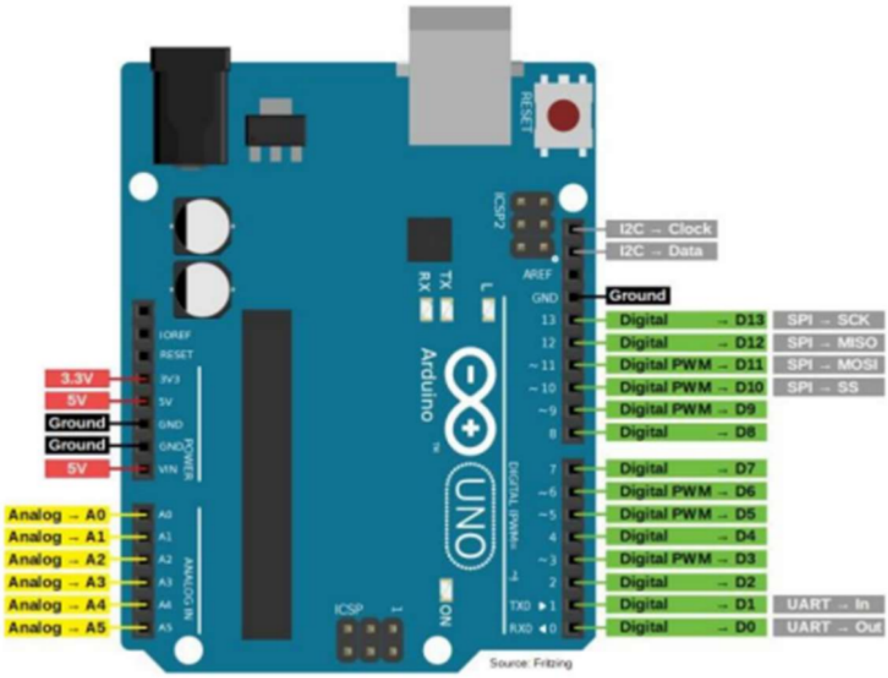

Fig.2.2 Arduino board[1]

The Arduino Uno is programmed using the Arduino Integrated Development Environment (IDE), which allows users to write, compile, and upload code to the board. The code is written in a simplified version of C++, making it accessible to beginners and experts alike. The Arduino Uno can also be expanded using various shields, which are boards that can be plugged into the Arduino Uno to add additional functionalities such as Wi-Fi, Bluetooth, and GPS.

The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc. The board is equipped with sets of digital and analog input/output pins that may be interfaced to various expansion boards and other circuits. The board has14 digital I/O pins (six capable of PWM output), 6 analog I/O pins, and is programmable with the Arduino IDE (Integrated Development Environment), via a type B USB cable. It can be powered by the USB cable or by an external 9-volt battery, though it accepts voltages between 7 and 20 volts.

Relay

A 5V relay is an electrical component used in electronic circuits that works as an electrically controlled switch. It is a type of electromechanical relay that is activated by a small voltage, typically 5V, which energizes the coil and closes the switch contacts. The switch contacts can be used to control a separate circuit, allowing for electrical isolation and protection of sensitive components. The 5V relay is commonly used in microcontroller-based projects, such as those using the Arduino, to switch high-power devices like motors, lights, and other electrical appliances.

Fig.2.3 Relay[1]

Relay module is an electrical switch that is operated by an electromagnet. The relay module function is mainly to switch electrical devices and systems ON or OFF. It also serves to isolate the control circuit from the device or system being controlled. A simple relay consists of wire coil wrapped around a soft iron core When electrical current is passed through a coil, it generates a magnetic field that in turn activates the armature. This movement of the movable contacts makes or breaks a connection with the fixed contact.

Solenoid Lock

A solenoid lock is an electronic lock that uses a solenoid to move a bolt or lever, which locks or unlocks a door or other device. The solenoid is an electromechanical device that converts electrical energy into linear motion, and is activated by an electric current. When the current flows through the solenoid, it creates a magnetic field that pulls the bolt or lever into the locked position. To unlock the device, the current is reversed, causing the solenoid to release the bolt or lever.

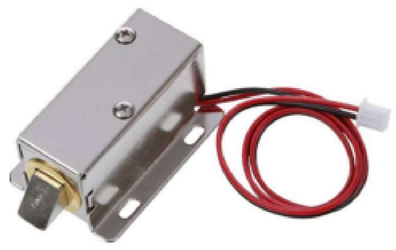

Fig.2.4 Solenoid lock[1]

Solenoid locks are commonly used in security systems and access control systems, as they can be controlled by electronic signals and are more secure than traditional mechanical locks. They are also commonly used in vending machines, ATM machines, and other devices that require a secure locking mechanism. Solenoid locks can be operated by a variety of input devices, such as a keypad, card reader, or biometric scanner.

Speaker

The speaker has a resistance of **8 ohm** and power rating equals to **0.5W**. Its small size allows it to be used in various applications where space is at premium. This is a transducer which converts **electromagnetic energy** into **sound waves**. It receives analog or digital inputs from the from computers or audio players and it converts them into sound waves. It can be used in different applications like simple amplifier projects, general warning alarm for some projects, will also fit in robots projects.

An 8 ohm 0.5W speaker is a type of electro-acoustic transducer that converts an electrical signal into an audible sound. The 8-ohm rating indicates the nominal impedance of the speaker, which is the resistance that the speaker presents to the electrical signal. The 0.5W rating indicates the maximum power that the speaker can handle before it becomes damaged.

Fig.2.5 Speaker[3]

In practical terms, an 8 ohm 0.5W speaker is a small, low-power speaker that can be used for a variety of applications, such as in portable electronic devices, toys, and small sound systems. It is important to match the impedance of the speaker with the output impedance of the amplifier or audio source to ensure maximum power transfer and avoid damaging the equipment.

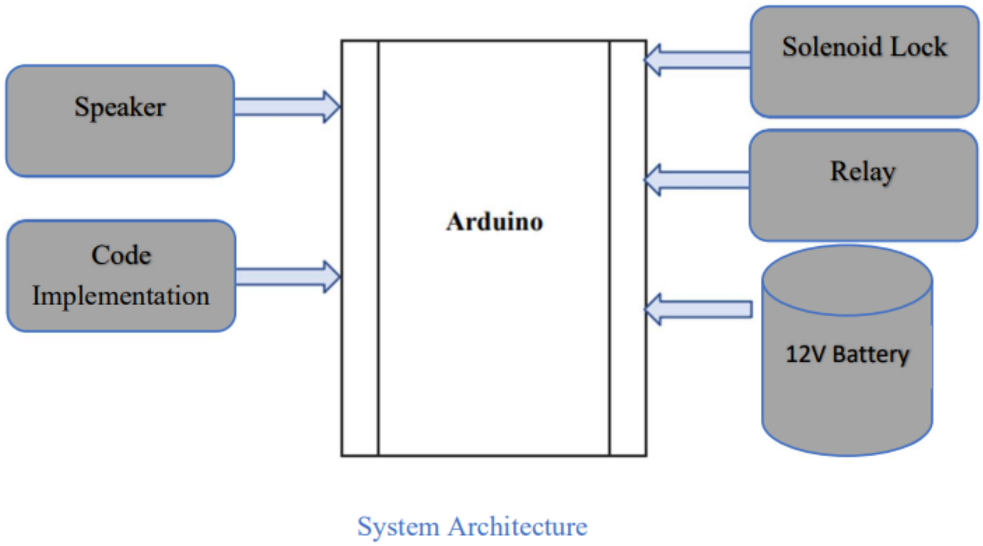

Fig.2.6 System architecture

12V Battery

A 12V battery is a type of rechargeable battery that provides a nominal voltage of 12 volts. It is commonly used as a power source for a wide range of electronic devices, including cars, boats, and solar power systems. The most common type of 12V battery is the lead-acid battery, which is known for its relatively low cost and high reliability. Other types of 12V batteries include lithium-ion, nickel-cadmium, and nickel-metal hydride batteries, which are often used in portable electronics such as cameras and cell phones. The capacity of a 12V battery is measured in ampere-hours (Ah), which represents the amount of charge the battery can deliver over a certain period.

Fig.2.7 Battery[3]

LED

An LED, or Light Emitting Diode, is a semiconductor device that emits light when an electric current passes through it. LEDs are commonly used as indicator lights in electronic devices, and they come in various sizes, colors, and brightness levels. They have a long lifespan and consume less energy than traditional incandescent bulbs, making them a popular choice for lighting applications. LEDs can be powered by a variety of sources, including batteries, AC power supplies, and solar panels.

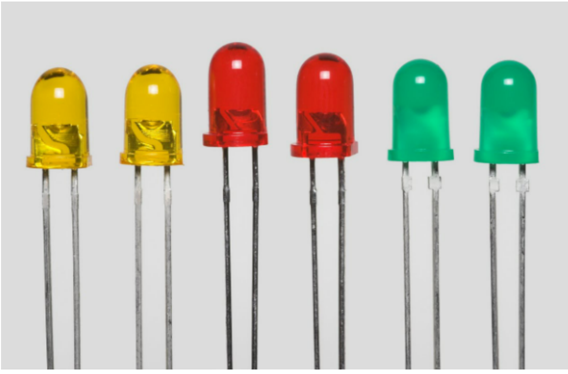

Fig.2.8 LED[3]

Push Button

A push button is a simple mechanical switch that is pressed to make or break an electrical connection. It is usually made up of a button or plunger, a spring, and two contacts. When the button is pressed, it pushes the contacts together, allowing electrical current to flow through the circuit. When the button is released, the spring returns the contacts to their original position, breaking the electrical connection. Push buttons are commonly used in a wide range of electronic devices and applications, from simple toys and games to complex industrial control systems. They come in a variety of shapes, sizes, and colors, and can be momentary or latching, normally open or normally closed, and with or without illumination.

Fig.2.9 Push button[3]

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2.4.2 Flow Chart

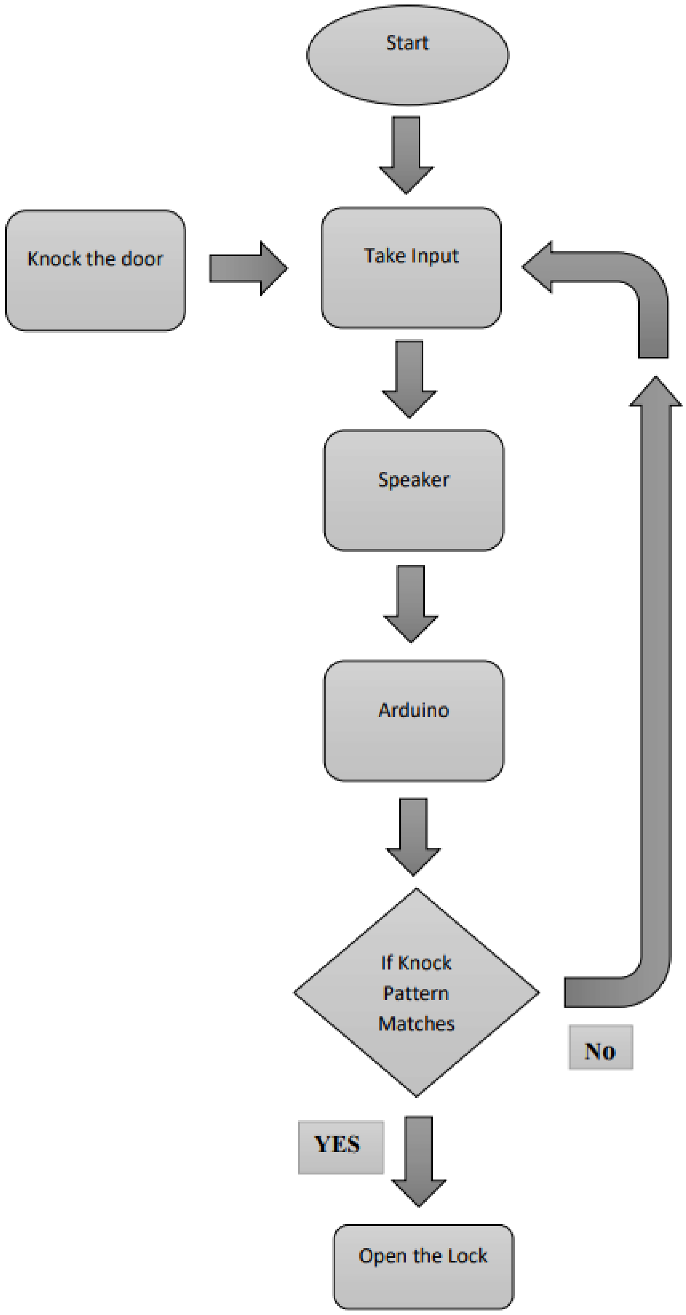


Fig.2.10 Flow chart

The flowchart (**Fig.2.10**) of the door unlocking system by knocking consists of several main stages, including sound detection, sound analysis, decision-making, and lock actuation. The sound detection module uses a piezoelectric sensor to detect knocking sounds and sends the signal to the microcontroller. The microcontroller then analyzes the sound signal to determine if it matches the pre-programmed knocking pattern. If the pattern matches, the microcontroller sends a signal to activate the solenoid lock to unlock the door. If the pattern does not match, the system will continue to wait for a valid knocking pattern or reset if too many incorrect attempts are made. Overall, the flowchart represents the logical sequence of steps necessary for the door unlocking system to accurately detect and recognize knocking patterns and actuate the lock.

2.4.3 Software Requirements

- Arduino IDE

The software requirements for the door unlocking system by knocking typically involve programming the microcontroller, which is usually an Arduino Uno, to recognize the specific knocking pattern of the user and initiate the unlocking mechanism when the correct pattern is detected. To do this, the Arduino IDE (Integrated Development Environment) software is commonly used to write and upload code to the microcontroller.

Arduino IDE

The Arduino Integrated Development Environment (IDE) is the primary software used to program Arduino microcontrollers, including the Arduino Uno. It is a free, open-source software that provides an easy-to-use interface for writing and uploading code to the microcontroller. The Arduino IDE supports several programming languages, including C and C++, and comes with a set of libraries and example codes to help beginners get started. The IDE includes a code editor, compiler, and uploader that can be used to write, verify, and upload code to the Arduino board. It also has a serial monitor that can be used to monitor and debug the serial communication between the microcontroller and the computer. The IDE is available for Windows, Mac OS X, and Linux.

To program the Arduino Uno, the user connects the board to a computer via a USB cable and opens the Arduino IDE. They can then write their code in the IDE's code editor, verify, and compile the code, and upload it to the microcontroller. The

IDE also includes a variety of tools for debugging and troubleshooting code, including a serial monitor for reading and writing serial data and a debugger for stepping through code and inspecting variables. In summary, the Arduino IDE is an essential software requirement for programming the Arduino Uno and is a powerful tool for writing, verifying, and uploading code to the microcontroller.

Algorithm

The algorithm for the door unlocking system by knocking can be divided into several steps:

1. **Initialization**: The system is initialized and all components are powered up.
2. **Sound detection**: The sound detection module listens for a knocking sound and records the sound wave as an input signal.
3. **Signal processing**: The input signal is processed by the microcontroller, which converts the analog signal into a digital signal and analyzes it to determine if it matches the pre-programmed knocking pattern.
4. **Pattern recognition**: If the input signal matches the pre-programmed knocking pattern, the microcontroller sends a signal to the relay.
5. **Relay activation**: The relay receives the signal from the microcontroller and activates the turning mechanism of the lock.
6. **Lock turning**: The turning mechanism, typically a servo motor, physically turns the lock to unlock or lock the door
7. **Feedback**: The LED and speaker provide feedback to the user to indicate whether the door is locked or unlocked.
8. **Power management**: The system continuously monitors the battery level and conserves power when necessary.
9. **Termination**: The system is terminated and all components are powered off.

These steps are implemented in the form of code written in the Arduino IDE, which is uploaded to the Arduino Uno microcontroller.

Chapter 3

Development of Knock to Unlock

After the design phase, the development phase of the knock to unlock system typically involves several steps/Modules.

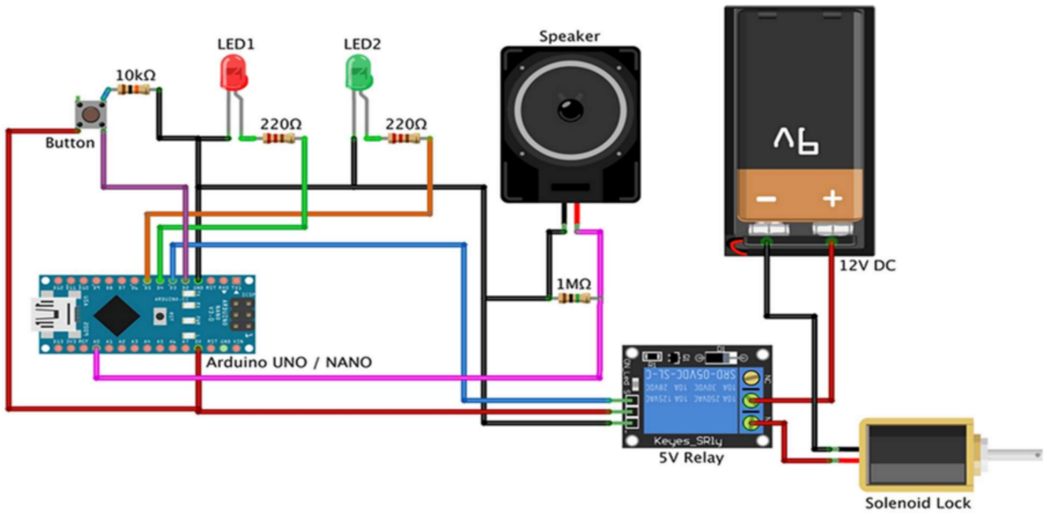
- **Building the hardware**: This step involves physically assembling the components of the system according to the design specifications. This includes wiring the Arduino Uno, sound detection module, relay, servo motor, solenoid lock, and other components, and connecting them to the power supply.
- **Programming the microcontroller**: Once the hardware is built, the microcontroller (Arduino Uno) must be programmed to recognize the unique knocking pattern of the user and activate the unlocking mechanism when the correct pattern is detected. The programming involves writing code in the Arduino IDE, which is then uploaded to the microcontroller.
- **Refining the design**: As the system is improved, adjustments to the design may be necessary to optimize the performance of the system. This may involve making changes to the placement of the components, adjusting the sensitivity of the sound detection module, or fine-tuning the code in the microcontroller.
- **Finalizing the product**: Once the system is functioning properly and all issues have been resolved, the final step is to finalize the product. This involves documenting the design and programming specifications, creating user manuals or guides, and preparing the system for production and distribution.

3.1 Development of Module-1 : Building the hardware

After gathering all the required components, the hardware development phase involves physically building the system according to the design specifications. The first step is to gather all the necessary tools, including a soldering iron, wire strippers, pliers, and a multimeter. The components are then placed on a breadboard or a custom PCB (Printed Circuit Board), and the connections between them are made using jumper wires or by soldering them onto the board (as shown in **Fig.3.1**). It is essential to ensure that all the connections are secure and that there are no loose wires. The wiring process usually starts with connecting the power supply, which in this case is a 9V battery. The battery is typically connected to a voltage regulator, which ensures that the system receives a steady supply of power. The regulator is then connected to the Arduino Uno, which serves as the brain of the system.

Next, the sound detection module is connected to the Arduino Uno. The module typically has three pins: ground, power, and output. The ground and power pins are connected to the corresponding pins on the Arduino Uno, while the output pin is connected to one of the digital input pins on the board. The relay is then connected to the Arduino Uno through a set of wires. The relay typically has four pins: ground, power, signal, and NC (Normally Closed) or NO (Normally Open). The ground and power pins are connected to the corresponding pins on the Arduino Uno, while the signal pin is connected to a digital output pin. The NC or NO pin is connected to the solenoid lock.

Finally, the Solenoid Lock is connected to the Arduino Uno (as shown in **fig.3.1**) through a set of wires. The lock typically has two wires: power, and signal. The power wires are connected to the corresponding pins on the Arduino Uno, while the signal wire is connected to a digital output pin. Once all the connections are made, the system is powered on to ensure that all the components are working correctly. If any issues are identified, they are addressed and fixed.



Circuit

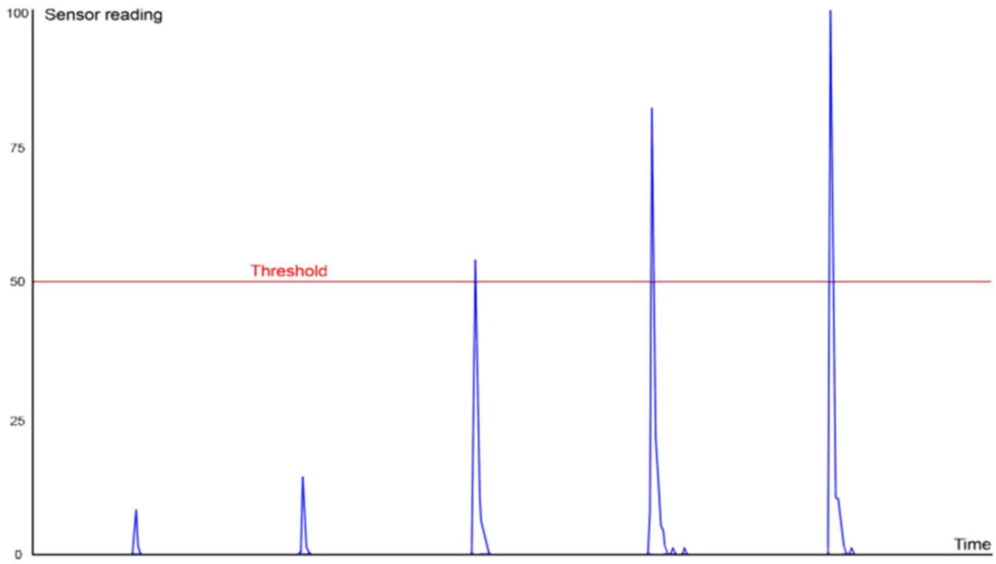
Fig.3.1 Circuit diagram

3.2 Development of Module-2 : Programming the micro-controller

we need to program the Arduino Uno to control the various components of the system. This involves writing the code to interface with the sound detection module and recognize the unique knocking pattern of the user. The code should also control the relay to activate the turning mechanism and unlock the door when the correct pattern is detected.

Once the code is written, it needs to be uploaded to the Arduino Uno using the Arduino IDE. After uploading, the system should be tested to ensure that it is functioning properly. This involves testing the sound detection module and verifying that the knocking pattern is recognized by the microcontroller, as well as testing the relay and Solenoid lock to ensure that they are properly controlling the turning mechanism. Next, the programmer must write the code to read and analyze the signals from the sound detection module. This typically involves setting up a loop that continuously reads the input from the sound detection module and compares it to a pre-defined pattern.

Finally, the system needs to be installed on the door, which involves mounting the solenoid lock to the locking mechanism. The system should be tested again to ensure that it is functioning properly and securely locking and unlocking the door. Overall, programming the microcontroller is a critical step in the development of the door unlocking system by knocking, as it is responsible for controlling the unlocking mechanism based on the user's unique knocking pattern.



Plot of speaker/piezo sensor readings with increasing knock strength, gathered from the Arduino Serial Plotter

Fig.3.2 Speaker/piezo sensor reading

3.3 Development of Module-3 : Refining the design

Refining the design involves making improvements to the system based on feedback and testing. During this phase, the system is tested to ensure that it meets the design specifications and functions as intended. If any issues or flaws are found, they are identified and addressed through changes to the hardware or software.

If the sound detection module is not accurately detecting the knocking pattern, adjustments may need to be made to the sensitivity or filtering settings. Similarly, if the solenoid lock is not unlocking reliably, the power supply or wiring may need to be adjusted. Once the necessary changes are made, the system is tested again to ensure that it is functioning properly. This iterative process of testing and refining continues until the system meets all the design specifications and performs reliably. For the Knock to Unlock system, refining the design may involve testing the accuracy of the sound detection module in recognizing the user's unique knocking pattern, and adjusting the sensitivity or threshold values as necessary. The system may also be tested under various conditions, such as different noise levels or knocking intensities, to ensure that it functions reliably. Additionally, the design of the physical components may be refined to improve the overall appearance and user experience. For example, the solenoid lock or servo motor may be concealed within a sleek housing to give the system a more polished look, and the push-button or sound detection module may be placed in a more accessible location for ease of use. Overall, the refining phase is critical for ensuring that the Knock to Unlock system is both functional and user-friendly, and meets the needs of the intended users.

3.4 Development of Module-4 : Final Development

After the refining, the next step is to finalize the product. This involves ensuring that the product meets all the design requirements and specifications, and that it is ready for use by the end-users. The final product may undergo further testing to ensure that it is reliable and performs as intended.

Documentation and user manuals may also be created during this phase to provide instructions on how to use the product. The manuals may include information on how to install the product, how to troubleshoot common problems, and how to replace components if necessary. Once the product has been finalized, next testing should be done and then it may be prepared for manufacturing or distribution. This could involve creating a bill of materials, determining the cost of manufacturing, and designing packaging for the product. In addition, considerations may need to be made for ongoing maintenance and support of the product. This could include providing technical support to end-users, offering repairs or replacement parts, and continually updating the product as necessary to ensure it remains functional and meets user needs.

Final development is the last phase of the product development process, where the focus is on testing and validation of the product. In this phase, the product is thoroughly tested to ensure that it meets all the design requirements and specifications. The testing process involves functional, performance, and reliability testing. Functional testing involves testing the product's various functions and features to ensure that they operate correctly and according to the design specifications. Performance testing involves testing the product's speed, accuracy, and response time under different conditions to ensure that it performs as expected. Reliability testing involves testing the product's durability and lifespan under different conditions to ensure that it can withstand normal wear and tear. Once the testing is complete, the product is evaluated against the original design specifications, and any necessary modifications are made.

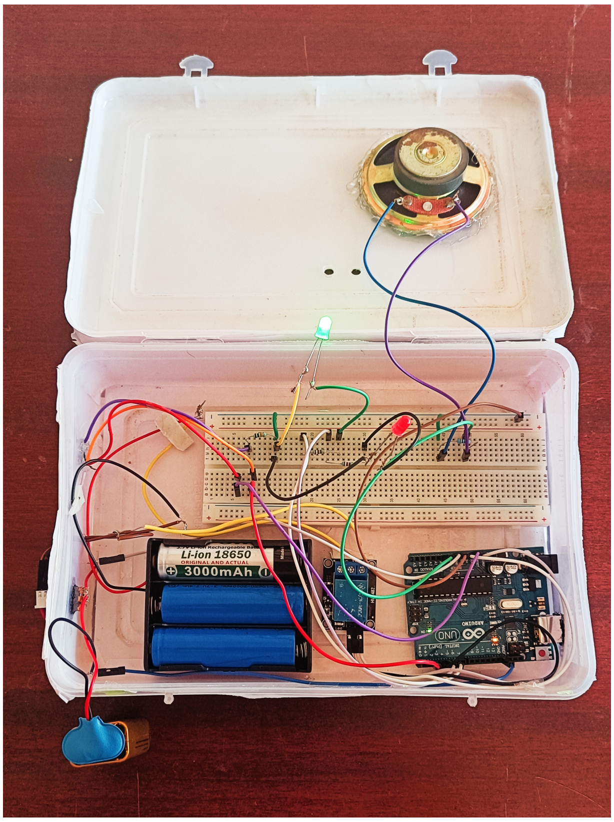


Fig.3.3 Implementation of Circuit

After the modifications are completed, the final version of the product is produced, and a final quality assurance check is performed to ensure that the product meets all the necessary standards. Once the product has passed all the necessary tests and quality checks, it is ready for release to the market. The final phase of development also involves creating user manuals, technical specifications, and packaging designs for the product. Overall, the final development phase ensures that the product is fully functional, meets all the necessary design specifications, and is ready for release to the market.

Once the necessary changes have been made, the product can undergo final testing to ensure that it functions as intended and meets all design specifications. This testing may involve a range of procedures and simulations, such as stress testing, environmental testing, and user testing, to ensure that the product is durable, reliable, and user-friendly.

Chapter 4

Testing and observation of Knock to Unlock

Testing and observation of Knock to Unlock involves validating the functionality of the system and assessing its performance. The system is tested under various conditions to ensure that it operates reliably and accurately. The following steps may be included in testing and observation:

1. **Functionality testing**: The first step is to test the basic functionality of the system, such as detecting knocks and unlocking the door. The system is tested with different knocking patterns to ensure that it recognizes them correctly and unlocks the door only when the correct pattern is detected.

2. **Performance testing**: The system's performance is assessed under various conditions, such as different levels of background noise, varying knock strengths, and different distances between the sound detection module and the door. The system's accuracy, speed, and reliability are measured under these conditions.

3. **User testing**: The system is tested with actual users to get feedback on its usability and effectiveness. Users are asked to use the system to unlock the door and provide feedback on their experience. This feedback is used to make any necessary improvements to the system.

4. **Observations and data collection**: The system is observed during use to gather data on its performance and identify any issues that may arise. This

data is analyzed to determine the system's effectiveness and identify any areas that may require improvement.

5. **Final adjustments**: Based on the observations and data collected during testing, any necessary adjustments are made to the system. This may include adjusting the sensitivity of the sound detection module, refining the knocking pattern recognition algorithm, or making changes to the hardware or software.

6. **Final adjustments**: Based on the observations and data collected during testing, any necessary adjustments are made to the system. This may include adjusting the sensitivity of the sound detection module, refining the knocking pattern recognition algorithm, or making changes to the hardware or software.

4.1 Real time testing by developers

Real-time testing by developers involves putting the product through various tests and scenarios to ensure that it functions as intended and meets the design specifications. The developers perform different types of tests such as functional testing, integration testing, unit testing, and system testing to verify that each component of the system works together as intended. They may also conduct stress testing to evaluate the product's performance under heavy loads or extreme conditions.

During the testing phase, developers also collect data and observe the behavior of the product to identify any potential bugs, glitches, or issues. They may use various debugging tools and techniques to pinpoint and fix any problems that arise. Once the testing is complete, the developers can make any necessary adjustments and improvements to the product before releasing it to the end-users. They may also document the testing results and use them to guide future updates and improvements to the product. During real-time testing, the developers would test the Knock to Unlock system to ensure that it meets the design specifications and functions as expected. They would knock on the door to see if the sound detection module accurately recognizes the unique knocking pattern of the user and triggers the unlocking mechanism. They would also test the system's response time and the reliability of the hardware components such as the servo motor and solenoid lock.

If any issues or malfunctions are identified during testing, the developers would need to identify the cause of the problem and implement necessary rectifications.

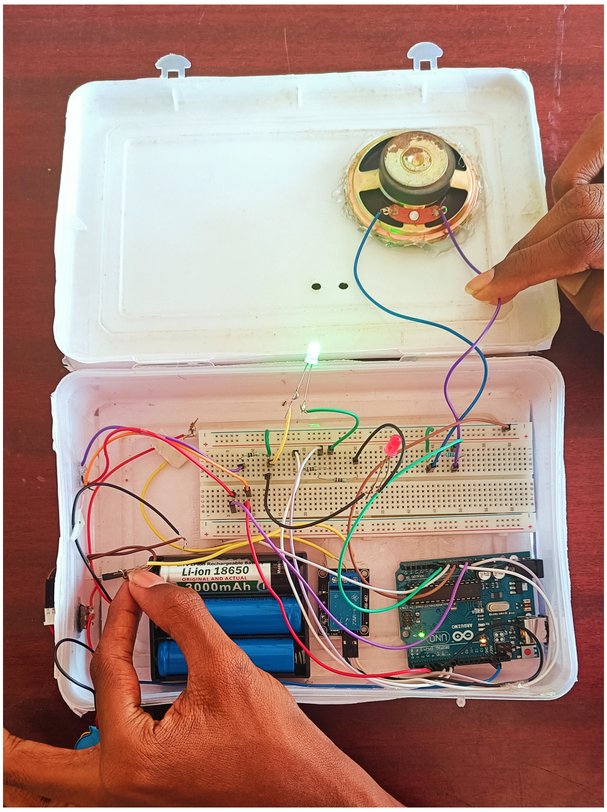


Fig.4.1 Testing

For example, if the sound detection module fails to recognize the knocking pattern consistently, the developers may need to adjust the sensitivity settings or modify the code to improve its accuracy. Similarly, if the servo motor or solenoid lock fails to operate properly, the developers may need to replace faulty components or adjust the wiring connections. Once all issues have been addressed and the system performs reliably, the developers would consider the product to be ready for deployment. After the real-time testing, the developers may identify some issues that need to be rectified. These issues may include software bugs, hardware malfunctions, or design flaws that were not caught during the previous stages of development. To address these issues, the developers will need to make changes to the code, hardware components, or design specifications, as needed.

Once the necessary changes have been made, the developers will need to conduct additional testing to ensure that the system is functioning as expected. This may involve repeating some or all the testing that was performed during the previous stages of development, as well as conducting new tests to verify that the changes have resolved the identified issues.

4.2 Real time testing by Users

Setting knock pattern:

- Hold the push button and knock the door as you want and leave the button and wait for a minute to process
- Hold the push button and knock the door as you want and leave the button and wait for a minute to process

Real-time testing by users is an important step in the final development phase of a product, such as the Knock to Unlock system. In this phase, the system is tested by actual users to identify any potential issues or areas for improvement.

During real-time testing, users interact with the system in a natural way, using it as they would in real-world scenarios. They provide feedback on the user experience, ease of use, and overall functionality of the system. This feedback can be used to make necessary adjustments to the design and functionality of the system. Through user testing, issues such as compatibility with different devices, user errors, or bugs can be identified and addressed. User feedback is also important in identifying areas for improvement and potential new features that could be added in future versions of the product. Overall, real-time testing by users plays a crucial role in ensuring that the final product meets the needs and expectations of its users, and delivers a high-quality user experience. The users are asked to perform a series of tasks that the product is designed to handle, such as unlocking the door using the knock pattern, and provide feedback on their experience. The feedback can be in the form of surveys, interviews, or observations.

Based on the feedback, developers may need to make further modifications to the product to improve its functionality or user experience. This may include changes to the hardware, software, or both. Once the necessary modifications are made, the product is tested again by the users to ensure that all issues have been resolved and the product meets their expectations.

Real-time testing by users can help identify potential issues that were not discovered during the development phase and ensure that the final product meets the needs and expectations of the end-users.

Trouble Shooting:

- Reset the Knock pattern
- Check if the batteries are working and replace them with new ones
- Switch off for some time and on it

Real-time user testing is crucial for any product development process, especially for ensuring that the system is functioning as intended. As a customer support provider, I offer assistance to users who encounter any issues while using the system, building trust and loyalty among them. With this information, developers can make the necessary improvements to optimize the system's performance. Additionally, real-time user testing can help identify system failure points, improving the system's reliability and reducing downtime. By conducting real-time user testing early in the development cycle, issues can be detected early on, allowing developers to address them promptly. This early detection of issues can reduce the likelihood of encountering them later in the project, resulting in a more efficient and effective development process.

4.3 Final Product

The final product (**Fig.4.1**)is an electronic lock system that uses a sensor/speaker to detect a unique knocking pattern to unlock the door. The system is designed to be user-friendly, secure, and reliable. The lock system is composed of various electronic components such as an Arduino board, a relay module, and speaker/ sensor. The product underwent several stages of development, including conceptual design, technical design, and testing by both developers and end-users. The product's performance was optimized by addressing issues identified through real-time user testing, resulting in a highly functional and reliable lock system.

Fig.4.2 Final Product

Chapter 5

Conclusion and Future Work

5.1 Conclusion

The Knock to Unlock system is a secure and convenient solution for home security, allowing users to access their homes without the need for traditional keys. The development process involved designing and building a hardware system using various components such as Arduino Uno, sound detection module, servo motor, solenoid lock, and more. The software development phase included programming the microcontroller to recognize the unique knocking pattern of the user and activate the unlocking mechanism when the correct pattern is detected. Real-time testing by developers and users helped identify and rectify any issues, resulting in a final product that is reliable, user-friendly, and secure. Innovative methodology for executive of doorway opening framework through incomplete specialized and manual taking care. This method has many advantages like sensible expense, upgraded security, little size. The contributions of information which put away in the Arduino UNO and the framework which peruses by approving the quantity of knocks and opens the door lock. The venture can without much of a stretch fulfill the client and furthermore easy to understand to make the way for each client. Here, to utilize servo library capacity to open and close the door. As a result, the efficiency for detecting the knock has been increased.

5.2 Future Work

In the future, the Knock to Unlock system could be further improved by implementing additional security features such as facial recognition or fingerprint scanning. Additionally, the system could be made more convenient by integrating it with other smart home devices, such as voice-activated assistants or smartphone apps. The hardware and software could also be optimized for power consumption, allowing for longer battery life and reduced energy usage. Further research could also be conducted to identify potential vulnerabilities and improve the overall security of the system. One potential area for improvement is the accuracy and reliability of the sound detection module. This could involve exploring different sound sensors or integrating machine learning algorithms to improve the system's ability to recognize unique knocking patterns. Another potential area for improvement is the security of the system. While the solenoid lock provides a basic level of security, future work could explore more advanced locking mechanisms or biometric authentication methods to further enhance the system's security. Additionally, the user interface and design of the system could be further refined to improve user experience and accessibility. This could involve designing a more intuitive and user-friendly interface for programming and setting up the system, as well as exploring different form factors and materials for the physical housing of the system. Overall, there are many potential avenues for future work and improvement in the Knock to Unlock system, and further research and development in this area could lead to even more advanced and innovative security solutions.

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Abbreviations

IDE : **I**ntegrated **D**evelopment **E**nvironment
AVR : **A**tmel **A**VR **M**icrocontroller
PWM : **P**ulse **W**idth **M**odulation
I/O : **I**nput/**O**utput
EEPROM : **E**lectrically **E**rasable **P**rogrammable **R**ead-**O**nly**M**emory
ADC : **A**nalog-**T**o-**D**igital **C**onverter
Vcc : **V**oltage **C**ommon **C**ollector
GND : **Ground**
NO : **N**ormally **O**pen
NC : **N**ormally **C**losed
COM : **C**ommon
PCB : **P**rinted **C**ircuit **B**oard
SSR : **S**olid **S**tate **R**elay
LED : **L**ight **E**mitting **D**iode
mA : **m**illi **A**mpere
E-field : **E**lectric **F**ield
FET : **F**ield **E**ffect **T**ransmitter
NDT : **N**on-**D**estructive **T**esting

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Firstly we would like to thank our professor's Dr. K. Krishna Naik and Dr. G. Praveen Kumar for organizing this course, lecturing and giving constructive feedback throughout the project.

The development and implementation of Knock to Unlock involved the collaboration and contributions of various individuals and organizations. These include developers and engineers, end-users, researchers and academics, organizations and institutions, manufacturers and suppliers. We would like to express our gratitude to all who contributed to the development and success of the Knock to Unlock project.

We would also like to thank the testers who provided invaluable feedback and helped to identify areas for improvement. Finally, we thank the end-users who have embraced this technology. We grateful for their work and dedication.

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Designation : **Technical and Product Designer**

Contribution

As the Technical and Product Designer for the Knock to Unlock project, my main responsibility was to design the overall system architecture, including selecting the appropriate components and ensuring that they worked together seamlessly. This involved researching various options for the microcontroller, sound detection module, relay, solenoid lock, and other components, and then make sure they met the project's requirements. I worked on creating the hardware components, wiring them together, and programming the microcontroller to recognize the knocking pattern. I should be able to explain technical concepts clearly to the project team. Throughout the development process, I collaborated closely with the other members of the team, including the mechanical and electronic designers, to ensure that the overall design was cohesive and functional. I also conducted real-time testing of the system and adjusted as needed based on user feedback. Overall, my goal was to create a user-friendly and efficient system that would provide a secure and easy way to unlock a door.

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Designation : **Electronic designer and Q/A tester**

Contribution

As a electronic designer and Q/A tester for this project, my role in ensuring the successful implementation of the knock to unlock system. I was responsible for testing the hardware and software components, identifying any issues or bugs, and working with the team to find solutions to these problems. I also designed and implemented the electronic circuitry necessary for the system to function properly. Through testing and debugging, I must also check any issues or errors encountered during testing and provide detailed feedback on how to improve the system. Additionally, I work closely with the development team to ensure that any reported issues are addressed and resolved in a timely manner I helped to ensure that the final product was reliable, efficient, and user friendly.

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Contribution

As a software designer, my main responsibility is to develop the code for the microcontroller (Arduino Uno) to recognize the unique knocking pattern of the user and activate the unlocking mechanism when the correct pattern is detected. I am responsible for writing the code in the Arduino IDE, testing it thoroughly, and ensuring that it works seamlessly with the hardware components. Additionally, I am also responsible for debugging and troubleshooting any issues that arise during the development process. My role is critical in ensuring the overall functionality and success of the knock to unlock project.

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Contribution

As a concept designer, my role in this project was to come up with initial ideas and designs for the Knock to Unlock device. I worked closely with the technical and product designers to ensure that the concept was not only innovative but also practical and feasible. My responsibilities included conducting market research, brainstorming sessions, creating sketches and models, and presenting the final design to the team. I was also responsible for providing feedback and collaborating with the team to refine the concept and make any necessary changes. Throughout the project, I focused on creating a design that was user-friendly, visually appealing, and aligned with the overall vision of the project. I used my creativity and design skills to bring the concept to life, and I am proud to have played a significant role in the development of this innovative product.

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Designation : **Mechanical Designer**

Contribution

As a Mechanical Designer in this project, my main role was to design and create the physical housing and components for the Knock to Unlock device. I was responsible for creating models and prototypes of the device using CAD software and ensuring that the final product met the necessary design requirements and was functional. Additionally, I worked closely with the electronic designer and product designer to ensure that the mechanical components were compatible with the electronic components and that the overall design of the device was aesthetically pleasing and user-friendly. Throughout the development process, I provided regular updates and made any necessary changes to the design based on feedback from the team and testing results.

Declaration by students

We here by declare that, the work submitted under the **Product Design Practice Course -EC308P** is a Practice work in the name of the product title "Door Unlock System by Knocking (Knock to Unlock)" by taking reference(s) from the open literature from the internet sources. This is not an Invention, and we will not claim any credit for it. We give all the credits to the original maker/inventors/developers/proposers. There are no liabilities toward the IIITDM Kurnool and associated faculty members in this regard. The whole responsibilities will be taken by the following team members in any case of plagiarism, copy right or similar acts.

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