University of Moratuwa

Department of Electronic and Telecommunication Engineering

EN2160 - Electronic Design Realization

Door Security system - Report

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Contents

Summary

Our Home Security Alert System utilizes ATmega328p and a Reed switch to detect unauthorized entry. When triggered, it activates a loud buzzer and sends SMS alerts via the GSM module. Protect your home and loved ones effortlessly with real-time notifications for ultimate peace of mind.

Project that proposed.

At first, I had the idea of creating a basic door security system using the ATmega328p Microcontroller. Initially, the system was designed to only incorporate a buzzer for alerting purposes. However, with further guidance, I expanded the project to include the capability of sending a notification message to the owner. This is how I presented and proposed my project.

Product Introduction

This door security system serves as a robust deterrent against unauthorized entry. Whenever an intruder attempts to access the house without permission, the system will immediately activate a loud buzzer while also promptly sending a direct message to the homeowner. Rest assured that this intelligent solution will protect your home by alerting you in real-time when any unauthorized access is detected.

Target Customers

- Homeowners: Individuals or families who want to enhance the security of their homes and ensure the safety of their property and loved ones.
- Small Business Owners: Small businesses and shops that require a cost-effective yet reliable security solution to protect their premises during non-business hours.
- Renters: Tenants who want to add an extra layer of security to their rental properties without making permanent installations.
- Elderly or Vulnerable Individuals: Seniors or people with specific vulnerabilities who seek a simple and effective way to bolster the security of their living spaces.
- Vacation Homeowners: Owners of vacation homes or secondary residences who want to keep their properties secure while they are away for extended periods.
- Airbnb Hosts: Hosts who wish to provide a secure environment for their guests and ensure only authorized individuals access their properties.
- Small Offices: Businesses with small office spaces that require a basic yet efficient security system to protect sensitive information and assets.
- Pet Owners: Individuals who want to keep their pets safe from potential intruders and ensure their wellbeing while they are not at home.
- Security-conscious Individuals: People who prioritize security and want to have peace of mind knowing they will be alerted if someone attempts unauthorized entry.
- Tech Enthusiasts: Customers interested in smart home technologies and automation, looking to integrate a smart security system into their living spaces.

Product Specification

Dimensions	Box - 10cm x 8cm x 8cm Top - 10cm x 8cm x 1.5mm
Power	12V DC Adapter
Input Interface	DC power jack
Microcontroller	Atmega328PU - High performance, low power AVR® 8-bit microcontroller, 32Kbytes of in-system self-programmable flash program memory, 1Kbytes EEPROM, 2Kbytes internal SRAM

Additional features

- Buzzer – Assists in notifying the owner whenever there is an unauthorized entry.

- Reed Switch – It is used to identify instances of unauthorized entry.

- Key Switch – The Reed switch serves as the means to control the product's activation and deactivation. When the owner attempts to enter the house, they can use the Key switch to turn off the product.

Conceptual Design

Schematic Block Diagrams

Schematic 01

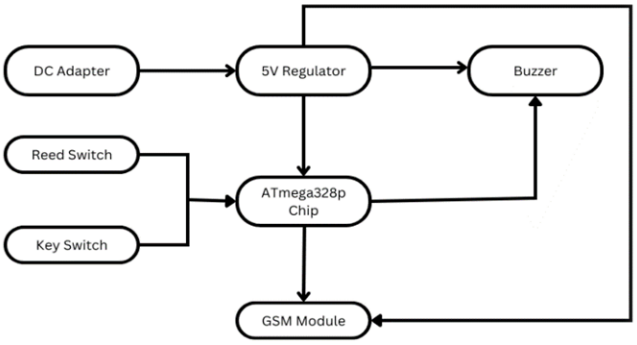

Figure 1 Block Diagram_01

Within the Schematic Block, our plan involved utilizing the ATmega328p microcontroller, which would be powered by a 5V regulator connected to a DC adapter. Additionally, we aimed to incorporate a GSM module to facilitate the sending of messages to the owner.

Schematic 02

In this revised Schematic, our plan involved utilizing an Arduino Uno instead of the ATmega328p microcontroller. This change allowed us to obtain a 5V power source for both the buzzer and GSM module. By directly powering the Arduino Uno using a DC adapter, we were able to obtain the required 5V supply. The remaining components remained the same as mentioned previously.

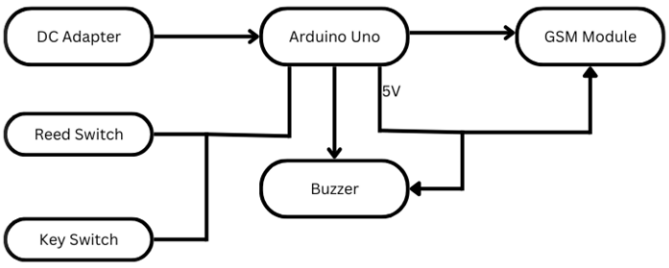

Figure 2 Block Diagram_02

Schematic 03

In this updated schematic, we have decided to replace the ATmega328p or Arduino Uno with a Wi-Fi module as the primary controller. This modification is the only change in Schematic 1. All other components and parts remain unchanged. With the inclusion of the Wi-Fi module, we enable the system to receive messages from mobile applications, offering an alternative to conventional text messages.

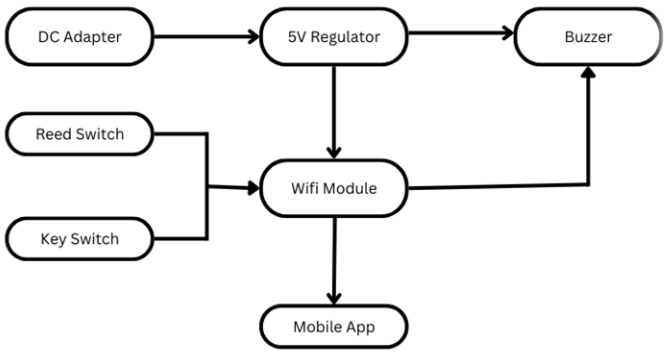

Figure 3 Block Diagram_03

Selection criteria for Schematic block

Objectives	Schematic 1	Schematic 2	Schematic 3
Functionality	8	7	6
Clarity	9	9	7
Connectivity	7	8	7
Efficiency	7	8	6
Power Consumption	7	7	6
Reliability	8	6	7
Cost-Effectiveness	8	5	6
Compatibility	7	4	7
Component Availability	8	8	7
Compliance	6	5	7
	75	67	66

Hand Drawn Sketches

Sketch 01

The initial sketch is straightforward and uncomplicated to design using Solidworks, as it does not involve intricate curves or complex features. It consists of a top part and a bottom part, which can be easily assembled using nuts and bolts to join them together.

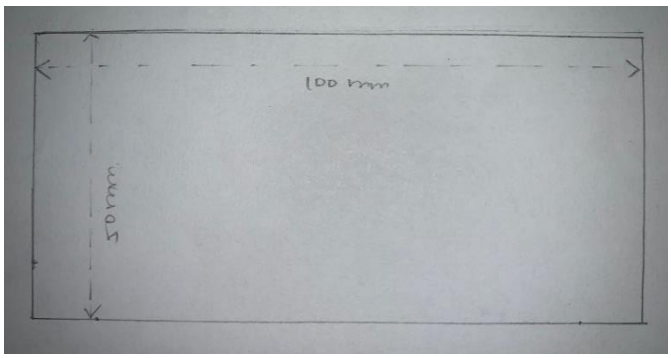

Figure 5 Side View of Box

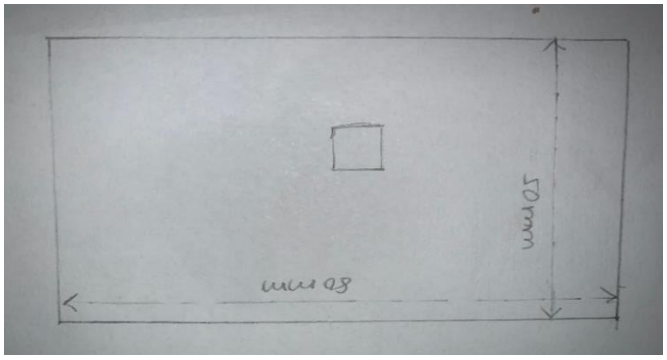

Figure 4 Front View of Box

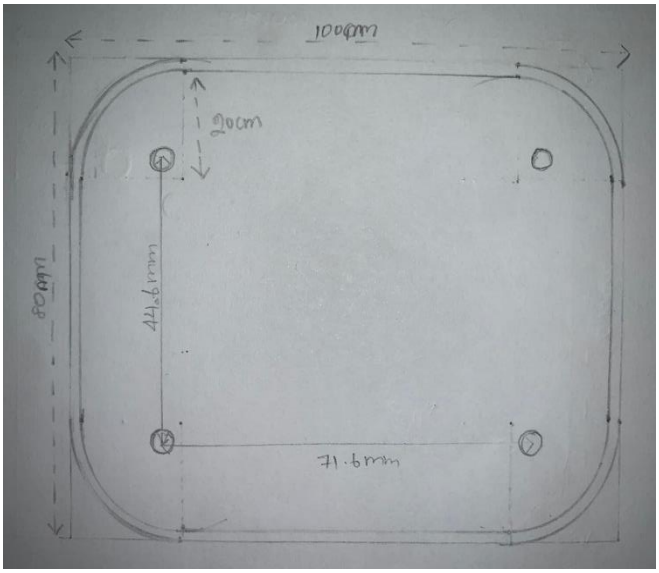

Figure 7 Top View of Box

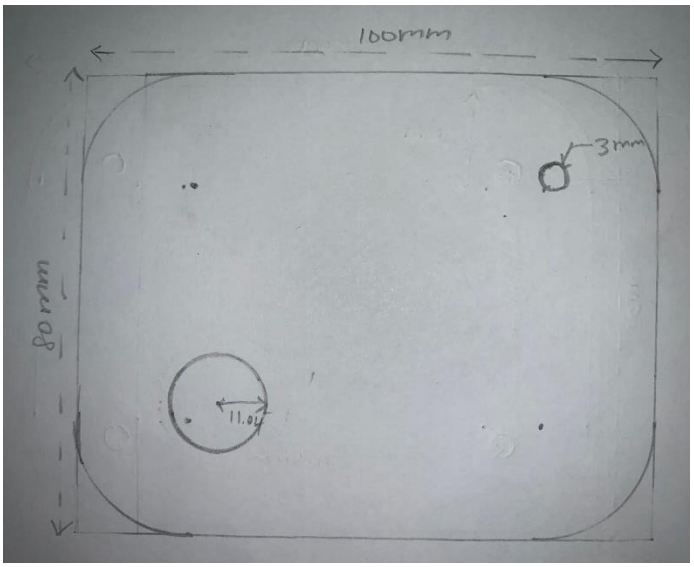

Figure 6 Top View of Top

Sketch 02

This sketch incorporates curved sections and intricate features, deviating from the simplicity of the previous design. In contrast, the current design consists of a single unified part that serves as the entire product. To accommodate the placement of the PCB, we can detach the enclosure into two parts, and then reassemble them using a lip and groove mechanism.

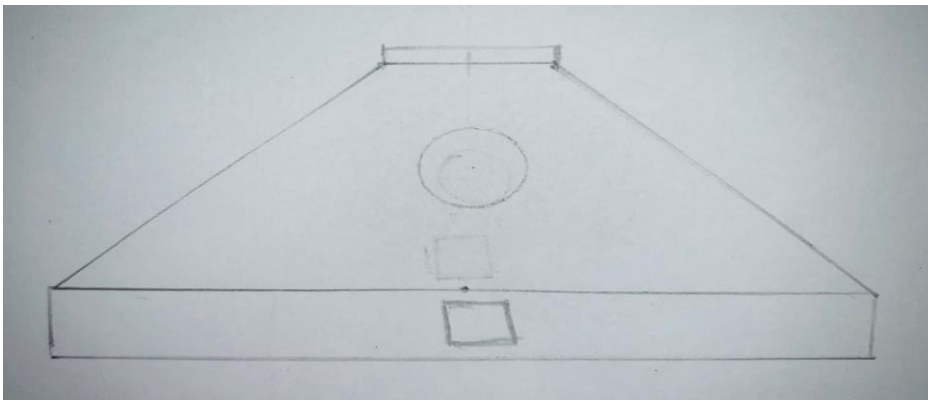

Figure 8 Side View

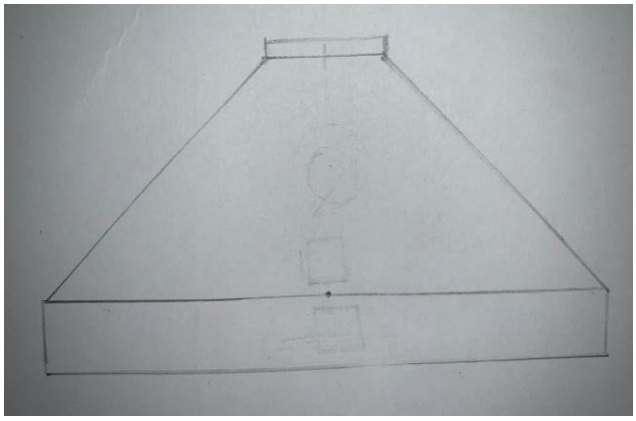

Figure 9 Front View

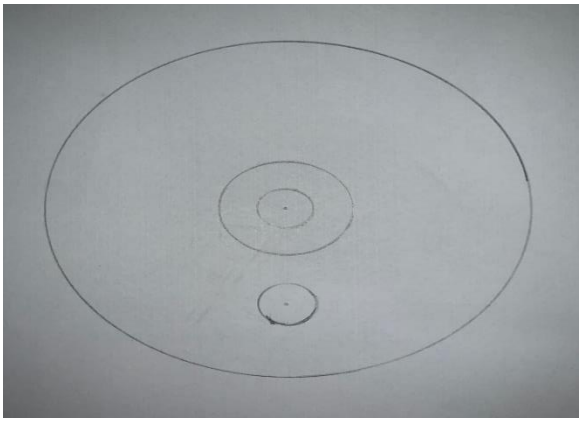

Figure 10 Top View

Sketch 03

In this improved sketch, inspired by a TV remote, we have introduced captivating modifications with intricate curves and complex features, enhancing its marketable appeal. Like the previous design, it consists of a single part that can be separated to accommodate the PCB placement. The parts can be securely joined using a lip and groove mechanism.

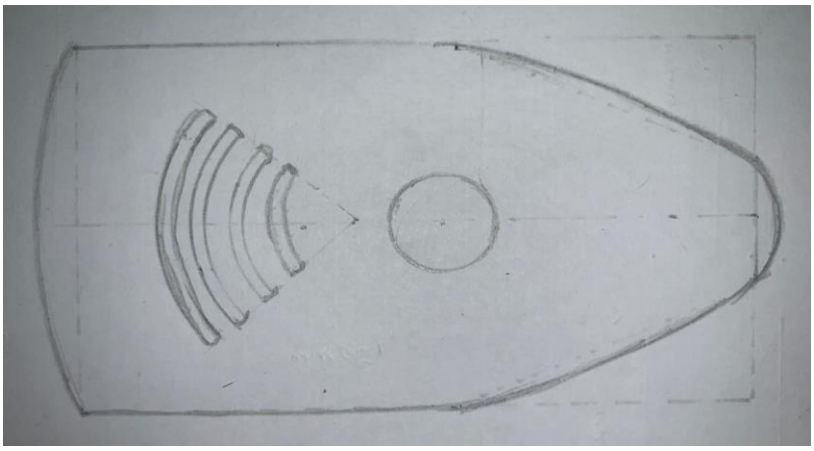

Figure 11 Top view of Sketch 3

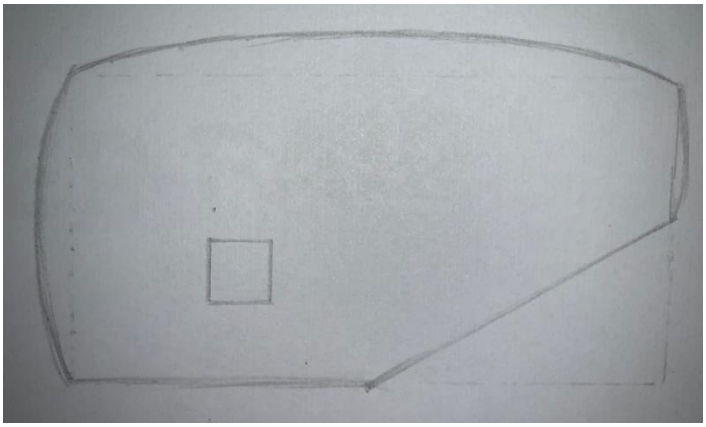

Figure 12 Side view of Sketch 3

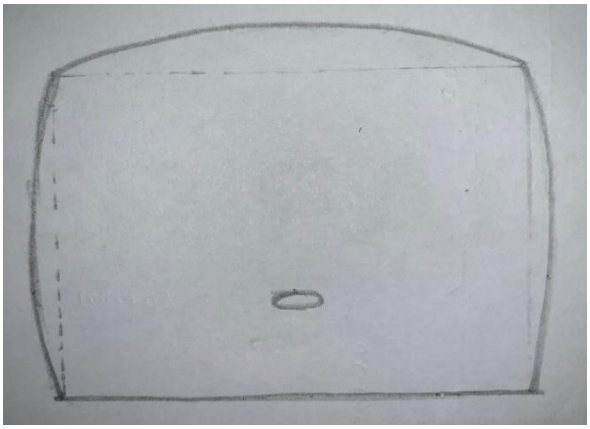

Figure 13 Front view of Sketch 3

Selection matrix for Sketches

Objectives	Sketch 1	Sketch 2	Sketch 3
Functionality	8	7	7
Aesthetics	7	8	9
Integration	5	6	7
Environmental Impact	8	6	7
User Experience	4	6	9
Scalability	3	2	4
Ergonomics	5	6	8
Size and Portability	5	4	7
Cost-Effectiveness	8	6	4
Compatibility	6	4	7
	59	55	69

Selected Sketch and Schematic

Schematic 01

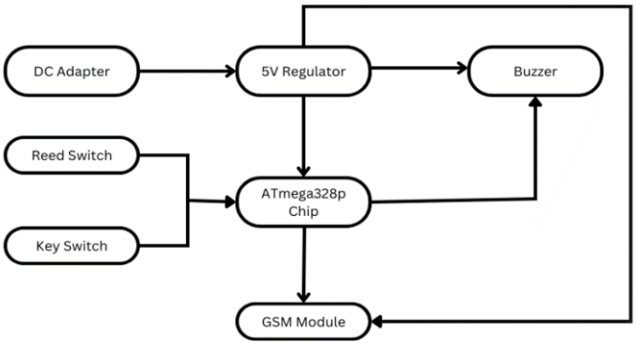

Figure 12 Block Diagram_01

Sketch 03

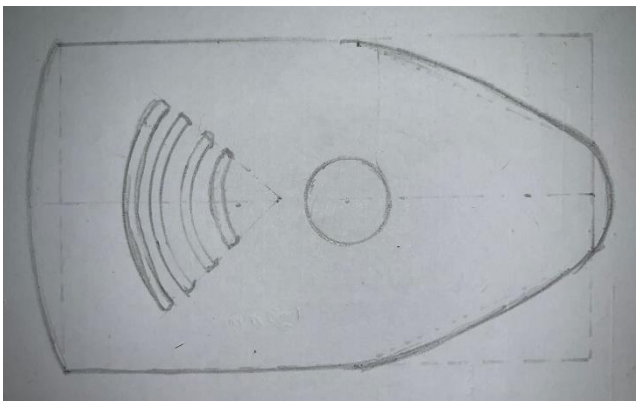

Figure 15 Top view of Sketch 3

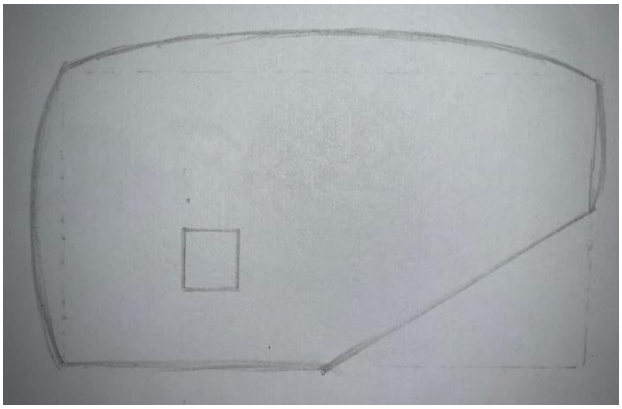

Figure 16 Side view of Sketch 3

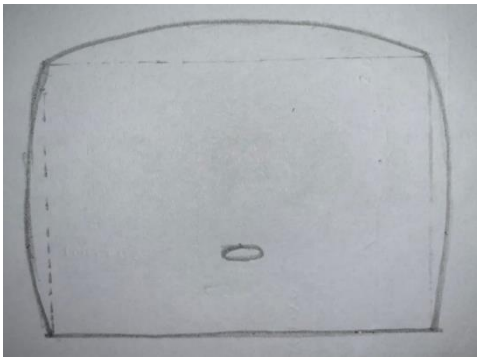

Figure 13 Front view of Sketch 3

User-Centered Design

Based on the feedback obtained from the questionnaire, users provided the following suggestions:

- Include motion detection functionality.
- Integrate a camera into the product.
- Develop a separate mobile application for enhanced user experience.
- Replace the buzzer with a more persuasive speaker.

Considering the user feedback, I made certain modifications to the Schematic and sketches to accommodate the future enhancements of my product. While it was not feasible to address all the user suggestions, I did consider a few of them, including:

- Adding motion detection functionality.
- Replacing the buzzer with a more compelling speaker.

To meet the user requirements, I made adjustments to the initial schematic block diagram and modified the sketch accordingly. These changes were implemented to fulfill the specific needs expressed by the users.

In the updated schematic, I incorporated a PIR (Passive Infrared) sensor to detect motion, providing an additional layer of security and alerting the user accordingly. Instead of using a buzzer, I opted for a speaker, allowing for the customization of different sounds. While I couldn't fulfill the camera requirement at this stage and develop a separate mobile application, I addressed the other aspects based on the user feedback. Further research is needed to meet the camera and mobile application requirements.

Schematic for user-centered design

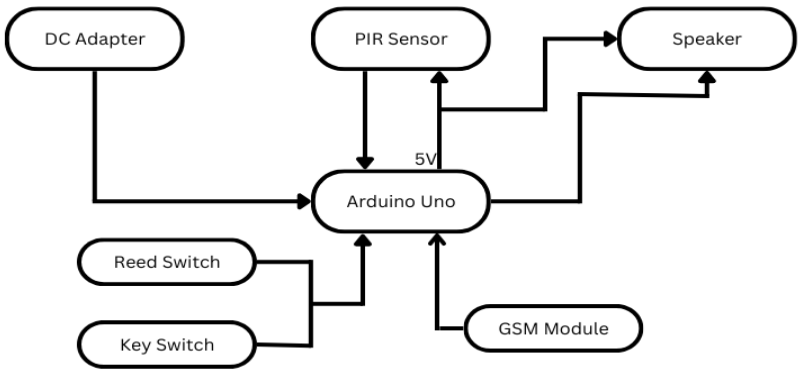

Figure 14 Schematic for user-centered design

Sketches for the user-centered design

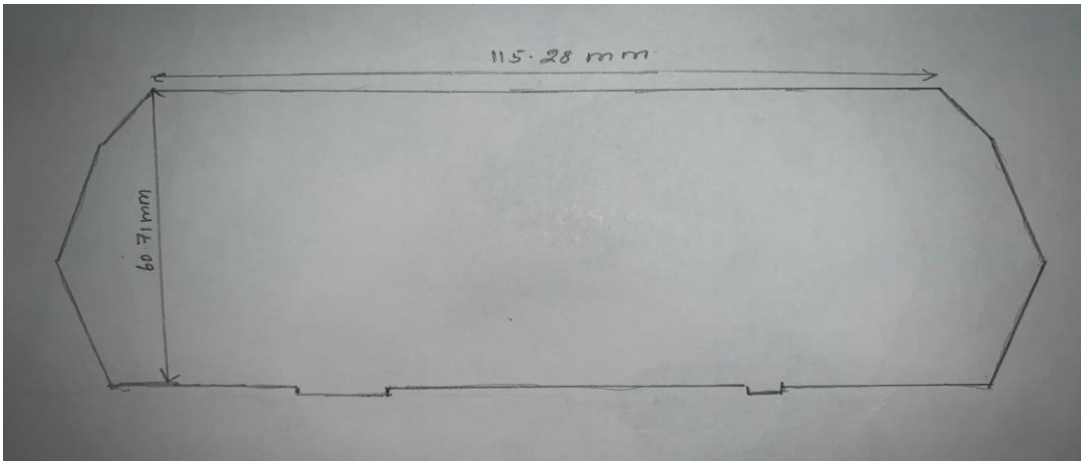

Figure 15 Side View

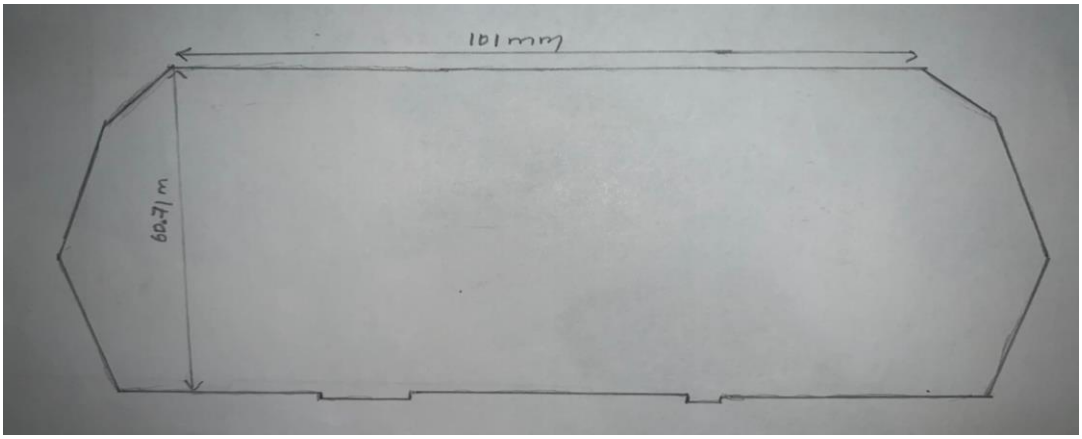

Figure 16 Front View

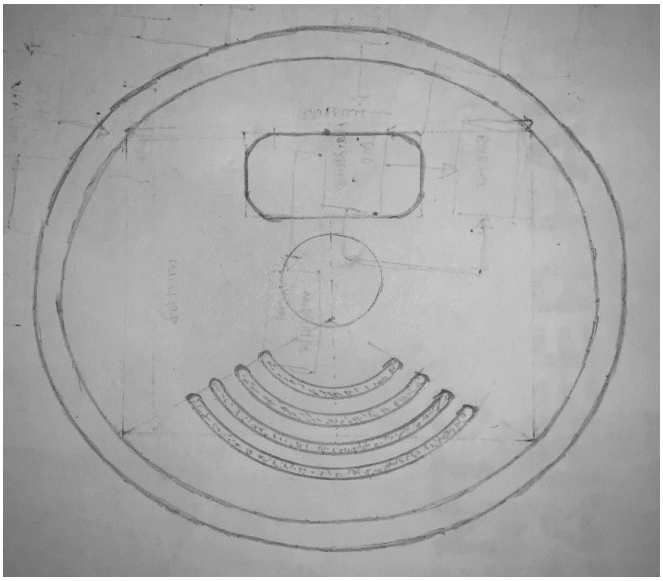

Figure 17 Top view

Preliminary Design

Implemented Sketch

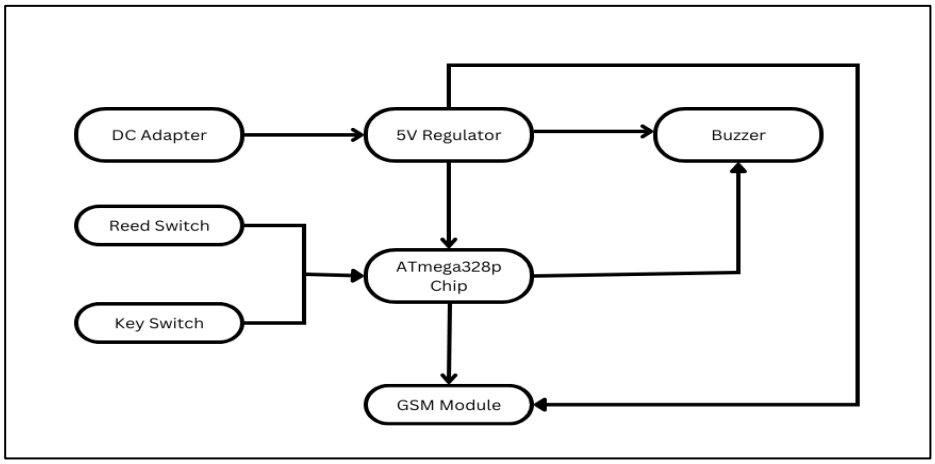

Figure 18 Implemented Schematic block diagram.

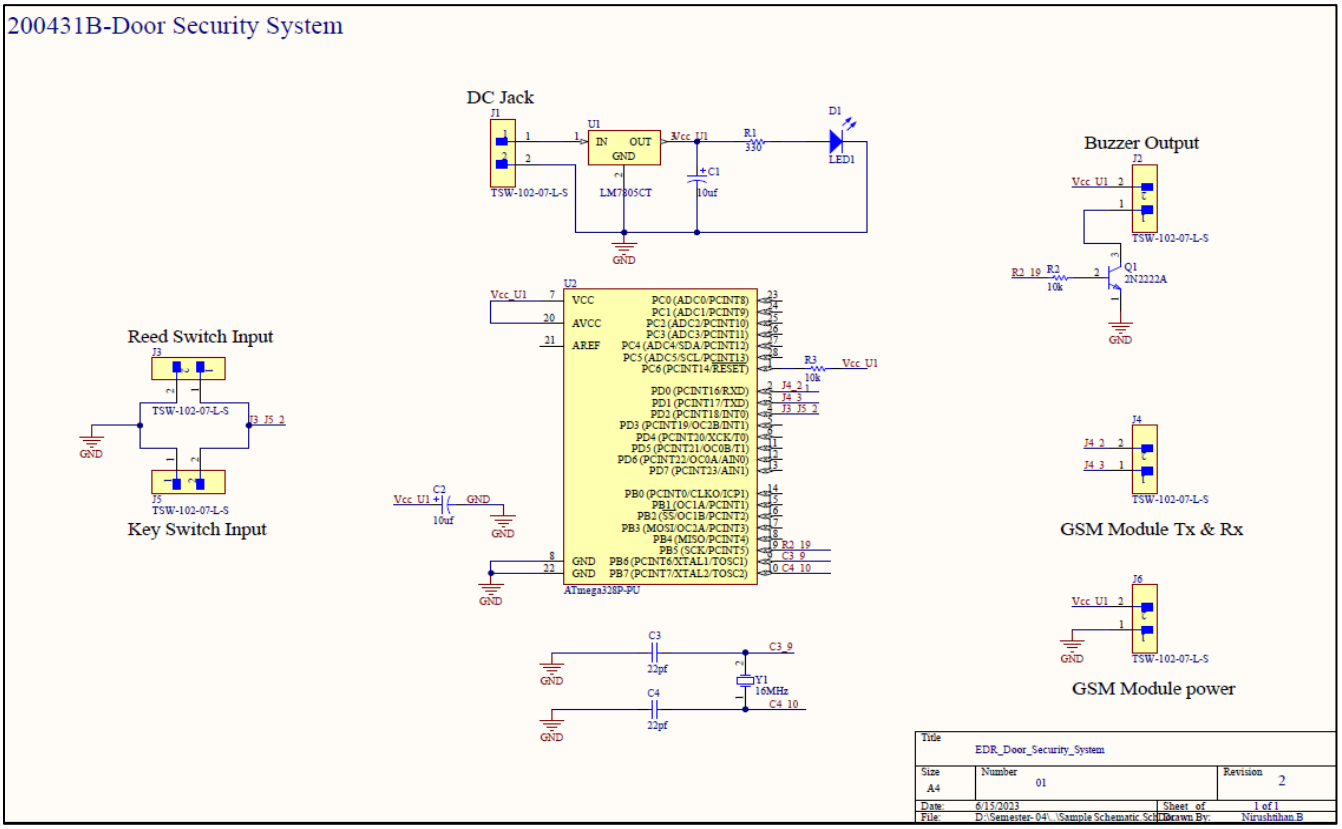

Figure 19 Implemented Schematic

Google Drive Link for the Schematic

Implemented Solidworks

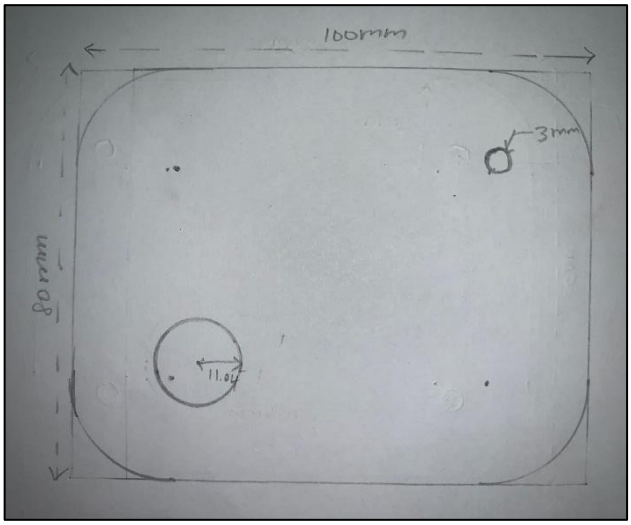

Figure 20 Top View of the top

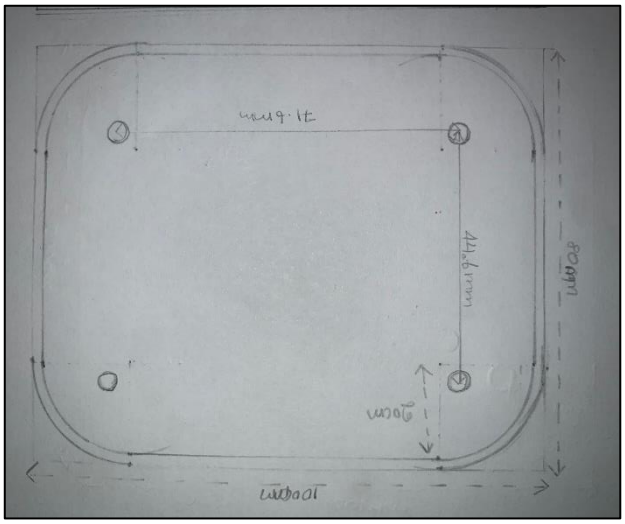

Figure 21 Top View of the box

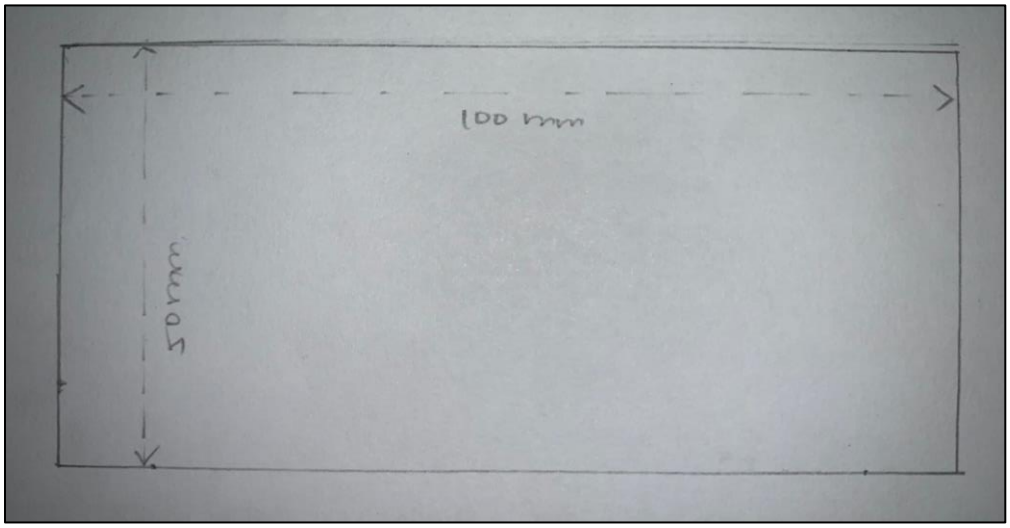

Figure 22 Side View of the box

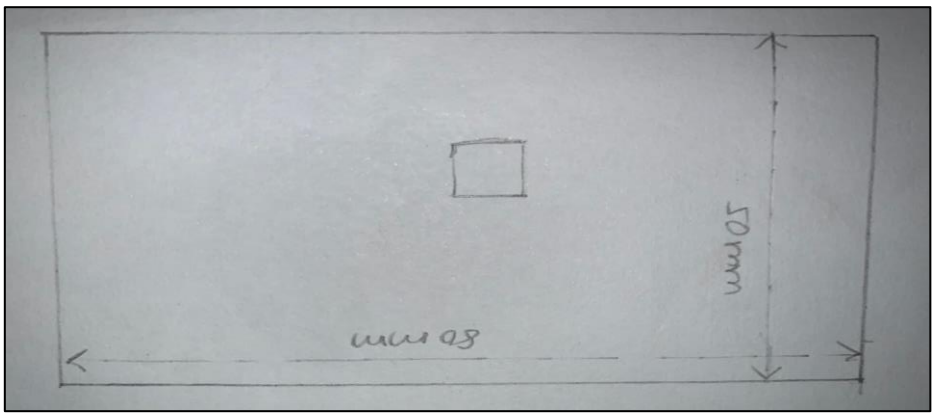

Figure 23 Front View of the box

Figure 24 Isometric View

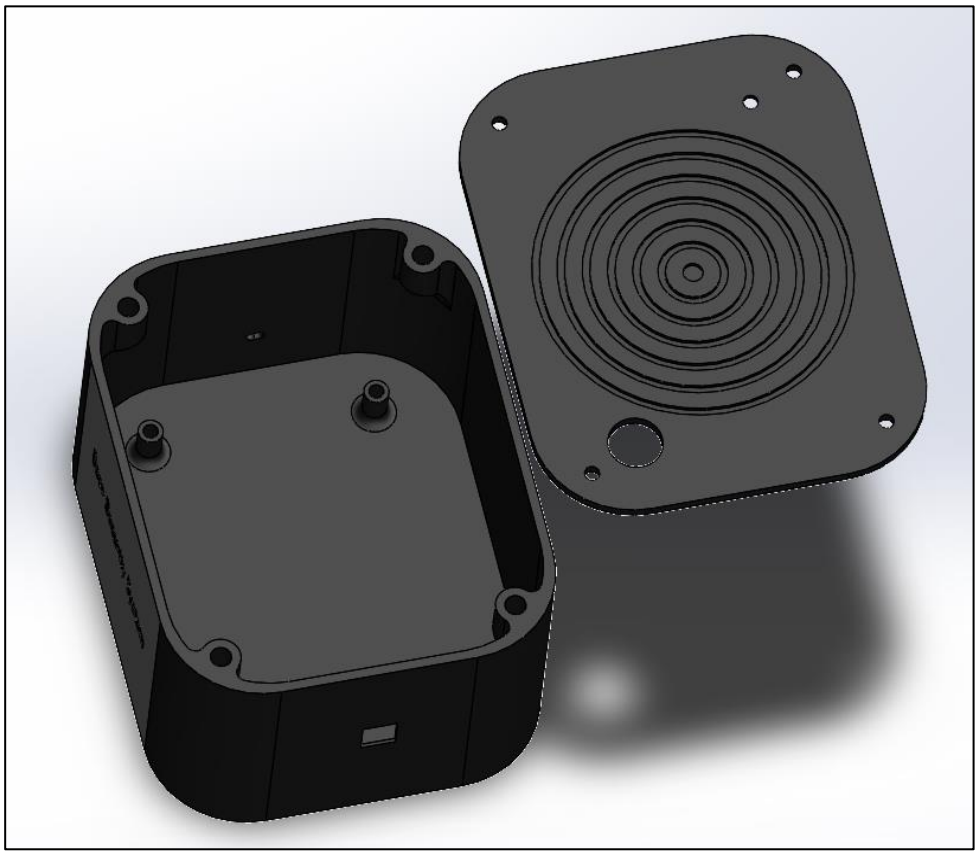

Figure 25 Isometric View of opened box

Problems identified by you considering the course contend delivered by Prof. Jayasinghe

- Large-scale production: For mass production, 3D printing may not be the most efficient method. Molding, on the other hand, allows for faster and cost-effective production of identical parts. However, my previous design cannot be molded, which suggests that it may have features or geometries that are not compatible with the molding process.
- Aesthetic considerations: Aesthetics play a crucial role in attracting customers and creating a desirable product. While functional aspects are important, the overall visual appeal of the design should not be overlooked. Consider elements such as clean lines, pleasing proportions, and a visually appealing color scheme to enhance the attractiveness of your product. I did not consider that part also in my earlier design.
- Draft angles: Draft angles are crucial in molding as they allow for easy removal of the molded part from the mold. Without appropriate draft angles, the part may get stuck or result in poor surface finish. It is important to incorporate draft angles in your design to ensure smooth production and high-quality molded parts. I did not consider about the draft angle.
- Screw placement: To enhance the marketability and user experience of your product, it is preferable to hide screws from plain sight. Placing screws on the bottom or inside the enclosure ensures a cleaner and more professional appearance. But in my enclosure, I placed screws in the top side.
- Surface modeling: Surface modeling involves creating smooth and visually appealing curves, chamfers, and fillets on the external surfaces of the enclosure. This technique is commonly used to achieve a professional and high-end appearance. But I did not design my previous design in that way.
- Enclosure assembly: To avoid the use of adhesives like hot glue, it is essential to ensure that the enclosure components fit together perfectly without the need for additional fixes. This requires meticulous attention to detail and precise dimensional planning. But I make some mistakes in that part also.
- The ideal approach for enclosure design is to begin with hand-drawn sketches. However, I did not follow this recommended process when initiating my design.

I have made the necessary improvements in my design to meet the requirements. It is now suitable for molding, aesthetically appealing, incorporates appropriate draft angles, hides screws, utilizes surface modeling, and ensures secure enclosure assembly without the need for adhesives.

Improvements according to my group members suggestion

- Lack of attractive curves: The initial design lacked visually appealing curves. To address this, my group members suggested incorporating more curves into the enclosure design, enhancing its overall attractiveness.
- Simple box design: The initial design resembled a simple box. To make it more visually interesting, my teammates recommended exploring different shapes and forms that are more captivating than a plain box design.
- Power source: Originally, my planned to use a 9V battery as the power source. However, my group members advised using a DC adapter instead, as it can provide more reliable and efficient power supply for the product.
- Space constraints for wiring: The previous design had limited space, making it challenging to accommodate proper wiring inside the product. To overcome this issue, my teammates suggested modifying the design to allow for adequate space for proper wiring connections.
- Additional ground pin for GSM module: A problem was identified in the previous schematic, where the GSM module required an extra ground pin for proper functioning. My teammates identified the problem and suggested to adding this additional ground pin to resolve the issue and ensure the optimal performance of the GSM module.

Improvements according to the user needs

We did a user survey to get user feedbacks and according to those feedbacks I did some modifications in my design and schematic. The following changes are I made according to user feedbacks.

- Addition of PIR sensor: Based on user feedback, there was a request to include a PIR sensor to detect motion in the product. In response, I redesigned the schematic to incorporate the PIR sensor, satisfying their needs and enhancing the functionality of the product.
- Preference for speakers: Some users expressed a preference for speakers over buzzers. Taking this into account, I made changes to both the schematic and the enclosure design, replacing the buzzers with speakers. This allowed for improved sound quality and the ability to customize the alarm sounds, providing a more pleasant and personalized user experience.

Improved Sketch

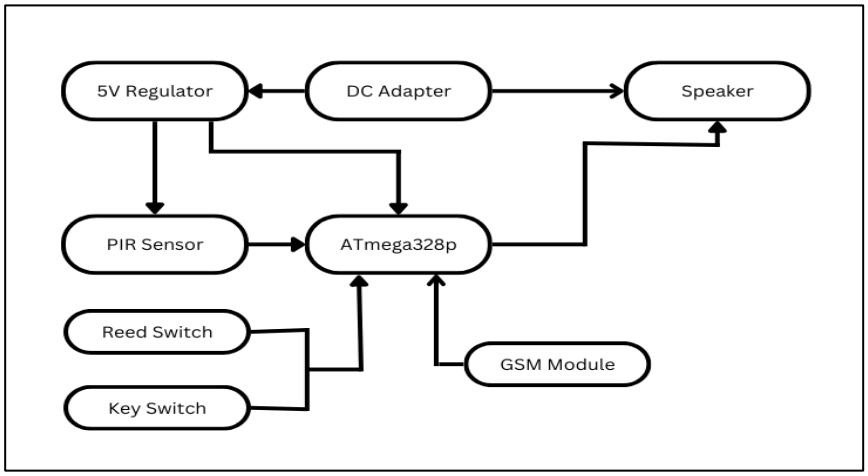

Figure 26 Improved Schematic block diagram.

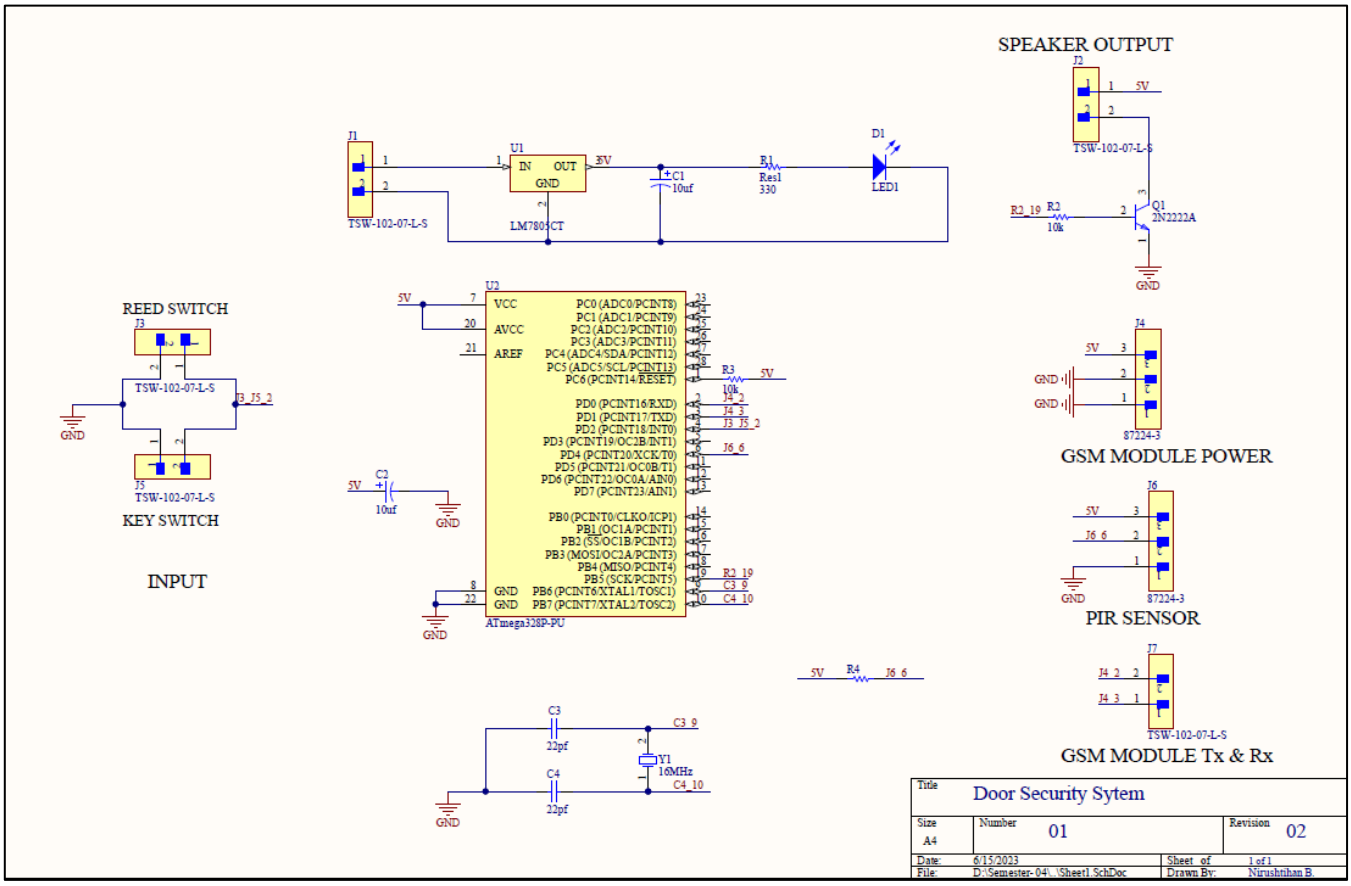

Figure 27 Improved Schematic

Google Drive link for the Schematic

Improved Solidworks

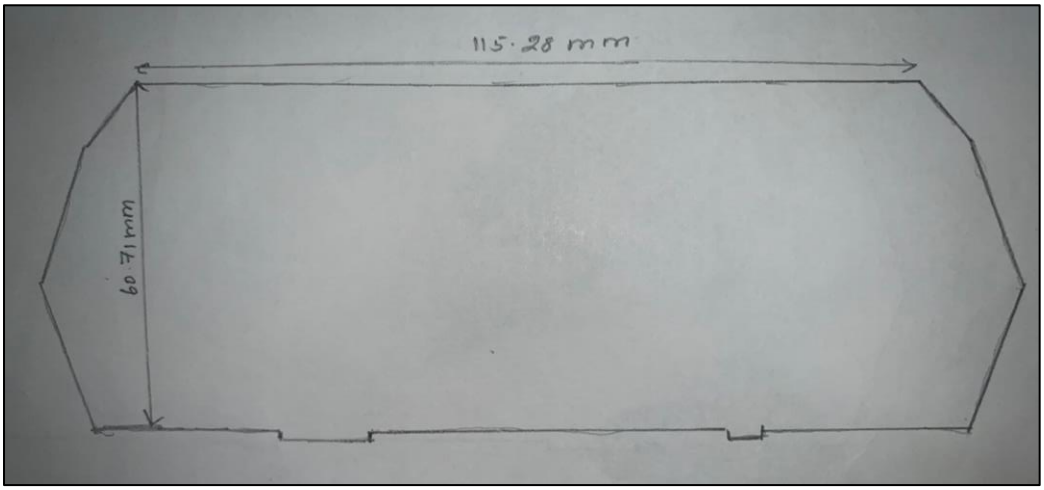

Figure 28 Side View

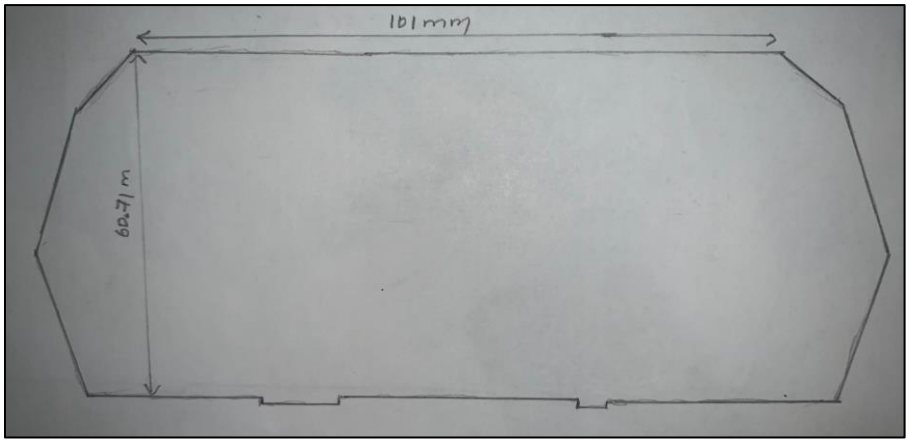

Figure 29 Front View

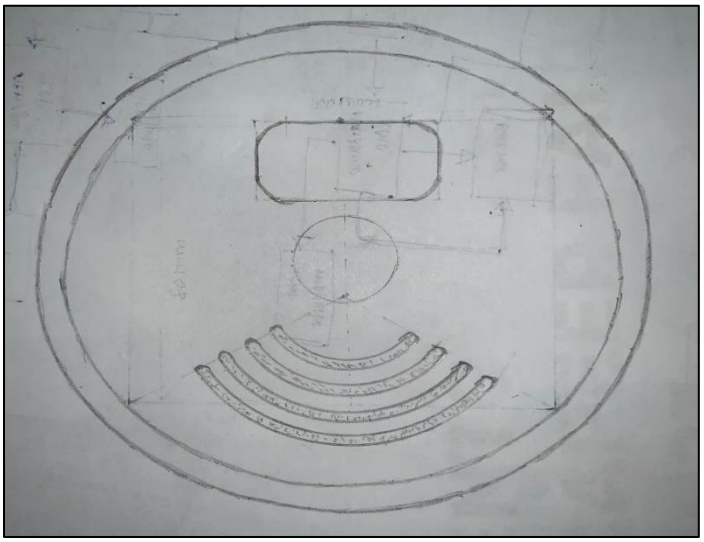

Figure 30 Top View

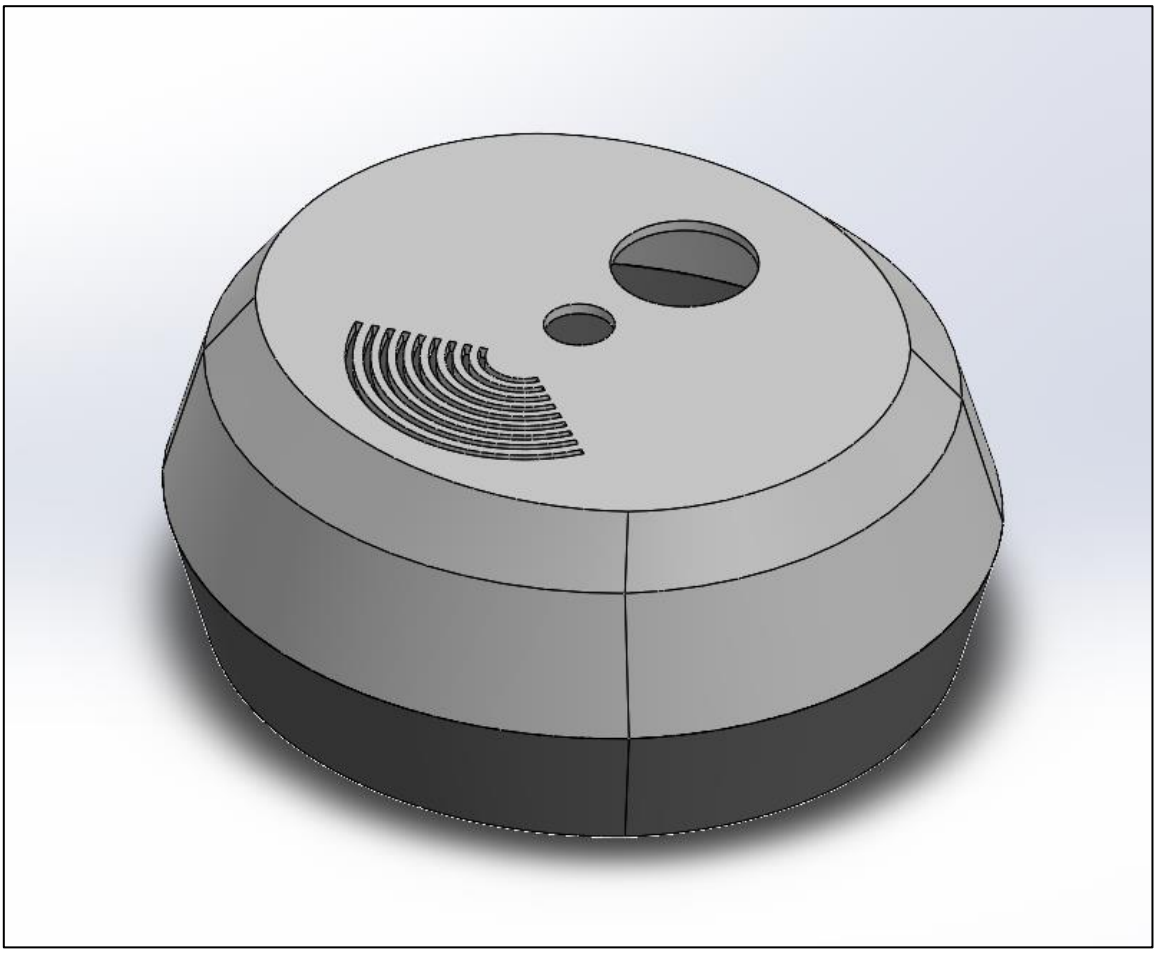

Figure 31 Isometric View

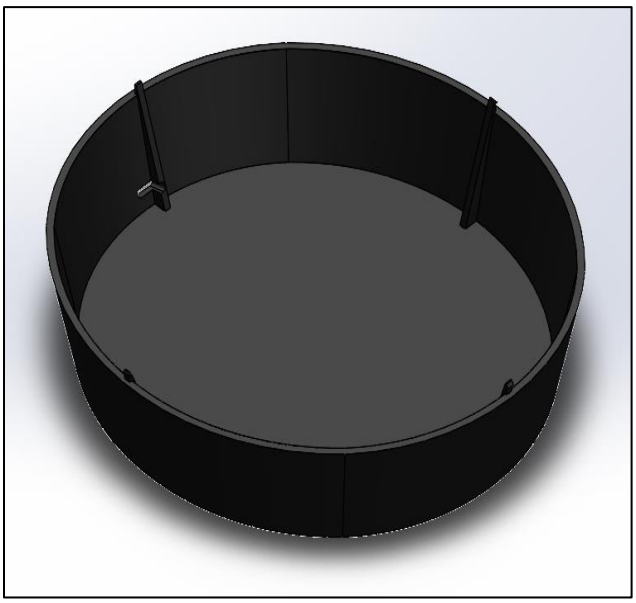

Figure 32 Isometric View of bottom

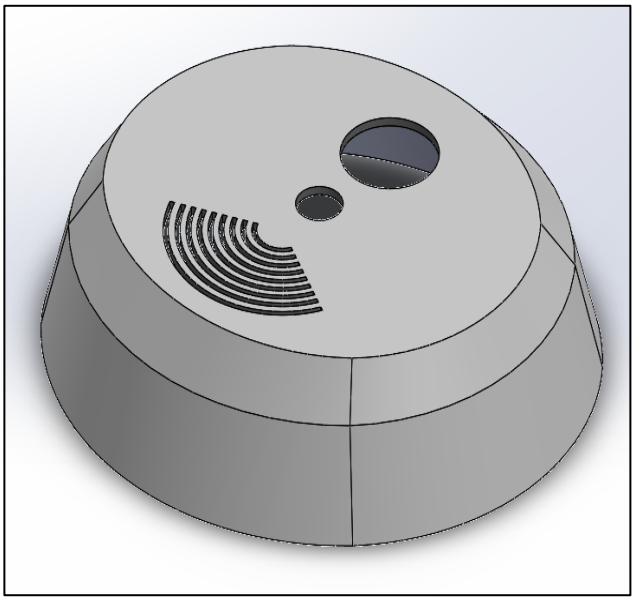

Figure 33 Isometric View of top

PCB

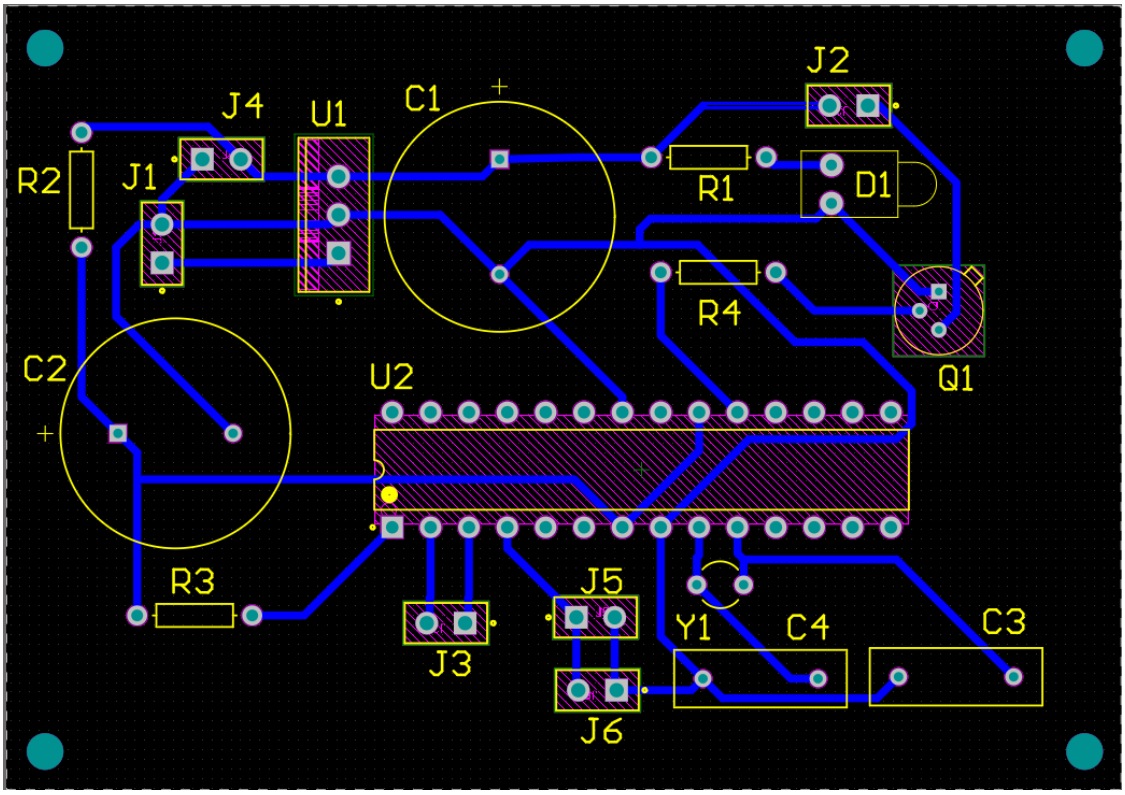

Figure 34 PCB in 2D view

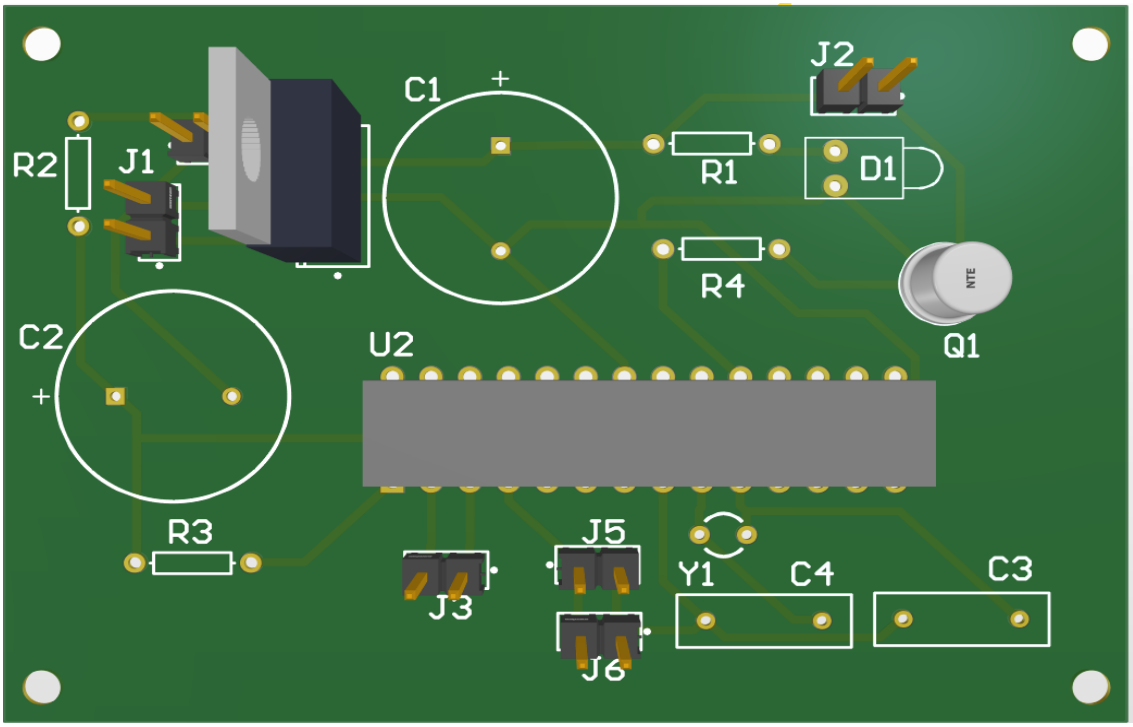

Figure 35 PCB in 3D view

User interface

The door security system was meticulously engineered with a strong focus on user-friendliness, making it accessible and manageable for individuals of all skill levels. Its intuitive design ensures that even ordinary users can effortlessly operate and navigate the system without any complexity. Furthermore, the enclosure's design was crafted with compatibility in mind, seamlessly fitting into various environments and architectural styles. By optimizing the space requirements, the system blends seamlessly with the surrounding decor, making it unobtrusive yet highly effective. This thoughtful approach to both user interface and physical design results in a seamless integration that enhances the overall user experience, offering reliable security without compromising on convenience.

Key Switch: - The key switch, conveniently located on the front side of the security system, puts the user in full control. Its secure design ensures that only authorized individuals with the suitable key can access and manage the system, providing an added layer of protection. This user-friendly approach makes it effortless for ordinary users to handle and operate the security system confidently, without the need for complex procedures. With the key switch at their fingertips, users can easily arm or disarm the system, ensuring a seamless and hassle-free experience for enhanced security and peace of mind.

DC power jack: - The system is powered by a DC 12V power adapter, and for convenient connectivity, a DC female jack is situated on the side of the product. This design allows users to effortlessly plug in the DC adapter, ensuring a reliable power source and a smooth setup process for seamless operation.

Reed Switch: - The Reed switch serves as the means to detect unauthorized entry. It consists of two parts: a magnet and a reed switch. When these components separate, the system activates the buzzer and sends a message alert. To allow for flexible placement, the Reed switch is connected to a long wire extending from the enclosure, enabling users to install it anywhere as needed.

Instructions for Assembly

Proper assembly steps are vital after PCB and enclosure manufacturing. Neglecting them can damage or impair the product's functionality. Careful alignment, secure mounting, and quality control ensure a functional and durable end product.

Place the components in the PCB: - During assembly, components are meticulously placed on the PCB for accurate positioning and electrical connections. Proper placement is crucial to avoid issues like electrical shorts or malfunctioning. Using specialized equipment and manual insertion for through-hole components, manufacturers conduct thorough inspections and quality checks before proceeding to the next stages of assembly. Adhering to stringent procedures ensures the PCB is prepared for further processing, resulting in a reliable and well-functioning end product.

Place the power jack & Buzzer & Key switch: - In the enclosure assembly, the power jack, buzzer, and key switch are thoughtfully positioned. The power jack serves as the interface for the external DC adapter, ensuring a stable power supply. The buzzer, located strategically, alerts in case of unauthorized entry. The key switch, conveniently placed, provides user control and security access. This arrangement maximizes functionality and user convenience, creating a compact and effective door security system. Careful consideration is given to their placement and secure attachment within the enclosure to guarantee seamless integration and optimal performance.

Place GSM Module: - The GSM module is placed on the top side for efficient communication with the cellular network. This ensures reliable message alerts to the owner in case of unauthorized entry. Thorough checks verify its proper alignment and secure attachment for seamless functionality within the door security system.

Wiring: - The wiring between the PCB and GSM module, buzzer, key switch, and power jack is meticulously done during the assembly process. The connections are established to ensure proper communication between the PCB and the GSM module, facilitating real-time alerts to the owner. Additionally, the wiring links the PCB to the buzzer, enabling it to sound an alarm in the event of unauthorized entry. The key switch is connected to the PCB to provide user control and security access. Lastly, the power jack's wiring enables a reliable power supply from the external DC adapter to the system, ensuring smooth and efficient operation. Thorough testing is conducted to validate the connections' integrity, ensuring a well-functioning and reliable door security system.

Close the Enclosure: - The enclosure is closed securely using proper nuts, protecting and firmly holding all the components in place. This step ensures a durable and reliable door security system. Thorough checks guarantee a tight and high-quality seal, providing customers with a secure and well-constructed product.

Test for functionality

Check the power supply: - To validate the power supply and ensure the proper functioning of the 5V regulator, the following steps can be taken. First, use a multimeter to measure the voltage output of the power supply. It should closely match the rated voltage, such as 12V for a DC adapter. Next, verify the input voltage to the 5V regulator on the PCB. It should match the expected input voltage, such as 12V from the power supply. After that, measure the output voltage of the 5V regulator. It should be approximately 5V, indicating that the regulator is functioning correctly. Additionally, check the 5V regulator for overheating. An unusually hot regulator may signify a problem. Finally, test the door security system's overall functionality with the proper power supply and stable 5V voltage from the regulator to ensure all components work harmoniously. By performing these checks, the manufacturer can ensure a reliable power supply and proper functioning of the 5V regulator, resulting in a well-performing and efficient door security system.

Delay in the Buzzer: - During the functionality test, one of the key aspects to evaluate is the delay between the moment the Reed switch is deliberately disconnected and when the buzzer is activated. This test is crucial as it determines how quickly the system responds to unauthorized entry. By deliberately simulating an intrusion, the time it takes for the alarm to sound provides valuable insights into the system's efficiency and responsiveness. Meticulous observation and precise measurements are conducted to accurately assess the system's performance. A short delay between disconnection and activation ensures that the system can promptly alert the homeowner about potential security breaches. This critical test helps ensure that the door security system operates effectively, providing timely alerts to protect the premises from unauthorized access.

Delay in getting alert message: - Another important aspect of the functionality test involves evaluating the delay in the response from the GSM module. After triggering the alarm through the Reed switch disconnection, the system initiates the process of sending a message to the homeowner's mobile device via the GSM module. This test focuses on measuring the time it takes for the message to be delivered successfully. During this evaluation, the system is closely monitored to ensure the GSM module responds promptly and sends the alert without significant delays. A quick response time is crucial to notify the homeowner about the security breach in real-time, allowing them to take immediate action. By carefully measuring the delay in the GSM module's response, the manufacturer can fine-tune and optimize the system's communication capabilities, ensuring reliable and efficient message delivery. This helps guarantee that the door security system fulfills its primary purpose of providing timely and accurate notifications to the homeowner, enhancing overall security and peace of mind.

Bill of materials

Component		Unit Price	Quantity	Total Price
Atmega328p chip		1400.00	1	1400.00
5V Regulator (7805)		50.00	1	50.00
5V Buzzer		60.00	1	60.00
Reed Switch		330.00	1	330.00
Key Switch		450.00	1	450.00
DC female jack		20.00	1	20.00
Resistors	10kΩ	60.00 (per packet)	1	60.00
	330Ω	60.00 (per packet)	1	60.00
Capacitors	10uf	5.00	2	10.00
	22pf	5.00	2	10.00
LEDs		50.00 (per packet)	1	50.00
JST connectors		20.00	6	120.00
2N222A Transistor		10.00	1	10.00
Total cost				2630.00

Components	Suppliers
Atmega328p chip	Microchip Tech
5V Regulator (7805)	Shanghai Siproin Microelectronics
5V Buzzer	LCSC Electronics
Reed Switch	
Key Switch	
DC female jack	
Resistors	
Capacitors	
LEDs	
JST connectors	
2N222A Transistor	Slkor (SLKORMICRO Elec.)

Components	Without shipping	2630.00
	Shipping	2000.00
PCB	Without shipping	1500.00
	Shipping	1000.00
Enclosure	Without shipping	3500.00
	Shipping	500.00
Total cost		11,130.00

Annexures

Figure 36 Door Security System with Reed Switch

References

1. 2N222 Datasheet
2. 7805 Datasheet
3. Atmega328P Datasheet
4. Document about reed switch
5. DC female jack Datasheet