THIEF DETECTOR

➢ Overview

A simple security device which alerts the user in the case of threat to his room or house.

➢ Done by - Group of engineering students in Electronics and Telecommunication Department -University of Moratuwa.

Group **22**

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➢ Problem Description, motivation and justification for the selection

❖ Problem

- Because of the economic crisis, many **theft incidents** are happening around Sri Lanka.
- We got this idea after hearing the news, that many of the boarding places around the university got robbed within the past weeks.

❖ Does this actually concern people?

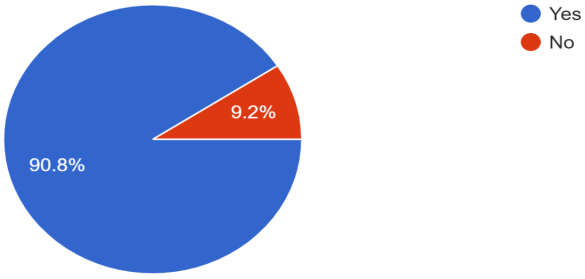
- According to our market analysis, nowadays a proper CCTV camera costs around 20 000 LKR. And the cheaper ones with lower build quality are around 8 000 LKR.
- The issue with these cameras is we need to have a router and a stable internet connection. The user will not be alarmed if anything happens if the above 2 factors are not available. If the power goes out, these cameras will still record for only a few hours and store them on an SD card. But there seem to be many complaints about the recording quality and the reliability of the products.
- If someone wishes these available systems to work on power cuts as well, a backup battery for the router is needed which will cost around 15000 LKR. Therefore the total cost for the security system with a single CCTV camera will cost around 25 000 LKR assuming that the user already has a wifi router.
- To install such a CCTV system a professional is needed.

We also did a small survey using a google form and collected some important information which was very useful for us to get a clear idea about the actual problem at what actions that the people expect from us.

Following are the results we got from our survey.

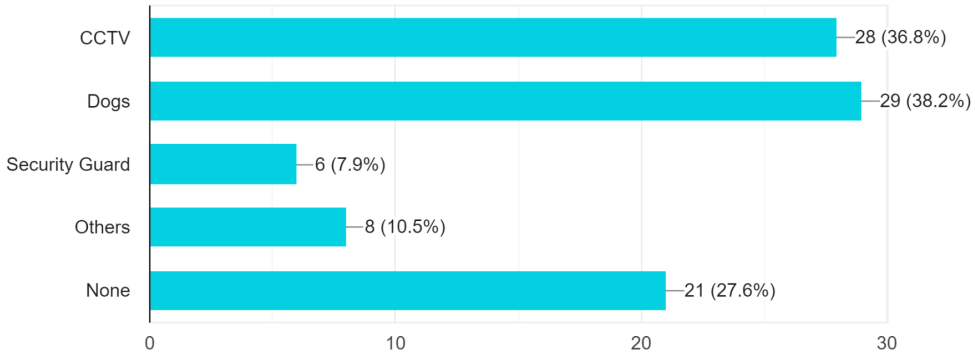
Are you concerned about the safety of your house/boarding place?

76 responses



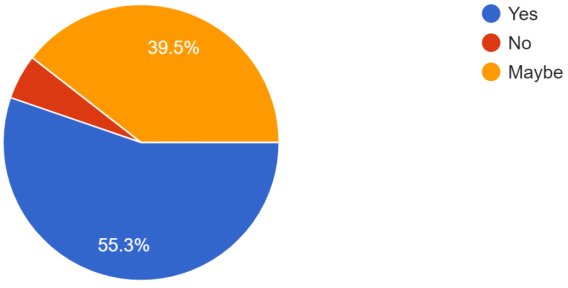
What are the existing security systems at your residence?

76 responses



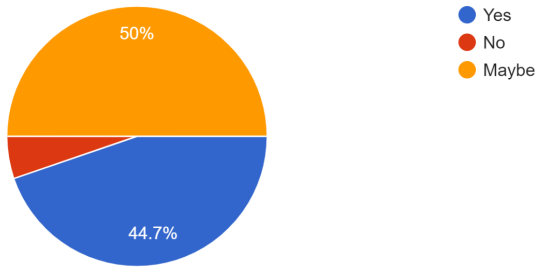
Are you looking for a simple and affordable security solution?

76 responses



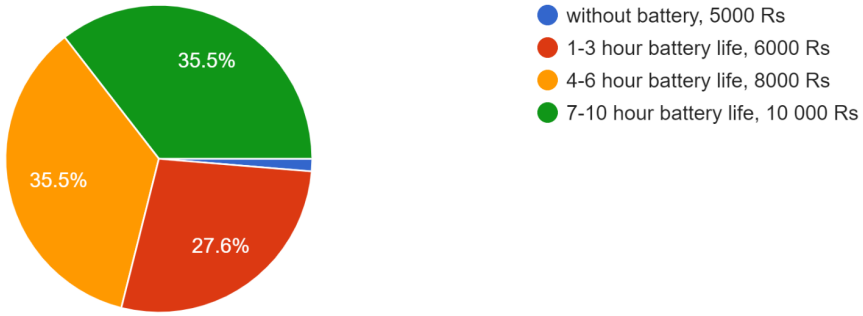
If a security device which cost less than 10,000 LKR is available, will you buy such a product?

76 responses



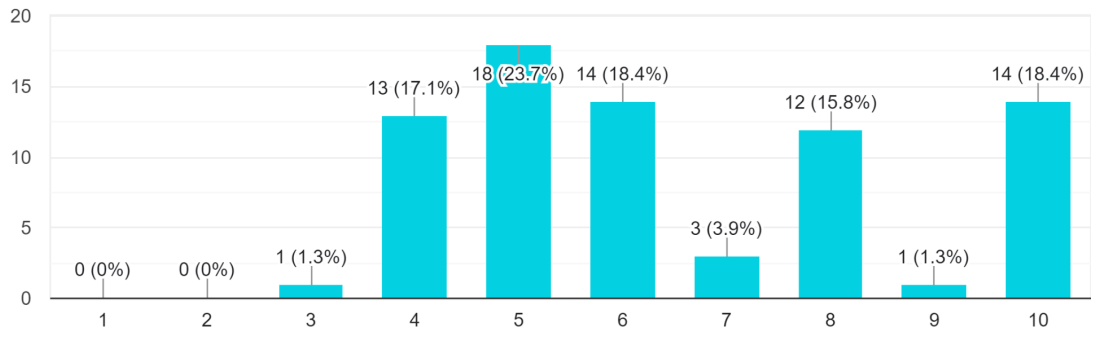
Which of the following models of the product are you willing to buy?

76 responses



For such a device, how long would you expect it to work with its battery during power cuts? (in hours)

76 responses



These results clearly indicate that people are interested in such a product. The most preferred models of our solution are the one which has a 7-10 hour battery life and cost about 10,000 LKR and the one with a 4-6 hour battery life for 8,000 LKR. But when creating the form, we added a 2000 LKR additionally, just to check whether people would go for such a product. Actually, we will be able to produce a product which has a 7-10 hour battery life for less than 8000 LKR. Even for a product with a 5-6 hour battery life, which is the most preferred battery life, the product cost margin would be roughly 5000 LKR. Which would definitely satisfy the market.

According to all the facts and the survey results mentioned above, It is perceivable that a security device has become an essential piece of equipment in every house and residence. Therefore we can ensure that our product will be very useful to customers and will have a high demand in the market and depending on that demand we can consider future developments as well.

❖ Our Solution

- As a solution, we decided to develop a **Thief Detector** device which is simple to use and directly pluggable into the power outlet.
- It will include a built-in battery, which will last about 10 hours, although the CCTV cameras we mentioned earlier cannot hold for long hours.
- Our product includes GSM connectivity, which allows users to communicate with the devices even during power cuts.
- The estimated market price of our product will be **8000 LKR**.

➢ Technical Feasibility

Electronic product development can be expensive, time-consuming and risky. Mistakes that go undetected at the start of a project can be very costly to fix later in the development cycle. The best way to mitigate these risks and cut unnecessary costs is to get a professional review of our project concept before starting the detailed design work.

By performing a technical feasibility study first, we understood key regulatory, technology, and supply chain options and associated risks before our client committed to the full development project.

❖ Performance Targets

- Detect strangers entering the room.
- Make phone call or SMS to alert the owner about the incident.
- Notify the user even with an alarm sound.
- Operation of the device up to 9-10 hours without main power.
- Capability of easily pluggable into wall outlets.

❖ Availability of Hardware components

Needs of this design project include some Hardwares and Softwares. Hardwares that are used and their corresponding performance targets are mentioned below.

1) To detect motions, we need a sensor which triggers only in the case of motion of a human being. So there is a sensor in the market which is called **PIR (Passive infrared sensor) .** Its operation is based on infrared rays which emit from living beings. This has a range of up to 10 meters, a single detector placed near the entrance is all that is necessary for rooms with only a single entrance.

2) To make a phone call or send SMS text to the user through the network, we need a device that has the functionality of providing connection between our device and a specific mobile phone of a user. **GSM Module** which can be easily found in the market provides that necessity.

3) Making an alarm sound is very straightforward, there are several methods and components, but in our device we continue with a simple small **buzzer.**

4) Operation of our device upto significant time (9-10 hours is our aim) without main power is the most critical point. Even in power interruptions, our device can operate as an internal rechargeable battery. The battery we are going to use can provide backup power to the device for more than 10 hours. And when power is back it can be recharged within a few minutes due to its fast-charging capability. Also it must have the capability of providing 2A current without any voltage dropping. So **7.2 v Lithium ion battery** is the option that we chose. Usually lithium ion batteries have high capacities so then it can last a long time and also they fulfill the current requirement.

5) We designed our enclosure for the product in a smart shape which provides much convenience to users.

All the modules that we are going to use are very popular because they are arduino development modules. So there are various brands with different manufactures in the market. We can go with one of them or choose multiple brands.We have found some local sellers who supply the electronic components with good quality.Also our required components and modules are easily available in their shops. So all the resource requirements are available and it paves the way to reach our performance targets.

❖ Time Management

The time we had given to complete our project is 10 weeks. First we had to find a problem that we can provide a solution within this time duration.Meanwhile because of the economic crisis, many theft incidents have happened around Sri lanka. Many of the boarding places around University got robbed. As a solution, we got our project idea to make a Thief Detector using a PIR sensor. To research the problem to find possible solutions that we can provide took 4 weeks for us. Then we started to develop a simple block diagram that elaborates the method we are going to use. After that, we searched for the components on the internet and as well as in shops.The Most critical issue that we faced was the unavailability of components in shops due to the economic crisis. But we could manage it and found the required components. Finally we designed a schematic diagram and a PCB layout, an enclosure for our device then connected all the components within that enclosure and finalized the project.

➢ Technical Specifications

In our device, we have included simple Features which facilitate the user to interact with the device. Those are the most suitable and applicable functions that can be managed by our budget. Even Though they are simple, they do the exactly necessary tasks that are essential to be performed.

❖ Key Features of the product

1) Sending SMS to mobile phone notifying the user.
2) Directly pluggable into the main power outlet.
3) Portable
4) Light weight
5) Power ON/OFF indicator and switch
6) Sleep mode ON/OFF indicator and switch
7) Alarming buzzer

❖ Physical Dimensions

- Width = 8cm Height = 10cm Thickness = 6 cm
- Overall Volume = 480 cm^3
- Approximated Weight - 250g

❖ **Interfaces**

1) 2 switches are mounted on the enclosure.
2) LED is placed for the indication of the power on/off states.
3) Buzzer is mounted on the front face
4) Helical antenna of the Gsm module is placed on the top side.

❖ **Power Consumption**

- ATmega 328p - operates at 5v with 15mA average current usage. So the total power is 75mW.
- GSM module - 4.2v and 18mA average current. Power = 75.6mW
- Pir sensor - 5v and 0.05mA . Power = 0.25mW
- Power dissipated at Voltage regulator - (7.2 - 5) x (15+18+0.05) = 72.71mW
- All other power losses at resistors and diodes = 50mW

Total Power Consumption of the device = 274mW

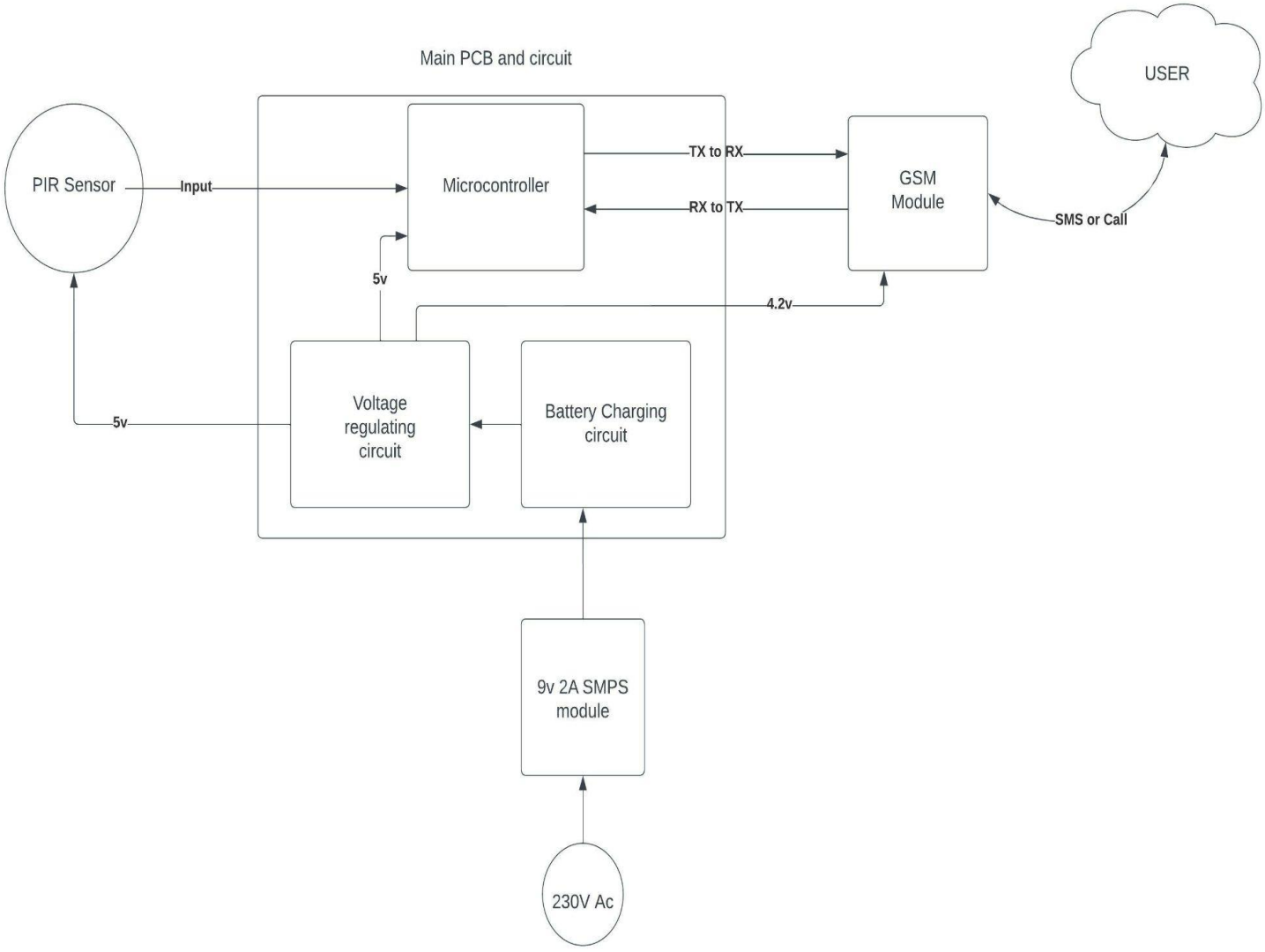
Total current requirement from battery = 38.06 mA

➢ Block Diagram view (Architecture of the product)

Our device has 4 major parts, which are mounted separately inside the enclosure.

- Main PCB and circuit
- PIR sensor
- GSM module (Sim 800l)
- 9v 2A smps power supply module

These 4 parts are connected within the enclosure as shown in the diagram below.



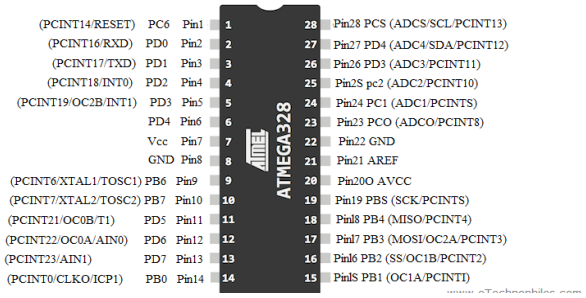
Specifications and functionalities of each block have been described below.

❖ Main PCB and circuit

This circuit has 3 sub circuits. They are the **microcontroller circuit , Voltage regulating circuit** and **battery charging circuit.**

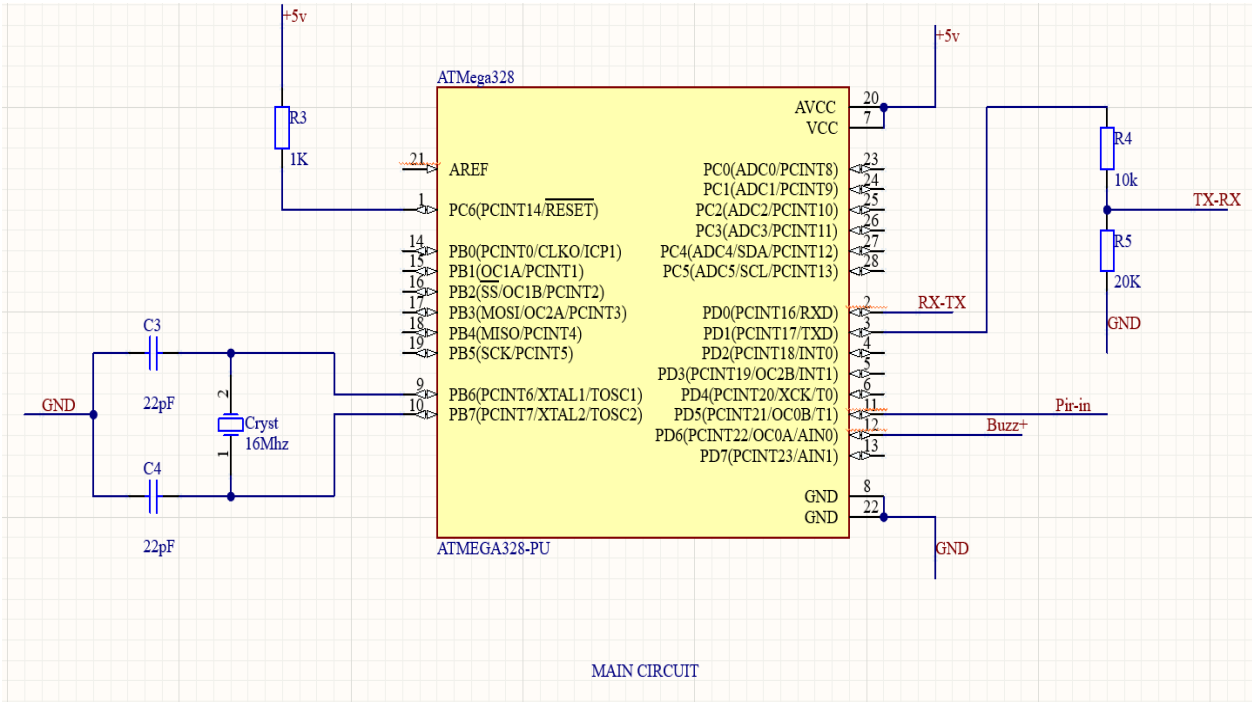
1) *Microcontroller circuit*

Microcontroller circuit is the main block which controls all the functionalities of our device. It gets inputs from the PIR sensor and analyzes it, then sends signals to the GSM module whether to make a call or send a SMS to the user. We used ***ATMEGA 328P*** microcontroller which can be programmed using C++ (Arduino) . It has I/O pins , So we can use them to get input from the PIR sensor and also to send signals to the GSM module.



PINOUT

In our circuit, Pin 11 is used to get the input from PIR sensor and pin 2 and pin 3 are used to Receive and Transmit (RX-TX) data transfer which corresponds to sending the signal to the GSM module. Also pin 12 is used as Output pin to connect a buzzer which makes an alarm sound. Regulated +5v is supplied to pin 7 and pin 20. Pin 8 and pin 22 are grounded.

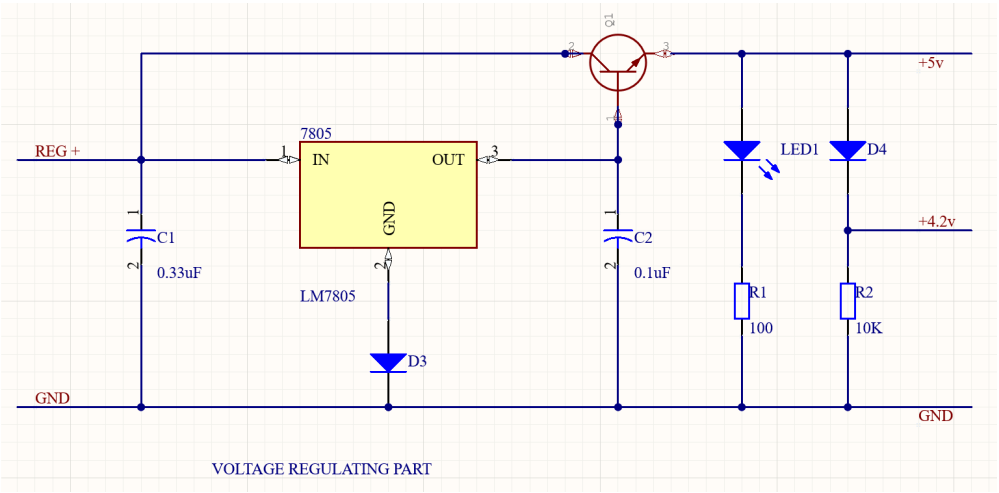


Schematic Diagram of Mircocontroller circuit

Output Voltage of pin 3 (Transmit) is reduced using a voltage divider and that reduced voltage is fed into the GSM module because the GSM module works on 3.3v = HIGH logic in contrast with 5v= HIGH logic. Also some other components like 22pF capacitors, 16 Mhz Crystal and 1K pull up resistor are needed to be connected as shown in the diagram.

2) Voltage regulating circuit

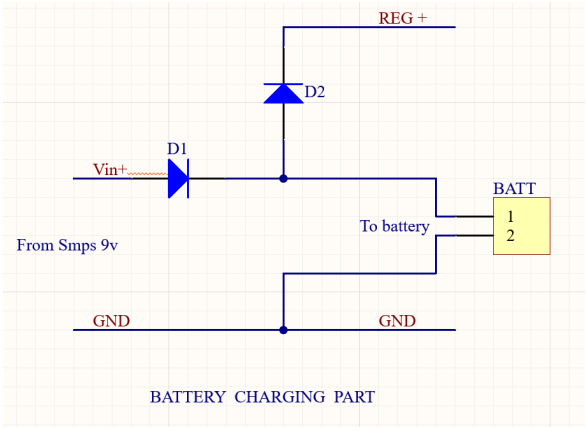
We are using a 7.2v lithium ion battery to power up our device, but Microcontroller works at 5v and the GSM module works in the 3.4 v-4.4v range. So 7.2v must be reduced to 5v and to a voltage between 3.4v and 4.4v. To do that, we added LM7805 voltage regulating IC and D313 power transistor to handle high current. Our device doesn't need much current but in transmission bursts, the Gsm module draws nealy 2A current so the D313 transistor is necessary.



Lm7805 outputs well regulated 5v voltage and by applying a diode(D4) and a resistor(R2) between 5v and ground we can get 4.2v output which is needed for the GSM module.

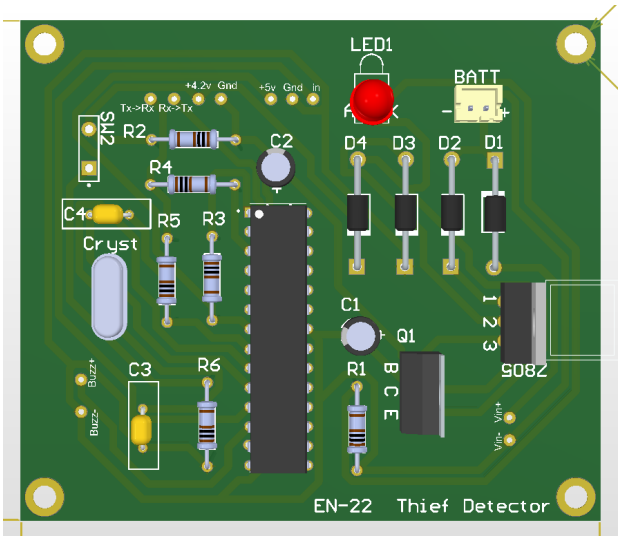
3) Battery charging circuit

In our device we use a 7.2v Lithium ion battery, So it will be being charged by 9v 2A SMPS module.

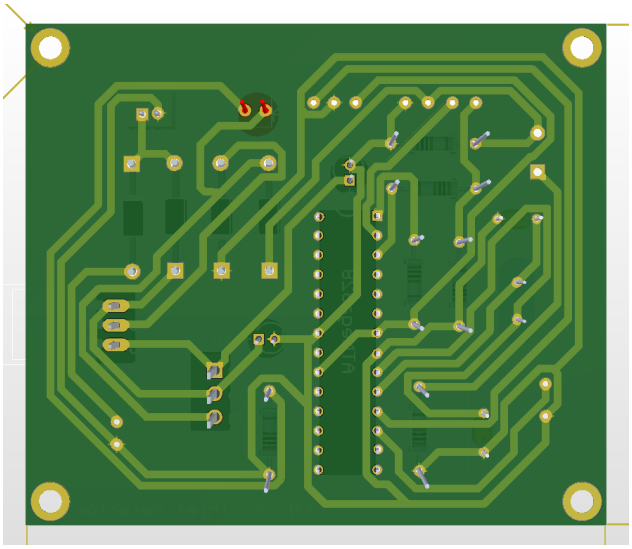


SMPS charges the battery and simultaneously it supplies power to other components as long as main power remains. When the main power is disconnected, Battery starts to give power to components.

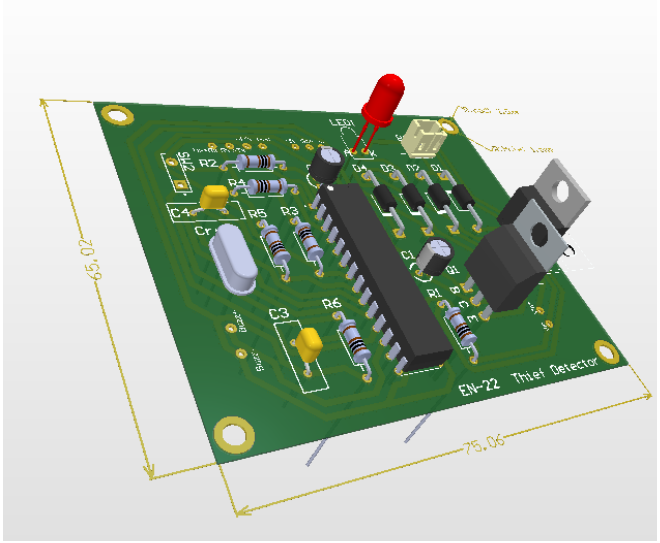
All these three subcircuits are placed on a one circuit board and interconnected. Our pcb is 75mm x 65mm in size. Bottom layer is used for routing because all the components that we used are through hole type components.



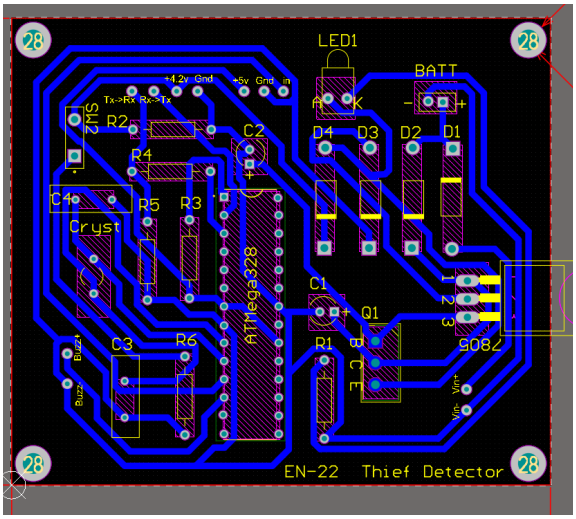
Top view



Bottom View



Inclined view



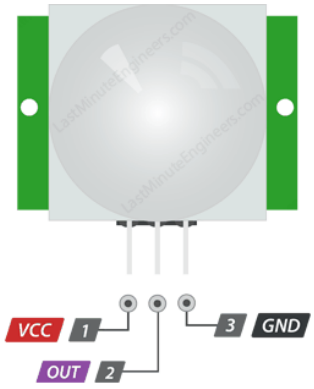
Routing

❖ PIR Sensor

Sensor that measures infrared light radiating from objects. PIR sensors are mostly used in motion detectors. Once there is infrared radiation from the human body particle with temperature, focusing on the optical system causes the pyroelectric device to generate a sudden electrical signal. Simply, when a human body or any animal passes by, then it intercepts the first slot of the PIR sensor. This causes a positive differential change between the two bisects. When a human body leaves the sensing area,the sensor generates a negative differential change between the two bisects.

So from this feature of the pir sensor, we could integrate it with microcontroller and develop a code to get signals from pir which indicates a motion of human beings.

The PIR sensor we are going to use is HC-SR501.The HC-SR501 has a 3-pin connector that interfaces it to the outside world. The connections are as follows:

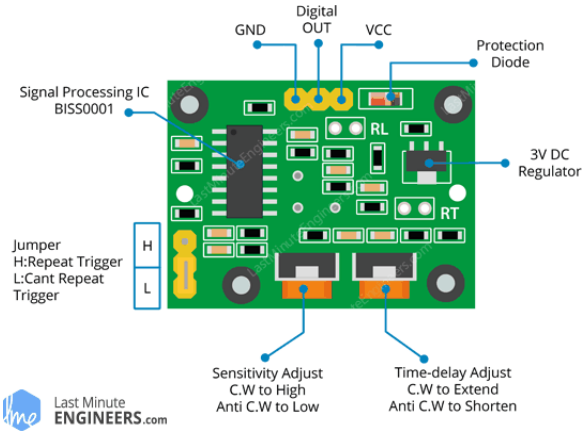


VCC is the power supply for the HC-SR501 PIR sensor which we connect to the 5V output in our main PCB.

Output pin is a 3.3V TTL logic output. LOW indicates no motion is detected, HIGH means some motion has been detected.

GND should be connected to the ground of the PCB.

It has a built-in voltage regulator so it can be powered by any DC voltage from 4.5 to 12 volts, typically 5V is used. Other than this, there are a couple options we can adjust with our PIR.

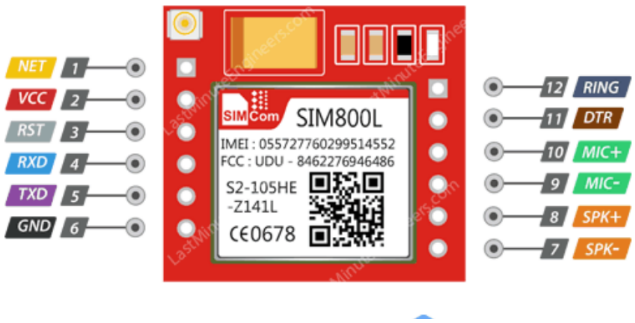


There are two potentiometers on the board to adjust a couple of parameters:

- Sensitivity– This sets the maximum distance that motion can be detected. It ranges up to 10meters. The topology of your room can affect the actual range you achieve.
- Time– This sets how long the output will remain HIGH after detection. At minimum it is 3 seconds, at maximum it is 300 seconds or 5 minutes.

❖ **GSM module (Sim 800l)**

The GSM module allows devices to communicate with the user.



One of the biggest issues with the SIM800L GSM module is the power supply to the module. If the power supply can't fulfill the required current well, then the module can't make the connection to the cellular network or it will shut down/reset in the middle of the action.The operating voltage range of the module is 3.4- to 4.4-V. In burst state (like sending a SMS or making a Call) it draws 2A current but in standby mode it only uses 18mA current. The Sim 800l module usually comes with a helical antenna which can be directly soldered into the NET pin module. But if any connection error occurs due to poor signal strength, we will have to use dBi antenna with u.fl connector.

To connect with the user, a SIM card is needed to be inserted into this module. Sim 800l only supports 2G SIM cards , but we have found that some SIM cards which are 4G support this module too.

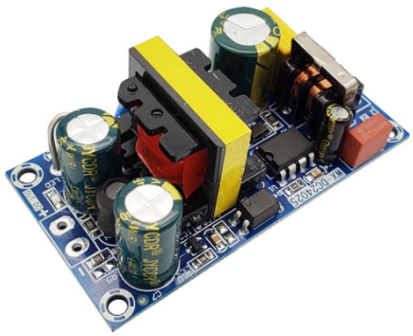
This has an inbuilt LED which blinks at every 1 seconds when it is not connected to the network and blinks at every 2 seconds when connected. So from that feature the user can identify whether the device has connected properly to the network or not.

There is a special pin called **DTR** in this module which provides us the capability of putting the module into Sleep mode. So it helps to minimize power consumption because in sleep mode the module only draws 1mA current.There is no need for the GSM module when the user is in his house, so then he can put the module to sleep mode which disables the SMS notifying service. By giving HIGH logic to DTR pin will enable the sleep mode and putting it to LOW logic brings it back to normal state. To do that we have placed a switch on the enclosure.

To communicate with this module, there are special type of commands called **AT commands.** We integrated them with our code so that communication is handled perfectly.

❖ SMPS module (9v-2A)

Since we are using a 7.2v lithium ion battery, we need to provide exact 7.2v or high voltage to charge it. So here we use SMPS 9v supply which can deliver 2A current. We chose SMPS supply rather than going for conventional transformer type supplies, because SMPS supplies are relatively small and they have low heat dissipation. We give 230v AC city power to this module and it outputs 9v regulated DC voltage.

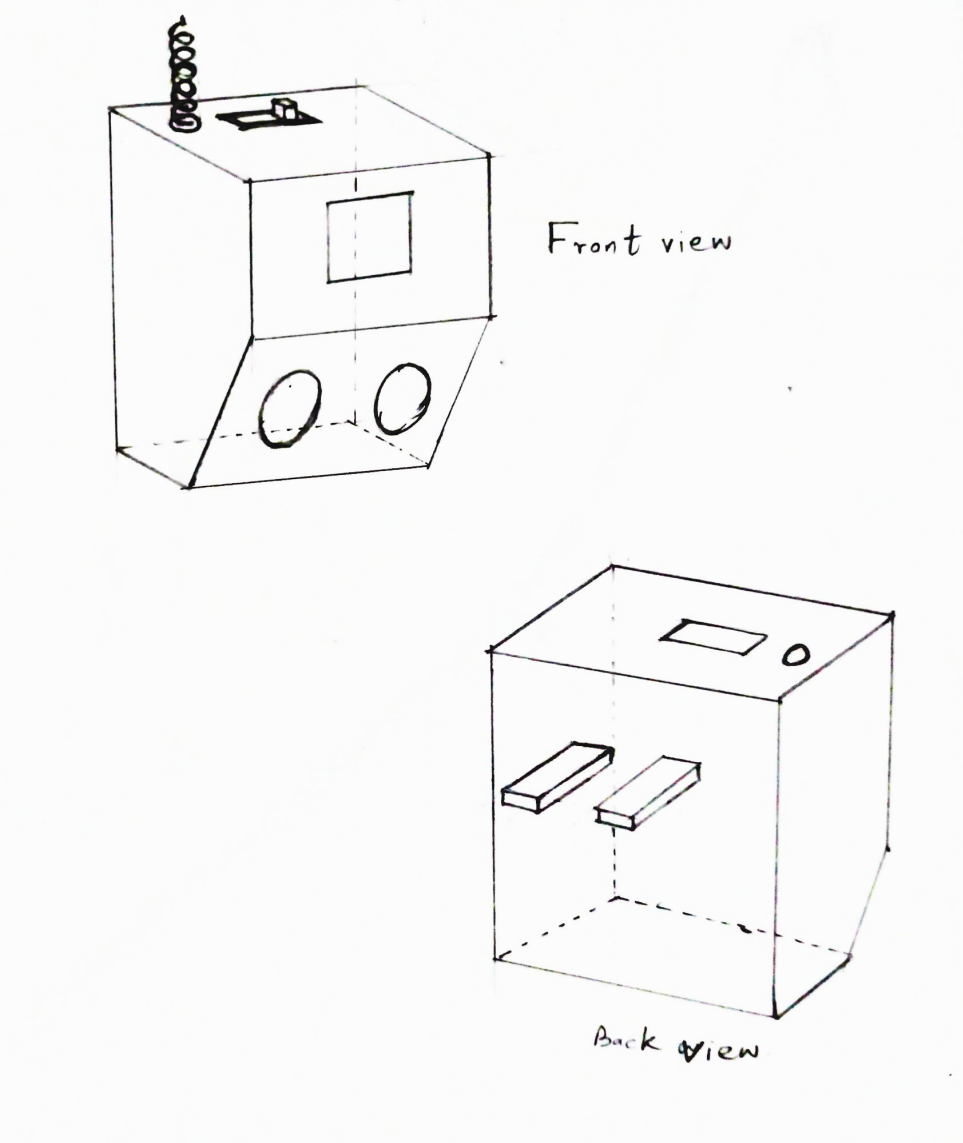


9v 2A AC to DC buck converter module

➢ Hand drawn and Finalized sketches of the Enclosure

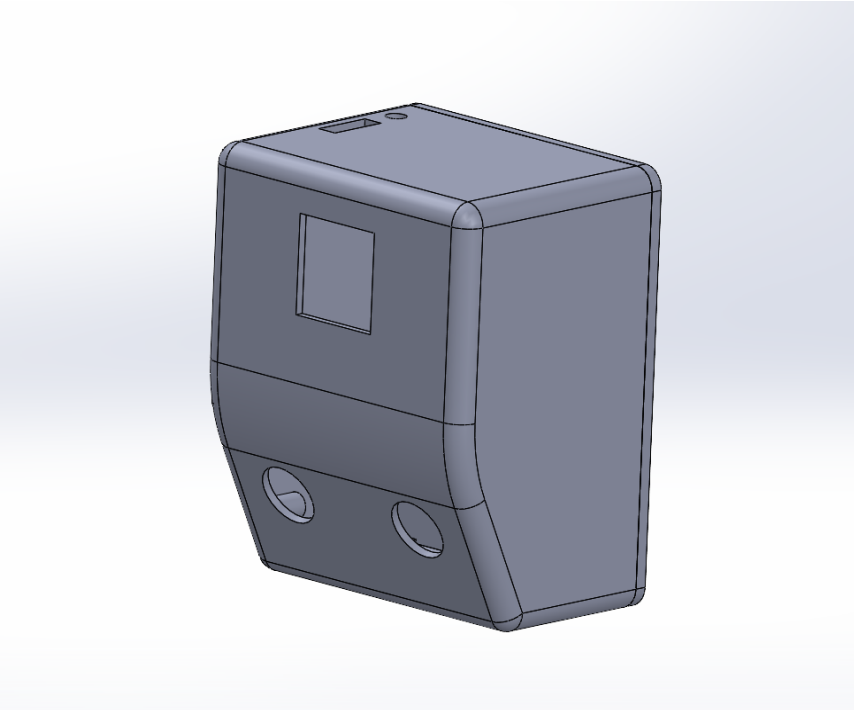
This device enclosure has two parts. A casing and its cover. Cover is fixed to the casing using two screws, and also the main PCB can be mounted inside the casing using 4 screws. 2 square plug pins are attached to the cover so that we can plug our device to any 13A standard plug socket directly. Since our casing is plastic we didn't add an earth pin.

All the dimensions mentioned below are in millimeters.

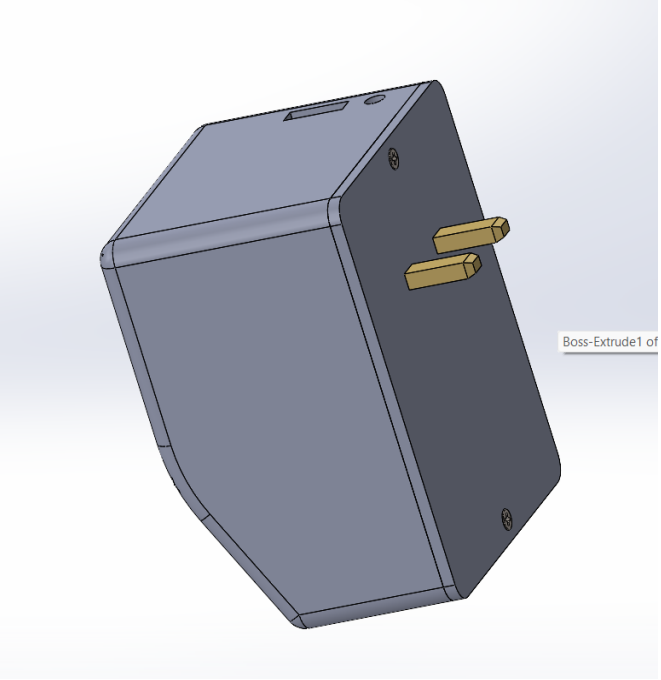


Hand drawn sketch of the enclosure

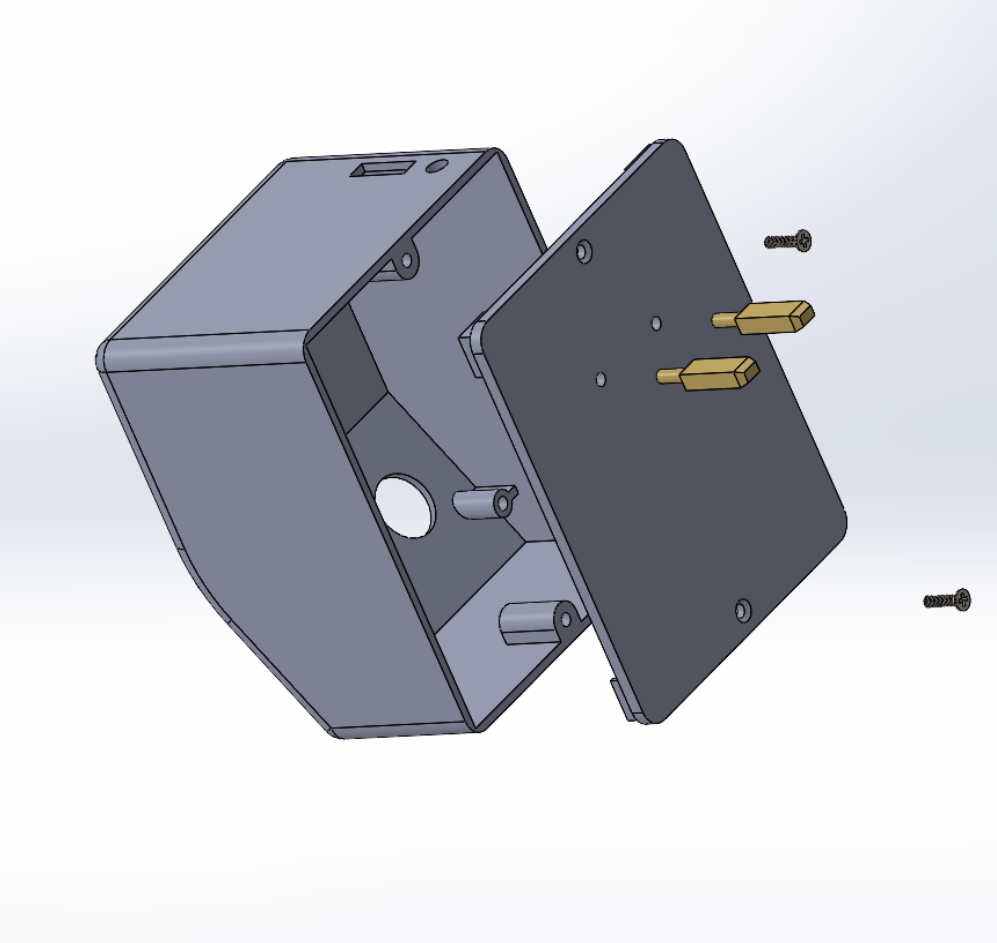
Following are the views of the designed 3D model.



Front view



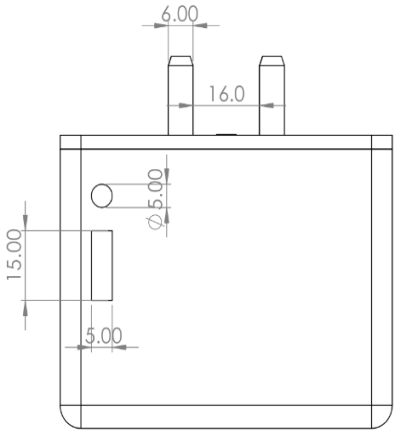
Back view

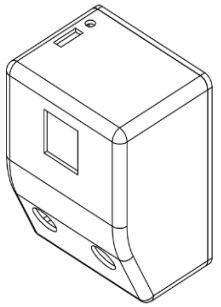


Exploded view

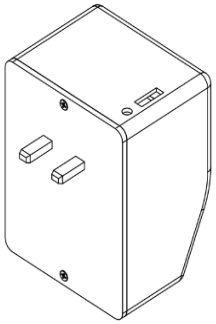
2D sketches

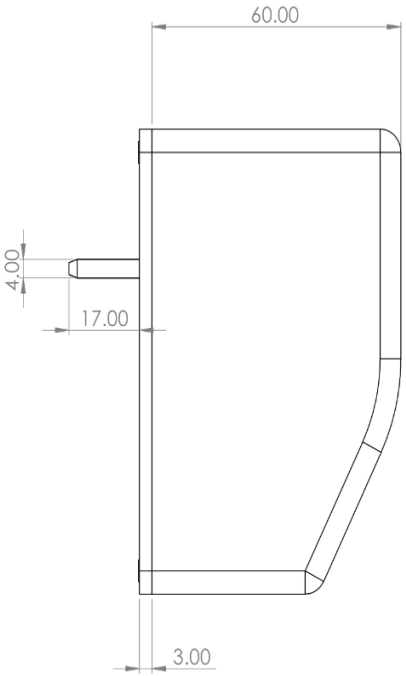
TOP VIEW



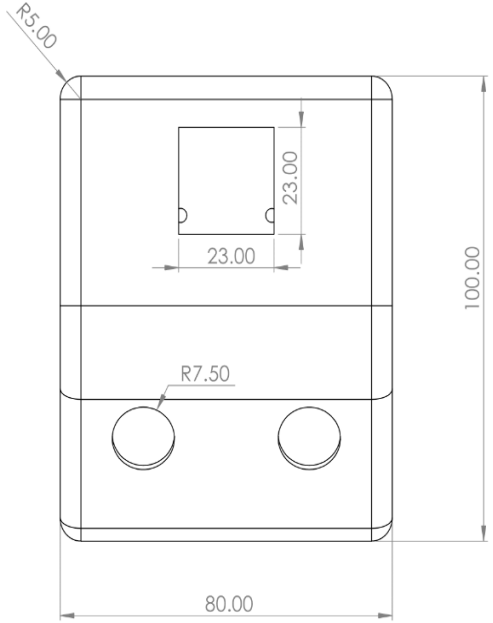


3D VIEW





LEFT VIEW



FRONT VIEW

➢ User interface Design (Controls Visible for the user)

- Enclosure will have an on-off switch , where the user can control the performance of the detector. There is an LED which will indicate the mode of the thief detector. It will turn on when it's in working mode.

- There is another button to switch on and off the GSM module directly. When the user is at home, if the thief detects anyone, it will automatically sound the buzzer. So there is no need to send a SMS notification for the user. This button enables the user to switch off the GSM module whenever he/ she does not need SMS notification.

- Users will be able to get SMS notifications to their phones immediately when anyone is detected in the Thief detector.

- There are simple SMS commands which will be provided to the user so that he/she can interact with the device just by sending that commands through a SMS to the sim number of our device. We will provide the sim number to the user so he can save it in his mobile as a contact.

➢ Marketing, Sales & Beyond

Nowadays people have concerns about security, since the number of robberies are increasing. So there is a high demand for electronic security systems. There are many varieties of security equipment in the market such as CCTV, Burglar Alarm. As the first step we have now identified the substitutes and compared with our product. One of the main demerits of those products is higher electricity consumption. Depending on that we have chosen our tagline for our marketing Campaign.

“Secure your Home, with less Energy”

At the initial stage, we will market these products locally. Once we capture the local market, we will enhance our product by adding new features. With that, we will get into foreign markets as well. Our marketing strategy is aligned with 4P s of the marketing mix. One very important aspect of the products being successful in the market is its price. The average price to implement a CCTV camera is between USD 150 - USD 450 (according to google). We have planned to sell with a low markup price, to capture the initial market.Initially we will sell our product through different e-selling platforms and small shops

locally. Once we get recognition from the people, we will start our own website to cut down the unnecessary commission costs. Once we revise our product with the suggestions of local users , we will start to market our product in foreign countries using ecommerce websites.

➢ Project Budget (Bill of Materials)

-Components

Name of the component	Quantity	Total Price (*Rs*)
1)ATMEGA 328 p microcontroller	**x 1**	**1900**
2)PIR sensor	**x 1**	**350**
3)SIM 800l GSM module	**x 1**	**1350**
4)9v-2A Ac to Dc buck converter	**x 1**	**800**
5)7.2v Lithium ion battery	**x 1**	**1500**
6)LM 7805 voltage regulator IC	**x 1**	**50**
7)D313 NPN transistor	**x 1**	**80**
8)Buzzer	**x 1**	**40**
9)Switches • **230v Switch** • **12 v Switch**	 • **x 1** • **x 1**	 **100** **20**
10)16MHz crystal	**x 1**	**20**
11)IC Base (28 pin)	**x 1**	**15**
12)LED bulb (red)	**x 2**	**5 x 2 = 10**
13)Diodes • **1N4007** • **1N5400**	 • **x 3** • **x 2**	 **10 x 3 = 30** **20 x 2 = 40**
15)Capacitors • **0.33uF** • **0.1uF** • **22pF**	 • **x 1** • **x 1** • **x 2**	 **20**
Total cost for the components		**6325**

-Manufacturing Process

- PCB printing- Rs 500
- Enclosure 3D printing - Rs 1200
- Soldering wires = Rs-70

Total Budget - *Rs 8095/=*

➢ Task allocation

- ☐ **Marketing & UI design - Vinirajan Viruthshaan**
- ☐ **Product idea validation and research - Lasitha jananjaya**
- ☐ **Circuit Schematic Diagram & PCB designing - Kavindu Shehan**
- ☐ **Enclosure designing- Pasindu Sandeep**

*** END ***