REPUBLIC OF RWANDA
ULK POLYTECHNIC INSTITUTE

ACADEMIC YEAR 2023-2024
DEPARTMENT: ELECTRICAL AND ELECTRONICS ENGINEERING
OPTION: ELECTRICAL TECHNOLOGY

DESIGN AND IMPLEMENTATION OF INTERCOMMUNICATION FOR SECURITY SERVICE WITHIN AN INSTITUTION

Submitted in partial fulfillment of the requirements of Advanced in Electrical Technology

SHEMA ALI ABAS
ROLL NUMBER: 202150204

Supervisor: Eng. TUMWINE Isaac

October 2024

DECLARATION A

I SHEMA ALI ABAS, Declare that this research studies is my original work and has not been presented for Degree or any other academic award in any University or Institution of Learning". No part of this research should be reproduced without the authors' consent or that of ULK Polytechnic Institute.
Student name: SHEMA ALI ABAS
Signature: …….
Dates: ……

DECLARATION B

I confirm that the work reported in this final year project entitled **"Intercommunication for security service within an institution"** was carried out by **SHEMA ALI ABAS** under my supervision and it has been submitted with my approval as UPI in Electrical and Electronics Engineering Department supervisor
Supervisor name: TUMWINE Isaac
Signature: …….
Dates: ……

DEDICATION

I dedicate this project to:

Our almighty god.
Our beloved parents, brothers and sisters.
Our Relatives.
Our friends, classmates.
Teachers and supervisor.

I all dedicate to you with many thanks for everyone who has participated by giving me any contribution accordingly!

ACKNOWLEDGEMENT

I would like to acknowledge and give thanks in a special way to the almighty God from whom all knowledge, wisdom and understanding rightly comes, for all he has done while carrying out my studies and projects I am thankful to him.

I also thank all staff of ULK POLYTECHNIC INSTITUTE POLYTECHNIC INSTITUTE, especially my supervisor and all my friends and family. There are no profound words to express my gratitude for the love and support that you have Given me. Finally, I also thank my classmates for the part they have played in my Lives during these exciting years.

May GOD keep endless blessings upon you!

ABSTRACT

The need for security cannot be overemphasized in today's modern world, where theft, causes much damages to the institutions and lead them to loss, so that is why I developed the security system entitled ***Intercommunication for security service within an institution*** *with the help of passive infrared ultrasonic sensor for detecting Objects, GSM SIM900 for sending the message to the person in charge of security, ARDUINO UNO, LCD for displaying the situation, and the buzzer for alarming. It is the project which will be used anywhere for safety, as some institutions has the private places where people are not allowed to go for examples in medical research laboratories they have the place where they keep their researches and they don't need anyone to go there, so they can use my project to keep the place safe. Because my project is able to display the message telling people that it is not allowed to come close by, it is able to detect the movement where it is not allowed, it is able to alarm giving the person close by to stop and even alarming the person in charge that someone is close, it also have the global system for mobile (GSM) system to send the sms to the person in charge wherever they are. The system resulted in a cost saving, smart, portable and a more efficient way of implementing Intercommunication for security service within an institution.*

Keyword: Arduino, GSM system, Ultrasonic sensor and Buzzer

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LIST OF ABBREVIATIONS AND ACRONYMS

ADC: Analog to Digital Converter
CPU: Central Processing Unit
EPROM: English erasable programmable read only memory
EEPROM: Electrically Erasable

GSM: Global System for Mobile

LCD: Liquid-Crystal Display
PROM: Programmable Read-Only Memory
RAM: randomly access memory
USB: universal serial bus

CHAPTER 1:

GENERAL INTRODUCTION

1.0. Introduction

In Rwanda and all over the world there frequently happing the unpredicted security attack on hospital laboratory, bureaus, banks, homes, etc. unfortunately in the underdeveloped countries is being increased in most of the banks. For those areas, the security system is essential part to be included. The effective and reliable monitoring object with lighting and alarming system becomes more efficient. With the use of today's technology, any passing people can be detected by measuring the changes of speed within the environment. The emphasizing of this project is the implementation of security system using motion monitor sensor. The system can detect the people by reinforcing the surveillance technique, which provides the important security with necessary control, and alarming in the most vulnerable areas. If any suspected case within the bank, ultrasonic sensor the movement around the sensor. The sensing pulse forces to activate the light switch, sound alarm and send the message to the person in charge wherever they are. It is the project which will be used anywhere for safety, as some institutions has the private places where people are not allowed to go for examples in medical research laboratories they have the place where they keep their researches and they don't need anyone to go there, so they can use my project to keep the place safe.

1.1 Background

Security refers to the condition of not being threatened, especially; physically, psychologically or emotionally. A security system is a system designed to detect intrusion or unauthorized entry into a building or an area. They are used in residential, commercial, military, and industrial properties for protection against burglary (theft) or property damage, as well as personal prote (https://en.wikipedia.org/wiki/Security_alarm, (March 2011),(June 2021))ction against intruders. Threats also need to be monitored. The 'modern and smart' security systems which do in fact cover other potential threats and do function smartly by incorporating other forms of alarms notably phone-based alarms for remote monitoring, costs a fortune to set up, operate and maintain, owing to the nature of software design, type of materials used etc (https://en.wikipedia.org/wiki/Security_alarm, (March 2011),(June 2021)). This design signifies a major improvement in terms of using cheaper materials, easier to maintain components and cheaper operating cost than other systems of the same kind, as notifications via text messages. **Intercommunication for security service within an institution** can be used in offices, institutions (laboratory, educational, military, commercial, industrial, banks, bureau etc.).

1.2 Statement of the problem

Insecurity of an institution in Rwanda is a huge problem, and as such home and personal security threats are something that all Rwandan experience on a daily basis. Although homes, businesses and people spend a significant amount of money on security fees and systems, many problems and weaknesses still exist within the systems that we use today. An institution without security system is more likely to be broken into than one with security system. Besides the existing security system is a dependent system, which depends on the security guards and the use of camera surveillance to inform the authority or the owner about any incident regarding the institution.
And the big problem of camera surveillance is that whenever there is nobody around it will just record but won't stop the intruders from breaking in while our system is able to stop them because if the intruders detected it put on the alarm and also send the message. The other benefit of our system is that it is of low cost comparing to the existing security system.

1.3 OBJECTIVES OF PROJECT

1.3.1 General objective

In this digital world, it is important to start relying on digital things that is why I thought about introducing the "intercommunication for security service with in institution" project to increase the security and communication for an institutions and minimizing the cost of intercommunication for security service with in institutions.

1.3.2 Specific objectives

i. To avoid any crimes especially stealing activities

ii. To design a laboratory protection by using electrical and electronic devices

iii. To help users and gives the favors to go anywhere

iv. To gather feedback from users to understand their experience and satisfaction with the system.

1.4 Research questions

i. How avoid any crimes especially stealing activities?

ii. How to design a laboratory protection by using electrical and electronic devices?

iii. How to help users and gives the favors to go anywhere?

iv. How to gather feedback from users to understand their experience and satisfaction with the system?

1.5. Hypothesis

Laboratory house valuable assets, including product of chemistry, sensitive documents, and other valuable items. Motion sensors can detect unauthorized movements or intrusions in restricted areas, triggering alarms and alerting security personnel immediately send message.
Motion detectors may be obviously installed around laboratory houses, such as chemistry, sensitive areas, to detect any unauthorized access or suspicious activities outside of operational hours.

1.6 Challengers faced during research

- **Technical challengers:** The performance of ultrasonic sensors may be affected by environmental factors such as weather conditions or physical obstructions, which could impact the accuracy of occupancy detection.
- **Cost Constraints:** Budget limitations may affect the scale of system deployment and the extent of testing across different.
- **User Variability:** Different laboratory behaviors and patterns may influence the effectiveness of the system and the accuracy of user feedback.

1.7 Scope of the study

1.7.1 Time Scope

The study will be conducted over a period of three months from 29th June to 25th September 2024, including the design, implementation, and evaluation phases of the Intercommunication for security System. This timeframe allows for comprehensive testing and analysis of the system's performance and effectiveness.

1.7.2 Content scope

- **System Design and Implementation:** The study focuses on the development and deployment of Intercommunication security System that utilizes ultrasonic sensors to provide real-time. The system aims to enhance laboratory efficiency by offering accurate detection and visual feedback.
- **Technical and Operational Challenges:** Challenges related to the accuracy of ultrasonic sensors and the overall system's integration with existing infrastructure will be examined. This includes assessing the impact of environmental conditions on

sensor performance.

- **Communication and User Interaction:** The system's communication protocols for providing real-time alerts and updates to user will be explored. This includes evaluating the effectiveness of visual signals and any potential issues with the communication infrastructure.
- **Durability and Design Considerations:** Materials and design considerations for the sensors will be analyzed to ensure durability and effectiveness under various environmental conditions. This includes evaluating the resilience of system
- components.

1.7 .3 Geographical Scope

The research was conducted CHUK laboratory, locations in Kigali, Rwanda. These locations will be used to assess the system's performance in real-world settings and to evaluate its effectiveness.

1.8 Significance of the study

1.8.1 To the Researcher

This study provides valuable insights into designing and implementing advanced intercommunication security system.
It contributes to the researcher's knowledge and expertise in sensor-based technology and real-time information systems, offering practical experience in developing and evaluating innovative solutions.

1.8.2 To College and Universities

The findings of this study offer educational institutions a practical example of applying technological solutions to real-world problems.
It can serve as a case study for engineering, computer science, and urban planning programs, enriching the academic curriculum with practical applications of sensor technology and system design.

1.8.3 TO ULK POLYTECHNIC INSTITUTE

For ULK Polytechnic Institute, the study demonstrates the institution's commitment to addressing contemporary challenges through innovative research. It showcases the institute's ability to contribute to advancements in technology and intercommunication security, potentially attracting collaborations and funding opportunities for future research projects

1.9 Organization of the study

This project will be subdivided into seven chapters.

Chapter 1: General introduction and background of the study, the problem statement and objectives and solutions.

Chapter 2: Literature Review. Details how the current system works. It also talks about the components and technologies that have been used to implement this system and the components, which build our system.

Chapter 3: Research Methodology tells in details all method used to get relevant data or information for this project, some methods of data collection procedures and techniques that were used and the results we get in data collections.

Chapter 4: Fabrication and testing

In conclusion, therefore chapter one felled about introduction, background study, problem of statement, objectives, research questions, scope ,limitation and organization of study.

CHAPTER 2:

LITERATURE REVIEW

2.0 Introduction

Security concerns have become increasingly prominent in my daily lives, particularly when I am away from home. To address these issues, modern technology has been harnessed to develop solutions for safeguarding me from various hazards. The field of security research has seen significant progress, as evidenced by recent studies in this area (A. Golder, 2023). Security alarm system employing an Arduino microcontroller and Ultrasonic sensor. The system detects people intruders, relaying notifications through an LCD display and GSM modem (A. Golder, 2023). Created a remote security system using Arduino and mobile phones, utilizing an infrared sensor for motion detection and sending message.

2.1Theoretical Framework

Security systems are known for their ability to deter and detect crime, providing crucial evidence if something does happen. They offer numerous benefits to companies, but there are some drawbacks as well, particularly when it comes to securing and monitoring locations that do not have existing infrastructure to support the network of cameras. Wired security systems come with, well, wires. Lots and many wires. In addition, all of those cables eventually experience wear and tear and sometimes even tampering by unauthorized parties looking for a chance to disable your outdoor security system.
In this research, if the user activated the system, the microcontroller will read the information when the Ultrasonic sensor detects an unknown person or motion. The Arduino Microcontroller activates the buzzer, and then sends a signal to the LCD displaying Intruding and then the GSM modem gets a signal from the Arduino and sends SMS to the designated Mobile phone number registered in the system. To communicate between the GSM modem and Mobile phone, AT command is applied to this research. This is because the GSM modem can merely comprehend AT command statements. From this, it can communicate with Mobile phones, computers, and Arduino (Muhammad Ahmad Baballe, 2021).

2.2 Arduino Uno Microcontroller

The microcontroller capacities to get the yield signal from the Ultrasonic sensor as its info. The microcontroller 1forms the sign and yield it by speaking with the venous yield gadgets including the GSM module, the Buzzer caution framework, and so forth. The Arduino Uno is a circuit board comprising of other info and yield gadgets including the microcontroller (*, 2022). Truth be told, the Arduino Uno is microcontroller board dependent on 8 – bit. At mega 328P, microcontroller, gem oscillator, sequential correspondence, voltage controller, and so forth, support the microcontroller. The highlights of the Arduino Uno used for this task development incorporate 14 computerized input/yield sticks out of which 6 can be utilized for beat without tweak (RWM) yields 6 simple, input pins (from A6 - A6) USB association, a force barrel jack an ICSP header and a reset catch (*, 2022).

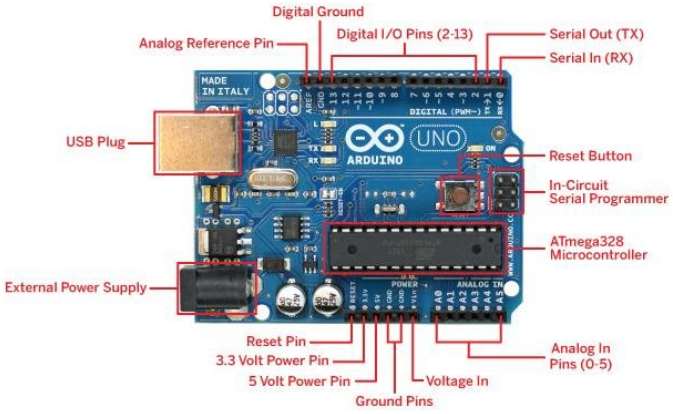

Figure 1: An Arduino Uno with pin outs and wiring

The microcontroller changes over the voltage signal from the Ultrasonic Sensor into helpful signs. It empowered interface between the Ultrasonic Sensor and the yield gadgets, the GSM module and the bell and oversees correspondence between them. It is the core of the developed GSM based security ready framework utilizing Ultrasonic Sensor (*, 2022). It is in the microcontroller that the focal preparing of the information happens. So the yield of the ultrasonic Sensor was associated with the microcontroller. The Arduino Uno was then customized fittingly, underneath, in order to speak with the GSM module send instant messages and make considers when the ultrasonic sensor recognized an interloper, just as initiate the bell to sound, to alarm close by people or neighbors about the nearness of a gatecrasher. The developed gadget was tried and it communicated something specific "there is an interloper" to a coded cell phone (*, 2022).

2.2.1 Arduino UNO Features and Technical Specs (AMAN SHARMA, 25 July 2020)

Table 1: Arduino UNO Features and Technical Spe

No.	Parameter Name	Parameter Value
1	Microcontroller	Atmega328
2	Crystal Oscillator	16MHz
3	Operating Voltage	5V
4	Input Voltage	5-12V
5	Digital I/O Pins	14 (D0 to D13)
6	Analog I/O Pins	6 (A0 to A5)
7	PWM Pins	6 (Pin # 3, 5, 6, 9, 10 and 11)
8	Power Pins	5V, 3.3V, Vin, GND
9	Communication	UART(1), SPI(1), I2C(1)
10	Flash Memory	32 KB (0.5KB is used by bootloader)
11	SRAM	2 KB
12	EEPROM	1 KB
13	ICSP Header	Yes
14	Power sources	DC Power Jack & USB Port

2.2.2 Arduino UNO Pin Description

There are several I/O digital and analog pins placed on the board, which operates at 5V. These pins come with standard operating ratings ranging between 20mA to 40mA. Internal pull-up resistors are used in the board that limits the current exceeding the given operating conditions. However, too much increase in current makes these resisters useless and damages the device.

- **LED.** Arduino Uno comes with a built-in LED which is connected through pin 13. Providing HIGH value to the pin will turn it ON and LOW will turn it OFF.

- **VIN:** It is the input voltage provided to the Arduino Board. It is different than 5 V supplied through a USB port. This pin is used to supply voltage. If a voltage is provided through a power jack, it can be accessed through this pin.

- **5V:** This board comes with the ability to provide voltage regulation. 5V pin is used to provide output regulated voltage. The board is powered up using three ways i.e. USB,

Vin pin of the board or DC power jack.

- USB supports voltage around 5V while Vin and Power Jack support a voltage ranges between **7V to 20V**. It is recommended to operate the board on 5V. It is important to note that, if a voltage is supplied through 5V or 3.3V pins, they result in bypassing the voltage regulator that can damage the board if the voltage surpasses its limit.

- **GND**: These are ground pins. More than one ground pins are provided on the board which can be used as per requirement.

- **Reset:** This pin is incorporated on the board which resets the program running on the board. Instead of physical reset on the board, IDE comes with a feature of resetting the board through programming.

- **IOREF:** This pin is very useful for providing voltage reference to the board. A shield is used to read the voltage across this pin which then selects the proper power source.

- **PWM**: PWM is provided by 3,5,6,9,10, 11pins. These pins are configured to provided 8-bit output PWM.

- **SPI**. It is known as Serial Peripheral Interface. Four pins 10(SS), 11(MOSI), 12(MISO), 13(SCK) provide SPI communication with the help of the SPI library.

- **AREF**. It is called Analog Reference. This pin is used for providing a reference voltage to the analog inputs.

- **TWI**. It is called Two-wire Interface. TWI communication is accessed through Wire Library. A4 and A5 pins are used for this purpose.

- **Serial Communication.** Serial communication is carried out through two pins called Pin 0 (Rx) and Pin 1 (Tx) (AMAN SHARMA, 25 July 2020).

Rx pin is used to receive data while Tx pin is used to transmit data.

- **External Interrupts.** Pin 2 and 3 are used for providing external interrupts. An interrupt is called by providing LOW or changing value (AMAN SHARMA, 25 July 2020).

2.2.2.0 GSM SIM900 and SIM800

The GSM modem module, which we have been used model, is SIMCOMSIM900. This modem is specialized and easy interfacing with Arduino Uno controller for any programming. The User call can be initiated from this unit (Md. Abdullah Al Ahasan).
The GSM SIM800 is a popular and cost-effective GSM module widely used for communication in various applications, including IoT projects, smart home systems, and security systems. It supports GSM and GPRS communication, enabling voice and data transmission over the cellular network. Operating on four frequency bands, it is compatible with global GSM networks. The module communicates with external devices using UART serial communication and requires a standard- sized SIM card for network connectivity. Its low power consumption makes it suitable for battery-powered devices, and can handle voice calls and data transmission. With GPIO pins for interfacing with external devices and easy integration using AT commands, the SIM800A is widely available. It is reliable for enabling communication in remote and limited internet connectivity scenarios (Md. Abdullah Al Ahasan).

2.2.2.1 Hardware Overview of SIM900 GSM

The SIM900 GSM/GPRS shield is designed to surround the SIM900 chip with everything necessary to interface with Arduino, plus a few extra goodies to take advantage of the chip's unique features.
There are three LEDs on the SIM900 GSM/GPRS shield, which indicates connectivity or power status. By observing these LEDs you can get a visual feedback on what's going on with the shield (htts:/lastmuniteengineers.com/sim900-gsm-arduino-tutorial).

2.2.2.2 LED Indicator on SIM900 GSM Shield

- **PWR:** This LED is connected to the shield's power supply line. If this LED is on, the shield is receiving power.

- **Status:** This LED indicates SIM900's working status. If this LED is on, the chip is in

working mode.

➢ **Net light**: This LED indicates the status of your cellular network. It'll blink at various rates to show what state it's in.

- **off:** The SIM900 chip is not running
- **64ms on, 800ms off:** The SIM900 chip is running but not registered to the cellular network yet.
- **64ms on, 3 seconds off:** The SIM900 chip is registered to the cellular network & can send/receive voice and SMS.
- **64ms on, 300ms off**: The GPRS data connection you requested is active (htts:/lastmuniteengineers.com/sim900-gsm-arduino-tutorial).

2.2.2.3 Supplying Power for SIM900 Shield

One of the most important parts of getting the SIM900 shield working is supplying it with enough power.
Depending on which state it's in, the SIM900 can be a relatively power-hungry device. The maximum current draw of the chip is around 2A during transmission burst. It usually won't pull that much, but may require around 216mA during phone calls or 80mA during network transmissions (htts:/lastmuniteengineers.com/sim900-gsm-arduino-tutorial).
This chart from the datasheet summarizes what you may expect:

Table 2: Chart from the datasheet

Modes	**Frequency**	**Current Consumption**
Power down		60 uA
Sleep mode		1 mA
Stand by		18 mA
Call	GSM850	199 mA
EGSM900		216 mA
DCS1800		146 Ma
PCS1900		131 Ma
GPRS		453 Ma

2.2.2.4 Transmission burst

The operating voltage of SIM900 chip is from 3.4V to 4.4V. To keep supply voltage safe at 4.1V, the shield comes with a high current, high accuracy, low-dropout voltage regulator MIC29302WU from Micrel – capable of handling load currents up to 3A.
You can add an external power supply to the shield with the 5.5mm DC jack, to which you can connect any 5V-9V DC wall adapter you have. Next to the DC jack, is a Slide Switch to select the power source labeled EXTERN. To use external power source (htts:/lastmuniteengineers.com/sim900-gsm-arduino-tutorial).

2.2.2.5 Warning

- **Power supply**

The power supply should be able to source minimum 2A of surge current, otherwise the chip will keep shutting down.

- **UART Communication**

The SIM900 GSM/GPRS shield uses UART protocol to communicate with an Arduino. The chip supports baud rate from 1200bps to 115200bps with Auto-Baud detection.
With the help of jumpers, you can connect (RX, TX) of the shield to either Software Serial (D8, D7) or Hardware Serial (D1, D0) of the Arduino.

- **Speaker & Microphone**

The shield comes with two standard 3.5mm jacks. One for stereo earphone and other for mono microphone. It allows you to use SIM900's audio interface to make and receive voice calls and listen FM radio.

✓ **Antenna:** An antenna is required to use the SIM900 for any kind of voice or data

communications as well as some SIM commands.

✓ **Shield:** The shield has two interfaces for connecting antenna viz. a U.FL connector and a SMA connector. They are connected through a patch cord.

The shield usually comes with a 3dBi GSM antenna and allows you to put the shield inside a metal case (as long the antenna is outside) (htts:/lastmuniteengineers.com/sim900-gsm-arduino-tutorial).

- **SIM Socket**

There's a SIM socket on the back. Any activated, 2G full-size SIM card would work perfectly.
The workings of the SIM card socket can take some getting used to. To unlock the latch, push the top part of the assembly, and then lift it up. Place the SIM card into the bottom part of the socket Then fold the arm back into the body of the socket, and gently push it forward towards the LOCK position.

- **RTC (Real Time Clock)**

The SIM900 shield can be configured to keep time. So there is no need for any separate RTC. This will keep the time even when the power is OFF.
If you want to use internal RTC, you need to install CR1220 battery at the back side of the shield.
Your network provider may not support setting the time automatically. In that case you can do it manually using AT+CCLK AT command (htts:/lastmuniteengineers.com/sim900-gsm-arduino-tutorial).

- **Connecting SIM900 GSM Shield to PC**

In order to operate SIM900 GSM Shield directly over PC, you need to connect it to PC using any USB to TTL converter.

- **Powering Up/Down SIM900 Chip**

Even if you power the shield up, you need to turn on the SIM900 chip to get it working.
As per datasheet, pulling the PWRKEY pin on the chip LOW for at least 1 second will power up/down the chip. There are two ways to do this with our shield.

- **Hardware Trigger**

The shield comes with a right angle tactile switch situated near the PWR LED indicator. You need to press that switch for about 2 seconds to power the shield up/down.

- **Software trigger**

Instead of manually pressing the PWRKEY every time, you can turn the SIM900 up/down programmatically.

- **Arduino Code – Testing AT Commands**

For sending AT commands and communicating with the SIM900 shield, we will use the serial monitor. Below sketch will enable the Arduino to communicate with the SIM900 shield on serial monitor (htts:/lastmuniteengineers.com/sim900-gsm-arduino-tutorial). Before we proceed with detailed breakdown of code, connect your Arduino to PC, compile below code and upload it to the Arduino.

- **Pin Description of SIM900 GSM GPRS**

Table 3: Pin Description of SIM900 GSM GPRS

Pins	Description
Power select	Select the power supply for GPRS shield(external power or 5v of Arduino)
Power jack	Connected to external 4.8-5V DC power supply
Antenna interface	Connected to an external antenna
Serial port select	Select either software serial port or hardware serial port to be connected to GPRS Shield
Hardware Serial	D0/D1 of Arduino
Software serial	D7/D8 of Arduino
Status LED	Tells whether the power of SIM900 is on
Net light	Tells the status of SIM900 linking to the net
UART of SIM900	UART pins breakout of SIM900
GPIO,PWM,& ADC GPIO, PWM and ADC	pins breakout of SIM900

Power key pins breakout of SIM900

- **Pins usage on Arduino**

□

Table 4: Pins usage on Arduino

Pins	**Arduino**
D0	Unused if you select software serial port to communicate with GPRS Shield
D1	Unused if you select software serial port to communicate with GPRS Shield
D2-D6	Arduino
D7	Used if you select software serial port to communicate with GPRS Shield
D7	Used if you select software serial port to communicate with GPRS Shield
D8	Used if you select software serial port to communicate with GPRS Shield
D9	Used for software control the power up or down of the SIM900
D10-D13	Unused
D14-D19	Unused

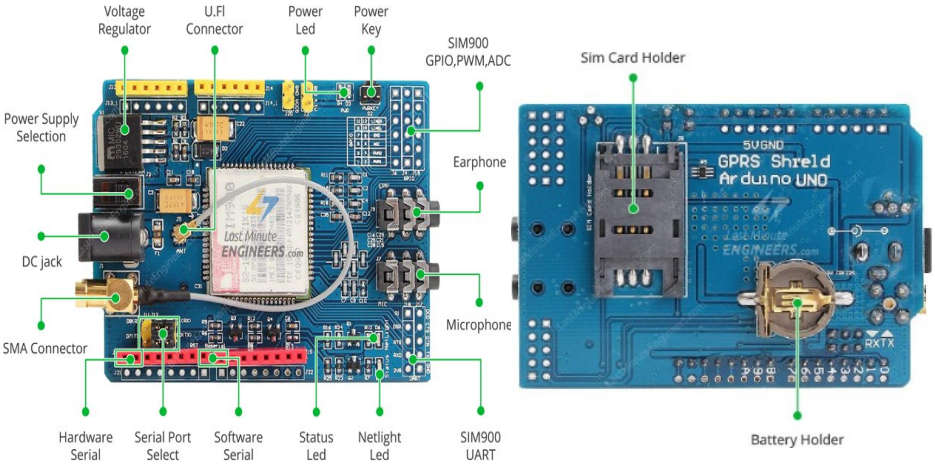

Figure 2: The SIM900 GSM/GPRS shield (htts:/lastmuniteengineers.com/sim900-gsm-arduino-tutorial)

2.2.3 16x2 LCD display

The first thing you need to do before working on the LCD is to check it. For this, do the connections as shown in the diagram above. Connect pin 15 on the LCD to Arduino's 5V pin. Next, connect pin 16 on the LCD to the Arduino's GND pin (Sanjeev, 2018). These pins are used to power the LCD's backlight.

Next, you need to set up the logic for the LCD. To do this, connect pin 1 on the LCD to the Arduino's GND pin. Then, connect pin 2 on the LCD to the Arduino's 5V pin. Next, you need to set up the contrast adjusting potentiometer. Take the 10K potentiometer and connect the first terminal to the Arduino's 5V pin and the second terminal (middle pin) to the LCD's pin 3 and the third terminal to the Arduino's GND pin (Sanjeev, 2018).

Power up the Arduino. You will notice that the backlight on the LCD turns ON. Also, when you turn the knob on the potentiometer, the character blocks on the LCD turn bright/dim. Check out the picture on below to see what I am talking about. If your LCD displayed what is shown in the photo below, it means that your LCD is correctly set up! If you were not able to achieve this, double-check your connections and your potentiometer.

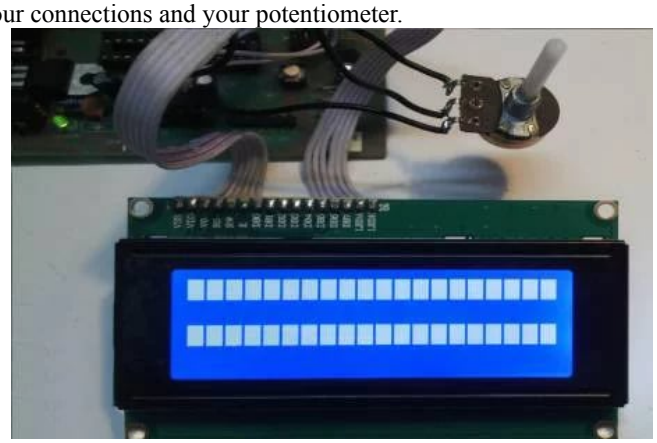

Figure 3: Adjusting the contrast on the LCD

2.2.4 Ultrasonic Sensor

Pulse pressure waves that have sound frequencies of 25 - 50 KHz, which no human can hear, are sent out through an ultrasonic sensor. Most of the working ultrasonic sensors are operated with pulse waveforms that identify the presence of a vehicle and gauge its speed. This measure the distance of the Object from the sensor by estimating the amount of the emitted radiation which is reflected back within the beam width of the transmitter towards the sensor (GmbH, 2024)

Figure 4: Ultrasonic sensor

2.2.5 BUZZER

A buzzer or piezo speaker is an audio signaling device commonly used to produce sound. Piezo buzzer produces sound based on the reverse principle of the piezoelectric effect. The buzzer is a less costly and light weighted electronic device that's why it is used in computer, alarm device, refrigerator, microwave oven, security devices and so on (darshandarshana711, 2024).

There are two conductors available inside the buzzer along with piezo crystal between them. Whenever the potential is applied across the crystal than the conductor's position get changed due to which 2 to 4 kHz sound wave produced by the buzzer (darshandarshana711, 2024).

I will explain to you how a buzzer can be operated with the help of Arduino Uno in a different manner to generate different toned sound. This is a very basic tutorial if you want to learn more like how can buzzer used in any security device then you can check my advance level project named Locker guard based on Arduino Uno.

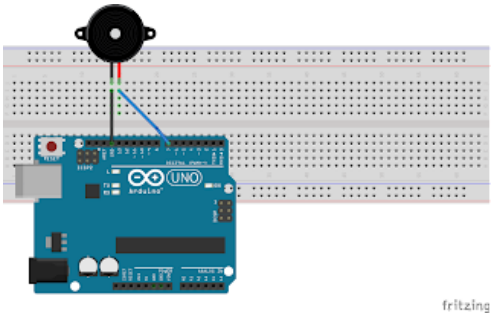

Figure 5: Arduino Uno and buzzer

Buzzer is a kind of voice device that converts audio model into sound signal. It is mainly used to prompt or alarm. According to different design and application, it can produce music sound, flute sound, buzzer, alarm sound, electric bell and other different sounds.

2.2.5.1 Circuit description

A buzzer is a two terminal (one is longer and another one is shorter) device. The longer leg is used to provide the input and the shorter leg is used to provide the ground connection. According to the circuit diagram, I have connected the pin 7 of Arduino with the longer leg of the buzzer. The shorter leg of the buzzer is connected with the GND terminal of the Arduino Uno (darshandarshana711, 2024).

2.*2.5.* Applications of Buzzer

Typical applications include siren, alarm device, fire alarm, air defense alarm, burglar alarm, timer, etc. It is widely used in household appliances, alarm system, automatic production line, low-voltage electrical equipment, electronic toys, game machines and other products and industries.

Figure 6: Buzzer

2.2.6 Printed circuit board (PCB)

The main purpose of a PCB is to interconnect electronic components. The components are soldered to the board via a pin or pad. Components are placed on the top or bottom layer of the PCB. Wires - or traces - are etched into the copper layers that are used to make an electrical connection between components. For more complex PCBs, a plurality of inner copper layers is required to connect each component. The layers are connected by so-called via's - small drilled holes that are plated with copper that form a connection between the layers (Steeghs-Turchina, September 2023). The second is to provide reliable electrical connections (and also reliable open circuits) between the component's terminals in a controlled manner often referred to as PCB design.

Each of the conductive layers is designed with an artwork pattern of conductors (similar to wires on a flat surface) that provides electrical connections on that conductive layer (darshandarshana711, 2024). Another manufacturing process adds visas, plated-through holes that allow interconnections between layers.

PCBs mechanically support electronic components using conductive pads in the shape designed to accept the component's terminals, and also electrically connect them using traces, planes and other features etched from one or more sheet layers of copper laminated onto and/or between sheet layers of a non-conductive substrate (Steeghs-Turchina, September 2023).

Components are generally soldered onto the PCB to both electrically connect and mechanically fasten them to it. Printed circuit boards are used in nearly all electronic products and in some electrical products, such as passive switch boxes.

PCBs can be single-sided (one copper layer), double-sided (two copper layers on both sides of one substrate layer), or multi-layer (outer and inner layers of copper, alternating with layers of substrate). Multi-layer PCBs allow for much higher component density, because circuit traces on the inner layers would otherwise take up surface space between components (Steeghs-Turchina, September 2023).

Figure 7: Printed circuit board

CHAPTER 3:

RESEARCH METHODOLOGY

3.0 INTRODUCTION

This deals with the specific procedures or techniques I used to identify select and analyze information about Intercommunication for security service within an institution using Arduino,

in which GSM Module is used to make the Call and Security circuit system is an important part of home security systems. This Security circuit system project is based on PIR sensor and ultrasonic sensor.

3.1 **RESEARCH DESIGN**

In this project, I based on the security of laboratory , due to life style of Rwandans, the security took a great part of life within all activities , this project emphasizes on laboratory security wherein I hard uncountable cases of theft , mismanagement or other illegal activities relating to intense loss perpetrated the customers , the ideation of this research comes from on how to design a system that is able to operate by monitoring to ensure the security of laboratory room , so that no one comes in without authorization because if this case happened, the inside alarm provide alerting message and sounding. The system provides security and tenuous control over household appliances when the owner is gone. The suggested design is simple to use and safe.

When developing an intercom system for communication between security services and an institution, the following aspects should be taken into account:

Objectives: Start from identifying purposes of the intercommunication system, capturing institution's security needs and objectives of a communication process.

Method: Investigate method that institution uses in order to make an assessment of feasibility of an intercommunication systems implementation. Look at factors such as resources that would be put onto the project, network infrastructure as well other systems that may be in place

Sampling: A random sampling strategy will be implemented whereby the samples will be targeting security system within urban and suburban areas. The sample will be stratified by location, age, and frequency of occurrence of the challenges in order to cover all the users comprehensively.

Data Analysis: data collected by the quantitative question of the survey will be checking for trends using statistics. Answers to questions asked in interviews will be evaluated considering the context which will help in understanding the motivation and the experience related to security services for the institution from the users.

3.2 Research population

The target population for the Design and Implementation of the Intercommunication Security System comprises all hospital areas with high demand for laboratory management.

3.3 **Target Population**

• The Design and Implementation of the security service within the institution is directed to all urban as well as rural areas where their need is great i.e. need for a security management system or service**.**

3.4 Sample size

The Intercommunication security System utilizes advanced technology, including ultrasonic sensors to improve laboratory efficiency through real-time occupancy detection. The system is designed to help manager quickly to know whereby entering laboratory room. Key feature is Ultrasonic Sensors.

3.5 Data collection

During the period of gathering information, I used only these techniques for gathering the needed data; we included the observation, interviews, questionnaires, schedules, and surveys. These were done in terms of conversation with bankers, bank owners and security agency.

3.4.3 Modeling formulation

This sample, I took deals with how I came up with the smaller area of laboratory (sample). I anticipate installing in different laboratory not more than five laboratories due to sample taken, laboratory found in Kigali. In sensor system used in motion detectors like automatically triggered lighting devices and protecting systems that monitors devices emitting infrared rays in their surroundings. Because everything with a temperature above zero releases heat energy, which is in the form of radiation. PIR sensors detect infrared radiation that is reflected from the targeted people instead of sensing heat that is it more efficient. If the sensor detects a person, the temperature at that point in the sensor's surroundings increases to the body temperature of the people and then back respectively from the sender.

3.4.4 Documentation

In planning, a research project required a theme for research can run smoothly and not out of the path that has been set. The theme is "Design of Power Bank Mobile Using Solar Panel Based Microcontroller ATMega 328". Literature is a very useful reverence in the research of a project. Therefore, the authors have obtained various literature studies to obtain additional information about the project to be made.

Planning a research project includes all the things that will be implemented in research, namely:

Determining Research Topics, Estimated tools and materials, Budget estimates, estimated time, possible applications and applications to be designed.

3.4.5 Simulation by software tool

It is my preference that this project will be done by designing system through the solid work, which will find the optimal solution. I anticipate to install in different laboratory not more than five laboratories due to sample taken, In sensor system used in motion detectors like automatically triggered lighting devices and protecting systems that monitors devices emitting infrared rays in their surroundings., Arduino IDE software is the tool, which has been used to get the simulation results.

3.4.6 Steps in the design process

Coding is a programming component in which the programmed component is Arduino Uno.

CHAPTER 4:

SYSTEM DESIGN ANALYSIS AND IMPLIMENTATION

4.0 INTRODUCTION

The System implementation is the process of making the new system available for users by putting a planned system into an action. It is also the actual coding and building of the project.

4.1 POSITION OF INTERCOMMUNICATION FOR SECURITY SERVICE WITHIN INSTITUTION

Normally, it is proposed that the system should be installed near the doors or on the walls but for our project, I chose to make it mobile so that you can put it anywhere according to you want.

4.2 BLOCK DIAGRAM OF OUR SYSTEM

Figure 8: Block diagram of our system

4.3 Flow Chart

Figure 9: Flow chart

4.5 CURCUIT DIAGRAM

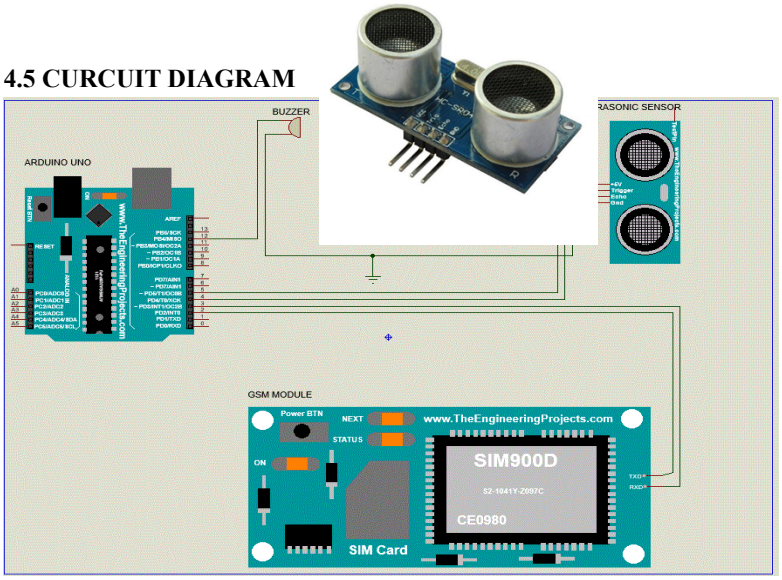

Figure 10:Circuit Diagram

4.6WORKING PRINCIPLE

The circuit is supplied by 3.7V and 5V, and it is divided into three stages, Sensing stage, notification stage, and programming stage. In sensing stage, I have ultrasonic sensor. In notification stage, I have only a GSM for sending alert message and LCD to display a message. The last stage is programming, here I have an Arduino Uno to process, analyze and link all data.
So according to the figure above of the block diagram we have six main part of our project "**intercommunication for security service within institution**". Which is ultrasonic sensor for detecting the movement near the secured area, where it can detect up to 10m and a maximum of 110^0 angle.

And when my ultrasonic sensor detect movement it gives signal to my ARDUINO UNO which act as brain in my circuit and the Arduino will activate my BUZZER and also give the instructions to my GSM sim900 to send message to the owner or guard or anyone in charge depending to the phone number I programmed.
After that then I have also used LCD 16X2 display which will constantly display the current situation when there is no movement or when it is safe in other words it will display the name of my project which is "**intercommunication for security service within institution**", and when there is movement or no safety then it will display that there is someone who is getting closer.

When the ultrasonic sensor detects movement, we will receive sms on my mobile phone, and when the sms is sent then my LCD display will display sms sent.
But I have to make sure that there is sufficient amount on my SIM CARD or otherwise the message will not be sent.

4.7 CALCULATION

Start by calculating the energy use of my project in Ws (joules) for a 24-hour period because a 24-hour day will include both the daylight and nighttime parts of the daily cycle. Calculating this

current consumption is easy if the device is on all the time and the current consumption is constant. Let me say I have a garden Ultrasonic sensor that consumes a constant 70mA from its 5V power supply. Sure, let me calculate the power consumption of the garden Ultrasonic sensor.
Given:
• Current consumed by the Ultrasonic sensor: 70 mA (milliamps)
• Voltage supply to the Ultrasonic sensor: 5V
To find the power consumption (P), I use the formula:
P=V×IP = V \times IP=V×I
Where:
• V is the voltage (5V in this case),
• I is the current (70 mA, which is 70×10−370 \times 10^{-three}70×10−3 A).
Let us plug in the values:
P=5V×70×10−3AP = 5V \times 70 \times 10^{-3} AP=5V×70×10−3A P=5×0.07P = 5 \times 0.07P=5×0.07 P=0.35 watts P = 0.35 \text{ watts}P=0.35 watts.
Therefore, the power consumption of the garden Ultrasonic sensor is 0.35 watts, or 350 mill watts (mW).This is the amount of electrical power the sensor consumes while operating at 5V with a current draw of 70 mA.

4.8 **Implementation**

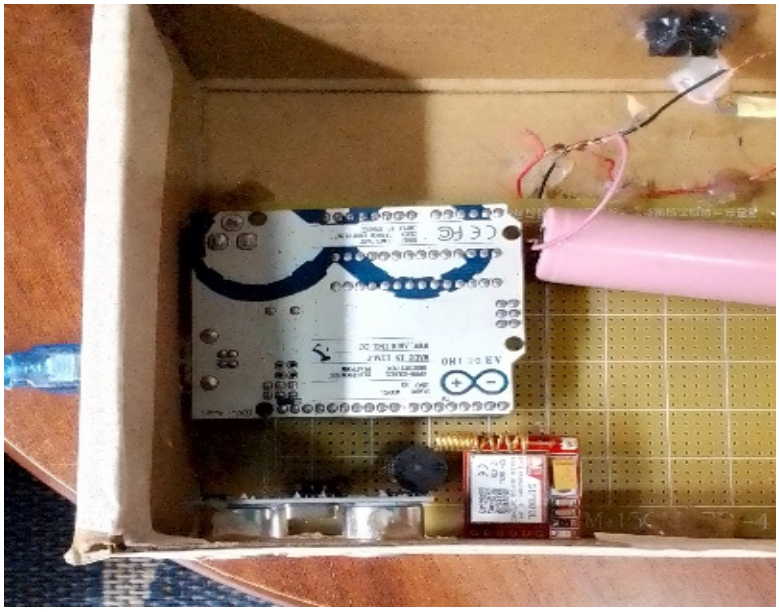

Figure 11: Implementation

Ultrasonic sensor for detecting objects, ARDUINO UNO, LCD for displaying the situation, the buzzer for alarming and GSM SIM900 for sending the message to the person in charge of security.

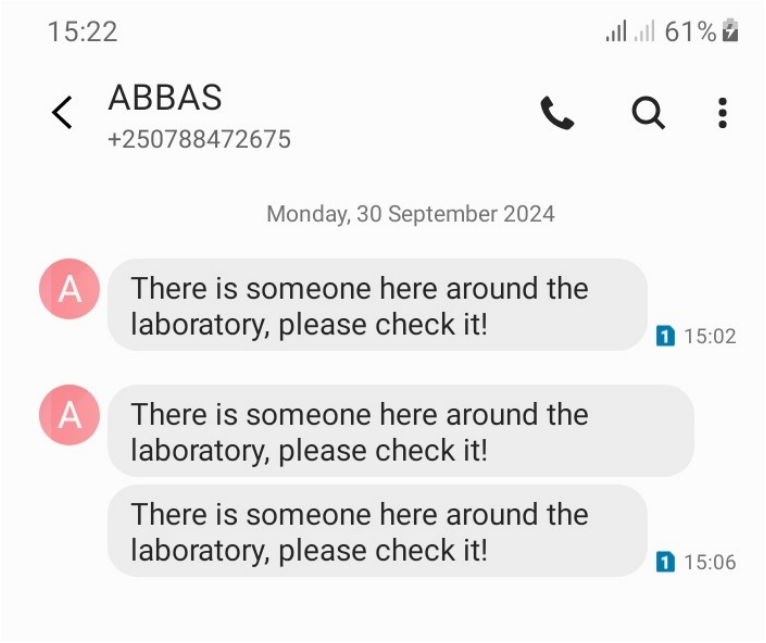

Figure 12: Message sent to registered phone number from the security system

□

CHAPTER 5:

CONCLUSION AND RECOMMENDATION

5.1 CONCLUSION

There have been projects security services; however, most of them have been proved expensive. Intercommunication for security service within institution is a low cost system and efficient, it enables the institutions with the needed security and communication. I am reporting that the expected results have been achieved.

5.2 RECOMMENDATION

Although the project was about the security system and communication within institution, I cannot conclude only without making recommendations necessary for successful implementation of the system of intercommunication of security service within institution, and some recommendations about the future undergraduate who shall need to work and improve this project. So for me I faced the issue of Ultrasonic sensor which does not cover the area as specified when I bought it as they said it can cover 7m but in my experiment it can't cover that distance.

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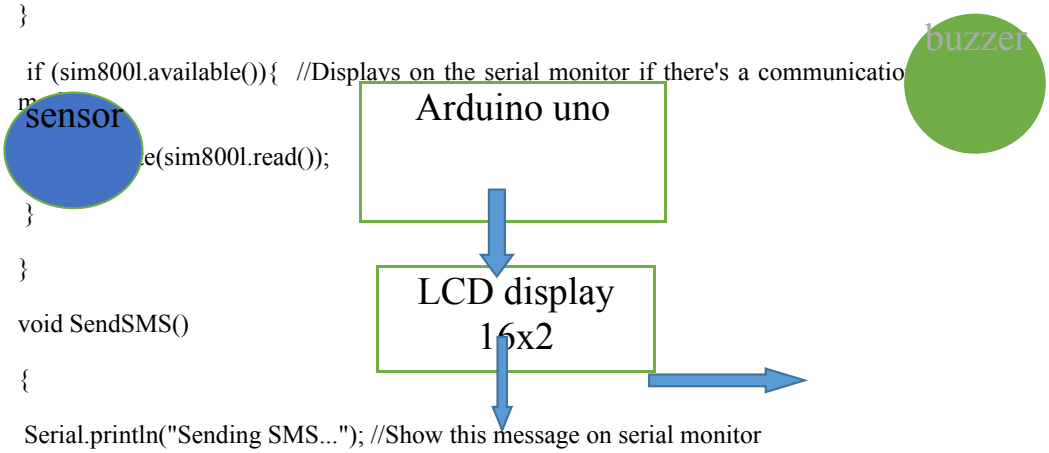
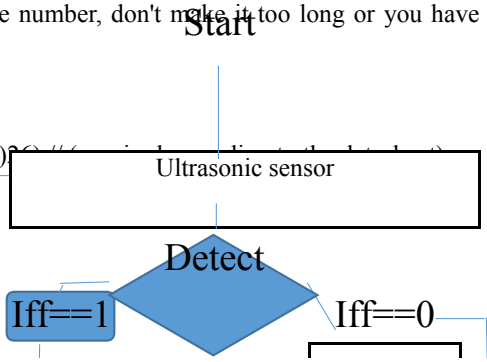
APPENDIX

Appendices-A: code of the project

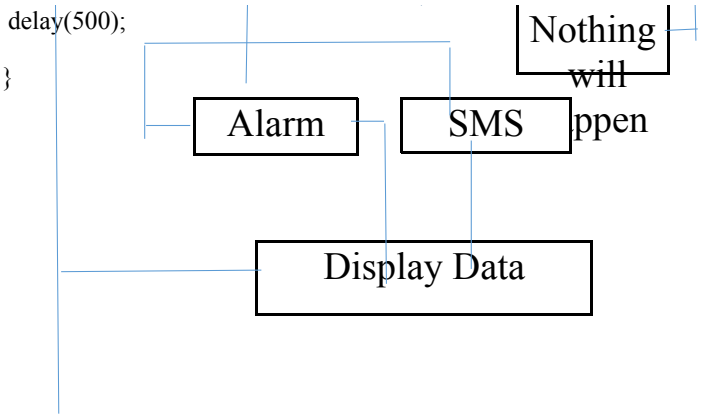
```
#include <SoftwareSerial.h>
SoftwareSerial sim800l(2, 3); // RX,TX for Arduino and for the module it's TXD RXD, they should be inverted
const int trigPin = 12;
const int echoPin = 11;
int Buzzer = 4;
long duration;
int distance;
int safetyDistance;
int x;
void setup()
{
pinMode(trigPin, OUTPUT);
pinMode(echoPin, INPUT);
sim800l.begin(9600);   //Module baude rate, this is on max, it depends on the version
Serial.begin(9600);
pinMode(Buzzer, OUTPUT);
digitalWrite(Buzzer, LOW);
//delay(500);
}
void loop()



{

// Clears the trigPin

digitalWrite(trigPin, LOW);

delayMicroseconds(2);

// Sets the trigPin on HIGH state for 10 micro seconds

digitalWrite(trigPin, HIGH);

delayMicroseconds(10);

digitalWrite(trigPin, LOW);

// Reads the echoPin, returns the sound wave travel time in microseconds

duration = pulseIn(echoPin, HIGH);
```

```
// Calculating the distance
distance= duration*0.034/2;
safetyDistance = distance;
if ( safetyDistance <= 10   ) {
Serial.println(safetyDistance);
delay(500);
digitalWrite(Buzzer, HIGH);
x=1;
SendSMS();   //And this function is called
delay(4000);
}
else{
 x=0;
digitalWrite(Buzzer, LOW);
Serial.println(safetyDistance);
delay(50);
}
 if (sim800l.available()){   //Displays on the serial monitor if there's a communicatio
m
e(sim800l.read());
 }
}
void SendSMS()
{
 Serial.println("Sending SMS..."); //Show this message on serial monitor
 sim800l.print("AT+CMGF=1\r");    //Set the module to SMS mode
 delay(100);
 sim800l.print("AT+CMGS=\"+250788472675\"\r");
 delay(500);
 sim800l.print("There is someone here around the labratory, please check it!"); //This is the text to send to the phone number, don't make it too long or you have to modify the SoftwareSerial buffer
 delay(500);
 sim800l.print((char)26);//(
 delay(500);
 sim800l.println();
 Serial.println("Text
```





```
delay(500);
}
```



Cost estimations

Table of cost estimation

s/N	Material/devices	quantity	Unity price	Total/price(FRW)
1	Arduino uno	1	18000	18000
2	Ultrasonic sensor	1	8000	8000
3	PCB	1	3000	3000
4	Battery	1	8000	8000
5	LCD	1	8000	8000
6	Buzzer	1	1000	1000
7	GSM	1	35000	35000
8	Switch	1	2000	2000
9	Sim card	1	1000	1000
10	wires	50 cm*2	2000	2000
11	Design	-	25000	25000
12	internet	-	15000	15000
13	Transport	-	10000	10000
	Total			136000