GSM BASED AND TSUNAMI DETECTION SYSTEM

An Engineering Project in Community Service

Phase – I Report

Submitted by

1. 18BCE10321 Vinay SR Reddy .
2. 18BCY10089 Shasshank S.
3. 18BCG10009 Alaistar Jophy.
4. 18BME10010 Ashwin Aji .
5. 18BCG10113Abhishek.
6. 18bec10013 Ashish deo.

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Bhopal
Madhya Pradesh

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1. INTRODUCTION

Natural disaster is an unfortunate event that results from natural processes on the Earth. One of these adverse processes is the Tsunami. Tsunamis are generated by disturbing the seafloor and shallow wind waves that disturb the ocean surface.

Tsunami waves are generally referred to as tidal waves. It is because of their long wavelengths that tsunamis behave as shallow water waves. A wave is characterized as a shallow water wave when the ratio between the water depth and its wavelength gets very small. Ocean flow is known to generate magnetic and electric fields which reach land and satellite observatories with detectable amplitudes [1].

A tsunami is a series of ocean waves caused by an underwater earthquake, landslide or volcanic eruption with a height that reaches over 100 feet. On the advent of a tsunami, timely measures need to be taken in order to prevent loss of life and property. The velocity of tsunami waves depends on the depth of the water through which it travels, with approximately 700 kmph in 400 meters depth of sea water which drops to 36 kmph at 10 meters of water depth causing major damage to life and property near the shore. A tsunami has a time period ranging from ten minutes to two hours with wavelengths greater than 500 kilometres.

1.1 Motivation

The main purpose of this project is to alert the people in the offshore as soon as possible so that they can find the high ground as soon as possible and there will be no loss of life .The statistics say , On December 26th 2004, the casualties arising due to the Indian Ocean tsunami in India alone tolled to 67, 12, and 84 with 18,045 deaths, 5,640 missing cases and 647,599 displaced. These are very high numbers, there is huge loss of life, by our project if we can minimize the numbers that would be a great help.

1.2 Objective

The main proposal of this project is an automated system that detects the occurrence of tsunami and notifies the warning in the form of a text message broadcasted over the offshore area. The proposal is for creating an early warning system that will help prevent the loss of life. The system proposed in this paper is a fully automated warning system consisting of Arduino which is the brain of the project. The Arduino senses the input from the sensor and sends the warning to the receiver through the sim which is present in the sim 900A module. This Arduino upon receiving

a warning message from the transmitter will broadcast a tsunami alert to the population in the harbour area via a text notification using GSM.

2. Existing Work

Current tsunami warning system proves to be ineffective because of time taken in processing and analysing the signal when the tsunami is triggered in shallow waters. Some are application-based systems these are very much time taking because at times when the phone storage is full or high the some frequently unused applications turn off on their own so trusting application-based system is problematic. In Indian not everyone can afford smartphones, people staying on the sea shore are mostly below the poverty line. But maximum people will have a keypad phone with a sim which is why we used the SMS process to alert the people offshore.

There are few existing systems in the market now developed by various developers which is similar to this prototype, one such is the underwater device which uses the pressure sensor (e.g.: piezoelectric disc sensor) and the vibrating sensor (e.g. : SideWinder 420) this device is placed underwater when the conditions like pressure and the unwanted vibrations of the water occur this will react and will give the thought the receiver module.

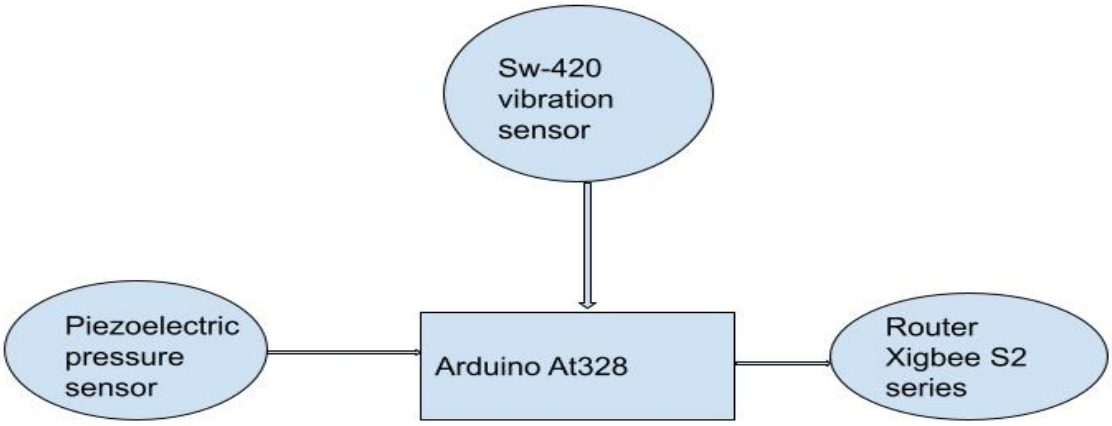


Figure 1: Transmitter module of the existing module

There is a receiver module where the underwater device will detect the unwanted pressure and vibration, the receiver module which is on the shore will redirect the signal and the people nearby will receive the tsunami alert.

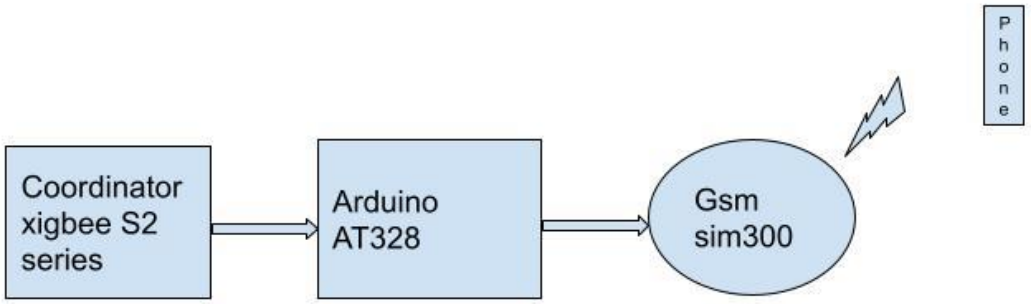


Figure 2: Receiver module of the existing module

This is the existing system which the team has come across. Though at maximum rate there are no such devices used, these devices will be used on small places of sea shore in India and many other developing nations with sea shore. This system is similar to the system which is now designed by the team because there are some drawbacks of this existing system as the transmitter module should be placed underwater there are chances the circuit might get damaged even though high-water proofing is done. If the system is damaged, then it's a waste for it to be there. It's difficult to maintain as it is kept under the water. Frequent monitoring of the system is required every time a person has to go under and get the system to monitor it which is hectic so to overcome all these teams has designed a system which can be kept on the buoy and works when tsunami comes.

3. Topic of the work

1.Arduino is an open-source electronics platform based on easy-to-use hardware and software. Arduino boards are able to read inputs - light on a sensor, a finger on a button, or a message - and turn it into an output - activating a motor, turning on an LED, publishing something online. Arduino projects can be standalone or they can communicate with software running on a computer. Arduino serves many applications such as robot/motor control, miniaturized applications, UAVs, sensor networks, etc. Arduino uses its own programming language, which is similar to C++. However, it's possible to use Arduino with Python or another high-level programming language. In fact, platforms like Arduino work well with Python, especially for applications that require integration with sensors and other physical devices. Inexpensive - Arduino boards are relatively inexpensive compared to other microcontroller platforms. The least expensive version of the Arduino module can be assembled by hand, and even the pre-assembled Arduino modules cost less than $50

Cross-platform - The Arduino Software (IDE) runs on Windows, Macintosh OSX, and Linux operating systems. Most microcontroller systems are limited to Windows.

Simple, clear programming environment - The Arduino Software (IDE) is easy-to-use for beginners, yet flexible enough for advanced users to take advantage of as well. For teachers, it's conveniently based on the Processing programming environment, so students learning to program in that environment will be familiar with how the Arduino IDE works.

Open source and extensible software - The Arduino software is published as open source tools, available for extension by experienced programmers. The language can be expanded through C++ libraries, and people wanting to understand the technical details can make the leap from Arduino to the AVR C programming language on which it's based. Similarly, you can add AVR-C code directly into your Arduino programs if you want to.

Open source and extensible hardware - The plans of the Arduino boards are published under a Creative Commons license, so experienced circuit designers can make their own version of the module, extending it and improving it. Even relatively inexperienced users can build the breadboard version of the module in order to understand how it works and save money.

Figure 3: Arduino Board

2.An Ultrasonic sensor is an electronic device that measures the distance of a target object by emitting **ultrasonic** sound waves, and converts the reflected sound into an electrical signal. Ultrasonic sensors have two main components: the transmitter (which emits the sound using piezoelectric crystals) and the receiver (which encounters the sound after it has travelled to and from the target).In order to calculate the distance between the sensor and the object, the sensor

measures the time it takes between the emission of the sound by the transmitter to its contact with the receiver. The formula for this calculation is **D = ½ T x C** (where D is the distance, T is the time, and C is the speed of sound ~ 343 meters/second). Ultrasonic sensors are used primarily as **proximity sensors**. They can be found in automobile self-parking technology and anti-collision safety systems. Ultrasonic sensors are also used in robotic obstacle detection systems, as well as manufacturing technology. In comparison to infrared (IR) sensors in proximity sensing applications, ultrasonic sensors are not as susceptible to interference of smoke, gas, and other airborne particles (though the physical components are still affected by variables such as heat). Ultrasonic sensors are also used as level sensors to detect, monitor, and regulate liquid levels in closed containers (such as vats in chemical factories). Most notably, ultrasonic technology has enabled the medical industry to produce images of internal organs, identify tumours, and ensure the health of babies in the womb. As the distance to an object is determined by measuring the time of flight and not by the intensity of the sound, ultrasonic sensors are excellent at suppressing background interference. Virtually all materials which reflect sound can be detected, regardless of their colour. Even transparent materials or thin foils represent no problem for an ultrasonic sensor.

Figure 4: Ultrasonic sensor

3.GSM is an open and digital cellular technology used for transmitting mobile voice and data services It is readily available **GSM**/GPRS **module**, used in many mobile phones and PDA. The **module** can also be used for developing IOT (Internet of Things) and Embedded Applications. **SIM900A** is a dual-band **GSM**/GPRS engine that works on frequencies EGSM 900MHz and DCS 1800MHz.There are various GSM modules available in market like SIM900, SIM700, SIM800, SIM808, SIM5320 etc.SIM900A module allows users to send/receive data over GPRS, send/receive SMS and make/receive voice calls. The GSM/GPRS module uses USART communication to communicate with microcontroller or PC terminal. AT commands are used to configure the module in different modes and to perform various functions like calling, posting data to a site, etc.vSIM900 GSM/GPRS shield is a GSM modem, which can be integrated into a great number of IoT projects. You can use this shield to accomplish almost anything a normal cell phone can; SMS text messages, Make or receive phone calls, connecting to the internet through GPRS, TCP/IP, and more! To top it off, the shield supports quad-band GSM/GPRS

network, meaning it works pretty much anywhere in the world. The SIM900 shield packs a surprising amount of features into its little frame. Some of them are listed below:

- Supports Quad-band: GSM850, EGSM900, DCS1800 and PCS1900
- Connect onto any global GSM network with any 2G SIM
- Make and receive voice calls using an external earphone & electret microphone
- Send and receive SMS messages
- Send and receive GPRS data (TCP/IP, HTTP, etc.)
- Scan and receive FM radio broadcasts
- Transmit Power:
  - Class 4 (2W) for GSM850
  - Class 1 (1W) for DCS1800
- Accepts Full-size SIM Card
- U.FL and SMA connectors for cell antenna

Figure 5: SIM 900

a) System Design

There are 2 sets, basically Arduino connecting to the sim 900A and the Arduino connecting to the sensors along with the display.

Sim900A and Arduino : these 2 are connected to each other to send the message and alter the people onshore .

The connection goes this way there are 5 pins that will connect to the Arduino Board, the first T (Transmitter) to Digital Pin 7 Arduino, R (Receiver) to Digital Pin 8 Arduino, GND (Ground) to GND Arduino, and 5 v power supply to pin 5 Volt Arduino. In SIM900A Module there is SIM Port, SIM This port is used to place SIM cards. The code is uploaded from the Arduino application in which we use the setting when sending SMS on AT-Command and Settings when receiving SMS on AT-Command. When sending using AT + CMGS commands and when receiving or viewing incoming messages using AT + CMGL commands.

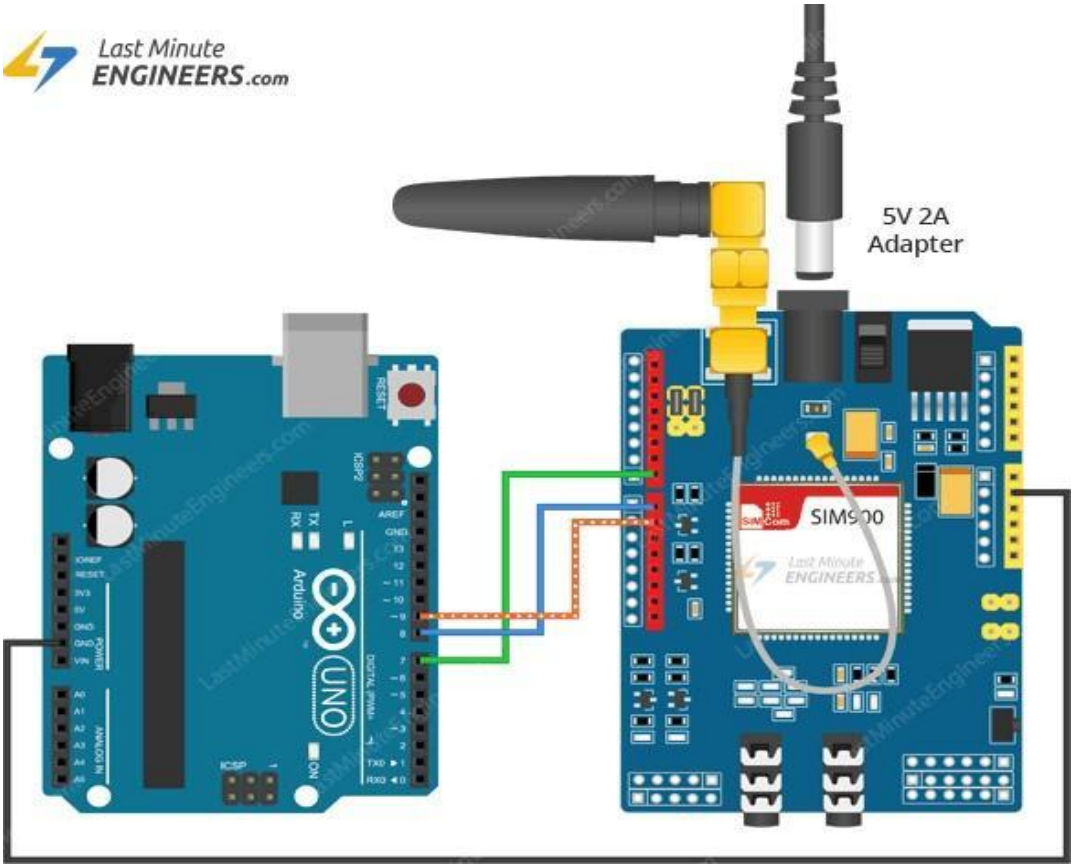


Figure 6: Arduino and Sim900A circuit connection

Code used in interfacing the Ardunio and Sim900A:

```
void sendsms(String message, String number) {
  String number = "AT + CMGS = \""+number+"\""; // command used to deliver the SMS
  SIM900.print("AT+CMGF=1\r");
  delay(1000);
  SIM900.println(mnumber);
  delay(1000);
  SIM900.println(message);      // required SMs will be sent through the command give
  delay(1000);
  SIM900.println((char)26);    // the ASCII values for the message that is to be send
  delay(1000);
  SIM900.println();
  delay(100);
```

Arduino with the ultrasonic sensor, display and pressure sensor: The basic idea of this circuit is the know the incoming of the tsunami the Arduino will power up the circuit, the ultrasonic sensor is used to calculate the distance it travels if the device goes above the sea level the message will go the people on the shore.

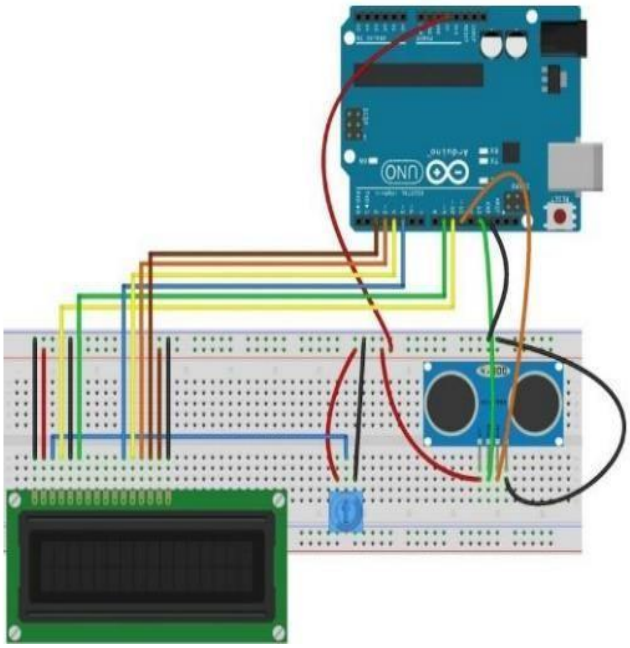


Figure 7: Arduino circuit with LCD display and ultrasonic sensor

Added Buzzer as voice indicator. Buzzer is used as an indicator when distance indicates unsafe state, for that besides 16x2 LCD as indicator, Buzzer is expected to increase the Indicator's complexity on prototype. Installation of buzzer shown in, Buzzer used has a voltage of 5 volts, buzzer or piezo has 2 pins that is GND and Data, for Data entry on Digital pin 8 Arduino Board.The difference is the addition of voice indicator piezo or buzzer 5 Volt. The function of the buzzer is as a complement to the prototype, although the buzzer function here is not too important because there is already a SIM900A role as a data sender or a very important indicator.

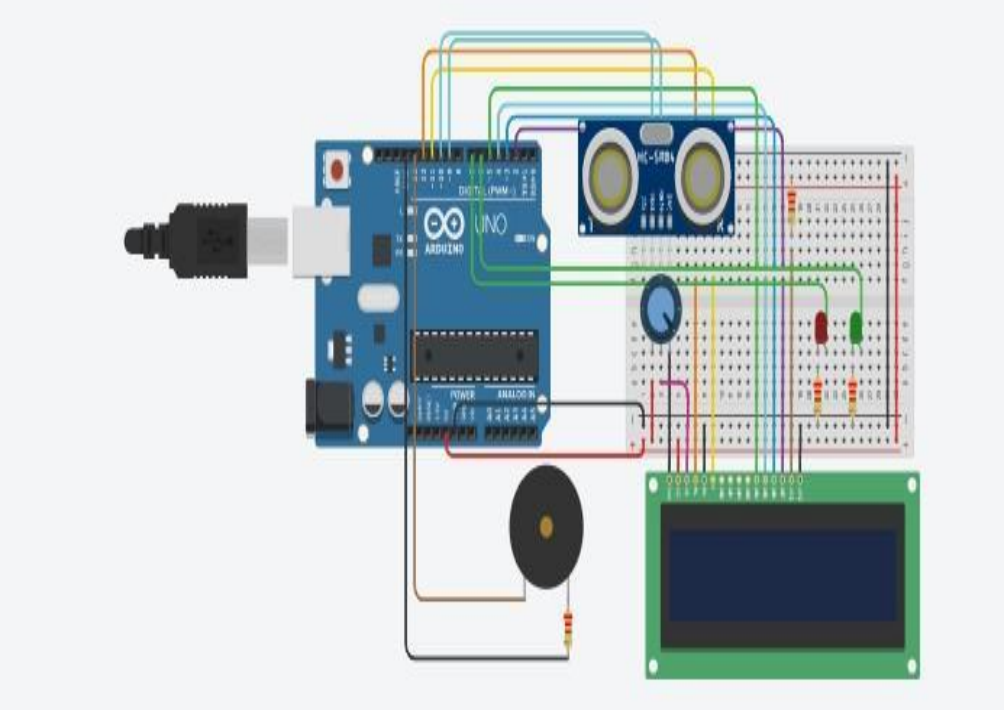


Figure 8: Arduino Board, 16x2 LCD, Ultrasonic Sensor and Buzzer Wiring

After the addition of buzzer to the prototype successfully completed, the next step is to combine the schematic in the picture 3, 4 and 5 so that it can be seen schematic in Figure. Figure 6 describes the merger between GSM Module SIM900A device with ultrasonic sensor that has been combined in one module

Code used in interfacing the sensor and Arduino to calculate the distance:

```
digitalWrite(trigPin, LOW);
delayMicroseconds(2);
digitalWrite(trigPin, HIGH);
delayMicroseconds(10);
digitalWrite(trigPin, LOW);
length = pulseIn(echoPin, HIGH);
tsunami_epics = length * 0.034 / 2; // senor uses this formula calculate the distance
```

Full code :

1.

```
#include<SoftwareSerial.h> // will include the library code
SoftwareSerial SIM900(7,8); // sim900a module is connected here in arduino
#define trigPin 10  // ultrasonic sensor trig pin is connected here
#define echoPin 9  // ultrasonic sensor echo pin is connected here
String textForSMS;
int data=0;
String f1001="+917760622959"; // cell no to send the SMS
long length;
int tsunami_epics;
void setup(){
  Serial.begin(9600); // baud rate
  pinMode(trigPin, OUTPUT);
  pinMode(echoPin, INPUT);
  SIM900.begin(9600);
  Serial.println(" logging time completed!");
  delay(5000); //delay of 5 seconds
  }
  void loop(){
  digitalWrite(trigPin, LOW);
  delayMicroseconds(2);
  digitalWrite(trigPin, HIGH);
  delayMicroseconds(10);
  digitalWrite(trigPin, LOW);
  length = pulseIn(echoPin, HIGH);
  tsunami_epics = length * 0.034 / 2; // To calculate the distance of the system travelled
  Serial.println(data);
  if(tsunami_epics < 100) //  condition to check if the waves are lethal
  {
  sendsms("no tsunami", f1001);
  Serial.println(textForSMS);
  Serial.println("message sent.");
  delay(5000);
}
if (tsunami_epics <200){
  sendsms("no tsunami", f1001);
  Serial.println(textForSMS);
  Serial.println("message sent.");
  delay(5000);
}
else {
  sendsms("tsunami alert get to safety and alert everyone", f1001);
  Serial.println(textForSMS);
  Serial.println("message sent.");
```

```
  delay(5000);

}
}
void sendsms(String message, String number) {
  String number = "AT + CMGS = \""+number+"\"";
  SIM900.print("AT+CMGF=1\r");
  delay(1000);
  SIM900.println(mnumber);    // recipient's mobile number
  delay(1000);
  SIM900.println(message);          // message to send
  delay(1000);
  SIM900.println((char)26);    // End AT command with a ^Z, ASCII code 26
  delay(1000);
  SIM900.println();
  delay(100);


}
```

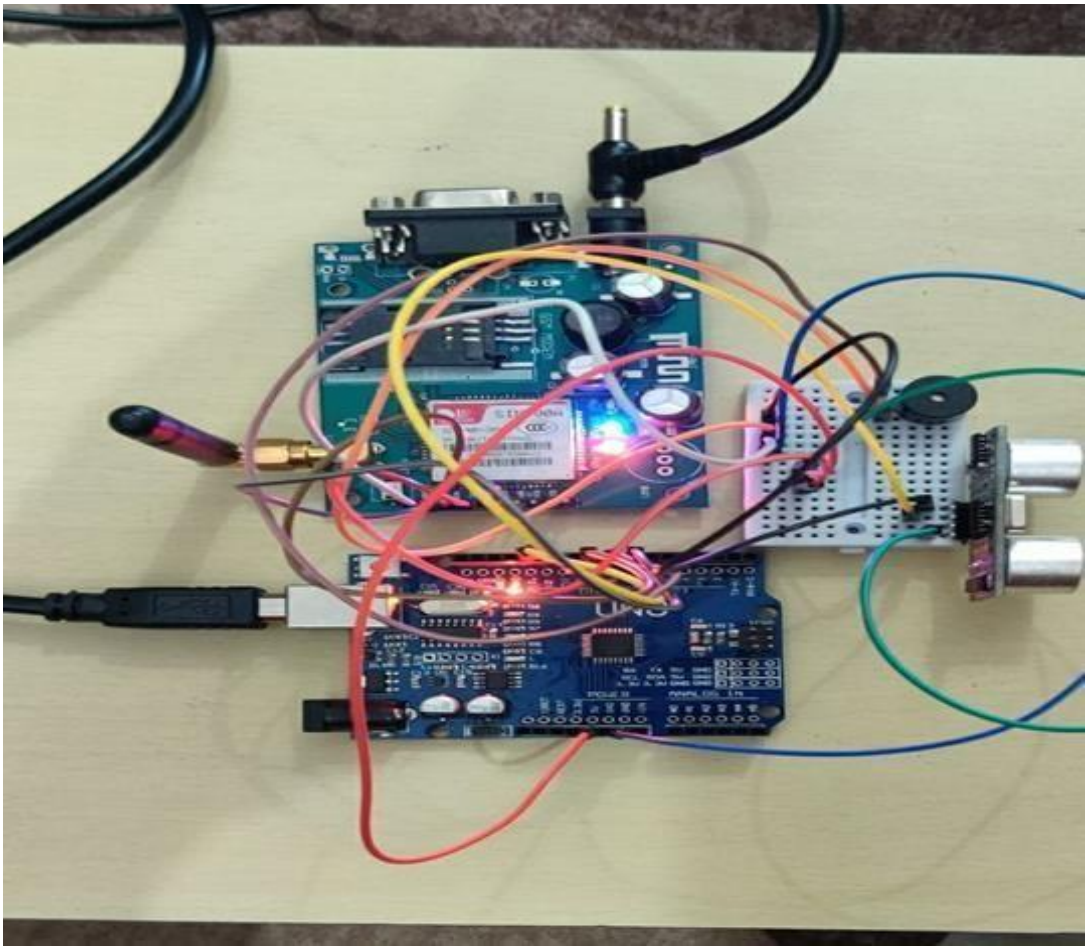


Figure 9: Prototype Tsunami detector

b) Working Principle

Sensor placement is at an estimated distance of 300 cm or 3 meters from sea level, on the prototype indicator there are 3 states that are safe, dangerous and out of reach.When safe conditions there is no data sent to GSM SIM900A Module because it is in the possibility of safe distance.

In condition -2 that is a dangerous condition. This condition allows the transmission of sensor data to GSM Module SIM900A due to the position or condition of the drastic drastic sea water that triggers the possibility of a tsunami, after ultrasonic sensors read the sea water distance conditions in accordance with the coding program that has been entered, then the data sent to SIM900A for later sent to phone.

In the 3rd condition the sensor does not read any normal distance or it is said out of the range. In this condition the sensor does not provide any output at all, and awaits the occurrence of distance changes in the sea water in accordance with the program code processed by the Arduino under normal or legible conditions.

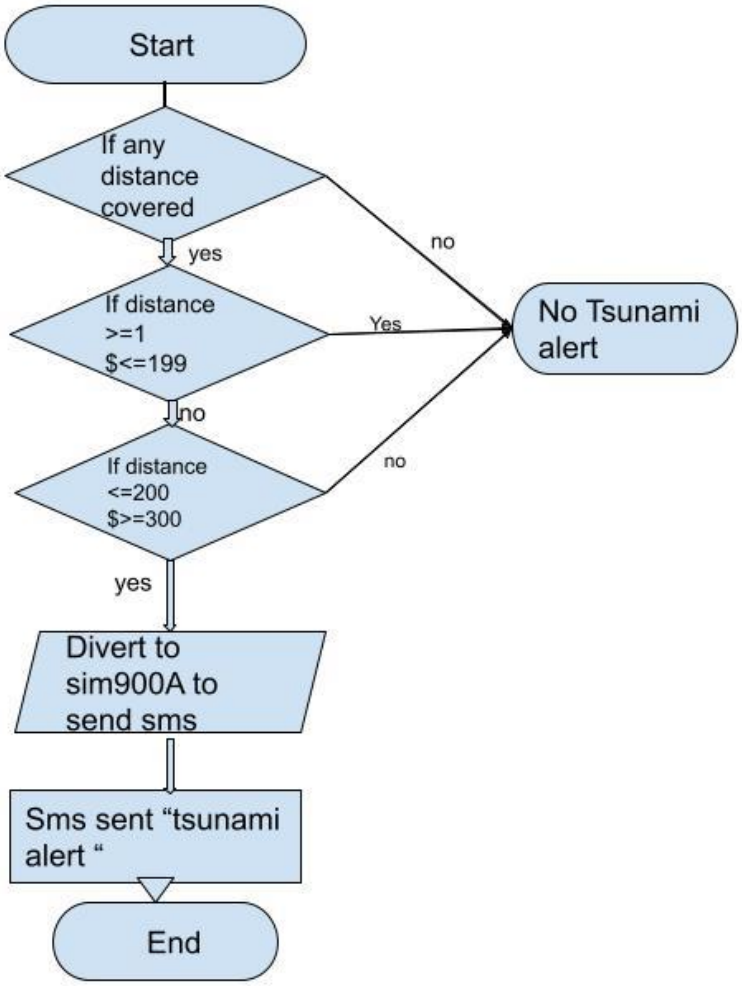
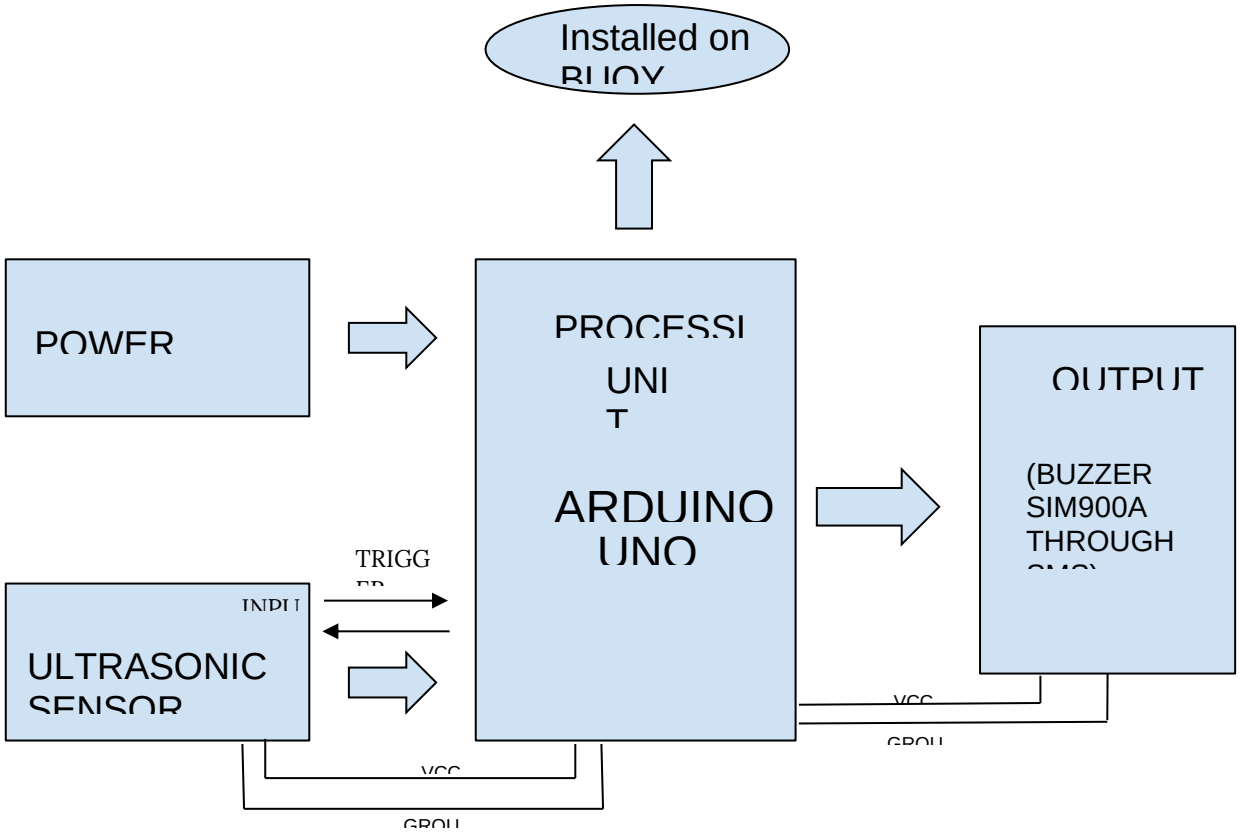


Figure 10: Flowchart of the System.



c) Expected Results

- On the completion of this project we expect to improve our tsunami detection and alert system. Whereby we can reduce the time taken to react to upcoming tsunamis. This project will replace the older technology which was slower, less reliable and depended on a more centralised system for sending out alerts. This project will make the detection and warning system faster, more reliable and decentralised. The developed system is expected to send alerts via gsm, which is more widely spread and accessible to people. This will enable individuals to react to tsunami threats as well as officials.
- We propose to keep our entire prototype on a buoy which would float at a suitable range to the coast. This helps in making products more efficient, cost effective and maintenance free from other existing products.

Figure 11: The above picture is a buoy which is the container of our prototype.

3. RESULT

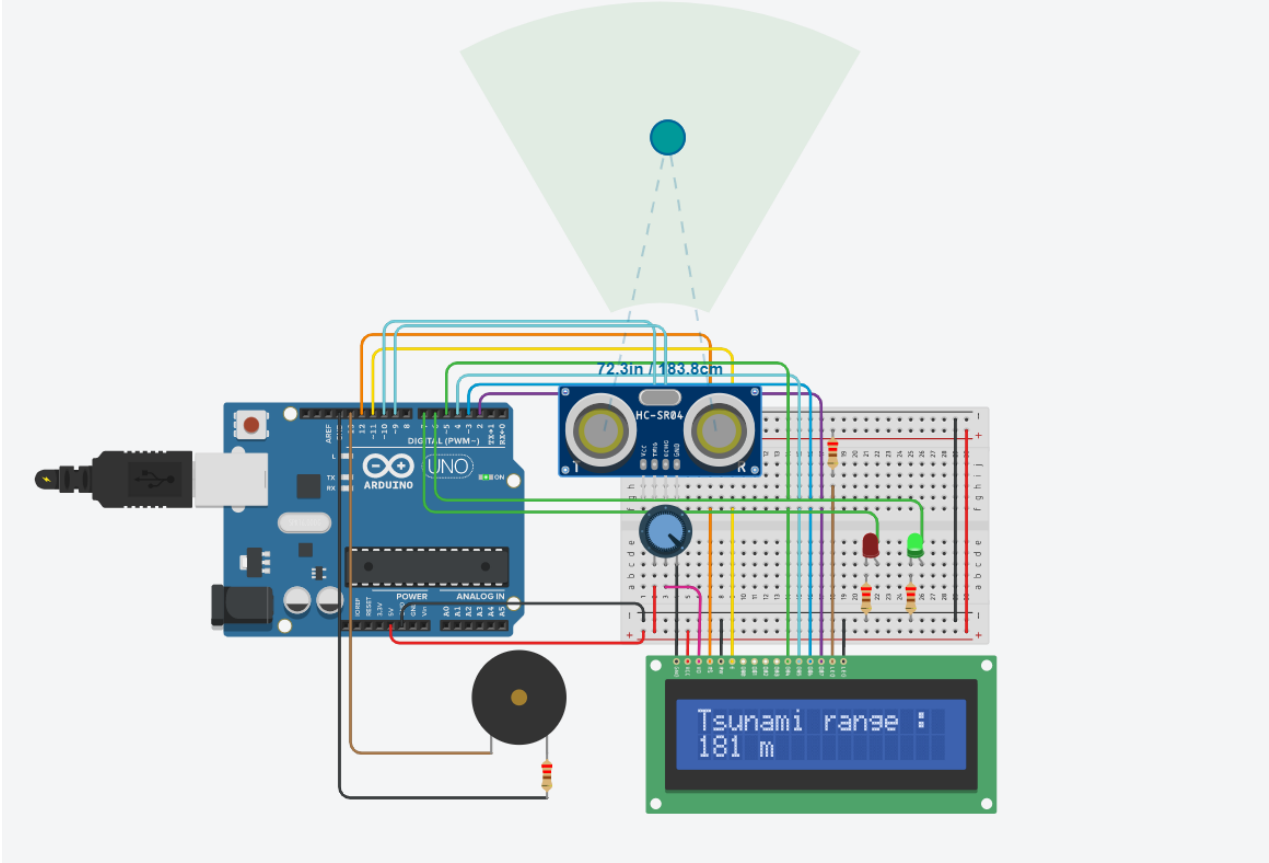


Figure 12 : The lcd display showing the distance(181 m) with no alert and no buzzer.

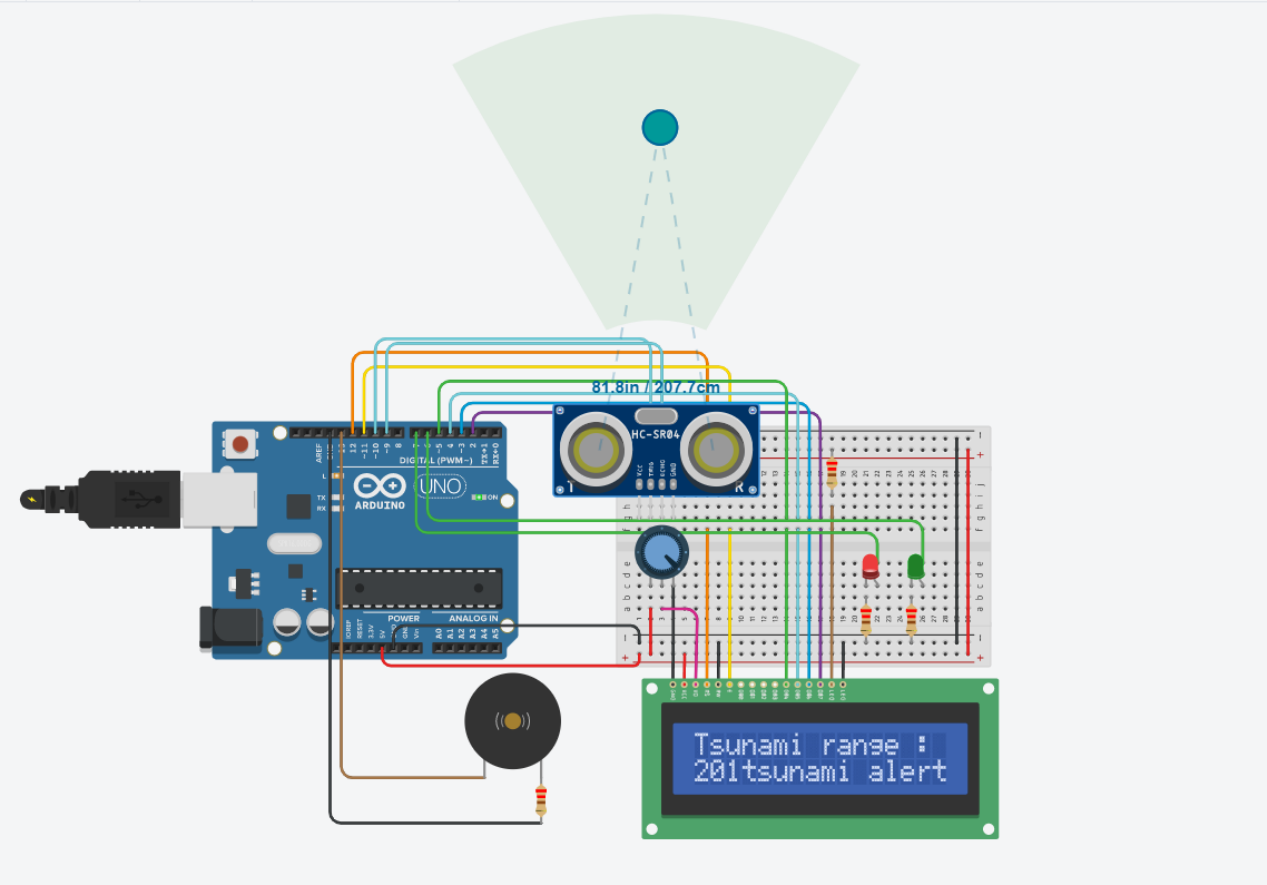


Figure 13: On lcd display distance (201 mtrs) is in tsunami range so the buzzer is on and tsunami alert

Individual Contribution by Members

•Shasshank ;- research and details about the existing system .also contribution in writing code for the required system. Studied research paper for the details about the existing project.
•Abhishek ;- objective and abstract and statistics on the effect of tsunami. Major contribution in making report and presentation of the particular details of the project
•Ashwin ;- research about future scope of our project and challenges . ideas about the smart way to install the system. How the system has to work and make the presentation.
•Vinay ;- research about structure and making of transmitter and receiver .major part in making the hardware research about the hardware material and also contribution in code installation.
•Alaistar ;- managing the outcomes of the project, learning making of the transmitter and receiver. Major part In report making and presentation of the product. examination of the outcomes

4. CONCLUSION

In conclusion the system or prototype designed here is not an underwater device it'll be placed on the buoy and the chances of the device getting damaged is very slim. This will work on the

sea level hike and have very less maintenance support which is the plus point when compared to the existing system which was mentioned earlier. Natural calamities can only be detected, its occurrence cannot be averted. Still, if the accurate timing of the disaster can be known beforehand, preventive measures are possibilism based Tsunami alert and detection system is a system that can help prevent the damage caused by the natural disasters like Tsunami and Earthquake by alerting about the calamity in advance along with its intensity on a GSM handset which does not require an internet connection making it a convenient and a reliable tool. There were many loss of lives in the past because of these natural calamities where we did not have the proper knowledge about the technology but we now have the resources to depict a tsunami . We don't need too many resources or a lot of funding to do this. It can be done in very less budget , where we can minimize the loss of lives and protect the families offshore. Sea water level and sensor <= 319 cm. because beyond that range or larger, the sensor can not read the object that is sea water. So it is necessary to have specific data about sea water conditions and the resulting vibration. From the prototype made it is expected to reduce the death of coastal populations due to a sudden tsunami and no sign of any, so that with this prototype can provide information as soon as possible using a prototype made based on early indications of tsunami disaster.

5. REFERENCE

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