IOT Based Manhole Monitoring System

A Mini Project Report

Submitted to the APJ Abdul Kalam Technological University

in partial fulfillment of requirements for the award of degree

Bachelor of Technology

in

Electronics and Communication Engineering

by

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Palakkad 2022-23

CERTIFICATE

This is to certify that the report entitled **IOT BASED MANHOLE MONITORING SYSTEM** submitted by **Adhith R** (NSS20EC003), **Anandu Vinod** (NSS20EC016), **Karthik A R** (NSS20EC046) & **Nandana P K** (NSS20EC098) to the APJ Abdul Kalam Technological University in partial fulfillment of the B.Tech. degree in Electronics and Communication Engineering is a bonafide record of the project work carried out by him under our guidance and supervision. This report in any form has not been submitted to any other University or Institute for any purpose.

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DECLARATION

We hereby declare that the project report **IOT BASED MANHOLE MONITORING SYSTEM**, submitted for partial fulfillment of the requirements for the award of degree of Bachelor of Technology of the APJ Abdul Kalam Technological University, Kerala is a bonafide work done by us under supervision of Ayswaryalakshmi MG

This submission represents our ideas in our own words and where ideas or words of others have been included, we have adequately and accurately cited and referenced the original sources.

We also declare that I have adhered to ethics of academic honesty and integrity and have not misrepresented or fabricated any data or idea or fact or source in my submission. We understand that any violation of the above will be a cause for disciplinary action by the institute and/or the University and can also evoke penal action from the sources which have thus not been properly cited or from whom proper permission has not been obtained. This report has not been previously formed the basis for the award of any degree, diploma or similar title of any other University.

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Finally, I thank my family, and friends who contributed to the successful fulfillment of this seminar work.

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Abstract

The rapid growth of urbanization has increased the need for efficient infrastructure management, including the monitoring of manholes. Manholes are critical for maintaining underground utility networks, but their improper maintenance can lead to accidents and damage to infrastructure. This project presents an IoT-based manhole monitoring system that utilizes Arduino, gas sensor, ultrasonic sensor, tilt sensor, and GSM module to ensure the timely detection and notification of hazardous conditions.The proposed system integrates multiple sensors to monitor various parameters within manholes. The gas sensor is employed to detect toxic gases, such as methane and carbon monoxide, which can accumulate in manholes. The ultrasonic sensor is utilized to measure the water level inside the manhole, providing insights into potential flooding situations. Additionally, the tilt sensor is used to monitor any structural movements or disturbances in the manhole covers.The Arduino microcontroller acts as the central processing unit, collecting data from the sensors and analyzing it in real-time. When any abnormal condition is detected, the system triggers an alert through the GSM module, which sends SMS notifications to the designated authorities. This enables prompt action to be taken to prevent accidents, infrastructure damage, and potential harm to workers or pedestrians.

Contents

Chapter 1

Introduction

Manhole monitoring is an important aspect of municipal infrastructure as accidents due to broken and missing manhole covers are quite frequent. Poor management and monitoring of the manholes can also cause urban floods which are most common in crowded cities. This problem can be addressed by using a manhole management device based on iot and sensor technology.

Chapter 2

Block Diagram and Description

2.1 Block Diagram

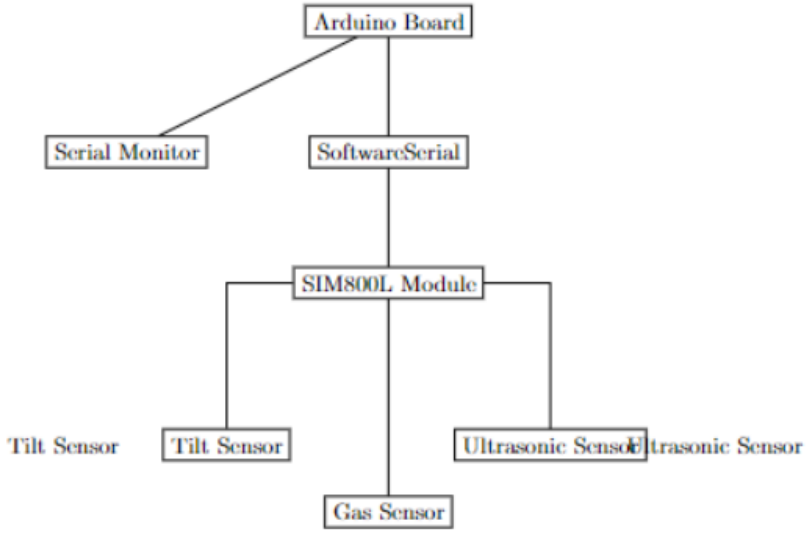


Figure 1: Block Diagram

Figure 2.1: Block Diagram

2.2 Block Diagram Description

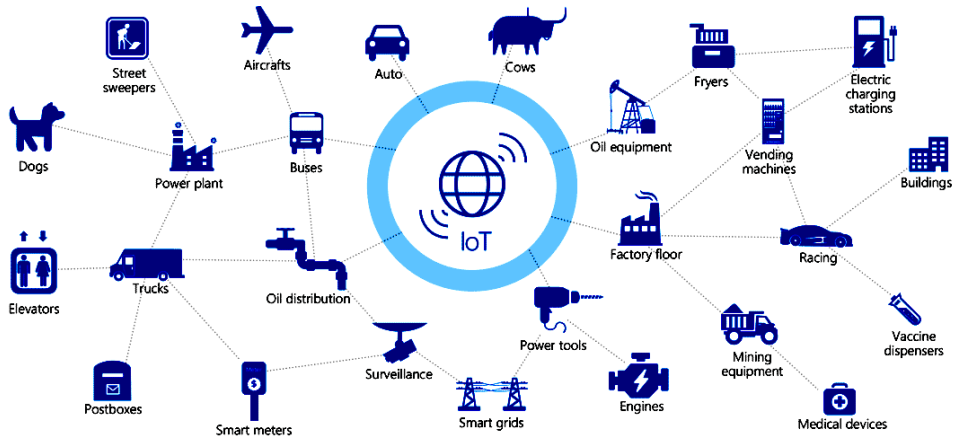
The block diagram of the IoT-based manhole monitoring system consists of several key components. At the center is the Arduino microcontroller, which acts as the main control unit for data processing and decision-making. Connected to the Arduino are the gas sensor, which detects toxic gases, the ultrasonic sensor, which measures the water

level inside the manhole, the tilt sensor, which monitors any structural movements, and the GSM module, which enables communication through SMS alerts. The sensors provide input to the Arduino, which analyzes the data and triggers alerts through the GSM module when abnormal conditions are detected.

Chapter 3

Technologies Used

3.1 Internet of Things (IoT)



IoT,or the Internet of Things, refers to a network of interconnected physical devices, objects, and systems that are embedded with sensors, software, and connectivity capabilities to exchange data and perform tasks without direct human intervention. In simple terms, it is the concept of connecting everyday objects and devices to the internet, enabling them to communicate, share information, and interact with each other.In this project, IoT (Internet of Things) technology is utilized to enable seamless connectivity and data exchange between the various components of the manhole monitoring system. The IoT aspect comes into play through the integration of sensors, Arduino microcontroller, and the GSM module, creating a networked system capable of real-time monitoring and communication.

Chapter 4

Components Used And Description

4.1 Arduino Mega 2560

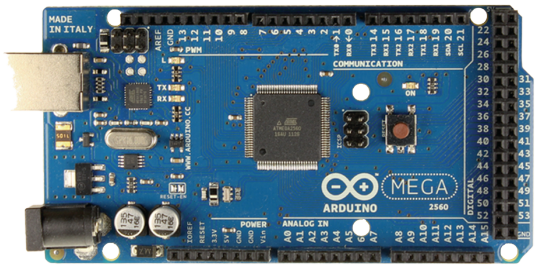


Figure 4.1: Arduino Mega 2560

The ATmega2560 serves as the foundation for a microcontroller board known as the Arduino Mega 2560. It has 54 digital input/output pins, 14 of which can be used as PWM outputs, 16 analog inputs, 4 UART serial ports, a 16MHz crystal oscillator, a USB connector, a power jack, an ICSP header, and a reset button Everything required to support the microcontroller is included; all that is required to get started is the insertion of a USB cable, an AC-DC adapter, or a battery. On this board, each pin is connected to a particular function. All of the analog pins on this board can be used as digital I/O pins. These boards offer a range of work memory capacity and processing speed that enable immediate operation with different kinds of sensors. Comparing these boards to other types of Arduino boards, they are physically superior.

4.1.1 Power

USB or an external power supply is used for powering the Arduino. Power pins are as follows:

- **Pin 3.3V & 5V**
  The microcontroller and other components used on the Arduino mega board are powered by this regulated power source. It can be acquired from the board's Vin pin or another regulated voltage source, such as a USB cable, or another regulated voltage source, such as 3.3V0-pin. This may draw a maximum of 50mA in power.

- **GND Pin**
  The 5-GND pins on the Arduino mega board are available for usage anytime the programme calls for it.

4.1.2 Reset (RST) Pin

This board's RST pin may be used to rearrange the board. This pin can be turned low to reorganise the board.

4.1.3 Vin Pin

The board may be supplied with the input voltage in the 7 to 20 volt range. The voltage provided by the power jack can be accessed using this pin. However, the board will by default output 5V through this pin.

4.1.4 Serial Communication

To send and receive serial data, this board's serial pins TXD and RXD are used. Information is transmitted when a Tx is used, and data is received when an RX is used. There are four configurations for the serial pins on this board. It comprises Tx (1) and Rx (0) for serial 0, Tx (18) and Rx (19) for serial 1, Tx (16) and Rx (17)for serial 2 and Tx (14), Rx(15) for serial 3.

4.1.5 LED

The LED on this Arduino board is connected to pin-13, sometimes known as digital pin 13. This LED may be regulated based on the high and low values of the pin. You will be able to alter your programming abilities in real time as a result.

4.1.6 AREF

Analog Reference Voltage, often known as AREF, is a reference voltage for analogue inputs.

4.1.7 Analog Pins

The board contains 16 analog pins with the designations A0-A15. The fact that all of the analog pins on this board can be used as digital I/O pins is crucial information. Each analog pin can be accessed with a 10-bit resolution that measures voltages between GND and 5 volts. However, the AREF pin and the analog Reference function both allow for the higher value to be changed ().

4.1.8 I2C

The Serial Data Line (SDA), which is used to store data, and the Serial Clock Line (SCL), which is primarily used to provide data synchronisation among the devices, are the two pins that may allow I2C communication.

4.1.9 SPI Communication

The data transmission between the controller and other components is done via a serial peripheral interface, or SPI. SPI uses four pins for communication: MISO (50), MOSI (51), SCK (52), and SS (53).

4.1.10 Dimensions

The widths and lengths of the Arduino Mega 2560 board are 101.6mm (4 inches) and 53.34mm (2.1 inches), respectively. Compared to other boards that are available on the market, it is far better. The power jack and USB port, however, are somewhat larger than the stated dimensions.

4.1.11 Programming

An Arduino Mega 2560 can be programmed using an IDE (Arduino Software), which supports the C programming language. In this instance, the code is written within the application and transmitted via a USB connection to the Arduino board to produce the sketch.

An Arduino mega board's boot loader eliminates the requirement to burn the program code onto the Arduino board using an external burner. Here, the boot loader's communication can be done using the STK500 protocol. When using the Arduino board for your project, the power supply can be supplied via a power jack or the board's Vin pin.

4.2 SIM800L GSM Module

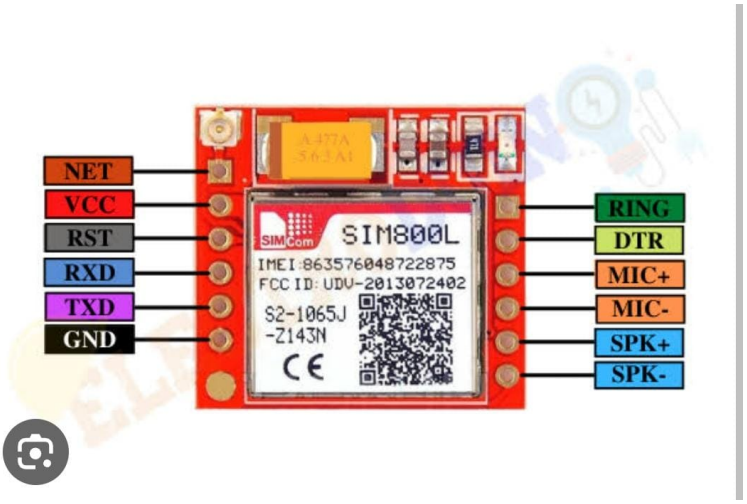


Figure 4.2: GSM SIM800L

The GSM SIM800L is a compact and low-power cellular module widely used in IoT applications for communication over the Global System for Mobile Communications (GSM) network. It integrates GSM/GPRS functionality, making it capable of transmitting and receiving voice calls, text messages (SMS), and data. The SIM800L

module operates on various frequency bands and supports 2G connectivity, making it capable of transmitting and receiving voice calls, text messages (SMS), and data. The SIM800L module operates on various frequency bands and supports 2G connectivity, making it compatible with most GSM networks worldwide. With its small form factor, low power consumption, and extensive command set, the GSM SIM800L is a popular choice for adding wireless connectivity to IoT devices, enabling remote monitoring, control, and communication capabilities.

4.3 MQ2 Gas Sensor

Figure 4.3: MQ2 Gas Sensor

The MQ2 gas sensor is a commonly used electronic device designed to detect various types of gases in the environment. It is particularly sensitive to gases like LPG, propane, methane, alcohol, hydrogen, and smoke. The sensor operates on the principle of chemical reactions between the target gas and its internal sensing element. When the gas molecules interact with the sensor, they cause changes in its electrical conductivity, which are then converted into measurable output signals. The MQ2 gas sensor is widely utilized in gas leakage detection systems, safety alarms, and air quality monitoring devices, providing a reliable and cost-effective solution for detecting the presence of hazardous gases in both residential and industrial settings.

4.4 Mercury Tilt Sensor

A mercury tilt sensor is a compact electronic device designed to detect changes in orientation or tilt. It consists of a small glass tube partially filled with mercury, which acts as a conductive element. When the sensor is tilted or inclined, the mercury inside the tube moves, causing a change in the electrical conductivity. This change is then detected and translated into a corresponding electrical signal, allowing the sensor to determine the angle or tilt of the object it is attached to. Mercury tilt sensors are commonly used in various applications such as automotive safety systems, leveling devices, and electronic games, where accurate and reliable tilt detection is required.

Figure 4.4: Mercury Tilt Sensor

However, due to environmental concerns and the toxicity of mercury, alternative technologies like solid-state accelerometers have largely replaced mercury tilt sensors in many modern applications.

4.5 Ultrasonic Sensor

Figure 4.5: Ultrasonic Sensor

An ultrasonic sensor is a type of technology that utilizes sound waves beyond the range of human hearing to detect the presence or proximity of objects. It typically consists of a transmitter that emits high-frequency sound pulses and a receiver that

detects the echoes produced when these pulses bounce off nearby surfaces. By measuring the time it takes for the sound waves to return to the sensor, the distance between the sensor and the object can be calculated. Ultrasonic sensors are widely used in various applications, including robotics, industrial automation, parking assistance systems, and object detection, due to their accuracy, non-contact nature, and ability to work in different environmental conditions.

4.6 18650 Cell and Cell holder

Figure 4.6: 18650 Cell and Cell holder

The 18650 cell is a commonly used rechargeable lithium-ion battery that takes its name from its dimensions—18mm in diameter and 65mm in length. It is widely employed in various portable electronic devices such as laptops, power tools, electric vehicles, and even some renewable energy storage systems. The 18650 cell boasts a high energy density, providing a substantial amount of power in a compact size. It typically operates at a nominal voltage of 3.6 to 3.7 volts and has a capacity that can range from around 1800mAh to over 3500mAh, allowing for extended use before requiring recharging. With its durability, long cycle life, and ability to deliver a consistent output, the 18650 cell has become a trusted choice for powering a diverse array of modern devices.

4.7 Jumper Wires

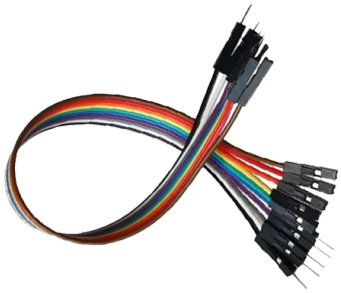


Figure 4.7: Jumper Wires

Electrical lines having connection pins at either end are known as jumper wires. They are employed to connect two circuit locations without the usage of solder. There are three types of jumper wires :

- Male-to-male jumper
- Male-to-female jumper
- Female-to-female jumper

While female ends do not have a projecting pin yet may also plug into objects, male ends do.

Chapter 5

System Design and Working

5.1 Detection of Tilt by Tilt Sensor

The tilt sensor measures the angle of inclination with respect to the horizontal plane. This is done by detecting changes in the position of an internal element(mercury ball).When the sensor is tilted or inclined, the mercury inside the tube moves, causing a change in the electrical conductivity. This change is then detected and translated into a corresponding electrical signal, allowing the sensor to determine the angle or tilt of the object it is attached to.

5.2 Detection of Poisonous gas by MQ2 Gas sensor

Gas Sensor is particularly sensitive to gases like LPG, propane, methane, alcohol, hydrogen, and smoke. The sensor operates on the principle of chemical reactions between the target gas and its internal sensing element. When the gas molecules interact with the sensor, they cause changes in its electrical conductivity, which are then converted into measurable output signals.

5.3 Detection of Water level by Ultrasonic sensor

Ultrasonic sensor typically consists of a transmitter that emits high-frequency sound pulses and a receiver that detects the echoes produced when these pulses bounce off nearby surfaces. By measuring the time it takes for the sound waves to return to the sensor, the distance between the sensor and the object can be calculated.

5.4 Sending messages to municipality authority using GSM SIM800L Module

SIM800L integrates GSM/GPRS functionality, making it capable of transmitting and receiving voice calls, text messages (SMS), and data. The SIM800L module operates on various frequency bands and supports 2G connectivity, making it capable of transmitting and receiving voice calls, text messages (SMS), and data.

Chapter 6

Result and Conclusion

6.1 Result

The system successfully detected the failures in the manhole and sent alert message to the authority.The alert system was triggered for the cases having tilt sensor value higher than 450,ultrasonic sensor value less than 30cm and gas sensor value more than 50.

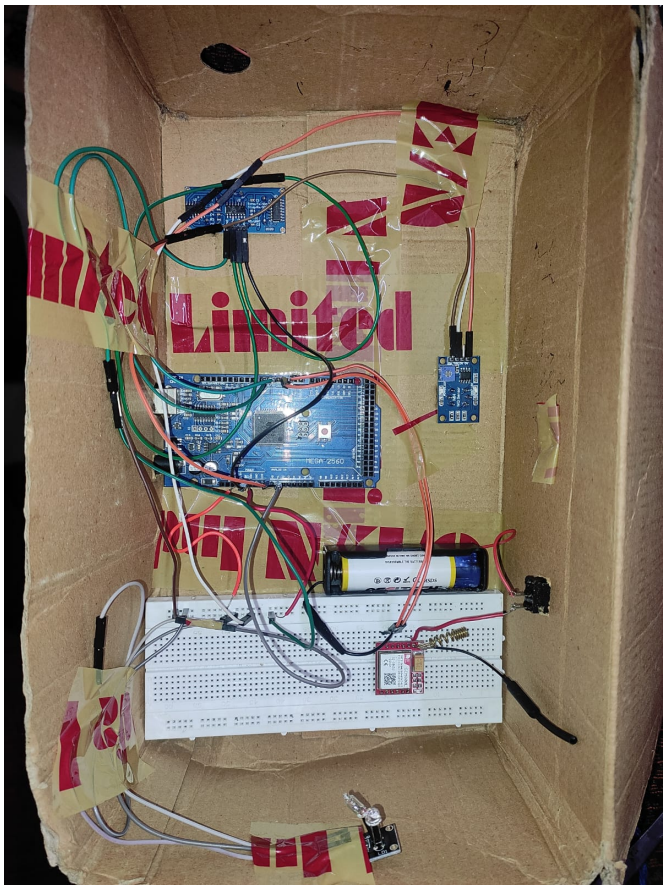


Figure 6.1: Prototype

6.1.1 Output

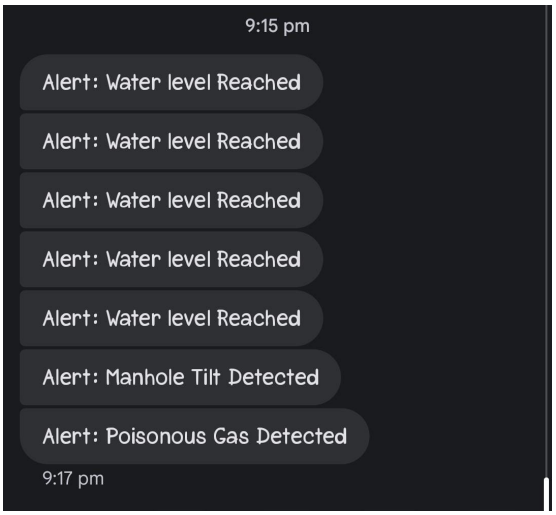


Figure 6.2: Output Message

6.2 Conclusion

Nowadays, underground observation is tough. This idea suggests a completely new approach to manage the subsurface system. This system offers a clever solution.Water level, poisonous gas and tilt can all be detected with this device. This may be the case. Smart cities have been introduced, and they are simple to operate by anybody. It is a low-cost, time-saving, and human-friendly option system of intervention.The system that has been presented identifies the sewer water level and thus detects the obstruction quickly present on the inside.It also identifies the Poisonous gas produced as a result from the factories.It can reduce the no. of accidents due to improper manhole coverings.

The system is easy to operate and does not require any prior technical knowledge.

References

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[2] A Pendharkar, J Chillapalli, K Dhakate, “IoT Based Sewage Monitoring System”, Available at SSRN, 2020, researchgate.net.

[3] M Aarthi, A Bhuvaneshwaran, “Iot Based Drainage and Waste Management Monitoring and Alert System for Smart City”- Annals of the Romanian Society, 2021 - annalsofrscb.ro.

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Appendix A

Program Code

```
#include <SoftwareSerial.h>

#define sensorPin1 A1
#define ECHOPIN 5
#define TRIGPIN 6
int sensorPin = A0;


SoftwareSerial mySerial(3,2); // SIM800L Tx & Rx is connected to Arduino #3 & #2

void setup()
{
  Serial.begin(115200);
  pinMode(sensorPin, INPUT);
  pinMode(ECHOPIN, INPUT_PULLUP);
  pinMode(TRIGPIN, OUTPUT);
  digitalWrite(ECHOPIN, HIGH);

  mySerial.begin(9600);
  delay(1000);
}

void loop()
{
  int tiltSensorValue = analogRead(sensorPin1);
  int distance = getDistance();
  int gasSensorValue = analogRead(A0);
  Serial.println(tiltSensorValue);
```

```
  if (tiltSensorValue > 450 )
  {
    sendMessage("Alert: Manhole Tilt Detected");
     Serial.println("tilt detected");
  }
  if (gasSensorValue > 80 )
  {
    sendMessage("Alert: Poisonous Gas Detected");
     Serial.println(" Poisonous Gas detected");
  }
  if (distance < 30  )
  {
    sendMessage("Alert: Water level Reached");
     Serial.println(" Water level Reached");
  }



  delay(1000);
}

int getDistance()
{
  digitalWrite(TRIGPIN, LOW);
  delayMicroseconds(2);
  digitalWrite(TRIGPIN, HIGH);
  delayMicroseconds(15);
  digitalWrite(TRIGPIN, LOW);
  int pulseDuration = pulseIn(ECHOPIN, HIGH, 26000);
  int distance = pulseDuration / 58;
  Serial.println(distance);
  Serial.println(" cm");
  return distance;
}
```

```
void sendMessage(const char *message)
{
  mySerial.println("AT"); // Once the handshake test is successful, it will back to OK
  updateSerial();
  mySerial.println("AT+CMGF=1"); // Configuring TEXT mode
  updateSerial();
  mySerial.println("AT+CMGS=\"+919495074331\""); // Change ZZ with country code and xxxxxxxxxx with phone number to SMS
  updateSerial();
  mySerial.print(message); // Text content
  updateSerial();
  mySerial.write(26);
}

void updateSerial()
{
  delay(500);
  while (Serial.available())
  {
    mySerial.write(Serial.read()); // Forward what Serial received to Software Serial Port
  }
  while (mySerial.available())
  {
    Serial.write(mySerial.read()); // Forward what Software Serial received to Serial Port
  }
}
```