VISVESVARAYA TECHNOLOGICAL UNIVERSITY VISVESVARAYA TECHNOLOGICAL UNIVERSITY JNANASANGAMA, BELAGAVI – 590014

A Project Report

on

"SMART SAFETY DEVICE FOR SEWAGE WORKERS"

Submitted in partial fulfillment for the award of *degree of*

Bachelor of Engineering

In

Computer Science and Engineering

Submitted By

FAIZA SHAREEF

(4BP19CS015)

UNDER THE GUIDANCE OF

Prof. UMAIRA

(Dept. of CSE)

(Academic Year: 2022-2023)

DEPARTMENT OF COMPUTER SCIENCE AND ENGINEERING

BEARYS INSTITUTE OF TECHNOLOGY

MANGALURU – 574199

BEARYS INSTITUTE OF TECHNOLOGY

(Affiliated To Visvesvaraya Technological University, Belagavi and Recognized by AICTE)

INNOLI, MANGALURU – 574199, KARNATAKA

Department of Computer Science and Engineering

CERTIFICATE

This is to certify that the project work of phase-II entitled ***"Smart Safety Device For Sewage Workers"*** *carried out by* ***FAIZA SHAREEF (4BP19CS015)*** *a bonafide students of* ***BearysInstitute of Technology, Mangalore*** *in partial fulfillment for the award of degree of* ***Bachelor of Engineering in Computer Science and Engineering*** *of the* ***Visvesvaraya Technological University, Belagavi*** *during the year* ***2022-2023****. The project phase-II report has been approved as it satisfies the academic requirements with respect to the project work phase-II prescribed for the said Bachelor of Engineering degree.*

Prof. UMAIRA	***Dr. AZIZ MUSTHAFA***	***Dr. S. I MANJUR BASHA***
(PROJECT GUIDE)	*(H.O.D)*	*(PRINCIPAL)*

EXTERNAL EXAMINATION

Name of the Examiners: **Signature with Date:**

1. ____________________ ____________________
2. ____________________ ____________________

BEARYS INSTITUTE OF TECHNOLOGY

(Affiliated To Visvesvaraya Technological University, Belagavi and Recognized by AICTE)

INNOLI, MANGALURU – 574199, KARNATAKA

Department of Computer Science and Engineering

DECLARATION

I Hereby declare that the dissertation entitled **“SMART SAFETY DEVICE FOR SEWAGE WORKERS”**, Project work of Phase-II, submitted by me is certainly original and the Project work Phase-II has been carried out by me independently in Bearys Institute of Technology, Mangalore, under the guidance of **Prof. Umaira**. This report has been submitted in partial fulfillment for the award of the **Degree of Bachelor of Engineering in Computer Science and Engineering**. I also declare that this work does not form the basis for the award of any other degree of a similar title of any other University or Institution.

By,

Place: Mangalore FAIZA SHAREEF

Date: **(4BP19CS015)**

ACKNOWLEDGMENT

I dedicate this page to acknowledge and thank those who have always supported me in this work, without their guidance and help, the experience would not have been so smooth and efficient.

I would like to express my deep sense of gratitude to our honorable Chairman, Sir **SYED MOHAMMED BEARY**, for his continuous effort in creating a competitive environment in our college and encouraging throughout this course.

I am extremely thankful to our Principal, **Dr. S.I MANJUR BASHA**, for his valuable support.

I express my sincere gratitude to **Dr. AZIZ MUSTHAFA**, Head of Department, Computer Science and Engineering for his continuous support and guidance.

I also thank **Prof. AKSHATHA S.A**, Project Coordinator, Department of Computer Science and Engineering, for her constant encouragement and support extended throughout.

I wish to express my sincere gratitude to my guide, **Prof. UMAIRA**, Department of Computer Science and Engineering for her continuous support and guidance, hence improving our knowledge.

I also thank all the faculty members of Bearys Institute of Technology, Mangalore for providing all the facilities that helped me in timely completion of this project phase-II report.

I also like to extend heartly gratitude and thanks to my friends and family members for their continuous support.

FAIZA SHAREEF

(4BP19CS015)

ABSTRACT

Sanitation workers are those who work in any part of the sanitation system. These workers are frequently in close contact with various types of garbage, such as human excreta, household wastes, and other hazardous materials, while working without proper safety equipment or protection, exposing them to a wide range of health risks and diseases. Toxic gases in septic tanks and sewers, such as Ammonia NH_3), carbon-monoxide (CO), and sulphur-dioxide (SO_2), can cause workers to pass out or die. In this project, a wearable smart safety device for sewage workers is proposed which intends to safeguard their life by providing early notifications for the presence of toxic gases. Values from sensors were registered and plotted on the ThingSpeak that same result represent in worker profile website. These parameters in real time alerts the worker to stay safe and detects harmful gases before any harm. It also gives notification to other persons like supervisors. If sewage workers are in an emergency, a buzzer starts beeping.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

CHAPTER 1

INTRODUCTION

1.1 OVERVIEW

The Internet of Things (IoT) refers to the interconnected network of physical devices, vehicles, buildings, and other objects that are embedded with sensors, software, and network connectivity, allowing them to collect and exchange data. IoT systems have the potential to revolutionize various industries and improve our daily lives by enabling automation, efficiency, and convenience.

From chemical exposure and equipment mishaps to fatigue, heat stroke and fatal falls, there are numerous workplace dangers facing industry. Robust regulations and extensive training alongside conventional personal safety equipment (PPE) are vital, however, these practices do not inform workers when external environments suddenly turn dangerous. Likewise, supervisors and managers are entirely unaware when remote field workers are reaching their physical thresholds.

The introduction of IoT and smart, connected devices are now giving rise to an unprecedented level of visibility into workers' health and their environments. Intelligent gadgets (watches, helmets, vests…) continuously capture vital physical metrics like heart rate, skin temperature, movement, activity, and location. In parallel, environmental sensors record critical information about employees' working conditions and their exposure to external dangers.

Leveraging an advanced analytics platform, situational data can then be distilled into actionable insights visualized at a remote management console. Through enhanced visibility, IoT for worker safety solutions empower data-driven decision-making, thereby improving the safety and productivity of the cross-industry field workforce.

1.2 ARCHITECTURE OF IOT

The architecture of IoT applications is shown in figure 1.2 consisting of four layers. The device layer consists of sensors, actuators, RFIDs and gateways. Gateways collect the data from the above-mentioned devices for further processing. This layer consists of resource constrained devices. Second layer, Network Layer, provides transport and networking capabilities for routing the data. Third Layer is a middle layer which hides the complexity of lower layers to higher layer and provides also storage and further processing of data. The Application layer caters for different IoT applications like Smart city, Smart industry and smart health. The security module provides necessary security features to each layer. It is known, the device layer consists of resource constrained devices. In order to implement a security mechanism in this layer LWT cryptographic techniques is required.

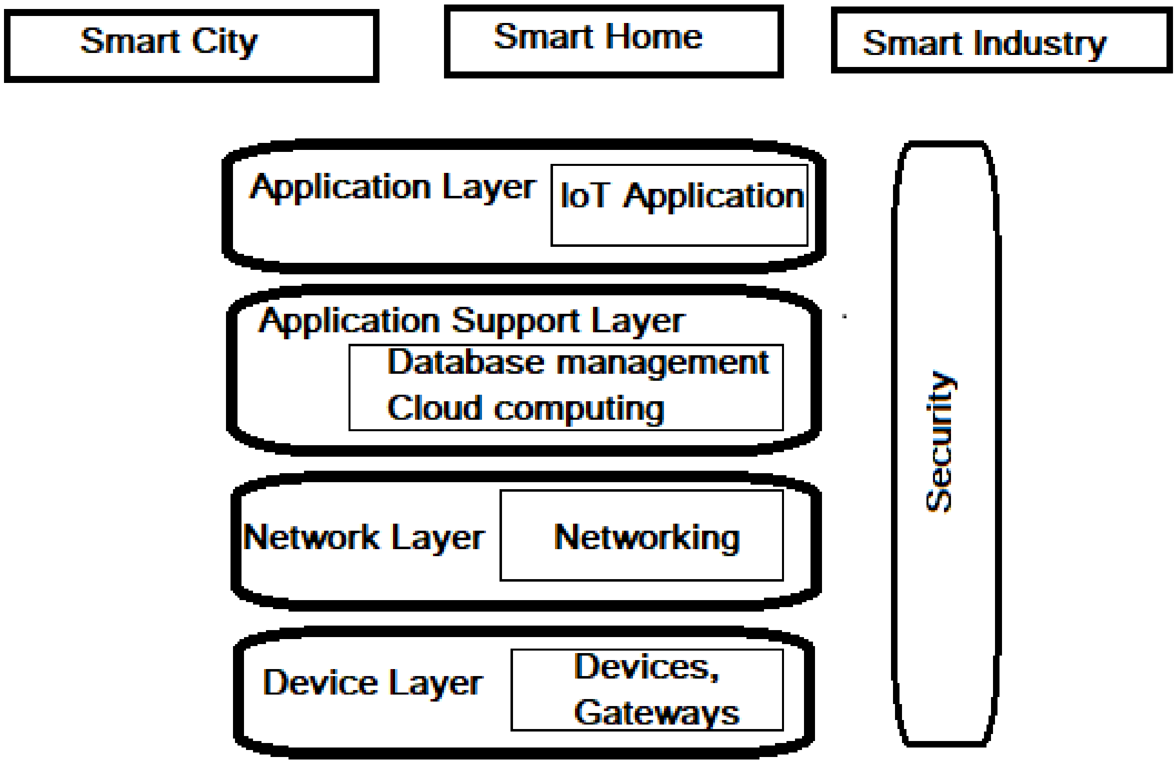

Figure 1.2 Architecture view of IoT

CHAPTER 2

LITERATURE SURVEY

2.1 IRJET -IOT Based Smart Safety Monitoring System for Sewage Workers with Two Way Communication

Most of the cities adopted the underground drainage system and it's the duty of Municipal Corporation to maintain cleanliness, health and safety of cities. If the drainage system is not properly managed then pure water gets contaminate with drainage water and infectious diseases may get spread. Drainage cleaning people are not aware of risk by sudden attack of poisonous gas since the gases are odorless if exposed for long time which may cause serious health problems. Due to the lack of using proper gas leakage detection system, a number of dangerous accidents occurred during the last few decades. To overcome all these problems effective monitoring system is needed in the drainage channels. The detected system is proposed with gas sensors like Carbon Monoxide, Hydrogen sulphide sensors and Methane, one Heart Beat sensor used to Calculate the pulse rate of Human. Carbon Monoxide, Hydrogen sulphide, Methane gases are highly toxic to human hence the proposed system will give alert through the LCD Display after reaching the threshold level of each gas sensors then people get alerts Heart Beat sensor will calculate the range of the Pulse rate then output at the abnormal range will give alert through notification through an IOT

Sewage system is an underground system of pipes commonly used to transport wastewater from homes and business either to a treatment facility, where the water is treated and released into natural water bodies like lakes and streams or in any river to permanently drain out from the area. Sewer manhole is one of the most important parts of the sewer system. Sewer manhole is a structure through which a person can gain access to the underground wastewater collection system. Manholes are not designed for someone to work in regularly, but workers may need to enter inside the manhole to complete their jobs such as cleaning, repair, inspection etc

Internet of Things has gained its wide popularity in recent days due to its various streams of applications which has paved way for smooth, safe and easier mode of living style for human beings. Though, several techniques are existing for the same, yet sewage cleaning is one major concern and a challenge always. This paper thus put forth a new proposed system which is microcontroller-based application of sewage workers health monitoring systems using IOT.

2.2 Smart Safety Monitoring System for Sewage Workers Using IOT

A large number of sanitation workers die every year due to erratic and lack of facilities available, and harmful toxic gases released while cleaning the sewage. Real time health monitoring systems for such workers will work in a sewage as a safety equipment. In our project, the device will monitor the pulse rate of the person using a Heartbeat sensor and the concentration of $CH_4$with respect to atmospheric O_2 and provide alert to the worker and exterior unit when parameters deviate from the safe range. This outcome will promptly alert the worker to stay safe and detect the toxic gases before any harm.

Sewage system is an underground system of pipes commonly used to transport waste water from homes and business either to a treatment facility, where the water is treated and released into natural water bodies like lakes and streams or in any river to permanently drain out from the area. Sewer manhole is one of the most important parts of the sewer system. Sewer manhole is a structure through which a person can gain access to the underground wastewater collection system. Manholes are not designed for someone to work in regularly, but workers may need to enter inside the manhole to complete their jobs such as cleaning, repair, inspection etc. The lack of prior caring of sewage work is the witness for the deaths of thousands of sewage cleaners throughout the year from accidents and various diseases such as hepatitis and typhoid due to sudden or sustained exposure to hazardous gases like CO, hydrogen sulphide, methane. The smart drainage system will have: Sensors to detect blockage, flood and gases. The intelligence of sensors and system will identify the clogging inside the drainage system and will give the details of the location and other information for further actions. The system will also sense the presence of various harmful gases such asCH_4, SO_2, CO etc.

Internet of Things has gained its wide popularity in recent days due to its various streams of applications which has paved way for smooth, safe and easier mode of living style for human beings. Though, several techniques existing for the same, yet sewage cleaning is one major concern and a challenge always. The device finds major application in household sewage systems, municipal manholes and sewage, sewer, deep well, gutters and drains etc. However, the places where toxic gases or fumes are present should never be handled by human workers directly. The smart safety device is cost wise less and fast in accessing the WSN and transfer the information to both the concerned department and emergency department. The proposed device helps the worker at a basic level of knowledge to understand the gas level and his pulse rate.

2.3 Smart Safety Monitoring System for Sewage Workers

U. Vijay Kumar Asst. Professor, Dept. Of CSE KITS Warangal

This project mainly focuses on safety of sewage workers as a large number of sewage workers die every year due to lack of facilities and harmful toxic gases released while cleaning a sewage. This Real-time health monitoring System will be very useful and works as safety equipment. In this Project, the device will monitor heartbeat of the person, hydrogen sulphide concentration and other toxic gases concentration and alerts the worker and exterior unit when the parameters deviate from safe range by sending SMS and provides location of the worker through GPS.

Sewage water or domestic water is a type of waste water that is produced by a community of people. This water contains all the impurities and it is sent to a treatment plant for purifying the water and the purified water is sent to the river bodies. So, here when the water is released from the communities, they reach the underground tunnels, and there is a huge work that has to be done by the sewage workers. Thousands of people are being killed every year because of the poisonous gases emitting from the manholes. The main reason behind this is that the workers are sent into the manholes without any safety equipment. Real time health monitoring systems for such workers will be helpful to save their lives. Gases like Carbon Monoxide Methane gas, Hydrogen Sulphide gas are very toxic. So, our problem of interest is to develop a device that will detect the harmful gases, temperature inside the manhole and heartbeat of the worker so that if anything is not under the normal buzzer is activated and the worker is saved on time.

Arduino MEGA is the primary component which acts heart of the project. It allows you to read sensor data from sewage, such as ppm values obtained from MQ2 and MQ136 sensors. Arduino also reads values from heart sensor and Temperature sensor to detect pulse of the person and temperature respectively. These parameters are also updated to the server at the same time using the ThingSpeak IoT platform. The analytics tool in ThingSpeak is used to plot the graphical representation of these parameters. The device includes a GPS module for tracking the worker's position. When the values exceed the threshold values, the GSM module sends an SMS alert to the specified mobile number. The warning specifies the coordinates of the worker's location.

Therefore, to prevent these hazards, an IOT based safety for sewage workers was proposed and designed which monitors toxic gases levels and heart rate of the worker in sewage. GPS module is used to know location of the worker in sewage. If any of the parameters divert from threshold values then an alert is given to worker and also to exterior unit using SMS before any harm.

2.4 IRJEdT -SMART IoT DEVICE FOR SEWAGE GAS MONITORING AND ALERT SYSTEM

This paper aims to design a system to measure and analyze the real-time levels of toxic gases and alert the workers. This project attempts to device an IOT technology that shall detect the mixture of gases, sensing each type of gas to measure its level while keeping track of the real-time dynamic changes in the above factors. The measured gases level is uploaded to firebase. If levels exceed beyond threshold, it shall send an alert on the connected mobile devices of the authorized people who are remotely located in the job. If sewage is about to overflow it can be informed to the officials through SMS message. An android application was developed and integrated with the designed system for monitoring purposes.

Sewage environment IoT device and IoT platform to monitor poisonous gas has been proposed as a solution to help the sewer workers who put their lives risk. Because of these poisonous gases, the death rate of sewer workers has increased in the recent years. The lack of treatment of sewage after crossing dangerous levels leads to the deaths of thousands of sewage cleaners throughout the year from accidents and various diseases such as hepatitis and typhoid that occur due to sudden or sustained exposure to hazardous gases. Septic tanks are devices which are found commonly in different types of localities, ranging from residential areas to largely developed industrial areas to provide solutions for treatment of sewage wastes.

The proposed system will help sewage workers to protect their lives from risk and harmful disease. According to recent news updates, many sewage workers lost their lives while doing their job by coming across the high concentration of such poisonous gases, which once inhaled led to serious health issues. This proposed system with advanced technology based on IoT will significantly impact the lives of sewage workers. Moreover, by introducing new functionalities like location services, tracking and modified alert system, this design can serve a great social cause.

The proposed system will help sewage workers to protect their lives from risk and harmful disease. According to recent news updates, many sewage workers lost their lives while doing their job by coming across the high concentration of such poisonous gases, which once inhaled led to serious health issues. This proposed system with advanced technology based on IoT will significantly impact the lives of sewage workers. Moreover, by introducing new functionalities like location services, tracking and modified alert system, this design can serve a great social cause.

2.5 IoT based Sewage Monitoring System

This paper aims to measure and analyze the real time levels of toxic gases. In order to ensure safety of the workers working under such severe conditions. This project attempts to device an IOT technology that shall detect the humidity, temperature levels and mixture of gases, sensing each type of gas to measure its level while keeping track of the real-time dynamic changes in the above factors. If levels exceed beyond threshold, it shall send an alert on the connected mobile devices of the authorized people who are remotely located in the job. If any blockage is encountered, it can be monitored with the help of live video streaming.

Effluent around the IoT system and network that detect toxic gases has been developed as a measure to help sanitation staff who risk their life to ensure reduced health hazards due to these toxic contaminants, sanitation employees' death rates have increased over the past few years. After reaching hazardous levels, the lack of proper sewage decontaminating results in the deaths of sewage cleaning staff from injuries and Specific illnesses including influenza and dysentery caused by abrupt yet prolonged harmful gas exposure.

The goal of this paper is to provide a methodology to check harmful release of gaseous materials in areas included in the drainage system, in social housing and industrial facilities. Sewage also contributes to the natural process of producing poisonous gases. When inhaled for a significant period of time, these gases can be harmful, and if high doses are absorbed in the bloodstream, it may lead to serious illnesses in the work force. Drainage systems indicate the presence of gases, namely sulfur dioxide, methane, ammonia, nitrogen dioxide, carbon dioxide, and carbon monoxide. Therefore, these toxic gases are hazardous, and sometimes lead to their death, particularly for sewage workers and cleaners. Hence, an IoT-based monitoring system is being introduced to avoid exposure to such workplace hazards. Previous programs suggested manual sampling for the sewer gas analysis at defined time intervals. Many variables such as humidity, temperature and generation of live videos were not considered. Using the latest design, the drawbacks of the current system will be addressed. In addition to the gas sensors, the humidity and temperature sensors can aid in assessing the overall environment of the sewage. While assisting sewage employees to check blockage, there will be live video streaming from the camera attached to the raspberry PI.

CHAPTER 3

PROBLEM IDENTIFIED

3.1 Problem Statement

Now a day`s people are becoming more and more busier with their own life and are forgetting to clean their own surroundings. When the cleaning is not done, the waste either remains as stagnant in that area or the municipality cleans it. So, when the municipality cleans the area all the impurities are dumped into the tunnel. These impurities are cleaned by the sewage workers. The sewage workers have to clean the impurities releasing from the communities, impurities dumped by the municipality and the industrial waste. In the existing system the worker will be in danger zone, it will send only a vibration alert to the higher officials or to the control room by the vibrator module. So, the sewage workers lives are always at risk. In-order to save their lives, A Smart Safety Monitoring System is developed that detect the condition of the worker, harmful gases inside the manhole and the temperature of the manhole so that when the values exceed the threshold values, buzzer is activated automatically and messages are sent to the headquarters via SMS and GPS in the device tracks the location of the worker so that the rescue team reaches the manhole on time and their lives are saved.

3.2 Proposed System

The smart safety device will have: pulse, flood and gas sensors. The system will sense the presence of various harmful gases such as Methane (CH_4), Sulphur dioxide (SO_2), Carbon monoxide (CO) etc. A wearable smart safety device for sewage workers is proposed which intends to safeguard their life by providing early notifications for the presence of toxic gases. Values from sensors were registered and plotted on the ThingSpeak that same result represent in worker profile website. These parameters in real time alerts the worker to stay safe and detects harmful gases before any harm. It also gives notification to other persons like supervisors. If sewage workers are in an emergency, a buzzer starts beeping.

CHAPTER 4
OBJECTIVE AND METHODOLOGY

4.1 OBJECTIVE

The purpose of this project is to provide the following objectives for safety of sewage workers. The condition of the sewage acts as an input using pulse sensor, water level sensor, Gas sensor detectors. It measures and analyze the real-time levels of toxic gases in order to ensure safety of the workers working under such severe conditions.

- To provide safety for sewage workers
- To avoid deaths of sewage workers due to toxic gases.
- To develop cost friendly system.
- To find location of the worker in the sewage tunnel.
- To update the readings in real-time over ThingSpeak analysis tool.
- To alert the worker if any parameters exceed.
- To alert the higher authorities in case of flood detected by raise in water level.

4.2 METHODOLOGY

Arduino MEGA is the primary component which acts heart of the project. It allows you to read sensor data from sewage, such as ppm values obtained from MQ2 and MQ136 sensors. Arduino also reads values from heart sensor and Temperature sensor to detect pulse of the person and temperature respectively. These parameters are also updated to the server at the same time using the ThingSpeak IoT platform. The analytics tool in ThingSpeak is used to plot the graphical representation of these parameters. The device includes a GPS module for tracking the worker's position. When the values exceed the threshold values, the GSM module sends an SMS alert to the specified mobile number. The warning specifies the coordinates of the worker's location. The data can be viewed by the consumer as well as an external unit to prevent any accidents that could occur when working in sewage and to save workers from health problems caused by harmful gases.

4.2.1 ARDUINO NANO

The Arduino Nano is a compact and versatile microcontroller board that is widely used in electronics projects. It is based on the ATmega328P microcontroller and provides a small form factor with a wide range of features, making it popular among hobbyists, students, and professionals. The Arduino

Nano board is designed to offer a convenient and cost-effective solution for prototyping and building various electronic devices. Its small size, measuring just 45mm x 18mm, allows it to be easily integrated into projects with space constraints. Despite its compact form, the Nano retains many of the essential features and capabilities of larger Arduino boards. The heart of the Arduino Nano is the ATmega328P microcontroller, which runs at a clock speed of 16 MHz It has 32KB of flash memory for storing the program code and 2KB of SRAM for data storage. The Nano also features a built-in USB interface, allowing it to be connected directly to a computer for programming and communication. The board offers a range of digital and analog input/output pins, providing flexibility for connecting various sensors, actuators, and other electronic components. It has 14 digital pins, of which 6 can be used as PWM (Pulse Width Modulation) outputs. Additionally, there are 8 analog input pins, which can be used to read analog signals from sensors. Programming the Arduino Nano is done using the Arduino IDE (Integrated Development Environment), a user-friendly software tool that allows you to write, compile, and upload code to the board. The programming language is based on Wiring and is similar to C/C++, making it accessible even to beginners.

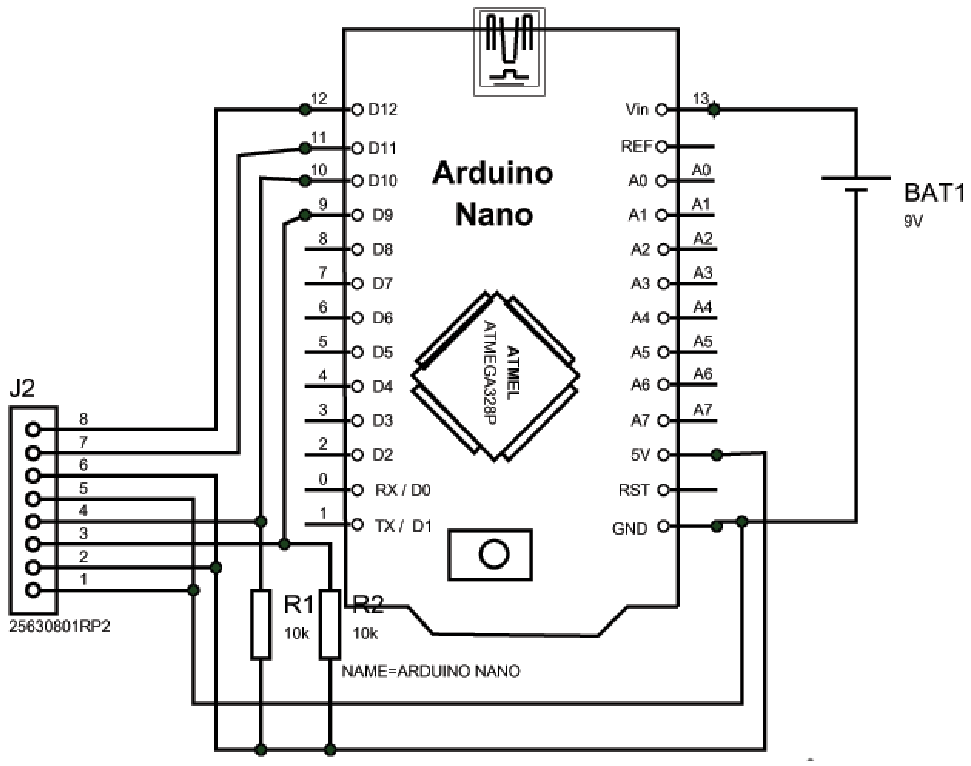

Fig 4.2.1 Arduino Nano

4.2.2 WIFI MODULE

A Wi-Fi module, also known as a Wi-Fi chip or Wi-Fi module, is an essential component that enables devices to connect wirelessly to local area networks (LANs) and the internet. When it comes to adding Wi-Fi capabilities to an Arduino Nano, one popular and cost-effective option is to use the ESP8266 Wi-Fi module. The ESP8266 is a standalone Wi-Fi module with an integrated microcontroller, making it an ideal choice for wireless communication in Arduino projects. To integrate the ESP8266 module with the Arduino Nano, you can establish a serial communication connection between the two. This involves connecting the RX (receive) and TX (transmit) pins of the ESP8266 module to the corresponding pins on the Arduino Nano, allowing them to exchange data. To program the ESP8266 module, you can use the Arduino IDE. However, before getting started, you need to install the ESP8266 board package in the Arduino IDE. This package includes the necessary tools, libraries, and examples to program the ESP8266 module using Arduino code. The ESP8266 module offers Wi-Fi connectivity, supporting the 802.11 b/g/n protocols. It can connect to existing Wi-Fi networks as a client or even create its own access point. This allows the Arduino Nano to communicate over Wi-Fi, exchange data with other devices, and access online services or cloud platforms.

Fig 4.2.2 Wifi Module

4.2.3 BUZZER

In an IoT (Internet of Things) project, incorporating a buzzer can be a valuable way to provide audible feedback or alerts to users. A buzzer can enhance the interactivity and user experience of an IoT system by notifying users about important events or triggering sound-based responses. To integrate a buzzer into an IoT project, you will need a microcontroller or development board that supports internet connectivity, such as the popular ESP8266 or ESP32. These platforms offer built-in Wi-Fi capabilities, making them suitable for IoT applications. Start by connecting the buzzer to a digital pin on the microcontroller board. Pay attention to the polarity of the buzzer and ensure the correct connections are made. Active buzzers usually have a positive terminal (+) and a negative terminal (-), while passive buzzers require an external oscillator signal from the microcontroller to produce sound. Next, you will need to write code to control the buzzer's behavior based on specific conditions or events. For example, you might program the buzzer to emit a certain sound pattern when a sensor detects a critical reading or when a specific command is received from a remote server.

Fig 4.2.3 Buzzer

4.2.4 GAS SENSOR

MQ-2 Semiconductor Sensor for Combustible Gas sensor is used as a gas detection module. Sensitive material of MQ-2 gas sensor is $SnO_{2,}$ which with lower conductivity in clean air. When the target combustible gas exists, the sensor's conductivity is higher along with the gas concentration rising. Please use simple electro circuit, convert change of conductivity to correspond output signal of gas concentration. MQ-2 gas sensor has high sensitivity to LPG, Propane and Hydrogen, also could be used to Methane and other combustible steam, it is with low cost and suitable for different application. The characteristics of MQ2 gas sensor are as follows:

- Good sensitivity to Combustible gas in wide range
- High sensitivity to LPG, Propane and Hydrogen
- Long life and low cost

Application of MQ2 gas sensor are as follows:

- Domestic gas leakage detector
- Industrial Combustible gas detector
- Portable gas detector

Fig 4.2.4 Gas Sensor

4.2.5 STRUCTURE AND CONFIGURATION OF MQ2 SENSOR

Structure and configuration of MQ-2 gas sensor is shown as Fig. 3, sensor composed by micro AL2O3 ceramic tube, Tin Dioxide (SnO2) sensitive layer, measuring electrode and heater are fixed into a crust made by plastic and stainless-steel net. The heater provides necessary work conditions for work of sensitive components. The enveloped MQ-2 have 6 pins, 4 of them are used to fetch signals, and other 2 are used for providing heating current.

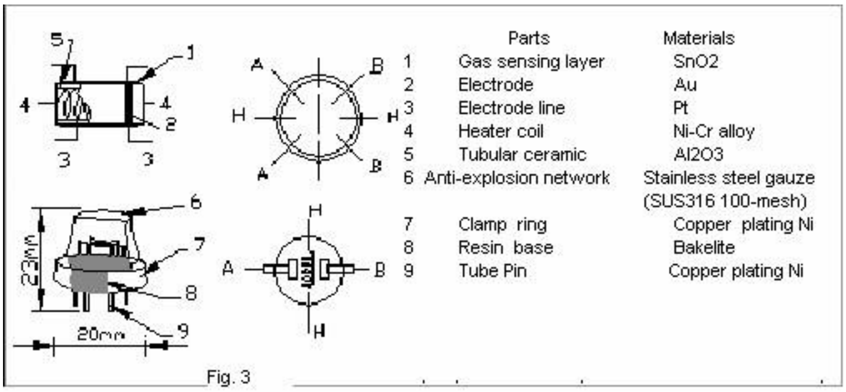

Fig 4.2.5 Structure and Configuration of MQ2 sensor

4.2.6 MAX30100 PULSE OXIMETER

The MAX30100 is an integrated pulse oximetry and heartrate monitor sensor solution. It combines two LEDs, a photodetector, optimized optics, and low-noise analog signal processing to detect pulse oximetry and heart-rate signals.

The MAX30100 operates from 1.8V and 3.3V power supplies and can be powered down through software with negligible standby current, permitting the power supply to remain connected at all times.

The applications of MAX30100 are as follows:

- Wearable Devices
- Fitness Assistant Devices
- Medical Monitoring Devices

The characteristics of MQ2 gas sensor are as follows:

- Integrated LEDs, Photo Sensor, and High-Performance Analog Front -End
- Tiny 5.6mm x 2.8mm x 1.2mm 14-Pin Optically Enhanced System-in-Package
- Ultra-Low-Power Operation Increases Battery Life for Wearable Devices
- Programmable Sample Rate and LED Current for Power Savings
- Ultra-Low Shutdown Current (0.7µA, typ)
- Advanced Functionality Improves Measurement Performance
- High SNR Provides Robust Motion Artifact Resilience
- Integrated Ambient Light Cancellation
- High Sample Rate Capability
- Fast Data Output Capability

The MAX30100 is a complete pulse oximetry and heartrate sensor system solution designed for the demanding requirements of wearable devices. The MAX30100 provides very small total solution size without sacrificing optical or electrical performance. Minimal external hardware components are needed for integration into a wearable device.

The MAX30100 is fully configurable through software registers, and the digital output data is stored in a 16-deep FIFO within the device. The FIFO allows the MAX30100 to be connected to a microcontroller or microprocessor on a shared bus, where the data is not being read continuously from the device's registers.

SpO_2 Subsystem

The SpO2 subsystem in the MAX30100 is composed of ambient light cancellation (ALC), 16-bit sigma delta ADC, and proprietary discrete time filter.

The SpO2 ADC is a continuous time oversampling sigma delta converter with up to 16-bit resolution. The ADC output data rate can be programmed from 50Hz to 1kHz. The MAX30100 includes a proprietary discrete time filter to reject 50Hz/60Hz interference and low-frequency residual ambient noise.

Temperature Sensor

The MAX30100 has an on-chip temperature sensor for (optionally) calibrating the temperature dependence of the SpO2 subsystem. The SpO2 algorithm is relatively insensitive to the wavelength of the IR LED, but the red LED's wavelength is critical to correct interpretation of the data. The temperature sensor data can be used to compensate the SpO2 error with ambient temperature changes.

LED Driver

The MAX30100 integrates red and IR LED drivers to drive LED pulses for SpO2 and HR measurements. The LED current can be programmed from 0mA to 50mA (typical only) with proper supply voltage. The LED pulse width can be programmed from 200µs to 1.6ms to optimize measurement accuracy and power consumption based on use cases.

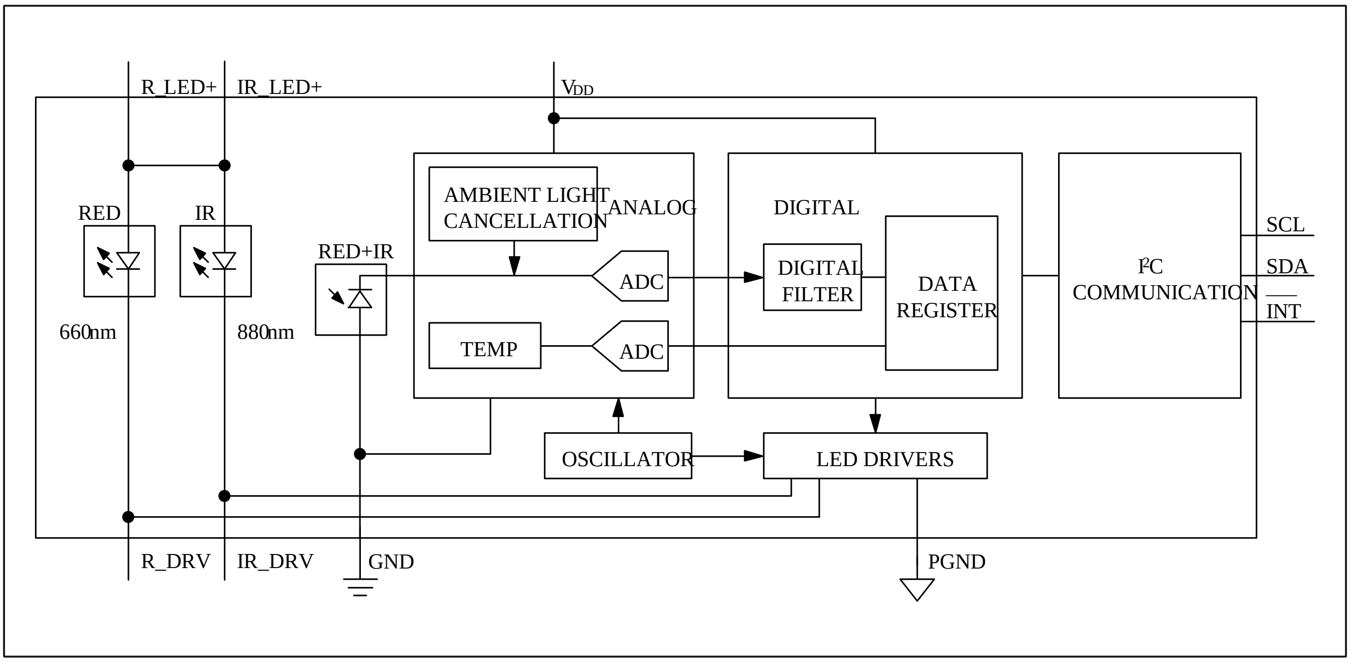

Fig 4.2.6 Functional Diagram Of MAX30100

4.2.7 WATER LEVEL SENSOR

The sensor has ten exposed copper traces, five of which are power traces and the remaining five are sense traces. These traces are interlaced so that there is one sense trace between every two power traces. Normally, power and sense traces are not connected, but when immersed in water, they are bridged There is a Power LED on the board, which will light up when the board is powered. The operation of the water level sensor is fairly simple. The power and sense traces form a variable resistor (much like a potentiometer) whose resistance varies based on how much they are exposed to water.

- The more water the sensor is immersed in, the better the conductivity and the lower the resistance.
- The less water the sensor is immersed in, the poorer the conductivity and the higher the resistance.
- The sensor generates an output voltage proportional to the resistance; by measuring this voltage, the water level can be determined.

The characteristics of the water float sensor are as follows:

- Uses Magnetic Read switch

  -Completely Shock proof

  -Can be used to Detect any Liquid level

  -Application - Water level Controllers

- Working

  -Float is free Movement As shown in the image

4.2.8 LCD DISPLAY

LCD (Liquid Crystal Display) screen is an electronic display module and find a wide range of applications. A 16x2 LCD display is very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi segment LEDs. The reasons being: LCDs are economical; easily programmable; have no limitation of displaying special & even custom characters (unlike in seven segments), animations and so on.

A **16x2 LCD** means it can display 16 characters per line and there are 2 such lines. In this LCD each character is displayed in 5x7 pixel matrix. This LCD has two registers, namely, Command and Data. The command register stores the command instructions given to the LCD.

Pin No	Function	Name
1	Ground (0V)	Ground
2	Supply voltage; 5V (4.7V – 5.3V)	Vcc
3	Contrast adjustment; through a variable resistor	V_{EE}
4	Selects command register when low; and data register when high	Register Select
5	Low to write to the register; High to read from the register	Read/write
6	Sends data to data pins when a high to low pulse is given	Enable
7	8-bit data pins	DB0
8		DB1
9		DB2
10		DB3
11		DB4
12		DB5
13		DB6
14		DB7
15	Backlight V_{CC} (5V)	Led+
16	Backlight Ground (0V)	Led-

Table 4.2.8 Pin Description

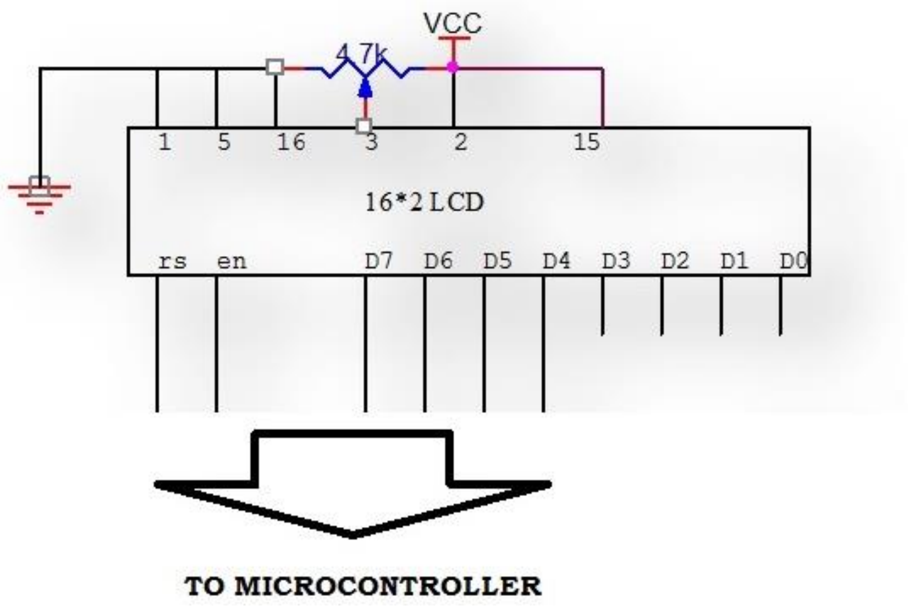

Fig 4.2.8 Schematics

4.2.9 ARDUINO IDE

The Arduino Software (IDE) makes it easy to write code and upload it to the board offline. We recommend it for users with poor or no internet connection. This software can be used with any Arduino board.

There are currently two versions of the Arduino IDE, one is the IDE 1.x.x and the other is IDE 2.x. The IDE 2.x is new major release that is faster and even more powerful to the IDE 1.x.x. In addition to a more modern editor and a more responsive interface it includes advanced features to help users with their coding and debugging.

4.3 GANTT CHART

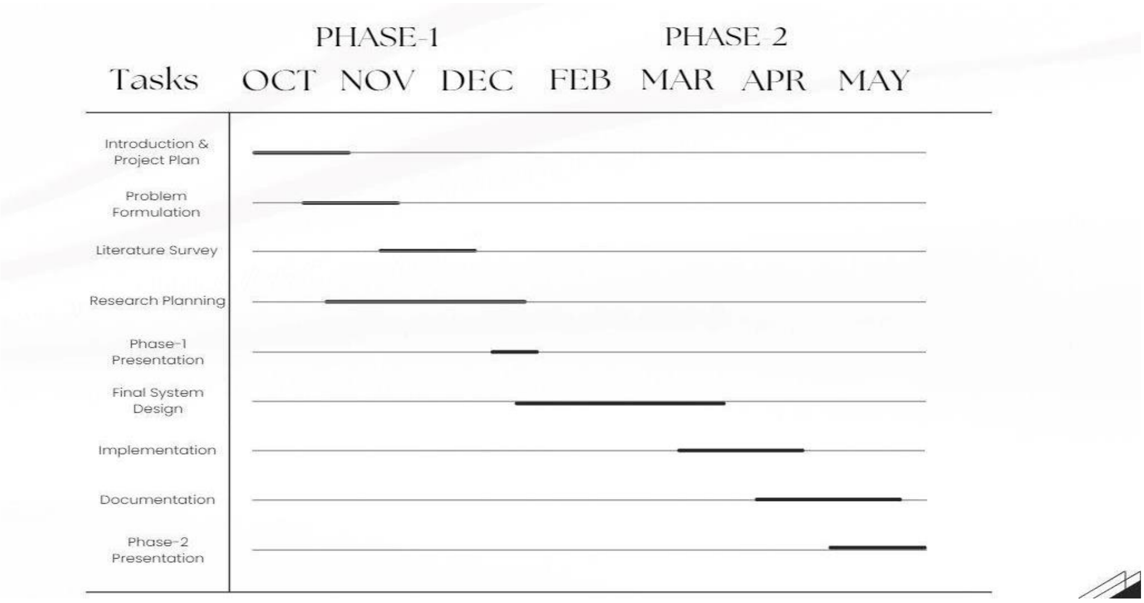

Fig 4.3 Gantt chart

CHAPTER 5

REQUIREMENTS

5.1 Software requirements

- Arduino IDE
- ThingSpeak

5.2 Hardware requirements

- Arduino Nano
- Wifi Module
- Buzzer
- Gas Sensor
- Power Supply
- Pulse Sensor
- Lcd Display
- Water Level Sensor

CHAPTER 6

IMPLEMENTATION

6.1 HARDWARE DESIGN

The Arduino Nano IoT can be powered via USB or an external power source. Connect a USB cable to the board's USB port for power and programming. Alternatively, power can be provided through the Vin pin or the barrel jack, making sure to observe the voltage at 5V. The board also supports SPI (Serial Peripheral Interface) communication, which is commonly used for high-speed communication with devices such as SD cards, displays, or other microcontrollers. The SPI pins on the Nano IoT include MOSI, MISO, and SCK, which you can use to establish SPI communication.
connect sensors to analog pins, such as Float sensor to pin A3, MQ2 Sensor to pin A2 and SPO2 Sensor to A5 and A4.
Buzzer is connected to pin 8. Pin 2,3,4,5,6 and 7 are given to LCD 16X2.
1.To connect the wifi module, pre requirements need to be fulfilled which includes establishing Serial Communication (UART):

- Locate the appropriate pins on the Arduino Nano for serial communication. The Nano has a dedicated UART interface with pins labeled RX (receive) and TX (transmit).
- Connect the TX pin of the Wi-Fi module to the RX pin of the Arduino Nano.
- Connect the RX pin of the Wi-Fi module to the TX pin of the Arduino Nano.
- Connect the ground (GND) pins of both the Wi-Fi module and Arduino Nano together.

Wi-Fi modules require a separate power supply, typically 3.3V. There is need to use a voltage regulator to ensure compatibility with the Arduino Nano, which operates at 5V.

- Connect the Wi-Fi module's power supply (3.3V) to an appropriate power source. Ensure the power supply is compatible with the module's voltage requirements.
- Connect the ground (GND) of the Wi-Fi module to the ground (GND) pin of the Arduino Nano.

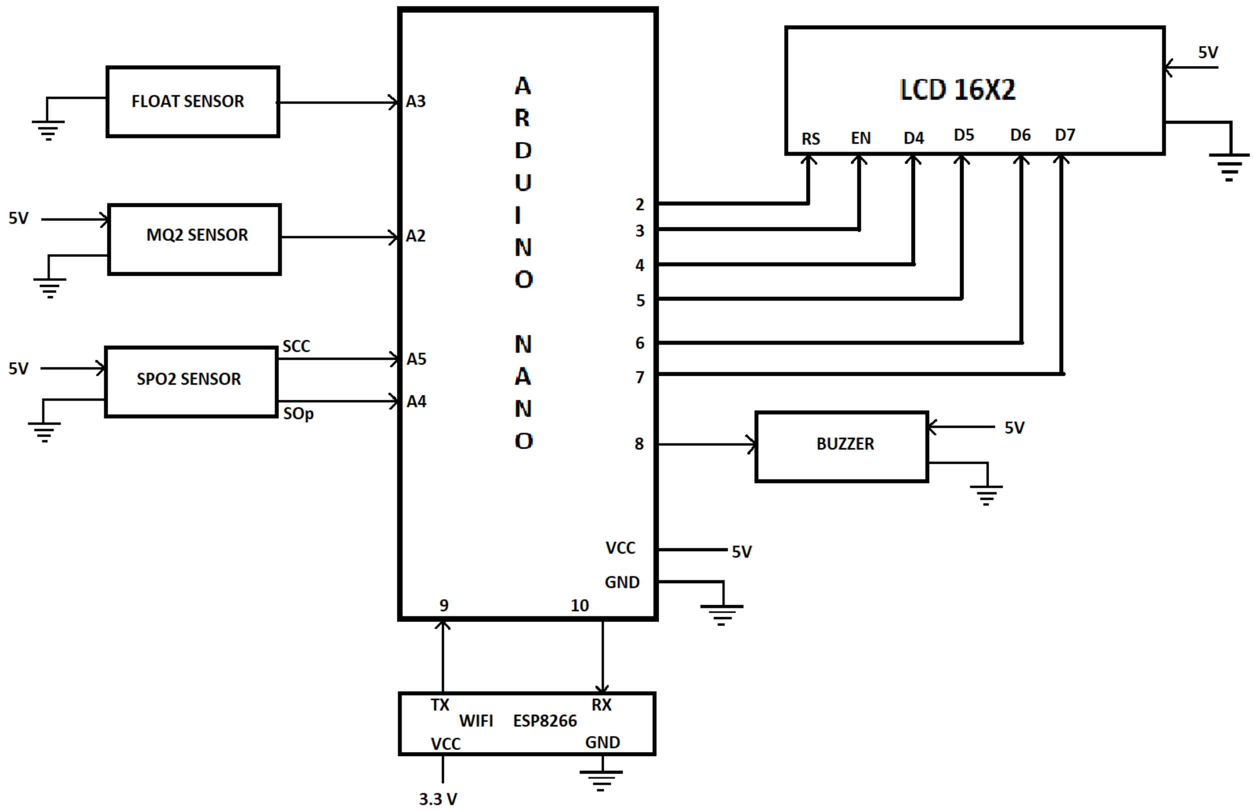

Fig 6.1 Hardware Design

6.2 SOFTWARE IMPLEMENTATION

6.2.1 ARDUINO IDE INSTALLATION

Step 1: Visit the official Arduino website

Go to the Arduino website at https://www.arduino.cc/.

Step 2: Navigate to the "Software" section

Click on the "Software" section on the Arduino website.

Step 3: Download the Arduino IDE

Choose the appropriate version of the Arduino IDE for your operating system (Windows, Mac, or Linux). Click on the download link to start the download.

Step 4: Run the installer

Once the download is complete, locate the installer file you just downloaded. The file extension will vary based on your operating system: .exe for Windows, .dmg for Mac, or .tar.xz for Linux.

Step 5: Install the Arduino IDE
Run the installer file and follow the instructions provided by the installer. Accept the license terms and select the destination folder where you want to install the IDE. Click "Next" or "Install" to proceed with the installation.

Step 6: Driver installation (Windows only)
If you're using an Arduino board that requires a driver (such as Arduino Uno or Mega), you might need to install it separately. During the installation process, you may be prompted to install the necessary drivers. Follow the instructions to complete the driver installation.

Step 7: Launch the Arduino IDE
After the installation is complete, locate the Arduino IDE icon on your desktop or in your applications menu. Double-click the icon to launch the Arduino IDE.

Step 8: Board manager setup
Once the Arduino IDE is open, go to the "Tools" menu and select "Board." From the drop-down menu, choose the type of Arduino board you're using (e.g., Arduino Uno, Arduino Nano, etc.).

Step 9: Port selection
Next, go to the "Tools" menu again and select the appropriate port for your Arduino board. If you're unsure, you can check the port in the "Device Manager" (Windows) or "System Report" (Mac).

6.2.2 ARDUINO IDE SETUP

The bar appearing on the top is called **Menu Bar** that comes with five different options as follow

- **File** – To open a new window for writing the code or open an existing one. The following table shows the number of further subdivisions the file option is categorized into.
- Go to the preference section and check the compilation section, the Output Pane will show the code compilation. Click the upload button.

- And at the end of the compilation, it will show you the hex file it has generated for the recent sketch that will send to the Arduino Board for the specific task you aim to achieve.
- **Edit** – Used for copying and pasting the code
- Arduino Module should be connected to computer by USB cable in order to activate the Serial Monitor.
- Select the baud rate of the Arduino Board using right now. For my Arduino Nano Baud Rate is 9600, and write the following code and click the Serial Monitor, the output will show as the image below.
- The main screen below the Menu bard is known as a simple text editor used for writing the required code.
- The bottom of the main screen is described as an Output Pane that mainly highlights the compilation status of the running code: the memory used by the code, and errors that occurred in the program. Fix those errors before you intend to upload the hex file into your Arduino Module

6.2.3 THINGSPEAK INSTALLATION AND SETUP

To use ThingSpeak, an open IoT platform for data collection and visualization, follow these steps for installation and setup:

Step 1: Sign up for a ThingSpeak account
Go to the ThingSpeak website at https://thingspeak.com/ and click on "Get Started for Free." Sign up for an account by providing the required information.

Step 2: Create a new channel
Once you have logged in to your ThingSpeak account, click on "New Channel" to create a new channel. Provide the necessary details such as channel name, field names, and other optional settings. Click on "Save Channel" to create the channel.

Step 3: Obtain your API Keys
In your newly created channel, navigate to the "API Keys" tab. You will find two API keys: "Read API Key" and "Write API Key." These keys are required to read and write data to your channel programmatically.

Step 4: Install necessary libraries

If you plan to use ThingSpeak with Arduino or other devices, you may need to install specific libraries to enable communication with ThingSpeak. Refer to the documentation or examples provided by ThingSpeak for the appropriate library installation steps for your platform.

Step 5: Connect your device to ThingSpeak

Depending on your device and programming language, you will need to establish a connection to ThingSpeak using the provided API keys. This typically involves making HTTP requests or using specific library functions to send and receive data.

Step 6: Send data to ThingSpeak

Using the appropriate syntax and functions for your device and programming language, send data to ThingSpeak. Ensure that you include the Write API Key in your request or function call to authenticate and associate the data with your channel.

Step 7: Visualize and analyze your data

Once data is successfully sent to ThingSpeak, you can view and analyze it on the ThingSpeak website. You can create plots, charts, and gauges to visualize your data, set up alerts, and perform other data analysis tasks using ThingSpeak's built-in tools and features.

6.3 IMPLEMENTED CODE

```
#include <Wire.h>

#include "MAX30100_PulseOximeter.h

#define REPORTING_PERIOD_MS     1000

PulseOximeter pox;

uint32_t tsLastReport = 0;

#include <LiquidCrystal.h>

//#define DEBUG true
```

```
#include <SoftwareSerial.h>

SoftwareSerial esp8266(9, 10); // RX, TX

#include <SoftwareSerial.h>

SoftwareSerial esp8266(9, 10); // RX, TX

#define DEBUG true

#define IP "184.106.153.149"// thingspeak.com ip

//String Api_key = "GET /update?key=PEOABLKCKCVC30V4"; //change it with your api key like "GET /update?key=Your Api Key"

String Api_key = "GET /update?key=G6UJUAJLLNMVHWGN"; //change it with your api key like "GET /update?key=Your Api Key"

int error;

String stringtemperature;

LiquidCrystal lcd(2, 3, 4, 5, 6, 7);

int val;

int sp = 0;

char c;

int e;

int f;

int e;

int f;

const int buttonPin = A2;
```

```
int buttonState = 0;
const int floatPin = A3;
int floodState = 0;
const int mq2Pin = A0;
int mq2State = 0;
const int buzzerPin = 8;
int buzzerState = 0;
int count = 0;
void setup()
{
  pinMode(buttonPin, INPUT_PULLUP);
  pinMode(floatPin, INPUT_PULLUP);
  pinMode(mq2Pin, INPUT_PULLUP);
  pinMode(buzzerPin, OUTPUT);
  Serial.begin(9600);
  lcd.begin(16, 2);
  lcd.clear();
  lcd.print("SAFETY SYSTEM ");
lcd.setCursor(0, 1);
  lcd.print(" FOR WORKERS ");
buzzerState = HIGH;
```

```
digitalWrite(buzzerPin, buzzerState);
    delay(3000);
    //======================================
    send_command("AT+RST\r\n", 2000, DEBUG); //reset module
    send_command("AT+CWMODE=1\r\n", 1000, DEBUG); //set station mode
    send_command("AT+CWJAP=\"ABC\",\"12345678\"\r\n", 2000, DEBUG);
    //=====================================
    delay(2000);
    if (!pox.begin())
    {
      Serial.println("FAILED");
      for (;;);
    }
    else
    {
      Serial.println("SUCCESS");
    }
    pox.setIRLedCurrent(MAX30100_LED_CURR_7_6MA);
  }
  void loop()
  {
  label1:
        pox.update();
    if (millis() - tsLastReport > REPORTING_PERIOD_MS)
    {
      sp = pox.getSpO2();
   tsLastReport = millis();
  lcd.clear();
```

```
    lcd.print("SPO2:");
    lcd.print(sp);
    lcd.print("%");
    lcd.setCursor(9, 0);
    lcd.print("|H:");
    lcd.print(pox.getHeartRate());
    if (sp > 20)
    {
      Serial.print("SpO2:");
      Serial.print(pox.getSpO2());
      Serial.println("%");
      Serial.print("Pulse:");
      Serial.print(pox.getHeartRate());
      Serial.println("bpm");
      /*
            buttonState = digitalRead(buttonPin);
            if (buttonState == LOW)
            { lcd.clear();
              lcd.print("Sending Data...");
              updatedata();
              setup();
          }
  */
      count++;
      if (count > 20)
      {
        count = 0;
        lcd.clear();
```

```
      lcd.print("Sending Data...");
      updatedata();
      setup();
    }
  }
  //=========checking air quality=================
  mq2State = analogRead(mq2Pin);
  lcd.setCursor(0, 1);
  lcd.print("Air Q:");
  lcd.print(mq2State);
/*   if (mq2State > 250)
  {
   buzzerState = LOW;
   digitalWrite(buzzerPin, buzzerState);
  }
  if (mq2State < 251)
  {
   buzzerState = HIGH;
   digitalWrite(buzzerPin, buzzerState);
  }*/
  //=====================================================
  //=========checking flood=================
  floodState = digitalRead(floatPin);
  lcd.setCursor(9, 1);
  lcd.print("|F:");
  lcd.print(floodState);
  if ((floodState == 1) && (mq2State < 251) )
  {
```

```
      buzzerState = HIGH;
      digitalWrite(buzzerPin, buzzerState);
    }
    if ((floodState == 0) || (mq2State > 250))
    {
      buzzerState = LOW;
      digitalWrite(buzzerPin, buzzerState);
  }
//===========================================================
  }
}
void updatedata() {
  String command = "AT+CIPSTART=\"TCP\",\"";
  command += IP;
  command += "\",80";
  Serial.begin(9600);
  delay(200);
  esp8266.begin(9600);
  delay(200);
  Serial.println(command);
  delay(200);
  esp8266.println(command);
  delay(2000);
  if (esp8266.find("Error")) {
    return;
}
command = Api_key ;
  command += "&field1=";
```

```
  command += String(sp);


command += "&field2=";
command += String(pox.getHeartRate());
command += "&field3=";
command += String(mq2State);
command += "&field4=";
command += String(floodState);
  /*
    command += "&field4=";
    command += String(t4);
    command += "&field5=";
    command += String(t5);
    command += "&field6=";
    command += String(t6);
    command += "&field7=";
    command += String(t7);
    command += "&field8=";
    command += String(t8);
    /*
        command += "&field9=";
        command += String(t9);
        command += "&field10=";
      command += String(t10);
 */
  command += "\r\n\r\n\r\n\r\n\r\n";
  Serial.print("AT+CIPSEND=");
  esp8266.print("AT+CIPSEND=");
```

```
Serial.println(command.length());
esp8266.println(command.length());
if (esp8266.find(">")) {
  delay(200);
  Serial.print(command);
  delay(200);
  esp8266.print(command);
  delay(200);
  delay(5000);
  esp8266.println("AT+RST");
  delay(200);
  esp8266.println("AT");
  delay(200);
  esp8266.println("AT");
  delay(200);
}
/*
  Serial.print("AT+CIPSEND=");
  delay(20);
  esp8266.print("AT+CIPSEND=");
  delay(20);
  Serial.println(command.length());
  delay(200);
  esp8266.println(command.length());
  esp8266.begin(9600);
  delay(200);
  if (esp8266.find(">")) {
   delay(100);
```

```
    Serial.println(command);
    delay(20);
    esp8266.println(command);
    delay(3000);
    esp8266.println("AT");
    delay(200);
   }
  */
  else {
   Serial.println("AT+CIPCLOSE");
   esp8266.println("AT+CIPCLOSE");
   //Resend...
   error = 1;
  }
}
String send_command(String command, const int timeout, boolean debug)
{
  esp8266.begin(9600);
  String response = "";
  esp8266.print(command);
  long int time = millis();
  while ( (time + timeout) > millis())
  {
   while (esp8266.available())
   {
    char c = esp8266.read();
    response += c;
   }
```

```
  }
  if (debug)
  {
    Serial.print(response);
  }
  return response;
}
```

CHAPTER 7

SNAPSHOTS AND RESULTS

7.1 HARDWARE DEMONSTRATION

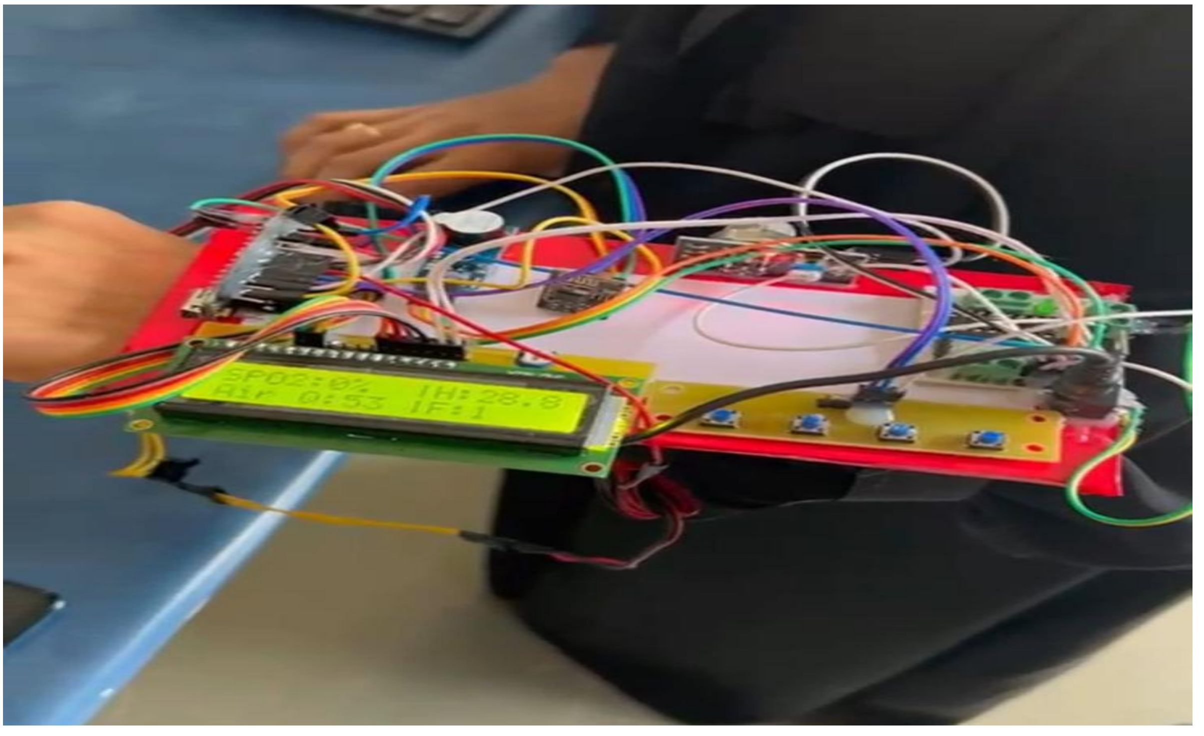

Fig 7.1 Prototype

7.2 UPDATES AT THINKSPEAK

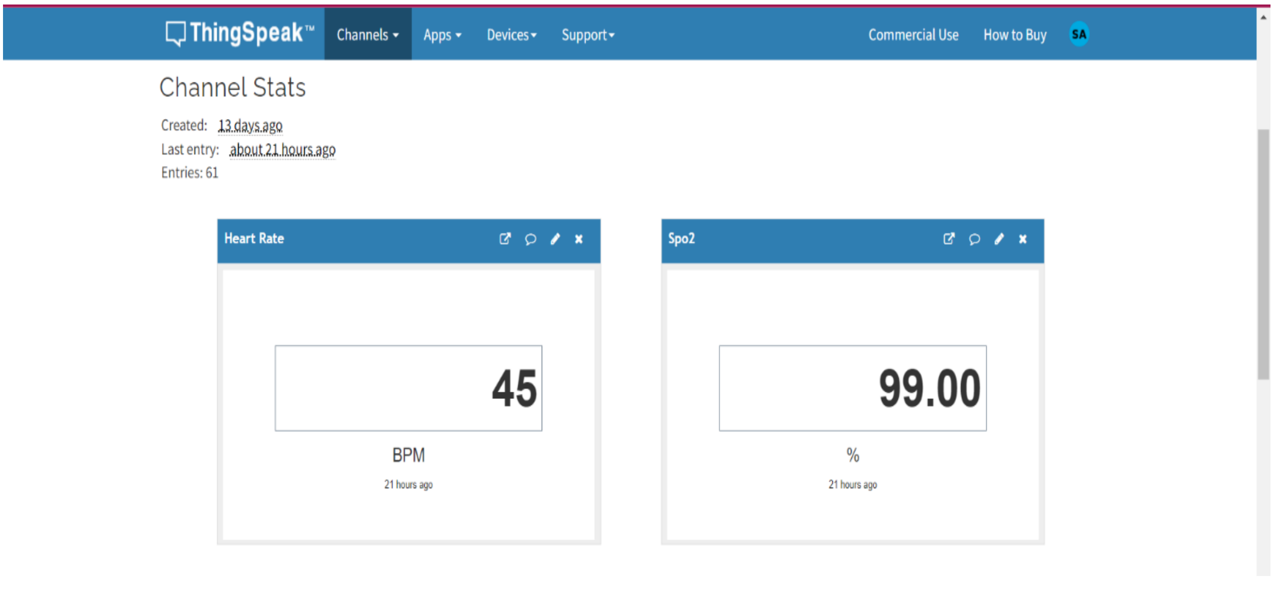

Fig 7.2.1 Heart rate and SPO2 sensor values at updated ThingSpeak

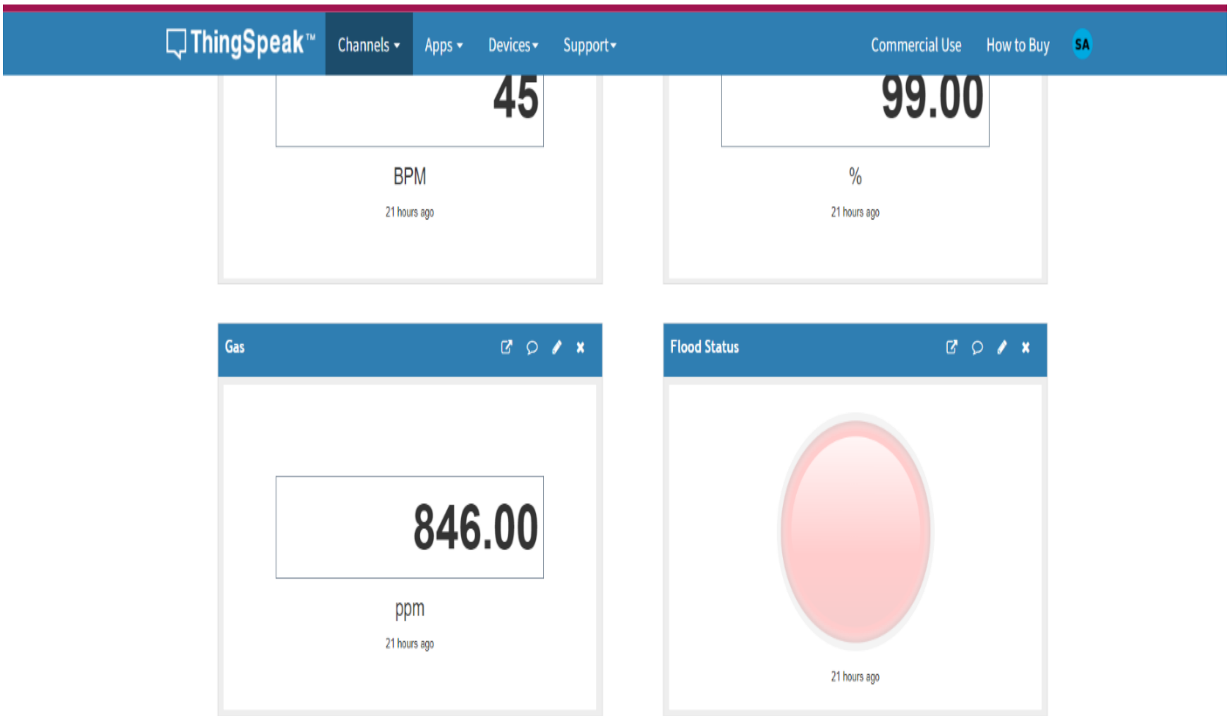

Fig 7.2.2 Gas sensor value and flood status at updated ThingSpeak

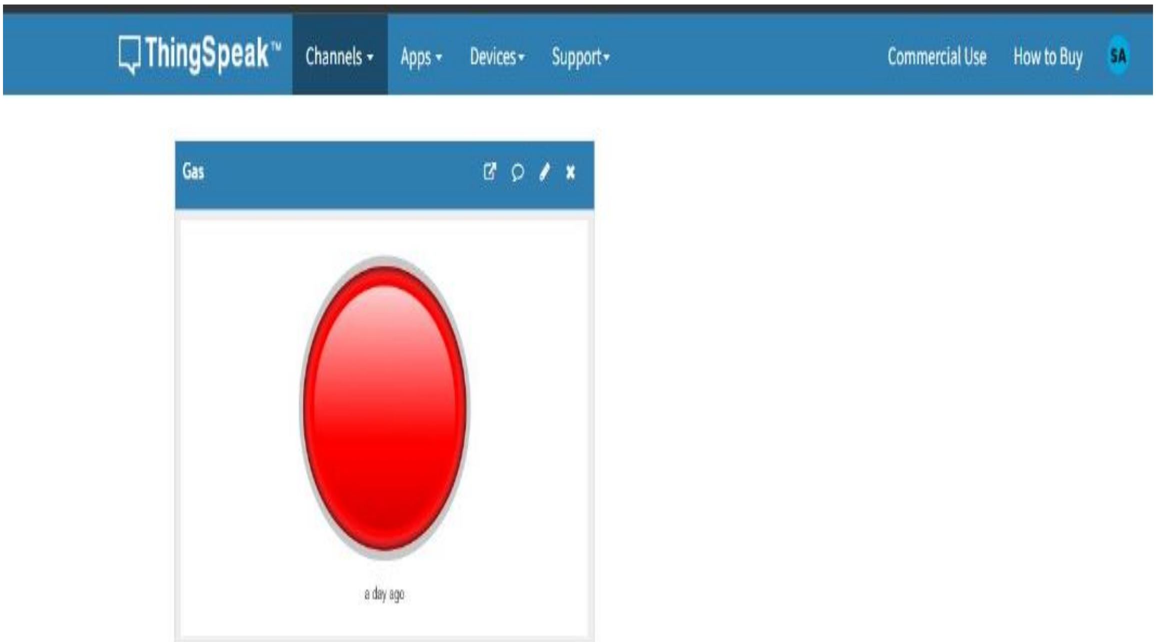

Fig 7.2.3 Gas sensor status at updated ThingSpeak

Fig 7.2.4 Flood status at updated ThingSpeak

CHAPTER 8

FUTURE SCOPE

The future scope of smart safety for sewage workers holds tremendous potential in improving the well-being and protection of these essential workers. With the rapid advancement of technology, innovative solutions can be implemented to address the safety concerns and challenges faced by sewage workers. Smart safety systems could include wearable devices equipped with sensors that monitor air quality, temperature, humidity, and toxic gas levels in real-time. These devices would provide early warnings and alerts to workers, allowing them to take necessary precautions or evacuate hazardous areas promptly. Additionally, smart safety equipment could incorporate augmented reality (AR) or virtual reality (VR) features to enhance worker training and provide them with immersive simulations of different scenarios they might encounter. This technology can help workers develop better situational awareness and improve their response to emergency situations. Furthermore, drones and robotic systems could be utilized for remote inspections and maintenance tasks, reducing the need for direct human contact with potentially harmful environments. Overall, the future of smart safety for sewage workers promises to revolutionize their working conditions, minimize risks, and prioritize their well-being.

CONCLUSION

If inhaled for an extended period of time, sewage gases can be toxic and can cause chronic illnesses and death if high concentrations are released into the body. Sulfur dioxide, hydrogen sulphide (H_2S), methane (CH_4), ammonia (NH_3), carbon dioxide (CO_2), and traces of carbon monoxide are all contained in sewage gases. These toxic gases are particularly dangerous for sanitation workers, and they can even cause death. Therefor to prevent these hazards, an IOT based safety for sewage workers was proposed and designed which monitors toxic gases levels and heart rate of the worker in sewage. If any of the parameters divert from threshold values then an alert is given to worker and also to exterior unit using ThingSpeak before any harm.

REFERENCES

1. Nitin Asthana, Ridhima Bahl. ―IoT Device for Sewage Gas Monitoring and Alert System‖.
2. IOT based smart drainage worker safety system by IJITEE.
3. IOT Device foe sewage Gas Monitoring and Alert System by IEEE.
4. M. Maroti, B. Kusy, G. Simon, and A. Ledeczi, ―The flooding time synchronization protocol, ‖ in Proc. ACM SenSys‘04,Baltimore, MD, November 2019
5. IoT based Sewage Monitoring System by IEEE.