UNIVERSITY of RWANDA

COLLEGE OF SCIENCE AND TECHNOLOGY

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“IoT based septic tank monitoring system”

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College of Science and Technology

African Center of Excellence in Internet of Things

Master of Science in Internet of Things – Embedded Computing Systems

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RESEARCH THESIS TITLE

"IoT based septic tank monitoring system"

By

Name: Joseph TUYISHIMIRE

Reference Number: 220019455

A dissertation submitted in partial fulfillment of the requirements for the degree of Master of Science in Internet of Things with specialization in Embedded Computing Systems at the College of Science and Technology, University of Rwanda.

Supervisor: Assoc. Prof. Charles Kabiri

Co-Supervisor: Dr. Enan M.Nyesheja

Declaration

I, **Joseph TUYISHIMIRE** hereby declare that the project work **“IoT based septic tank monitoring system”** is the record of my work and has never been presented or submitted for any academic award authentic in any University or Institution as a whole or in part except where specifically acknowledged. The contents of this project may be made available for academic purposes in the College of Science and Technology/African Center of Excellence in Internet of Things.

Student Name and Number

Joseph TUYISHIMIRE
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Signature:

Date:06/01/2023

BONAFIDE CERTIFICATE

This is to certify that the Project work entitled **"IoT based septic tank monitoring system"** is a record of the original work done in partial fulfillment of the requirements for the degree of Master of Science in the Internet of Things-Embedded computing system at the African Center of Excellence in IoT (ACEIoT)-College of Science and Technology (CST) at the University of Rwanda (UR).

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Acknowledgments

First and foremost, I want to express my gratitude to the Almighty God for the gift of life and the ability to complete this task. I want to convey my heartfelt gratitude to my supervisors, **Assoc. Prof. Charles Kabiri** and **Dr. Enan M. Nyesheja**, for their excellent supervision and guidance in the completion of this study, from which I benefitted so much. I would also like to thank the African Center of Excellence in the Internet of Things of the College of Science and Technology at the University of Rwanda. Lastly, I extend my gratitude to my family members, who made significant sacrifices in order to get everything I needed for a quality education.

May the Almighty God bless you all!

Abstract

Air pollution consists of a mixture of solid particles and gases in the air. Gases from septic tanks, car emissions, and chemicals from factories, dust, pollen, and mold spores may be suspended as particles. The effect of air pollution has many bad things, and some of them may cause problems for our health, such as asthma, cough, and lung disorders. In addition, the pollutant can cause global warming, acid rain, and disturbing plant growth. Basically, a human being cannot determine whether the air is good or not. Hence, it is necessary to have a tool that can measure the air quality. We aimed at designing an IoT-based septic tank monitoring system. The septic tank will be interfaced with a DHT22 sensor, MQ7, MQ135, and ultrasonic sensor to monitor and collect data that will be sent to the Atmeg328p microcontroller for processing purposes. Our aim is to enable users to monitor the level of hydrogen sulfide and Carbon Monoxide which is higher than 100 PPM. The system will send alert message to authorized users to make them know that the hydrogen sulfide and Carbon Monoxide has become harmful. The system will make it possible to pump the neutralizer in the septic tank until the hydrogen sulfide gas reaches the level which is less than 100 PPM. The system will enable the users to monitor the status of septic tank so that when it is greater than 80% of the human waste, an alert is provided to the authorized users informing them that the is about to be full. The last phase of the system will consist of measuring the level of the neutralizer, to ensure that when it is less than 20% of neutralizer, the system will send an alert message to authorized users informing them that the neutralizer is about to be finished. All the monitored data will be sent to the platform using GSM.

Keywords: *Septic tank, Gas sensor, IoT, GSM, Atmeg328p*

List of Acronyms

ACEIoT: African Centre of Excellence in the Internet of Things

API: Application Programming Interface

CO: Carbon Monoxide

DHT: Digital Humidity and Temperature

GSM: Global System for Mobile Communication

GUI: Graphical User Interface

H2S: Hydrogen sulfide

IDE: Integrated Development Environment

IoT: Internet of Things

LED: Light Emitting Diode

MCU: Microcontroller Unit

PPM: Parts per Million

SMS: Simple Message System/ Short Message

USB: Universal Serial Bus

WSN: Wireless Sensor Network

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1. CHAPTER ONE: GENERAL INTRODUCTION

1.1 Overview and Background

In recent years, gases from septic tanks, car emissions, chemicals from factories, smoke, and dust are everywhere. As a result, the air is now extremely polluted. The effect of air pollution is very for harmful to our health, especially in parts of our body which play a role in breathing. Some diseases, such as asthma, coughing, and lung disorders, can be caused by bacteria in our lungs [1]. Human beings are incapable of detecting air pollution. The air pollution may contain a lot of dangerous substances, such as LPG gas, smoke, carbon monoxide, and hydrogen sulfide [2]. Substances in the polluted air are very dangerous. For example, if the hydrogen sulfide is above 100 ppm, [3] it makes humans feel dizzy, nauseous, and within minutes they can even die. This research aims at making human beings be able to find out the level of hydrogen contained in septic tanks. With Arduino Atmeg328p module, we can remotely monitor the air pollution, the status of the septic tank and the status of the neutralizer tank. To detect Gas Leakage using MQ7 and MQ135 Sensor. The SMS based alert system is set up by using GSM Module which sends alert messages to authorized users. Once the gas leakage is detected, a sound alarm is produced and automatically the gas leak is controlled. In case of the hydrogen sulfide gaze is over 100 ppm, [1] the pump starts pumping the neutralizer. The user can remotely determine the status of the septic tank by sending alert messages to user. An electronic design that is used to detect the leakage of hydrogen gas in a closed environment. Gas sensor detects the leakage of the gas. GSM Module sends the alert SMS to the authorized users. The buzzer is also activated when the hydrogen sulfide gas leakage is detected and the gas neutralizer is started as it is connected to a water pump.

1.2 Problem statement

Rwanda is the most densely populated country in Africa, with a population of about 13 million people occupying an area of 24,670 square kilometers. There is not enough distance for septic tank disposal and as a result, there is a negative effect on the air that we breathe at home and in public places like in schools and particularly in hospitals, where too much attention is commonly required for patients. Commonly, several negative effects on a human being result from the mistreatment of septic systems that can generate toxic gases like Hydrogen sulfide [3]which exert regulatory effects on the pathogenesis of various cardiovascular diseases like hypertension, shock, pulmonary hypertension, and myocardial injury [4].

A smart environment is the vision of the current community, yet there is no way to know the status of gases that surround a human being and no warning solution to neutralize that dangerous gases generated from septic tanks that we have in our homes, hospitals, and schools. Therefore, the hydrogen sulfide gas, the status of septic tank and the status of the neutralizer tank can be monitored every time.

1.3 Objectives of the research

General objective

The main objective of this research is to design and implement an IoT based septic tank monitoring system that will monitor the level of septic tank, the level of hydrogen sulfide gas in septic tank and reduce the concentration of hydrogen sulfide gases

Specific objectives

To achieve our general objective, the following specific objectives will be considered:

1. To monitor the level of septic tank using Ultrasonic sensor.
2. To monitor the level of hydrogen sulfide gazes and Carbon Monoxide in septic tank using Mq7, Mq135 sensors.
3. To neutralize concentration of hydrogen sulfide and Carbon Monoxide gases in septic tank using the neutralizer.
4. To monitor the level of neutralizer tank using Ultrasonic sensor.

1.4 Hypotheses of the research

In this study, the two primary null hypotheses are taken into account when evaluating the suggested techniques which are:

1. The use of the internet of things in septic tank.
2. IoT Based septic tank monitoring system will come up to solve the challenges of not getting information in due time about the septic tank. This prototype will be used to facilitate users to take measures according to the real-time information from the septic tank. This research will also help measure the hydrogen sulfide produced from septic tank and neutralize them. As a result, good health and well-being, a clean septic tank, and a clean environment are all important. Sustainable cities and communities and climate action will be achieved.

1.5 Scope of the research

This study will concentrate on toxic gas detection, temperature, and tank level in septic tank storage. and notify the authorized users. The research will be limited to the improvement of septic tank management by detecting the presence of hydrogen sulfide monitoring the temperature, and evaluating the efficacy. The tank level refers to the highlighted threshold values. Within the implementation of a prototype, the solution will eliminate the gaps existing in the literature during the detection of hydrogen sulfide neutralize them, and raise the level of the tank.

1.6 Benefits of the research

The thesis aims to design and implement an IoT-based septic tank monitoring system solution that will monitor the level of septic tank, the level of gases in septic tank and reduce their concentration. The project will help to achieve the implementation of real system and solve the faced problem caused by hydrogen sulfide from septic tank and enables the septic tank to contribute to the achievement of Sustainable Development Goals (SDGs) related to the environment and the well-being of the local community. This concept can be improved in future to offer a cleaner environment and a better quality of life for people who live nearby.

1.7 Significance of the Study

The research, is expected that the prototype system will be used to monitor the level of hydrogen sulfide the status of septic tank and neutralize them. Therefore, it will make possible the implementation of IoT based septic tank monitoring system which in turn will have a positive impact to the community safety in different areas:

1. Contribution to the attainment of sustainable development goals related to the environment and well-being of people such as SDGs, Goal 3: Good Health and Well-being and Goal 13: climate Action
2. Helping the authorized users to get real time information about gases and the level of septic tanks
3. Improving hygienic conditions for better well-being near septic tanks
4. Helping public toilet owners to protect their customers from hazardous and poisonous gases

1.8 Organization of the research report

This thesis is organized into six chapters as follows:

Chapter one: General introduction

The general introduction explains the context of the study, problem statement, goals, scope, significance, and project interests as well as how the study was organized.

Chapter two: **Literature review**

The researches related to an IoT-based septic tank monitoring system are discussed in this chapter.

Chapter three Research methodology

This chapter thoroughly explains the researcher's recommended methodology.

Chapter four: **System design and analysis**

This chapter demonstrates the prototype, associated data dashboard, and sensor installation.

Chapter five: **Results and analysis**

The prototype results are displayed in this chapter.

Chapter six: Conclusion and recommendation

The study findings and suggestions for future researchers are provided in this chapter.

2. CHAPTER TWO: LITERATURE REVIEW

2.1 Introduction

This chapter examines comparable works, points out their shortcomings, and offers contributions to their addition for effective IoT-based septic tank monitoring. An outline of the history of this scientific field is covered in this chapter. This chapter presents related work. Also mentioned are similarities and differences between conference proceedings and journal articles. Our scientific contributions are noted, along with some of the variables, tools, and materials that some earlier researchers did not take into account.

2.2 Review of related works

Iot Base toxic gas monitoring and controlling in septic tank developed by Dr.G Ranjitham and his team by capturing hydrogen sulfide carborn Monoxide and methane continuously from sensors data were analyzed graphically in Thingspeek platform and notification part was working as long as toxic gases goes beyond the limit .moreover the system automatically pumps out the gas and desulfurizes the toxic gases, but they didn't focus on measuring the remaining desulfurizer (neutralizer) in its container, which can be used as a savoir of human beings from toxic gases [5].

To measure and analyze the real-time level of toxic gases. The main thing that was done in order to ensure the safety of the workers working under severe conditions of septic tanks by using IOT technology was to alert the user when the level of gases exceeds the threshold, as was the aim of Anyushka Pendharkar and his professional team of researchers. The gap was that they did not cover the reduction of toxic gases inside their working area. [6][7]

Detection, Monitoring and Control of Toxic Gas using Iot [7] developed by Ms. K. Shanthi1, L. Manoj2 One of the most hazardous issues in the industries is the detection and control of toxic gas on the field.This study's goal is to identify the leaking of hazardous gas and take action to stop the leak by being proactive. Gas leakage is considered the input. The alert system, exhaust fan, and solenoid valve receive the output after additional processing of this input. The MQ-7 gas sensor is the input sensor used to find the gas leak. the system receives the analog input from the sensor as a digital input. Then, it is contrasted with the Lab state, environment, and the desired result is produced. The gas leakage is controlled by this control signal, which is delivered to the output.

IoT based Air Quality Monitoring [8] developed Dr. Setiabudhi a combination of gases and solid particles in the air cause air pollution. Automobile emissions, industrial pollutants, dust, pollen, and mold spores might all be suspended as particles. The negative effects of air pollution are numerous, and some of them may have an adverse effect on our health, such as lung illnesses, asthma, and coughing. Additionally, the pollutant can lead to acid rain, global warming, and disturbed plant growth. Essentially, a person.

Monitoring and controlling toxic gas in septic tank system using IoT developed by Anandhi , D.Citharthan M.Varatharaj in that paper a unique solution was given for common septic tank problem which are occurring in India by monitoring the toxic gases in septic tank and process it in FRED(Cloud based Node Red to build and deploy IoT application) In septic tank system density of toxic gases such as hydrogen sulfide are continuously monitored by the gas sensors and analyzed graphical form in FRED if the gases are going beyond permissible exposure limit then the controller will send alert to user moreover the system will automatically add salt and bleaching powder to septic tank by decreasing the density of toxic gases. The gas in that paper was that they did focus on measuring the remaining salt and bleaching powder for decreasing the density of toxic gases which can be used as a savoir of human being from toxic gases. [9].

IoT based Sewage Monitoring Alert System using Raspberry PI developed by Jyothi chillapalli and Yogesh Jadhav the goal of that project was to provide a technique to measure the harmful release of gaseous materials into the drainage system and thereby give the authorities a waring message to save the lives of the sewer workforce Moreover The gap was that they did not cover the reduction of toxic gases inside their working area [11].

The level of hazardous gases from septic tanks that are released into the environment has been tracked using the current techniques. The sensor system's intelligence is utilized to pinpoint the obstruction in the drainage system and provide details and other information. The current system is capable of detecting a variety of gases, including methane, carbon monoxide, sulfur dioxide, and others. The device uses an alarm system to send out a warning when the level of gas surpasses the threshold value, allowing the health department to respond appropriately. The Wireless Sensor Networking (WSN) technology is used to create the module, and each node will carry both its own data and the data of nearby nodes. The complete data packet will be collected, stored, and retrieved in real time on the cloud for the purpose of ongoing monitoring.

2.3 Proposed system

Harmful gas leaks that mostly rely on chemicals. By utilizing the Internet of Things and the most recent information technology advances, gas leaks can be quickly found and analyzed. A DHT22 sensor, MQ7, MQ135, and ultrasonic sensor are all connected to the Arduino Atmeg328p board, which serves as the system's main microcontroller. Gas will keep an eye on the corresponding environmental conditions. Through the Arduino IDE software, the Arduino translates analog values into digital values and the device executes a set of instructions. If the amount of the gases rises above the normal level, an alarm is immediately generated and signaled through the internet-specific receiver portion [8].and the pump will be started to pump neutralizer into the septic tank when the level of the tank is nearly full [4]. then, text messages are sent to approved individuals with updates on the septic tank's condition and gas levels. Data collected by sensors is kept in the cloud where it can be processed further and evaluated to enhance safety rules. This concept can be improved in the future to offer a cleaner environment and a better quality of life for those who live nearby.

3. CHAPTER THREE: METHODOLOGY

3.1 Introduction

This chapter describes the overall hardware and software designs of our suggested solution. The methodological approaches identified cover both physical designs, which reflect the choice and design of hardware components, and logical designs, which also reflect the choice and design of software components.

3.2 Research and design approach

Figure 3.1 shows the process flow of hydrogen sulfide leakage detection, monitoring, and control system. As the process begins, the first action sensor value is read. Then, if the read sensor value is less than the sensing value, the next process begins, if the value is greater than the threshold value, the sensing value is sent to the next stage action. Otherwise, the next step is to read the sensor value again without performing any action; and if the sensor value exceeds the threshold value, the next process begins. The alarm and pump systems are then activated. The alarm system includes features such as sound notification, light notification, and the display of the alert message. The pump system sends neutralizer into septic tank while continuously comparing the sensor value to the given condition and the threshold value and operating according to their conditions. Either the sensing value is less than the threshold value, or it does not satisfy the condition that the alarm and pump systems do not respond or do not initiate the process. The sensor value is then continuously read and checked to see if the condition is satisfied or not.

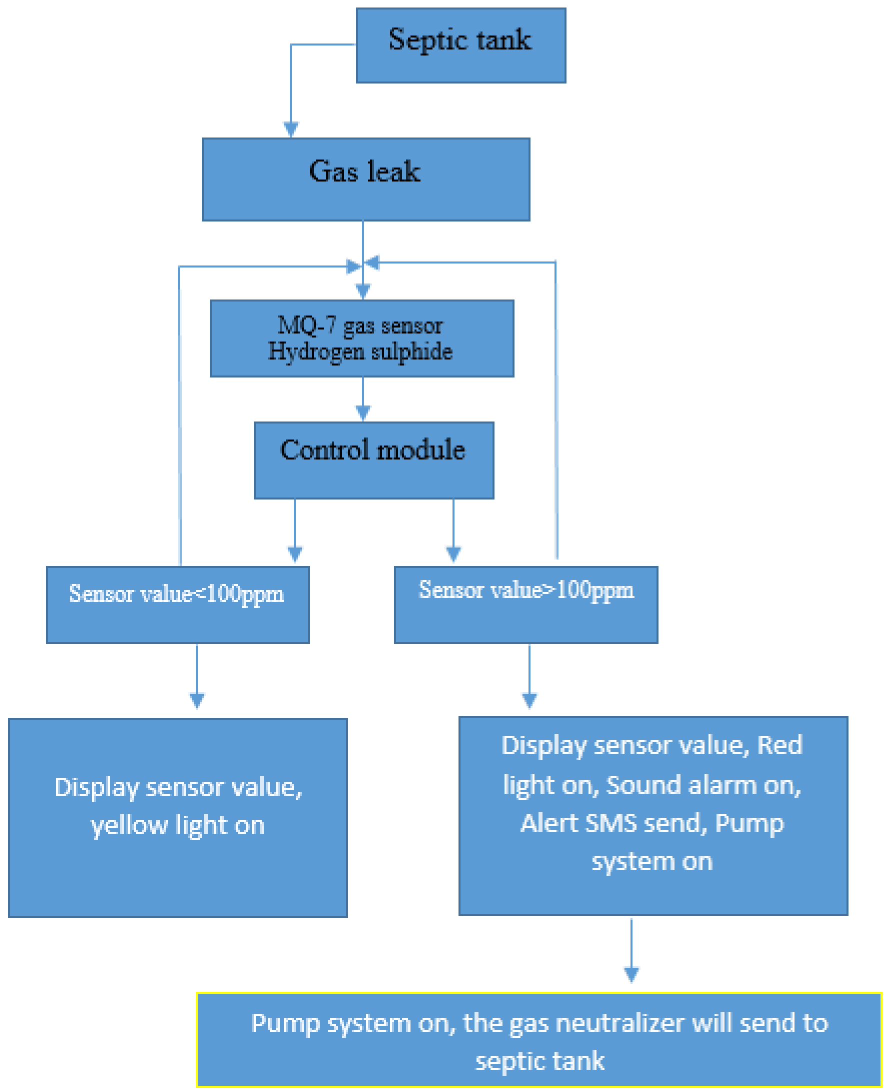


Figure 3. 1 : Process flow of hydrogen sulfide leakage detection, monitoring

The MQ-7 and MQ 135 sensor is used in this method to detect hydrogen sulfide. [4] [9] When the process begins, the sensor's value is read as the first step. The MQ-7 gas sensor's sensitive material is SnO2, which has lower conductivity in clean air. It discovers by strategy for high and low-temperature cycles and distinguishes hydrogen sulfide [4]when low temperature (warmed by 1.5V). Along with the gas, the conductivity of the sensor increases. It cleans various gases adsorbed under low temperature at the point when the high temperature (warmed by 5.0V) is reached. The MQ-7 sensor value is fed into the DAQ as analog data. With the help of DAQ, analog data sends information to the microcontroller, which then initiates the next step in the process. Compare the system's given levels, which are safe, and dangerous. It then compares the available value to the system to determine whether the given conditions are met. The DAQ sends the value of MQ-7 and MQ-135 to the microcontroller, which then sends the system signal to the output devices to run. The microcontroller output signal has a 5V DC microcontroller The relay switch and the alarm system are powered by 5V DC. 12V DC power is supplied to the water pump. When the sensor value is less than 100 PPM, the condition is safe. The green light illuminates as if it were present, while the sensor value is still being read, and the system compares whether the sensor value is less than 100 PPM [1] or greater than 100 PPM. At the same time that the yellow light flashes. If this level exceeds 100 PPM [1], the water pump will send the gas neutralizer in septic tank. It continues with the process of comparing the statements that are followed by the values sent to the microcontroller.

Figure 3.2 shows the process flow of septic tank status monitoring, and control system.

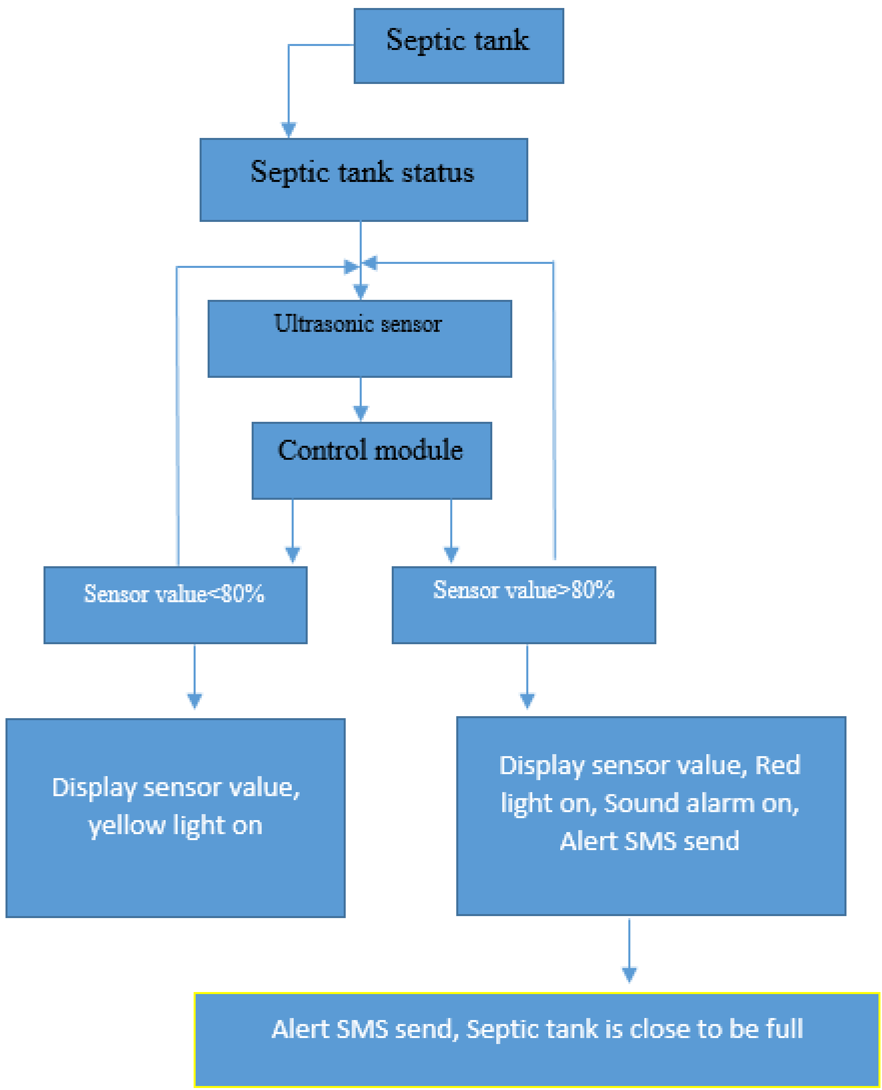


Figure 3. 2 : Process flow of septic tank status monitoring

The ultrasonic sensor is used in this method to measure the level of the septic tank. When the process begins, the sensor's value is read as the first step. Ultrasonic emitting sound waves at a frequency too high for humans to hear into a septic tank, and then wait for the sound to be reflected back, ultrasonic calculate the distance it takes a sound wave to return after hitting an object. The ultrasonic sends values to the microcontroller, which then initiates the next step in the process. Compare the given levels of the system, whether the given condition is met. When the sensor value is less than 80% for septic tank occupation, the condition is safe. The green light illuminates as if it were present, and while the sensor value is still being read, if the sensor value is greater than 80%. the microcontroller using GSM will send an alert notification that the level of the septic tank is going to be full.

3.3 Scientific research approach

In this research, we have used qualitative research including observation of the existing system septic tank monitoring, and document consultancy by reading journals and papers. The goal was to investigate the existing system and to find its merits and weaknesses to find a way of improving it by applying technology.

3.4 System Development

During the development of this system, the model called the "Modified Waterfall Model" was adopted. The MWF model is a derivative of the traditional waterfall model but with some minor variations related to iterations between certain stages. The whole process of software development is divided into separate phases which are cascaded to each other [20]. Those include the system requirements, software requirements, analysis, system design, and implementation code, testing the system, system deployment and maintenance.

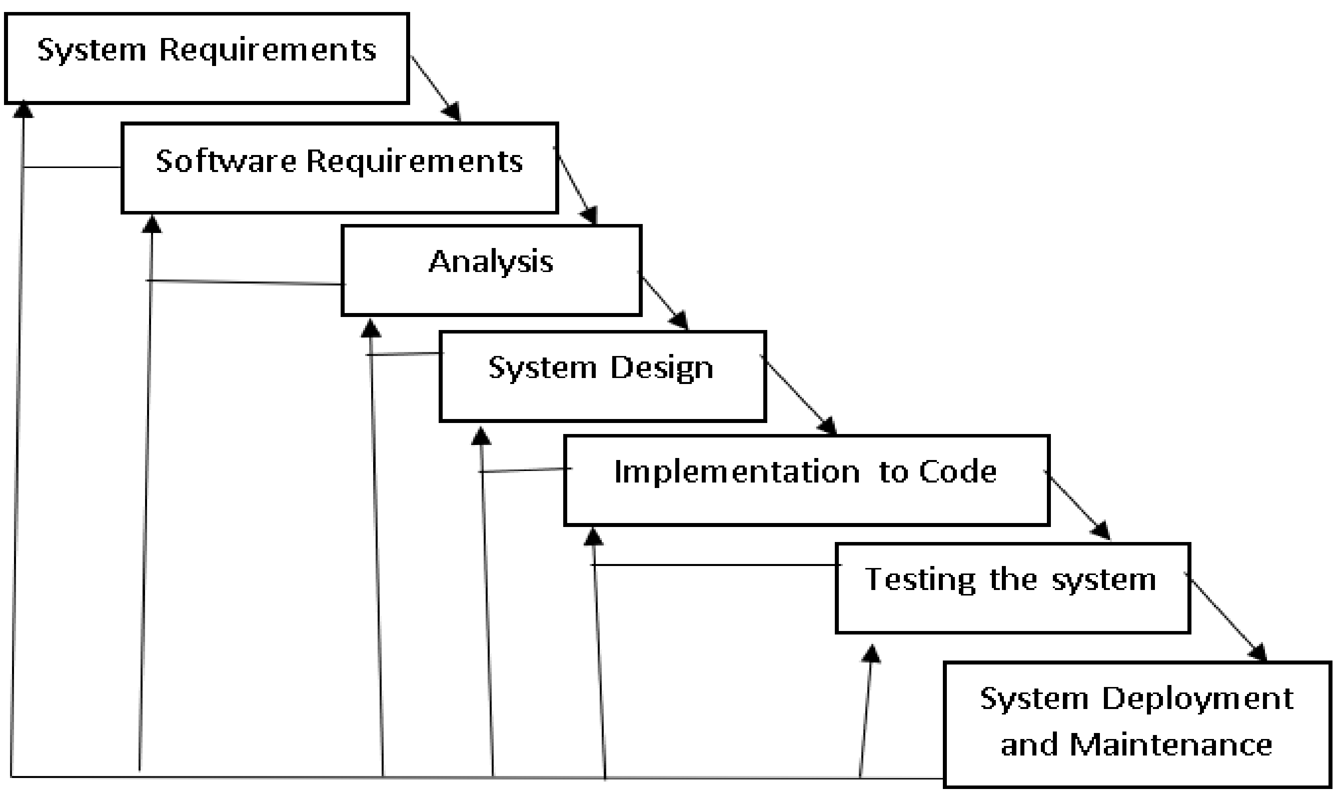


Figure 3. 3 : Modified Waterfall Model

Requirements in this phase, data were collected by observation; internet search and then information obtained was analyzed to help system design by designing how the system will work. The next step is implementation code where coding is the main objective. It is concerned with coding and testing sub-components of the system referring to the system design from the system requirements of previous phases to make this system. In the testing system, the system was tested for confirmation with the system requirements by seeing that the results obtained are those the system aimed, the project has started with a unit test first, where every single activity was tested and then tested all activities as a single unit. the final step is the system deployment and maintenance where the system must be deployed to different locations to detect the leakage once the leakage in the septic tank happens must be maintained directly.

4. CHAPTER FOUR: SYSTEM DESIGN AND ANALYSIS

This chapter explains the suggested system architecture where the aforementioned problem's solution was discovered. Initially, a system that employs an ATMEGA328P controller and is powered by a solar panel with a backup battery. toxic gas values are sensed using gas sensors MQ7, [1] and MQ135, [1] and the data are sent to the microcontroller using and uploaded to the cloud storage every 15 seconds using a GSM module. the data is shown on an LCD, and when the gas's poisonous level exceeds the limit, a message is sent to the cloud-connected devices, and the automatic regulating system that we installed reacts immediately, lowering the toxic level. A pump connected to the controller through a relay circuit and a chemical chamber for the neutralization process to remove hydrogen are included in the automatic controlling approach. When the gas level exceeds 100 ppm, [10] the automated regulating mechanism kicks in and minimizes the harmful level.

4.1 Components of the proposed system

4.1.1 Logical components

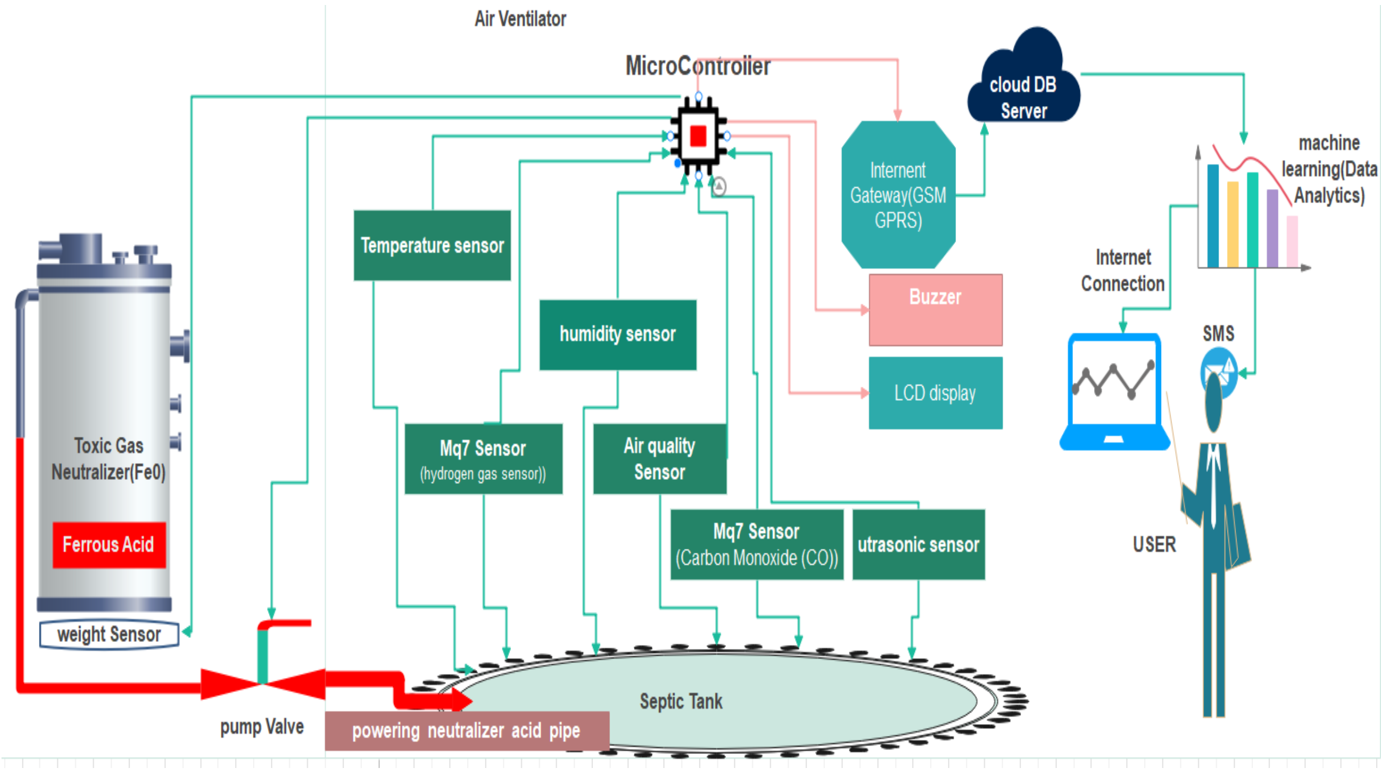


Figure 4. 1: logical component diagram

The figure above describes architecture design of new proposed system which show how all sensors, display, pump and buzzer will be connected to gather to collect real time data, we are describing how data will be transferred to cloud server using GSM (GRPS) service and machine learning algorithms will be applied for data analytics process

B. Flowcharts Design of the proposed system

We proposed a system that employs an ATMEGA328P controller and is powered by a solar panel with a backup battery. Toxic gas values are sensed using gas sensors, MQ7, and MQ135, and the data are sent to the microcontroller using and uploaded to the cloud storage every 15 seconds using a GSM module. The data is shown on an LCD, and when the gas's poisonous level exceeds the limit, a message is sent to the cloud-connected devices, and the automatic regulating system that we installed reacts immediately, lowering the toxic level. A pump connected to the controller through a relay circuit and a chemical chamber for the neutralization process to remove hydrogen is included in the automatic controlling approach. When the gas level exceeds 100 ppm, the automated regulating mechanism kicks in and minimizes the harmful level.

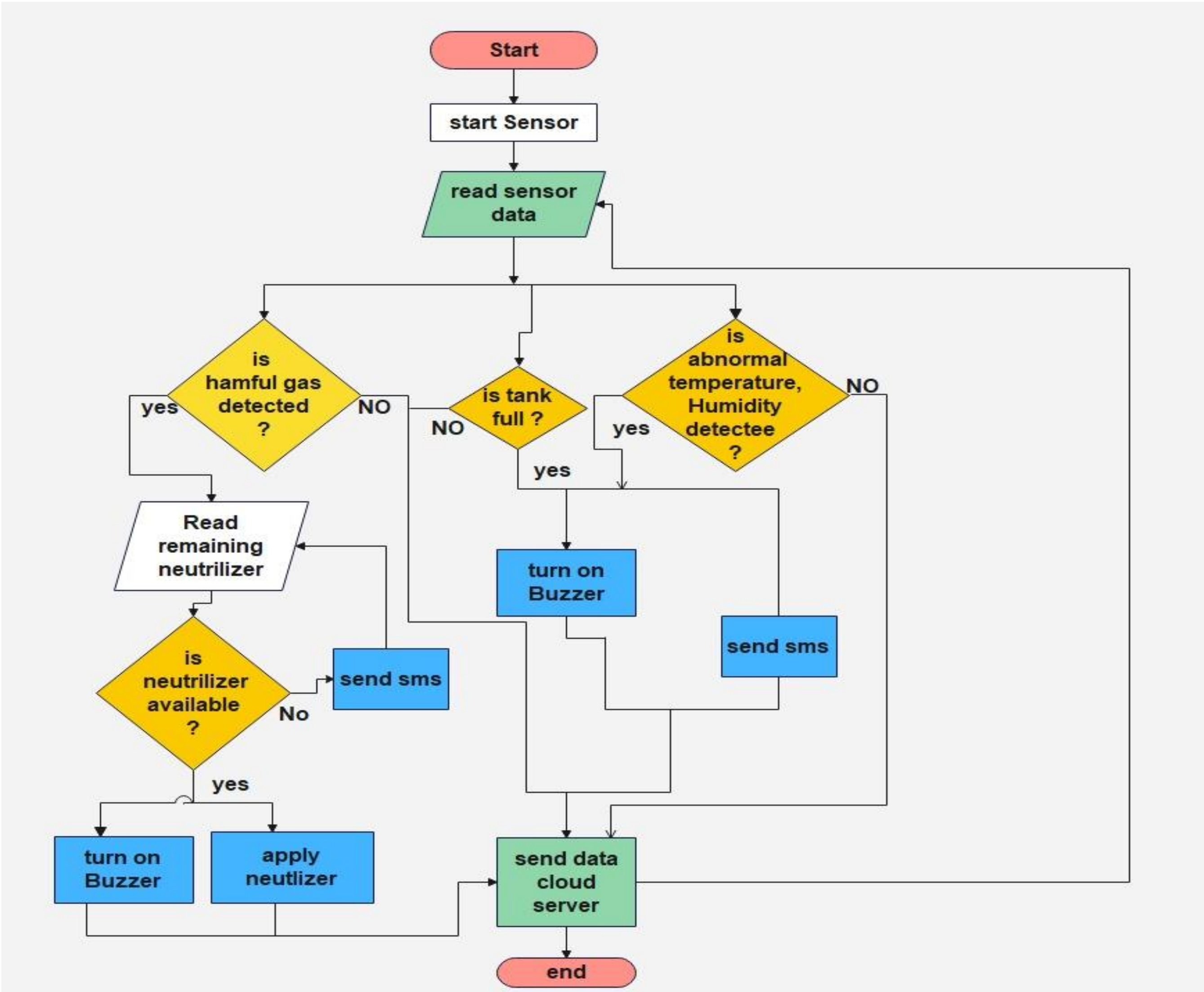


Figure 4. 2: IoT based septic tank monitoring system flowchart

4.1.2 Physical components

The proposed system's design is based on Figure 12, which has three primary sides: a detecting side, a regulating side, and an actuating side. The temperature and humidity sensors for the sewage tanks, a MQ7 sensor for monitoring carbon monoxide, and an ultrasonic sensor for measuring the level of the septic tank make up the sensing side. The actuation module is built of one 12V DC water pump and one relay so that it may be controlled by a Microchip ATMEGA328P, which is utilized in ARDUINO boards and a cloud platform for data analytics

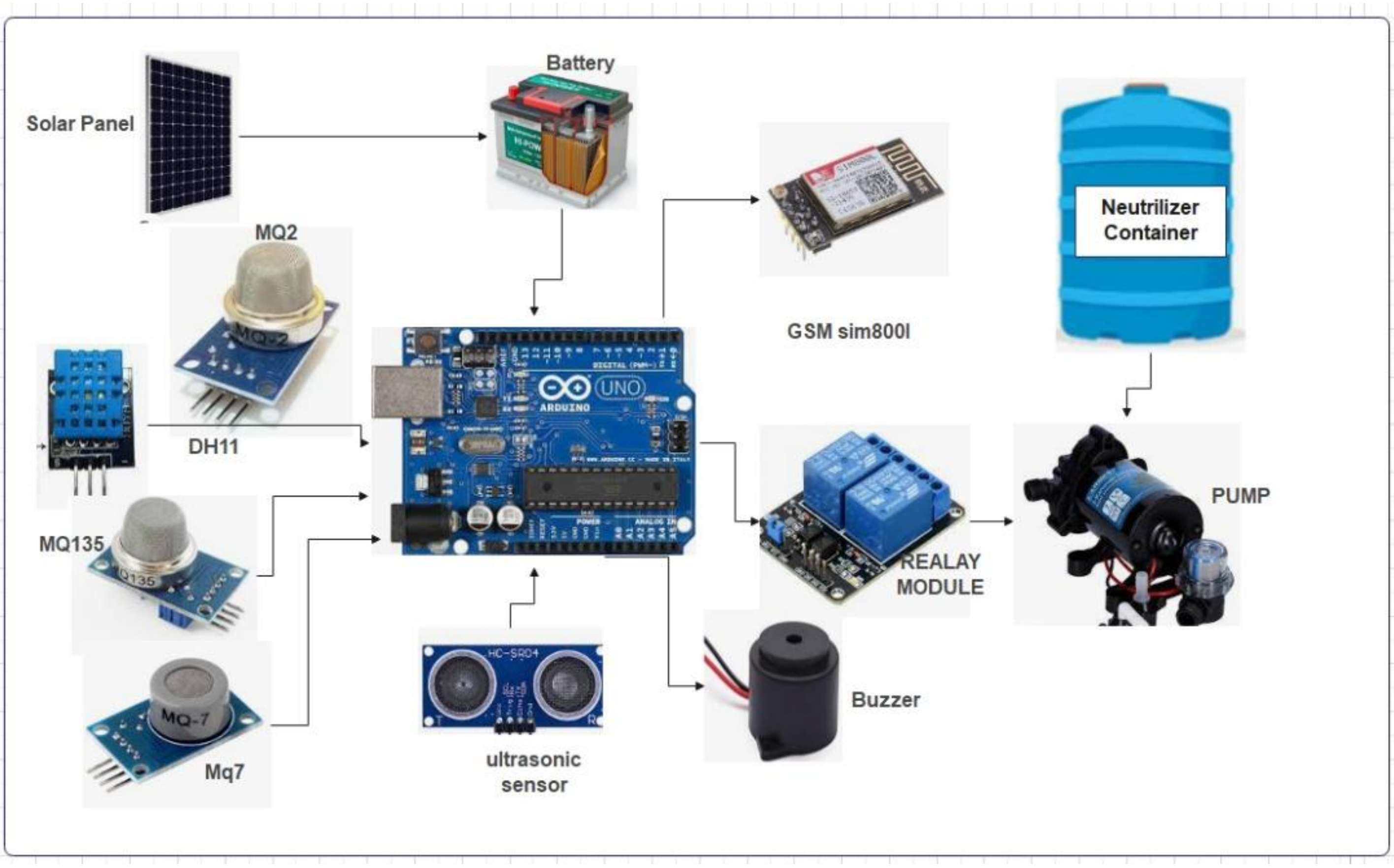


Figure 4. 3: Physical components of IoT based septic tank monitoring system

4.2 Hardware components selection

Components	Functions
MICROCONTROLLER	Microchip's ATMEGA328P is a high-performance, low-power controller. ATMEGA328P is an AVR RISC microprocessor with an 8-bit resolution. because it is used in ARDUINO boards, it is the most popular of all AVR controllers. **Specifications and features of the ATmega328P:** Voltage Range: 1.8 to 5.5V Cycles of Writing/Erasing: 10,000 Flash/100,000 EEPROM Retention of data: 20 years at 85°C and 100 years at 25°C Independent Lock Bits in the Optional Boot Code Section On-chip Boot Program 6-channel 10-bit ADC Programmable Serial USART Master/Slave SPI Serial Interface for In-System Programming

DHT11 SENSOR	Sensor Data Output, Ground, and VCC are the three pins on the DHT11 digital Humidity and Temperature Sensor. To detect the ambient air and provide a digital output on the data pin, a capacitive humidity sensor and a thermistor are employed. the sensor data is read using the ad fruit Library. **Dimensions of the DHT11 Sensor:** Accuracy of temperature measurement: 2.0 Digital Output Temperature Range: 0 to 50o C Range of Humidity: 20 to 90% RH Accuracy of Humidity: 5% RH Supply voltage: 3.3 to 5V Dimensions: 2.3 x 1.2 x 0.5 cm
MQ-7 SENSOR	-This is a Carbon Monoxide (CO) sensor that is simple to use and effective in detecting carbon particles gas radiation that is visible all around. The detection range of this MQ-7 sensor for carbon particles gas radiation is 20 to 2000 PPM. This sensor has a strong affectability and a fast response time**.** **-Features & Specifications of the MQ2 Gas Sensor** +5V is the operating voltage. 0V to 5V for the analog output voltage 0V or 5V as the digital output voltage (TTL Logic) reheating time of 20 seconds Suitable for use as either a digital or analog sensor The potentiometer can be used to change the digital pin's sensitivity.
	-MQ135 Sensor SnO2 has a reduced conductivity in clean air, which is

MQ135 SENSOR	employed as the gas detecting material by MQ135 gas sensor. The conductivity of this gas sensor rises as the amount of harmful gas in the atmosphere rises. MQ-135 is extremely good in detecting sulfide, ammonia, and benzene steam, as well as smoke in the surrounding environment. MQ135 is a good choice for many gas detecting applications since it is extremely cost effective and adaptable for detecting a wide range of dangerous gases. -**Technical Information Regarding the MQ135 Gas Sensor** 150 mA of power is consumed. Measure and/or detect NH3, Nox, CO2, Alcohol, Benzene, and Smoke 5V is a typical operating voltage. 0V to 5V (TTL Logic) at 5V Vcc Digital Output Output analog: 0-5V @ 5V Vcc
ULTRASONIC SENSOR	-An ultrasonic sensor is an electronic device that uses ultrasonic sound waves to detect the distance between a target item and transforms the reflected sound into an electrical signal. Ultrasonic waves move quicker than audible sound waves the transmitter -**Specifications:** 5V, the operating voltage 15 mA is the operating current. Theoretical measurement range: 2 cm to 4 m Practical Measurement Range: 2 cm to 80 cm 3mm accuracy Covered angle measurement: 15° -**Merchandise Description** A 5V supply is used to power this module. The trigger pin must be made high for 10 us and then turned off in order to begin the measurement. This will cause a 40HZ ultrasonic wave to be sent by the transmitter. The

	time it takes for the ultrasonic wave to return to the sensor is represented by how long the echo pin is high.
WATER PUMP	-An electronic device that transforms direct current into mechanical power is a water pump, which is a type of direct current motor. due to its compact size and inexpensive cost, a 12V DC water pump is frequently used in IoT systems, including smart irrigation projects. - A 12V R365 Diaphragm DC Motor Pump like this one is utilized for tiny water pump applications like automating the watering of plants and fish tanks, among others. It needs between 0.5 and 0.7 amps and 6 to 12 volts DC. [3]
PIEZO BUZZER	Piezo Buzzer is an electrical device that produces a tone, alert, or sound. It's often a low-cost product that's lightweight and has a simplistic structure. Depending on the piezo ceramic buzzer parameters, it's also dependable and may be built in a variety of sizes that function at different frequencies to provide distinct sound outputs. **Specifications for Piezo Sensors** Golden in hue About 35 x 35 x 0.5mm in size; made of copper and porcelain Resonant impedance: 300 ohms maximum 50000 pF static capacitance at 30%
LCD DISPLAY	-LCD display LCD Screen The LCD (Liquid Color Displays) for Arduino allows for simple and understandable communication between the customer and the electronic framework. Perusing and creating characters to the LCD is a necessary task for every microcontroller, and Arduino is the greatest among microcontrollers. Arduino is a fantastic platform for developing LCD displays, actuators, sensors, and other electronic devices. Depending on your requirements and requirements. **Specifications for the 16x2 lcd display module:**

	operating voltage: between 4.7- and 5.3-volts operating current: 0.1 mA Could show (16x2) 32 Alphanumeric Symbols Support for Custom Characters Both 8-bit and 4-bit modes are functional.
GSM	GSM module Through the Short Messaging Service, a customized Global System for Mobile Communication (GSM) module is built for wireless radiation monitoring (SMS). This module can receive serial data from radiation monitoring devices like survey meters and area monitors and send it to a host server as text SMS **Specifications** common AT commands Item 4.54 g in weight Package Size: 12.1, 10.6, and 0.2 cm A variable serial baud rate of 1200 to 115200 bps is available. Voltage for a single supply: 3.4V to 4.5V energy-saving mode 1.5mA is the typical power consumption while in SLEEP mode. SIM900A frequency bands EGSM900 and DCS1800 are dual-band. The SIM900A can automatically search the two frequency bands. The AT command can also be used to set the frequency bands. GSM category Little MS GPRS connectivity: GPRS multi-slot classes 8 and 10 (the default) (option) Class 4 (2W) at EGSM 900 and Class 1 (1W) at DCS 1800 are the transmitting powers. 30°C to +80°C is the operating temperature. Temperature range for storage: 5 to 90 °C
CLOUD SERVER APPLICATION	Any data produced by the sensors installed in the septic tanks is stored by the thing speaks cloud server program [29] This cloud service enables text message warnings to be sent to authorized users about a variety of situations, such as showing the current status of a septic tank by alerting users when the tank is getting close to being full and when gases

	produced by the tank have a significant risk of endangering human health.
BATTERY	The electrical energy produced by the generator is stored in a lead acid battery. the solar panel that serves as the circuit's power source. Battery ON all day long since the circuit is operational all day. Specifications: Power: 6V Right now: 4.5A 27W power rating
REVERSE CIRCUIT	Relays are electromagnetic switches that are used when multiple circuits need to be controlled by a single signal or when a low power signal is needed to turn on and off a circuit. Relays are most commonly utilized in situations when a circuit can only be controlled by a low-power signal. It is also employed in situations when a limited number of circuits can be controlled by a single signal. Relays were first used when telephones were first developed. They were crucial in the telephone exchanges' call switching. The following phrase also they telegraphy

Table 3. 1: Hardware components of IoT based septic tank monitoring system

5. CHAPTER FIVE: SYSTEM RESULTS AND DISCUSSION

5.1 Introduction

This chapter displays the system results and discussion from the use of an IoT-based septic tank monitoring system. In light of the restrictions that were experienced throughout the prototype's implementation and the knowledge acquired. the hardware connectivity, design, and execution of the project are discussed.

5.2 Hardware connectivity

A system that employs an ATMEGA328P controller and is powered by a solar panel with a backup battery. toxic gas values are sensed using gas sensors, MQ7, and MQ135, and the data are sent to the microcontroller using and uploaded to the cloud storage every 15 seconds using a GSM module. the data is shown on an LCD, and when the poisonous level of the gas exceeds the limit, a message is sent to the cloud-connected devices, and the automatic regulating system that we installed reacts immediately, lowering the toxic level. a pump connected to the controller through a relay circuit and a chemical chamber for the neutralization process to remove hydrogen are included in the automatic controlling approach. When the gas level exceeds 100 ppm, the automated regulating mechanism kicks in and minimizes the harmful level.

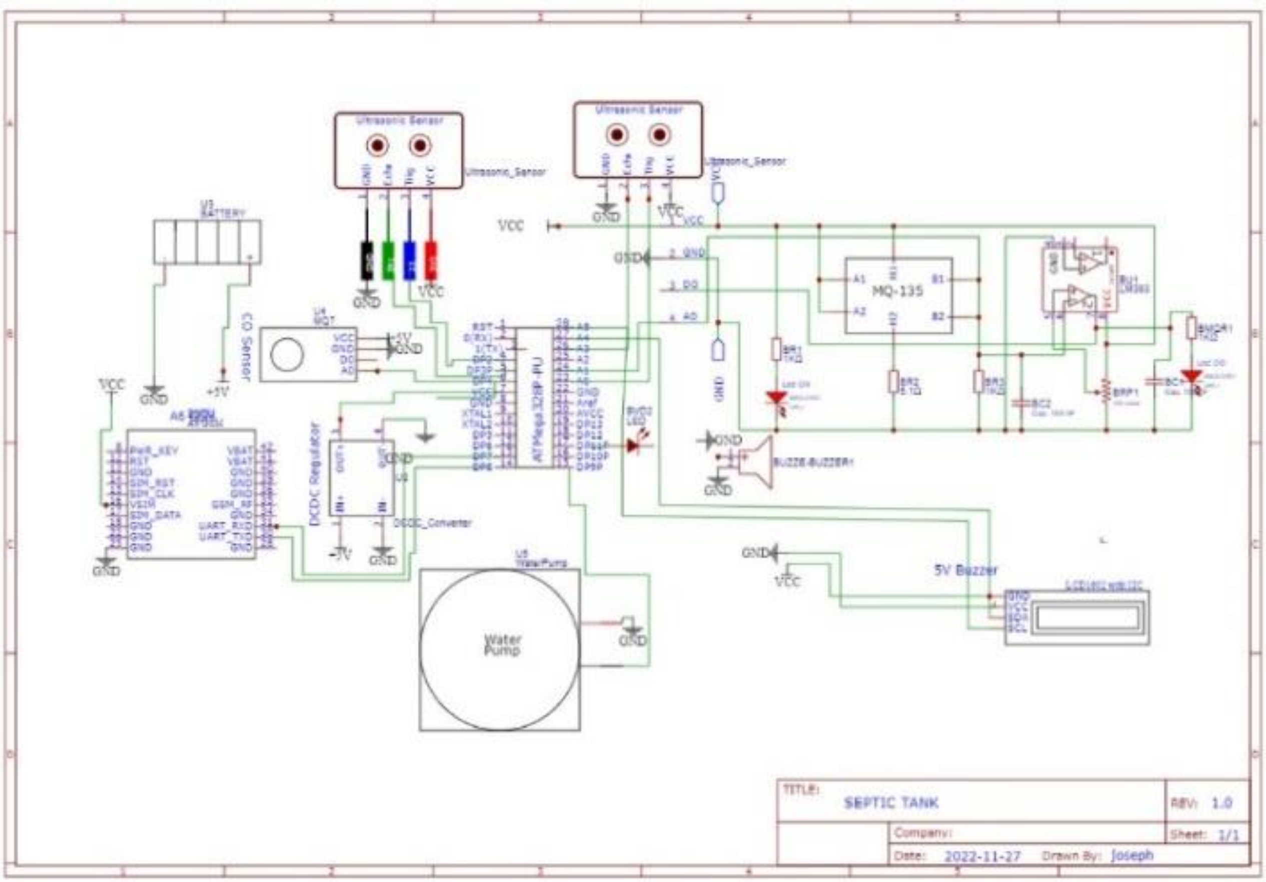


Figure 5. 1: Hardware connectivity IoT based septic tank monitoring system

5.3 Results

The results show that if the red line is upward, the particle level of pollution is higher and dangerous. At the level of 0-100 ppm, healthy air falls into the healthy category, while in the range of 100-200 ppm, air is not healthy, 200-300 ppm is very unhealthy, while 300 upwards is said to be very dangerous [8]. As shown in figure 10, the smoke point indicates that the smoke level is above 10k, indicating that the ambient air condition is very dangerous. When the hydrogen sulfide is inhaled into the lungs, it will participate in blood circulation and will block the entry of oxygen needed by the body. This can happen because CO gas is toxic metabolism, participating to react metabolically with blood. Like oxygen, hydrogen sulfide gas readily reacts with blood [9]. Figure 15 shows that the ppm content is almost 500, implying that the air is dangerous and Figure 16 illustrates that the air condition is dangerous because the ppm content is almost 1000.

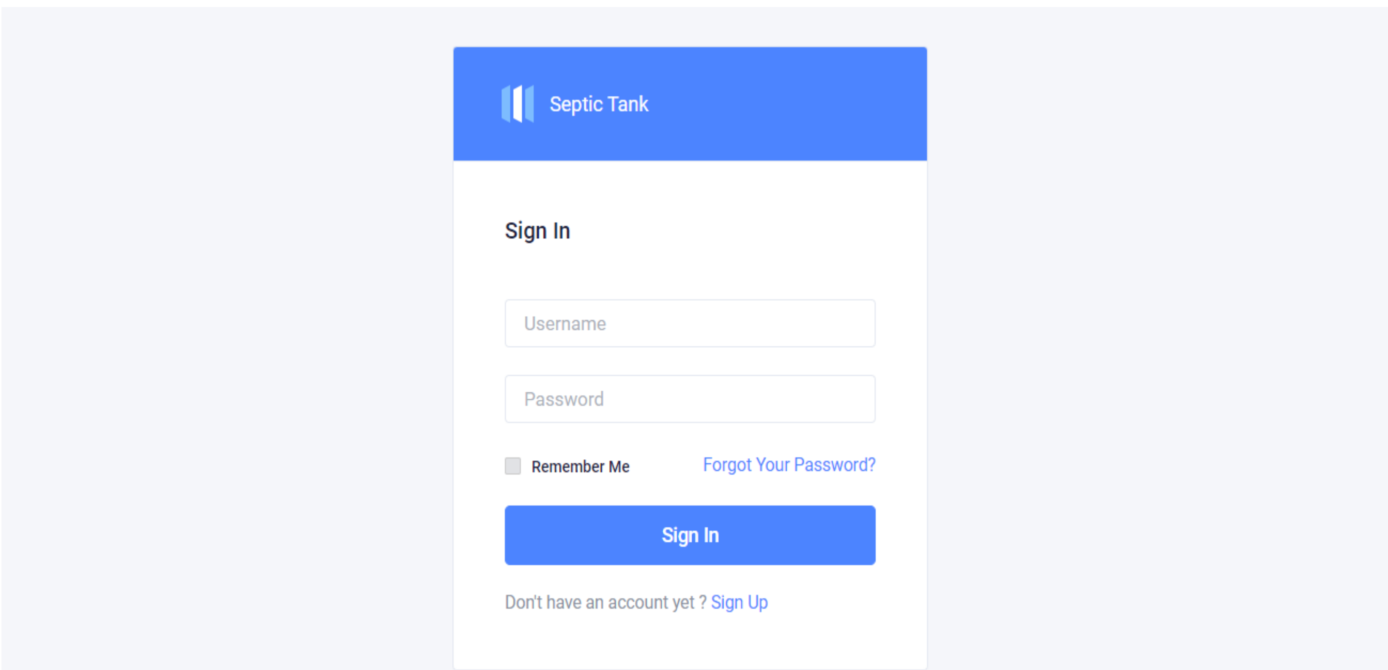


Figure 5. 2: Login platform of septic tank

Your private cloud space has now been created together with the accessing author name and channel ID. In that window, select the API keys option by clicking. Both the read and write API keys are located here. We can link the microcontroller to the cloud storage by utilizing this API key in the code. User can login on platform using username and password

Figure 5. 3: Complete experimental setup of IoT based septic tank monitoring system

Figure 5. 4 displays the output of the gas sensor. The Arduino board receives a signal from the gas sensor once it has determined that there is a gas leak. Through the interface, the output is shown in LED. An alarm message is sent to the consumer using a GSM module. Even people who find it difficult to detect the smell of gas can identify the leak. This module was utilized to prevent an accident caused by a gas leak. This approach is less expensive, and the MQ7, MQ 135 Gas sensor responds to leaks more quickly than other sensors. It also alerts the Arduino Boar when the tank is almost full.

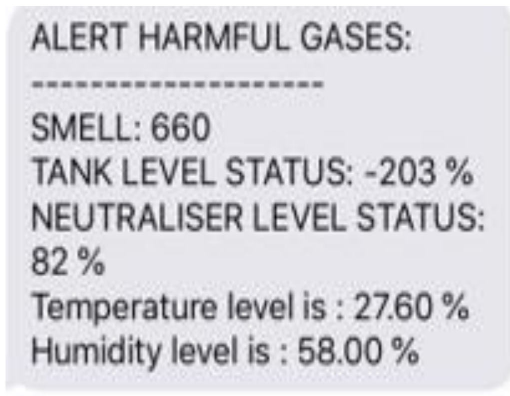


Figure 5. 5: SMS alert results for different toxic gases and septic tank status

This device has several safety advantages that are crucial for detecting gas leaks early. When there has been a gas leak and the tank is almost full, an alert message is received.

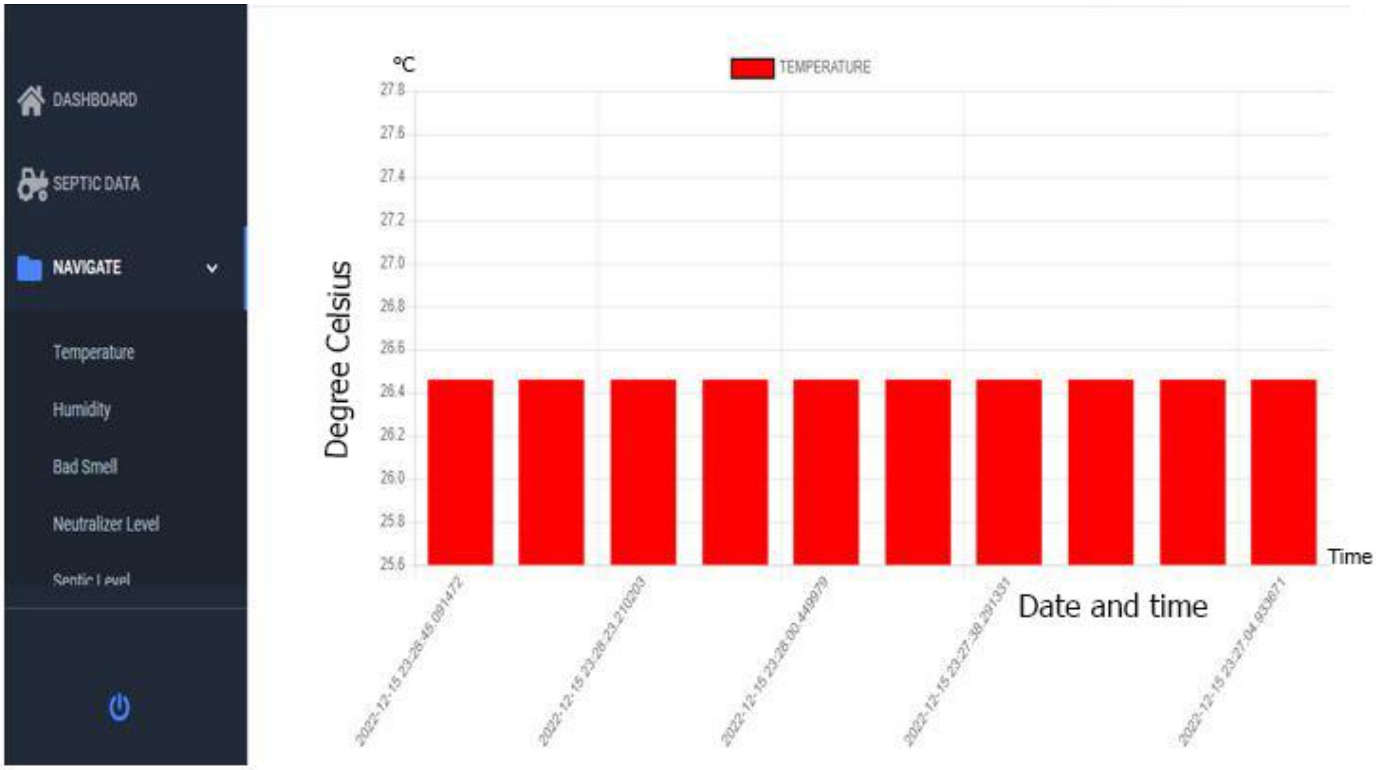


Figure 5. 6: Temperature line graph of IoT based septic tank monitoring system

The graph of temperature variation over time is shown in Figure 9. The system monitors the temperature data on a cloud app every 15 seconds. As the temperature increased, the toxic gas would lessen the offensive odor and the bacteria might perish.

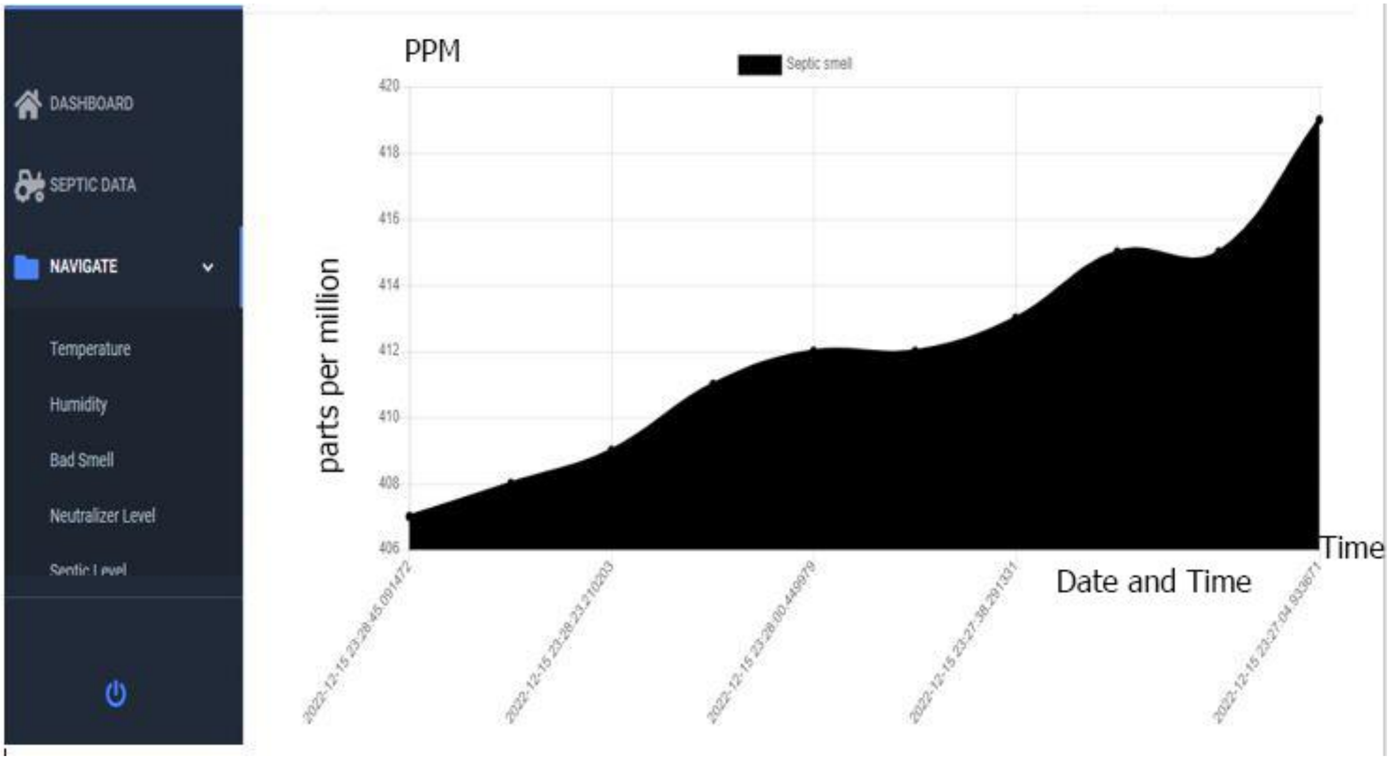


Figure 5. 7: Smell graph line from Septic tank

The graph of gas level data from the cloud application, which the system checks every 12 seconds, is shown in Figure 10. The system must send an SMS to the users to inform them that the gas concentrations are greater than 100 ppm. and as the humidity rises, the constriction of hazardous gases can also increase.

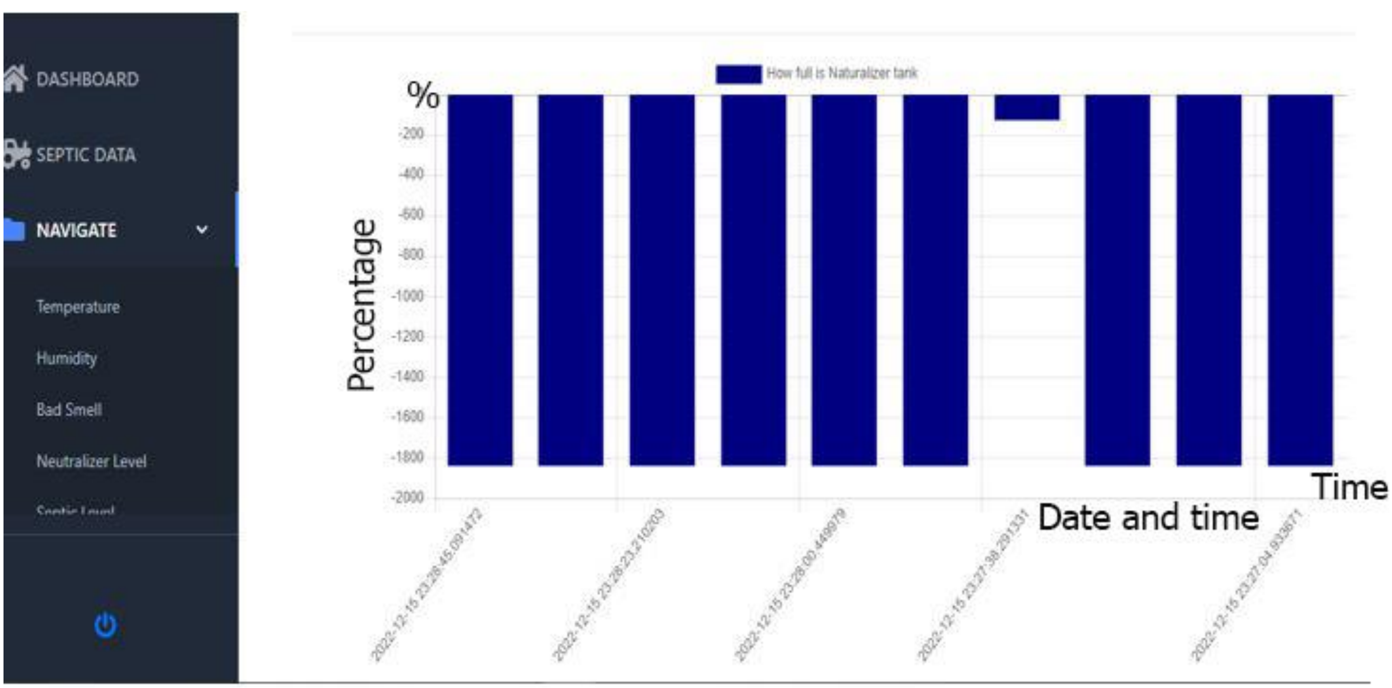


Figure 5. 8: Neutralizer tank level

The graph of neutralizer level data from the cloud application, which the system checks every 12 seconds, is shown in Figure 12. The system must send an SMS to the users to inform them that the neutralizer is less than 20%

5.3 Discussion

The results show that if the red line is upward, the particle level of pollution is higher and dangerous. At level of 0-50 ppm, healthy air falls into the healthy category, while in the range 50 – 100 ppm is categorized medium air. The range of 100-200 ppm, air is not healthy, 200-300 ppm is very unhealthy, while 300 upwards is said to be very dangerous [8]. As shown in figure 5 .6, the septic tank indicates that the concentration of Carbon monoxide, hydrogen sulfide is above 800, indicating that the ambient air condition is very dangerous. Carbon monoxide when inhaled into the lungs will participate in blood circulation and will block the entry of oxygen needed by the body. This can happen because CO and H2S gas is toxic metabolism, participating to react metabolically with blood. Like oxygen, CO gas readily reacts with blood (hemoglobin) [9]. Figure 5 .6, shows that the ppm content is almost 500, implying that the air is dangerous and Figure 5 .6, illustrates that the air condition is dangerous because the ppm content is almost 1000 ppm Ultrasonic emitting sound waves at a frequency too high for humans to hear into a septic tank, and then wait for the sound to be reflected back. The ultrasonic calculates the distance it takes sound waves to return after hitting an object. The ultrasonic sends values to the microcontroller, which then initiates the next step in the process. Compare the given levels of the system, whether the given condition is met. When the sensor value is less than 80% for septic tank occupation, the condition is safe. The green light illuminates as if it were present, and while the sensor value is still being read, if the sensor value is greater than 80%. the microcontroller using GSM will send an alter notification that the level of the septic tank is going to be full.

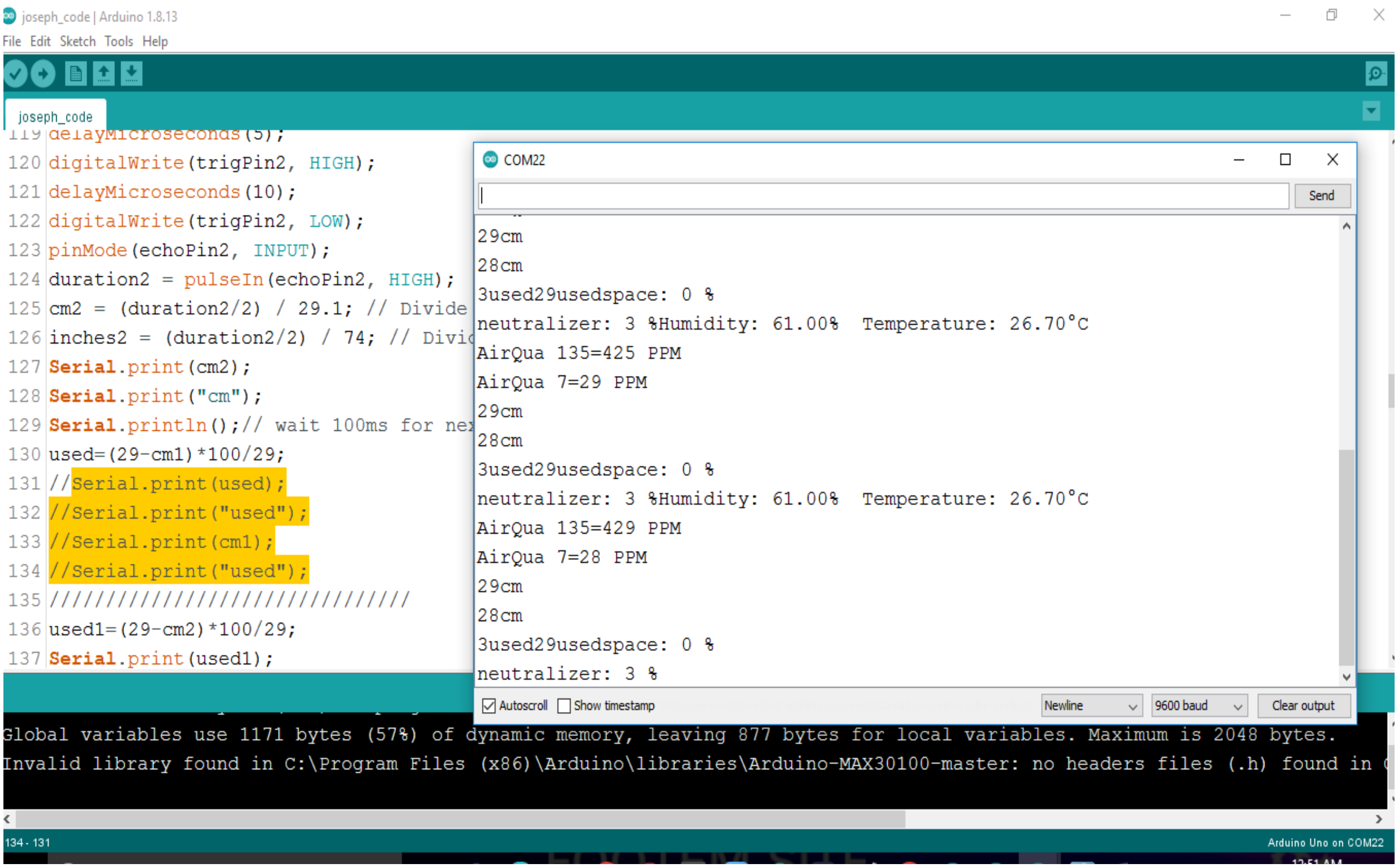
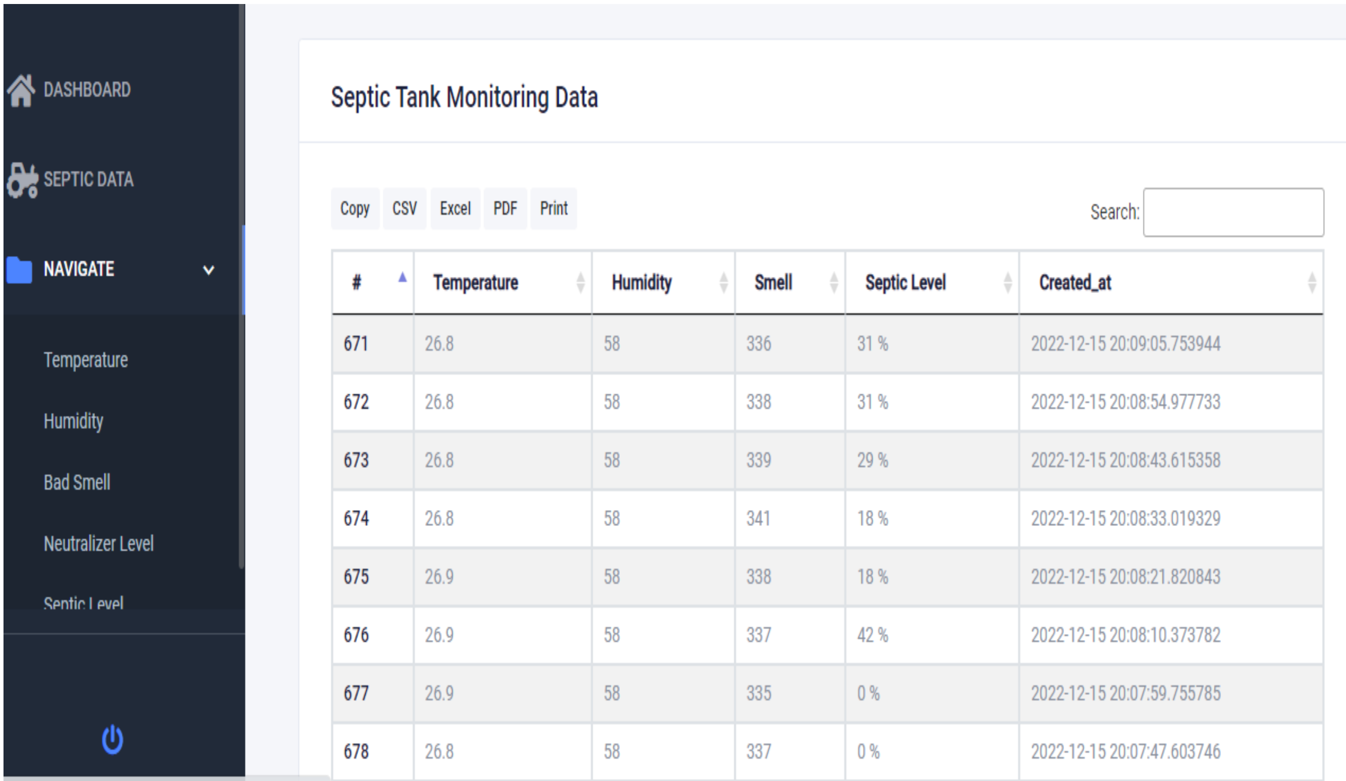


Figure 5. 9: Data of IoT based septic tank monitoring system



#	Temperature	Humidity	Smell	Septic Level	Created_at
671	26.8	58	336	31 %	2022-12-15 20:09:05.753944
672	26.8	58	338	31 %	2022-12-15 20:08:54.977733
673	26.8	58	339	29 %	2022-12-15 20:08:43.615358
674	26.8	58	341	18 %	2022-12-15 20:08:33.019329
675	26.9	58	338	18 %	2022-12-15 20:08:21.820843
676	26.9	58	337	42 %	2022-12-15 20:08:10.373782
677	26.9	58	335	0 %	2022-12-15 20:07:59.755785
678	26.8	58	337	0 %	2022-12-15 20:07:47.603746

Figure 5. 10: Data of IoT based septic tank monitoring system from platform

6. CHAPTER SIX: CONCLUSION AND RECOMMENDATIONS

In this chapter, we draw conclusions from the findings in the light of the papers we reviewed and the techniques we suggested. Then, we provide recommendations for further researches into an IoT-based septic tank monitoring system.

6.1 Conclusion

IoT based septic monitoring system is a developing technology that assists in monitoring remote septic tank issues and in implementing controlling techniques to ensure the safety of the septic tank cleaners while they are working inside. When the poisonous level surpasses the limit, users are informed and safely evacuated from the area and it makes it simple to manage septic tanks and ensure that the tank will be pumped out at the appropriate time. Users will receive notification alerts when septic is about to be full and alert users when gases produced by septic tank has significant potential to cause harm to human health of people who are breathing the surrounding air. It will also provide information about humidity of the soil that surrounds the septic tank.

6.2 Recommendation

Based on the research and discussions, septic tanks are the most practical invention everywhere. Septic tank monitoring systems are used to address issues with waste management in buildings and will be tested in places like schools, prisons, and hospitals where large numbers of people share a single toilet and where septic conditions can endanger patients' lives. It is advised to use this method in public facilities and institutions with large buildings, such as hospitals, schools, and prisons.

6.3 Future work

The project prototype that was created shows that there are various restrictions and hardware security issues that need to be considered and addressed in future development. Researchers ought to take into account these issues, using these human wastes in septic tanks to generate electricity, energy, and biogases.

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