INTELLIGENT MANHOLE MONITORING SYSTEM USING DATA MINING

A PROJECT REPORT

Submitted by

SATHIYA PRIYA I. (REG.NO:911719104060)

REEMA HAJRA A. (REG.NO:911719104056)

SELCIA M. (REG.NO:911719104062)

In partial fulfillment for the award of the degree

of

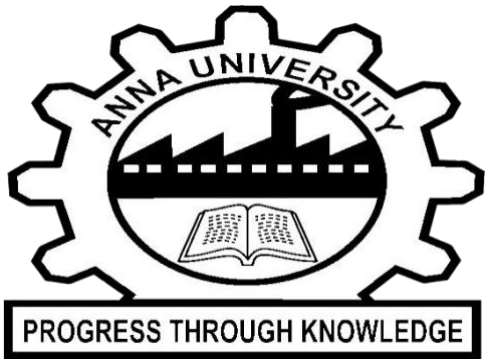
BACHELOR OF ENGINEERING

IN

COMPUTER SCIENCE AND ENGINEERING

MOUNT ZION COLLEGE OF ENGINEERING & TECHNOLOGY,

PUDUKKOTTAI – 622 507



ANNA UNIVERSITY :: CHENNAI - 600 025

May - 2023

ANNA UNIVERSITY, CHENNAI 600 025

BONAFIDE CERTIFICATE

Certified that this Thesis titled "**INTELLIGENT MANHOLE MONITORING SYSTEM USING DATA MINING**" is the bonafide work of **SATHIYA PRIYA I. (Reg.No:911719104060), REEMA HAJRA A. (Reg.No:911719104056), SELCIA M. (Reg.No:911719104062)** who carried out the work under my supervision. Certified further that to the best of my knowledge, the work reported herein does not form part of any other thesis or dissertation on the basis of which a degree or award was conferred on an earlier occasion on this or any other candidate.

SIGNATURE
Mrs. Elavarasi D, M.E., Ph.D*.,
HEAD OF THE DEPARTMENT
Department of Computer Science,
Mount Zion College of
Engineering &Technology,
Pilivalam, Thirumayam TK,
Pudukkottai - 622 507.

SIGNATURE
Mrs. Elavarasi D, M.E., Ph.D*.,
SUPERVISOR
Department of Computer Science,
Mount Zion College of
Engineering &Technology,
Pilivalam, Thirumayam TK,
Pudukkottai - 622 507.

Submitted for the Viva-Voce Examination held on _____

INTERNAL EXAMINER **EXTERNAL EXAMINER**

ACKNOWLEDGEMENT

From my deepest soul, I thank God, the Almighty for helping me complete my project work.

I am Wholeheartedly grateful to **Mrs. Florence Jayabarathan, M.A, B.Ed., Chairperson,** Mount Zion college of Engineering and Technology, for providing me with all the facilities which helped me to do my project work.

I would like to express my sincere thanks to **Dr. Jayson K Jayabarathan, M.Tech, Ph.D., Director,** Mount Zion college of Engineering and Technology, for all his technical expertise for successful completion of my project.

With a deep sense of gratitude, I record my thanks to **Dr. P. Balamurugan, M.E., Ph.D., Principal,** Mount Zion college of Engineering and Technology, for all his support throughout the completion of my project.

I am vastly indebted to **Mrs. D. Elavarasi, M.E, Ph.D*, Head of the Department,** Department of computer science and Engineering, for the immense encouragement, support and guidance to complete my project.

I also would like to thank my guide, **Mrs.D.Elavarasi , M.E, Ph.D*, Assistant Professor,** Department of computer science and Engineering for her constant encouragement through my work.

I would also like to thank all the staff members of CSE Department for their kind cooperation. Also, I express a sense of gratitude and love to my friends and my family for their support and strength helped me carries out my project successfully

ABSTRACT

Drainage is the system or process by which water, sewage, or otherliquids are drainedfrom a place and to maintain the proper function of drainage, its condition should be monitored regularly. But manually it is very difficult to monitor all areas where a human cannot reach. This influences the blockage of underground pipes and overflows of water causing health problems. An intelligent manhole monitoring system represents the implementation and design functions for monitoring and managing underground drainage systems with different approaches. This project describes various functions used to maintain and monitor the underground drainage system. It provides a system that can monitor the water level, atmospheric temperature, water flow, and toxic gases. If the drainage system gets blocked and water overflows the sensor system can identify it. It also describes a water-wise system and detection method to detect leakage defects in sewer pipelines thus providing this system to work appropriately to keep the city clean, safe, and healthy. This project also considers the gaslevel inside particular drainage which can be found such that it helps people be aware of toxicgasses, the people refer to the ones who clean andgo nearby. Another interesting feature is thedetection of open-lid drainage holes which cause several accidents and leads to death, this problem has been somehow This proposal notifies the municipal corporation, the persons, andany other source who go nearby places.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS

ABBREVIATIONS	EXPANSION
API	Application Programming Language
GND	Ground Connectivity
GSM	Global System For Mobile Communication
IDE	Integrated Development Environment
IOT	Internet Of Things
WSN	Wireless Sensor Networks

CHAPTER 1

INTRODUCTION

1.1 Overview

This chapter serves as the background of this master thesis by giving a brief summary about the proposed system. Water is considered to be one of the vital resources used around the world. And most of the countries highly depend on the standard of water management. Sustainability of available water resources has now become a dominant issue for several reasons. The issue is quiet related to poor water allocation, inefficient use and absence of good enough and integrated water regulation. Therefore, wastage of water due to pipeline leakages is one of the most critical and largest challenges confronted throughout the globe. Previous few decades many tracking gadget integrated with water leakage detection have been common.

Monitoring water leakage is a necessary responsibility for government and residence prospect. Thus from an engineer's aspect, distribution of water can be enhanced mainly by limiting the water waste that occurs along the path, between the source and the end-users. But leakages are unavoidable due to some circumstances, such as corrosion, manufacturing defects and aging of pipes. Most management on underground drainage is manual therefore it is not efficient to have clean and working underground system also in such big cities, it is difficult for the government personnel to locate the exact manhole which is facing the problem. Therefore, it is essential to develop a system which can handle underground drainage without human intervention.

Underground Drainage involves sewerage system, gas pipeline network, water pipeline, and manholes. In India most of the cities has underground drainage system and the sewage system is maintained by Municipal Corporation to make the environment clean and healthy. Sometimes due to poor maintenance of the drainage system, the water in the drainage system gets mixed up with the pure water and infectious diseases may spread on the environment. Due to variations in the climate during different seasons the drainage gets blocked and makes the environment unhealthy and makes the people upset and distribute the routine life.

To overcome all the issues in the drainage system and inform the municipal corporation about the condition of the drainage system by sending SMS through GSM, so that the officials can take the necessary action to repair the drainage system. Even the gas formed inside the drainage system due to bio wastage also detected using the gas sensor so that we can avoid explosion due to pressure inside the drainage system. If the drainage system lid is opened for long hours using tilt sensor we can detect the opening of the lid and inform the municipal corporation officials to take action on it. So our main aim of this idea is to monitor the drainage system using the sensor. If the sewage system gets blocked or water overflows or if the drainage lid is opened it is monitored using the sensor and the sensed information are sent to the nearby municipal corporation official via SMS using the GSM shield and the water overflow and gas value are stored in the cloud storage for the later analysis purpose.

This project describes various functions used for maintenance and monitoring of underground drainage system. It provides a system which is able to monitor the water level, atmospheric temperature, water flow and toxic gasses. Drainage is the framework or procedureby which water, sewage or different fluids are depleted from a spot. So as to keep up the best possible capacity of waste, it ought to be checked normally. It is likewise hard to screen all the territory of drainage due to physical impediment of individuals. The sporadic observing outcomes in obstructing the drainage that shapes the sediment which triggers flooding in the area. Manual observing is additionally wasteful. It required a committed group which is just ready to keep up the restricted record with less precision. These shortcomings lead to the moderate treatment of issues in drainage. It additionally has fallen in view of a lot of downpour. These issues can be relieved with the observing innovation which comprises low force sensor hubs. Sensor hub comprises controller, memory, handset and battery to supply the ability to thesensor hub. Size of the sensor hub relies upon its application.

This paper will talk about the structure of waste frameworks to screen conditions by utilizing remote sensor organization. Some hub sensors are conveyed in the waste sewer vent and will transmit the information about the state of sewage to the cloud and metropolitan versatile. The parameters will be observed through water levels in drainage, stickiness and temperature of waste sewer vent. It will likewise check the conditions whether drainage sewer vent is open or shut to maintain a strategic distance from mishap because of an open sewer vent.

1.2 Project Scope

The underground drainage system is an important component of urban infrastructure. It is considered to be city's lifeline. Most management on underground drainage is manual therefore it is not efficient to have clean and working underground system also in such big cities, it is difficult for the government personnel to locate the exact manhole which is facing the problem. Therefore, it is essential to develop a system which can handle underground drainage without human intervention. Underground Drainage involves sewerage system, gas pipeline network, water pipeline, and manholes. This project describes various functions used for maintenance and monitoring of underground drainage system. It provides a system which is able to monitor the water level, atmospheric temperature, water flow and toxic gasses. If drainage system gets blocked and water overflows it can be identified by the sensor system. And that sensor sends information via the transmitter which is located in that area to the corresponding managing station.

1.3 Problem Statement

The underground drainage system is an important component of urban infrastructure. It is considered to be city's lifeline. Most management on underground drainage is manual therefore it is not efficient to have clean and working underground system also in such big cities, it is difficult for the government personnel to locate the exact manhole which is facing the problem. Most of the cities adopted the underground drainage system and it is the duty of managing station (Municipal Corporation) to maintain cleanliness of the cities.

The drainage gets blocked during rainy season, it will create problem for routine life such as traffic may get jammed, the environment becomes dirty, and totally it upsets the public. Suppose if there should be a facility which would be there in Municipal Corporation (managing station) that the officials come to know immediately after blocking of drainage in which area and the exact place where it is blocked. Also due to lot of toxic gases like CO2, methane etc lot of skin diseases occur and lung disease comes into picture, the over flown water brings out many mosquitos that gives malaria, dengue issues. The open vents or lids may cause accidents like children falling into the manhole, bike accidents due to flowing water and other risks. Therefore, it is essential to develop a system which can handle underground drainage without human intervention.

This project describes various functions used for maintenance and monitoring of underground drainage system. It provides a system which is able to monitor the water level. If drainage system gets blocked and water overflows it can be identified by the sensor system. And that sensor sends information via the transmitter which is located in that area to the corresponding managing station.

Today's drainage system is not high-tech. So whenever there is blockage, it is difficult to figure out the exact location of the blockage. Also, early alerts of the blockage are not received. Cleaner cities and intelligent management of drainage in the city. Detection of drainage water level and blockages in the drainage. The main objective is to obtain an effective low-cost and flexible solution for condition monitoring and infrastructuremanagement in the city.

1.4 Purpose Goal

To implement a wireless sensor-based monitoring and controlling system that can beaccessed in close proximity along with remote access.

To make certain provision of the monitoring system in case of underground water distribution where there is a constant need to detect possible underground water leakage for residential water pipes which can be monitored from a Personal Computer.

To ensure this proposed system can be employed globally and to provide a very user-friendly environment for people to use the application and the hardware without need for extensive training.

To Publish connectivity to unreachable and dangerous areas.

To notify the water leakage without human intervention under the ground.

1.5 Project Description

In this project, we propose an intelligent manhole monitoring system, which represents the implementation and design functions for monitoring and managing underground drainage system with different approaches. Thus, from an engineer's aspect, distribution of water can be enhanced mainly by limiting the water waste that occurs along thepath, between the source and the end-users. But leakages are unavoidable due to somecircumstances, such as corrosion, manufacturing defects and aging of pipes. Most management on underground drainage is manual therefore it is not efficient to have clean and working

underground system also in such big cities, it is difficult for the government personnel to locate the exact manhole which is facing the problem. This project describes various functions It provides a system which can monitor the water level, atmospheric temperature, water flow, and toxic gasses. If the drainage system gets blocked and water overflows the sensor system can identify it. It also describes a waterwise system and detection method to detect leakage defects in sewer pipeline thus provides this system to work appropriately to keep the city clean, safe and healthy. Another interesting feature is the detection open lid drainage holes which cause several accidents and leads to death, this problem has been somehow avoided in this proposal it notifies the municipal corporation as well as the persons and any other source who go nearby.

1.5.1 Internet Of Things

The Internet of thinks (IOT) is a rapid explained technology that is shaping up to bring the next revolution in computing and information technology. IOT system has application across industries through their unique flexible and ability to be suitable in any environment. The physical layer consists of the devices that are to be controlled. The sensors to sense the surrounding environmental conditions are also connected to this layer. The data link layer consists of IoT gateway router, device manager and various communication protocols. The application and presentation layer consist of web protocol.

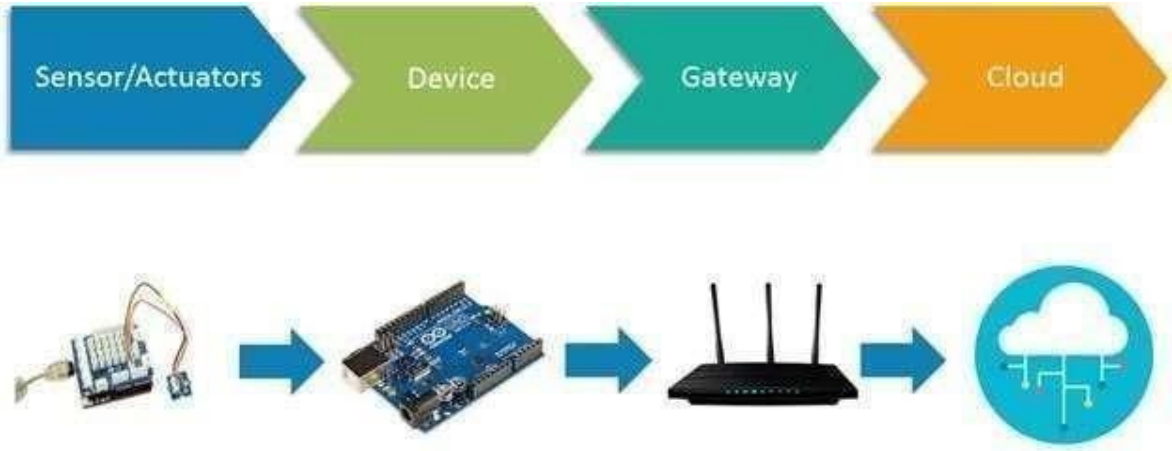


Fig 1.1 Internet of Things

1.5.2 Blynk Cloud

Blynk is a new platform that allows you to quickly build interfaces for controlling and monitoring your hardware projects from your iOS and Android device. After downloading the Blynk app, you can create a project dashboard and arrange buttons, sliders, graphs, and other widgets onto the screen. Using the widgets, you can turn pins on and off or display data from sensors.

A platform differences seen earlier Blynk is a solution for building IoT applications available for Android and iOS. Based on platforms known as Arduino, Raspberry pi, ESP8266, Intel Galileo, Particle, Serial devices and Wifi among others, in a few minutes you can create a high-quality dashboard, we highlight the large number of available widgets, Control, display, Notification and Video Steaming. In this case we will perform the Tests with Module ESP8266 in the following tutorial show step by step installations and configurations for the Blynk application.

Advantages of Blynk App:

- Connection management. Blynk Library can connect any hardware over Ethernet, Wi-Fi, or GSM, 2G, 3G, LTE, etc.
- Flexible firmware API. Extensive hardware-cloud-app API.Public and private servers. Blynk Cloud is open-source Fast and reliable.

CHAPTER 2

LITERATURE SURVEY

This chapter introduces earlier researches done in similar areas. The idea has been developed under various applications which are described below;

Yovanovitch Silverite have presented a paper on A dependability evaluation tool for the Internet of Things. The Internet of Things (IoT) is a promising networking paradigm which immerses objects (cell phones, goods, watches, sensing notes, TVs, etc. in a well wide connection. Despite its high degree of applicability, the IoT faces some challenges. One of the most challenging problems is its dependability (reliability and availability, vice failure might put people in danger or result is final es The Ink of a design tool for assessing the dependability of IoT applications at the only planning and design phases prevents system designers from optimizing their decisions to minimize the effects of stuck faults can the network devices. In this paper, we propose a dependable- its evaluation tool for IoT applications, when hardware faults and permanent link faults are considered. Sho Fujita have presented a paper "Identifying and verifying clock synchronize protocol parameters. Proceedings of the workshopon internet of Things and Platform. In the physical space, the notion of time iso universal that the information there in often combined with timestamps. To make them consistent manage IoT nodes applications need a clock synchronization mechanism, which has been an importanttopicin the research continuity. Warren liar studies focusing on improving synchronization on improving efficiency to achieve a given synchronization accuracy in a given environment. Thisviewpoint is important because applications done always require the best synchronization accuracy and only limited resources are available for IoT nodes. We propose methods to identify and verify appropriate parameters for clock synchronization protocol. Because our methods are not limited to a specific protocol, we introduce a clock synchronization protocol model that generalizes a class of clock synchronization protocols and discuss IoT methods basedon it. Our methods am demonstrated on a trace of time information collected in our test bed.

Lara Srivastava Tal have presented a paper on "Towards a narrative-aware design framework for smart written to The Future Internet: Sensation in smart city systems is based on the principle that devices, places and everyday things can each be able to serve people in responsive manner. This chapter presents a novel approach to the design of smart city systems

environment, but the power of human storytelling in an always on networked world. It isonly when environments are both sensor-driven and socially aware that more lattice, and therefore narrative can emerge in the future Internet context.

Flavia C. Delicato et al have published a paper entitled Towards IoT code. Proceedings of the First International Workshop on Software Engineering for Systems of-Systems. In the near future it will be p able that every object Earth can be identifiable and addressable. Such objects will be able to be monitored and monitor their physical environments and of executing actions on such environmental in benefit of human res. Moreover, these so called smart objectswill be endowed with wireless communication capabilities By being uniquely blessed, wirelessendowed and through the existing protocol and standardized formats, start things can be integrated in the Internet and accessed as any other Web resource, In this context, the Internet of Things (IoT) as a paradigm in which smart things actively collaborate among themand with other physical and virtual objects available in the Web, providing value added information andfunctionalities for uses. The LT paradigm has recently showed its potential of considerably impacting the daily lives of human beings mainly due to the use and interaction of physical devices in several domains, including complex systems composed of other systems. In this paper we deduce the IoT paradigm from the perspective of Systems of Systems and present reading a lot platform that integrates heterogametes devices to provide real-time data control, visualization, and storage. In Decodify devices, information, users and applications areintegrated to create an IoT ecosystem in which new ideas and products can bedeveloped in anagile way. [1]

Denis Carvin. Philippe have published a paper on Managing the upcoming ubiquitous computing, Proceedings of the 8th International Conference on Network and Service Management The Internet of Things (101) is a promising theme of research. Covering subjects from euro-electronic to social sciences with a major field in computing, network and telecommunication. It is judged as the future of the today's Internet. The main ideais to benefit from ambient intelligence instantiate by objects assisting humans in their daily tasks Oil Unsalted imagined use cases and challenging projects in separates, but diligence per for inches and requires expertise specific implementations or technological. [3]

An Internet of Things for Underground drainage management fragmentation starves us from a rapid growth of the Jo T where it prevents is to be loaded by the characterized traffic it would gently Intersecting three domains of rematch that are Systems Monitoring and Management, Ubiquitous Computing and Cognitive Radio, we introduce our ongoing work on a new transversal to case called Ubiquitous Cognitive Systems Management (UCSM) to tackle this para dox and alginate the chatty object concept. [6]

Monitoring Smart City Applications using Raspberry PI Based on IOT Authors: Prof. S A. Shaikh 1, Suvarna A. Sonawane; Describes the Smart city is the development goal to monitor the quality of resource in the city to improve good management and faster development of the city required necessity is to upgrade healthy and safe cities that delivering real time services and latest facility to implement the concept of smart city use IoT concept by which easy wireless communication is possible .The system consist of sensors, collect different types of data from sensors and transfer to the Raspberry Pi3 controller. The acquired output from the controller is sent to the control room through the E- mail and also display on the personal computer. [5]

Automated Internet of Things for Underground Drainage and Manhole Monitoring System for Metropolitan Cities. Author: Murages S and Santhosha Rao Describes about The Internet of Things (IoT) consists of real-life objects, communication devices attached to sensor networks in order to provide communication and automated actions between real world and information world. [2]

CHAPTER 3

SYSTEM ANALYSIS

This Chapter gives the analysis to detect the flaws that occur in the underground manholes, this helps us to develop a system that overcomes all the issues;

3.1 Existing System

As we have already slightly mentioned about the few existing systems are pretty good, they still lack the availability issue and being costly. When we are paying in such large amounts theleast, we can expect is that the system is constantly available for monitoring and controlling the system. The existing water leakage monitoring and control systems are monitored manually and controlled automatically or vice versa. There are various systems that have been developedto support monitoring and controlling of water pipes, but such systems will usually have a lot of disadvantages such as increased cost and labor, also monitoring and controlling these systemswill have a big disadvantage that is there will be human intervention necessary, but this methodwas very inefficient because there was no indication if the water is already overflowing or he might have to go and check it many times before he finishes his job. The biggest disadvantage is that the person can't know it before hand and this could lead to problem such as overflowing of water and result in water wastage. Let us check certain existing water level monitoring systems and its advantages & disadvantages.

3.1.1 Manual Monitoring

When leakages are caused in underground water pipelines there need to be a person to monitor, who had to do it manually and had to go to the location to check if there are any cracks exist in the pipelines. But this method was very inefficient because there was no indication if the water is already overflowing or he might have to go and check it many times before he finishes his job. The biggest disadvantage is that the person can't know it before hand and thiscould lead to problem such as overflowing of water and result in water wastage.

3.1.2 Acoustic Leak Detection

Acoustic leak detection is one of the internally-based technologies, sometimes called as rarefaction-wave monitoring. This technology is primarily based on detecting absolute pressure waves that are generated when a leak occurs. Acoustic pressure waves passing inside the pipeline at the speed of sound of the fluid that is being transported and can be detected through dynamic pressure sensors. Numerous filters and algorithms can be used to analyze this disturbance and distinguish it from other pressure events on the pipeline.

3.1.3 Correlate Leak Detection

A leak noise correlator is an electronic device used for Leak Detection and as a leak locator to find leaks in pressurized water or gas lines. The two recordings to decide the difference between the times it takes noise to travel from the site of the leak to each of the sensors. Hence the sound input is processed via a mathematical algorithm which compares or correlates these recordings. If the distance between the sensors is known in advance, this timing information can be used to determine the location of the leak.

3.1.4 Ground Penetrating Radar

It is a geophysical method that uses radar pulses to image the subsurface. This nondestructive technique uses electromagnetic reflected in the microwave band (UHF/VHF frequencies) of the radio spectrum, and detects the pondered signals from subsurface structures. GPR may have applications in a variety of media, along with rock, soil, ice, fresh water, pavements and structures. In certain circumstances, professionals can use GPR to identify subsurface objects, variations in material properties, and voids and cracks.

GPR makes use of high-frequency (usually polarized) radio waves, normally in the range 10 MHz to 2.6 GHz. A GPR transmitter emits electromagnetic energy into the ground. When the energy encounters a buried item or a boundary between materials having different permittivity, it may be reflected or refracted or scattered back to the surface. To record the variations in the return signal a receiving antenna is used.

3.1.5 Pressure/Flow monitoring

The hydraulics of the pipeline changes due to leaks, and thus changes the pressure or flow rate after some time. Simple leak detection method can be obtained by local monitoring of pressure or flow rate at one point. As it is done locally it requires in principle no telemetry. It is only useful in steady-state conditions, however, and its ability to deal with gas pipelines is limited.

3.2 Proposed Method

The proposed system uses IoT technology to provide an effective solution for monitoring manhole. The main reason to use IoT for continuous monitoring such as environmental agriculture, real time monitoring, Industries, wastewater treatment, military, battlefield is it is more reliable and can reach where it is difficult or impossible for human being to access or stay for a long time. The sensor node is deployed where a human cannot reach to monitor and collect the data, so the operation of the sensor node depends on inbuilt battery. The sensor collects information from the surrounding areas and this sensed relative data is exchanged it among them as well as with an admin via a GSM modem.

This project describes various functions used for maintenance and monitoring of underground drainage system. It provides a system which is able to monitor the water level, atmospheric temperature, water flow and toxic gasses. If drainage system gets blocked and water overflows it can be identified by the sensor system. And that sensor sends information viathe transmitter which is located in that area to the corresponding managing station.

Our proposed system proposes the following features.

- ➢ Detects the specific drain where the blockage occurs.
- ➢ Detects toxic gas levels that would be harmful.
- ➢ The system governs the flow of sewage from the pipes.
- ➢ Finds out open vents to intimate, thus prevents accident.
- ➢ Get the prior alerts of blockages and locate them using IOT.

3.2.1 Block Diagram

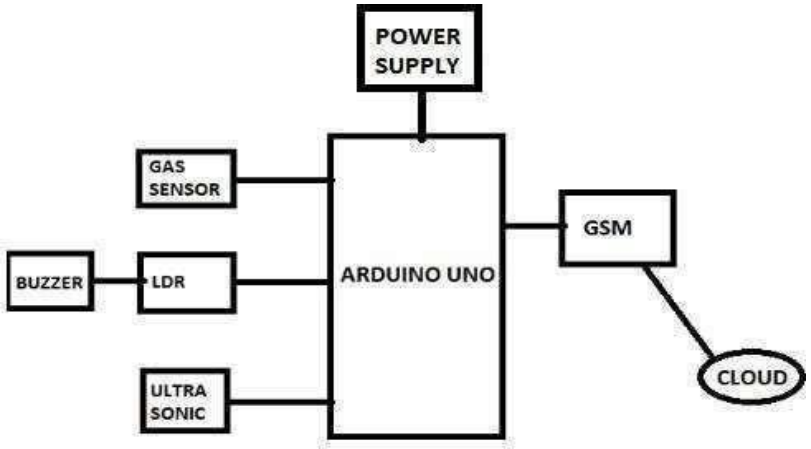


Fig 3.1 Block Diagram for the MZ SCADA

The above block diagram describes the setup of the proposed system. There are 4 sensors involved in the proposed system; they are Gas sensor, Ultrasonic, LDR these sensors are used for the calculations of the flow and gas levels and also the lid status. These sensors are connected to the Arduino Uno microcontroller. GSM module is also connected with Arduino, this acts as the interface between the hardware and software component of the proposed system

3.2.1 Advantages of Proposed System

➢ Can find the frequent flaw occurring regions.'

➢ The only requirement is a mobile device (such as mobile or laptop), with internet to monitor and control the water or gas leakage.

➢ The proposed system can be used to prevent unnecessary wastage of water and gas thereby reducing the cost that could be incurred.

3.3 System Architecture

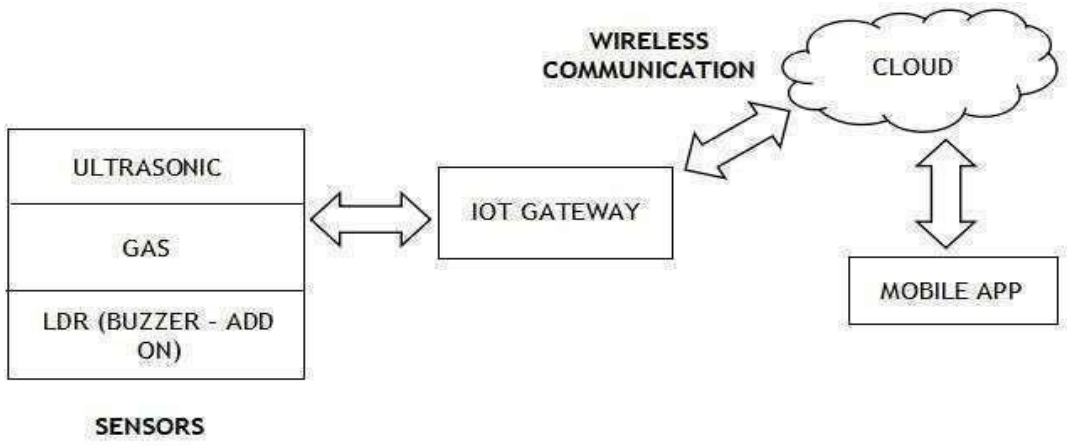


Fig 3.2 Architecture Diagram of MZ SCADA

An architecture description is a formal description and representation of a system, organized in a way that supports reasoning about the structures and behaviors of the system. A system architecture can consist of system components and the sub-systems developed, that will work together to implement the overall system. There have been efforts to formalize languages to describe system architecture; collectively these are called architecture description languages. The above diagram represents the architecture of the proposed system, it can be divided into sensors, gateway and the software module.

The sensor includes all the sensors that we will be using. These are interfaced with the microcontroller. The IOT gateway contains the mediator between the hardware and software.

3.4 System Requirement

The software requirement specification is a comprehensive description of the proposed system. The software requirement specification describes completely what the system can do and how it is expected to perform. An SRS (Software Requirement Specification) helps to reduce the time and energy needed by developers to attain their desired goals and additionally minimizes the time for development. The parameters like operation speed, interval, availability, portability, maintainability, foot print, security and speed of recovery from adverse events are evaluated.

3.4.1 Hardware Requirements

1. Arduino Uno Microcontroller
2. Gas Sensor (MQ135)
3. Ultrasonic Sensor
4. GSM 900A module
5. LDR sensor
6. Buzzer Power Supply

3.4.2 Software Requirements

1. Modbus Stimulator
2. Firebase

3.4.3 Specific Requirements

The requirements specification document enlists all necessary requirements that are required for the project development. To derive the necessities, one should have clear and thorough understanding of the products to be developed. This is prepared after detailed communications with the project team and customers. Simple UI Design: The main focus in theapp is to make it as simple to use as possible any layman should be able to use it. So, the requirements from most probable users were taken to understand what design would make the app simple to use.

3.4.4 Functional Requirements

In the functional requirement we focus on documenting the operations and activities that our app as well as the hardware is supposed to perform and they include the following.
The description of each sensor and the values it could display.

The proper labeling of each valve and the two states that it can be in (on and off). The requirement of the hardware is needed for the entire setup to function seamlessly.The description of the flow of control of the entire system.
The description of the various operations each module has to perform.
How the system will meet the applicable regulatory requirements.

3.4.5 Non-Functional Requirements

In terms of non-functional requirements, we should be mainly focusing on the performance requirements of our system, and at a minimum the performance requirement should document the following:

- The ideal wait time is a very important performance requirement and it is supposed to be from the time the user provides the input to start a function till he gets a complete and satisfactory feedback from the system so that he can continue with the next set of instructions to be given to the system.
- The next is the time interval the user has to wait for the throughput if the current interest for the user is to wait for half the time, we have specified then unless we can provide that time interval for the throughput, we cannot move forward to the next requirement specification.
- The size of the application being developed should be as small as possible because just for the purpose of monitoring a system we should make sure the size required shouldn't exceed the already existing systems size requirements. Also, since our prime focus is to introduce the application to an android device and we should consider the space constraint in case of smaller devices.
- The next performance constraint that should be focused on is availability of the entire system. We should make sure the app as well as the hardware will be consistently providing a very good

performance rating because the application of this system is in a critical area and there is a big necessity for constant availability.

- Then comes the number of users that can concurrently be connected to the same system and also receive updates on the status of the system as well as monitor and control the system by not interfering with other users.
- And lastly the most important requirement is that the cost of the system since most existing systems are quite efficient as it is the only problems, we face with those systems are human intervention at inaccessible places. Since these systems are very costly to implement, we had tomake sure our system will be able to handle their disadvantage as well as be made easily available.

3.4.6 Performance Requirements

Performance is measured in terms of the output provided by the application. Requirement specification plays an important part in the analysis of a system. Onlywhen the requirement specifications are properly given, it is possible to design a system, whichwill fit into required environment. It rests largely in the part of the users of the existing systemto give the required specifications because they are the people who finally use the system. This is because the requirements have to be known during the initial stages so that the system can be designed according to those requirements. It is very difficult to change the system once it has been designed and on the other hand designing a system, which does not cater to the requirements of the user, is of no use.

The requirement specification for any system can be broadly stated as given below:

The system should be able to interface with the existing system.
The system should be accurate
The system should be better than the existing system.
The existing system is completely dependent on the user to perform all the duties.

3.4.7 Safety and Security Requirements

The most important factor in any system being implemented is the safety and security concerns. The systems being developed should be made with the thought of safety of the users as well as the surroundings in mind. By implementing a new system, they will be only concernof how safe is the system and what are the diverse effects of the system is implemented.In case of the system, we are developing we have researched few existing systems and the diverse effects. Some being the effects of severely limited by less-than ideal environmental conditions,it involves human efforts in hearing the sound waves which effects the health, The main downside of getting a pipeline tracing system is the cost. Also, the system being designed is mostly used in underground water pipeline and there is a probability of wasting water due to slight crack or leak in the pipes. To avoid such incidents a system being designed we have madesure to avoid the use of any harmful sound waves as well as less human labor. Incase of security, we have made sure the pairing cannot happen without authorization and the key required to access the system will be available only with the higher security officials which means unless the users get the clearance from the administrator to gain access to the systems the users cannot access the system. By applying such security measures, we can guarantee no security breaches will occur and the system will be safe to use at all times without any disruptions to the processand will not cause any downtime.

3.4.8 Software Quality Attributes

Software quality attributes are used to measure the products performance and we need to make sure the software being developed is up to the industry standards and also to ensure that our system meets all the below mentioned quality attributes so that all the qualities that are to be meet is being explored:

Reliability: Reliability is an important quality in any product for that matter. Since the product is being used for a specific reason if the product isn't reliable then there is no point in using it. People can go for other similar products. And in case of the system, we are making sure that thesystem usability will be 100% reliable. That is, by introducing wireless ZigBee technology we want to improve reliable quality of our system.

Maintainability: The system being developed should be easier to perform maintenance on. Any issues that may occur shouldn't cause any large-scale damage and any repairs to be done should be easy to perform and, in the system, we have developed the maintenance will be of lessof human labor and easy to perform as the hard ware will be placed in a closed location whilethe sensors will be placed inside the protective layer of the pipes, making any kind of upgradesor repairs easier. Also, the software is just a simple website any latest releases will be easily accessible by a common IP
address.

Usability: Usability is the factor which focuses on ease of use that is how easy it is for people to use the system. Since the system we proposed make use of the application is the one which is under the limelight here. The app has been designed in such a way that the UI can't be made anymore simpler. Any person who can understand the terms ON and OFF can make
use of the system. For as long as the app is paired to the hardware it will be the easiest touse as the person only needs to turn on or off the motor depending on the sensor value which is displayed.

Portability: Portability is one of the biggest advantages with any system. If the system can be taken to any place without having to go through a lot of trouble, then that system has the biggestadvantage. Which is the case with our system, since our system is very small and can be movedaround without any issues and since there isn't any requirement for a specific system to be connected to this hardware for it to work, we can say this system is portable. And since monitoring happens via mobile devices there is no need to be worried about the systems to be moved about when relocating.

Efficiency: Efficiency is the major system quality attribute. If the system isn't efficient then the whole point in introducing a solution to a problem is moot. We should make sure the system being designed for a specific problem has to be prepared for any kind of efficiency problems that may occur. As in our case the system was designed to make sure the existing systems can be incorporated along with our system to complement each other and thereby helping in improving the efficiency of the entire setup. By making sure the systems are being merged the possible errors of the existing system will be patched by this system and the disadvantages if any will be easily patched by the existing system. There by providing an efficient solution to the problem.

CHAPTER 4

SYSTEM DESIGN AND IMPLEMENTATION

4.1 Modules

4.1.1 Data Logging

Data logging refers the initial step where the hardware system is power up and the data gathering from each individual sensors that are involved in the proposed system. Each sensor starts accumulating the values. These values are the major role-playing entities in the proposed system. The data of each sensor is transferred to the system in the further modules.

4.1.2 Data Communication

The sensor senses the values simultaneously, but the values are not updated to any visual module, thus this module involves the simultaneous updating of the sensor values to the end user. This module plays the vital role. This logs all the values that are updated whenever the sensor finds its new value.

4.1.3 Interpretation

Interpretation refers the analysis that takes place to find out whether the sensor value increases more than the set value, this is the most important module which is responsible to update an notify any failure that happens. Each sensor has been set to threshold value (For this prototype, own threshold values are been calculated), whenever the sensor value reaches the threshold, this module's responsibility is to trigger the notification to report the problem.

4.1.4 Notification

The final module brings the result phase where upon their interpreted value the system send notification to the mobile app as well as a SMS service is provided to the working men in the particular region.

4.2 Hardware Implementation

Here all the integrating concepts of microcontroller architecture, software and interfacing to accomplish the required system are explained. The single board is designed around the Arduino Microcontroller to accomplish the above-mentioned system requirements. The hardware section is divided into six subsections as follows:

1. Arduino Uno Microcontroller
2. Gas Sensor (MQ135)
3. Ultrasonic Sensor
4. GSM 900A module
5. LDR sensor
6. Buzzer
7. Power Supply

4.2.1 Arduino Uno

Arduino is an open source, PC paraphernalia and programming organization, endeavor, and client group that plans and produce microcontroller packs for constructing programmed devices and intelligent object that can detect and control questions in the real world. The inception of the Arduino extends began at the Interaction Design Institute in Ivrea, Italy. The equipment reference plans are appropriated under a Creative Commons Attribution Share.

Fig 4.1: Arduino Uno

Specification of Arduino UNO:

It is an ATmega328P based Microcontroller

The Operating Voltage of the Arduino is 5V

The recommended input voltage ranges from 7V to 12V

Digital input and output pins-14

Digital input & output pins (PWM)-6

Analog I/P pins are 6

DC Current for each I/O Pin is 20 mA

DC Current used for 3.3V Pin is 50 mA

Flash Memory -32 KB, and 0.5 KB memory is used by the boot loader

SRAM is 2 KB

EEPROM is 1 KB

The speed of the CLK is 16 MHz

In Built LED

Length and width of the Arduino are 68.6 mm X 53.4 mm

- The weight of the Arduino board is 25 g

4.2.2 GSM

GSM stands for World System for Mobile Communication. it's a digital cellular technology used for transmission mobile voice and information services. GSM provides basic to advanced voice and information services together with roaming service. Roaming is the ability to use your GSM telephone number in another GSM network.

Fig 4.2: GSM 900a

Specification of GSM SIM900A:

Dual-Band 900/ 1800 MHz
GPRS multi-slot class 10/8GPRS mobile station class B
Compliant to GSM phase 2/2+
Dimensions: 24*24*3 mm
Weight: 3.4g: Control via AT commands (GSM 07.07 ,07.05 and SIMCOM enhanced AT Commands)
Supply voltage range: 5V
Low power consumption: 1.5mA (sleep mode)
Operation temperature: -40°C to +85 °

4.2.3 Gas Sensor

A gas detector is a device that detects the presence of gas in a region, usually as a part of a safety system. This type of equipment is used to notice a gas leak or other emissions and might interface with a control system so a method is automatically shut down. A gas detector will sound associate alarms to operators in the area where the leak is occurring, giving them the chance to depart. This kind of device is very important because there are several gases which will be harmful to organic life, like humans or animals. The operating voltage of this gas sensoris from 2.5V to 5.0V. The MQ-3 gas sensor has a lower conductivity to clean the air as a gas sensing material.MQ-135 gas sensor can be implemented to detect the smoke, benzene, steam,and other harmful gases.

Fig 4.3 Gas Sensor Mq135

4.2.4 Ultrasonic Sensor

An ultrasonic detector is a device which will measure the distance to an object by using sound waves. It measures distance by causing a sound wave at a particular frequency and listening for that sound wave to recover. By recording the time period between the sound wave begins and therefore the sound bounces back it's possible to calculate the distance

Fig 4.4 Ultrasonic Sensor

4.2.5 LDR Sensor

LDR is a photoresistor which is a semiconductor device that uses the light energy to control the flow of electrons and hence current flow through them. When the light is absorbed by the material then the conductivity reduces, when light falls on the electron's valence band eager to conduction band. Using this detector we find whether the lid of the manhole is open or closed.

Fig 4.5 LDR Sensor

4.3 Hardware Implemented Model

Arduino Uno is used as the microcontroller; this is interfaced with various sensors to perform data acquisition. The sensor values are thus sent to the cloud.

The various sensors used are,

➢ Ultrasonic, for the water level sensing, this will detect the level of water for which the notification is sent for water level increasing such that it may increase the flow and blockage occurs in return causes blockage.

➢ Gas sensor, the toxic gases inside the manhole will cause dangerous diseases for lungs and respiration. The gases might also cause death to the workers who dive into the vent for cleaning. Thus, the gas sensor monitors the gas level.

➢ LDR sensor, this detect the lid of the manhole to be closed or not. This results in the precaution of avoiding accidents due to open vents. The Buzzer, this is fixed in the lid to alarm the person/any object that comes near the open vent.

➢ The GSM module, is used to send data to the cloud also send message to the workers who are assigned to the particular area. The GSM module thus integrates the data and process them to send them.

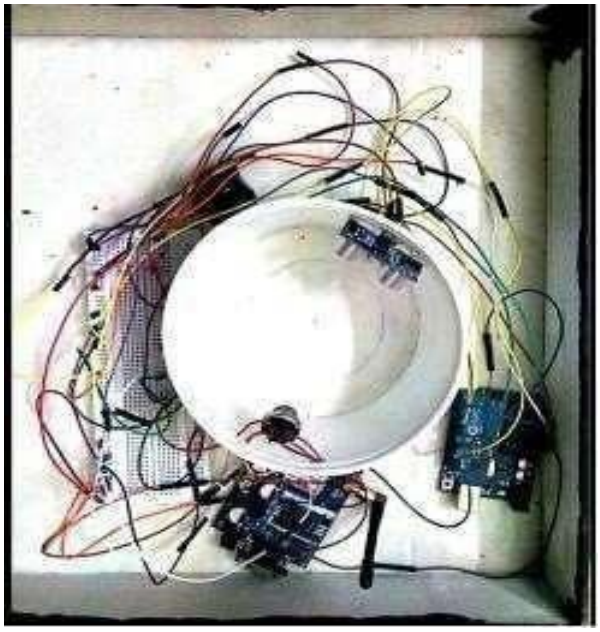


Fig 4.6 Hardware Implemented Model

The Arduino microcontroller is the main module in the proposed system. The number of sensors used in the system are connected to the Arduino. Arduino Uno R3 is one kind of ATmega328P based microcontroller board. It includes the whole thing required to hold up the microcontroller; just attach it to a PC with the help of a USB cable, and give the supply using AC-DC adapter or a battery to get started. It comprises 14-digit I/O pins. From these pins, 6pins can be utilized like PWM outputs. This board includes 14 digital input/output pins, Analog inputs-6, a USB connection, quartz crystal-16 MHz, a power jack, a USB connection, resonator16Mhz, a power jack, an ICSP header an RST button. To start with we power up the Arduino with 5v normally, and give the GND to the bread board.

The ultrasonic sensor for detection of water level has 4 pins namely, echo, trig, +VCC and GND the GND and +VCC are connected to the Arduino's GND and VCC. The echo pin is connected to the PIN 6 of Arduino, these are digital pins and trig is connected to the PIN 5 of the Arduino.

The GAS sensor has 6 pins where it connects to the analog of Arduino. The analog PIN A1is connected to the gas sensor and it has 2 GND connection one direct to the GND and one connected with resistor. The rest 3 pins are connected to the +VCC of the Arduino.

The LDR sensor has 2 pins which connects to analog pin A0 further resistor to GND and another pin connects to the +VCC of Arduino. The buzzer used to provide alarm connects to the pin 2 of the Arduino and followed by GND connection.

The other ultrasonic sensor used for the movement prediction connects to digital pin of Arduino that is the echo to the PIN 11 and trig to the PIN 12 followed by +VCC and GND connection.

The most important connection is the GSM which connects to the TX and RX of Arduino. TX refers to the transmitter and RX refers to the receiver, the transmitter and receivers is so important in any type of communication modem. GSM needs additional power supply in addition to the +VCC of the Arduino. The TX is connected to the PIN 9 of Arduino, RX is connected to the PIN 10. The additional power supply can be given with help of battery.

4.4 Software Implementation

The system architecture is the conceptual design that defines the structure and behavior ofa system. An architecture description is a formal description of a system organized in a way that supports reasoning about the structural properties of the system. An architecture diagram isthe one which describes the overall view of this work. It is the pictorial representation of the entire work which is to be carried out.

4.4.1 Modbus Stimulator

Modbus is a communication protocol widely used in industrial automation to communicate between electronic devices. A Modbus Simulator is a software tool that can simulate a Modbus Master or Slave device to test and debug Modbus communication systems.

The Modbus Simulator allows users to create virtual Modbus devices and test Modbus communication between different devices. It can also be used to test the behavior of the Modbus Master device when communicating with Modbus Slave devices. The simulator can help identify problems and errors in the communication between devices and ensure that the system is working correctly.

Modbus Simulators are useful for testing Modbus communication systems during the development and implementation stages. They can help ensure that Modbus devices are communicating correctly and can reduce the time and cost of troubleshooting and fixing problems in the system. Overall, Modbus Simulator is an essential tool for Modbus developersand engineers to test and debug Modbus communication systems efficiently.

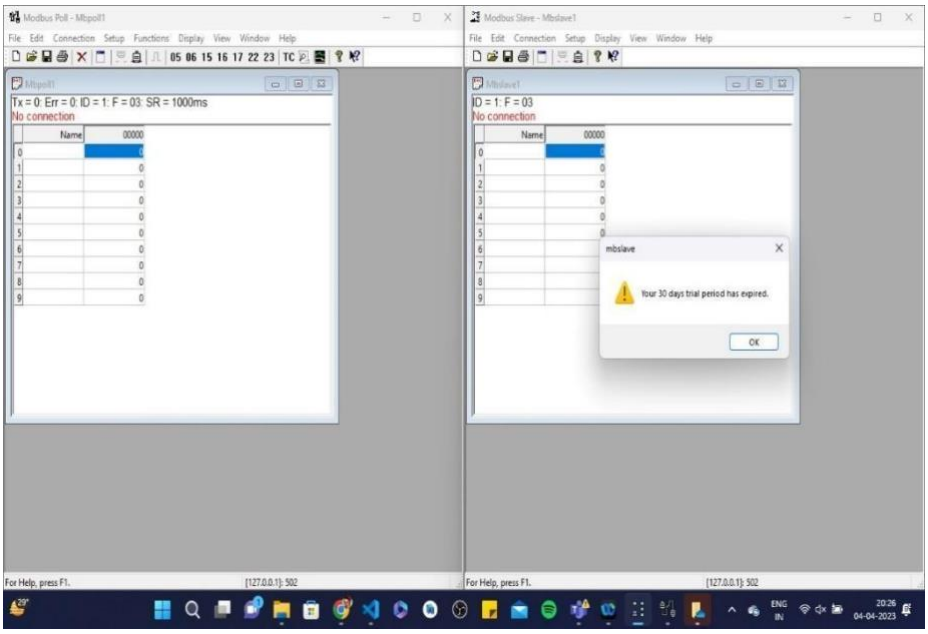


Fig 4.7 Modbus simulator

Here is a general guide to setting up a Modbus Simulator:

1. Choose a Modbus Simulator software: There are several Modbus Simulator software options available, such as Modbus, Modbus Poll, Simply Modbus Choose asimulator that meets your requirements and download and install it on your computer.

2. Configure the communication settings: Open the Modbus Simulator software and configure the communication settings such as the serial port or TCP/IP settings, baud rate, data bits, parity, and stop bits. You may also need to configure the device address, function code, and register type, depending on the software.

3. Set up the virtual device: Create a virtual Modbus device by configuring the device address and function codes. You can also define the data values of the virtual device, such as coils, registers, or input registers. Make sure the virtual device settings match the Modbus device you want to simulate.

4. Test the Modbus communication: Start the Modbus communication between the virtual device and the Modbus Master device, and send or receive Modbus messages.

Check the simulator logs to ensure that the communication is working correctly, and the values are being read or written correctly.

5. Debug and troubleshoot: If there are any issues with the Modbus communication, use the simulator logs to debug and troubleshoot the problem. Check the communication settings, device addresses, and data values, and make sure they match the requirements of the Modbus device you are simulating.

4.4.2 Firebase

A development platform dubbed Firebase was created by Google to cater for mobile and web applications. Its features comprise a package of tools and services essential for managing the various aspects of app development, backend services included, analytics, authentication, messaging functionality among others.

Features of Firebase include:

1. **Real-time database:** Firebase provides a real-time database that allows developers to store and sync data in real-time across multiple clients. This database uses JSON as its data format and provides real-time data synchronization across all connected clients.

2. **Cloud storage:** Firebase provides a cloud storage service that allows developers to store andshare user-generated content, such as photos, videos, and audio files.

3. **Authentication:** Firebase provides a user authentication service that allows developers to easily add authentication to their mobile and web applications. It supports different authentication methods, such as email/password, Google, Facebook, and more.

4. **Analytics:** Firebase provides a powerful analytics service that allows developers to track userbehavior and engagement in their mobile and web applications. This service provides real-timeanalytics, conversion tracking, and user segmentation.

5. **Cloud messaging:** Firebase provides a cloud messaging service that allows developers to send notifications and messages to their users. This service supports both iOS and Android devices and provides advanced targeting and segmentation options.

6. **Hosting:** Firebase provides a hosting service that allows developers to easily deploy and host their mobile and web applications. This service provides a secure and scalable hosting solutionfor developers.

4.4.3 Algorithm of the Implemented Model

1. Install the Modbus simulator software on your computer.
2. Create a new project in the SCADA tool.
3. Add a new device to the project and select the Modbus protocol.
4. Configure the Modbus communication settings, such as the communication port, baud rate, and parity.
5. Define the Modbus registers that you want to monitor or control in the SCADA tool.
6. Map the Modbus registers to the corresponding tags in the SCADA tool.
7. Set up alarms and notifications for the monitored values, if necessary.
8. Configure the data logging settings to record the historical data of the monitored values.
9. Set up the user authentication and access control settings for the SCADA tool.
10. Test the SCADA tool by connecting to the Modbus simulator and verifying the data readings and control functions.

4.5 Context Analysis

4.5.1 Flow Chart

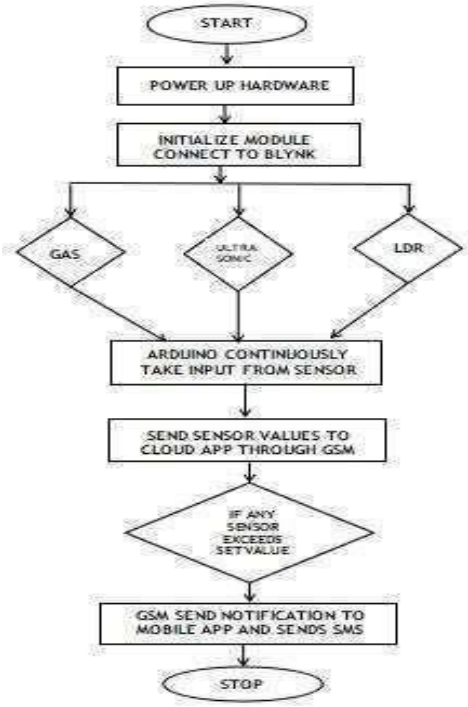


Fig 4.8 Flow Chart of Proposed System

The above diagram describes the flow of the proposed system. The process is actually a loop where sensor values are updated for each loop that runs. The loop runs until there is a connection or power supply available.

4.5.2 Use Case Diagram

The use case diagrams are used to analyze the requirements of the system from a high-levelperspective. So, when we analyze these requirements, we can determine the functionalities in these use cases. Therefore, we can say that use case diagrams are nothing butsystem functionalities written in an organized manner. The second thing relevant in a use case is the actors, and they are something that interacts with the system. Actors can be human users, computers, apps or artificial intelligence. Here we are planning to draw the use case diagrams for our system and try to analyze the various user interactions possible with our system and how each of these use cases are relevant in the working of our system.

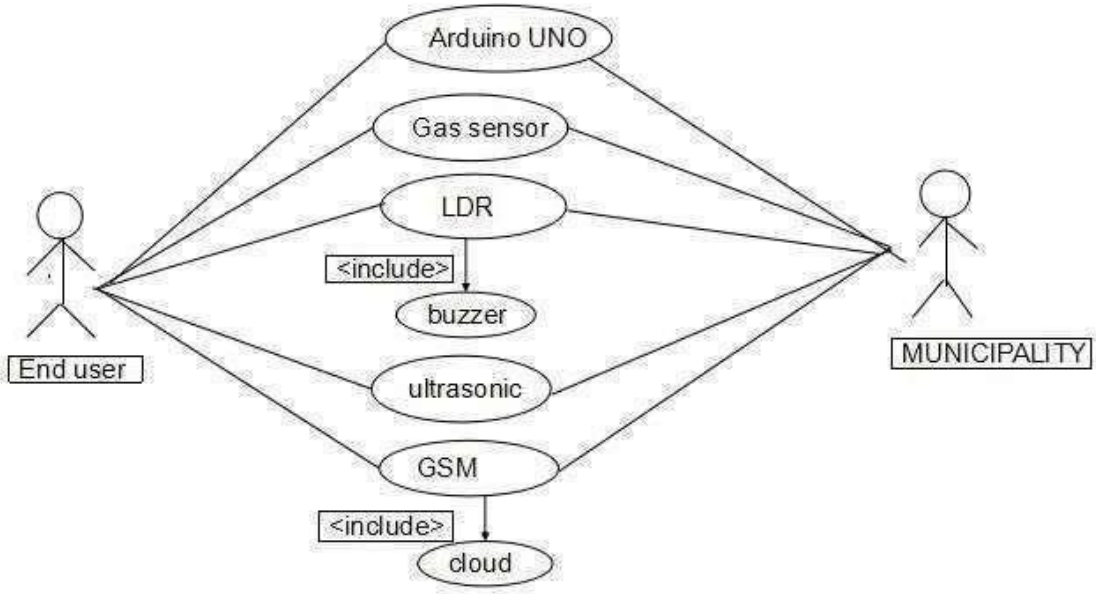


Fig 4.9 Use Case Diagram

4.5.3 ER Diagram

An entity-relationship diagram (ERD) is a data modeling technique that graphically illustrates an information system's entities and the relationships between those entities. An ERD is a conceptual and representational model of data used to represent the entity framework infrastructure. For each data flow, at least one of the endpoints (source and / or destination) must exist in a process. The refined representation of a process can be done in another dataflow diagram, which subdivides this process into sub-processes in the proposed system the major entities are the municipal corporation, end-user and the hardware itself, each entity contains its own attributes. Each entity has a unique key value that might vary depending upon the name, place, things.

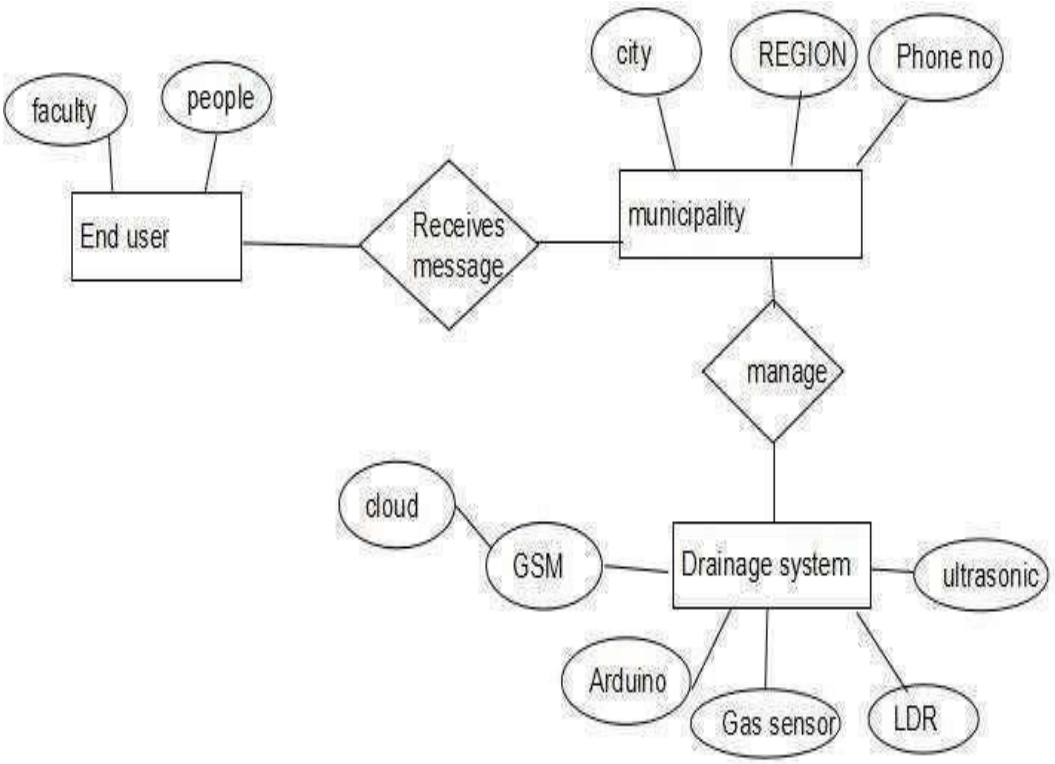


Fig 4.10 ER Diagram

4.5.4 Data Flow Diagram

A DFD is a graphical representation of the flow of the data that flows entirely through the system. A DFD can also be used to envision the flow of data through the system. The data can flow from an outsider source of data or from an insider source of data to an external destination or an internal destination itself through an internal method or subroutine.

A data flow diagram is an imaginative and instinctive way of displaying how the data and information is processed and flows inside the system. These Data flow diagrams are mainly used to explain the system design and how the data flow in a specific sequence will change the system behavior and how it affects the system as a whole.

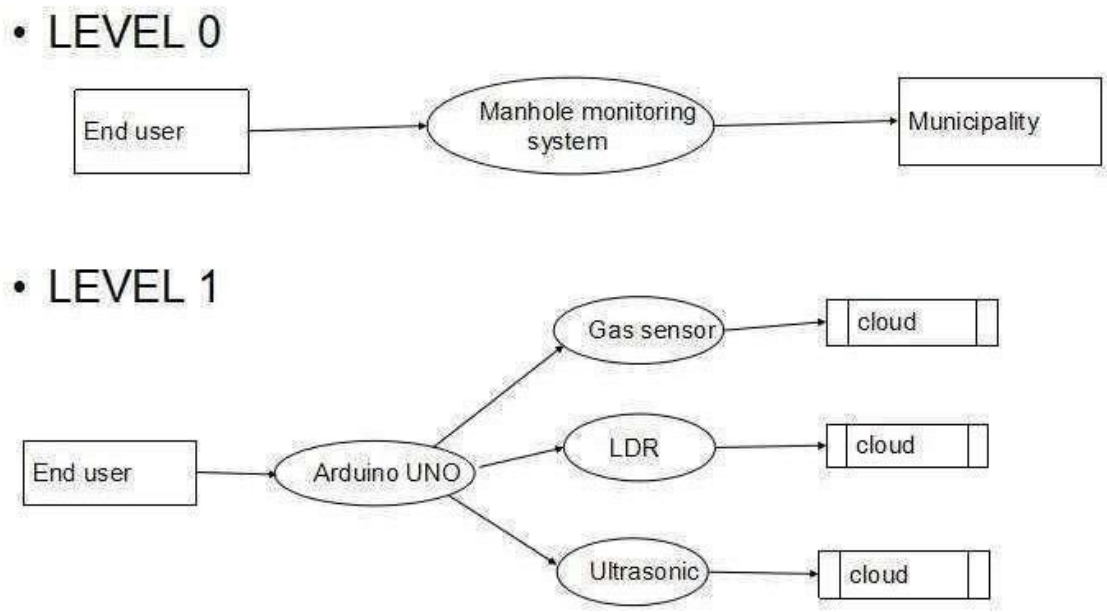


Fig 4.11 DFD Diagram Level 0 And 1

The level 0 DFD is commonly referred to as the context level DFD's and it is mainly created for the purpose of depicting the outsider's involvement in the system. The designers usually create this to show how exactly different entities can interact with the system and how the system can be controlled by the users to make efficient use of the system

In level 0 we made sure the secured connection between the PC and the hardware module has been established. From here on out the remote monitoring process happens and the user has gained access to the system and can remotely monitor the entire process.

- LEVEL 2

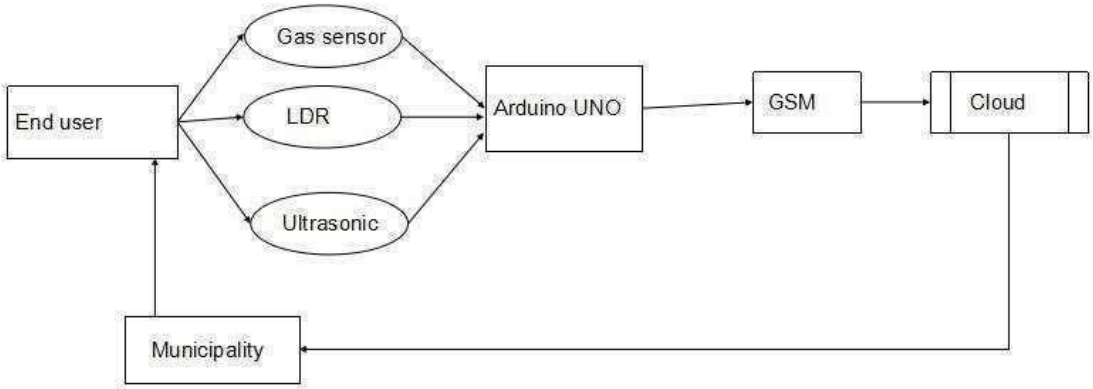


Fig 4.12 DFD Diagram Level 2

The level 2 DFD clearly depicts the entire system functionalities where we can see how the user communicates via the PC to gain access to the system and then the constant monitoring of the system and once the water flow rate decreases from the expected threshold the users move into action where the user sends the command depending on the water flow rate to control the specific valves. The valve may be turned on or off depending on the water flow rate and will be still under observation.

CHAPTER 5

SYSTEM TESTING

System testing is the process used to help identify the correctness, completeness, security, and quality of developed computer software. Testing maybe a method of technical investigation, performed on behalf of stake holders, i.e., intended to reveal the quality related information regarding the product with reference to context during which it is supposed to be control. This includes; however, it is not restricted to, the method of executing a program or application with the intention of finding errors. Testing furnishes a 'criticism' or comparison that compares the state and behavior of the product against specification.

5.1 Testing Methodologies

The following are the Testing Methodologies:

5.1.1 Unit Testing

Individual component is tested to make sure that they operate correctly. Each component is tested independently, without other system component. This system was tested with the set of proper test data for each module and the results were checked with the expected output. Unit testing focuses on verification effort on the tiniest unit of the software design module. This is also known as module testing. This testing is distributed throughout phases, each module is found to be functioning adequately as regards to the expected output from the module.

5.1.2 Integration Testing

Integration testing is another aspect of testing that is generally done in order to find out the errors related with the flow of data across interfaces. The unit-tested modules are grouped together and tested in small segment, which makes it simpler to isolate and correct errors. This approach is continued until it has been integrated all modules to form the system as an entire.

5.1.3 User Acceptance Testing

User Acceptance of a method is the key factor for the success of any system. The system under consideration is tested for user acceptance by regularly in contact with the prospective system users at time of developing and making changes wherever required is done in regard to the subsequent point:

5.1.4 Output Testing

Output testing of the proposed system is very much essential as no system could be useful if it does not create the required output in the specified format. Asking the users regarding the format needed by them tests the outputs generated or displayed by the system into consideration.

5.1.5 System Testing

System testing is generally a series of various tests whose primary purpose is to completely exercise the computer-based system. Although every test has a completely special purpose, all work to verify that all system elements have been properly integrated and perform allocated functions.

5.2 Test Cases

Here are the test cases and the expected outcomes which comprised the test plan developed for this system.

5.2.1 Non-Functional Testing

Non-functional testing is the testing of a software application or system for its nonfunctional requirements: the way a system operates, relatively than specific behaviors of that system.

# TEST CASE	1
NAME OF THE TEST	CONNECTING TO THE CLOUD

ITEM BEING TESTED	CLOUD CONNECTIVITY MODULE
SAMPLE INPUT	POWER UP HARDWARE; INTITATE MODEM
EXPECTED OUTPUT	INIT SUCCESSFUL
ACTUAL OUTPUT	SUCCESFUL CONNECTIVITY
REMARKS	PASS

Table 6.1 Test Case For Successful Connection To The Cloud

# TEST CASE	2
NAME OF THE TEST	CONNECTING TO THE CLOUD
ITEM BEING TESTED	CLOUD CONNECTIVITY MODULE

SAMPLE INPUT	POWER UP HARDWARE; INITIATE MODEM
EXPECTED OUTPUT	INIT SUCCESSFUL
ACTUAL OUTPUT	UNABLE TO FIND MODEM
REMARKS	FAIL

Table 6.2 Test Case for Unsuccessful Connection to The Cloud

# TEST CASE	3
NAME OF THE TEST	UPDATING WATER LEVEL
ITEM BEING TESTED	ULTRASONIC SENSOR
SAMPLE INPUT	WATER LEVEL RATE
EXPECTED OUTPUT	SENSOR VALUE OF WATER LEVEL
ACTUAL OUTPUT	LEVEL UPDATED
REMARKS	PASS

Table 6.3 Test Case for Water level Sensing

# TEST CASE	4
NAME OF THE TEST	UPDATING GAS LEVEL
ITEM BEING TESTED	GAS SENSOR
SAMPLE INPUT	GAS RATE INSIDE THE MANHOLE
EXPECTED OUTPUT	SENSOR VALUE OF GAS LEVEL
ACTUAL OUTPUT	LEVEL UPDATED
REMARKS	PASS

Table 6.4 Test Case for Gas Sensing

# TEST CASE	5
NAME OF THE TEST	LID OPEN STATUS
ITEM BEING TESTED	LDR SENSOR
SAMPLE INPUT	LID CLOSED NOW
EXPECTED OUTPUT	NO ISSUE IN THE LID
ACTUAL OUTPUT	NO CHANGES
REMARKS	PASS

Table 6.5 Test Case for Lid Status

5.2.2 Functional Testing

Functional Testing is a testing technique that is used to test the features/functionality of the system or Software, should cover all the scenarios including failure paths and boundary cases.

# TEST CASE	1
NAME OF THE TEST	WATER LEVEL INCREASED TEST
ITEM BEING TESTED	ULTRASONIC SENSOR
SAMPLE INPUT	SENSOR VALUE>=SET VALUE (2.5)
EXPECTED OUTPUT	SEND NOTIFICATION/SMS TO APPLICATION/MOBILE
ACTUAL OUTPUT	NOTIFICATION/SMS RECEIVED
REMARKS	PASS

Table 6.6 Test Case for Increased Water Level

# TEST CASE	2
NAME OF THE TEST	GAS LEVEL INCREASED TEST
ITEM BEING TESTED	GAS SENSOR
SAMPLE INPUT	SENSOR VALUE>=SET VALUE
EXPECTED OUTPUT	TO SEND NOTIFICATION/SMS APPLICATION/MOBILE
ACTUAL OUTPUT	NOTIFICATION/SMS RECEIVED
REMARKS	PASS

Table 6.7 Test Case for Increased Gas Level

# TEST CASE	3
NAME OF THE TEST	LID OPEN STATUS
ITEM BEING TESTED	LDR SENSOR
SAMPLE INPUT	LID IS OPEN
EXPECTED OUTPUT	SEND NOTIFICATION/SMS TO APPLICATION/MOBILE
ACTUAL OUTPUT	NOTIFICATION/SMS RECEIVED
REMARKS	PASS

Table 6.8 Test Case for Lid Open Status

# TEST CASE	4
NAME OF THE TEST	ALARM BUZZER
ITEM BEING TESTED	BUZZER
SAMPLE INPUT	LID IS OPEN SOMEONE COMES NEARBY
EXPECTED OUTPUT	BUZZER SOUND
ACTUAL OUTPUT	BUZZER ON
REMARKS	PASS

Table 6.9 Test Case f or Buzzer Alarm

CHAPTER 6

CODE IMPLEMENTATION

```
import 'package:flutter/material.dart';

import 'dashboard.dart';

import 'dashboard_phone.dart';
class response extends StatefulWidget

  {const response({super.key});

  @override

  State<response> createState() => _responseState();

}

class _responseState extends State<response>

  {@override

  Widget build(BuildContext context) {

    return LayoutBuilder(builder: (context, constraints) {
```

```
      if (constraints.maxWidth < 700)
        {return mobile(context);
      }
      // else if (constraints.maxWidth < 1250) {
      //  return Desktop(context);
      // }
      else {
        return Desktop(context);
      }
    });
  }
  Widget mobile(BuildContext context)
    {return pdash();
  }
  Widget Desktop(BuildContext context)
    {return dash();
  }
}
```

CHAPTER 7

RESULT AND DISCUSSIONS

7.1Result

In this project different methods for monitoring and managing underground manhole system. It explains various applications like underground drainage and manhole identification in real time. Various parameters like temperature, toxic gases, flow and level of water are being monitored and updated on the internet using the Internet of Things. Also, the addition feature of being giving the lid open status might help to avoid unnecessary accidents. This enables the person in-charge to take the necessary actions regarding the same. In this way the unnecessarytrips on the manholes are saved and can only be conducted as and when required. Also, real time update on the internet helps in maintaining the regularity in drainage check thus avoidingthe hazards.

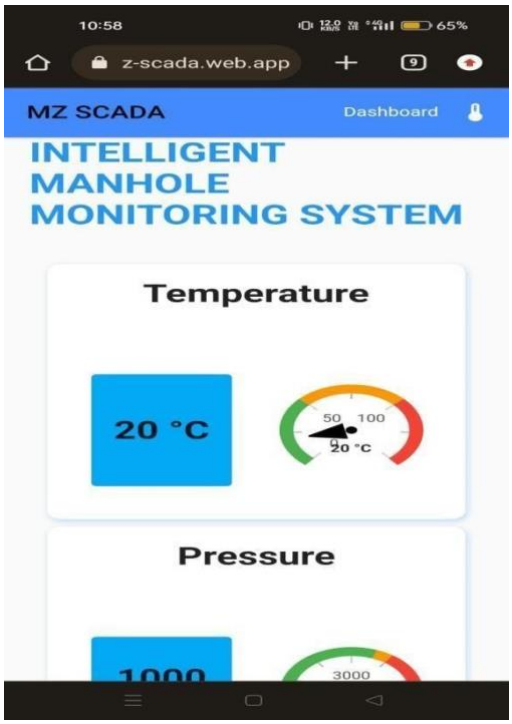


Fig 6.1 UI of Proposed System

The UI of MZ SCADA shows the graphical representation of the alert generated on pressure and temperature deviation. Along with the tab of lid status, gas leakage can be displayed in mobile view.

2. MZ SCADA HOME:

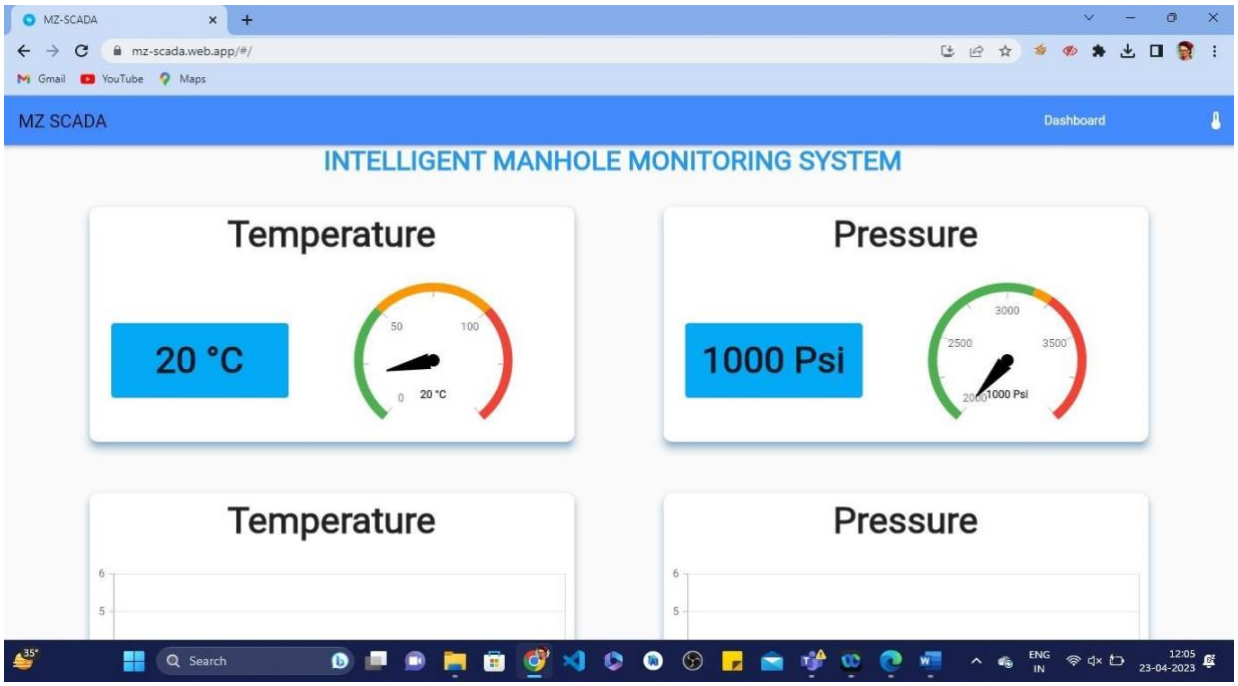


Fig 7.1 Home page

Home page consists of gauge meter of temperature and pressure along with graphs. Itcontains logs of alert reports.

3. MZ SCADA ANALYSIS REPORT:

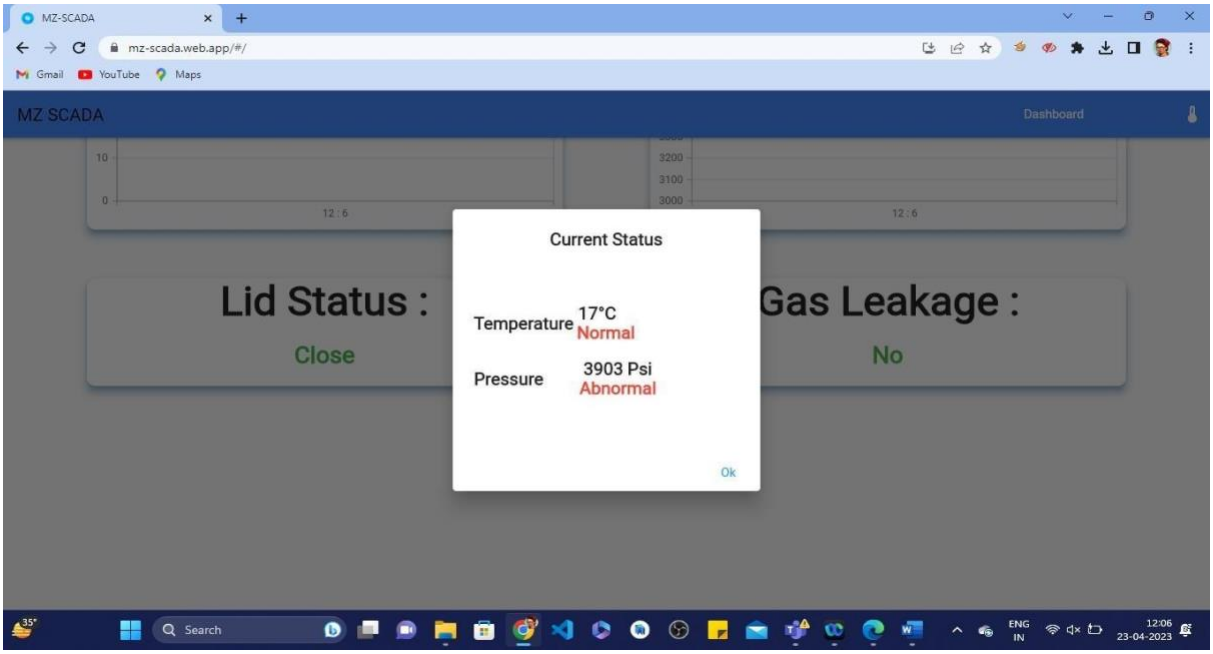


Fig 7.2 Analysis report

Analysis report shows the current status of the temperature and pressure. It pop up whenclicking the check status button.

4. MZ SCADA ALERT BOX :

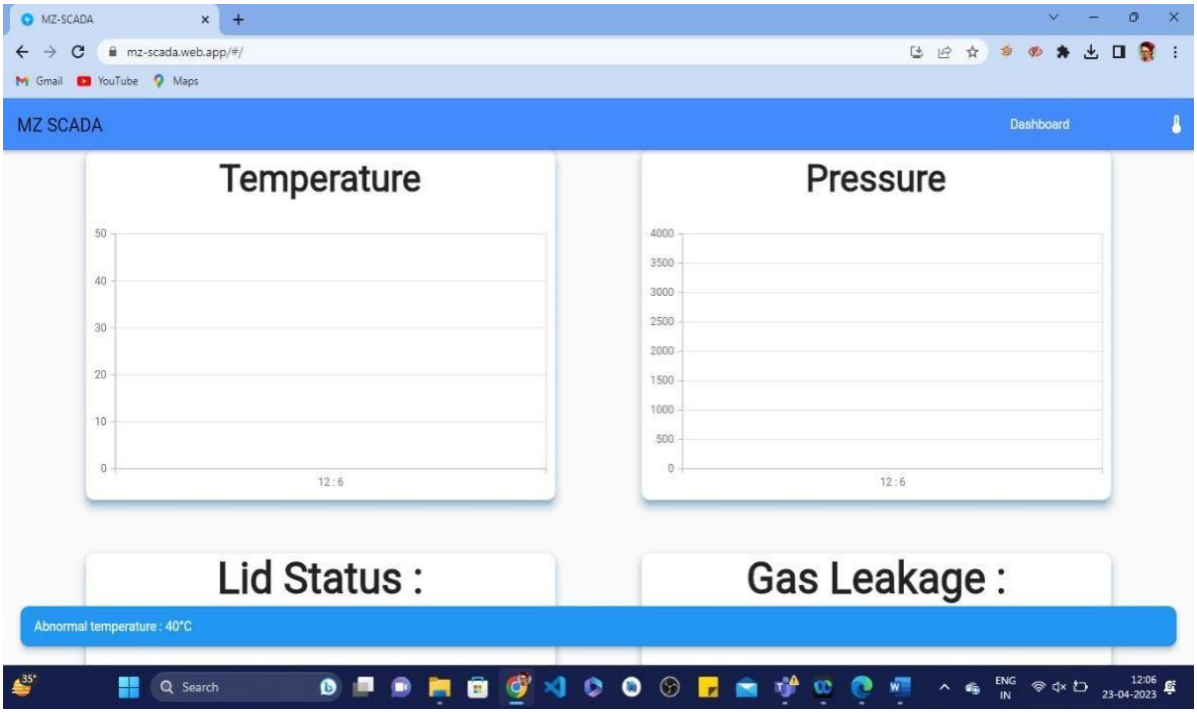


Fig 7.3 Alert box

Alert box shows the alert report of temperature , pressure, gas leakage and lid status.

5. MZ SCADA ALERT GRAPH RESPONSE:

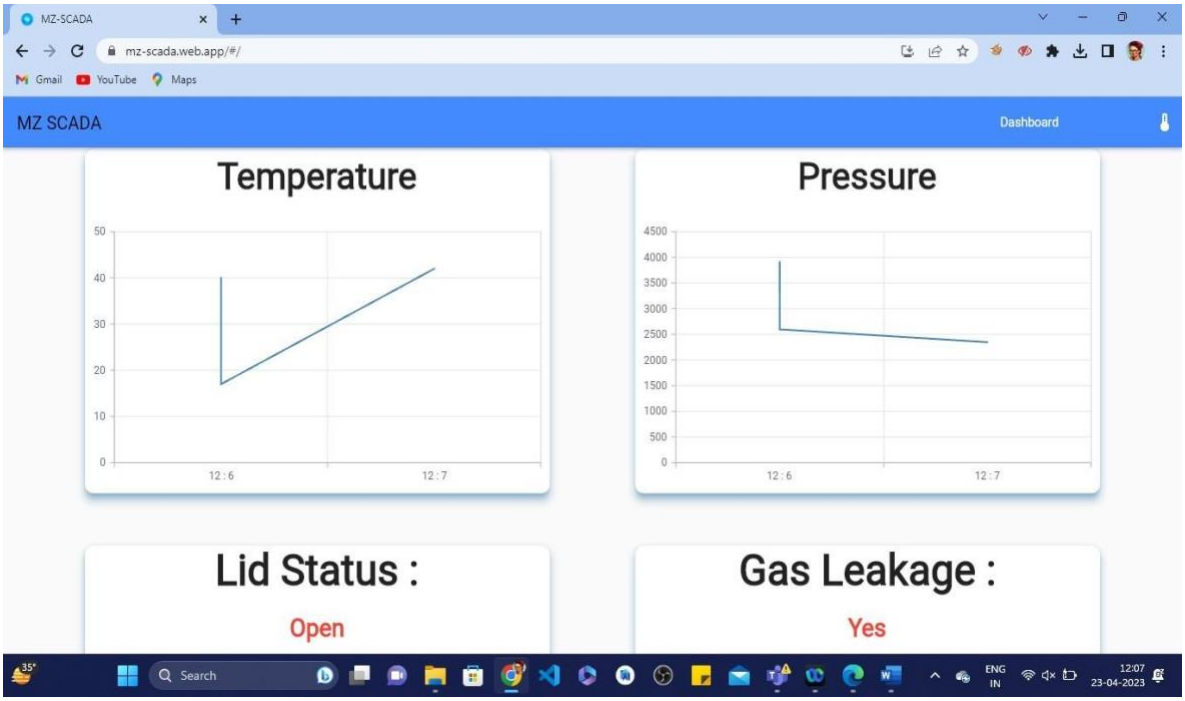


Fig 7.4 Graph response

Graph response is denoted by the schematic representation of the alerts on temperatureand pressure. It captures the live updates of the alerts.

6. MZ SCADA ALERT LOGS:

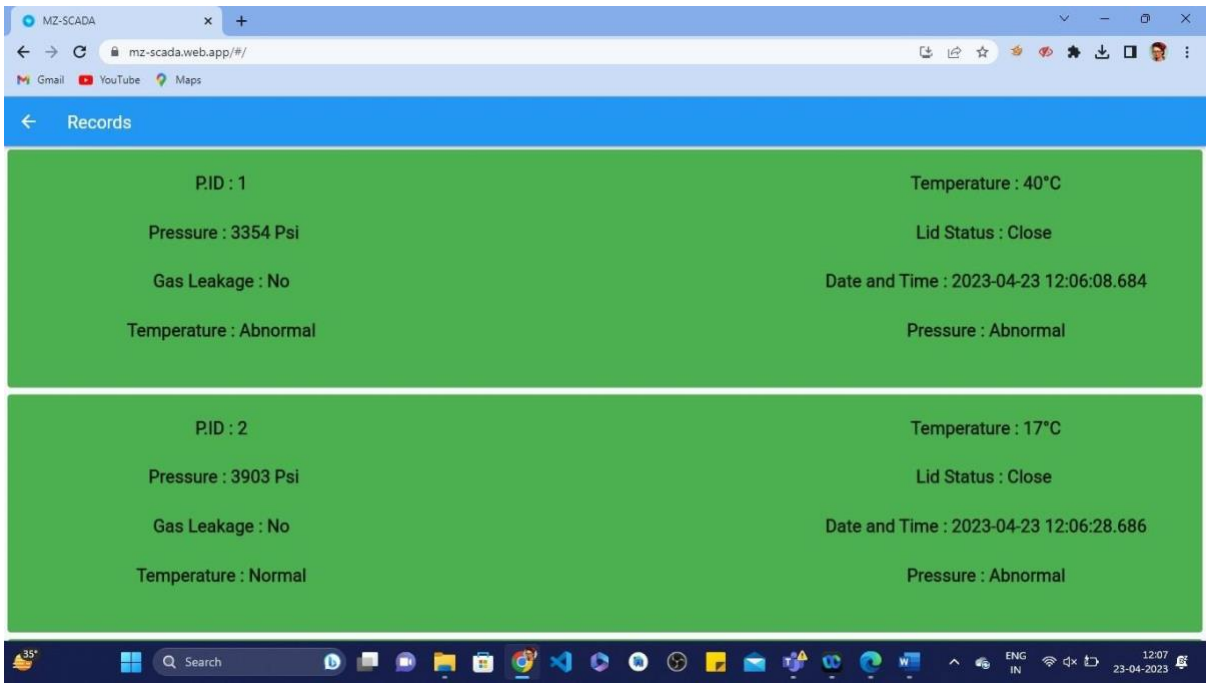


Fig 7.5 Alert logs

Alert logs contains the history of all the alert generated by MZ SCADA. It consists of PID, lid status, gas leakage, temperature and pressure report.

6.1 Discussions

This project proposes totally different ways for observance and managing underground system. It explains varied applications like underground maintaining and monitoring in real time. This permits the person in change to require the actions concerning the identical web mistreatments. Also, in real time update on the web that helps in maintaining and checking that will reduce and avoid the hazards. The low price, efficient, time period water quality metering system has been enforced and tested. Through this method, the officers will keep track of the levels of pollution occurring within the drainage and send immediate message to the officers. This can help in preventing diseases caused to contaminated water. Fast actions may be taken to curb extreme levels of pollution. To fix these critical issues the system has been proposed for drainage monitoring using IoT, data acquisition can be done in the parallel way by detecting by the use of sensor, Global System for Mobile. By this way it reduces the wastage of water anddiseases and might save from accidents.

CHAPTER 8

CONCLUSION AND FUTURE ENHANCEMENTS

8.1 Conclusion

Underground drainage monitoring is challenging problem. This project proposes different methods for monitoring and managing underground drainage system. It explains various applications like underground drainage and manhole identification in real time. Various parameters like flow and level of water, toxic gases inside vent, manhole lid open status are being monitored and updated on the internet using the Internet of Things. The status is updatedinstantly to the cloud. This enables the person in-charge to take the necessary actions regarding the same. By using this project, we can reduce the man power and time consumption to verify the manhole blocking and underground drainage pipe lines and also avoids the hazards. The features are the most welcoming factors for the maintenance, thus helps to keep city clean.

8.2 Future Scope

Sensor networks are considered as the key enablers for the IoT paradigm. However, due to the widening variety of applications, it is increasingly difficult to define common requirements for the WSN nodes and platforms. This project addresses all automated Internet of Things for Underground Drainage phases of the practical development of an Underground Drainage Monitoring System (UDMS) through IoT applications for metropolitan cities. A real life, demanding application is selected as a reference to guide. Aspects of sensor network platform considered are: platform structure, flexibility and reusability, optimization of the sensor nodes, optimization of the communication, error recovery from communications and node operation, high availability of service at all levels, application server reliability and the interfacing with IoT applications. This project can be used to guide the specification, optimization, and development of sensor network Platforms for other IoT application domains.

REFERENCES

[1] Lazarescu, M.T., "Design of a WSN Platform for Long- Term Environmental Monitoring for IoT Applications," Emerging and Selected Topics in Circuits and Systems, IEEE Journal on , vol.3, no.1, pp.45,54, March 2023

[2] Kelly, S.D.T.; Suryadevara, N.K.; Mukhopadhyay, S.C., "Towards the Implementation of IoT for Environmental Condition Monitoring in Homes," Sensors Journal, IEEE, vol.13, no.10, pp.3846, 3853, Oct. 2021.

[3] I. Akyildiz, W. Us, Y. Sankarasubramanian, E. Cabiric, “A Survey on Sensor Networks”, IEEE Communications Magazines, August 2022.

[4] A. Mozambican and Ozgur B. Akan and V. Agrigento, “Spectrum-Aware and Cognitive Sensor Networks for Smart Grid Applications,” IEEE Communications Magazine, No. 5pp. 158-165. 2022

[5] J. Guevara, F. Barrero, E. Vargas, J. Becerra, S. Toral, “Environmental wireless sensor network for road traffic applications,” IET Intel. Transp. Syst., Vol. 6, Is. 2, pp. 177–186, 2021

[6] M. T. Lazarescu, “Design of a WSN platform for long- term environmental monitoring for IoT Applications,” IEEE Journal Emerging and Selected Topics in Circuits and System, vol. 3, No. 1, pp.45-54, 2023.

[7] ZigBee Alliance, Zigbee 2007 Specification, 2020.

[8] Romer, K.; Mattern, F., "The design space of wireless sensor networks," Wireless Communications, IEEE, vol.11, no.6, pp.54,61, Dec. 2020

[9] M. Koriehs, M. Kohvakka, J. Suhonen, P. Hamline, M. Hinokinin, and T. D. hemline, Ultra-Low Energy Wireless Sensor Networks in Practice. New York: Wiley, 2021.

[10] Chang, A.Y.; Chang-Sung Yu; Sheng-Chi Lin; Yin-Yih Chang; Pei-Chi Ho, "Search, Identification and Positioning of the Underground Manhole with RFID Ground Tag," INC, IMS and IDC, 2009. NCM '09. Fifth International Joint Conference on vol no.pp.1899, 1903 25-27 Aug.2009 doi:10.1109/NCM.2021.306

[11] Timofte, R.; Van Gool, L., "Multi-view manhole detection, recognition, and 3D localization, "Computer Vision Workshops (ICCV Workshops), 2011 IEEE International Conference on, vol., no., pp.188,195,6-13 Nov.2011DOI:10.1109/ICCVW.2021.6130242

[12] “Manhole explosions causes and case studies”, by W.Z. Black Georgia Institute of Technology, Atlanta GA June2023.

[13] Manhole cover type sensor node apparatus US 20120206270A1 publication date 16 Aug 2022.

[14] Cloud-based power estimation and power-aware scheduling for embedded systems, Darren Chen, Kai- Feng Chiang, Computers & Electrical Engineering, Volume 47, October 2023, Pages 204-221, ISSN 0045- 7906.

[15] Cloud-based power estimation and power-aware scheduling for embedded systems, Darren Chen, Kaifeng Chiang, Computers & Electrical Engineering, Volume 47, October 2021, Pages 204-221, ISSN 0045- 7906

[16] Information integration for ground-based cloud classification using joint consistent sparse coding in heterogeneous sensor network, Shuang Liu, Zhong Zhang, Jianzhong Cao, Signal Processing, Volume 126, September 2022, Pages 165-172, ISSN 01651684.

[17] An intelligent cloud-based data processing broker for mobile e-health multimedia applications, Future Generation Computer Systems, Da-Ren Chen, Kai-Feng Chian Computers & Electrical Engineering, Volume 47, October 2020, Pages 204-221, ISSN 0045-7906.

[18] A multi-sensor study of the impact of ground-based glaciogenic seeding on clouds and precipitation over mountains in Wyoming, Binod Pokharel, Bart Geerts, Xiaoqin Jing, Katja Friedrich, Kyoko Ikeda, Roy Rasmussen, Part II: Seeding impact analysis, Atmospheric Research, Volume 183, 1 January 2023, Pages 42-57, ISSN 0169-8095.

[19] Mobile cloud-based physical activity advisory system using biofeedback sensors, Future Generation Computer Systems, Hawazin FaizBadawi, Haiwei Dong, Abdulmutallab El Sadik, Volume 66, January 2021, Pages 59-70, ISSN 0167739X

[20] Social construction of storm water control measures in Melbourne and Copenhagen: A discourse analysis of technological change, Herle Mo Madsen, Rebekah Brown, Morten Elle, Peter Steen Mikkelsen, embedded meanings and potential mainstreaming, Technological Forecasting and Social Change, Available online 10 October 2021, ISSN 0040-1625.

[21] Prototyping Business Models for IoT Service, Procedia Computer Science, Daeheon, Mi-Seon Kim, Jehoash, Volume 91, 2022, Pages 882-890, ISSN 1877-0509

[22] IoT-aided robotics applications: Technological implications, target domains and open issues, Computer Communications, L.A. Grieco, A. Rizzo, S. Colucci, S. Sicari, G. Piro, D. Di Paola, G. Boggia, Volume 54, 1 December 2021, Pages 3247, ISSN 0140-3664.

[23] Algorithm-embedded IT applications for an emerging knowledge city: Istanbul, Turkey, Expert Systems with Applications, Melohkule, Muhammed Ali Önder, Vura Akcakale, Volume 41, Issue 12, 15 September 2023, Pages 5625-5635, ISSN 0957-4174.

[24] A library for developing real-time and embedded applications in C, Journal of Systems Architecture, Pablo Basanta-Val, Marisol García-Valls, Volume 61, Issues 5– 6, May– June 2022, Pages 239-255, ISSN 1383-7621.

[25] Big data analytics and firm performance: Effects of dynamic capabilities, Samuel Fosso Wamba, Nagappan Gunasekaran, Steven Ji-fan Ren, Rameshwar Dubey,

Stephen J. Childe, Journal of Business Research, Volume 70, January 2021, Pages 356- 365, ISSN 0148-2963.

[26] Big data and predictive analytics for supply chain and organizational performance Nagappan Gunasekaran, Thanos Papadopoulos, Rameshwar Dubey, Samuel Fosso Wamba, Stephen J. Childe, Benjamin Hazen, Journal of BusinessResearch, Volume 70, January 2023, Pages 308-317, ISSN 0148-2963.

[27] How to improve firm performance using big data analytics capability and business strategy alignment Samuel Fosso Wamba Nagappan Gunasekaran, Rameshwar Dubey, Stephen J. Childe, International Journal of Production Economics, Volume 182, December 2022, Pages 113-131, ISSN 09255273.

[28] Potential of big visual data and building information modelling for construction performance analytics: An exploratory study, Automation in Construction Kevin K. Han, Mani Gopura-Fard, Available online 16 November 2020, ISSN 0926-5805.

[29] Economic effects of a reservoir re-operation policy in the Rio Grande/Bravo for integrated human and environmental water management. J. Pablo Ortiz-Partida, B.A. Lane, S. Sandoval-Solis, Journal of Hydrology: Regional Studies, Volume 8, December 2022, Pages130- 144, ISSN 2214-5818.

[30] Novel integrated systems for controlling and prevention of mosquito-borne diseases caused by poor sanitation and improper water management Mooyoung Han, Shervin Hashemi, Sung Harjo, Schengen Kim, , Journal of Environmental Chemical Engineering, Volume 4, Issue 2021.