Bangladesh University of Business and Technology (BUBT)

Course Code: CSE 426

Course Name: IoT Lab

Project Report

Manholes Monitoring System (IoT Solution)

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ABSTRACT

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.IoT came into existence because, without human interaction computers were able to access data from objects and devices, but it was aimed at, to overcome the limiting factors of human entered data, and to achieve cost, accuracy and generality factors. Sensor Network is a key enabler for IoT paradigm. This paper represents the implementation and design function of a Manhole Monitoring System for IoT applications. The vital considerations of this design are low cost, low maintenance, fast deployment, and high number of sensors, long life-time and high quality of service. The proposed model provides a system of monitoring the water level and atmospheric temperature and pressure inside a manhole and to check whether a manhole lid is open. It also monitors underground installed electric power lines. In real time, UDMS can remotely monitor current states of the manholes.

DECLARATION

We declare that this thesis and the work presented in it are our own and has been generated by us as the result of our own original research. We confirm that: This Work is done wholly or mainly while in candidature for a research degree at this University. This thesis work has not been previously submitted for any degree at this university or any other educational institutes. We have quoted from the work of others; the source is always given. With the exception of such quotations, this thesis is entire our own work.

CERTIFICATE

This is to certify that Tanvir Ahmed, Sourav Hazra, Sujoy Mitra and Sihab Mahmud students of B.Sc. in CSE have completed their project work titled ”Manholes Monitoring System” satisfactorily in partial fulfillment for the requirement of B.Sc.in CSE. Bangladesh University of Business and Technology in the year 2023.

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DEDICATION

Dedicated to our parents for all their love and inspiration.

ACKNOWLEDGEMENTS

First of all, we are thankful and expressing our gratitude to Almighty Allah who offers us His divine blessing, patience, mental and physical strength to complete this project work.

We are deeply indebted to our project supervisor Md. Anwar Hussen Wadud, Assistant Professor, Department of Computer Science and Engineering (CSE), Bangladesh University of Business and Technology (BUBT). His scholarly guidance, important suggestions, work for going through our drafts and correcting them, and generating courage from the beginning to the end of the research work has made the completion of this project possible.

We would like to express our deep gratitude to our Teacher Md. Mahbubur Rahman, Assistant Professor, Department of Computer Science and Engineering (CSE), Bangladesh University of Business and Technology (BUBT). It was fantastic to get help from him and without his support it will be tough for us to reach the accurate goal.

A very special gratitude goes out to all our friends for their support and help to implement our works. The discussions with them on various topics of our works have been very helpful for us to enrich our knowledge and conception regarding the work.

Last but not the least; we are highly grateful to our parents and family members for supporting us spiritually throughout writing this thesis and our life in general.

APPROVAL

This Project “Manholes Monitoring System” Submitted by Tanvir Ahmed, Sihab Mahmud, Sujoy Mitra, Sourov Hazra ID NO: 19202103424, 19202103032 and 19202103407, 19202103036 Department of Computer Science and Engineering (CSE), Bangladesh University of Business and Technology (BUBT) under the supervision of Md. Anwar Hussen Wadud, Assistant Professor and, Department of Computer Science and Engineering has been accepted as satisfactory for the partial fulfillment of the requirement for the degree of Bachelor of Science (B.Sc. Eng.) in Computer Science and Engineering and approved as to its style and contents.

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1. Introduction

1.1 Introduction

Many cities in Bangladesh have an underground drainage system and Municipal Corporation manages the sewage system for clean and healthy climate. The water in the drainage system is sometimes mixed with pure water, due to poor maintenance. The drainage system can spread to the atmosphere and diseases that caused by pathogens. Drainage is disrupted over various seasons due to change in climate, and the environment is volatile and disturbs people and disturbs their daily lives. To solve all the problems of the drainage system and to inform the municipal corporation by sending Blynk notification of the state of the drainage system, so that the officials can take the necessary steps to repair drainage system. The gas itself formed inside the bio-waste drainage system was also detected using a gas sensor to prevent explosion by the pressure inside the drainage system. So our aim of this idea is to track the drainage system using the sensor. When the sewage system is blocked or wateroverflows or the drainage lid is removed, the drainage is monitored using sensor and sensed information is transmitted via Blynk to the nearby municipal corporation official using integrated Wi-Fi, and the water overflow and gas value is displayed live in the cloud for later analysis. And the particular drainage's GPS location is also sent via Blynk Server.

Fig:

1.2 Existing Theory (with Problem Statement in a short form)

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. Hence detection and repairing of the blockage become time consuming. It becomes very inconvenient to handle the situation when pipes are blocked completely. Due to such failure of drainage line people face a lot of problems.

So, this system proposes:

- Detect the location
- The system governing the flow of sewage from the pipes.
- Use of flow sensors to detect the variations in the flow.
- Get the prior alerts of blockages and locate them using IOT.
- Trace location using GPS and send SMS through GSM.

1.3 Motivation

The manhole monitoring system is a safety system in which the city of London has installed sensors in the underground sewer system to detect any gas leaks. The sensors can also be used to detect any manhole covers that have been removed, allowing the city to send out a team of inspectors to fix any issues before they cause any potential danger. Many technologies has been developed, but some how people are still entering into the manhole to clean the sewage's and risking their life to clean the sewage's , so we find a way to monitor the manholes.

1.4 Objectives

- Cleaner cities and intelligent management of drainage in the city
- Detection of drainage water level and blockages in the drainage.
- Checking water flow rate continuously, as well as sending automatic mail, display on the monitor if the water level is outside of an expected normal range.
- The main objective is to obtain an effective low-cost and flexible solution for condition monitoring and infrastructure management in the city.
- Sensing the temperature and leakage of gas and updating it in real time through IoT.

1.5 Contributions

An underground drainage monitoring system will not only help in maintaining the proper health and safety of the city but also in reducing the work of government personnel. Various types of sensors (flow, level, temperature and gas sensors) are interfaced with microcontroller Arduino Uno in order to make the system smart. When the respective sensors reach the threshold level, the indication of that respective value and sensor is being sent to the microcontroller. Furthermore, Arduino Uno then sends the signal and location of the manhole to the municipal corporation through GSM and GPS and the officials could easily locate which manhole is having the problem and could take appropriate steps. Also, Arduino Uno updates the live values of all the sensors in the manholes falling under the respective area using IoT. A message will also be displayed on the LCD.

1.6 Conclusions

A smart city is that the future goal to possess cleaner and better amenities for the society. Smart underground infrastructure is a crucial feature to be considered while implementing a sensible city. System monitoring plays an important role keep the town clean and healthy. Since manual monitoring is incompetent, this results in slow handling of problems in drainage and consumes longer to unravel. Sensor unit automatically senses and updates the live values of the physical parameters like temperature, humidity, water level and flow, blockages, and manhole cap is open or closed through IoT. This makes the system smart and automatic.

2. Existing System

2.1. Introduction

The existing system for manhole monitoring is a manual system that relies on regular inspections by city workers to identify and address issues such as flooding or overflow. Inspections are typically performed on a periodic basis, such as daily or weekly, and involve physically checking each manhole cover to ensure it is not obstructed and that the water level is within an acceptable range.

2.3. Existing/supporting Literature

The readings of many sensors are taken into consideration in this research work, and the manhole is constantly maintained and checked. The simulation method was carried out using Arduino. Then all of the values are double- checked, and the stages are as follows:

Step 1: The water level sensor determines whether or not the water level has risen. If yes, it sends a message through IoT to the corporation's headquarters; otherwise, it continues to monitor.

Step 2: The gas sensor will then check for the presence of gas within the manhole, and if there is any, it will send a notification; otherwise it will continue to monitor.

Step 3: The next sensor monitors for temperature increases, and if there is a significant rise, it alerts the authorities; otherwise, itcontin- ues to monitor.

2.4. Analysis of Existing System

Water level sensor: The water level sensor is used to determine how much water is in the manhole. If the water has increased from its original level, a notifica- tion will be sent to the authorities.

Gas Sensor: Gas sensor is used widely in various applicationsto sense whether the gas is present or not,so that gas sensor is used to check whether the harmful gas presence in the manhole. If it detects any harmful gas, the message will be sent to the corporation office. The MQ-6 sensor is a sensitive component and it is adjustable on the board and also it is a protection resistor. LPG, isobutene, and propane are particularly sensitive to the MQ-6 gas sensor, whereas alcohol is less sensitive.

Temperature Sensor: A temperature sensor is a gadget that measures how much heat energy an item produces. It also has a modest self-heating temperature. If the temperature rises above a certain threshold, an IOT message will be sent. The LM35 is an integrated circuit temperature sensor with a proportional output(in OC). Temperature is monitored more precisely with the LM35 than with a semiconductor device (thermistor).

2.5. Conclusion

Internet of Things has gained its wide popularity in recent days due to its various streams of applications which has paved way for smooth, safe and easier mode of living style for human beings. Though, several techniques is existing for the same, yet Manhole cleaning is one major concern and a challenge always.. This device is designed keeping in mind, the measurement of necessary parameters, which needs to be monitored for unhindered safety of the workers. The device finds major application in Manhole systems, municipal manholes and sewage, sewer, deep well, gutters and drains etc. However, the places where toxic gases or fumes are present should never be handled by human workers directly. In country like Bangladesh where Manhole is mostly cleaned by humans, which make this device useful around Bangladesh. The proposed methodology helps to prevent the sudden accident of workers and also helps to keep the society clean.. The proposed device helps the worker at a basic level of knowledge to understand the gas level. The smart device can be implemented and used across the world and also helps to monitor the overflow of the Manhole water.

3. Proposed model

3.1. Introduction

A manhole is a critical component of urban infrastructure that provides access to underground utility systems such as water supply, sewage, and telecommunication lines. These manholes are located in public areas and need to be monitored regularly to ensure public safety.

Traditionally, monitoring manholes has been a time-consuming and labor-intensive task, involving manual inspections by trained personnel. This method is not only inefficient but also exposes workers to potential hazards.

This is where IoT solutions come in. The use of IoT sensors and cloud-based platforms can provide real-time monitoring of manholes, enabling prompt detection of potential issues and the implementation of appropriate measures.

The proposed Manhole Monitoring System is a cutting-edge IoT solution that is designed to provide reliable and real-time monitoring of manholes. The system uses advanced sensors to measure parameters such as water level, temperature, humidity, and gas levels inside the manhole. This data is then transmitted to a cloud-based platform, where it can be monitored remotely using a mobile app or web interface.

The system is designed to provide alerts and notifications in the event of gas leaks, open manhole covers, or other potential hazards. These alerts can be received in real-time, allowing prompt action to be taken to mitigate any potential issues.

Overall, the proposed Manhole Monitoring System is a reliable, efficient, and safe solution for monitoring manholes, providing essential data and alerts to ensure public safety and the efficient management of urban infrastructure.

3.2. Feasibility Study

In this section, we will discuss the feasibility of our proposed real-time Monitoring System for Manhole Monitoring System using IoT technology.

Technical Feasibility:

The proposed Manhole Monitoring System appears to be technically feasible, as it utilizes well-established IoT technologies such as advanced sensors, wireless communication, and cloud-based platforms. The system is designed to provide reliable and real-time monitoring of manholes, enabling prompt detection of potential issues and the implementation of appropriate measures.

However, challenges related to wireless connectivity in certain locations and ongoing maintenance requirements should be carefully considered when implementing the system. Nonetheless, the proposed system offers a cost-effective and efficient solution for monitoring manholes, promoting public safety and efficient management of urban infrastructure.

Data Feasibility:

The proposed Manhole Monitoring System is data feasible, utilizing cloud-based platforms to collect, process, and store real-time data from sensors. The platform provides customizable options for data visualization, analytics, and alerts, enabling informed decision-making and effective management. However, challenges related to the volume and quality of data generated by the sensors will need to be carefully monitored and calibrated to ensure the system's effectiveness.

Cost Feasibility

1.Hardware Costs:

The proposed system requires sensors, microcontrollers, wireless communication modules, and power supplies. The cost of these components can vary based on the quality and quantity of the components used. However, compared to the existing manually monitoring system, the cost of implementing an IoT-based system can be higher, especially if high-quality sensors and wireless communication modules are used.

2. Software Development Costs:

Developing software for the system requires expertise in programming languages and experience with IoT platforms. The cost of software development can vary based on the complexity of the system and the expertise required. However, this cost can be offset by using open-source software libraries, reducing the overall software development cost.

3. **Installation and Maintenance Costs:**

The cost of installing and maintaining the system can vary based on the complexity of the system and the number of manholes being monitored. However, compared to the existing manually monitoring system, the cost of installation and maintenance can be higher for the IoT-based system, especially if the system is installed in remote or inaccessible areas.

4. Cost Savings:

Despite the higher initial costs, the proposed Manhole Monitoring System using IoT technology can provide long-term cost savings by reducing the need for manual inspections and minimizing the risk of accidents caused by uncovered manholes. This can help reduce the overall cost of urban infrastructure maintenance and increase safety for citizens.

Overall, the cost feasibility analysis shows that the proposed Manhole Monitoring System using IoT technology may have higher initial costs compared to the existing manually monitoring system. However, the potential long-term cost savings and safety benefits can justify the investment in the IoT-based system.

3.3. Requirement Analysis

To implement the proposed real-time Monitoring System for Manhole Monitoring System using IoT technology., we need to identify and analyze the following requirements:

1. Sensor Requirements:

The system requires sensors that can accurately detect the presence of manholes. The sensors should be reliable, durable, and able to withstand harsh environmental conditions.

2. Microcontroller Requirements:

The system requires microcontrollers that can process the sensor data and communicate it wirelessly to the server. The microcontrollers should be low-cost, energy-efficient, and have adequate processing power to handle real-time data analysis.

3. Wireless Communication Requirements:

The system requires wireless communication modules that can transmit sensor data from the microcontroller to the server in real-time. The wireless communication modules should be reliable, have a long-range, and low-power consumption.

4. Data Processing and Analysis Requirements:

The system requires a server that can receive the sensor data and process it in real-time. The data processing and analysis techniques should be efficient, reliable, and accurate in detecting and tracking manholes.

5. Power Supply Requirements:

The system requires a reliable power supply that can ensure uninterrupted operation. The power supply should be low-cost, energy-efficient, and have a long battery life.

6. Software Development Requirements:

The software development for the system requires expertise in programming languages and experience with IoT platforms. The software should be reliable, efficient, and scalable to handle multiple manhole monitoring stations.

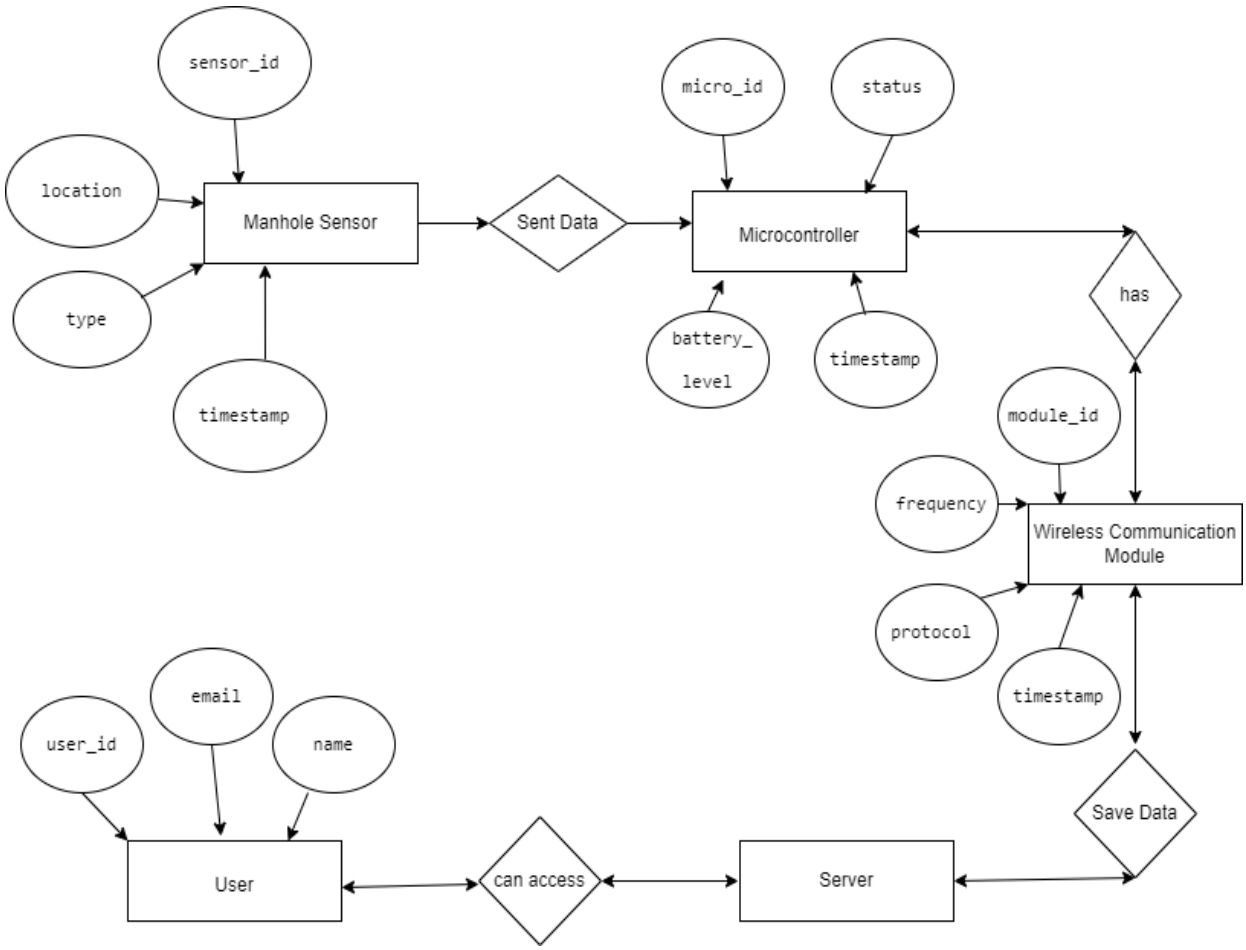
7. Installation and Maintenance Requirements:

The system requires installation and maintenance, which should be done by trained professionals. The installation and maintenance should be cost-effective, efficient, and reliable.

Overall, the requirement analysis shows that the proposed Manhole Monitoring System using IoT technology requires reliable sensors, low-cost microcontrollers, long-range wireless communication modules, efficient data processing and analysis techniques, reliable power supply, scalable software development, and cost-effective installation and maintenance.

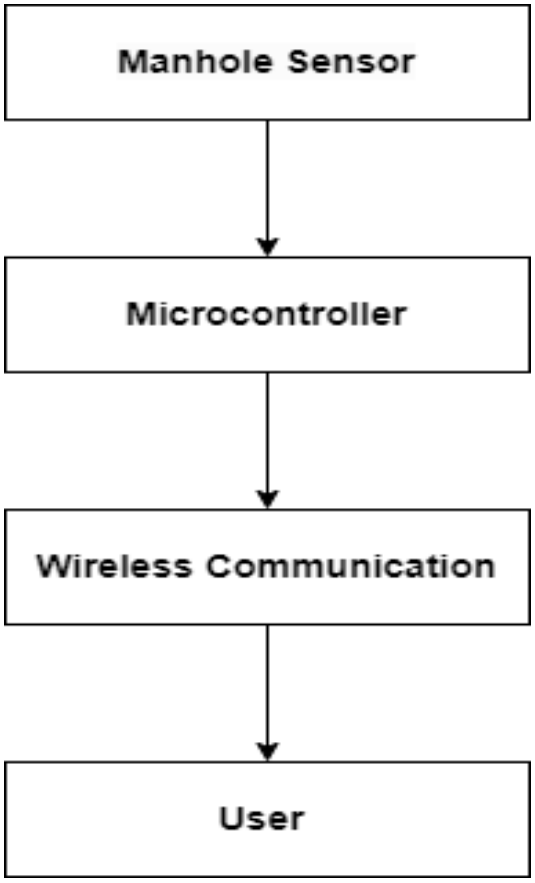
3.4 System Design

3.4.1 ERD



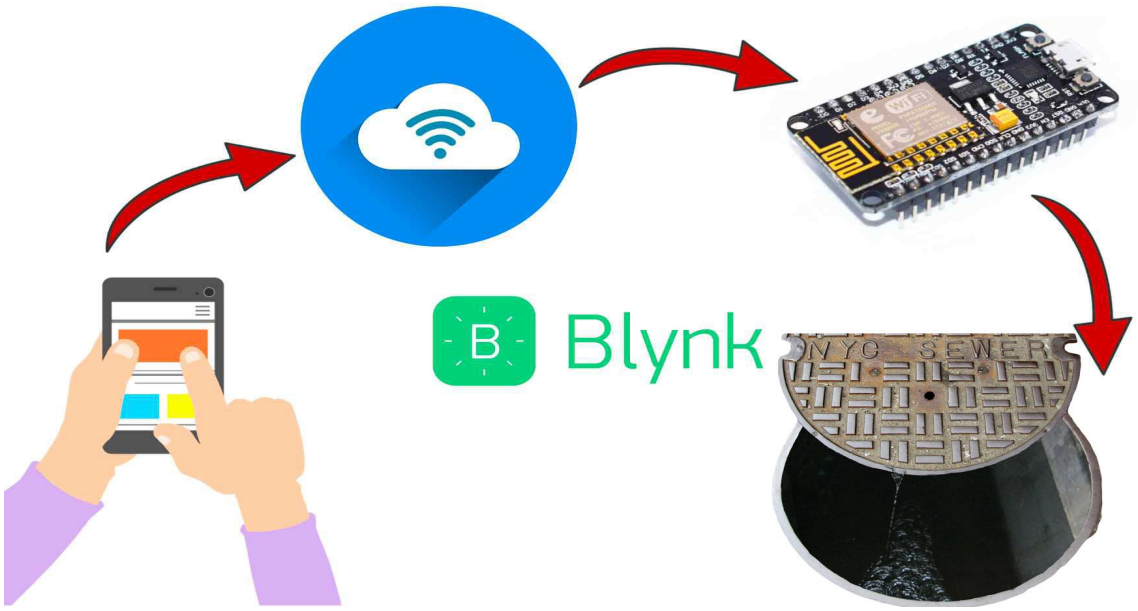
ERD diagram

3.4.2 DFD



DFD diagram

3.4.3 Database Design



Blynk.cloud dataset

3.5 Implementation

1. Hardware Selection:

Select the appropriate sensors, microcontrollers, wireless communication modules, and power supplies based on the requirement analysis.

2.Software Development:

Develop the software for the system based on the requirement analysis. Use open-source software libraries where possible to reduce the software development cost.

3. Prototype Testing:

Build a prototype of the system and test it in the laboratory to ensure that it meets the technical requirements.

4. Field Testing:

Install the prototype system in a real-world environment and test it for a sufficient amount of time to collect data on its performance.

5. Data Analysis:

Analyze the data collected from the prototype system and optimize the system based on the results.

6. System Integration:

Integrate the hardware and software components to create a complete system.

7. Installation and Maintenance:

Install the system in the designated locations and perform routine maintenance to ensure proper operation.

8. System Evaluation:

Evaluate the system's performance over time to ensure that it meets the required technical and functional specifications.

9. Scaling Up:

Once the system has been proven to be effective, scale up the production and installation to cover all the required manholes in the designated locations.

Overall, the implementation plan shows that the proposed Manhole Monitoring System using IoT technology requires careful hardware selection, software development, prototype testing, field testing, data analysis, system integration, installation and maintenance, system evaluation, and scaling up to ensure that it meets the required technical and functional specifications.

3.6 Conclusion

The proposed Manhole Monitoring System using IoT technology can offer an efficient, reliable, and cost-effective solution to monitor manholes in real-time. The system can provide a safer working environment for maintenance personnel, prevent accidents and injuries, and reduce maintenance costs. While the initial implementation cost may be higher than the existing manually monitoring system, the long-term benefits justify the investment in this IoT-based

solution. With proper hardware selection, software development, testing, and maintenance, the system can be successfully implemented and scaled up to cover all the required manholes in designated locations.

4. Experimental Results

4.1 Introduction

I designed this web software using bootstrap framework and font awesome. Those two helps us to design a better visual for the users and it is also responsive in many formats. “The process of enhancing user satisfaction with a product by improving the usability, accessibility, and pleasure provided in the interaction with the product”. “Designers focus on creating engaging web interfaces with logical and thought out behaviors and actions. Successful interactive design uses technology and principles of good communication to create desired user experiences”.

4.2 Result Analysis

When the system get started by taking power supply externally all the sensor will start working The gas sensor sense the harmful gases and report to microcontroller. The water level detection sensor check the flow of water and send value to microcontroller by using ATmega328P microcontroller and ESP 8266 Wi-Fi module output is shown on blynk application.

4.3 Application

The Arduino Integrated Development Environment (IDE) is a cross-platform application (for Windows, macOS, Linux) that is written in functions from C and C++. It is used to write and upload programs to Arduino compatible boards, but also, with the help of third-party cores, other vendor development boards. The source code for the IDE is released under the GNU General Public License, version 2. The Arduino IDE supports the languages C and C++ using special rules of code structuring. The Arduino IDE supplies a software library fromthe Wiring project, which provides many common input and output procedures. User-written code only requires two basic functions, for starting the sketch and the main program loop, thatare compiled and linked with a programstub main() into an executable cyclicexecutive program with the GNU toolchain, also included with the IDE distribution. The Arduino IDE employs the program avrdude to convert the executable code into a text file in hexadecimal encoding that is loaded into the Arduino board by a loader program in the board's firmware. By default, avrdude is used as the

uploading tool to flash the user code onto official Arduino boards

4.4 Conclusion

Our project helps to reduce the problem of drainage system with the help of sensors like water level detection sensor and gas sensor our mechanism helps to notify the connected network, when the harmful gases are detected to gas sensor and water level is detected by water level detection sensor with help of ATmega328P microcontroller and ESP8266 Wi- Fi module which is connected with the Blynk server. by this project the underground drainage system can be easily organized.

5. User Manual

5.1 Introduction

This user manual is designed to provide an overview of the Manholes Monitoring System based on IoT technology. The system is designed to help municipalities and other organizations manage their infrastructure more efficiently by monitoring the condition of manholes in real-time. This user manual will provide instructions on how to set up and use the system, including hardware and software requirements, installation, and configuration. The manual will also provide information on how to access the data collected by the system, generate insights, and perform basic troubleshooting.

5.2 System Requirements

Based on the project's objectives, here are some potential system requirements for the Manholes Monitoring System:

IoT-based sensors: The system should be able to collect data from various sensors, including temperature, humidity, water level, gas level, and Ultrasonic sensor sensors.

Real-time monitoring: The system should be able to monitor the manholes in real-time, alerting the concerned authorities when any issues arise.

Data transmission: The system should be able to transmit data from the sensors to a central server through a wireless or cellular network.

Data storage and analysis: The system should be able to store and analyze the data collected from the sensors. The analysis should be able to identify any patterns or anomalies that require attention.

User interface: The system should have a user interface that is easy to use and allows authorized users to access the data and receive alerts.

Alarms and notifications: The system should be able to send alarms and notifications to the concerned authorities and maintenance teams when specific events occur.

Power management: The system should be designed to conserve power to ensure that the batteries powering the sensors and the central server last as long as possible.

Data security: The system should be designed to protect the data collected from the sensors and ensure that it is only accessible to authorized users.

Scalability: The system should be scalable and able to accommodate additional sensors and devices as the number of monitored manholes increases.

Maintenance and support: The system should be easy to maintain and come with support from the manufacturer or supplier to ensure that any issues can be quickly resolved.

5.2.1 H/W Requirements

Sensors: The system will require different types of sensors such as temperature, water level, gas sensors, and Ultrasonic sensor. These sensors will be used to collect data from the manhole and send it to the central server for analysis.

Communication devices: The system will require communication devices such as GSM, Wi-Fi, and Bluetooth modules. These devices will be used to send data from the sensors to the central server.

Microcontrollers: The system will require microcontrollers such as Arduino or Raspberry Pi to process the data collected by the sensors and send it to the central server.

Power supply: The system will require a power supply such as batteries or solar panels to ensure that it remains operational even in the absence of a direct power source.

Enclosure: The system will require an enclosure to protect the hardware from environmental conditions such as rain, dust, and extreme temperatures.

Central server: The system will require a central server that will receive data from the sensors and process it to provide insights to the end-users. The central server will require sufficient processing power and storage capacity to handle the data collected from multiple manholes.

User interface: The system will require a user interface such as a mobile application or web-based dashboard that will allow end-users to access the insights generated by the system. The user interface will require an internet connection to connect to the central server.

5.2.2 S/W Requirements:

Operating System: The system will require an operating system such as Linux or Windows to run on the microcontroller.

Programming language: The system will require a programming language such as Python or C++ to develop the code that will process the data collected by the sensors and send it to the central server.

Cloud platform: The system will require a cloud platform such as AWS or Azure to store the data collected by the sensors and provide insights to the end-users.

Database: The system will require a database such as MySQL or MongoDB to store the data collected by the sensors.

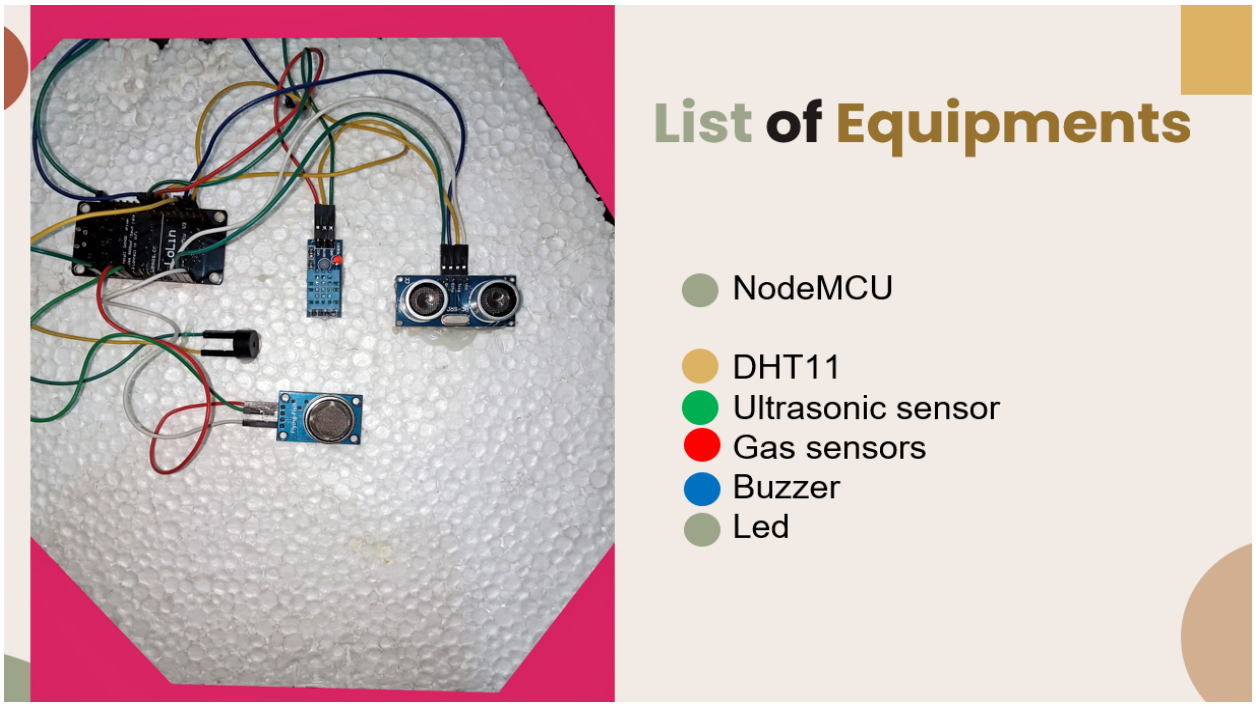
Data visualization: The system will require data visualization tools such as Tableau or Power BI to generate insights from the data collected by the sensors.

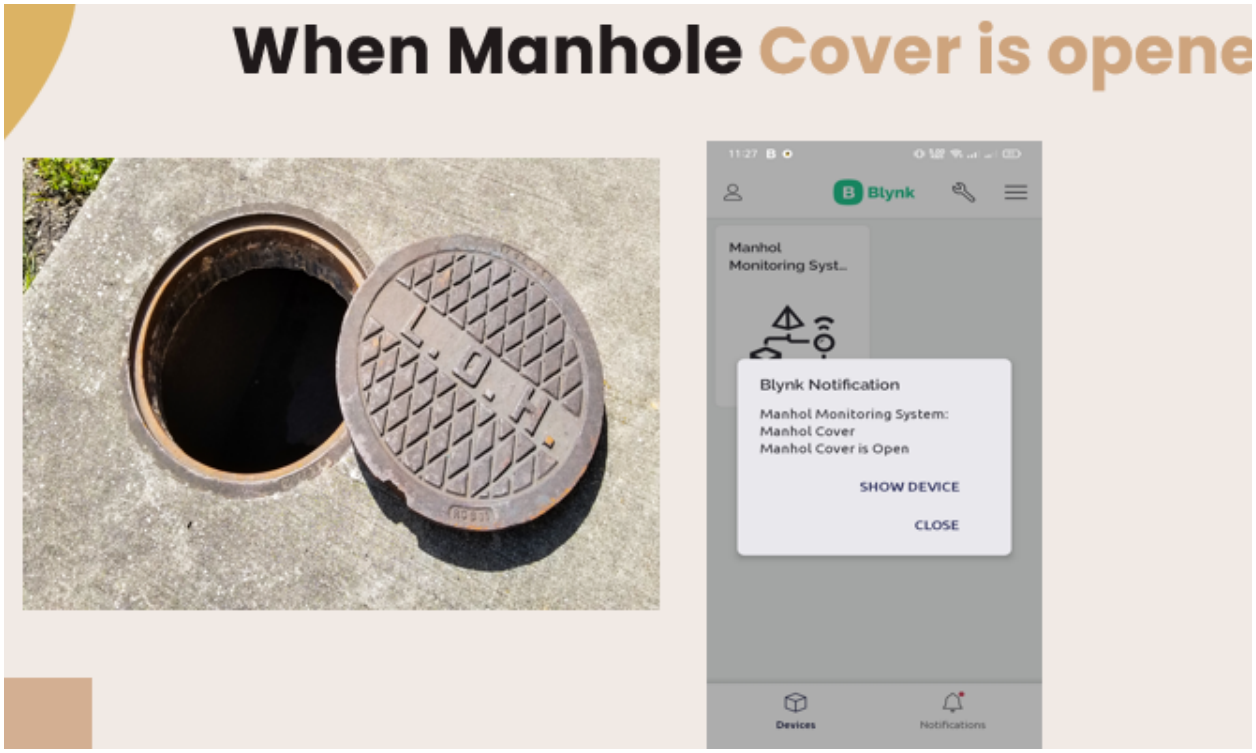
Mobile application or web-based dashboard: The system will require a mobile application or web-based dashboard that will allow end-users to access the insights generated by the system.

API integration: The system will require integration with APIs such as Google Maps to provide location-based insights to the end-users.

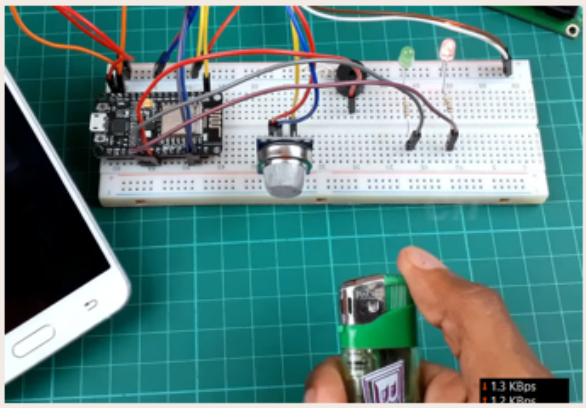
Security: The system will require security measures such as encryption and authentication to protect the data collected by the sensors and ensure that only authorized users can access the insights generated by the system.

5.3.1 User Interfaces and Corresponding Output(screenshot)

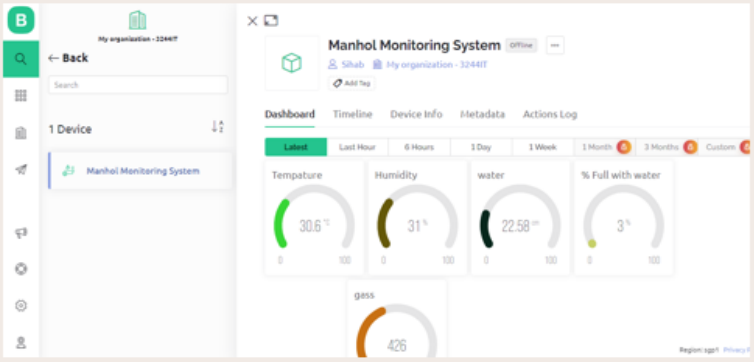


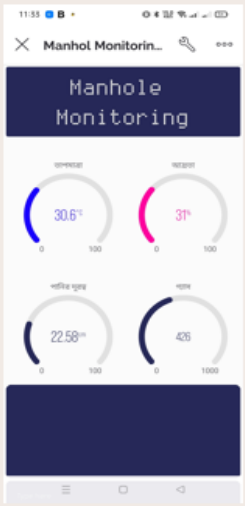


Gas Detection



User Interface(UI)





6. Conclusions

6.1 Conclusion

In conclusion, a manhole monitoring system based on IoT technology can provide a practical solution to the problem of infrastructure maintenance and management. With the use of sensors, microcontrollers, communication devices, and cloud platforms, the system can collect data on the condition of manholes and transmit this data to a central server for analysis. The system can generate insights that can be used to identify potential problems before they occur and enable quick responses to emergency situations.

The hardware and software requirements of the system include sensors, communication devices, microcontrollers, power supply, enclosures, a central server, operating systems, programming languages, cloud platforms, databases, data visualization tools, mobile applications or web-based dashboards, API integration, and security measures.

Overall, the manhole monitoring system based on IoT technology can help municipalities and other organizations manage their infrastructure more efficiently, reduce maintenance costs, and improve public safety.

6.1 Future Work

Future work for the manhole monitoring system based on IoT technology could include:

Machine Learning Integration: The system can integrate machine learning algorithms to analyze data collected over time to predict potential issues before they occur.

Integration with Other Smart City Systems: The system can be integrated with other smart city systems, such as traffic management, waste management, and street lighting, to improve the overall management of urban infrastructure.

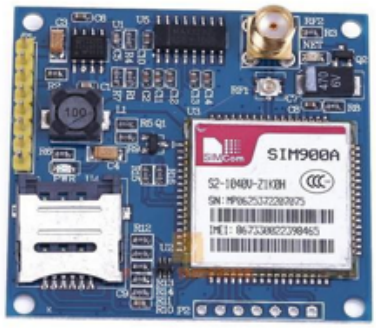
Advanced Analytics: The system can include more advanced analytics capabilities to identify patterns and trends in data that may be missed by traditional analysis.

Battery-Free Sensors: The system can explore the use of battery-free sensors that can harvest energy from the surrounding environment, eliminating the need for batteries and further reducing maintenance costs.

5G Communication: The system can explore the use of 5G communication, which can provide faster data transfer rates, lower latency, and increased bandwidth, improving the system's overall performance.

By implementing these future work items, the manhole monitoring system can continue to evolve and improve, providing better insights into infrastructure conditions and helping municipalities and other organizations make better decisions to manage their infrastructure more efficiently.

Future Work



Wireless Module

GPS Module

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