Embedded System Solutions for Manhole Chamber Safety and Sensor Integration: Next-Gen Smart City Management

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Abstract *- The long-term objective is smart city management with greater amenities for society and cleaner environments. When building a smart city, intelligent subsurface infrastructure should be a key component. Hence due to its importance, many Indian towns have installed emptying underground systems. All of the manhole chambers don't appear to be in a secure position. The majority of manholes are open and free from obstructions that could lead to mishaps. Due to inconsistent inspections, overflow, chambers blast, clogged emptying systems, open manholes pose a safety hazard. Manually keeping track of this problem results in inefficient handling of problems that takes more time. Our Embedded System identifies an open manhole, early fire detection, Overflow, Pressure temperature in the chamber, gas level and alerts the area to the control center in the form of alert message. Also this activity is monitored by the control room through blynk web. The public's safety is at danger from these damaged chambers. In order to prevent accidents, save lives and smart city management this research is put to use.*

Keyword *- Manhole Chamber, Embedded System, BMP180, MQ2, Water Sensor, ESP 8266, IR Sensor***.**

I. INTRODUCTION

Manholes that were left open were at blame for the majority of accidents involving vehicles, motorcycles, and pedestrians. During the rainy season, this type of accident occurs more frequently, and manholes are damaged as a result of water overflow. A region's economy, security, and safety may be severely impacted by MC failure. The gap left by numerous occurrences in urban settings cannot be filled by traditional techniques of control measures. The manhole cover contributes to public safety as well. If a manhole cover is missing, the authorities will be aware that something has been stolen. Accidents may occur if the manhole cover's angle is changed in any way. . As a result, the development of smart cities today includes the use of fully automated monitoring systems. The manhole detection system designed here aims to resolve systemic problems and notify the municipal corporation of the current status of the system so that officers can take the appropriate action to fix the system in order to reduce accidents and provide people safety.

II. LITERATURE REVIEW

[1] The concept behind this artwork stems from the fact that lost or stolen manholes cause a number of traffic accidents and degrade the urban environment. This technique uses a Naive Bayes classifier to train a dataset and identify any missing manholes on a road as well as to detect them. MATLAB was the programme utilized for image processing. The missing manhole covers locations on BLYNK IOT were updated using the coordinates retrieved with an Arduino Mega and SIM808 GSM modem. [2] The correct health and safety of the city are maintained with the use of an underground drainage monitoring system. Additionally, it lessens the workload for government employees. To make the system smart, various types of sensors, including flow, level, temperature, and gas sensors, are interfaced with the Arduino Uno microcontroller. Through GSM and GPS, signals and the manhole's location are communicated. [3] It leads to waterlogging, which breeds bugs, and is unhealthy for the nearby population. Our IoT system, which alerts city officials about overflowing drains instantly via email or notification at the city control center as well as residents via social media or a mobile app, is our solution to this issue. A low-power, IoT-based portable device positioned underneath the manhole cover is the key element of this solution. [4] When there is a blockage in a particular road, there is a variation in the flow of drainage in water, which when across the seat value will display the alerts in the managing station by

the system. This project overcomes the drawback of paper by detecting drainage water flow speed rate by installing water flow rate sensors at the intersection of nodes. With this system, which consists of a variety of high-output, high-input, and very efficient components, we can identify any issue that may arise in a manhole without the need for a human operator. [5] In order to prevent accidents, this project will steer clear of open manholes in major urban areas. To discover the position of the manhole, the authorities of the municipal corporation department and the councilor of the local region utilize sensors such as tilt sensors to detect rifts and damage to the manhole lids. [6] It is planned to use a wireless sensor network with sensor nodes. With the aid of distinct transmitter and receiver models, the Underground Drainage and Manhole Monitoring System (UDMS) implementation and design functions are carried out. [7] The purpose of this study is to identify the drainage system that is using the instrument. When a sewage works' water level rises or the evacuation lid is removed, the evacuation is monitored by a device, and any detected information is sent via an Internet of Things server to a nearby municipal corporation official using the Raspberry Pi's built-in intrinsic Wi-Fi module. Overflow and gas value are also displayed in the cloud for later analysis. The sensor-based system for road monitoring recognises the cars and continuously feeds information to the cloud system.[8] This research uses mobile laser scanning (MLS) data to provide a novel framework for automatic detection of urban road manhole covers. Road surface points are first segregated from a raw point cloud using a curb-based road surface segmentation approach, which narrows the search regions and lowers computational complexity. The road surface points are then rasterized into a georeferenced intensity image using inverse distance weighted interpolation. Next, a multilayer feature generation model for representing high-order features of local picture patches is built using a supervised deep learning model. Next, mappings from high-order patch features to the likelihoods of urban road manhole covers existing are trained into a random forest model, with the model being centered at particular places. [9] Detecting road surface conditions is crucial for Intelligent Transportation Systems (ITSs), and one common factor impacting roads is the depression of manhole covers. This paper introduces a novel large-scale manhole cover detection dataset created by using smartphones to capture both road images and inertial data. A hierarchical classification method based on convolutional neural networks is proposed. The proposed approach achieves an accuracy of approximately 86.3% for road manhole cover detection. The outcomes indicate that the proposed approach can effectively detect manhole covers under different weather and road conditions. This offers a cost-effective solution for road manhole cover data collection and detection, presenting a new avenue for road manhole cover detection. [10] The improper placement of underground utilities is becoming an increasingly significant issue in both developed and developing nations due to urban expansion and technological advancements. However, certain utility networks feature surface access traps that may be discernible on high-resolution airborne or satellite images, serving as indicators of their presence. We propose a methodology for identifying manhole covers and grates in extremely detailed aerial and satellite images. We evaluate two methods: the first employs a geometric circular filter, while the second utilizes machine learning to recognize specific patterns. The outcomes from both methods are compared and integrated to capitalize on the strengths of each approach.

III. METHODOLOGY

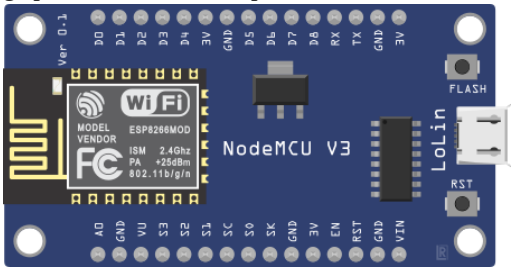
Materials/Components/Flowchart/Theory –

The methodology is divided into three main steps:

1) Hardware Development/Components -

We have developed the hardware protocol using NodeMCU(ESP8266), IR sensor, BMP180, MQ2 and Water Sensor -

I) NodeMCU : We have used a NodeMCU to interface the IR sensor. It has an inbuilt Wi-Fi module along with being compact in size.It can be easily programmed using the open source Arduino IDE. NodeMCU has better rating specifications as compared to Arduino.



Fig[1]: Nodemcu Chip (ESP 8266 Wifi

II) IR sensor : We have used IR sensor because of its features,it gives binary values in 0 and 1. The IR sensor helps to detect whether the manhole is opened or closed.

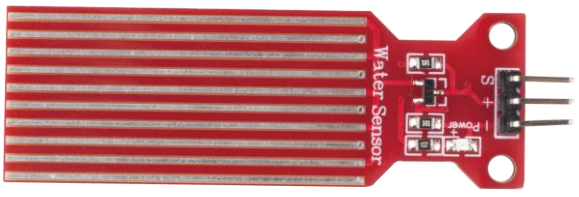
As the distance between the IR sensor and the lid of the manhole increases,the sensor gives the binary output as 1 indicating the opening of the manhole's lid.

Fig[2]: IR Sensor (Infrared Sensor)

III) MQ2 : The MQ-2 sensor may be a useful tool in manhole chamber detection projects, especially when it comes to identifying gases that could be dangerous or signal certain environmental issues. This is a basic overview of how you may include the MQ-2 sensor into your project to detect manhole chambers.

Fig[3]: MQ2 Smoke Sensor

IV) Water Sensor :The water sensor in our research is essential to improving the manhole chamber environmental monitoring system. The water sensor, which is integrated with the NodeMCU and other sensors, measures the water level in the manhole and provides information about any flooding or water intrusion problems. We may create preset water level thresholds and monitor in real-time, sending out notifications when permissible levels are exceeded, by integrating the analogue output of the water sensor into our code.



Fig[4]: Water Sensor

V) BMP 180 :Our manhole chamber detection project would not be the same without the BMP180 sensor, which provides accurate data of both temperature and barometric pressure. This sensor, which is interfaced with the NodeMCU, contributes to an extensive monitoring system by providing real-time environmental data. The incorporation of BMP180 measurements into our programming and user interface provides us with significant insights on variations in temperature and ambient pressure within the manhole chamber.

Fig[5]: BMP180 Sensor

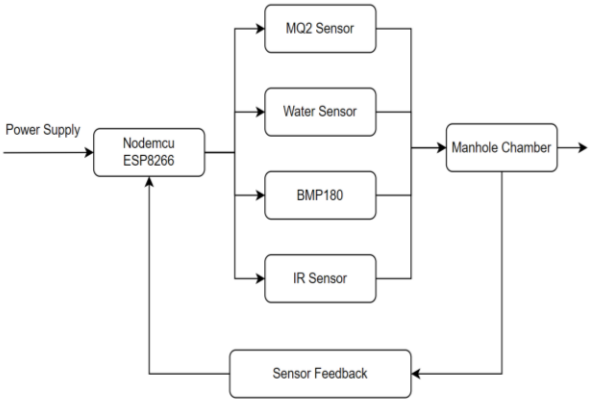
2) Program Development - For the program development we have used arduino IDE.

Arduino IDE : Sketches are computer programmes created using the Arduino Software (IDE). These drawings are created in a text editor and saved as files with the.ino extension. The editor offers functions for text replacement and text searching. When saving and exporting, the message section provides feedback and shows errors. The console shows text generated by the Arduino Software (IDE), including error messages in their entirety and other data. The configured board and serial port are visible in the window's bottom right corner. You may create, open, and save sketches, validate and upload programmes, open the serial monitor, and more using the toolbar buttons.

3) Block Diagram of system -

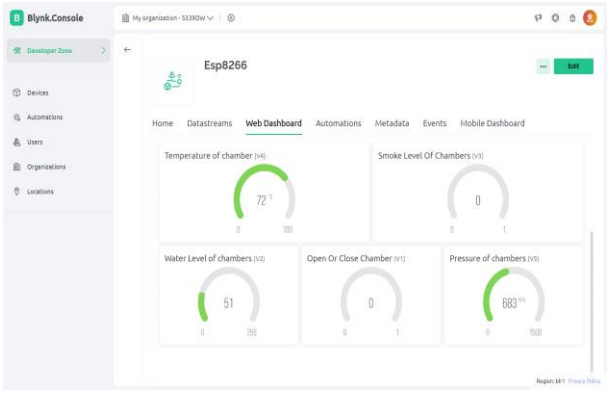
1. Read the sensor : Reading data from the MQ2 gas sensor, water sensor, BMP180 sensor, and IR sensor initiates the main loop. Specific data, including temperature, water levels, gas concentrations, and manhole condition, are provided by each sensor.
2. Process sensor data : In order to obtain pertinent information, process the raw sensor data. For example, translate relevant gas concentrations and water levels from the analogue signals from the MQ2 and water sensors, respectively.

3. Checking Threshold : Check the processed sensor readings against setpoints, or predetermined threshold values. These limits are set in accordance with environmental and safety standards. Establish boundaries, for instance, for acceptable temperature ranges, allowable water levels, and maximum gas concentrations.
4. Triggering Alerts : Set off the alarm mechanism if any of the sensor values exceed the predetermined criteria. In order to start the alarm system, this entails raising an alert flag or sending a signal.
5. Feedback to controller : Give the NodeMCU controller input on each sensor's condition. This might entail changing flags or variables to reflect which sensor set off an alarm.
6. Activation of the Alert System : Activate the alert system to notify the appropriate persons whenever an alarm flag is raised. This might entail setting up audio and visual alerts or sending notifications via email or SMS.
7. Constant Observation: Establish a continuous monitoring loop to make sure the sensors are regularly giving the NodeMCU input. This loop's continuous and iterative operation enables real-time response to shifting external circumstances.
8. Data Transmission : Send the sensor data, including readings and warnings, to a cloud platform or server for remote monitoring on a regular basis or in response to alert triggers. To enable connection between the NodeMCU and the cloud, use IoT protocols.
9. User Interface update : Update the web-based or mobile application's user interface to reflect the most recent sensor data and alert status. The status of the system and any active alarms can be shown visually.

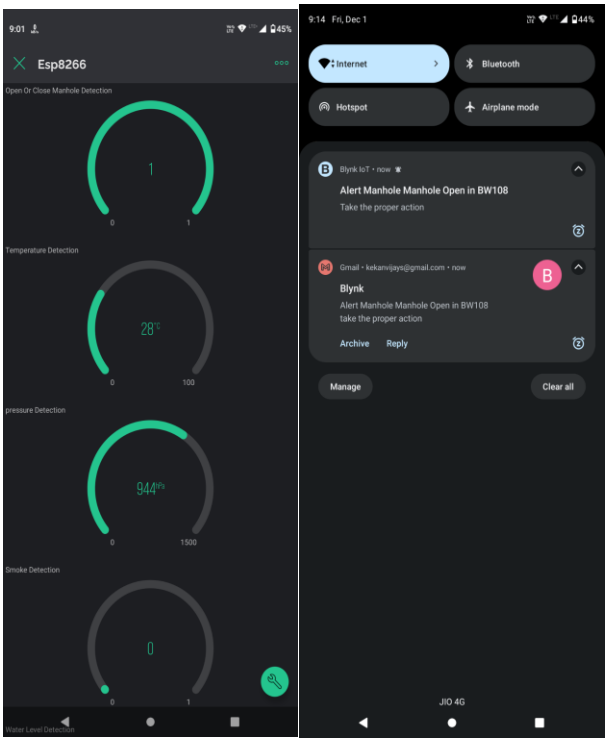


Fig[6]: Block diagram of proposed system

4) Blynk Web/App -All activity of manhole chambers is monitored by the system room all the time through blynk web and blynk app vice versa, The NodeMCU is completely integrated with the Blynk platform in our Internet of Things manhole detection solution to improve monitoring and enable real-time notifications. Installed on our mobile devices, the Blynk app serves as an easy-to-use interface for receiving notifications and sensor data. The NodeMCU continually transmits water level, gas concentration, and alarm status information to the Blynk app via virtual pins. The app receives notifications from the system whenever any reading above the safety standards, which are predetermined thresholds.



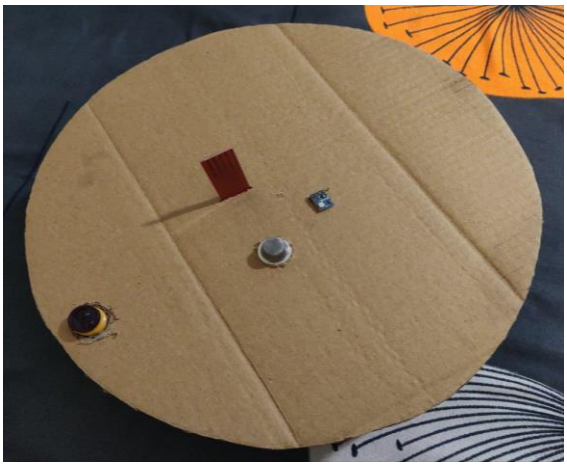
Fig[7]: Blynk Web with monitoring all the parameters



Fig[8]: Blynk App getting alert messages and also monitoring the activities

IV. RESULTS AND DISCUSSIONS

This system facilitates timely manhole repairs through an alarm mechanism. It successfully detects open chambers, overflow,early fire detection and alerts the control station and informs their location.



Fig[9]: Successful prototype of embedded system

Fig[10]:Arduino sketch for proposed system.

```
20:59:29.432 -> ------------------------------------------------
20:59:30.532 -> Temperature: 28.70 °C
20:59:30.564 -> Pressure: 944.49 hPa
20:59:31.551 -> prox sensor: 1  |  Manhole Open
20:59:32.531 -> water sensi output  134
20:59:33.554 -> MQ2 sensi Output: 0
20:59:33.554 -> ------------------------------------------------
```

Fig[11]:Serial Monitor Output.

V. FUTURE SCOPE

1. We can also detect the harmful gasses being emitted from the manholes via gas sensors.
2. Google API's can be added to get an exact location of the uncovered location through the google maps.
3. The depth of the manhole chambers also monitored by various sensor

VI. CONCLUSION

The cover of the manhole can be monitored using the IOT technology. Through the Blynk app the user gets an alert on the mobile or on the control panel of the municipality stating the damage or specifying the location of uncovered manhole. The municipality can immediately take an action after receiving an alert and the issue can be solved. The Iot based manhole system is very essential especially during floods or water clogging.

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