An IoT Based Manhole Monitoring System

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Abstract— In Mumbai, out of 3.60 lakh manholes only 1 percent follow the safety norms by BMC. Most manholes are open without any monitoring which lead to accidents or fatal accidents. Since, manual monitoring is incomplete, this leads to slow handling of problems inside the manhole and consumes more time to solve this problems. In the view of these problems we have created an Iot based manhole monitoring system which monitors the temperature, gas and the presence of lid on the manhole and along with this, transmits information to a standard authority using the WIFI module. The proposed system is low cost, low maintenance, Iot based real time which alerts the managing station about the status of the manhole when any manhole crosses its threshold values. And thus, the concern authority can take the proper action to maintain the condition of manhole. This system reduces the risk of death of people who clean the underground drainage and also benefits the public.

Keywords: Manhole, Wireless, IoT, Sensors, Real time

I. INTRODUCTION

The safety net of manholes is one of the major factor for preventing fatal accidents. There are over 3.60 lakh manholes in the city out of which only 1 percent follow the safety norms laid down by BMC. Most of the accidents that include vehicle, motorcyclist and pedestrian are due to open manholes. The open manholes need to be monitored to prevent such cases, but in reality, mostly they are not monitored. These accidents are severe during monsoons, wherein due to overflooding of water the manholes were kept open. This has caused several tragedies and the blame comes on the civic body officials.

Usually, manholes are covered with lid which is made up of metal that keeps it safe from the passersby. If the lid is not close properly or get displaced then there is a chance of accidents and people may get fall into it. Explosions in manholes have been occurred in almost every cities. Such explosions are mostly happened due to the explosive gases such as Lpg, Methane, Carbon Monoxide, etc. and also due to the rise in temperature inside the manhole. [4] To avoid such problems, there should be a facility in the city corporation, which alerts the authority about the status of the manholes in city.

During summers, the heat produced from the earths surface may lead to rise in temperature of the sewage drains. This may cause formation of harmful gases such as methane, nitrogen, carbon monoxide etc. Thus during its cleaning which is done manually, there is harm that the person may inhale such harmful gases. The temperature may also cause blasts which could prove fatal. The lid of the manhole plays a key role in maintaining the safety of the pedestrians and passersby. If the lid of the manhole is missing, or there is a case of thievery then the authority should need to know that situation.

Our aim to implement this project is to have continuous monitoring of these manholes which monitor the status of the lid, temperature inside the manhole and formation of harmful gases in manhole and provide the civic body with its status so as to take immediate action and help to reduce these incidents. It is necessary to create a safer and friendly environment for passersby, children, sweepers and the people.

II. RELATED WORK

In cities there is a problem of stolen manhole cover along with their poor management. Thus, this paper aims to design an intelligent manhole cover monitoring system using the NB-IoT technology. NB-Iot technology is the narrow band Iot technology. There are various layers present in this such as the perception layer, network layer, application layer etc. It also consists of the sensing layer. The sensing layer consists of the ARM microprocessor which is used to collect the sensor data from the manhole. This data is transmitted using the NB-IoT technology for communication of data. The advantages of using this system is that the results are stable. The NB-IoT technology offers better scalability, quality of service and security. It uses very less power and electricity. But it offers very low data transmission rates. [2]

Along with stolen manhole covers there are also covers which are owner less and thus finding them becomes difficult if they are stolen or missing. Several RFID transmission base stations are xed at points where the stolen or missing covers are frequent. Theses covers are then tied with and RF card. Once the owner less manhole cover is separated from the wellhead, the RF card will get activated. The RF card has an built in data transfer unit. This unit will help to send messages to a xed IP address using a GPRS wireless network. [3]

While mostly all other papers consisted of finding the lid or sensing the composition of various gases present inside the manhole. This paper [4] focused on lid detection, pressure and temperature detection, water level detection and also notifies the authority along with alarm generation if there is an increase in any of the above.

The research paper [6] presented a detection system of high liquid levels in waste water handling system. It consisted of wireless sensor modules, processor and network system. In paper [1], there was a Underground drainage and manhole monitoring system for IoT applications which monitored the water levels, the atmospheric pressure and the lid of the manhole.

Paper [7] represents the implementation and design function of Manhole Monitoring System by using the sensors which send its data to the micro controller unit i.e Arduino. And the data is further transmitted to the Raspberry Pi and cloud. With the help of these, an alert message is displayed in the managing station and email is send to the respective authority. But in this system, authorities can’t view the status of manhole continuously or whenever they want.

This [5] project acquire a viable ease and adaptable solution for condition monitoring and infrastructure.
management in the city by detecting water level in manhole and blockages in manhole to prevent overflow and leakage. For continuously monitoring the system uses ZigBee technology and alert the concerned authority. The system has drawback that is ZigBee has short transmission range and low output power limit.

The paper [8] helps to solve the problem by a smart device using IoT. The MQ4 sensor and the single board computer raspberry pi3 helps to detect the gas level with the LED display. This system identify the gas level inside the drainage manholes so that the worker can get idea of entering into the manholes. Here, they are using MQ4 gas sensor which is not that efficient compared to the MQ2 gas sensor. Because, MQ4 sensor can only sense methane or natural gas easily.

III. CONCEPTUAL DESIGN OF THE SYSTEM
We introduce the Iot based manhole detection system in order to prevent accidents and increase safety of the passerby, vehiclist etc. These accidents mostly occur due to absence of lids, especially during the monsoon season. Due to water logging often the drains are kept open which has lead to fatal accidents. Due to absence of lids, there are often road accidents that prove to be fatal especially for motorcyclists. Due to this, these manholes need constant monitoring, which is not possible manually.

The systems consists of two parts: The hardware module and the software module. The hardware module includes the interfacing of sensors with Arduino and interfacing of Arduino with Esp module. And the software part includes programming the sensors such that they provide us the desired output using the Arduino Uno R3 module, connecting Esp to the WiFi, displaying the sensors data on the web page etc. The data collected from the sensors transmitted to the ESP8266 WiFi module using Arduino uno R3.

A. Hardware Used
1) Arduino UNO R3
The R3 is the third and the latest version of Arduino Uno. Arduino UNO has 20 i/o pins. Among these 20 pins, 14 pins digital and the remaining 6 pins are analog pins. Arduino UNO supports 3 communication protocols which are Serial communication Protocol, I2C Protocol and SPI Protocol. Here, we are using the serial communication protocol.

2) Esp8266
This is the WIFI module which is capable of hosting an any application. In this module, built-in cache memory is there which will decrease memory requirement and supports to upgrade system performance. It has easy interfacing connection facilities.

3) LM35 Sensor
LM35 is a temperature measuring device which gives analog output voltage proportional to the temperature. The sensitivity of LM35 is 10 mV/degree Celsius. i.e. 350 mV means 35 degree C.

4) MQ2 Sensor
MQ-2 Gas sensor is used to detect the gas level around the area. This sensor detects the gases like methane, car-bon monoxide, Lpg, alcohol, hydrogen, smoke, etc. We detects the gases LPG, carbon monoxide(CO) and smoke successfully. It can detect gases in the concentration of range 200 to 10000ppm.

5) Inductive Proximity Sensor
A inductive proximity sensor can detect metal targets approaching the sensor, without any physical contact with the target. Here, this sensor is used to detect the cover or lid of the manhole.

B. Technology Used
The technology used in this project is Internet of Things (IoT). The system consists of multiple manholes in the city. Each individual manhole has information regarding the temperature, presence of harmful gases and presence of the lid. This system does not have any human monitoring at its location. Thus the information is sent to the sever automatically without any human to computer interaction. This makes it easy to establish multiple manhole monitoring systems and also causes error free transmission of information. Thus we use IoT technology.

C. Protocols Used
1) HTTP Protocol
HTTP is a TCP/IP based communication protocol which is used to deliver data on the World Wide Web (WWW). HTTP is designed to enable communications between clients and servers. In this system, the esp8266 is the server (Web page) and the browser (Authority) is the client.[3]
2) **Web Socket**
The Web Socket protocol is a HTTP(S) based full-duplex real time communication between a web server and its clients. It provides real time communication. Data can be sent to the client continuously at any time, even without the client requesting it. [9]

### IV. IMPLEMENTATION

**A. Interfacing of Sensors with Arduino**

Connections of all three sensors with Arduino is same. Sensors Vcc pin is connected to the 5V pin of the Arduino. The GND pin of sensors is connected to the GND pin of the Arduino. And the output pins of the sensors are connected to the analog output pins of the Arduino.

**B. Interfacing of Arduino with Esp8266**

In this, we simply connect the Tx pin of the Arduino to the Rx pin of esp and the Rx pin of the Arduino to the Tx pin of Esp. This creates the serial communication between the Arduino and Esp8266. In this, Arduino collects the data from sensors and forwarded to the Esp.

1) **Arduino side code**

This code is comprises of all three sensors programs (LM35, MQ2 and Inductive Proximity Sensor). First, the information receives by the sensors is converted from analog to digital with the help of ADC pins located in the Arduino board. The output of these sensors are added in one array. That means, the array is consists of 5 elements and it starts from 0 (0-4).

![Pin Diagram of the System](image)

2) **Esp side code**

This code also written in Arduino Ide. In this code, we include various libraries.

Connecting Esp to WIFI and hosting a web page by Esp:

For hosting the website or webpage we need server. In our system, the Esp host the webpage where the final output will get displayed. This means that the esp acts as a server i.e webpage. The data is passed through the internet to the web page. By uploading this code, we will get the IP address on serial monitor to which the Esp is connected. We can view the final output by searching the ip address of the same to which the esp is connected.

Also, we made one web page whose code is also included in this Esp side code. On this web page authority can view the final output by searching the ip address.

The received data (set of array) of Esp which is coming from the Arduino is separated according to the respective sensors output and get displayed on the web page. For real time output Web Socket protocol is used. With real time sensors output, the authority will come to know whether the area around the manhole is safe or not. The threshold values of the sensors are mentioned in the code. We can also change this thresholds. This is all about the esp side code.

When we upload this code, will get the IP address on serial monitor to which the Esp is connected (Fig:3). Copying this IP, and searching on browser will get the information about the status of temperature, gas inside the manhole and also status of presence and absence of lid in the form of website.

![IP address of Esp WIFI Module](image)
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V. CONCLUSION

The proposed system ensures the security of the human lives by avoiding the accidents, which has common occurrence. If this system implemented properly, it can bring progressive changes in the environment. The system provides the real time output of the sensors which helps authority to take necessary actions before the any critical situation. Also it provides the information about the temperature and presence of any harmful gases inside the manhole and the presence or absence of lid on the manhole.

This system too come with some drawbacks that the author-ity need to see the web page continuously to check the status of manhole because alert message regarding the manhole can not directly come on authorities computer. So, in future we can implement this feature that the alert-Email message is directly will receive on registered email id so they don’t need to see the web page continuously. Also we can make this system more efficient by implementing one more feature of seeing the web page on any WiFi connection instead of the WiFi connected to the Esp module.

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