Drainage Inspection and Monitoring System

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ABSTRACT:

In urban areas, drainage systems are critical for effective water management. The condition of these systems is vital to ensure that they function optimally, preventing waterlogging and other related problems. Manual inspections are labor- intensive, time-consuming, and can be prone to errors. Therefore, there is a need for an automated system that can monitor and inspect the drainage system in real-time. In this paper, we present an Automatic Drainage Monitoring and Inspection System that can monitor and inspect drainage systems in real-time, providing insights into the system's condition. A highly automatic, smart, precision and decision taking system that will help us to detect the presence or formation of blockage in manholes or in drainage pipes. The non-contact sensors will help us to detect the flow, level, toxicity and motion of the liquid, fluid and/or gasses flowing through the drainage pipes. The data received from these sensors will help us to inspect the system and can predict the formation of blockage inside the drainage pipes or manholes.

I. INTRODUCTION

The Automatic Drainage Monitoring and Inspection System is designed to provide a real- time monitoring and inspection solution for urban drainage systems. The system consists of various sensors and a central processing unit that collects and analyzes data to determine the condition of the drainage system. The system is also equipped with a camera that can capture images of the drainage system, enabling visual inspection of the system. In this proposed concept, we are basically focusing on the detection of the sewage blockages. Now-a-days even though automation plays a vital role in all industrial applications, the proper disposal of sewage from industries and commercials is still a challenging task. Drainage pipes are used for the disposal and unfortunately sometimes there may be loss of human life while cleaning the blockages in the drainage pipes. This kind of difficulty occurs because it becomes very difficult to inspect or detect the blockage inside the drainage lines. To overcome this problem and to save human life we implement design.

II. RELATED WORK

1. Detection and location of a partial blockage in a pipeline using damping of fluid transients.

The effects of a partial blockage on pipeline transients are investigated analytically. A partial blockage is simulated using an orifice equation, and the influence of the blockage on the unsteady pipe flow is considered in the governing equations using a Dirac delta function. A simplified, linear dimensionless governing equation has been derived, and an analytical solution expressed in terms of a Fourier series has been developed under non varying boundary conditions. The linear analysis indicates that pipe friction and a partial blockage both introduce damping on fluid transients. The friction damping and blockage damping are exponential for each of the individual harmonic components. For each individual harmonic component, the blockage- induced damping depends on the blockage magnitude and position and is also independent of measurement location and the transient event. A new blockage detection method using the blockage- induced transient damping is developed based on the analytical solution. The magnitude of the blockage- induced damping rate indicates the size of the blockage, and the ratios of different damping rates can be used to locate the blockage. The proposed blockage detection method has been successfully used in detecting, locating, and quantifying a pipe blockage based on laboratory experiments.

2. Sewage Level Maintenance Using IOT

Over flow of sewage on roads is been a major problem in many developed and under developed cities as well. Sewage is generally considered as waste water. The response to the complaints is not properly answered or taken into account. A precautionary system is developed where this issue of sewage overflow can be reduced by early sensing of increase in its level. The system design comprises a sensor to sense the level, a controller to command, a communication network to register the complaints on blockage and continuous increase in the level of sewage. A database is to be maintained to record the data. Rather than simply monitoring the level, it generates alarm signals via complaints to the required departments through mail and SMS regarding prior to overflow.

3. Research on the Monitoring System of Multi- Sensor Based Sewage Treatment Process

This article puts forward a multi-sensor data collection and the methods on the real time control of the sewage treatment process. The three-layer distributed control system and parallel sensor integration scheme are designed according to the needs of the sewage treatment process, then the model selection is made on the hardware of the sensors and control module according to the needs of the sewage water quality monitoring and process control and hardware configuration distribution is conducted according to the distribution, types and information of the monitoring points, control points and data points and finally corresponding procedures are prepared and the relevant test is conducted as well according to the target sewage treatment process.

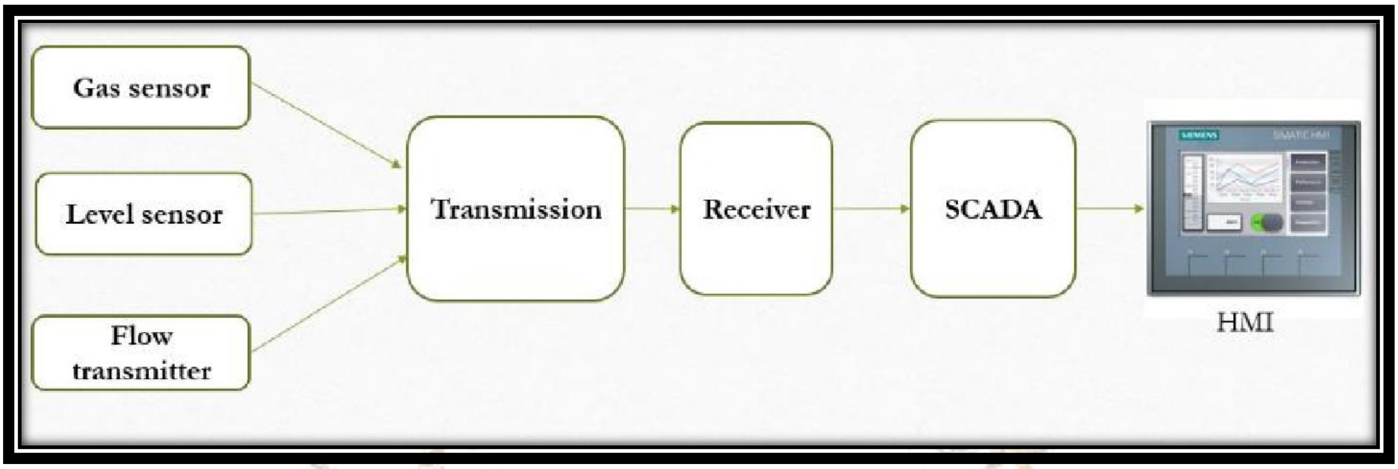
4. IoT Based Smart Sewage Monitoring System using GSM and Wi-Fi Module

Monitoring of sewage system is important to keep the city clean. The uneven monitoring of sewage system leads to blockage of the drainage. Blockages in sewers are major causes of both sewer flooding and pollution. Sometimes due to ignorance the workers may meet with an accident as they might not be aware of the condition inside the manhole. This paper represents an experimentation of the smart sewage system using IoT which is tested and demonstrated at campus of Galgotias University. In this model, a regulator circuit, sensor driver circuit, microcontroller, serial communication devices and IoT module is used to obtain the desired output from the module. A Cost-Effective IoT Model for a Smart Sewerage Management System Using Sensors.

III. COMPONENTS

SR NO .		MODEL	DESCRIPTION
1		SR04	To measure the level (distance) in the manhole
2		MQ-9	To detect the presence of hazardous gas present in pipe.
3		YF-S201	To measure the flow in manhole
4		NRF24L01	It is used for transmission and receiving purpose.

IV. BLOCK DIAGRAM:



ULTRASONIC SENSOR

This is the HC-SR04 ultrasonic distance sensor. This economical sensor provides 2cm to 400cm of non-contact measurement functionality with a ranging accuracy that can reach up to 3mm. Each HC-SR04 module includes an ultrasonic transmitter, a receiver and a control circuit. There are only four pins that you need to worry about on the HC- SR04: VCC (Power), Trig (Trigger), Echo (Receive), and GND (Ground). You will find this sensor very easy to set up and use for your next range-finding project. This sensor has additional control circuitry that can prevent inconsistent "bouncy" data depending on the

application.

GAS SENSOR

Highly toxic components of sewer gas include hydrogen sulfide and ammonia. Sewer gas also contains methane, carbon dioxide, sulfur dioxide, and nitrous oxides. In addition, chlorine bleaches, industrial solvents, and gasoline are frequently present in municipal and privately owned sewage treatment systems. Gas sensors (also known as gas detectors) are electronic devices that detect and identify different types of gasses. They are commonly used to detect toxic or explosive gasses and measure gas concentration. Gas sensors are employed in factories and manufacturing facilities to identify gas leaks, and to detect smoke and carbon monoxide in homes. Gas sensors vary widely in size (portable and fixed), range, and sensing ability. They are often part of a larger embedded system, such as hazmat and security systems, and they are normally connected to an audible alarm or interface. Because gas sensors are constantly interacting with air and other gasses, they have to be calibrated more often than many other types of sensors.

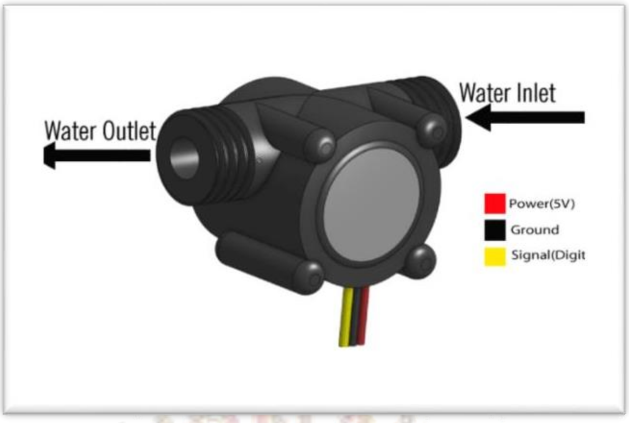
FLOW SENSOR

Description of the YF-S201

YF-S201 is a water flow measurement sensor with high-grade quality sealing property. It works on the Hall Effect principle and with a flow rate range of 1~30L/min. The module has three pins: Power, Ground, and the Analog output. YF-S201 consumes very little current and can work with an allowing pressure of ≤1.75MPa.

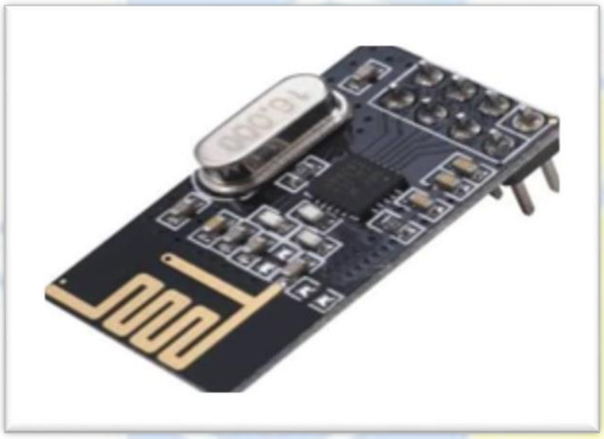
Features of YF - S201:-

- Operating Voltage: 4.5V to 18V DC
- Output type: 5V TTL
- Maximum current draw: 15mA at 5V
- The sensor used: Hall Effect
- Working Flow rate: 1 to 30 Liters/Minute
- Accuracy: ±10%
- Pulses per Liter: 450
- Output duty cycle: 50% +-10%
- Maximum water pressure: 2.0 MPa
- Flow rate pulse characteristics: Frequency (Hz) = 7.5 * Flow rate (L/min)



RADIO TRANSRECEVER

NRF24L01 is a radio transceiver module (SPI protocol) used to send and receive data at ISM operating frequency from 2.4 to 2.5 GHz. This transceiver module is composed of a frequency generator, beat controller, power amplifier, crystal oscillator modulator, and demodulator.



Arduino UNO (Testing)

The Arduino Uno is an open-source microcontroller board based on the Microchip ATmega328P microcontroller and developed by Arduino.cc and initially released in 2010. The board is equipped with sets of digital and analog input/output (I/O) pins that may be interfaced to various expansion boards (shields) and other circuits. The board has 14 digital I/O pins (six capable of PWM output), 6 analog I/O pins, and is programmable with the Arduino IDE (Integrated Development Environment), via a type B USB cable. It can be powered by the USB cable or by an external 9-volt battery, though it accepts voltages between 7 and 20 volts. It is similar to the Arduino Nano and Leonardo. The hardware reference design is distributed under a Creative Commons Attribution Share-Alike 2.5 license and is available on the Arduino website. Layout and production files for some versions of the hardware are also available.

V. WORKING:

SCADA is the major component and the drainage level is monitored by supervisory control and data acquisition technique. Automatic drainage water pump monitoring and control system consists of Solenoid valve, gas exhauster, flow transmitter, level sensors. The gas sensor is a device that detects the presence of gases in the drainage pipe area, often as a part of a safety system. The toxic and non-toxic gases were separated, by using the gas exhauster. The flow and the level sensor get activated, to check the water level and the flow level created inside the pipe. When the flow exceeds the certain limit the flow transmitter will indicate it. If the water level is high, the compressor operates with minimum pressure.

1. Manholes
2. Non-Contact sensors (Actual Implementation)

Contact Sensors (For Prototype)

3. Power supply

Types of Manholes:

Shallow Manhole:

A shallow manhole has a depth ranging between 75 to 90 ft.. These are constructed at the start of a branch sewer or in an area where there is not much traffic. The shallow manhole is provided with a light cover called as the inspection chamber.

Normal Manhole:

These are provided at the sewer line with a heavy cover on its top. It has a depth of 150 ft. . normally the manhole takes a square shape.

Deep Manhole:

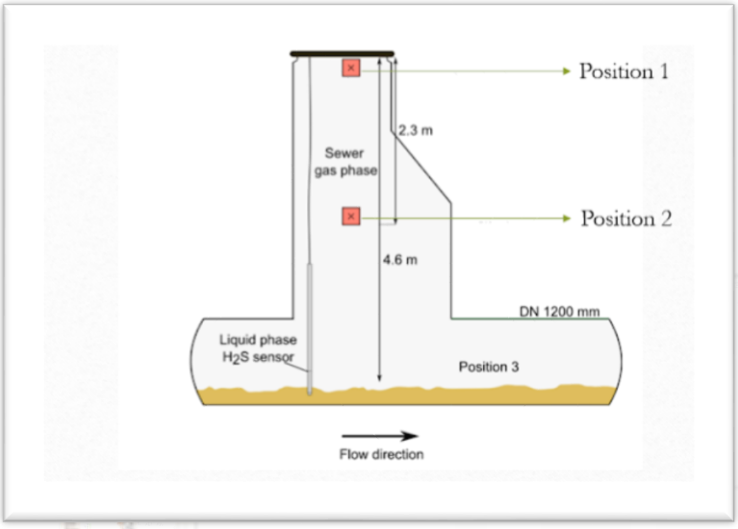
Deep manhole is provided at a depth greater than 150ft with a very heavy cover at its top. The size can be increased and the facility for going down is also increased.

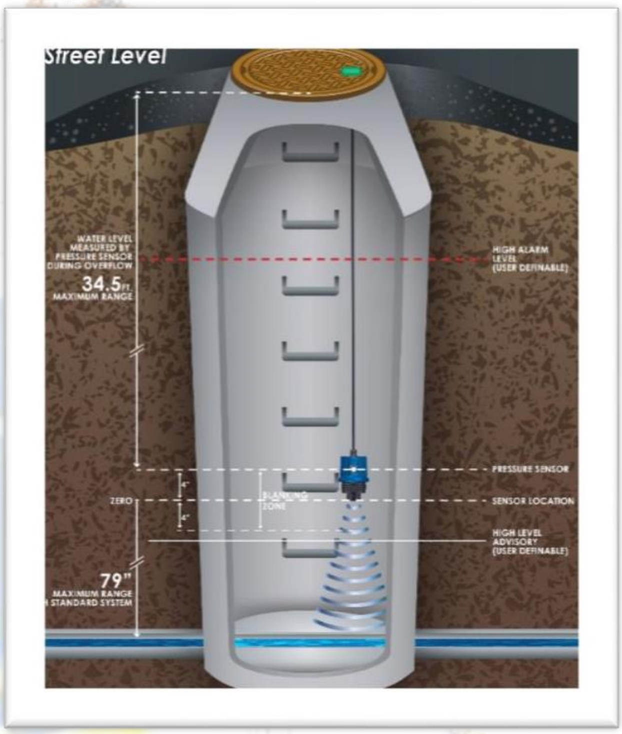
Once the manholes are analyzed, the system or the measuring circuit is installed inside the manholes. This circuit consist of the measuring sensors like ultrasonic sensor, flow sensor, gas sensor for the measurement of height, flow of water and nauseous smell coming from the sewage line. All these measuring instruments are connected to the micro-controller (for testing its ardunio and for real time usage its esp-32). This micro- controller is connected to the NRF module. This is a trans receiver. So the NRF connected with the microcontroller will act as transmitter and the other connected towards connected output side will act as receiver. When the sensor will sense the process parameters, the corresponding data will be send to the microcontroller. This microcontroller will process the data and accordingly will transmit the data to the receiver side. The transmission of the data will take wirelessly. This wireless transmission of the data will follow the principle of Radio Frequency Transmission. Radio frequencies have a better transmission rate and gives efficiency over the communication.

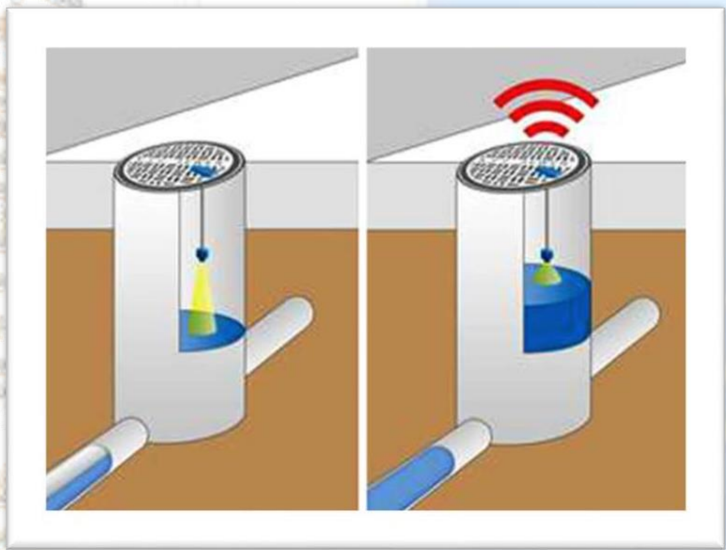
The NRF 2401 module connected towards the output side consist of receiver, controller and the IOT server and SCADA server. IOT server is made with hubs. This IOT server is divided in 2 levels that are leve1 1 and level 2. Level 1 consists of Area wise manholes hub whereas level 2 is the monitoring hub. NRF 2401 at a time connects 8 transmitters to a single receiver i.e. in a ratio of 8:1. Hence, in the level 1 if there exists 3 hubs – H1, H2, H3 then each hub consist of the data of the 8 manholes respectively. Each manhole is represented with a specific number or a header number. Hence, any time when the operator comes to the control room for the data collection of a particular manhole, he simply needs to enter the header number and the data assigned to that particular header number of that particular manhole will be accessible to him. In level 2, there will be groups of the hubs present in level 1. Same way as per the level 1, these hubs will be assigned with another header number. So, when someone want to access a particular manhole, he just needs to enter the header number for level 1 and he will get access for the same and again, if he enters the next header number, the operator will get access to the particular manhole assigned to that header number. With this simple process of measuring the process parameters present in the sewage line and analyzing and monitoring the calculated values we can inspect/analyze the formation of the blockages in the sewage line. This system can be accessible both on computer via software and via application on mobile.

Along with the IOT application, we can also implement real time visualization i.e. the SCADA appapplication.

V. Postion of sensors in Manhole







VII. CONCLUSION

By using SCADA data is collected easily and the output is obtained as a graph so that the presence of clog is detected easily. This project is mainly focused to avoid the manual scavenging. This project is made up of low cost so that the work time will be minimized. Here the maintenance cost is absolutely low compared with the advanced prototypes. Here, the defect and the clog can be identified through the mobile where the model is added with the iot module. By the above statement the clogging can be identified easily and the process of work time will be minimized. It also helps to avoid the unnecessary digging or damaging of pavements.

VIII. REFERENCES

[1]. Jahid Hasan Rony, Nazmul Karim, MD. Abdur Rouf, Md. Monirul Islam, Jia Uddin, Momotaz Begum, "A Cost-Effective IoT Model for a Smart Sewerage Management System Using Sensors", MDPI Multidisciplinary Scientific Journal, July 2021.

[2]. Dk Nurul Saiyidha binti Pg Md Jeffery,S.H. Shah Newaz, Shariar Shams, Nicolas Guillou, Nazmus Shaker Nafi, "LoRaWan based Smart ewage Monitoring System", 2021 International conference on Electronics, Communications and Information Technology (ICECIT), Sept 2021.

[3]. Mohamed A.Ahmed, Jose luis Gallardo, Nicolas Jara, Marcos D. Zuniga, "LorRa Based IOT platform for remote Monitoring of Large Scale Agriculture Farms in chile", Department of Electronics, Univer sidad Tecnia Federico Santa Maria, Valparaiso 2390123, Chile, April 2022.

[4].B. Sumathy, G. Gowthaman, K. Hari Haran, G. Keerthee Rajan, A. Sweeto Jeison "SEWAGE LEVEL MAINTENANCE USING IOT", International Journal of Mechanical Engineering and Technology (IJMET), Volume 9, Issue 2, February 2018.

[5] Priya Tiwari, IoT Based Smart Sewage Monitoring System using GSM and wifi module, International Journal of Innovative Science and Research Technology, Volume 6, Issue 5, May – 2021