MAT JOURNALS

Journal of Communication Engineering and Its Innovations
Volume 5 Issue 1

Underground Drainage Monitoring System

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DOI: 10.5281/zenodo.2590942

Abstract

India has taken up the initiative of developing smart cities hence there is a need for designing proper underground infrastructure which includes underground water pipelines, drainage monitoring for the purpose of keeping the city clean. If the drainage system is not monitored properly it may lead to blockage and sewage overflow which in turn leads to contamination of pure water resulting in spreading of infectious diseases. An underground drainage monitoring system is designed which has various sensors that detect the overflow of the sewage, level of drainage, the concentration of harmful gases within the manhole, flow rate and sends the information to the authority via GSM module.

Keywords: *drainage monitoring system, smart city, overflow, GSM, sensors*

INTRODUCTION

Drainage system plays a very important role in big cities where the population is very large. In most of the cities the drainage management system is monitored manually which is incompetent and needs a lot of persons who are only able to record limited report with inefficient accuracy, also it becomes inconvenient for the government persons to detect the accurate location of the manhole which is facing issues such as blockage arising due to unwanted waste materials, abrupt increase in the level of water as well as various toxic gases such as methane, carbon monoxide, etc if the proper cleaning actions are not taken time to time and these gases are harmful and cause severe problems to human health if inhaled in large quantities.

Most of the drainage systems are not computerized due to which it is hard to know if the blockage is occurring in particular location and also the early alerts of the blockages are not received, hence detection of the blockage and its repair becomes time-consuming. Such problems can cause issues in the daily routine of the city. The system also explains various functions that are used for the purpose of monitoring of the underground drainage system, monitoring the water level, rate of flow of water as well as the content of the toxic gases. If there is a blockage in the drainage system and sewage starts overflowing through it then it can be detected by the sensor system which is interfaced to the microcontroller and this information is sent to the respective authority via GSM (Global System for Mobile).

The rest of the paper is organized as follows. Section II reviews the literature survey that tells us about different approaches for underground drainage monitoring. Section III describes the methodology that tells us about the working of the proposed system. Section IV describes the working of the various components. Section V describes the

advantages of the system. Section VI explains about the obtained results of the proposed system. Section VII outlines the conclusion.

LITERATURE SURVEY

Yash Narale et al. [1] published the Underground Drainage Monitoring System using IOT which describes the need of the smart underground infrastructure to keep the city clean, safe and healthy. The system makes use of ARM 7 microcontroller which collects the information from all the sensors which are interfaced to it and the obtained results are sent as early alerts to the government persons through GSM and the location of the manhole is identified using GPS. Since GSM is sending the alerts along with which the location can also be sent, hence there is no need of using GPS as it requires an extra power supply.

Gaurang Sonawane et al. [2] proposed a Smart Real-Time Drainage Monitoring System using the Internet of Things. The system makes use of microcontroller Atmega 328 which collects the information through a gas sensor, level sensor, and blockage sensor. The monitoring system checks the status of the manhole and detects if there is a blockage between the two manholes and also senses the rise in the concentration of various toxic gases. The system is not the most efficient way of monitoring the drainage because it does not make use of the overflow sensor which detects the overflow of the sewage.

Prof. S. A.Shaikh L et al. [3] published Monitoring Smart city Applications using Raspberry Pi based on IOT which describes monitoring of peculiarity of the resources in the city to improve the development of the city. The system includes Raspberry Pi3 microcontroller which is interfaced with different sensors (proximity, water level sensor) that collect data and transmit it to the raspberry pi3 controller. The results obtained by the different sensors are transferred to the raspberry pi microcontroller and this information is sent to the respective government personnel through the E-mail facility. The whole system is effectively monitored and implemented using Internet of things.

METHODOLOGY

The following figure represents the interfacing of various sensors to the Arduino AT mega 2560 controller.

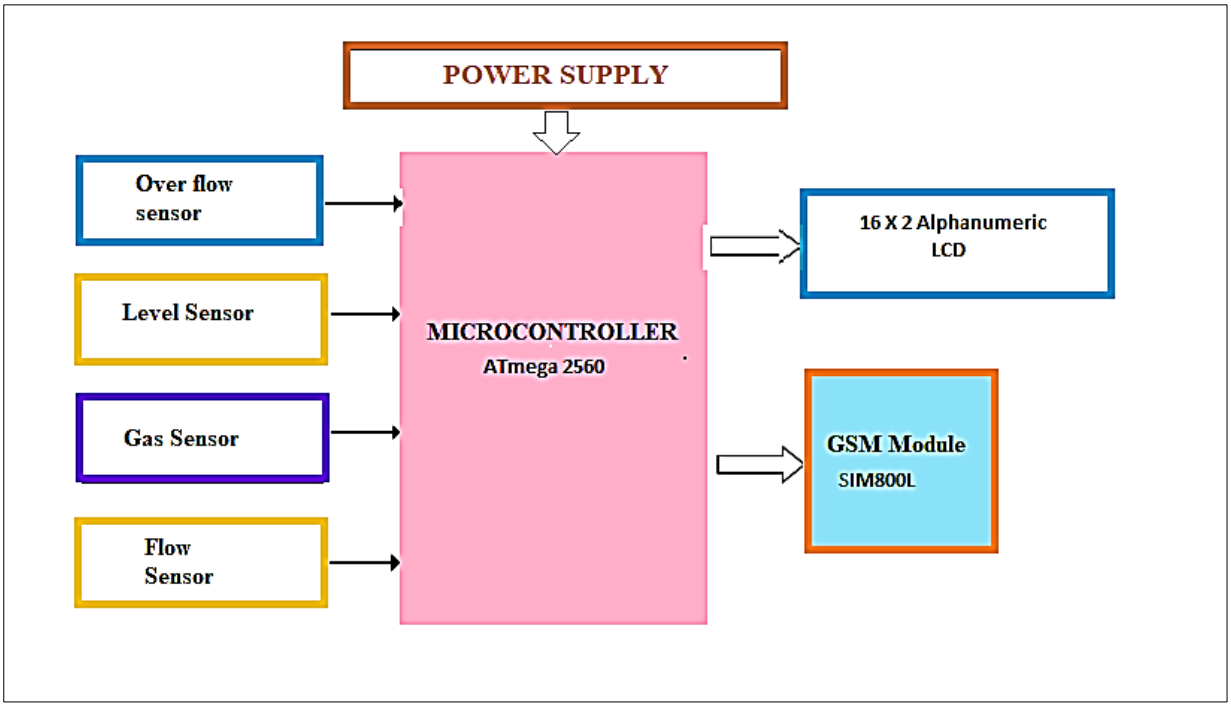

Figure 1: *Block Diagram of Underground Drainage Monitoring System*

An underground drainage monitoring system helps in enabling the cause of well-being of humans, safety of the city, and also in reducing the work of the government persons. Different types of sensors such as flow, level, overflow and gas sensor are interfaced with the microcontroller. When the sensors such as level, gas, and overflow reaches a value above a standardized one then the sensor values are sent as alert signals to the microcontroller. The microcontroller processes the information to the government authorities through GSM so that proper actions can be taken prior to the overflow of sewage. The microcontroller continuously monitors the present values of all the sensors interfaced to it. A message will also be displayed on the 16 x 2 alphanumeric LCD.

SYSTEM SPECIFICATIONS

Microcontroller Atmega 2560

Arduino Mega is a microcontroller board which is based on Atmega 2560. The board has 54 digital I/O pins out of which 15 are used for pulse width modulation and it also has 16 analog pins. The board has a USB cable port that is used to connect and dump code from the computer to the board and it also has crystal oscillator of 16MHz frequency. There is a reset button and four hardware serial port called USART which stands for Universal Synchronous/Asynchronous Receiver/Transmitter that is used for setting up communication.

Overflow sensor

Overflow sensor is basically a board which has a coating of nickel in the form of lines and works on the principle of resistance. The module is based on LM393 op-amp. The sensor is a resistive dipole that shows less resistance because water conducts electricity and connects the nickel lines in parallel and hence reduces resistance and voltage drop across it. The sensor shows more resistance when it is dry.

Level sensor

The level sensor used here is an ultrasonic sensor that is basically used for distance measurement and water level measurement without actual contact with the obstacle. The principle of distance measurement is based on echo. The sensor transmits a sound wave which returns back to the origin as echo after striking the obstacle. Hence the traveling time of the sound

wave is noted and the distance is being calculated.

CO gas sensor
MQ-7 sensor is used for detection of carbon monoxide (CO). It can Detect the carbon monoxide concentration between 20-2000 ppm (parts per million). The sensor's conductivity is higher along with the gas concentration rising. Hence by knowing the sensor conductivity gas concentration can be determined. The sensor provides has high sensitivity with fast response time at low cost.

Methane gas sensor
MQ-4 sensor is used for detection of methane gas (CH4). It can detect the methane concentration between 20-10000ppm. The conductivity of the sensor increases with the concentration of the gases. Hence by knowing the sensor conductivity gas concentration can be determined. The sensor provides high sensitivity with fast response time at low cost.

Flow sensor
Flow sensor consists of a plastic valve body, water rotor, and a magnetic Hall Effect sensor. When liquid flows through the pipe valve the rotor rolls due to the movement of liquid. Based on the rotation of the rotor the Hall Effect sensor outputs the corresponding pulse signal by using which the signal flow of liquid can be determined. The Hall Effect sensor is sealed from the water pipe which allows the sensor to stay safe and dry.

16 x 2 alphanumeric LCD display
The 16 x 2 display has 32 characters overall i.e. 16 in one line and the other 16 in the second line. Each character is made of 50 pixels, therefore, all the pixels must work together to display the character correctly and this function is controlled by another controller (HD44780) in the display unit. Basically, the LCD is used to display the information obtained from the various sensors.

GSM module
The GSM used in this system is SIM800L which is a miniature cellular module that allows GPRS transmission and other functions such as receiving and sending SMS and voice calls. The module requires a power supply of range 3.4V-4.4V. It has a quad-band frequency which makes this module perfect for projects that require long-range connectivity. The module has two antennas, one is made of wire that is useful in narrow places and the other is the PCB (Printed Circuit Board) antenna.

Arduino 1.8.8
The Arduino software IDE is an open source which is used to write the code and upload it to the board. It runs on all types of operating systems such as Windows (both 32 and 64 bit), Linux, and Mac OS. This software can be used with any type of Arduino board.

ADVANTAGES
The proposed system prevents water accumulation by generating early alerts when the blockage just starts developing. The system provides an effective solution for proper monitoring of infrastructure management in the city and aims at keeping the city clean, safe and healthy by replacing the manual work of drainage monitoring for safety of the sewer workers.

RESULTS
The microcontroller used in the system is ATmega 2560 to which various sensors such as a gas sensor, level sensor, overflow sensor, and flow sensor are interfaced successfully. The interfacing of GSM is yet to be studied and implemented. The entire circuit is yet to be designed and implemented on the printed circuit board as per its specifications and the prototype for the manhole is yet to be designed.

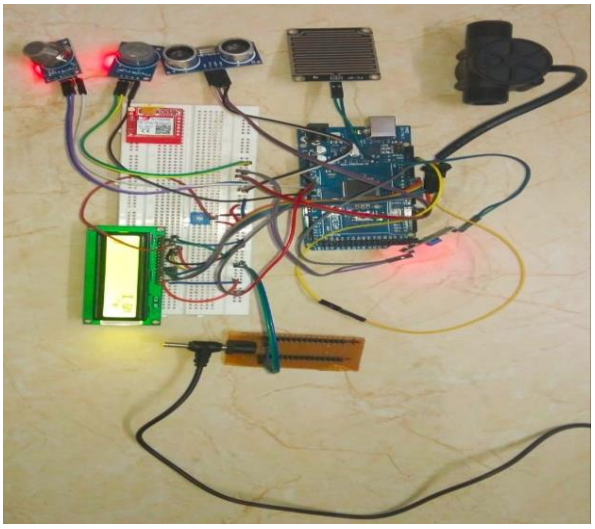

Figure 2: *Experimental setup*

Figure 3: *Display showing readings of the sensors*

Fig 2 describes the interfacing of various sensors to the microcontroller ATmega 2560 on a breadboard and Fig 3 shows the results that are obtained through various sensors.

CONCLUSION

The manual monitoring of the drainage is quite difficult and inefficient which may lead to blockages, therefore, the system proposes a method for proper monitoring and management of the underground drainage system. The system describes various applications such as manhole identification and its status in real time. Various parameters like concentration of harmful gases, the flow rate of sewage, and the level of water in the manhole are being monitored continuously and updated through GSM. If any alerts are obtained through the sensors then it allows the government persons to take necessary actions. Thus the unnecessary trips that are done to check the status of the manholes can be avoided and can only be done as and when required.

ACKNOWLEDGMENT

We would like to thank our Respected guide Dr. Sayed Abdulhayan, for his valuable guidance and for helping us in this work. We would also like to show our gratitude to the Telecommunication Department, Dayananda Sagar College of Engineering for providing us an opportunity and facilities to carry out the project.

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