Underground Drainage Monitoring System

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***Abstract*: Recently, the government of India had taken up the initiative of developing smart cities for which there is a need of developing proper land and underground infrastructure. Majority of the cities in India do not have proper underground infrastructure which includes water pipelines, drainage monitoring, etc hence there is a need of developing an automated drainage monitoring system which focuses on keeping the city clean and prevent the contamination of pure water and avoid spreading of harmful water borne diseases. A system is developed which consists of sensors that detects level of drainage, concentration of harmful gases, and the flow rate of the drainage inside the drainage system. If the system faces any issues then a text notification is sent to the respective municipal authorities through GSM so that proper action can be taken prior to the overflow of drainage.**

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

INTRODUCTION

In majority of the cities in India the drainage systems are not properly developed and maintained. In regions where the population is high there is a need for the development of proper functional drainage system. The drainage systems in India are monitored manually which is quite incompetent and the data recorded by the sewer workers are limited with an inefficient accuracy. In a normal drainage system if any of the manhole faces blockage issue due to unwanted waste materials, rise in the level of drainage then it becomes difficult to track down the appropriate location of the drain hole due to which the problem is arising. There are also possibilities of flooding of drainage on the roads due to which the pure water may get contaminated and harmful water borne diseases such as dengue, typhoid, and malaria may start spreading. Therefore to avoid the odds of existence of all these possibilities there is a need of developing a proper automated drainage monitoring system.

A system is developed which comprises of various sensors that are interfaced to the microcontroller which processes the data obtained from all the sensors and displays the status of the system on a liquid crystal display. The sensors used here are rain sensor which is basically used to detect whether the overflow has occurred or not, an ultrasonic sensor that is used to measure the distance or level of drainage by making use of the principle of Echo, a flow sensor that continuously monitors the flow rate of the drainage between two different manholes, gas sensors that detect the concentration of toxic gases concentrations such as CO and methane.

The microcontroller used is Arduino ATmega 2560 which has an oscillation frequency of 16MHz. If there is a blockage detected 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.

The latter part of the paper comprises of sections which are arranged as follows. Section II explains about 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 gives a brief introduction and explains about the basic working principle of all the sensors that are interfaced in the system. Section V describes the flowchart of the drainage monitoring system. Section VI explains the algorithm of the automated drainage system. Section VII gives the representation of the circuit diagram. Section VIII tells us about the advantages of the proposed system. Section IX explains about the obtained results of the proposed system. Section X outlines the conclusion.

LITERATURE SURVEY

Yash Narale et al. [1] published the Underground Drainage Monitoring System using IOT which describes the need of proper underground drainage infrastructure for the betterment and cleanliness maintenance in the city. The system makes use of ARM 7 microcontroller which is basically the heart of the system as it collects information from all the sensors that are interfaced to it and the results obtained are sent as early alerts to the municipal authority that is handling issues related to the drainage system through GSM and the system also comprises of GPS which helps in locating the exact location of the manhole where the overflow might occur. The system also makes use of temperature sensor which is not a necessity as the drainage systems in India do not have underground power grid lines.

Gaurang Sonawane et al. [2] published a Smart Real-time Drainage Monitoring System using the Internet of Things. The microcontroller used in this system is ATmega 328 whose basic functionality is to collect information from the sensors that are interfaced to it. The sensors used are gas sensor to detect the concentration of toxic gases, a level sensor, and a blockage sensor which detects whether the blockage has occurred. The system also makes use of flow sensor which is basically used to measure the flow rate of the drainage between two different drainage systems. The system is not the most efficient way of monitoring the

drainage.

METHODOLOGY

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

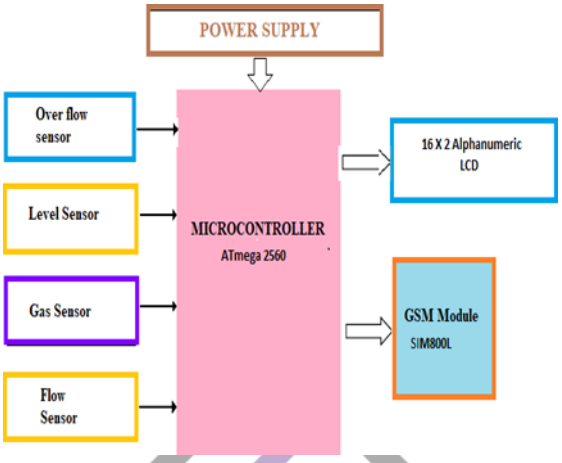


Fig 1: Block Diagram of Underground Drainage Monitoring System

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. The sensor that is used to identify the level of sewage is ultrasonic sensor which works on the principle of echo of signals. The sensor measures the distance between the lid and drainage level without actually getting into contact with it. MQ-4 and MQ-7 sensors are used as gas sensors to detect the concentration of methane and carbon monoxide inside the drainage system and the sensors work on the principle of conductivity. The system also makes use of flow sensor that works on the principle of magnetic hall effect to measure the water flow rate. In order to avoid the overflow of the sewage an overflow (rain) sensor is used which has parallel coatings of nickel lines on a metallic plate and works on the principle of variation of resistance. The microcontroller processes the information to the government authorities through GSM so that proper actions can be taken prior to the overflow of sewage. To identify the location of the manhole which is facing problems the GSM is assigned with an address, therefore along with the alert message the address is also sent to the respective municipal authorities. 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:
The ATmega board comes with 54 digital I/O pins of which there are 14 pulse width modulation pins and it also comes with 16 analog pins. The frequency of the crystal oscillator is 16MHz. The board is equipped with an in built reset button which restarts the operation of the microcontroller and has four hardware serial ports called USART which stands for Universal synchronous/asynchronous receiver/transmitter that is used for setting up communication. The input voltage that is recommended for use is of the range 7-12V and each pin has a DC current of 40mA. It has an EEPROM of 4kb which is basically used to store long term information and is non-volatile in nature.

Overflow sensor:
Overflow sensor works on the principle of resistance and comprises of a plate which has a coating of nickel in the form of parallel. The nickel plate of the sensor is connected to a Microcontroller module which performs all the processing operations such as sending the data to the Arduino board. If the sensor plate has some moisture content on it then the nickel coated lines on the sensor get shorted and therefore current starts flowing because of which the resistance decreases. Similarly when the sensor plate is dry which means there is no moisture content on the sensor then there is no connection between the successive lines of nickel on the sensor plate and hence the resistance value increases.

Level sensor:
For the purpose of distance measurement or water level measurement without actually getting into contact with the obstacle inside the drainage system a level sensor namely an ultrasonic HC-SR04 sensor is used. The level measurement is done based on the principle of Echo. Initially a high level signal for 10 microseconds is sent using trigger pin. Once the high level signal is sent then the ultrasonic module sends eight pulses of 40KHz signal automatically and after the pulses are sent it detects whether the pulses are received or not. If the signal is received back then it is through the high level signal and the time gap between the signal being sent from the trigger and then getting received is noted.

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 is made up of Tin Oxide, conductivity of this will be lower in clear air, it detects Carbon monoxide at low temperature. Rise in the carbon monoxide in the atmosphere results in increase in temperature of Sensor. It avoids gases at lower conductivity and user can change the conductivity of the sensor as per the requirements. For sensing the carbon monoxide the sensor provides the wide range of sensitivity, the sensor comes with long life, simple drive and low cost.

Methane gas sensor:
MQ4 is widely used for detection of Methane. The sensor is used widely in many applications because of its low cost. The composition of sensor includes a ceramic tube which is made up of aluminium oxide, a layer of sensitive material which is made up of tin dioxide, a heater and a measuring electrode are fixed into a shell made of stainless steel net and plastic. The gas sensors comes with 6 pins of which four of them are used for fetching signals and the remaining two pins are used for providing heat current. Sensor detects natural gas in the range of 300-10000 ppm.

Flow sensor:
The flow sensor works on the principle of magnetic hall effect and the sensor comprises of a body which is made of plastic and it also comes with a built in rotor through which water flows and for every rotation of the rotor a pulse is generated and around 2.25 milliliters of water will pass through it. The sensor is placed in between two different drain holes to measure the flow rate of the sewage inside the drainage system.

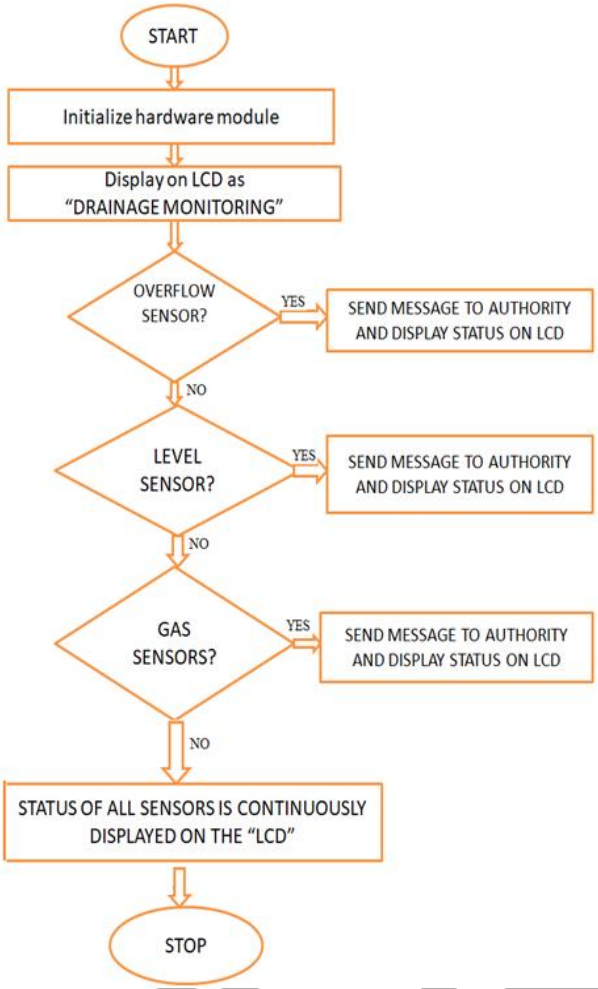
The sensor operates at a voltage range of 5 to 18V but the standard operating voltage is considered to be 4.5V and withdraws a maximum current of about 15mA. It can withstand a maximum pressure of about 2MPa. The minimum durability of the sensor is 3,00,000 cycles.

16 x 2 alphanumeric LCD display:
The 16 x 2 display has 32 characters overall and each character is made of 5x8 pixels. The maximum number of characters that this display can hold is thirty two and therefore has 1280 pixels. To display the data on the crystal board the display must be programmed as to how one wants to display data on the board. Basically, the LCD is used to display the information obtained from the various sensors.

GSM module:
SIM 800L is a miniature modem that supports communication in quad-band network to achieve long range connectivity and is basically used to send or receive SMS text messages. It uses 3.3 volts level logic as it requires a power supply in the range of 3.4 to 4V. Moreover the GSM module does not have an in-built voltage regulator therefore for the GSM module to be in the working condition it is very necessary that voltage supply should be within the specified limits. In the SIM800L module there is an LED present at the top right corner which keeps blinking and indicates about the status of the network.

Arduino v1.8.8:
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 and64 bit), Linux, and Mac OS. This software can be used with any type of Arduino board.

FLOWCHART



ALGORITHM

- ✓ START
- ✓ Power up the hardware system.
- ✓ Display on the LCD as "SMART DRAINAGE SYSTEM"
- ✓ Rain sensor checks for the overflow.
- ✓ The HC-SR04 sensor detects the level of drainage system.
- ✓ The flow sensor continuously monitors the flow rate.
- ✓ The MQ-4 sensor checks the CH_4 gas concentration.
- ✓ The MQ-7 sensor checks the carbon monoxide gas concentration.
- ✓ If any of the sensors exceeds its threshold value then message is sent to the respective municipal authorities via GSM.
- ✓ All the sensor readings are displayed on the LCD.
- ✓ STOP

CIRCUIT DIAGRAM

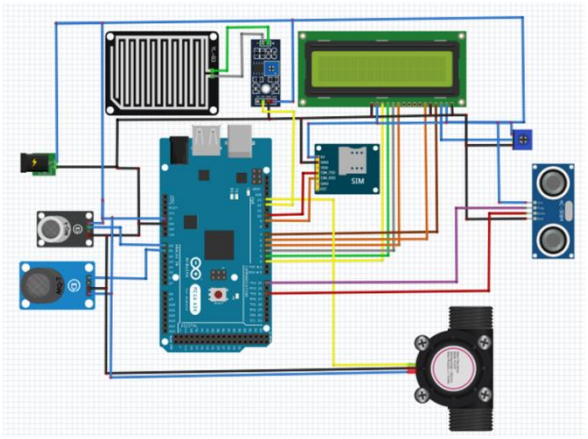


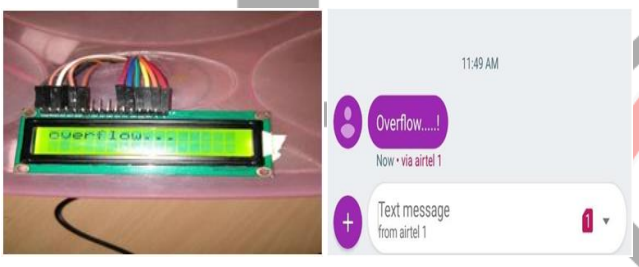
Fig 2: Circuit diagram of the proposed system

ADVANTAGES

- ✓ Prevents accumulation of water on roads.
- ✓ The system helps in detecting the overflow of the sewage prior to the overflow.
- ✓ Implementation of this system reduces the possibilities of soil erosion.
- ✓ The system generates alerts when the blockage just starts to develop.
- ✓ The system prevents flooding of sewage on the roads if proper actions are taken.
- ✓ The system detects the concentration of toxic gases.

RESULTS:

The microcontroller used in the system is Arduino ATmega 2560 to which various sensors such as gas sensor, level sensor, overflow sensor and flow sensor are interfaced. Initially the overflow sensor checks whether the drainage overflow has occurred. Then the level sensor detects the level of the drainage based on the principle of Echo. The gas sensor detects the toxic gases concentration such as carbon monoxide and methane. If any sensor exceeds its threshold value then a text notification is sent to the respective municipal authorities through GSM which is shown in below figure so that proper action can be taken prior to the overflow.



Overflow detection

Increase in water level detection

Gas detection

Status of the system

I. CONCLUSION

The manual monitoring of the drainage is quite difficult and an inefficient way which often leads to blockages and overflow. In order to avoid these problems a system is proposed 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 toxic gases, the flow rate of sewage inside the drainage system, and the level of sewage in the drain holes 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.

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