SEWAGE MONITORING AND MAINTENANCE ALERT USING IOT

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Abstract:
The sewage system is a primary element of a city and is responsible for the congestion of both rain and gray water from homes and industries. To avoid massive disruption, it is essential to have a monitoring system and a plan to perform prior expansion in the sewerage management system. However, there is no monitoring system in several overpopulated cities in the world, and the expansion process faces myriad difficulties and takes much time. This paper presents a model for an intelligent sewage management system that provides real-time monitoring without any major changes to the previous system, using water sensors, mobile software (BLYNK APPLICATION) for the Mobile Communications module, and a microcontroller.

Keywords: Ultrasonic sensor, Water Level Sensor, Node MCU,Blynk App.

1.Introduction:

Human health denotes the mental, social, and physical state of a lifestyle, not only a disease-free condition. To lead a healthy life, it is essential to living in a healthy environment; the ingredients related to a healthy lifestyle in a city depend on several issues, and one of them is the sewerage management system. When it comes to the management of the sewerage system in a heavily populated country such as Bangladesh, it is quite complicated.

Dhaka, the capital of Bangladesh, is the sixth most densely populated city in the world having more than 21 million inhabitants with a density of 46,997 people per square kilometer. However, to maintain the sewerage system, engineers face different challenges such as changes in real-time information, surveying, maintenance, and expansion, and with limited resources, they often fail. The failure of the sewerage system can release harmful gases like hydrogen sulfide and methane. As a result, people sufferfrom various infections and cardiovascular diseases. To avoid such situations, the Dhaka water supply and sewerage authority (DWASA) is always trying to survey and expand in advance. Unfortunately, most of the existing drainage system was planned a long time ago without proper supervision or capability to handle such a significant number of inhabitants. Nevertheless, in many places, the drain lines are congested, and rivers and canals have been forced to disappear because of the city's waste dumping.

For example, the country's poor drainage management came to light in 1998 and again in 2017, when 68% and 48% of the land were flooded [respectively, causing an enormous loss to the country's economy. On the other hand, the waste management system is another vital issue for a healthy city's environment. In that regard, the conditions in Bangladesh are truly miserable Because of the lack of awareness, people often throw waste onto the roads, which causes insoluble waste like polythene and plastic bottles to enter the sewerage line and block the drainage system. It is quite hard to manually determine the clogged area. Subsequently, maintenance becomes time-consuming, causes economic loss, and people suffer tremendously. In Figure, a flow diagram of conventional sewerage maintenance is presented, where complaints from a user or a time-scheduled survey trigger problem identification, which may take a long period. The Bangladesh government has taken various steps to boost the system in Dhaka and bring other cities under a similar sewerage network, but those steps were not able to fulfill the targets.

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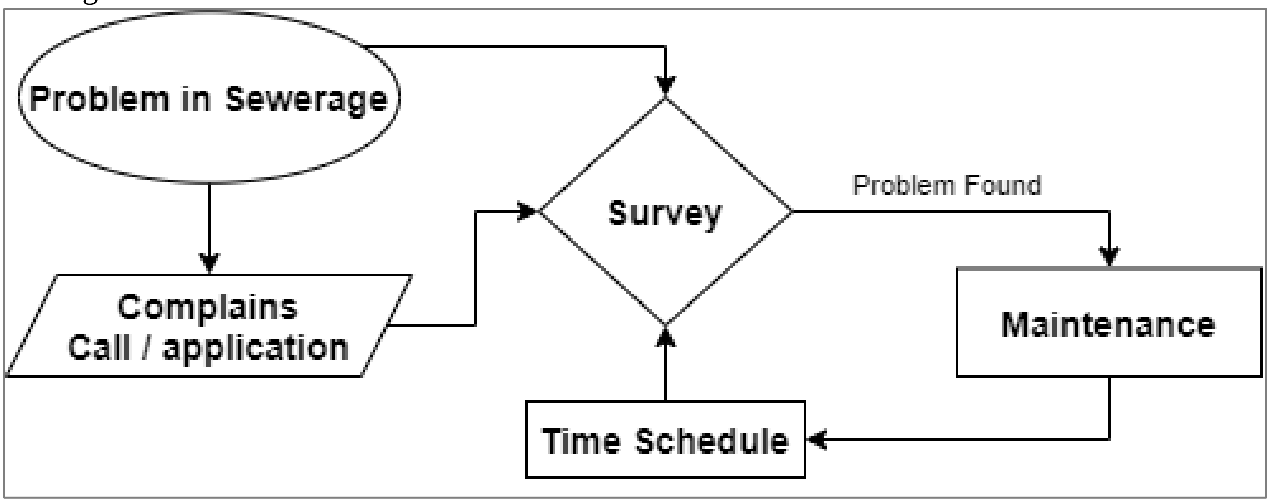

Figure 1. Flow chart of a man-powered sewerage maintenance system.

Today's world is more data-driven and automation-oriented, and the internet of things (IoT) is like a gift to us. Internet-connected objects that can store and exchange data without human interruption over a wireless connection represent an IoT system. Nowadays, cars, refrigerators, lights, and all other types of appliances are connected through the IoT. Briefly, the IoT allows us to build and control a system cost-effectively and efficiently.

Several previous studies in sewerage systems proposed implementing a vacuum sewerage system, a camera monitoring system, or fitting a net in maintenance holes, but because of the nature of Dhaka's sewerage system, none of those methods achieved the desired target. With this regard, our motivation is to construct a very cost-effective system that can be implemented, without changing the conventional sewerage, to provide real-time monitoring and an automatic waste removal mechanism.

Overall, the problems of a conventional sewerage system in impoverished countries are that they do not have real-time monitoring or a data collection method, an alerting system to act quickly for the worst-case scenario, or a mechanism to separate the solid waste that causes blockages. Moreover, it is time-consuming and expensive to establish and maintain such a system that provides modern facilities.

The following contribution is presented in this paper:

- Low-cost real-time monitoring.
- Overflow detection.
- SMS alerts.
- Waste-removing mechanisms.

This project presents a smart sewerage management system that addresses the stated problems at an attractive cost. The IoT system allows real-time monitoring to observe the current condition of the drainage system by getting input through sensors. In addition, there is a primary waste-removing unit for non-disposable waste that can automatically collect insoluble floating waste, like plastic bottles, to a moving conveyor belt for avoiding blockages. Besides this, an automatic graphical report shows vital information such as water level and overflow information in the area. In addition, an SMS (short message service) giving the affected area's location is sent to the authority immediately, whenever overflow is detected.

2.Literature Survey:

For modern and healthy life, a sewerage system is essential. As a result, various works have been proposed regarding sewerage monitoring and automation. Saba Latif et al present a system for transforming a graph model into a formal model using the Vienna development method-specification language (VDM-SL) to predict and control the water flow. The authors report an approach for a flood prediction system in the United Kingdom by analyzing sensor data for live monitoring with distributed sensors. In addition, a GIS and IoT-based management system were implemented in Hainan province, China, which contains modules like GIS management and an analysis control center, sewerage pipe network grid management, a dynamic pipe network simulation, and information control. Consequently, Sajedul Talukdar et al. proposed a system for an automated routine checkup and waste filtering system using Arduino.

The authors report the flow and quality check of dust water in urban areas using a comprehensive mathematical model. A monitoring system based on a wirelessmesh network is presented to solve the problems of a conventional monitoring system for the sewerage treatment plant. Sharmad Pasha uses monitoring and sensing for IoT with MATLAB analysis using different microcontrollers. Tigor Hamonangan Nasution et al. proposed a prototype of an electric appliance control tool via SMS by using GSM, which does not depend on a mobile device platform. Different approaches to maintaining communication between the IoT and a cloud database have been proposed earlier, such as Li, L et al., who present a way that Wi-Fi can be utilized in the IoT, then Novo Oscar et al. show the usage of a cellular network; similarly, ZigBee or LoRa can be utilized for communication. In the application of IoT, different papers show how trash and garbage collection or even aquatic fisheries can be modernized by predictive analysis using different machine learning techniques, such as k-means clustering.

However, for a city that is densely populated and has a very poor sewerage management system, like Dhaka City, these aforementioned methods do not work well and present various difficulties. This paper proposes a new, comprehensive IoT-based method to develop a monitoring, survey, and automatic waste removal system, including an alert, within the existing system in a very cost-effective way.

3.Components used:

(a) Ultra-Sonic Sensor:

Ultrasonic sensors are reliable, cost-effective instruments for these applications. In operation, the sensor is mounted over the water. To determine the distance to the water, it transmits a sound pulse that reflects from the surface of the water and measures the time it takes for the echo to return.An ultrasonicis used to detect the blockage water.

(b)Water Level Sensor:

Level sensors are used to detect the level ofsubstances that can flow. Such substances include liquids, slurries, granular materials, and powders. Level measurements can be done inside containers or it can be the level of a river or lake.

(c)Node MCU:

Node MCU is an open-source platform based on ESP8266 which can connect objects and let data transfer using the Wi-Fi protocol. In addition, by providing some of the most important features of microcontrollers such as GPIO, PWM, ADC, etc.

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- The information from ultrasonic and water level sensors is received and processed in the ESP8266 which acts as both Microcontroller and Wi-Fi module.
- The ESP8266 performs all the logical and mathematical operations inside and sends the appropriate signals to the Blynk cloud for the necessary actions. Here, the real-time ultrasonic distance is sent to the Blynk application, and also a push notification is sent to the mobile in case of Blockage or Overflow.

IoT-based Sewage Monitoring Circuit Diagram:

First, the circuit can be connected as per the circuit diagram of the sewage monitoring device shown below.

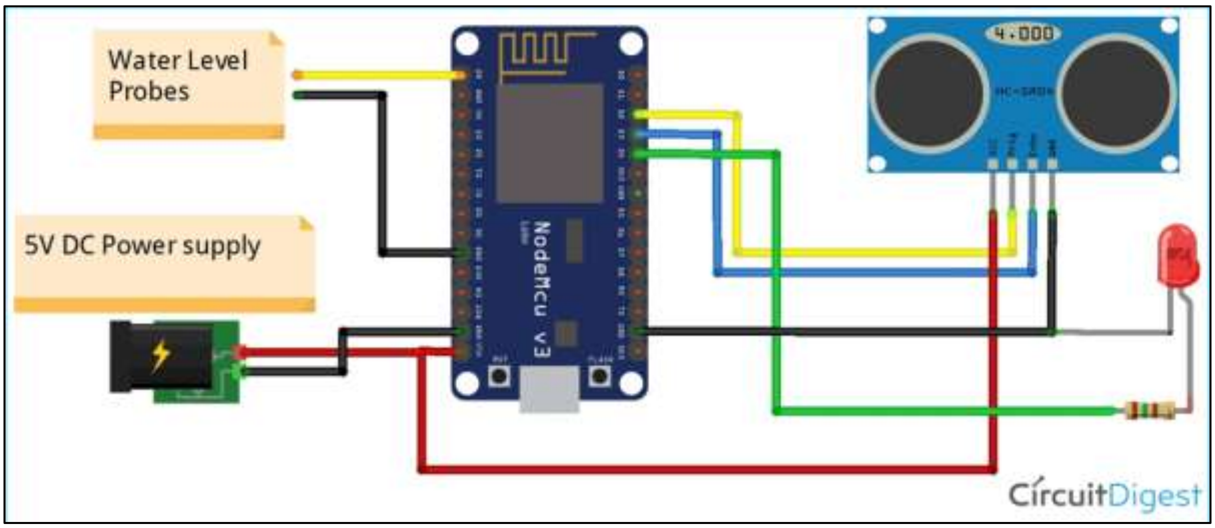
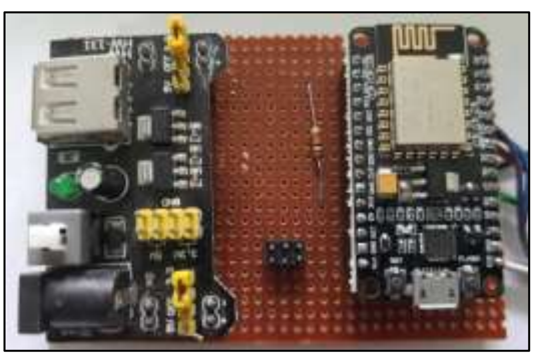


Fig.3.1 Circuit Diagram

Here, two conductors were used as water level detectors which can also be replaced with **float sensors** similarly. Then for external protection, it is encased within a Plastic enclosure and the final assembly.



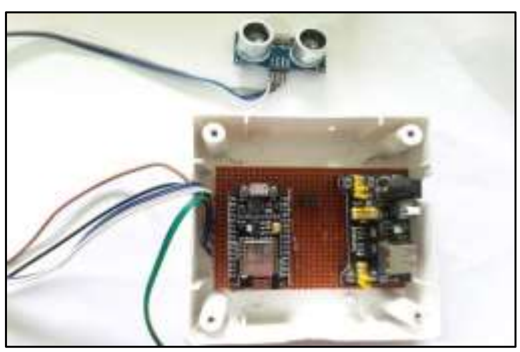


Fig.3.2. a. Soldered circuit in a perf board Fig.3.2. b. Final Assembly

Set up the Blynk Application for Remote Sewage Monitoring. Once the complete set-up is ready, just upload the code to NodeMCU and the project will be ready for testing.

4. Existing Methodology:

In the field of automatic water quality monitoring, high-cost monitoring equipment in the past will be replaced by a large number of wireless sensor network nodes with low prices, superior performance, and strong mobility. This not only reduces the cost of monitoring but also increases the scope of water quality monitoring. In the beginning, the sensors were randomly distributed, and the sensors in the area to be measured were deployed through airplane spreading or artillery ejection.

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However, random distribution does not result in efficient coverage, especially when the distribution of wireless sensors is particularly concentrated and there are few sensors in the critical area of the area to be measured. Therefore, algorithms must be used to optimize sensor deployment and data optimization to improve sensor coverage and effective utilization.

Water is not a commercial product like any other resource but, rather a heritage that must be protected, defended, and treated as such. It is perhaps the most vital of all-natural resources because it is essential to all fundamental processes of mankind, and it is an irreplaceable resource. Its management is important because it has major control over the socioeconomic development of any country. Adequate and sustainable supplies of clean water are vital to the world's health, environment, and economy. About 70% of the earth contains water and out of which only 2.4% is freshwater. More than 60 billion m^3 of freshwater is needed yearly to manage the annual global population growth. For the next 50 years, the world population is estimated to increase by another 40%–50%. This population growth—coupled with industrialization and urbanization—will result in increasedwater demand and will have serious consequences on the environment. Worldwide concerns over the social, ecological, and security implications of water shortages with formidable challenges in meeting rising demands for potable water are increasing as the available supplies of freshwater are decreasing due to extended droughts, population growth, and decline in water quality.

5. Proposed Methodology:

The objective of our project is to detect the water level using water level sensors and eradicate the clog using pressurized motors with IoT module in order to avoid an unclean environment, save the government time and revenue being spent on manual intervention.

The following figure shows the block diagram of the proposed methodology. It has three parts; the system configuration shows how the architecture of the proposed system is arranged in Section 5.1.

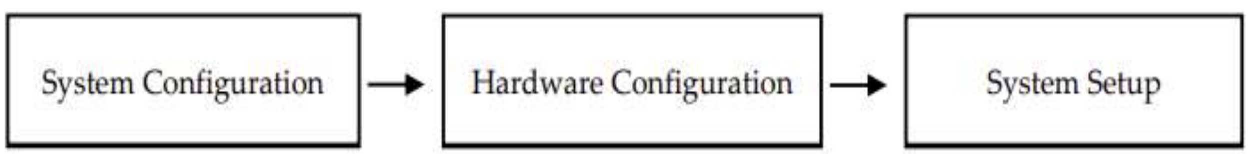

Figure:5.1. Block diagram of the proposed methodology

The water level sensor detects the flow of water in three levels which depends on the clog in the drainage system. The levels of identification can be classified as the first level, second level, and third level.

FIRST LEVEL:

If the range in the water level sensor is between 100 to 200 then it is the first level. At this level, the clog can be automatically removed with the help of a pressurized pump. The pressure can be applied with some delay inside the drainage pipe.

SECOND LEVEL:

The clog which can't be cleared from the first level will increase the level of water. Then it will reach the second level. If the range in the water level sensor is between 200 to 300 then it is the second level. It can be removed in two ways. They are auto mode and manual mode. This mode can be selected by people working with it. In the auto mode, the clog can be removed by increased pressure or with some chemical acids like sulphuric acid, hydrochloric acid, etc.,

THIRD LEVEL:

Some of the clogs cannot be cleared in auto mode. This means the first-level and second-leveloperations cannot be used. If the range in the water level sensor is above 300 then it is called the third level. It cannot be cleared by automatic mode. The highest-level notification is sent to the authorized

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person and it should be removed manually.

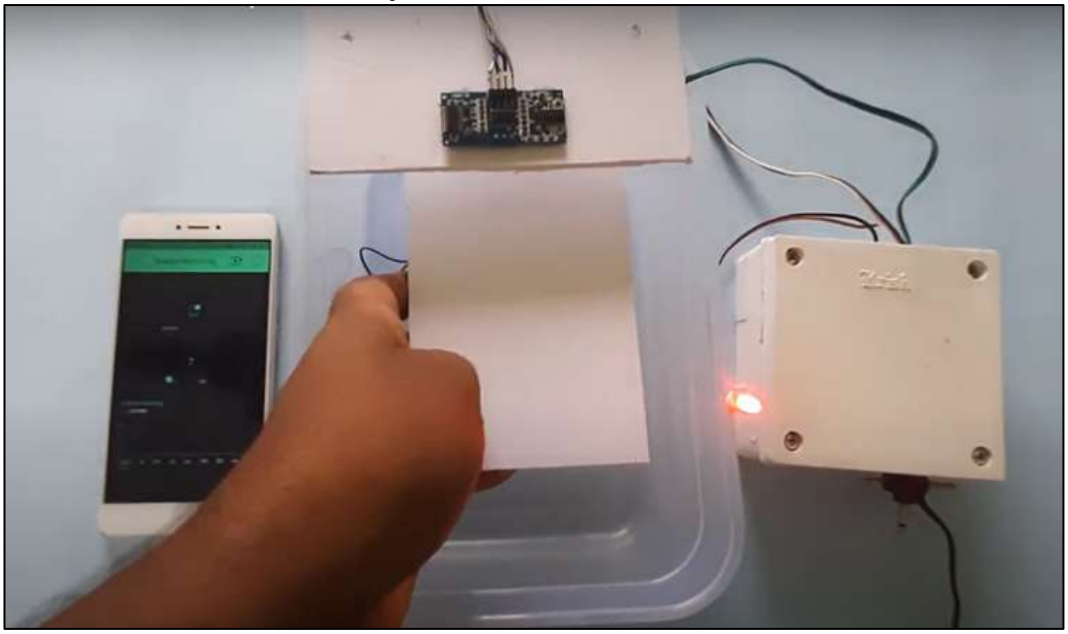

Fig.5.2Hardware Setup for Sewage monitoring and maintenance

The analog data from the water level sensor is sent to the Arduino module, where the analog data is converted into digital data. The Arduino module is used in the project as Multiple Input and Multiple Output (MIMO) and Analog and Digital Converter (ADC).

The digital data is sent to the module through the Arduino module.The BLYNK application is a cross between a computer and a microcontroller board as you would find in so many smart devices. In our project, it acts as an intermediate between the Arduino and the Client. There are three types of notifications that are sent to the client based on the level of water measured by the water level sensor. Initially, the sensor will be in an ideal state i.e., zeroth level (no clog is present).If the clog is present in the sewage system there will be an increase in the water level. The level sensor detects the change in water level and the notification is sent to the server reporting the first level warning.

Suppose the clog is not cleared in the first level, then there will be a further increase in the water level. This rise in water level is detected by the sensor and the notification is sent to the server. The server passes the information to its clients. This stage is called the second level. At this level, the clog can be eradicated in two ways i.e., manual mode and auto mode. Auto in two ways i.e., manual mode and auto mode, to clear the clog in the drainage system. Certain chemicals like hydrochloric acid, Sulphuric acids can chemicals like be used to remove the clog by breaking its molecules. If the clog is not cleared in these two levels, then the clog can be cleared by an authorized person only. This level is called the third level. This message is passed to the client through the server. The authorized person will clear the clog.

SOFTWARE CODE:

The below code which is written in C language is fed to the Arduino. It will automatically measure the level of water (sewage water) and send a notification to the client or municipal official to avoid the overflow of sewage water. so that immediate action can be taken by the officials.

CODE:

```
#Define BLYNK_PRINT Serial
#include <BlynkSimpleEsp8266.h>
#include <ESP8266WiFi.h>
const int trigPin1 = D3;
```

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```
const int echoPin1 = D2;
#define redled D4
char auth[]="aX3Cded2oxBxxxxx9bAVEGt1U";
char ssid[] = "admin";
char pass[] = "123456789";
int duration1,distance1;
int count=0;
void setup()
{
  pinMode(trigPin1, OUTPUT);
  pinMode(echoPin1, INPUT);
  pinMode(A0, INPUT);
  digitalWrite(A0, OUTPUT);
  pinMode(redled, OUTPUT);
  digitalWrite(redled, LOW);
  Serial.begin(9600);
  Blynk.begin(auth, ssid, pass);
}
void loop()
{
  int float1=analogRead(A0);
  digitalWrite(trigPin1, LOW);
  delayMicroseconds(2);
  digitalWrite(trigPin1, HIGH);
  delayMicroseconds(10);
  digitalWrite(trigPin1, LOW);
  duration1 = pulseIn(echoPin1, HIGH);
  distance1 = duration1 * 0.034 / 2;
  Serial.println(float1);
   Blynk.virtualWrite(V1,distance1);
   if(distance1<=5)
   {
    Blynk.notify("Blockage Alert!");
    digitalWrite(redled, HIGH);
   }
   else if(float1<=800)
   {
    Blynk.notify("Overflow Alert !");
     digitalWrite(redled, HIGH);
   }
      else
   {
    digitalWrite(redled, LOW);
   }
    Blynk.run();
   }
```

6. Conclusion:

Thus, our project aims to create a safe and healthy environment by creating a smart drainage monitoring system. The crucial role of our project is to detect the clog automatically with minimum human intervention thereby reducing the mortality rate of people working in the drainage system. This project is a one-time implementation and there is minimum management, hence the overall time and cost are reduced. The proposed project is to monitor and take quick action for the eradication of the clog automatically.

This project proposes an IoT-based system that provides real-time monitoring and alert systems, with a waste-detecting mechanism that works without any major modifications within the conventional system, such as implementing a full new route or the acquisition of land for expansion.

Because of the monitoring and alarm functionality, the water authority can respond quickly to any unusual occurrence and make data-driven decisions. Then, the live conditions activate the waste collection feature, which prevents unnecessary energy loss. In addition, the related personnel can monitor the whole system with just an internet-connected device from anywhere in the world, which gives great portability.

7.Future Scope:

Further development, like a more powerful motor to clear the clog at the lower level of the clog, power backup, and a waterproof chamber for electronics equipment, is required for the final system. In the future, we plan to employ green energy by using solar cells. A large-scale trial could also be conducted in different cities. In addition, for network connectivity, Wi-Fi and LoRa are utilized, but alternatives such as cellular connectivity or ZigBee could also be utilized.

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