Design and Development of Smart Manhole

Praveena B A 1*, Balachandra P Shetty 2, Murthy Samartha S Kalasi 3, Shivpratap Singh Yadav 1, Mahadeva Prasad 1, Sujith M N 3, Naresh Reddy 3, Mallikarjun L 3

1, Assistant Professor, Department of Mechanical Engineering, Nitte Meenakshi Institute of Technology, Yelahanka, Bangalore: 560064, India.
2, Professor, Department of Mechanical Engineering, Nitte Meenakshi Institute of Technology, Yelahanka, Bangalore: 560064, India.
3, U G Student, Department of Mechanical Engineering, Nitte Meenakshi Institute of Technology, Yelahanka, Bangalore: 560064, India.

*E-mail: praveena404@gmail.com

Abstract: - In today’s world, urban area house a majority of the population of any country. Analysis of both historical and real-time data results in an enhanced understanding of the urban infrastructures systems and consequently in an improvement in their management. By 2030 it is estimated to grow more. As urban areas are resorting to smart methods, either by IoT or by redesign of existing service sector, underground drainage plays a prominent role to provide a healthy environment, good hygiene and safety to a large population density. For this a good underground drainage system is necessary. We can bring about a change by simplifying and reducing the cost of maintenance of existing system. This can done by drastically reducing the time taken to pinpoint the area affected. By replacing existing manhole with sensor based manhole cover at certain key locations, real time data like flow rate of water, concentration of toxic gases can be determined. This data is sent to the authorized service station prior to its blockage thus preventing the flooding of streets through a speedy maintenance regime.

Keywords: sensor, power independent, manhole, flow rate, data center.

1. Introduction

Rapid development and the expansion of urban clusters are essential to our drainage network success in India. We do have a higher population level than many nations and so a reliable wastewater network is required. A research analysis lately has shown that a properly managed drainage network eliminates up to 40 percent and even up to 80 percent the chance of lethal diseases. Another research found that a healthy drainage network would stress pathogens without needing to encourage personal hygiene. Therefore, it is important for such a wellbeing of population to have a healthy drainage network. According to the context of 2011, at country level 48.9% of households neglect drainage facilities, although 33% of residences have public sewage facilities [1].

The National Family Health Survey 3 in 2006 indicates that in metropolitan settings, there was a 52.8% increase, which implies that the flush townhouses connecting with piped, septic sanitation systems were insufficient for 40% of residences, whereas public toilets were in need of about 23.7 percent and accessible protection was performed by about 17.9 percent. A second analysis indicates that 30% of metropolitan inhabitants remain in slum zones. At Bangalore, In Hyderabad, Andhra Pradesh 86 out of 124 cities had no sanitation or drinking water, but just half of the 52 towns were supplied by sanitation.

In metropolitan cities, there are most sewage treatment plants, 40 per cent of which generate sewage. 17 percent of all wastewater is generated in the cities of Delhi and Mumbai. Waste water in urban centers, as it can pollute ground water sources, is necessary to handle. A shift from unified supply to semi-centered supply is needed because it may reduce insecurity between quick urban growth and infrastructure supply for that growth [2].
2. Problem Statement
It is known that a major portion of the population move to cities, which means that by 2030 we would need more water to deliver up to 600 million people and that it would make India a sub urban country, with 2,86 treatment of wastewater, recycling and reuse every year. There is a huge pressure to provide clean water to the people of India and that could be a priority. Exported water may be supplied to urban areas for urban prerequisites from semi urban areas. Rough about 80% of all water is required in urban areas. In this report, we seek to understand the volume of waste produced in cities such as Ahmedabad, Hyderabad, New Delhi, Kolkata and Kanpur, as well as various livelihood application and agriculture. A combination of household and industrial waste is a major challenge in most of the cities which makes the system complex. Due to the lack of organized data on different types of water waste, estimation of quantity and quality are considered a problem [3].

Data from 900 cities of category I and of category II showed that the waste water from these sewages constitutes a mixture of urban and industrial wastewater. This makes it more difficult to process the generation of waste water than the treatment of water. In India the scheme used today is not that high technology, which leads to more obstructions in drains, and it is difficult to pin the position of the block when this occurs. This means that it takes a lot of time to repair the blockage. Because of such failures, people on the ground must suffer [4].

3. Methodology
- Old manholes are replaced by Smart Manholes. They’re retro fit and can be designed to any shape and size to match existing manholes.
- They’re designed to be power independent. So, solar panels with reinforced toughened glass is attached
- Smart Manholes are equipped with Flow Sensors, Microcontroller, Transmitter and Receiver.
- Once they start to collect data of flow rate from underground sewage system, it is stored and saved in data centres for further researches.
- If flow rate crosses threshold limit in any manhole, immediately message is sent to maintenance team to take necessary action.
- Service team will look after the issue with respective manhole with pinpoint accuracy and work can be easily done by advanced cleaning devices. (BandiKoot)

3.1 Redesign of Manhole Cover
An underground unit for the supply of accesses to utilities like a water system etc may be a manhole or inspection chamber. Underground facilities are then checked, updated, washed and preserved with the aid of a manhole. Typically manholes are 0.5 m from the roads' curb lines. Most of the house is too far away from the central traffic path. The top cover can be a plug to protect the manhole from any non-service access, which usually consists of rectangular, square or circular covers [5]. Canopy fabrics are usually precast, material or plastic materials enhanced by glass. Smart Manholes cover outdated manholes. These are retro designed and will conform to the predominant manholes of any form and scale. We took an existing manhole element of ward 18, Bengaluru for this phase.

![Figure 1. Dimensions of Redesign of Manhole](image)
3.2 Solar Panel as power source
As global climate change comes, it is all the more important that we do our best to reduce greenhouse gas emissions pressure on our atmosphere. Solar panels do not have movable parts and require no upkeep. These are constructed robustly and when properly managed these last for many years. The storage is designed for charging small batteries of up to 7 Ah or 7000 mAh, with a capacity of 10 watts and a 12 volt solar rating that can be used to charge a 12V vehicle or a deep cycle battery [6].

They are designed to be autonomous. So, reinforced toughened glass solar panels are related. The 5V/1.25W manufacturing solar array is adequate to power the control panel. Now we have used the solar array with 12V/10W power. This is 24 * 14 cms in thickness.

![Figure 2. Solar array retrofit Manhole](image)

3.3 Installation of Controller
Arduino Mega, a programmable micro controller, is systematically configured according to the need and is linked to the information transfer module GSM 800A in an efficient manner. GSM serves as information relay to Data Centre. The Arduino network has only started with electronics and has been really fashionable men. The Arduino does not need a separate piece of equipment (called a programmer) as most other configurable circuit boards. You'll just load a fresh file onto the board with the USB cable. The IDE also uses a simplified C++ version, making searching for bent software easier. Arduino also offers a standard form factor that disconnects the roles of the microcontroller into a more functional bundle [7].

It's a microcontroller board promoting the at mega 2560 microcontroller Arduino Super 2560. With their simple to use interface, Arduino boards have revitalized the automation market, where some people with little to no technological background will begin studying basic programming and running skills on boards [8].

GSM can be a handheld modem for communication; it stands for a global mobile networking network (GSM). In 1970 Bell Laboratories developed the concept of GSM. This is commonly used worldwide mobile messaging system. GSM is an open and digital cellular technology that operates at the 850MHz, 900MHz, 1800MHz and 1900MHz frequency bands used to transmit mobile voice and data services [9].

![Figure 3. Controllers setup](image)
SIM808 module SIM808 GSM / GPRS / GPS Bluetooth Compatible Wireless Board GPS Antenna (Arduino and Raspberry Pi Compatible) will be a computer board; SIM808 module allows you able to use GSM connectivity and GPS functionality in combination with the Arduino or Raspberry Pi device. You can send and receive SMS with this app; track a path and also create on-card functionality with your own telephone. SIM808 app as a GSM communicator and GPS receiver. The power supply module is 5 – 26V if the power supply is smaller than 2A, whichever is required for 9V. Next. Next. Street power supply port with an extra 3.5-4.2V battery power source lithium appropriate. USB device monitoring – TTL is also a lightweight [10].

3.4 Algorithm of the program

Step 1: Start
Step 2: Initialize levels and controls Step 3: IF L>20 if NO back to step 2
Step 4: Warning message
Step 5: IF L > 26 if NO back to step 2 Step 6: CRITICAL ALERT MESSAGE
Step 7: Stop

3.5 Flow chart of Program

3.6 Sample code in C

```c
void loop()
{
    int s1 = sensorU1(); int s2 = sensorU1();

    if (s1 == T1)
    {
        send_SMS("S1 Threshold Level 1");
    }
    if (s1 = T2)
    {
        send_SMS("S1 Threshold Level 2");
    }
    if (s2 == T1)
    {
        send_SMS("S2 Threshold Level 1");
    }
```
{ if (s2 == T2) {
    send_SMS("S2 Threshold Level 2");
}

3.7 Assembly
Once all the parts are prepared with required codes and finishing it is assembled as shown below with all circuit connections.

Figure 4. Complete setup of Experiment

- Redesigned Manhole fitted with Solar Panel
- Battery
- Programmable Microcontroller and GSM module
- Ultrasonic Sensor setup

3.8 Sample Output
Continuously tracking the water flow rate and automatically sending mails receive a text message when the water level is outside the normal range expected also feel and update.

Figure 5. Sample output in mobile phone in text format
4. Results and Discussions

Once they start to collect data of flow rate from underground sewage system it is stored and saved in data centers for further research. Every season data is stored and referred timely to standard the threshold limits and critical limits. If flow rate crosses threshold limit in any manhole, immediately message is sent to maintenance team to take necessary action.

- Alert before Clog
- Prevention of spillage and overflow at junctions
- Maintain hygiene
- Process and Cost efficient
- Checking and cleaning is easy, because the main parts are retro fit.
- Handling is easy
- No Manual power
- Easy to Repair.
- Replacement of parts is easy

5. Conclusions

A smart city is that the future goal to possess cleaner and better amenities for the society. Smart underground infrastructure is a crucial feature to be considered while implementing a sensible city. System monitoring plays an important role keep the town clean and healthy. Since manual monitoring is incompetent, this results in slow handling of problems in drainage and consumes longer to unravel.

To mitigate of these issues, the system employing a wireless sensor network, consisting of sensor nodes is meant. The proposed system is low cost, low maintenance, IoT based real time which alerts the managing station through an email when any manhole crosses its threshold values. This technique reduces the death risk of manual scavengers who clean the underground drainage and also benefits the general public.

Sensor unit automatically senses and updates the live values of the physical parameters like temperature, humidity, water level and flow, blockages, and manhole cap is open or closed through IoT. This makes the system smart and automatic.

The deployment of Wireless Sensor Networks (WSN), helps within the implementation of the Smart cities during a developing countries. This WSN also can be useful in designing of environmental monitoring systems, which helps in monitoring of volcanic activities, flood detectors and other system. by a little modification within the implementation, this project are often utilized in agriculture fields or other environmental fields to watch and control the systems. In future, Smart cities infrastructure might be modified for intelligent communication and management of traffic signals, street lights, transit applications, active lanes, and so on. With the mixing of smart devices during a city infrastructure can makes life during a city tons easier.

Also further by using PLC controller and SCADA systems, drainage water are often controlled, monitored and also this water are often wont to irrigate plants, clean toilets, etc. This PLC and SCADA systems are often used as a treatment system for drainage water. Primarily, PLC controls the method of sewage treatment plant and SCADA may be a link-attached terminal unit, which monitors and controls the whole area.
References

[1] Kumar SG, Kar SS, Jain A. Health and environmental sanitation in India: Issues for prioritizing control strategies. Indian J Occup Environ 2011; 15:93–6.

[2] Norman G, Pedley S, Takkouche B. Effects of sewerage on diarrhoea and enteric infections: A systematic review and meta-analysis. Lancet Infect Dis. 2010; 10:536–44.

[3] Moraes LR, Cancio JA, Cairncross S, Hurtly S. Impact of drainage and sewerage on diarrhoea in poor urban areas in Salvador, Brazil. Trans R Soc Trop Med Hyg. 2003; 97:1538.

[4] Report of the working group on urban and industrial water supply and sanitation for the twelfth five-year-plan (2012-2017)

[5] Kaushik A, Kumar K, Kanchan T, Sharma HR. Water quality index and suitability assessment of urban ground water of Hisar and Panipat in Haryana. J Environ Boil. 2002; 23:325–33.

[6] Weber B, Cornel P, Wagner M. Semi-centralised supply and treatment systems for (fast growing) urban areas. Water sci technol. 2007; 55:349–56.

[7] Saravanane, R., Ranade, V. V., Bhandari, V. M., & Seshagiri Rao, A. (2014). Urban Wastewater Treatment for Recycling and Reuse in Industrial Applications. Industrial Wastewater Treatment, Recycling and Reuse, 283–322. doi: 10.1016/b978-0-08-099968-8.

[8] Bieker S, Cornel P, Wagner M. Semi centralized supply and treatment systems: integrated infrastructure solutions for fast growing urban areas. Water Sci Technol. 2010; 61:2905–13.

[9] Sundaravadivel M, Vigneswaran S. Wastewater collection and treatment technologies for semi-urban areas of India: A case study. Water Sci Technol. 201; 43:329–36.

[10] Yash Narale, Apurva Jogal, Himani Choudhary, S. P Bhosale ,Underground Drainage Monitoring System Using IoT, ISSN: 2454-132X Impact factor: 4.295 (Volume 4, Issue 1).