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# A Review of Sensor and Communication Medium for Monitoring Sewage Pipeline

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***Abstract*—The rapid development, industrialization and population increase causes high demand of pure water in the urban area. Firstly, the industries, residential areas etc. release dirt, sludge in excess, hence pure water in the rivers get contaminated. Secondly, sewage network operator cannot predict that pipeline would overflow. When an emergency situation occurs, the damage caused by the waste water from sewage networks can be enormous. The government should come up with such a system where it could gather information about muddy water like level, volume, velocity etc. which enable government to restrict the industries. Moreover, critical situation like pipeline overflow can be identified, thus operator gets prior notification about the same. Operating expenses can also be reduced. In addition to above benefits, the information aids the researchers in their research. Pipeline network can be represented on GIS. There could be a security breach to the system so a light-weight and secure cryptographic algorithm should be developed to provide the security for data.**

***Keywords— Sensor; Communication Medium; Security; Sewage, GIS***

## I. INTRODUCTION

About one-fifth of the world's population lacks access to safe drinking water. By 2025 two out of every three persons on the earth would live in water stressed conditions with the present consumption patterns. Water shortage is a serious problem throughout the world.

Surat one of the fastest growing cities in Southern Gujarat of India, has major sources of water as river Tapti. The river Tapti debilitates the city's condition during floods. The flood has agonized the city during the floods before. This flood water can be stored in reservoir and can be used efficiently for all purposes including water consumption and other daily activities. The city has problems of Khar land, climatic changes are the major causes [1].

In PUNE MIRROR (Fig. 1), they stated that "Civic body has no records of nullahs that merge with rivers and the untreated sewage they carry, State government writes to municipal commissioner; PCMC admits it is clueless", on 11 November 2013 [2].

For the better water management there is a need of intelligent system which can monitor the flow, volume, temperature of water and other parameters in Sewage pipelines. By implementing such a system one can efficiently identify critical situation, preventing environmental disaster, accounting for city and regional infrastructure and reduce operating expense.

Fig. 1. Nullahs like this one that runs by Deluxe Talkies in Pimpri could be carrying untreated sewage to the rivers in the area

Following are the objectives of this review paper:

- To identify sensor which could be placed inside the sewage pipeline which can measure the level, velocity and temperature of sewage material.
- To identify communication medium and send the data collected by sensor to the central server.
- The data could be used for monitoring the sewage pipeline and can be represented on GIS so that operator can easily identify the location of the blockage.
- The data can be useful for accounting for city and regional infrastructure so that government can keep the record of nullahs.
- The data is also used for research work.

## II. IDENTIFICATION OF SENSOR

Liquid-level measurement methods are classified into two types:

1. Contact
2. Contactless

Contact-type liquid-level measurement methods include those for float-type mechanical, electrical (capacitive and resistive), and pressure sensing. Liquid level is measured with these methods directly by using a sensor that gets into contact with the liquid. Although Contactless methods are more complicated than contact methods, they are necessary for specific applications, such as measuring hazardous solutions and medical instruments.

Below portion shows four major types of liquid-level measurement methods [3].

### A. *Float Type Sensor*

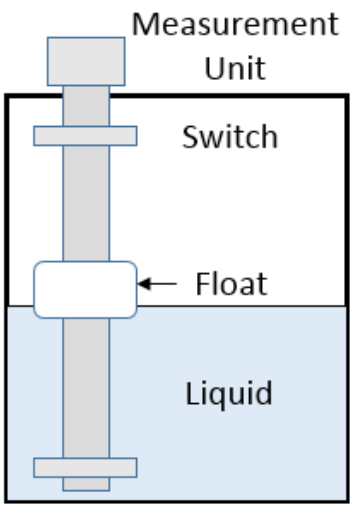


Fig. 2. Float Type Sensor

Float-type mechanical sensing is the simplest and most widely used (Fig. 2) [4]. The sensors use a float as the primary sensing element and operate on the basis of the buoyancy effect. Switching occurs as a result of the movement of the float against a switch, which is usually set to upper and/or lower limits. The sensor detects the switching and measures the liquid level. Although a float-type sensor is simple and not expensive, it must contact the liquid because the sensor is put into the liquid.

### B. *Capacitive Sensor*

Capacitive sensing is another well-known method for contact-type liquid-level measurement (Fig. 3) [5]. A sensor, which consists of two electrodes, is inserted in a target liquid. The two electrodes are composed of a capacitor, and the liquid acts as a dielectric medium. The capacitance changes in response to the liquid level between the electrodes. Then, the liquid level is calculated from the measured capacitance. The capacitive sensor can accurately measure the liquid level, but it must come in contact with the liquid.

A capacitive semi-cylindrical sensor mounted around a liquid container can measure liquid level without having to contact the liquid, but its measurement accuracy is not high because the capacitance is very much reliant on the distance between the container and sensor.

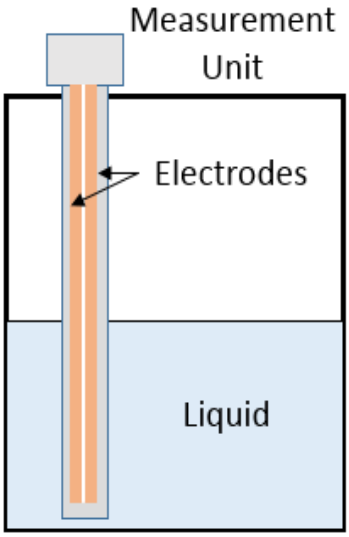


Fig. 3. Capacitive Sensor

### C. *Optical Sensor*

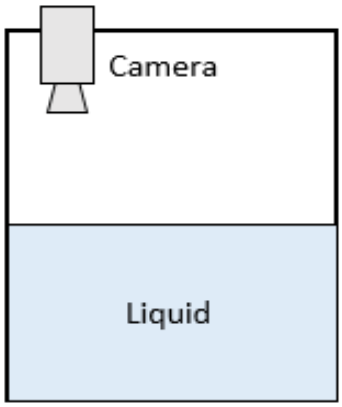


Fig. 4. Optical Sensor

Optical sensors can be used for liquid-level measurement without having to contact the liquid (Fig. 4) [6]. An optical camera and an image signal processor are used to measure liquid level by detecting the edge of a captured image and calculating the liquid level.

### D. *Ultrasound Sensor*

Ultrasound sensors can measure liquid level without having to contact the liquid (Fig. 5) [3]. This measurement method is based on the time-of-flight principle. The ultrasound sensors emit high-frequency (typically 20 to 200 kHz) acoustic waves onto the liquid surface. The waves are reflected at the liquid surface, and the sensor detects the echo from the surface. The distance between the sensor and the liquid surface is calculated from the time of flight, and the liquid level is estimated. Because the method is based on the

time-of-flight principle, proper mounting of the sensor, which achieves "line of sight" of the sensor to the target liquid surface, is required.

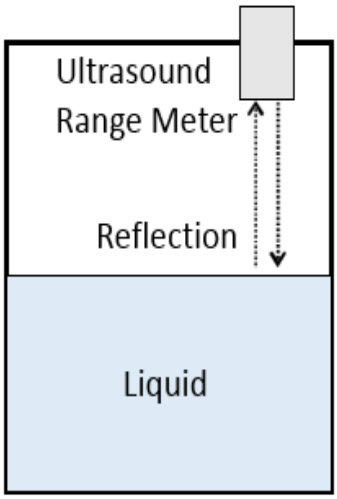


Fig. 5. Ultrasound Sensor

## III. IDENTIFICATION OF COMMUNICATION MEDIUM

There are number of technologies existing for wireless communication, like Wi-Fi, Zig bee, Bluetooth. Following are the details of each technology.

### *A. Wi-Fi technology*

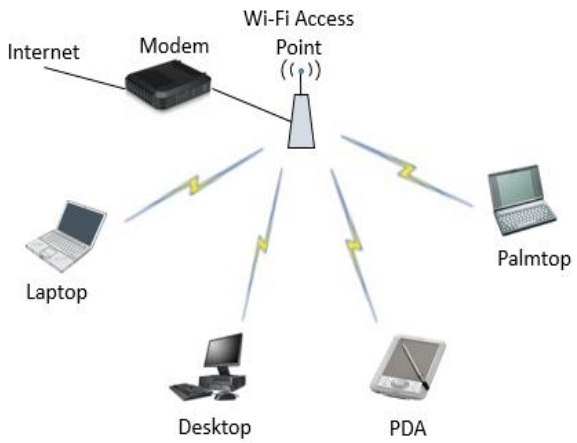


Fig. 6. Wi-Fi Architecture

Wi-Fi widely is becoming the ideal mode of internet connection. To access connection of this type, one must have a wireless adapter on their computer. Hot Spots are the areas with Wi-Fi connectivity. Radio waves are used to transfer information across a network. The system should have a wireless adapter that translates the data sent into a radio signal. An antenna is also used to transmit signals, to a translator known as the router. Later the data is sent to the Internet via a wired Ethernet connection. As the wireless network will work Wireless network is a dual way network, the data obtained from the Internet would pass via the router to be coded into a radio signal. This would be receipted by the wireless adapter of the system. Wi-Fi offers wireless connectivity by producing frequencies between 2.4GHz to 5GHz based on the load of data on the network [7]. Architecture of Wi-Fi as show in Fig. 6.

Wi-Fi is a common wireless application for computer communication and Ethernet network. As shown in Fig.7, Wi-Fi provides swift connection, comparatively better range, higher data rate transmission and protection for gadgets. [7].

### *B. ZigBee technology*

ZigBee device operate under the 802.15.4. The ZigBee is a group of companies that produce trustworthy, cost-effective, and have less power requirements, version of a personal wireless communication devices. The significance of these devices is that it has very less power consumption, which extends their battery life noticeably. ZigBee devices have many applications. ZigBee devices are suitable for home automation, and are used for security of smart-home and environmental controls. It can also be used in medical observations of the people who use devices with ZigBee wireless enabled. It can be used to open and shut the curtains. There is a 100 meters transmission distances which is provided by ZigBee devices if nothing is obstructing the signal. ZigBee uses low RF signal, which does not harm humans [7].

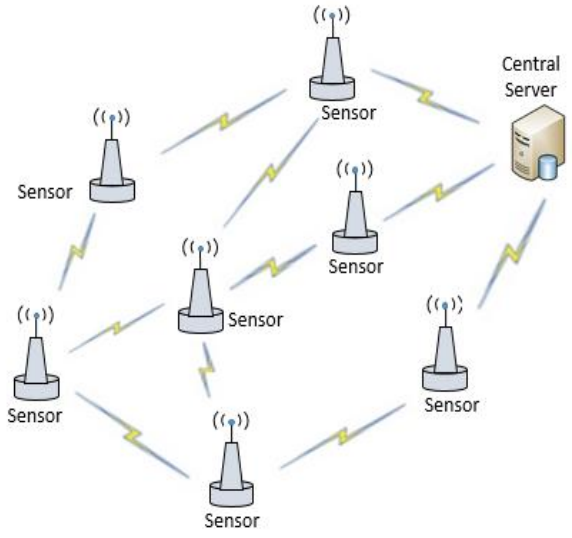


Fig. 7. ZigBee Mesh Architecture

As show in Fig. 7 mesh connections among the sensor nodes forming a network. If two network points are unable to communicate as intended, transmission is dynamically routed from the blocked node to a router with a clear path to the data's destination [7].

### C. Bluetooth

Bluetooth technology is a wireless communications technology for less distances to replace the physical connection of electronic devices through cables. The Bluetooth RF transceiver functions in the uninhibited ISM band run at 2.4 GH. The channel is further divided into time units known as slots. Data is transmitted in packets within the devices in which Bluetooth is switched on, that are located in these slots. Frequency bounding takes place between the transmissions and receiving of packets, so the packets that come in one transmission may be directed over various frequencies within the ISM band. The channel is also used as a transport for one or more logical links that support synchronous and asynchronous traffic as well as broadcast traffic. The former traffic is used to carry hands free audio data, while latter traffic may carry other data in different forms that can resist more changeability in the timing for delivery [8].

*Visibility of wireless Technology:*

Wi-Fi provides fast connection, relatively better range, higher data rate transmission and security protection for desktop, laptop and Personal Digital Assistant (PDA).

Bluetooth provides short-range transmission, low data rate and low power consumption.

ZigBee also provides short-range transmission, low cost of production, low data rate and low power consumption. For comparison, ZigBee is more energy conservable than Bluetooth and perfect solution for smaller packets over a large network.

*Limitation:*

Wi-Fi, ZigBee and Bluetooth are used for short range communication. It is not reliable for large range. So Wi-Fi, ZigBee and Bluetooth are not useful for establishing wireless communication between sensors and server.

## IV. Critical Review

As mentioned above, for the deployment of the sensor inside the sewage pipeline, techniques like contact type liquid level measurement cannot be used. Because in the cleaning process of the sewage system they have such motors which can release the water with heavy force so that they can remove the blockage. If contact type liquid level measurement is used then there might be a chance of physical damage to the sensor which is a problem to ponder about. So one has to use contactless type sensor.

There are two options available for measurement of water level without any kind of contact of sensor in sewage pipeline namely, Optical sensor and Ultrasound sensor. Research says that the Ultrasound sensor will work properly inside the sewage pipeline [9]. Because inside the sewage pipeline the state of material is semi-solid and also there are so many chemicals inside the water. So if one uses Optical sensor there, lens of the camera should be taken care. It is a tedious task and the result will not be accurate. So the Ultrasonic sensor is the best for this proposed system.

There are number of technologies used for communication medium like Wi-Fi, ZigBee, Bluetooth and Cellular GSM etc. Sensors should be deployed inside the sewage pipeline network and apparently the area covered by the sewage network is very huge. So if Wi-Fi or ZigBee system for communication is used, would not be feasible. The range of such kind of system is very less so that we have to put repeaters. Now assume the expensive cost of the system, because one has to deploy such a network in the whole area. In the wireless network we have to face problem of radiation. If it is deployed in the whole area then people might oppose this kind of system [10].

These days Cellular GSM network is popular, available in any urban area and if we use such a network for communication then there is no requirement for any extra network deployment. One has to attach only GSM module with sensor.

## V. Expected Outcome

By developing and implementing such a system, we can get many benefits which are listed below:

### A. Applications

- Integration of sensor data into GIS
- Analysis of sensor data using GIS
- Identifying warning and critical situation
- Accounting for city and regional infrastructure
- Preventing environmental disaster
- Reducing OPEX

### B. Monitoring waste water in city sewers

- Detect and warn against sewer blockage and overflow
- Detect and warn against flood conditions
- Prevent premature reservoirs dry-out
- Simple installation - no need for road digging
- Non-contact sensor - Minimal maintenance

## VI. Conclusion and Future Work

In this report we have seen the need for monitoring the sewage pipeline in urban area using sensor.

Ultrasonic sensor could be placed inside the sewage pipeline and measures the level, velocity and temperature of sewage material and sends this data using GSM module to the dedicated system. This data could be used for monitoring the sewage pipeline and can be represented on GIS so that operator can easily identify the location where the blockage is created. The government can also use this data for keeping track of waste water coming out from industries.

*Security Issues:*

Though there are plethora of cryptographic algorithms for data security, none can be more effective in the aspects of less battery power, limited processing, consumption of less memory and more security as these are key for sensor.

So there is a need for an effective algorithm which leads to less consumption of battery power, optimum utilization of memory and provide more security of data.

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