International Journal of Innovative Technology and Exploring Engineering (IJITEE)
ISSN: 2278-3075 (Online), Volume-9 Issue-6, April 2020

Water Monitoring System using Unmanned Surface Vehicle

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Abstract*: *In today's world where climate activists focus more on large water bodies like seas and oceans, many smaller water bodies which lie neglected are also being contaminated. These smaller bodies also affect the groundwater, which goes unnoticed. The system checks parameters such as turbidity, temperature and pH levels. In addition to these monitoring, the depth of the water is measured to check whether any unnoticed large dumping/deposition had occurred. It is integrated on a USV so that human intervention is minimized. This system aims to provide continuous quality surveillance of water in places where large scale monitoring is not feasible, with the help of LoRa Communication which ensures low energy consumption and easier to implement compared to IoT technology. It can be implemented in rural as well as urban water bodies to check whether the quality of water has deviated from regular levels due to any external factors.

Keywords*: *LoRa, USV, Water monitoring

I. INTRODUCTION

Water cannot be neglected as no life could exist without them. Taking care of all water bodies is important as even smaller water bodies play a vital role in maintaining the balance of that place. It is the responsibility of fellow citizens in ensuring that nearby water bodies are maintained properly.

Water bodies located in our locality play a vital role in the ecological habitat. India being the seventh largest and second populated country, it has only four per cent of the total freshwater resources. In reference to 'Water Quality Analysis in Pallikaranai Wetland, Chennai [1]. If stagnant water bodies may be impacted by this project, it is vital to establish a proper monitoring system to ensure the water quality is affected as little as possible, and so that any impact can be mitigated if it is detected. Temperature plays a major role in determining quality. It affects the physical and chemical properties of water. Even pH, metabolic rates, Conductivity and salinity, photosynthesis rate, Dissolved oxygen and other dissolved gas, and Water Density is affected.

Revised Manuscript Received on April 30, 2020.
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To eliminate problems associated with manual water quality monitoring, Central Pollution Control Board (CPCB) has planned to go for a hi-tech solution which is used for large water bodies [2]**.** The parameters that CPCB plans to monitor online are pH, turbidity, conductivity, temperature, Dissolved Oxygen, Dissolved Ammonia, Biochemical Oxygen Demand, Chemical Oxygen Demand, nitrates and chlorides. These proposed large water monitoring systems which are operated real-time are able to collect data and send it to the central station where all the data is stored for further processing. These stations will not require manual intervention for at least 5 years, except for routine calibration and battery replacement [2]. This implementation requires very high implementation cost and is not suited for smaller waterbodies. Because it is unfeasible to implement such a system for smaller water bodies this paper focuses on a low-cost system which will help us to monitor the water quality parameters.

Malche T and Maheshwary P [5] proposed an IoT system in villages which seems to be complex when compared to LoRa communication. It is simple and independent to use as it does not require any other sources for its functionality which makes it more independent, especially more applicable in villages when comes to power and cost reduction.

II. SYSTEM STRUCTURE

This system shown in the Fig.1 is deployed in the closed water body to determine the water quality parameters. These parameters are sent from the onboard microcontroller to the receiving substation through LoRa communication along with the geographical position in bigger water bodies to know the exact position of the boat. LoRa is adopted so that the system works under low power consumption and low cost. The data received in the substation is checked for any drastic change in the permissible levels if so, the GSM module sends an alert message to the concerned department.

III. SYSTEM HARDWARE

A. USV System

The USV consists of the water quality sensor mounted on a small hard chine boat structure to have more stability on the surface water. This provides better navigation control along the coast of the water body. The two propellers attached to the rear of the USV for faster navigation. The USV system is made with the help of the three ultrasonic sensors and the MPU is used to find the stability of the boat.

The ultrasonic on the right helps to maintain its course of direction and keeps it within the specified distance.

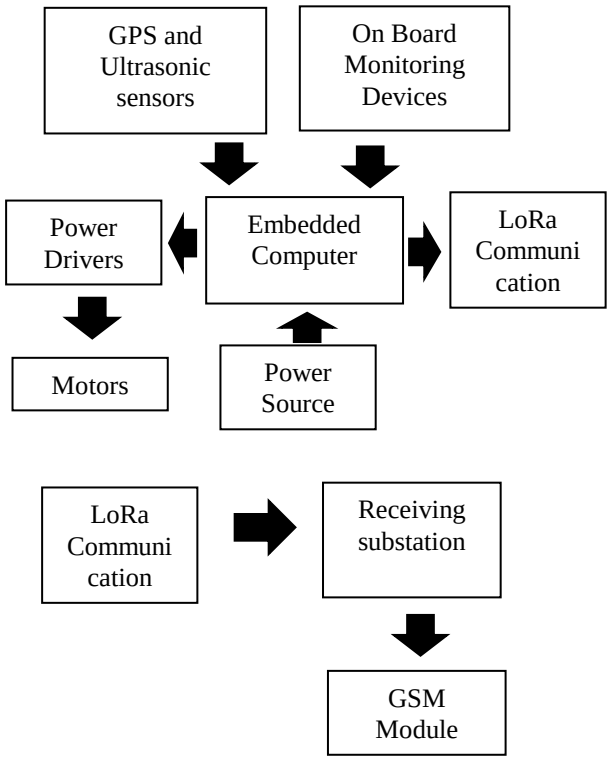

Fig 1. Block diagram of USV and Receiving Substation

When the boat deviates from the specified distance from the shore, the boat returns to its predefined path as shown in the Fig.2. At the same time, the front sensor checks for any obstacle the boat changes its course of direction and follows the path as shown in the Fig.2 [8]. The MPU 6050 helps to measure the tilt angle of the boat and if there is a change in the threshold value an alert is sent through LoRa and is reached to the concerned department via GSM. The third ultrasonic is employed in the case when the boat is navigated in the opposite direction.

B. Monitoring System

The sensors integrated to measure the water quality are pH sensor, temperature sensor and turbidity sensor. [6,9] And the waterproof ultrasonic sensor is used to measure the depth of the waterbody to check for any change in the regular depth. The GPS neo-6m is integrated along with the sensors and the location is sent along with the parameters through LoRa so that we can keep track of the area which is getting contaminated and helps to reduce the time taken to identify the origin of the contamination taken place.

C. Receiving Substation

The receiving hub consists of the LoRa receiver and GSM module connected to a Raspberry Pi 3B+. It is used to store data which we receive from the boat and it can act as a platform for future data analysis. The microcomputer continuously monitors the water quality parameters, in case of sudden high deviation in the parameters if noticed then an alert message is generated and sent with the help of GSM to call for human intervention if necessary.

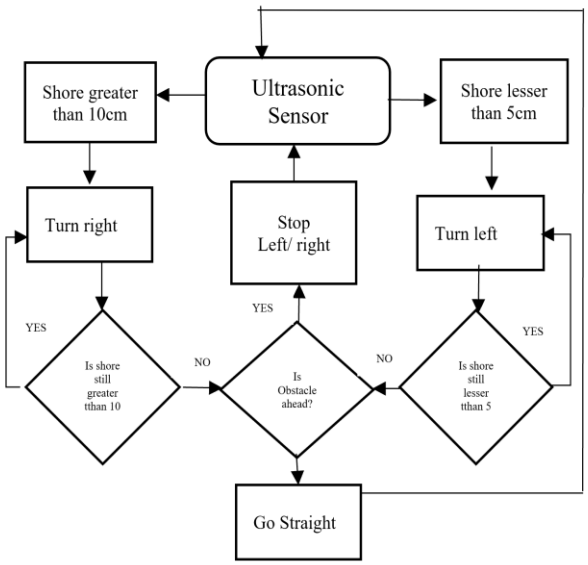

Fig 2. USV Flow Diagram

IV. WATER QUALITY PARAMETERS

A. Temperature

The temperature parameter influences the water quality through various factors which contribute to indirectly affect the nature of the water body. Factors that get affected due to temperature change are the diffusion rate of gases, photosynthesis, dissolved oxygen. Temperature also influences the organisms that can live in water body which ultimately affects the ecology[9].

B. Turbidity

Turbidity helps us to determine the level of contamination by finding the haziness of water which is caused by dissolved particles. When the turbidity level is high, it affects the functioning of the ecosystem making it unhealthy as it becomes more prone to virus and bacteria. It also acts as a huge threat to aquatic life.

C. pH

pH changes the nature of water making it more acidic/alkaline which is due to chemical wastes disposed of in the water body. Temperature changes also have an indirect effect on pH variations. As pH decreases, the level of dissolved oxygen decreases due to the increase in CO_2. When the pH is too low, the micronutrients become more mobile and are absorbed more than what the plant needs, resulting in this potential for toxicities. When the pH is too high, the micronutrients are less mobile and the plant cannot absorb enough, which results in deficiencies.[4]

V. COMMUNICATION

The unit is integrated with an Arduino Uno board for data transmission module at one end and Raspberry Pi board for the reception with help of Ra-02 LoRa. LoRa is adopted because of its usage of ISM bands for communication which eliminates the interference with mobile phones in urban areas[7].

IoT was also not considered due to its feasibility issues present which restrict its usage in rural underdeveloped areas.[3].

The unit is also provided with a GPS module that is necessary to identify the location of the boat. This technology can transmit data to distances up to 20 km in line-of-sight and it is ideal since it may allow data transmission to a remote data collection center without using power-hungry and more expensive solutions like GPRS/UMTS.

VI. RESULT

The test results in Table 1. was conducted in the water body in our locality. Based on parameters received we can see that the pH level is close to the neutral value (7). Turbidity is very low indicating less turbid water suitable for drinking. Depth is almost constant indicating no change due to external factors. The temperature may vary due to various external factors. The data is received on the raspberry pi terminal window.

Table1: Sample Testing in Water Body

Surface points	pH	Turbidity (NTU)	Depth(cm)	Temperature (Celsius)
A	7.7	9.08	156	30.4
B	7.6	10.71	156	31.2
C	7.7	15.75	153	31.6
D	7.8	12.54	154	30.8

VII. CONCLUSION

Nowadays, many places let it be land or water both are getting highly contaminated due to various factors. Waterbodies that are unattended are the ones getting affected the most due to various reasons that lie unnoticed. The severities of these contaminations lead to unknown health issues in the locality by affecting the groundwater and it affects the ecology of the environment. This system monitors the water quality regularly with the help of sensors integrated into the USV and the GPS send the exact location of the boat from where the data was sent via LoRa technology which has been proved in recent times to be very effective at low power for greater distances. In an era where energy efficiency is of utmost importance, this system operates using very low energy due to the nature of the components involved and so can be used in all water bodies with low energy to monitor parameters effectively at a minimal cost.

FUTURE SCOPE

In future, the system can be developed by having multiple USVs' and can be interconnected through LoRaWAN. The government can provide an initiation to install such a system in all the local water bodies to ensure the well-being of a much larger area. It can further be integrated with alternative non-conventional power sources such as solar.

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