Real-Time Water Quality Monitoring system for Vrishabhavathi River of Bengaluru

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Abstract

Water plays most important role in human survival but, increasing population in urban areas has led to pollution of water. So, there is a necessity to check and maintain the quality of water continuously. This paper aims to design real time water quality monitoring system in IoT environment for Vrishabhavathi River of Bengaluru. Five parameters are being monitored i.e. Temperature, pH, Turbidity, Flow and Conductivity using sensors. All the sensors are interconnected to form a sensor node. The data from the sensor node is conditioned and transmitted to Arduino microcontroller. Thus, forming wireless sensor network (WSN). In microcontroller the data computation takes place and the output is displayed on LCD and open source cloud platform.

Keywords: *Vrishabhavathi river, water quality, IoT, pH, WSN.*

I. INTRODUCTION

Water is most essential for human beings, plants and animals but with the increasing industrialization the water sources are reducing tremendously. In Bengaluru, Vrishabhavathi river water was once used as the source of water supply in addition to Cauvery reservoir. But, nowadays quality of water is being affected because of direct discharge of industrial effluents, domestic wastes into the river. This polluted water harms the environment which affects the health of people and causes the destruction of water ecosystem and water shortage situation [6]. Over population also contributes to water pollution. Hence it is required to maintain the quality of water.

Traditional methods of checking quality involve manual collection of water samples at different locations, followed by laboratory analysis in order to check water quality. Such approaches are time consuming and are considered as inefficient [7], apart from this, water quality can also be monitored through microbial measurements and physiochemical measurements. Physiochemical parameters include electrical conductivity, pH, oxidation reduction potential (ORP), turbidity, temperature and flow [1].

In this project work we have collected samples of Vrishabhavathi river from different points i.e. Nayandahalli junction, BWSSB water treatment plant, Mailasandra, and Byramangala lake point where water is used for agricultural purposes. This system is a real time monitoring system, so any changes in any of the parameters are monitored every second hence increasing the efficiency of the system.

In this project all the sensors are interconnected to form a sensor node (WSN). All the data from sensor node is signal conditioned and transmitted to control unit for further computations.

II. DESIGNED SYSTEM

In order to achieve portable effluent monitoring system for Vrishbawathi River the IoT based system has been proposed which has the following modules: (a) sensory modules; (b) signal conditioning circuit; (c) computational circuit; (d) data display module and (e) cloud platform.

a. Sensory Module

The following sensors are being used to collect different parameters of river water:

1. **Temperature sensor:** to measure the temperature of the river water we use DS18B20, having a temperature range of -55 to 125-degree C.
2. **Analog pH Sensor:** To know the acidic and basic levels of water having a range of 0-14.
3. **Gravity analog turbidity sensor:** to know the turbidity and the total suspended solids in water a DFRobot is used.
4. **Flow sensor:** to calculate the flow of the different samples YFS201, is used.
5. **Analog conductivity and TDS meter:** to find the voltage levels in water.

b. Signal conditioning circuit

The signal conditioning boards have amplification circuits, calibration circuit and potentiometers for adjusting the analog values of voltage received. We have separate signal conditioning boards for all the sensors that are being used.

c. Computational Unit:

Arduino microcontroller is used as a computational circuit to perform all the computation and controlling. The set points of all the sensors is fed into the microcontroller and the values received for each sample for all the parameters is compared with the set point and any mismatch causes the buzzer to ring and the solenoid valve can be shut off thus preventing the water to flow forward.

d. Data display module

For displaying the values of all the sensors and to display whether the water is portable or not, 1602 Liquid Crystal Display (LCD) is being used. The LCD receives all the values serially and displays in the same order.

e. Cloud platform

For displaying the real time values to the cloud, we are using the Adafruit cloud platform. The reasons to select this cloud platform is because its free and it has an inbuilt storage for a period of one month.

III. METHODOLOGY

To design the system for water quality monitoring of Vrishabhavathi river water, various water quality parameters are investigated.

A. Water quality parameters

As part of our project, we visited Sewage treatment plant (STP) of Vrishabhavathi river water which is located in Mailasandra, Kengeri. Bangalore Water Supply and Sewerage Board (BWSSB) is the government organization which operates this treatment plant.

STP monitors several parameters like flow, temperature, pH, Biological Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Total solids (TS), Total suspended solids (TSS) etc. In proposed system, we have considered temperature, pH, flow, turbidity and conductivity. To monitor these parameters sensors were selected with the help of literature survey.

B. Block diagram

As shown in the figure, five different sensors are deployed to collect the required data on the obove mentioned parameters. All the sensors selected are compatible with the Arduino UNO microcontroller. Sensors collect the data in real time and are sent to WSN module. Microcontroller is programmed to check whether the parameter values are in nominal range or not. The output data is displayed in Liquid crystal display and sending to the cloud platform.

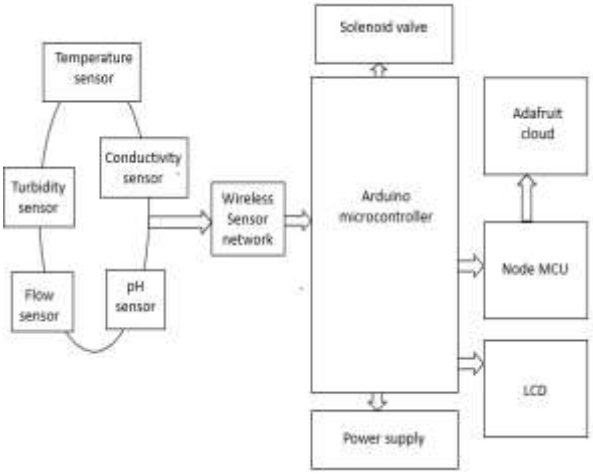

Fig 1:Block diagram of the system

C. Hardware and Software

Temperature sensor is DS18B20 is thermometer which provides 9-bit to 12-bit digital output in Degree Celsius. Flow sensor YF-S201 is used which works based on the Hall effect principle. Flow sensor is placed in-line with liquid flow and has pinwheel sensor to measure the amount of liquid which has moved through it. Flow sensor has Hall Effect sensor in it which produces pulse for each and every revolution. Turbidity sensor is used to measure the amount of total suspended solids (TSS) in the water. Turbidity is measured based on the amount of light that is transmitted through the water since the transmitting and scattering rate varies depending upon the suspended solids. The pH sensor is the measure of acidity or basicity of water based on H+ ions.

All these data are sent to microcontroller for further processing and control and the data is displayed on the liquid crystal display interfaced with Arduino. The output data are transferred to cloud platform through a Wi-Fi module, Node MCU. The cloud platform which is used is Adafruit IO cloud platform which is an open source cloud platform which offers wide range of IoT applications. Steps to setup the cloud are:

- Connect the ESP8266 module to the Arduino
- Include the configuration libraries
- Initialize all the input pins
- Secure a stable connection for the Wi-Fi module whose Wi-Fi details are fed in the program
- Declare the status pins
- Data is serially transmitted to the ESP8266
- Login into your Adafruit account with the respective credentials
- Go to the dashboard and download all the water parameters
- To check the past one month record we can go to the feeds

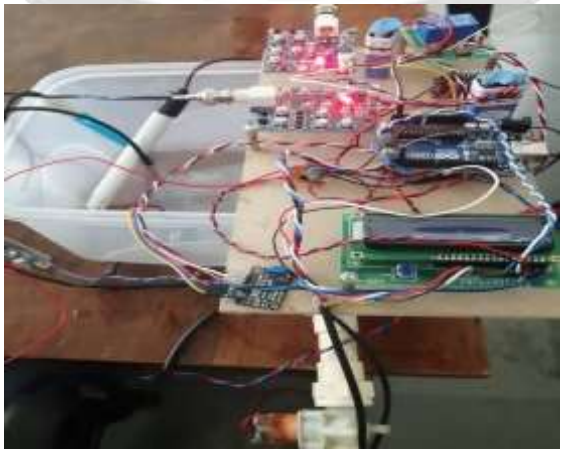

Fig 2: Photo of practically designed syste

D. Design of sensor:

There are no real time heavy metal detection techniques. The current methods used for the heavy metal detection is Atomic absorption spectroscopy and X ray diffraction methods which have very costly setup and apparatus. Due to the unavailability of existing sensors to measure the heavy metals in water in real time we have designed a SAW based lead sensor for detection lead in water. We have used Lithium Niobate as the substrate, gold as the sensing layer and aluminum as the electrode. The different displacements of the sensing layer at different frequencies due to the presence of lead is seen.

IV. EXPERIMENTS

A. Experiment setups

As shown in Fig. 4, four samples of water source of river water in different places are tested. Four samples of river water are represented by A, B, C and D. In situ testing of the water samples at the respective location was done and all the parameters were tabulated.

Nayandahalli water sample | Kengeri water sample

Treated water Sample | Byramangala lake

Fig 3: Four saples of Vrishabhavathi river water

Table 1: Experimental results

Sample	Place	Quality
A	Nayandahalli	Temperature:33.67°C pH:9.27 Conductivity:415mV Turbidity:0.94V Flow: 0.780l/min
B	Kengeri	Temperature:28.75°C pH:5.48 Conductivity:369mV Turbidity:1.76V Flow:1.03l/min
C	BWSSB treated	Temperature:24.3°C pH:7.49 Conductivity:283mV Turbidity:3.29 Flow:1.27l/min
D	Byramangala lake	Temperature:28.6°C pH:5.16 Conductivity:391mV Turbidity:3.76 Flow:1.12l/min

V. RESULTS

The proposed system measures different water quality parameters of Vrishabhavathi river and monitored through online using cloud computing via Adafruit IO platform. The sensor data are stored in web server and the concerned authority will be given valid user ID and password to login on the website. Hence, the data is secured and can be accessed anywhere. The following figures shows the data stored in cloud.

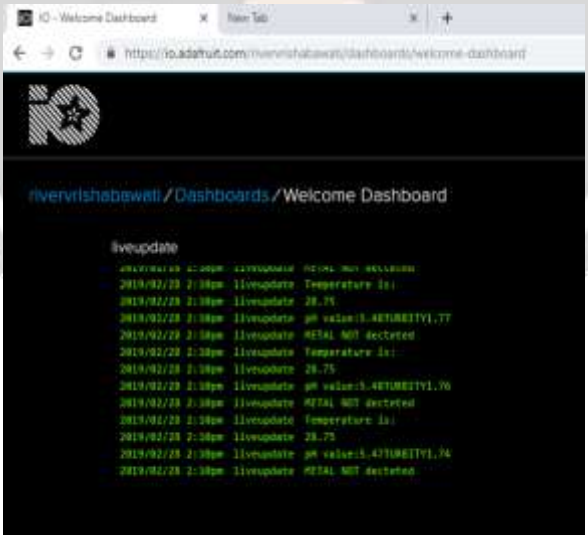

Fig 4: Adafruit cloud results

The valve that is attached at the outlet can be closed when the water is beyond the tolerance band.

Fig 5: LCD results

The displacement graph of the gold made sensing layer to measure the lead. These displacements are seen at different frequencies and through results it can be said that the eigen frequency is 855MHz.

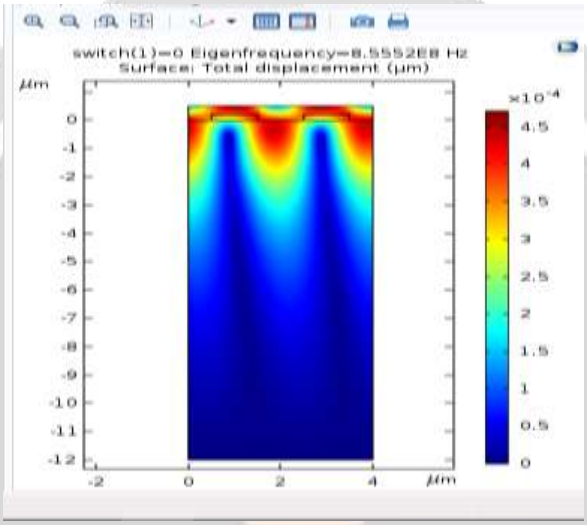

Fig 6: Displacement graph of the SAW based lead sensor

VI. CONCLUSION AND FUTURE WORK

According to the experimental results we can conclude that even after the BWSSB treatment of Vrishabhavathi River the water is still not suitable for agriculture. The real time water quality monitoring system for real time applications which is efficient and low cost is designed. The level of pollutions in the water bodies are governed. The system can monitor water quality automatically, and it does not require people on duty.

In future, the parameters like Dissolved oxygen, BOD, COD hardness, chloride, ammonia, iron, fluoride etc should be considered to check the purity of water for many purposes such as drinking, agriculture and daily requirements. In Vrishabhavati river heavy metals like Pb, Cr, Mn and Fe which are predominant, so methods to detect them should be developed. SAW based sensor to detect heavy metals can be fabricated with the design made in COMSOL Multiphysics tool but due to the cost other alternatives need to be found and test for the same.

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