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IoT and ML Based Monitoring of Urban Wastewater System

Jacob Paul P[1], Ashok T[2], Arun A[3], Dr. Nirmala Devi[4]

Department of Electronics and Communication Engineering
KCG College of Technology, Chennai, India

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Abstract*—The product mainly focuses on monitoring water quality (urban city wastewater) for agriculture purposes. Various water parameters such as pH, temperature, electrical conductivity, dissolved oxygen, turbidity, and color are considered for monitoring the water quality and the quantity of water. The location of the setup will also be recorded in the cloud. The nominal range in which various water parameters must be present to make the water suitable for agriculture was collected from the FAO website. The algorithm used is a Decision tree classifier (Machine Learning). A comparison between the observed value and the nominal range is made and can be viewed on the website and a mobile app that we developed. Both the website and the mobile app will display the harmful effect if the unsuitable water and the necessary steps to be taken to treat the water. The website and the mobile app are also available in different languages other than English, such as Hindi and Tamil. If toxic water suddenly comes, the motor will be switched off automatically, and an alert message will be sent to the end-user stating, "There was a sudden inflow of toxic water, and so the motor has been switched off." Later the end-user can turn on the motor just by clicking a button in the mobile app.*

Index Terms*—Alarm alert system, Decision tree classifier (Machine Learning), Geotagged Sensors.*

I. INTRODUCTION

A. Origin of theProposal

Nowadays, water quality is threatened by untreated industry outlets, climatic change, etc., which results in an oversupply of contaminants. The need to bring better ways to check water quality continuously through real-time monitoring, which involves lesser human intervention and cost-efficient than the existing methods. Utilizing sullied water for farming affects plants; for example, hindered development, caramel departs a noteworthy reduction in yield, sustenance insufficient yield, and so on.

B. Definition of theProblem

Urban wastewater is a major source of pollution of soil and water bodies in our country. The contaminants contain toxic levels of heavy minerals and harmful microorganisms, causing more than 50 million Indians. Besides, peri-urban agriculture uses urban wastewater as a major irrigation source, thus posing health hazards to both farmers and consumers. Decentralized urban wastewater treatment has been identified as the only solution in light of ever-increasing urban settlements and shrinking availability of unused land and good water resources quality. A decentralized treatment plan can work with precision when the plant's input and output are monitored unbiasedly on a real-time basis. Installation of geotagged sensors viz. Turbidity, DO, PH, EC, Color, dissolved ammonia, etc., at various critical control points with continuous data streaming and analysis using artificial intelligence can help monitor and control the treatment process more efficiently.

C. Objectives

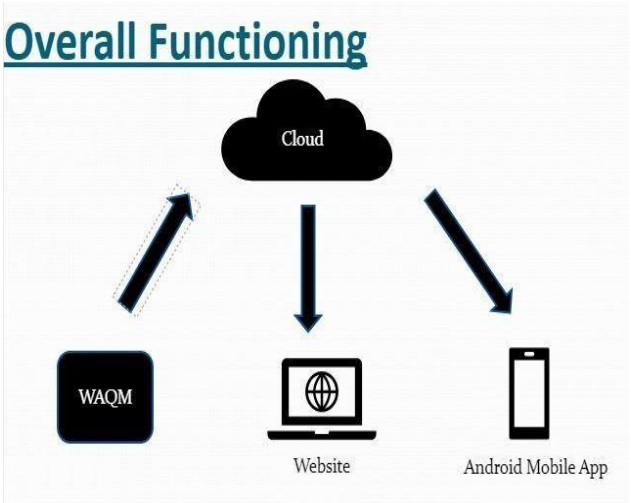
- To develop a prototype to monitor the quality of water entering into the decentralized water treatment plant.
- To provide a cloud-based continuous water quality monitoring system (digital solution) for various stakeholders.
- To identify whether the water is suitable for agriculture.

II. IMPORTANCE OF PROPOSED PROJECT IN THE CONTEXT OF CURRENT STATUS

Over the few years, it is observed that there has been a fall in the production and yield of crops. This raised fears that the world would face a situation where they will not be enough food and other commodities to feed the future population. About 71 percent of the Earth's surface is water-covered; urban wastewater is found to be a major source of pollution of soil and water bodies in our country. It consists of many heavy metals such as mercury (Hg), cadmium (Cd), arsenic (As), chromium(Cr), thallium (Tl), and lead (Pb), and many other types of harmful microorganisms.

The annual growth rate of world demand for cereals has declined; all this causes health hazards to farmers and consumers. Decentralized urban wastewater treatment has been identified as the only solution in light of ever-increasing urban settlements and shrinking availability of unused land and good water resources quality. A decentralized treatment plan can work with precision when the plant's input and output are monitored unbiasedly on a real-time basis.

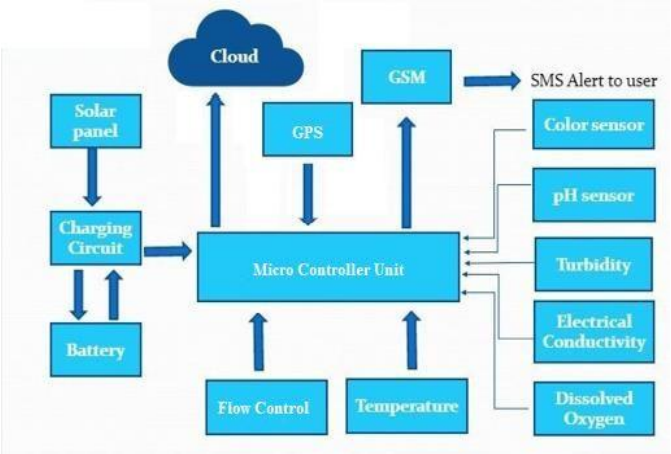
Hence, the project titled "IoT and ML Based Monitoring of Urban Wastewater System." uses Artificial Intelligence and Machine Learning to build the product. The product will provide continuous data streaming and analysis to monitor and control the treatment process with the help of the website and mobile app; this is achieved by installing Geotagged sensors viz. Turbidity, DO, PH, EC, Color, dissolved oxygen, etc., at various critical control points. The website and the Mobile app also provide flexibility to the end-user by changing the content in other languages apart from English such as Tamil and Hindi.



III. WORK PLAN

A. Methodology:

From the sensors, the data is collected and uploaded to the cloud (Google-Firebase). Using the GSM module, initially, an SMS is sent to the user which contains the values of all the parameters in the water. This data is graphically represented on the website. When the results button is clicked, it compares the expected value and the obtained values of pH, turbidity. electrical conductivity, dissolved ammonia, based on this data analysis is done using artificial intelligence to provide solutions to the problems encountered in the water. Remedies for abnormal water parameters are displayed. The data canal so be viewed from the mobile app, it provides an alarm-alert feature to notify the user if there's a sudden change in the water to a treatment facility.

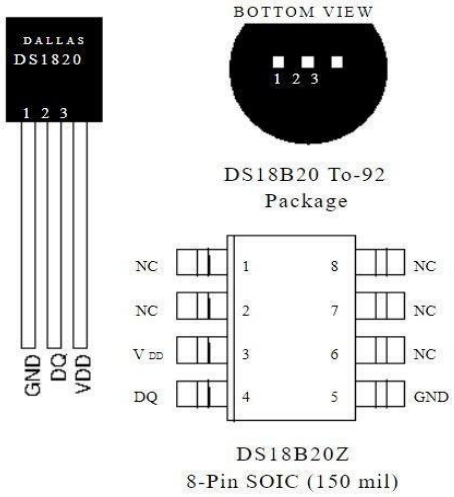


B. ModuleDescription:

***a) TEMPERATURE SENSOR*: T**he temperature sensor we used here is the DS18B20 Stainless Steel Temperature Sensor. It is a pre-wired and waterproofed version of the DS18B20 sensor and is very accurate in measuring the water temperature.

The DSI8B20 digital thermometer provides a 9 to 12 bit (configurable) temperature reading, indicating the device's temperature. The information is sent to/from DS18B20 over al-wire interfaces o that only one wire (and ground) needs to be connected from the central microprocessor to DS18B20. Power for reading, writing, and performing temperature conversion can be derived from the data line itself with no need for an external power source because each DS18B20 contains a unique silicon serial number, multiple DS18B20 can exist on the same l- wire bus. This permits the temperature sensor to be placed in a wide range of spots. Applications where this feature is useful include HVAC environmental control, sensing the temperature inside buildings, equipment or machinery, and process monitoring and control.

PIN ASSIGNMENT



PIN DESCRIPTION

GND - Ground
DQ - Data In/Out
V_{DD} - Power Supply Voltage
NC - No Connect

b) PH SENSOR: A pH sensor measures the hydrogen-ion concentration (or pH) and tells about the solution's acidity or alkalinity. A pH sensor comprises three components: a measuring electrode, a reference electrode, a temperature sensor, a preamplifier, and an analyzer or transmitter. pH, commonly used for water measurements, is a proportion of acidity and alkalinity, or the harsh and base present in a given arrangement. It is commonly expressed with a numeric scale running from 0-14. The value of 7 is neutral. The numbers on the scale increase with increasing alkalinity, while the numbers on the scale decrease with increasing acidity. Every unit of change represents a tenfold change in alkalinity or acidity. The pH esteem is additionally equivalent to the negative logarithm of the hydrogen-ion concentration or hydrogen-particle movement.

c) TURBIDITY SENSOR-Turbidity is the cloudiness of any fluid. By measuring the turbidity, water quality can be checked. According to the World Health Organization, the allowable range of drinking water's turbidity should not be more than 5 NTU. Turbidity Sensor is a submersible instrument used for environmental or process monitoring. The turbidity sensors' applications include water quality testing,river monitoring, measurement of the stream, and reservoir water quality testing. Groundwater testing, wastewater treatment, and effluent and industrial control. By USEPA Method 180.1 for turbidity measurement, the Turbidity Sensors are a 90-degree scatter nephelometer. The turbidity sensor directs the beam focused on the monitored water. The light beam reflects off particles in the water, and the resultant light intensity is measured with the help of a turbidity sensor whose photodetector is positioned at 90 degrees to the light beam. The light intensity detected by the turbidity sensor is directly proportional to the turbidity of the water. The turbidity sensors require a second light detector to correct the light intensity variations, color changes, and minor lens fouling. For environmental and process monitoring, place the Turbidity sensor directly in water and position it where the turbidity is to be monitored since the turbidity sensor uses range subscribed by the network operator. The power supply light to detect the water's turbidity makes sure that the amount of external light possible is exposed to the monitoring site.

d) ELECTRICAL CONDUCTIVITY SENSOR: Salinity is the measure of the concentration of dissolved salts in water. Salinity is a ratio and not a physical parameter that can be measured. Thus. "Salinity sensors" do not exist, but the one which refers to as a salinity sensor is, in fact, a conductivity sensor.

A conductivity probe is a simple device. It refers to two conductors with a fixed surface area at a fixed distance from each other. This distance and surface area is known as the conductivity cell. The cell's distance and surface area is quantified as the conductivity cells K-constant.

An E.C. (electrical conductivity) probe determines the electrical conductivity of a solution. It is mainly used in hydroponics, aquaculture, and freshwater systems to monitor the number of nutrients, salts, or impurities in the water. Inside the conductivity probe, two electrodes are placed opposite each other; an AC voltage is applied to the electrodes, which causes the cations to move to the negatively charged electrode while the anions move towards the positive electrode. The freer electrolyte the liquid contains, the higher will be the electrical conductivity.

e) DISSOLVED OXYGEN SENSOR:

This is a dissolved oxygen sensor kit, which is compatible with the Arduino microcontrollers. This product is used to determine the dissolved oxygen content in water to reflect the water quality.

It is widely used in many water quality applications, such as aquaculture, environment monitoring, natural science, etc. Dissolved oxygen is one of the important parameters that reflect the quality of the water. This sensor kit helps you to build your own dissolved oxygen detector quickly.

The probe used is galvanic, no need for polarization time, and it stays available at any time. The filling solution and membrane cap are replaceable, leading to low maintenance of cost. The signal converter board is plug-and-play, and it has good compatibility. It can be easily integrated into any detecting system.

f) GSM-MODULE:

GSM (Global System for Mobile communication) is a mobile communication modem. The modem is a device that can be used to make a computer, or any other processor communicates over a network. A GSM modem requires an activated SIM card to operate over a network range subscribed by the network operator. The power supply to the board should be5v.

Features of GSM Module:

- Improved spectrum efficiency
- International roaming
- Compatibility with integrated services digital network (ISDN)
- Support for new services
- SIM phonebook management. Fixed dialing number(FDN)
- Realtime clock with alarm management. High-quality speech
- Uses encryption to make phone calls more secure Short message service(SMS)

g) GPS-MODULE:

The Ublox NEO-6M GPS sensor has high precision binary output. It has a high sensitivity for indoor applications. UBLOX NEO-6M GPS Module also has a battery for backup and EEPROM for storing configuration. The antenna is connected to the mod through a UFL cable, allowing flexibility in mounting the GPS for best performance. This makes it powerful to use with indoor and outdoor applications.

IV. EXPERIMENTALSETUP

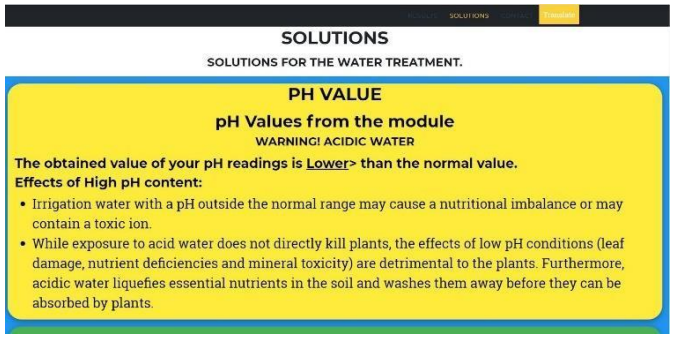
V. RESULTS

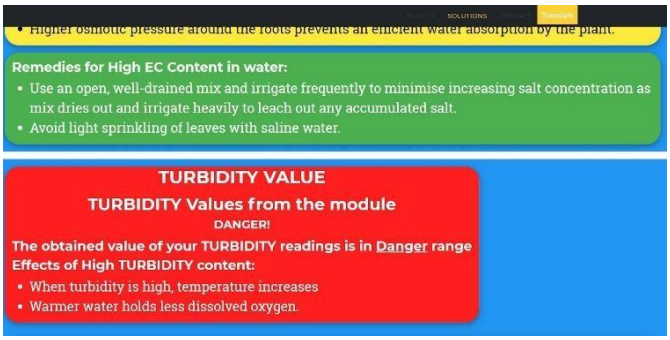
Website:

Screenshot of website:

A comparison between the observed value and the nominal range can be viewed on the website.

Based on the obtained value, the harmful effects and solutions are provided on the website.



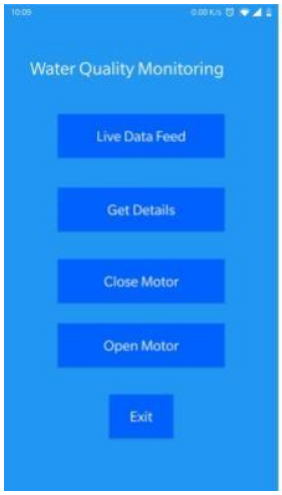


The website is available in different languages other than English such as Hindi and Tamil.

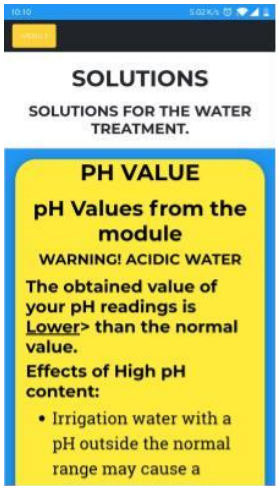
Mobile app:

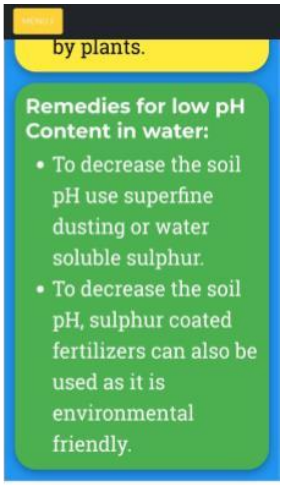
Screenshot of Application:

The user can control real-time operations like opening and closing the motor valve using the button “Close Motor and Open Motor” on the mobile app.



The “Get Details” button displays the stored data and the solution to treat the water. “The Live Data Feed” displays the live data.





VI. CONCLUSION

Identifies whether the water is suitable for use by monitoring the quality of water based on the given parameter. Provides a cloud-based real-time water quality monitoring system. The Machine Learning Algorithm provides solutions for the treatment of Continuous data streaming provides regular updates about the quality of water on demand.

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