Smart Water Quality Monitoring System

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Abstract —Water is one of the most essential elements for living. Even though 70% of the earth is full of water, there is scarcity of pure drinking water. The saddest part is people are not aware of pure water and they use polluted water for drinking, farming and other uses. The use of fertilizers in agriculture as well as other chemicals in industries like mining and construction has significantly lowered the quality of water worldwide. One of the reasons is the cost of the water purity testing system. The system is very cost not effective and not available for everyone as it needs lab testing. So our goal is to make a smart water quality system which will be available for everyone and cost effective at the same time. In order to monitor, gather, and analyze data, various research fields use remote sensing (RS) and internet of things (IoT) techniques. IOT has many wireless sensors which can be connected by using a microcontroller and collect data from the sensors. In this Project we will use Arduino Uno R3, Esp8266, ultrasonic sensors, turbidity sensor and DHT -11(Temperature and Humidity sensor) sensor to make the system. The research suggests an inexpensive and effective IoT-based smart water quality monitoring system that continuously tracks the quality parameters.
Keywords — pure drinking water, farming, IOT, Arduino, DHT-11, Ultrasonic, pH sensor, Turbidity sensor, microcontroller, wireless, temperature, humidity

I. Introduction

Human health is impacted by drinking water that has been polluted. For humans and all other types of life on earth, water is a vital natural resource. The world has a variety of water sources, including rivers, lakes, and rainfall. Rainwater that falls on the soil is both beneficial and destructive, and it may either be soluble or insoluble. The amount of salt and other necessary or harmful soil particles determines how acidic the water is. Water can only be used for certain applications if traditional procedures fail to remove insoluble particles from the water. Farming water is a must for human beings. If we drink unsafe water, it will affect our health. Even we need to maintain a pH level and temperature level of water for framing. Because to keep the soil fertile we need to maintain a certain acidity level of water and to grow more crops pH level of soil and temperature of water must be maintained. If the water is unsafe and the pH level of water is undetermined then there is a high chance of the soil being polluted and unsuitable for farming. Even there is a chance of the crops being unhealthy for us.

Water quality monitoring is defined as the collection of data at predetermined or desired locations and at regular intervals in order to provide information that can be used to describe current water conditions. The existing system has significant equipment costs and takes a long time to process. Traditional methods include shortcomings such as long results wait times, expensive costs, low measurement precision, and difficult approach. In this proposed system the complexity reduces and the performance increases.

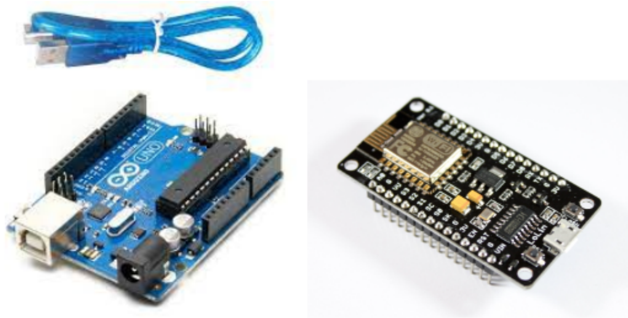

Fig. 1. Esp8266

So, to solve this problem we need to monitor the water which is being used for farming and drinking. A smart water monitoring system can be used for this purpose. We will use some IOT sensors to determine if the water is suitable for drinking and farming or not. The turbidity sensor is used to find the concentrations of particles of the certain liquid elements. We will use the DHT-11 sensor to observe the temperature and humidity of the water. By using ultrasonic sensors, we can find the speed of sound in the water and can determine if any other particles are present in the water. pH sensor is used to detect the pH level of water which is used for farming and drinking.

Fig. 2. Turbidity, DHT-11 and Ultrasonic Sensor, Breadboard

The system is low-cost, does not require someone to be on duty, and can automatically check water quality. It also promptly activates alerts to avert any health dangers. This approach for measuring water quality is probably more accurate and convenient.

The core controller, which oversees the operation, receives data from all the sensors, compares it to the standard values, and then transmits the results to the appropriate end user or authorities using wireless modules.

II. System Topology

For the requirements of drinking water quality, the World Health Organization (WHO) published a set of norms and guidelines. To stop the spread of illnesses transmitted by contaminated water and to protect the general population from drinking contaminated water, a number of physical and chemical features must be regularly monitored and assessed. Since crops require a specific range of temperature and pH to grow more quickly and healthily, the agricultural sector also needs a system for accurately monitoring water quality. To do that, we must use technology from our water monitoring system to keep an eye on those things. Here is a list of the hardware elements of the system. ultrasonic sensor, temperature sensor (DHT-11), turbidity sensor, Arduino board, and for the node mcu esp8266. Turbidity must be measured in order to assess other aspects of water quality, such as pH level. The health of people, plants, and other living things on earth is impacted by water quality. Because the coolant temperature is detected by the temperature sensor, which also notifies the ECU, the control unit can identify engine overheating or an unexpected rise in temperature owing to the water temperature sensor. We will use ultrasonic sensors to measure the distance between the transceiver and the water's surface and determine the depth of the water. Timing the echo allows us to determine how long it takes for the ultrasonic pulse from the sensor to reach the liquid and return. The Arduino Mega can be powered by either an external power supply or a USB port. Temperature, ultrasonic, PH, and turbidity sensors are attached to the arduino board. These sensors transmit data to an Arduino board that is connected to a node mcu esp8266. The notorious WiFi module known as ESP8266 is a system on a chip (SoC) created by Shanghai-based Espressif Systems. It was initially used in conjunction with Arduino boards to enable WiFi in hardware projects.

The primary goal of the offered system is to keep water and environment safe by taking important steps after getting the data. As a result, the audience can grasp this project, which will be beneficial for future work. Significant mechanization and upgrading are possible with this project. Any number of microcontrollers and construction methods can be used to build this project again.

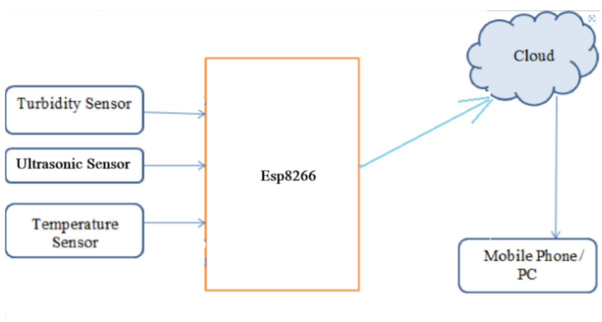

Fig. 3. Flowchart Of Proposed Algorithm

In the making of the system the first step was connecting all the sensors with Arduino(uno) and NodeMCU ESP8266 for the wifi system that will help to provide the data of water quality in the mobile. The connection of all the sensors with microcontrollers will be done by connectors and breadboard. In the second step to enable the sensors with arduino(uno) and ESP8266 uploading code in the microcontroller is required. For every sensor after uploading the code there will be a testing process where every sensor will be checked if those are working or not. All code will be uploaded in the Arduino memory chip by using the Arduino IDE and for the Wi-Fi connection there is some other specific code that will be uploaded in NodeMCU ESP8266. After all these the developed model is tested with three water samples if it works properly then, the process ends there.

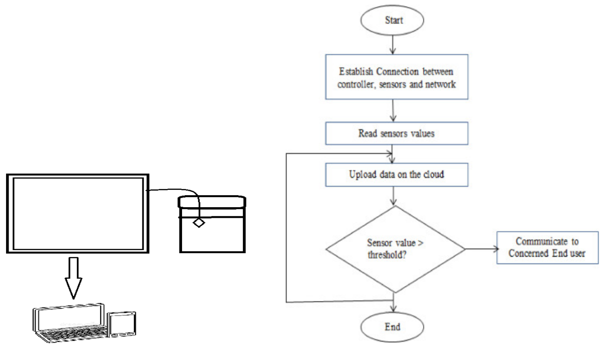

Fig. 4. Flowchart Methodology of Proposed Algorithm

The accompanying diagram demonstrates the fundamental concept underlying the project. Let's examine the diagram closely using a smartphone and the system itself.

First, connect your mobile device with the system's Wi-Fi system. A password is needed to connect your device with the system. After you are connected with the system, Once you are connected you are good to go. A website will open as soon as you are connected to the system through Wi-Fi. Then the website will show an interface of the water monitoring database.

$$W_p' = \Lambda - \alpha_1 W_p S - \alpha_2 W_p I + \rho\alpha_2 I - \mu W_p,\ \ W_{po} \geq 0, \qquad (1.1)$$

$$S' = \alpha_1 W_p S + \delta I - (\theta_1 + \mu)S,\ \ S_o \geq 0, \qquad (1.2)$$

$$I' = \alpha_2 W_p I - \rho\alpha_2 I - (\delta + \theta_2 + \mu)I,\ \ I_o \geq 0, \qquad (1.3)$$

$$T' = \theta_1 S + \theta_2 I - \mu T,\ \ T_o \geq 0, \qquad (1.4)$$

$$N' = W_p' + S' + I' + T',$$
$$= \Lambda - \alpha_1 W_p S - \alpha_2 W_p I + \rho\alpha_2 I - \mu W_p + \alpha_1 W_p S + \delta I - (\theta_1 + \mu)S + \alpha_2 W_p I - \rho\alpha_2 I - (\delta + \theta_2 + \mu)I + \theta_1 S + \theta_2 I - \mu T$$

$$= \Lambda - \mu W_p - \mu S - \mu I - \mu T,$$
$$= \Lambda - \mu V \quad \text{since} \quad N \equiv W_p - \mu S - \mu I - \mu T$$

Now,

$$\frac{dN}{dt} = \Lambda - \mu N$$

$$\frac{dN}{dt} + \mu N = \Lambda \qquad (1.5)$$

III. Proposed System Design and Simulation

Data from Nodemcu esp8266 is sent to a smartphone or computer by serial code. The receiver system can be a mobile or laptop or a Tablet. The simulation circuit consists of water parameters measuring sensors such as ultrasonic sensor, turbidity sensor, temperature sensor.

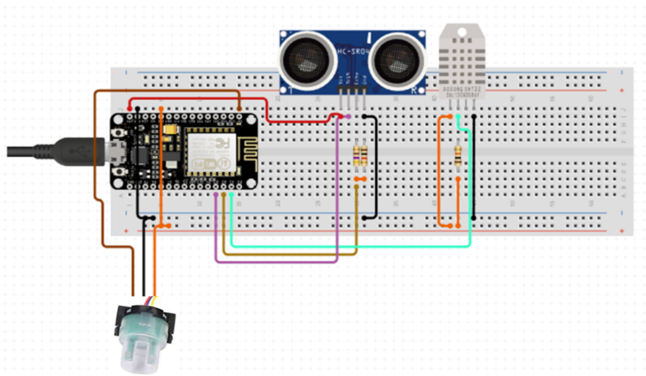

Fig. 5. Simulation circuit of Proposed Algorithm

The prototype for the project's internal system uses a connector to extend the wire that is with a turbidity sensor that has to put in water to acquire the data of the water that is switched on by simply utilizing the power supply in the microcontroller. The NodeMCU ESP8266 is a microcontroller with programmable 2.4GHz wi-fi that is used to control electronic devices. It also enables the development of an environment for developing applications on hardware using open-source software (SoC). This module was utilized in the project demonstration to make the system work wirelessly and to control the water monitoring system.

The turbidity sensor is used to test the water quality system to determine whether or not the water is clean. The Turbidity Sensor detects the turbidity of fresh-water or ocean samples in NTU. The standard unit used by most water collection agencies and organizations is NTU, which stands for Nephelometric Turbidity Units.

A sensor that measures the depth of the water tank or well will also be included in the prototype project. Ultrasonic sensors, as the name implies, use ultrasonic waves to measure distance. The sensor head generates an ultrasonic wave and detects the reflected wave from the target. The time between emission and reception is used by ultrasonic sensors to calculate the distance to the target.

DHT11 is the name of another sensor in the system that measures temperature and humidity. This is a low-cost digital temperature and humidity sensor. This sensor can simply be interfaced with any microcontroller, such as Arduino, Raspberry Pi, and so on, to detect humidity and temperature in real time. The DHT11 humidity and a temperature sensor is offered as both a sensor and a module. The pull-up resistor and a power-on LED distinguish this sensor from the module. DHT11 is closely related.

humidity detector A thermistor and a capacitive humidity sensor are used in this sensor to measure the surrounding air. Connectors and a breadboard link them all. There are some pins on the Nodemcu that perform different functions and are all required to connect with the sensors. This project may be beneficial if you are unable to obtain a static IP address from your internet provider and have a website on which to store the data.

The Wi-Fi module is set to Client mode in this project, and it sends data from the Arduino analogue input A0 and digital input D3 to a website. Simultaneously, the Arduino reads the button state selected on the webpage and changes output 7. By logging into a page on my website from anywhere, I can peruse the Arduino input data or control the Arduino output. Changes to the code enable more data to be transferred. One disadvantage of this technique is that you cannot access the wifi module directly from an internet browser. Insert the wifi network's SSID and PASSWORD into the code.

Furthermore, when considering current water quality monitoring needs, monitoring findings for a small number of nodes are not representative. To deal with large-scale distributed monitoring scenarios, the gateway's downlink channel must be extended. The device's architecture is unique in that it measures all parameters concurrently, yielding pretty accurate findings. A conductivity sensor measures the value of several water quality indicators. Water conductivity is a key parameter in determining the other characteristics. To determine the relationship between electrical conductivity and other factors, regression analysis was performed, graphs between various parameters were constructed, and device standards were established.

We discuss the theory on real-time monitoring of water quality and quantity using IoT in this paper. The system is made up of an Arduino, a microcontroller, and several sensors such as a water flow sensor, a pH and turbidity sensor, and an ultrasonic sensor. The Arduino is the system's principal CPU, controlling and processing the data collected by the sensors. A general architecture for the gathering and processing of quality and quantity data on water resources is provided and addressed. The suggested architecture incorporates physical and chemical water parameter monitoring, data networking, and high degrees of information processing, especially machine learning.

IV. HARDWARE DEVELOPMENT AND TESTING

The Nodemcu microcontroller is used in this study. The program is finally burned to MCU to complete development after compilation, simulation, and debugging. The program primarily completes the functions of data collection, signal conversion, and data uploading.

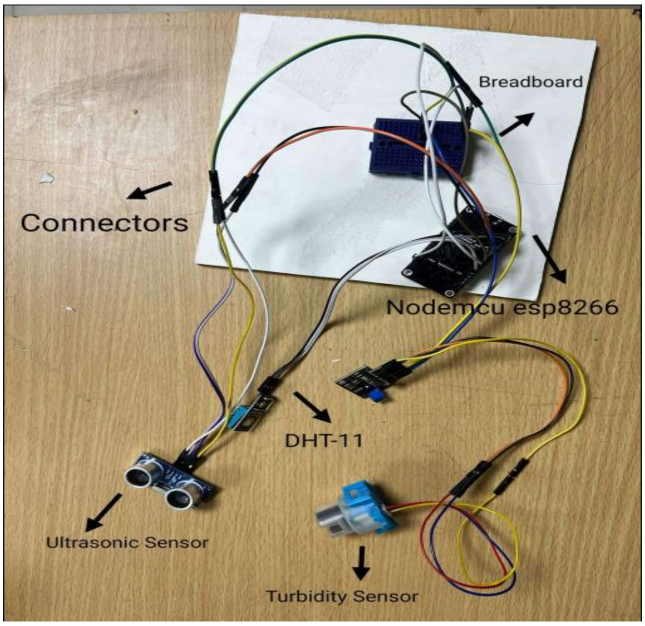

Fig. 6. Flowchart Methodology of Proposed Algorithm

To continue to use the System and IoT wireless technology. The system requires power, which is why there is a power supply cable. A breadboard, NodeMCU, turbidity sensor, dht11, and ultrasonic sensor are all part of the circuit. The NodeMCU has an RX TX Pin that is connected to the sensors. Connect Vcc and Gnd of the sensor to Nodemcu, and the signal line to Nodemcu D2.

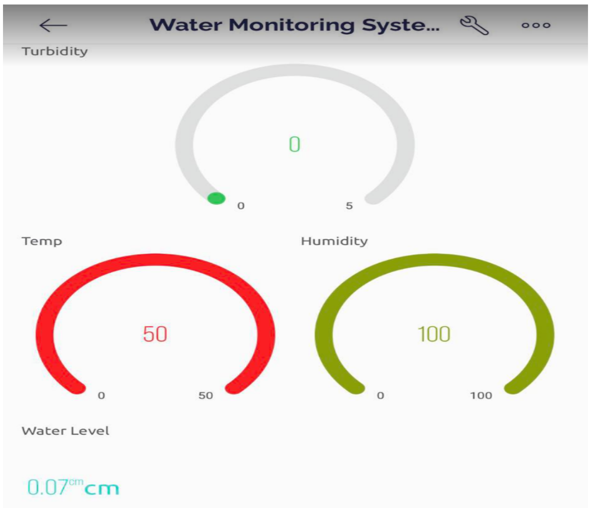

Fig. 7. System data checking screen by mobile

Control any external equipment, such as the Pump, from anywhere in the world over the internet. The Blynk App is used in this project. Blynk is an application that provides both a dashboard and connectivity. It is available for download from the Google Play store or app store then use the code to connect with the wifi module.

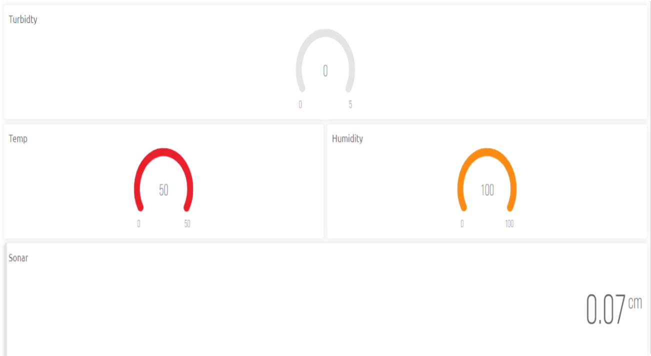

Fig. 8. System data checking screen by Computer

V. Results and Discussion

This is the project's final design, a cardboard box with sensors for sensing water level, temperature, and quality. The turbidity sensor is implemented in a wire that will be placed in the water to collect data. This allows the user to connect with the water monitoring system via an IOT-based system, which is one of the priority-based authorizations.

Fig. 9. Final Project

Three separate water samples were examined to establish a reference on the parameters for each water type. At indoor ambient temperature, three water samples were examined simultaneously using three distinct, identical devices. For a total of 6 hours, readings were recorded at 1 hour intervals. The systems were not deployed in the precise areas of interest for security concerns; instead, water samples were collected and evaluated in a safe, controlled setting. However, the tap water sample was replaced every hour to ensure that the values were consistent.

Table.1

Water Quality Monitoring	
Temperatures	24 degrees
Humidity	64
Water Level	30 cm
Turbidity	0.99

Table.2

Water Quality Monitoring	
Temperatures	40 degrees
Humidity	74
Water Level	47 cm
Turbidity	3

Table.3

Water Quality Monitoring	
Temperatures	22 degrees
Humidity	74
Water Level	54 cm
Turbidity	2.4

According to the functionality of the project design, the cost of this project is very low. This project design's use case is important for individuals.

VI. Conclusions

Water pollution is a huge hazard to every country since it harms health, the economy, and biodiversity. This paper discusses the causes and effects of water pollution, as well as a complete examination of numerous techniques of water quality monitoring and an effective IoT-based method for water quality monitoring. Despite the discovery of several outstanding smart water quality monitoring systems, the research topic remains demanding. This work gives a summary of current research conducted by researchers in an attempt to create smart, low-powered, and highly efficient water quality monitoring systems that can monitor continuously and send alerts/notifications to the appropriate authorities for further processing. The created approach is both cost effective and easy to utilize (flexible). Three water samples are examined, and the findings determine whether the water is drinkable or not.

The wireless interface between transducers and the sensor network on a single chip solution is accomplished by employing a WI-FI module. Verifying the four characteristics of water allows for a system that is reliable and feasible for the monitoring process. Depending on the situation, the monitoring interval may need to be altered. This study illustrates a smart system for monitoring water quality. The outcomes were in line with what was expected from the research. For all of the water samples, the relationship between temperature and conductivity was also noted. In a nutshell, the system demonstrated its usefulness by giving accurate and consistent data during the testing period, and with the added capability of adding IoT platforms for real time water monitoring, this should be a strong contender in real time water monitoring systems.

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