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Multi-Sensor based Water Quality Monitoring in IoT Environment

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Abstract - *To analyse the safe supply of the water, the quality needs to be monitor in real time. In this paper, we present a low-cost system for real-time monitoring of the water quality in IoT (internet of things).The system consists of several sensors is used for measuring physical and chemical parameters of the water. The parameters such as temperature, turbidity, pH, Conductivity of the water can be measured. The measured values from the sensors can be processed by the core controller. The Arduino mega can be used as a core controller. Finally, the sensor data can be viewed on internet using Wi-Fi module.*

***Key Words*: Temperature, Conductivity, pH, Turbidity, Arduino mega, Wi-Fi module.**

1. INTRODUCTION

Water is a limited resource in the world and is essential for agriculture, industry and for creatures existence on earth including human beings. This challenge occurred because of limited water resources growing the population, aging infrastructure etc. Hence, therefore, there is a need for better methodologies for monitoring the water quality. Monitoring the quality of surface water will help protect our waterways from pollution.

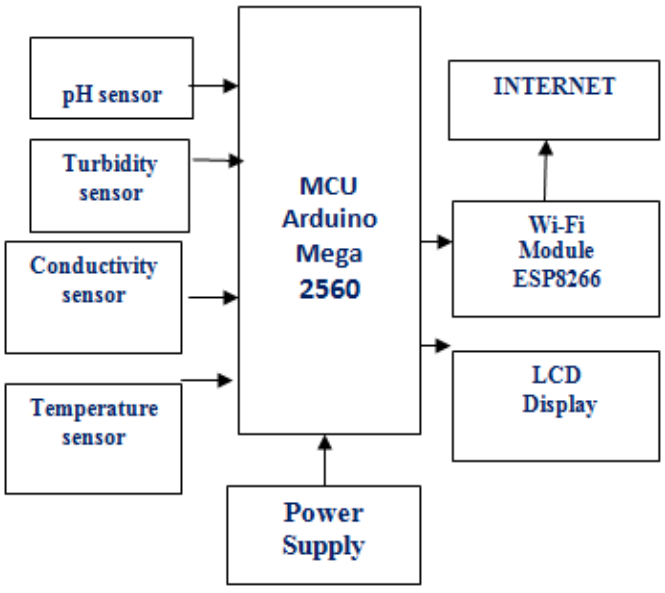
Traditionally, the water quality detection has been carried out manually wherein the water samples are collected and taken to the laboratories for analysis. Since these methods fail to deliver real-time data, we propose a system which can sense the water quality parameter continuously and send the data real time to the monitoring station using wireless technology. The result from the microcontroller unit is then wirelessly transmitted using Wi-Fi module.

2. System Description

The objective of the system is to design a low cost and robust system, to monitor water quality problem for drinking water and online multisensory measurements at the local level are developed to assess the water contamination risk. The overall functions of the system architecture are,

- A microcontroller is been used for collecting the data from the sensors.
- The system contains turbidity sensor, pH sensor, a temperature sensor which is interfaced with Arduino mega board 2560.
- Turbidity sensor is used for turbulence measurement of water.
- The PH sensor is used to measure the %PH of water.
- The temperature sensor is used to check the temperature of water.
- The Conductivity sensor is used to measure the ability of the water to carry electric current.
- All these sensors are directly connected to the microcontroller.
- The microcontroller collects the data and processes it with Wi-Fi module.
- The Wi-Fi module (ESP8266) transfers data to the PC where the data analysis is done.
- LCD display has also displayed the output correspondingly.
- To publish the corresponding record over the web for public information and further assessment of water resource.

3. BLOCK DIAGRAM



4. Hardware Design

4.1 Control Board

An Arduino mega is used as a core controller. The Arduino used here is mega 2560 because multiple analog input sensors probes need to be connected with the Arduino board. It has a set of registers that function as a general purpose RAM. Special purpose control registers for on-chip hardware resources are also mapped into the data space. The addressability of memory varies depending on device series, and all PIC devices have some banking mechanism to extend addressing to additional memory. Later series of devices feature move instructions which can cover the whole addressable space, independent of the selected bank. In earlier devices, any register move had to be achieved via the accumulator. Thus the mechanism functions with the help of coding inbuilt in the Arduino board.

4.2 Sensors for Monitoring

4.2.1 Ph Sensor

The pH of water is an important parameter to monitor because high and low pH levels can have enormous effects on the source. The pH of a solution can range from 1 to 14.A pH sensor is a device that measures the hydrogen-ion concentration in a solution, indicating its acidity or alkalinity. Its range varies from 0 to 14 pH. For acid output voltage is positive, for neutral it is null and for bases it becomes negative. The value greater than the optimum range is considered fatal to the marine ecosystem. Extreme pH values also increase the solubility of elements and compounds making them toxic.

Mathematically pH is referred as,

$$pH = -\log[H^+]$$

4.2.2 Turbidity Sensor

Turbidity level sensor is used to measure the clarity of water or muddiness present in the water. The turbidity of the surface water is usually between 255 NTU. The Unit is NTU (Nephelometric turbidity unit). Water is visibly at levels above 80 NTU. The standards for drinking water is 130 NTU to 250 NTU. The turbidity sensor consists of light transmitter and receiver, the transmitter needs to transmit clear light to the receiver if it not to be clear, it is said to be turbid. Generally, it measures the amount of light coming from the source of the light to the light receiver, in order to calculate water turbidity.

The effect of turbidity is a reduction in water clarity, aesthetically unpleasant, decreases the rate of photosynthesis, increases water temperature.

4.2.3 Temperature Sensor

Here LM35 is used as the temperature sensor. Normally it will use to sense the temperature of the room, if we place the sensor inside the copper electrode and placed into the water, it can detect the temperature of water also. The average temperature of the room is 20℃-25℃.

4.2.4 Conductivity Sensor

Conductivity is the measure of a solution's ability to pass or carry an electric current. The term Conductivity is derived from Ohm's Law, E=I•R; where Voltage (E) is the product of Current (I) and Resistance (R); Resistance is determined by Voltage/Current. When a voltage is connected to a conductor, a current will flow, which is dependent on the resistance of the conductor. Conductivity is simply defined as the reciprocal of the Resistance of a solution between two electrodes. The more ions that are in the solution, the higher the conductivity.

4.2.5 LCD Display

LCD (Liquid Crystal Display) screen is a flat plate electronic display module and finds in a wide range of applications. A 20x4 LCD display is the very basic module and is very commonly used in various devices and circuits. These modules are preferred over seven segments and other multi-segment LEDs.

4.2.6 Wi-Fi module

Wi-Fi or Wi-Fi is a technology for wireless local area network with devices.

Devices that can use Wi-Fi technology include personal computers, video-game consoles, smartphones, digital cameras, tablet computers, digital audio players and modern printers. Wi-Fi compatible devices can connect to the Internet via a WLAN network and a wireless access point. Such an access point (or hotspot) has a range of about 20 meters (66 feet) indoors and a greater range outdoors. Hotspot coverage can be as small as a single room with walls that block radio waves, or as large as many square kilometers achieved by using multiple overlapping access points.

The depiction of a device sending information wirelessly to another device both connected to the local network, in order to print a document.

Wi-Fi technology may be used to provide Internet access to devices that are within the range of a wireless network that is connected to the Internet.

5. ANALYZED WORK

In order to get the good quality of water, we have made a survey of different water taking it from various locations (underground, pond, well, bore well waters).The difference between the values is dependent upon the areas. By identifying the values of pH, temperature, and turbidity of water using various sensors, we analyze the usage of water for the specific purposes. For example drinking, washing purpose, watering plants, battery water in UPS and in the car. Over 50 samples are collected and surveyed.

Using HTML program, we designed a webpage that will use to display corresponding ph, temperature, conductivity, turbidity values on the internet.

Below picture is the screenshot of water quality monitoring. This will update outputs every 5 seconds on the web page.

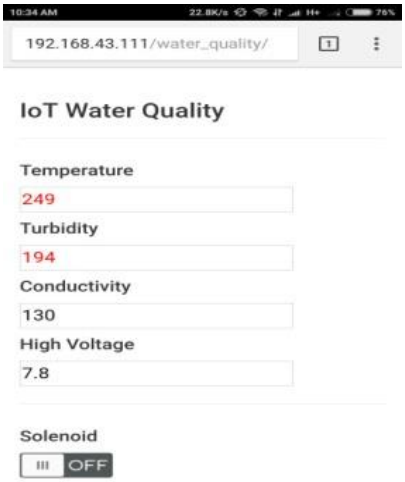


Table -2: Usage of analysed water

The water which has collected from various areas and their analyzed pH, temperature, turbidity and conductivity values are listed below.,

Table -1: Surveyed samples of water from various locations at different areas.

Samples	Area	Type	pH	Turbidity	Conductivity	Temperature
S_1	Sattur	Under ground	7.1	59	52	Depend upon room temperature
S_2	Sattur	Well	7.4	97	72	
S_3	Sattur	River	7.7	176	122	
S_4	Virudhunagar	Under ground	6.9	187	120	
S_5	Virudhunagar	Pond	6.7	108	76	
S_6	Virudhunagar	River	6.6	120	78	
S_7	Thirumangalam	Under ground	6.8	69	51	
S_8	Thirumangalam	Purified-Well	7.6	143	108	
S_9	Thirumangalam	Pond	6.1	92	62	
S_{10}	Nagercoil	Sea	6.2	57	47	
S_1	Sattur	Under ground	7.1	59	52	

Table -2: Usage of analysed water

Purposes	pH	Turbidity	Conductivity	Temperature
Drinking Water	7 - 8	130 – 250 NTU	100 – 200 µS/cm	-
Agriculture	6 - 8	90 – 250 NTU	60 – 200 µS/cm	-
Washing Machine	6 - 12	50 – 145 NTU	100 µS/cm – 2 mS/cm	5 - 90 °C
Air Conditioner	6.4 - 7.2	50 – 150 NTU	100 – 150 mg/L	up to 55 °C
UPS Water	5 - 7	<20 mgL	$<10^{-5}$ ohm^{-1} /cm	20 - 25 °C

6. EXPERIMENTAL RESULTS

The Water quality monitoring is important for specific applications such as monitoring of boiler water in power plant and several other applications such as pond and ecosystem, drinking water distribution and measurement, Contamination Detection in Drinking Water etc. such applications need a separate technique for monitoring the water quality. In our proposed system, we can monitor the water quality parameters on the internet by using cloud computing. The water quality parameters values are stored in separate web server on the cloud. These parameters can be viewed by using a separate IP address.

Fig -1: The picture shows the water quality monitoring using Wi-Fi module

By using various sensors, Temperature, pH, and Turbidity of the water can be measured. Finally, an essential measurement node that collects water quality measurements from sensors, implements the algorithm to assess water quality and transmits data to the web server.

7. CONCLUSION

In this paper, the design and development of the real-time monitoring of the water quality parameters in IoT environment are presented. The proposed system consists of several water quality parameter sensors, Arduino mega 2560 core controller, and an IoT module. These devices are low cost, more efficient and capable of processing, analyzing, sending and viewing the data in the cloud and also through Wi-Fi to the mobile device. This can implement for suitable environment monitoring, ecosystem monitoring, etc and the data can be viewed anywhere in the world. In the future, we plan to implement biological parameter of the water and install the system in several locations of a pond and also in water distribution network to collect water quality data and send to the water board.

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