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IoT Based Low Cost System for Monitoring of Water Quality in Real Time

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Abstract - *Now a day's water pollution is one of the biggest fears for the green globalization. To prevent the water pollution, first we have to estimate the water parameters like pH, turbidity, temperature and TDS as the variations in the values of these parameters point towards the presence of pollutants. In this paper we design and develop a low cost system for real time monitoring of the water quality in IoT. At present, water parameters are detected by chemical test or laboratory test, where the testing equipments are stationary and samples are provided to testing equipments. Thus the current water quality monitoring system is a manual system with tedious process and is very time consuming. In order to increase the frequency, the testing equipments can be placed in the water resources and detection of pollution can be made remotely. This paper proposes a Sensor-Based Water Quality Monitoring System which is used for measuring physical and chemical parameters of the water. The parameters such as Temperature, pH, TDS and Turbidity of the water can be measured. The measured values from the sensors can be processed by the core controller. The Raspberry Pi model can be used as a core controller. Finally, the sensor data can be viewed on internet using ThingSpeak API. The uniqueness of our proposed paper is to obtain the water monitoring system with high frequency, high mobility, and low powered*

Key Words: **Raspberry Pi processor, Temperature sensor, pH sensor, TDS sensor, Turbidity sensor, IoT technology (Internet of Things).**

1. INTRODUCTION

The pollution in water is increasing day by day, and many researchers and scientists are trying to solve the problem by checking and maintaining the quality of water. This paper focuses mainly on the quality checking of water. The aim of the paper is to test the water quality so that it will be n real time to keep human life safe from the polluted water. Analyzing the condition and checking whether the water is favorable for the living beings and plants is the main target. There are different kinds of the available water quality measuring device on the market, ranging from cheap to expensive ones and house to industrial applications. Ex. Dr.Meter TDS-3C Water Quality, Sunny Water Tester ,Water quality Meter by generic, Play X-STORE Water Quality Meter ,APEC Water Systems Digital Meter and Started Filter Tester. Devices are very costly and hard to understand for the consumer and might be affordable but cannot fulfill the needs of quality checking ineffective and fast ways. And these water testers measure either turbidity or pH, but none of them measures the pH, turbidity, TDS as well as the temperature of the water. Some other water quality testers only measure the pH of water. If all the parameters are available in the device, then that device is not affordable for common people. Since it is not available on the market, this project includes all three required parameters for checking the quality of water in affordable cost. This paper will check the value of pH, Turbidity, TDS and Temperature of the water and determines whether the water is suitable for the normal use.

This paper is considered beneficial for the development of water quality measuring devices for the measurement and analysis of water used for living things, for example, human beings, animals as well as marine fishes and plants. We consume water every day, so it is indispensable for us. Therefore, water should be checked in real time. Since water has a direct effect on life on earth; it has become crucial to check whether the water is in good condition to use. Checking the quality of water requires much hard work. Most of the things that exist in the earth dissolve in water, and it is very hard to determine the amount of the material mixed in it. For determining the number of materials in water requires much hard work and is time-consuming. It has become necessary with the evolving technology a quick and efficient method determine the quality of water.

This paper focuses on checking the TDS, pH value, Turbidity and Temperature, which can be verified on a daily basis. It includes the description of the needed sensors and its specifications. It is possible to make the device either from the starting phase, or you can select the parts and combine it. Therefore, it has two ways to make the device. It is quite a new step in developing water quality measuring device, which will be helpful for the new researchers to go through the development of a new improved device for the quality check of water. This paper focuses on the present requirement for the development of sanitation in water. There are many other factors which could be found in water, but these three factors like pH, TDS, Turbidity and Temperature are crucial to determine the quality. It helps to determine either water is basic or acidic as well as to determine the number of solid particles dissolved in water. As a whole, this paper contributes to determining the quality of water in a convenient and user-friendly method for measuring the pH, Turbidity and Temperature.

2. RELATED WORK

In [Geetha S and S Gotham, 2017], system is divided into three subsystems. Data management subsystem accesses the data storage cloud & displays the same to end user. Data

transmission subsystem consists of a wireless communications device along with build in security feathers which transmit the data from the controller to data storage cloud. Data collection subsystem consists of multi – parameter sensors & optional wireless communication device to transmit the sensor information to the controller, a controller gathers the data processes the same.

In [Mithila Barabde and Shruti Danve, 2015], their main aim here is to develop a system for continuous monitoring of water quality at remote places using wireless sensor networks with low power consumption, low cost and high detection accuracy. The proposed water quality monitoring system based on WSN can be divided into three parts:

- Data monitoring nodes: The data sensed by the sensor will be passed through a signal conditioning circuit. Then the manipulated data will be given to the controller. With the help of the RF module the manipulated sensed data will be sending to the data base station

- Data base station: The data from all the nodes is collected at the data base station consisting of ARM processor. This obtained data is displayed on a LCD display.

- Remote monitoring centre: The remote monitoring station consists of a Zigbee module which will receive the data sent by the data base station. This data will be fed to a server PC consisting of Graphic User Interface (GUI) via serial communication. Also the obtained data is compared with the standard values of the water parameters. If the obtained water parameters do not match the preset values then SMS will be sending to an authorized person in order to take preventive measures.

In [Nikhil Kedia, 2015], highlights the entire water quality monitoring methods, sensors, embedded design, and information dissipation procedure, role of government, network operator and villagers in ensuring proper information dissipation. It also explores the Sensor Cloud domain. While automatically improving the water quality is not feasible at this point, efficient use of technology and economic practices can help improve water quality and awareness among people.

In [Niel Andre Cloete et.al, 2015], In this paper the development of a a low-cost, wireless, multi-sensor network for measuring the physicochemical water parameters; enabling real-time monitoring, is presented. The system implements flow, temperature, conductivity and pH sensors from first principles. All the data from the sensors are processed and analyzed, and transmitted wirelessly to a notification node. Algorithms are developed to detect possible contaminations. The notification node informs the user as to whether the water quality parameters are normal or abnormal.

In [Poonam j et.al.,2016], the water analysis is done manually by taking the samples from the water source and send to the lab for study. To mechanize this process water quality monitoring sensors. The ARM7, ZIGBEE module and data concentrates module are physically placed in each and every water sources. The water quality monitoring sensors gather data from water.ARM7 forward that data to concentrates module through ZIGBEE module for remote transfer of data to the lab. The data concentrates which is located in each & every lake sends that data to the cloud configured server which is situated TWAD testing laboratory. The TWAD department workers monitoring this data remotely & securely provide this data to the requested users which are stored in the cloud.

In [Kulkarni Amruta and Turkane Satish, 2016], created Solar Powered Water Quality Monitoring framework utilizing remote Sensor Network. In this framework the WSN innovation controlled utilizing sun oriented board. The framework comprises hub and base station in which the hub gathers that get from the distinctive remote sensor. The hub is associated with the base station through the Zigbee innovation that fueled by the sunlight based board. This framework is ease yet in the event that the sun oriented board can't be charged due to the some environment impact then the framework will quit working. From, all above specify procedure we come to realize that each unique framework comprise some impediment however it can't meet the point of ongoing, minimal effort consistent checking of water quality parameters. Along these lines, to conquer this confinement, that lead us to be created and plan the new technique that will minimal effort, ongoing and easy to use.

In [Pradeepkumar M et.al, 2016], system consists of Turbidity, pH &Temperature sensors of water quality testing Arduino microcontroller data acquisition module, information transmitted an module, monitoring center and other accessories. Turbidity, pH & Temperature &ware are automatically detected under the control of single microcontroller all day. The single chip gets the data & then processes and analyses them, if the water quality is abnormal, the data will be sent to monitoring center & alert the public at the same time.It is convenient for management to take corresponding measures timely & be able to detect real time situations of water quality remotely.

In [Jayti Bhatt and Jignesh Patoliya ,2016], In this system we present the design of IoT Based Water Quality Monitoring System that monitor the quality of water in real time.This system consist some sensors which measure the water quality parameter such as pH, turbidity, conductivity, dissolved oxygen, temperature. The measured values from the sensors are processed by microcontroller to make compatible for Zigbee module. These processed values are transmitted remotely to the call controller using Zigbee protocol. Finally sensors data can view on internet browser application using cloud computing

In [Aaina Venkateswaran et.al, 2017], Autonomous water quality monitoring system using GSM:This was developed jointly as an element of the Autonomous Live Animal Response Monitor (ALARM) Toxicity biosensor designed to be displayed in stream for continuous observation. The objective of this system is to develop a low cost wireless water quality monitoring system that aids in continuous measuration of water conditions. Their contribution during this is that the system level integration of biosensors sensing element signal processing and sensing element information management.Their syetem was designed to measure a suite of biologically relevant physiochemical parameters in fresh water.They measure temperature, intensity level,pH element electrical conduction.Total dissolved solid,salinity,dissolved oxygen there parameters provide insights into the current status of changing water conditions and assist in identifying pollution sources.

3. PROPOSED SYSTEM

The proposed method is used to overcome the drawbacks present in existing method. Here we are using Raspberry pi as core controller and various sensors to monitor the water Quality. The block diagram of our system is shown in Figure 1. Raspbian os run on the Raspberry pi to manage various types of equipments including sensors and so on. We are connecting different sensors Raspberry pi to monitor the conditions of water. The Raspberry pi will access the data from different sensors and then processes the data. The sensor data can be viewed on the cloud using ThingSpeak App.

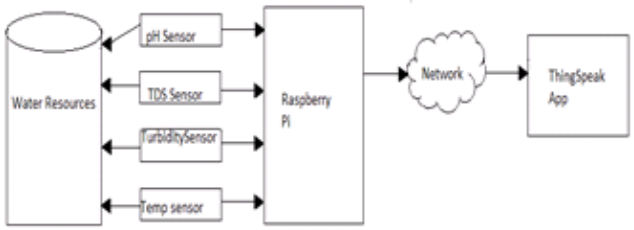

Fig-1: Block diagram proposed system

3.1 Internet of Things (IoT)

Global network of "smart device" that can sense and interrelate with their environment using the internet for their communication and interaction with users and other systems. The main conceptions behind every IoT technology and implementation are "Device is integrated with virtual world of Internet and interacts with it by following, sensing and monitoring object and their environment".

3.2 ThingSpeak API

ThingSpeak is an open source Internet of Things (IoT) application and API to store and retrieve data from things using the HTTP protocol over the Internet or via a Local Area Network. ThingSpeak enables the creation of sensor logging applications, location tracking applications, and a social network of things with status updates.

3.3 Hardware Components

Raspberry pi processor: It is a Minicomputer, Usually with a Linux OS to run multiple programs. Raspberry pi has the built in Ethernet port, through which you can connect to the network. Raspberry pi is shown in Figure 2.But to starts with Pi you don't need dive into the loading language and a small knowledge of electronics and is component is enough.

Fig-2: Raspberry Pi 3 Model

pH Sensor*:* pH sensor (SKU:SEN0161) is a sensor which detects pH value of water . This sensor is shown in Figure 3. The term "pH" set off from Latin and is an acronym for "potential hydrogenii" or "the power of hydrogen". pH is the hydrogen-ion concentration in water-based solutions, which indicates the acidity and alkalinity in the solution.

Fig- 3: pH Sensor (SKU: SEN0161)

The pH scale is a logarithmic scale whose range is from 0-14 with a neutral point being 7. Values above 7 indicate a basic or alkaline solution and values below 7 would indicate an acidic solution. The normal range of pH is 6 to 8.5.

Turbidity Sensor *:* Turbidity is the measure of a number of particles in the water. We used Turbidity Sensor(SEN0189) for measuring the Turbidity which is shown in Figure 5. Turbidity is measured in Nephelometric Turbidity Units (NTU). It is taken as the optical property of water and is an expression of the amount of the light that is scattered by the suspended particles in the water when a light is shined through the water sample. As the intensity of scattered light is increased, the turbidity increases.

During the period of low flow, many rivers are a clear green color, and turbidity is low, usually less than 10 NTU. During rainstorm, floods, water flows fast and mixes with the different particles, which makes the turbidity of water high.

Fig-4: Turbidity Sensor (SEN0189)

High Turbidity has effect in the lakes, rivers and ponds. Because of the turbidity lakes and ponds are filled faster with the solid particles and causes aquatic life in danger for habitat. These kind of particles provide the place which could be suitable for the pollutants, mostly metals and bacteria. This is the reason why turbidity measurements can be used as an indicator of possible pollution in a water body.

Temperature Sensor: The temperature sensor (DS18B20) used for measuring the temperature of water. This is shown in Figure 5.When the accurate measurement is needed, we should always consider the temperature. The increase in temperature of water increases the ionization rate .For example, pH value as well as turbidity changes with the change in Temperature. pH is temperature dependent, when the temperature goes up, the rate of ionization increases and vice versa. Temperature plays a vital role when measuring water quality.

Temperature is the key element for determining much other application for water quality analysis . We used DS18B20 to measure the temperature water its range is -55 to 125°C . This sealed digital temperature probe lets you precisely measure temperatures in wet environments with a simple 1-Wire interface. The DS18B20 provides 9 to 12-bit (configurable) temperature readings over a 1-Wire interface, so that only one wire (and ground) needs to be connected from a central microprocessor. The pinout for this sensor is as follows: RED=Vcc BLACK=GND WHITE=SIG.

Fig-5: Temperature Sensor (DS18B20)

TDS Sensor *:* "Dissolved solids" refers to any minerals, salts, metals dissolved in water. Total dissolved solids (TDS) comprise in organic salts(principally calcium, magnesium, potassium, sodium, bicarbonate, chlorides, and sulphate) and some small amounts of organic matter that are dissolved in water.TDS (Total Dissolved Solid) sensor kit which is compatible with IoT Device, plug and play, easy to use. This is shown in Figure 6. we can build a TDS detector easily to measure the TDS value of liquid.

Fig- 6: TDS Sensor (SEN0244)

This sensor supports 3.3 ~ 5.5V wide voltage input, and 0 ~ 2.3V analog voltage output, which makes it compatible with 5V or 3.3V control system or board. The excitation source is AC signal, which can effectively prevent the probe from polarization and prolong the life of the probe, meanwhile, increase the stability of the output signal and this TDS sensor Measurement Range is 0 ~ 1000ppm.

The TDS probe is waterproof; it can be immersed in water for long time measurement. This sensor can be used in water quality application, such as domestic water, hydroponics. With this sensor, you can easily DIY a TDS detector to reflect the cleanliness of water to protect your health.

4. APPLICATION

- This system is used in commercial and domestic use.
- Mainly helpful for Water Supply Agencies.
- For health department to identify the reason of water diseases.

5. ADVANTAGES

- Due to automation it will reduce the time to measure the parameters.
- This is economically affordable for common people.
- Low maintenance.
- Prevention of water diseases.

6. RESULTS AND ANALYSIS

In our proposed system four sensors are connected (Temperature, pH, TDS and Turbidity) are connected to the Raspberry Pi as shown in Figure 1. These four sensor measures of Temperature, pH, TDS and Turbidity parameters of the water when they dipped in water.

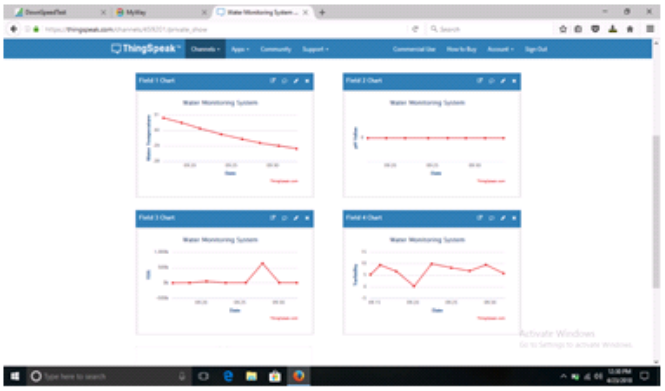

Fig-7: Data displayed in ThingSpeak

Then Raspberry Pi will access the data from these sensors and process the data, finally sends the data to ThingSpeak API using network. The Figure 7 which shows the readings of all the sensors measuring Temperature, pH, TDS and Turbidity levels of Water from different resources.

a. Measurement of Water Temperature using temperature sensor

Figure 8 shows how sensor measuring the water temperature in the range from -50°C to 125°C. Basically water temperature is classified into cold, normal and hot based on its temperature. If the temperature is in the range from -55°C to 20°C is considered as cold water, from 21°C to 39°C is considered as normal water and from 40°C to 125°C is treated as hot water.

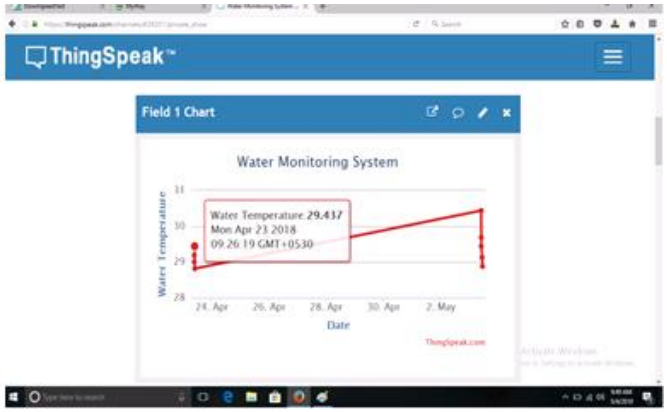

Fig-8: Measurement of Water Temperature

b. Measurement of pH value of water using pH sensor

Figure 9 shows how sensor measuring pH value of the water that ranges between 0 and 14. Based on the pH value, water is classified as acidic, normal and basic. If the value is below 7 it is considered as acidic, above 7 as basic and 7 as normal or good water. In acidic, it is again classified as low acidic (3 to 6) and high acidic (0 to 2). In the same way basic water is also classified into two types. They are low basic (8 to 10) and high basic (11 to 14)

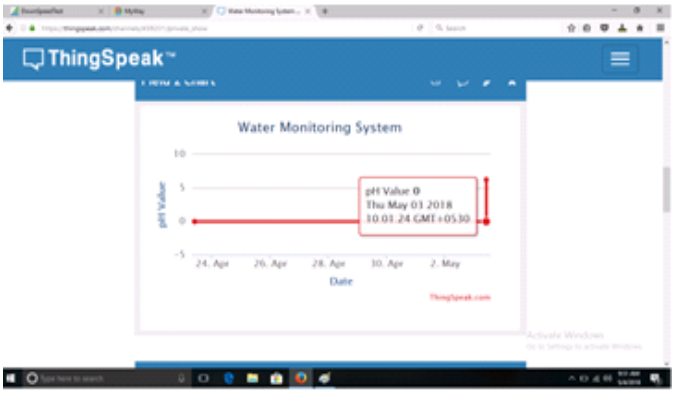

Fig- 9: Measurement of pH value

c. Measurement of TDS value of water using TDS sensor

"Dissolved solids" refers to any minerals, salts, metals dissolved in water. Total dissolved solids (TDS) comprise in organic salts(principally calcium, magnesium, potassium, sodium, bicarbonate, chlorides, and sulphate) and some small amounts of organic matter that are dissolved in water.

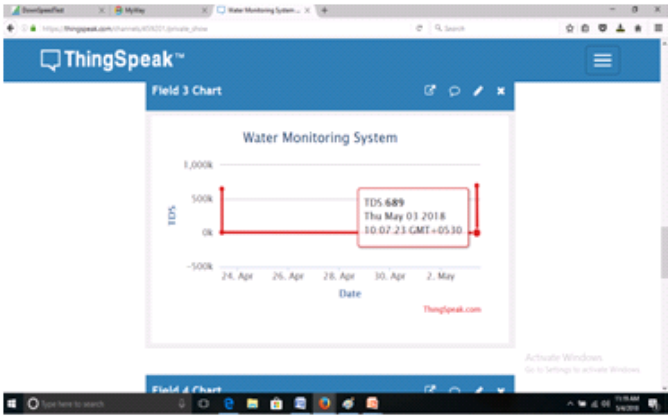

Fig- 10: TDS level Measurement

According to WHO (world Health Organization) TDS ranges from 0 to above 1200. The TDS is measured in ppm. TDS range less than 300ppm range is Excellent for drinking water, 300- 400 ppm is good, 600-900 ppm is fair, 900-1200 is poor and above 1200 is unacceptable. And figure 10 shows the measurement of TDS range.

d. Measurement of Turbidity of Water using Turbidity sensor

The turbidity of water is its clarity. If any mud, slit or sand particles etc. are mixed with the water, its quality varies. According to the water quality norms, normal water ranges from 0 NTU (Nephelometric Turbidity Units) to 5 NTU and also maximum of up to 5 NTU is permissible. If the water goes over 6 NTU up to 3000 NTU it is classified as turbid or mud mixed water. Figure 11 shows the measurement of Turbidity of water.

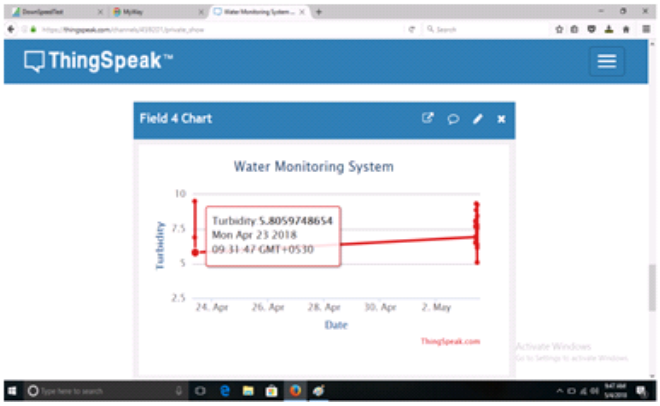

Fig 11-: Measurement of Turbidity of water

7. CONCLUSIONS

Our project "IoT Based Low Cost System for Monitoring of Water Quality in Real Time" focused on analyzing the water quality with high performance, real time and accurate. In our proposed system we have measured TDS, Temperature, Turbidity and pH values of water with the help of Raspberry Pi and various Sensors. In future, the parameters like conductivity, hardness, chloride, ammonia, iron, fluoride etc also considering water quality measurement and these values are used to check the purity of the water for many purposes such as drinking water and daily requirements.

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