Design and Development of IoT Device to Measure the Quality of Water and Water Content in Soil

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***Abstract*:- The water is main resource in the world, without water no one can survive. The quality of water is very important role in the field of agriculture, daily purpose, power plants etc. We have to find whether the water is contaminated or pure. The conventional method of measuring the quality of water is to take the samples manually and send it to laboratory for analysis. This technique is time consuming and not economical. Also it is not possible to take water sample to laboratory after every hour for measuring its quality. Hence it ming process to everyone. So, to avoid this problem we are proposing new system to measure the quality of water. In this system we are using four sensors with Raspberry pi model to measure the quality of water. The measured values are sent to the controlling center with the help of Ethernet local area network .Further measurid values are sent to the registered user and also user can retrieved the data from database. The complete system depends upon the sensors with Raspberry pi model. .**

Keywords:- Raspberry pi 3, water. Sensors turbidity, temperature, pH, and Moisture sensor, Internet of Things (IoT)

1. INTRODUCTION

Water is a resource of prime importance, without water life on the earth would not have been imagined. The availability of high quality water is a key determinant for human, animal and plant survival. Water quality refers to the chemical, physical, biological and radiological characteristics of water. It is a measure of the condition of water relative to the requirements of one or more biotic species or human need or purpose. The quality of water determined by many factors that include total dissolved solid, conductivity, PH, turbidity and temperature.

Internet of things (IoT) enables us to build a system without human interference. In other words IoT is an environment that has the ability to transfer data over a network, without human to human computer interaction. The IoT allows objects to be sensed and controlled remotely across existing network infrastructure, creating opportunities for direct integration between the physical word and computer based system and it provides more efficiency accuracy as well as economic benefits. The quality of water is measured to find whether the pure or worst. The main four factors of the quality of water are temperature, turbidity, and pH, moisture.

The many factories, power plants etc, discharge heated water into rivers and lakes results in increasing of water temperature. When water temperature becomes too high, it effects on the organisms lived in the rivers and lakes and also high water temperature and reduces the solubility of oxygen and increases the toxicity. Which effects living organisms present in water for these reasons it is one of the important parameter in water quality measurements. Turbidity is the cloudiness of fluid caused by large numbers of individual particles. Turbidity in water is caused by human activities that disturb the land such as construction, mining and agriculture. Certain industries such as petroleum, refineries, mining coal recovery generate the very high levels of turbidity from colloidal particles. If the turbidity level is high means, higher the risk that people may suffer from gastrointestinal disease therefore turbidity is another key parameter of the water quality measurement.

The important factor for water quality measurement is pH. It is measure of water whether hard or soft. The range goes from 0-14.If the pH value is too high or low aquatic organisms living within it will die and is not suitable water for drinking. The moisture sensor is used to measure the water content of soil.

In our IoT system the quality of water is measured using sensors such as temperature sensor, pH sensor, turbidity sensor, moisture sensor and raspberry pi .The quality which are measured by sensors are transmitted to raspberry pi and then it is sent to controlling center through internet. This system allows the user to access the data from database through website and provides advantage of improved efficiency, accuracy and low price.

2. LITERATURE SURVEY

Shruti Sridharan et al. [1] addressed in their project about developing an efficient wireless sensor network (WSN) based water quality monitoring system, that examines water quality, an important factor as far as, irrigation, domestic purposes, industries, etc are concerned.

R.Karthik Kumar etal. [2] investigated Underwater wireless sensor network to monitor the quality of water using wireless sensor network (WSN) technology powered by solar panel. Through WSN various data collected by various sensors at the node side such as pH, Turbidity and oxygen level are sent to base station. At the base station collected data is displayed as visual and is analyzed using different simulation tools.

Marco Zennaro, Athanasios Floros, Gokhan Dogan, Tao Sun, Zhichao Cao,Chen Huang, Manzoor Bahader, Herve' Ntareme et al. [3] proposed the design of a water quality monitoring system and, building upon the SunSPOT technology, aprototype implementation of a water quality wireless sensor network(WQWSN) as a solution to the water quality monitoring problem.

Kirankumar G.Sutar, Prof.Ramesh T.Patil [4] presented the fish farm monitoring system based on wireless sensor network. The system is constituted by a base station and sensor nodes. The sensed parameters with their exact precision values are transmitted to the observing station through wireless communication and details are monitored by the administrator. When any of the parameter is found to be above a threshold value an indicator will indicate it. The system has advantages such as low power consumption, more flexible to deploy.

A.C.Khetre, Prof.S.G.Hate [5] investigated and defined a wireless sensor network for water environment monitoring system. It provides a useful feature's such as large monitoring ranges, low cost, low powerconsumption, flexible configuration and very small damage tom the natural environment. The system successfully provides on-line auto monitoring of the temperature, turbidity, water level, and salinity.

Xiuna et al.,[6] authors have proposed a smart water quality monitoring system to forecast water quality using artificial neural networks. Extensive tests have been carried out for a period of 22 months at isolated local area network and the data has been transferred to internet using CDMA technology.

Gerson et al., [7] authors have developed biosensors using Arduino microcontroller to monitor animal behavioral changes due to aquatic pollution. The abnormal behavior of animals can be considered as an indication of water contamination.

Geethanjali.S, Mekala.M,Deepik et.al[8] presented a narrative water eminence monitoring organization Zigbee based on wireless sensor network contributing small power utilization with high reliability.

Zhu Wang Qi Wang, Xiaoqiang Hao et.al, [9] discussed the problem of the manual analytical method adopted in water quality detection with bad real-time character and introduced a novel kind of remote water quality measuring and monitoring system based on WSN.

Peng jiang and Hongbo xia et.al, [10] have proposed the Design of water environment system based on wireless sensor network. This system takes MSP430F1611 main processor to develop automatic water environment monitoring system.

O'Flynn,B,Martinez-Catala et.al [11] have developed automated water environment monitoring system using GSM technology, this system sends the online measurement of water parameters directly on mobile phone through GSM technology.

Mingfie Zhang, Daolaing L et.ali [12] presents a system framework taking the advantages of the WSN for the real-time monitoring on the water quality . They design the structure of the wireless sensor network to collect and continuously transmit data to the monitoring software then accomplish the configuration model in the software that enhances the reuse and facility of the monitoring project. This system has been realization of the monitoring digital, intelligent, and effectively ensures the quality of aquaculture water.

Nikhil Kedia entitled [13] "Water Quality Monitoring for Rural Areas-A Sensor Cloud Based Economical Project." Published in 2015 1st International Conference on Next Generation Computing Technologies (NGCT-2015) Dehradun, India. This paper 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.

Jayti Bhatt,Jignesh Patoliya entitled [14] "Real Time Water Quality Monitoring System".This paper describes to ensure the safe supply of drinking water the quality should be monitored in real time for that purpose new approach IOT (Internet of Things) based water quality monitoring has been proposed. In this paper, we present the design of IOT based water quality monitoring system that monitor the quality of water in real time. This system consists 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 and this processed values are transmitted remotely to the core controller that is raspberry pi using Zigbee protocol. Finally, sensors data can view on internet browser application using cloud computing.

3 SYSTEM DESIGN AND DEVELOPMENT :

We are using pH, turbidity and temperature, moisture sensors to measure the quality of water. These sensors measure the corresponding values in the water. These four sensors are connected to Raspberry Pi. The Measured information send to Raspberry Pi. The output of the pH sensor is analogue in nature, so it is converted into digital using ADC (analog to digital converter).This system uses LAN/wireless network for communication with the control center. It's a real time system and it doesn't require any man machine interaction. The systematic arrangement of the components are shown in the Figure 1.

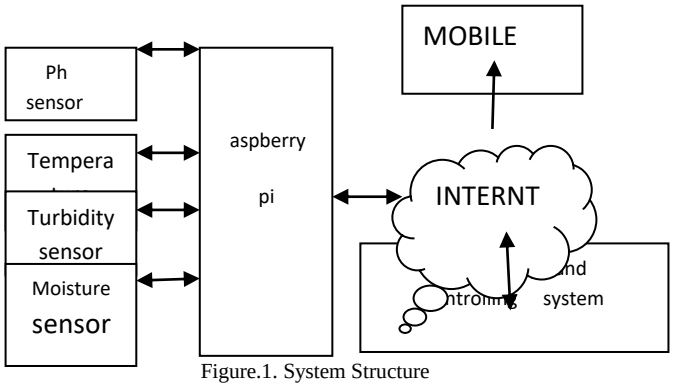

Figure.1. System Structure

3.1 RASPBERRY PI:

There are many devices in IoT and here we consider a Raspberry pi which is shown in figure 2. A Raspberry pi is a credit card sized computer originally designed for education. This can be plug into monitor or Tv and uses a standard keyboard and mouse. All Raspberry Pi is included the same Video Core IV GPU and either a single core ARMv6-compatible CPU or an ARMv7-compatible quad-core one. Pi is also included the 1GB of RAM or a Micro SDHC one for boot media.

Figure: 2 Raspberry pi

Here we used Raspberry Pi 2 model . The pH sensor, Temperature sensor , Turbidity sensor and moisture sensor are connected to Raspberry Pi as shown in the Figure 1. Python programming language is used to connect various sensors. PHP and html languages are used for Graphical User Interface and MySql is used for information storage and retrieval.

3.2 PH SENSOR:

The pH electrode is analytical sensor which is used for measuring potential of hydrogen (pH) shown in figure 3. The pH value of substance is directly related to the ratio of the hydrogen ion[H+] and the hydroxyl[OH-] concentrations. It is one of the most common laboratory measurements because many chemical process are dependent on pH. The pH Electrode BNC is used to measure the pH value of the water. It is a gel-filled combination pH electrode designed to make measurements in the pH range of 0 to 14.The body that extends below the glass sensing bulb of the electrode makes this probe ideal for making measurements in the environment.

Figure 3: pH electrode

3.2.1 Measurement of pH value using pH sensor:

The pH sensor measures hydrogen potential in the water that ranges between 0 and 14. Based on the pH value we classify water 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). The Figure 4 shows the flow chart of pH value measurement.

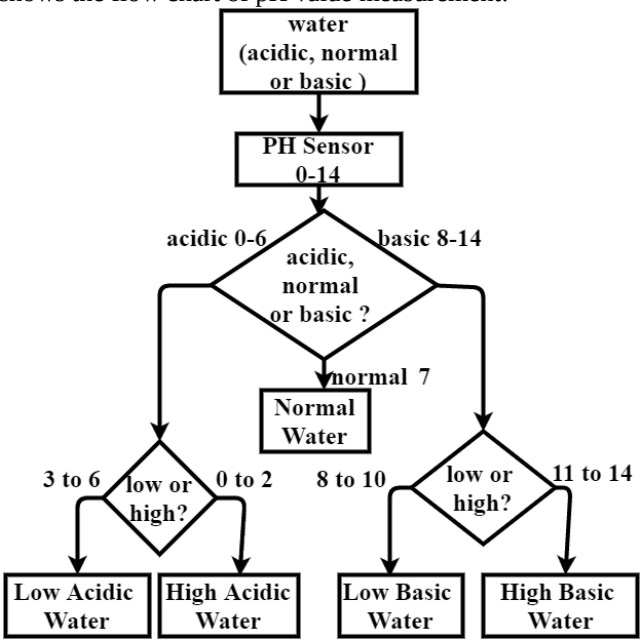

Figure 3.1 Flow chart of pH value measurement

3.3 TEMPERATURE SENSOR:

The DS18B20 is a one wire temperature sensor that can measure temperature with minimal amount of hardware and wiring shown in figure 5. This sensor use a digital protocol to send accurate temperature readings directly to the raspberry pi without need of analog to digital converter. It is a waterproofed version and it good up to 125°C. It is digital, so you don't get any signal degradation even over long distances. The sensor has 3 wires: red (VCC), black (GND) and yellow (DATA). Connect the red to +5V, the black to GND and the yellow to the digital pin D10 of Pi. Then put a 4.7k ohm resistor between yellow wire and +5V. We have added a 4.7K resistor, which is required as a pull up from the DATA to VCC line when using the sensor. It is a digital sensor so it is directly connected to Raspberry Pi.

Figure 5: Temperature sensor

3.3.1 Measurement of temperature using temperature sensor:

Figure 5.1 shows how the sensor water temperature in the range from -55˚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.

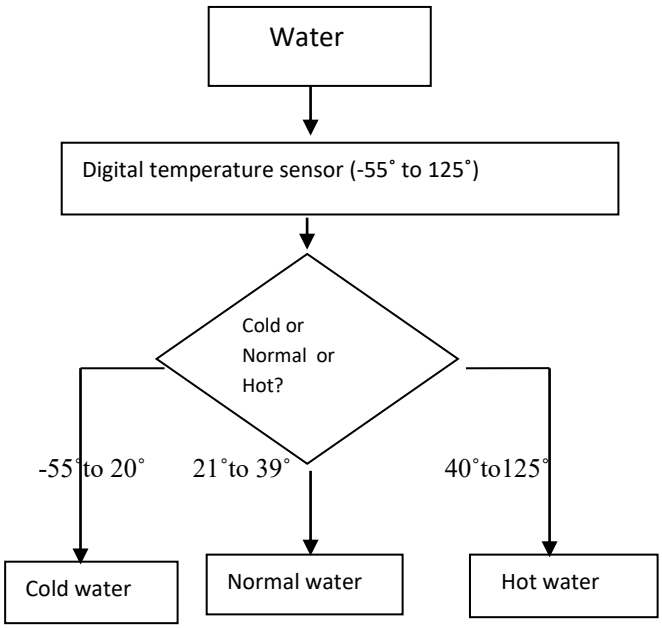

Figure 5.1 flow chart of temperature measurement

3.4 TURBIDITY SENSOR:

Turbidity is the most difficult property of water to analysis of water .Since turbidity is the optical property of water .It has quite many ways to measure the amount in water .Turbidity sensor is used check some dirt material in the water . In this work SKU: SEN0189 Turbidity sensor is shown in figure 6 This sensor measures turbidity of water in form of analog signal and this signal is goes to ADC where the signal is converted into digital and it is measure the turbidity of the water ,this includes turbidity probe and turbidity circuit to drive data to raspberry pi . send to Raspberry Pi. Pi process the signal and code written in the Pi convert the digital signal into NTU.

Figure 6:Turbidity sensor

3.4.1 Measurement of pH value using pH 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 25 NTU is permissible. If the water goes over 26 NTU up to 3000 NTU it is classified as turbid or mud mixed water. Figure 6.1 shows flow chart of water classification based on turbidity value of water.

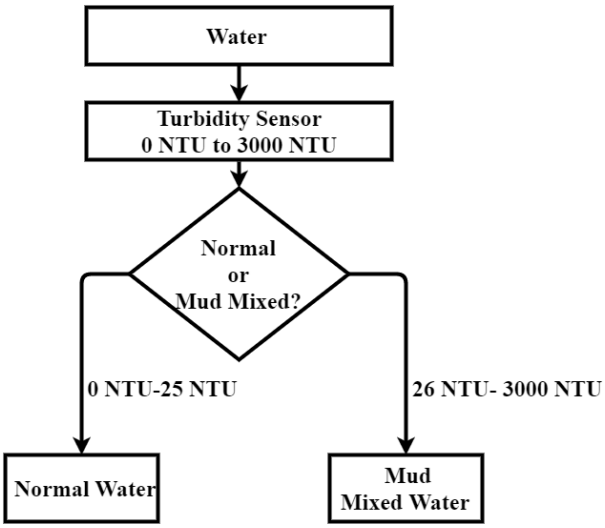

Figure 6.1 flow chart of turbidity value measurement

3.5 MOISTURE SENSOR:

Soil moisture sensor measure the volumetric water content in soil sensor is shown in figure 7.This sensor is designed to estimate volumetric content based on dielectric constant of the soil .When the soil is having water shortage ,the module output is very high , else in low level . this sensor reminds the user to water their plants and also monitors the moisture content of soil .It has been widely used in agriculture ,land irrigation and botanical gardening .This sensor gives the analog value , we require digital value hence this connected ADC(analog to digital converter) . And digital value is sent to the raspberry pi.

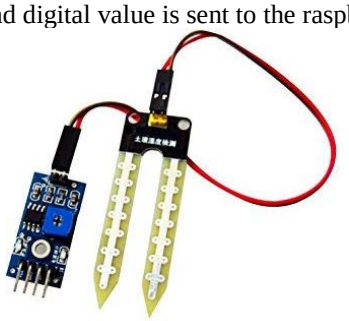

Figure 7: Moisture sensor

In this work we also implemented data storage facility. Here, Pi will sent the sensors data to controlling center . This system also provides SMS notification facility for authorized users using SMS gateway. An SMS gateway allows a Pi to send Short Message Service (SMS) to a telecommunications network using web browser to people within the limit served by that gateway. An SMS gateway can also serve as an international gateway for users with roaming capability, allowing SMS communication away from the home network. In this work Way2SMS.com is used as SMS gateway to notify the registered users about sudden water quality variations that are measured by the sensors as show in Figure 8

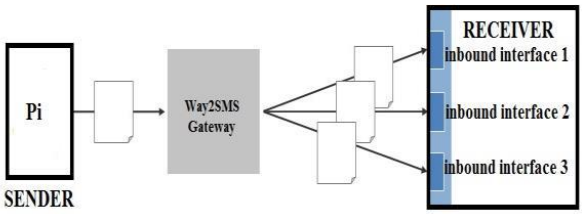

Figure 8 SMS transmission

4 RESULT AND ANALYSIS:

Four sensors (Temperature, Turbidity, pH ,Moisture) are connected to Raspberry Pi as shown in the Figure 9. The digital temperature sensor DS18B20, which is a one wire digital device . So, it is directly connected to Raspberry Pi along with a 4.7k Ohm resistor which is required as a pull up from the DATA to VCC line when using the sensor. The turbidity sensor SEN-0189 is an analog sensor which senses the clarity of the water. Raspberry Pi supports only digital sensors and it will take only digital values. Therefore in this approach, an analog to digital converter is used (ADC- MCP3008) to convert analog signals into digital signals. Sensor is connected to channel 1 of the ADC to convert the analog value to digital. Later, digital value input to Raspberry Pi. Similarly, pH electrode BNC-E201 is also an analog sensor, therefore this sensor is connected to channel 2 of ADC .and also Moisture sensor is connected to channel 3 of ADC to . Here, turbidity sensor , pH electrode and Moisture sensor are connected to ADC. ADC is connected to Raspberry Pi . The Ethernet cable is connected to Raspberry Pi to send the information control centre. The breadboard is used for the connections.

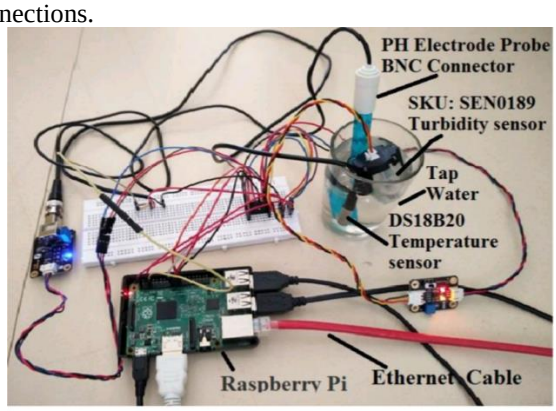

Figure 9:Connection of Sensors to Pi

The Temperature, pH and Turbidity values of the water is displayed along with its measuring units in the Terminal (Command Prompt) of the Raspberry Pi. It also shows the SMS notification sent to the registered user when there is a variation in the water quality and in moisture

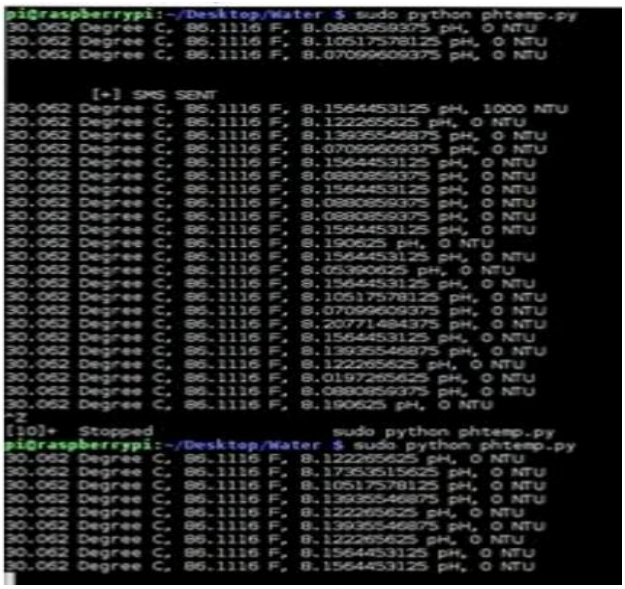

Figure 9:Readings from Sensors.

The Figure 10 shows the SMS notifications sent to the registered users of the device to know the quality of water. Here, users' needs provide their mobile numbers to get notifications from the Raspberry Pi device. There are different notifications related to water temperature, pH ,moisture and turbidity are send to registered users via SMS gateway. These notifications are received by the user when water quality and moisture content is varied suddenly than some prefixed threshold values.

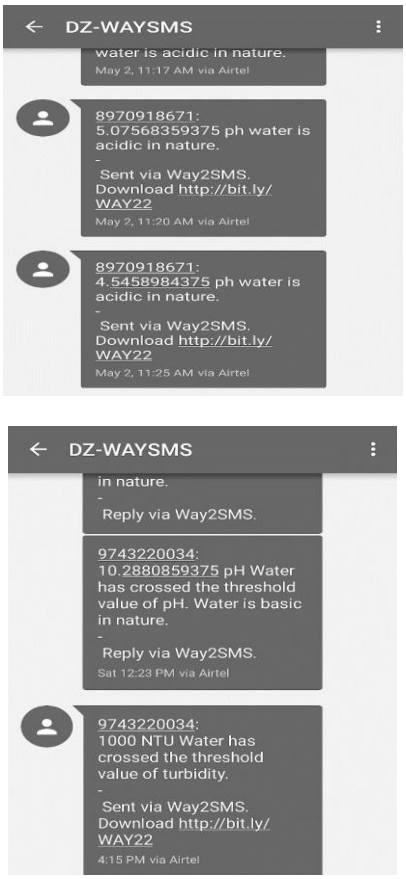

Figure 10 SMS Notification

The Figure 11 shows the data retrieved from the database. It will help the users to know about water quality at any time and from anywhere. This page also provides an option to get the stored water quality information based on the specific date.

Temp(C)	Temp(F)	Date	Time	pH	Turbidity(NTU)
32.437	90.3866	2016-05-16	15:11:46	6.73799	1000
32.437	90.3866	2016-05-16	15:11:46	6.73799	1000
32.437	90.3866	2016-05-16	15:11:46	6.73799	1000
32.437	90.3866	2016-05-16	15:11:46	6.75508	1000
32.437	90.3866	2016-05-16	15:11:46	6.75508	1000
35.187	95.3366	2016-05-16	15:11:45	6.7209	1000
34.687	94.4366	2016-05-16	15:07:18	6.61836	1000
34.75	94.55	2016-05-16	15:07:15	6.61836	1000
35.25	95.45	2016-05-16	15:06:53	6.61836	1000
35.312	95.5616	2016-05-16	15:06:50	6.61836	1000

Figure 11:Data Retrieved from Database

5 CONCLUSION:

This work focused on analyzing the water quality and soil moisture with high performance, real time, accurate and low cost. This system can be used to measure the quality of water, and moisture of soil in field river water, sea water etc. Water quality and moisture of soil is determined by considering several parameters like pH, temperature, turbidity, Total Dissolved Solids (TDS), conductivity etc. In this work pH, temperature and turbidity ,Moisture parameters are considered to measure the quality of water. These four parameters of the water are measured with the help of Raspberry Pi and sensors. The proposed system measures the temperature, turbidity and pH of water for every 5 minutes and these measured values are stored in database. based on the threshold values set, Raspberry Pi notifies the registered user by sending text SMS with the values and these values can also be retrieved through website.

In future, the parameters like Total Dissolved Solids (TDS), conductivity, hardness, chloride, ammonia, iron, fluoride etc are also considering for water quality measurement and these values are used to check the purity of water for many purposes such as drinking water and daily requirements.

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