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Design and Development of Remote Location Water Quality Monitoring System using IoT

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Abstract*: *This paper aims in the design of low-cost water monitoring system in remote location areas using IoT technology. Pollution has become one of the major problems in the environment. In which water pollution is caused by the industrial waste and by other means. Once the water is polluted is cannot be used for drinking, aquaculture, agriculture, and for many other purposes. In order to use the water first we need to check the quality of the water weather it is suitable for the specific purpose by taking PH, TURBIDITY value into consideration. The aquaculture requires continuous monitoring of water for safe and good production. The can be used to monitoring the water quality and send the notification to the end-user or the remote user according the predefined values in the systems. The design uses an Arduino as the central processing system, SIM900A as the communication module to send the short message service (SMS) to the authenticated user. All the sensors are connected to the central processing system. The developed prototype is test by taking the different water samples from diverse locations.

Index Terms*: *Water samples, quality, sensors, pollutants

I. INTRODUCTION

The world is full of pollution now days and especially the drinking water and It is very hard to find the pure drinking water. Water is getting more polluted because of adding the industrial wastes and chemical wastes into the water and by adding the waste materials such as plastic products, sewage. To test the water quality of the water there are diverse methods and approaches to assess the water are suitable for drinking, agriculture, aquaculture and for many purposes basing on the parameters. Many people across many places are suffering from harmful diseases like, bone deformation due high fluorine content in the water, heart diseases, skin diseases ect.by drinking these types of water like tap water bore water and river water etc. because it contains large number of unwanted particles, they are harmful to us like nitrate, iron, arsenic, fluoride, lead, cyanide, metals etc. Mostly in villages they don't have safe water [1]. Water plays a main role in the agricultural lands and in the marines. Due to the polluted water the agricultural lands and the marine lands may damage and leads to heavy damage for the people. The polluted water for the agricultural lands to several disadvantages such as crop damage and low yielding of the crop and the virus infection caused by the water. All these can damage the crop and leads to the low yielding of the crop or it completely damages the crop and effects the farmers [2]. The polluted water at the marine lands particularly for the farmers who are involved in the aquaculture, the polluted water may contain the poisonous chemicals which can damage the health of the fishes and may kills the fish. The water may have high range of pH value which results in the more pollutants present in the water. On the surface layer of the water a bacteria layer will be formed which doesn't allow the oxygen to get into the water for the fishes and this will result in the death of the fishes. The water used for the aquaculture must be tested before they are allowed in to the fish ponds [3]. The paper develops system prototype device that satisfies all these conditions and concludes the water whether the water satisfies these conditions are not and gives the alert if the water is not satisfying these conditions. We can judge that the water is pure or not by having a look at it. So, to check the water quality our device will gives the result that whether the water is drinkable or not and whether the water can be used for the agricultural purposes and for the marine lands and it gives the values that how much pure the water is within a few seconds. For that we are going in a smart way and developing the testing equipment smartly, that which can test the water and gives out values within seconds by using the microcontroller. Water is polluted in different ways and we don't know whether it is suitable for all the purposes or not. The paper mainly concentrating on the two aspects that is agriculture and drinking. Our device tests the water and gives out the results whether it is suitable for drinking or not. The process of acquiring the data from the sensors in done in different ways. This can be done using the Wireless-Lan technology and the collected data is validated and reconstructed and it undergoes testing for the detection of the any failure in the sensors [4]. The quality of water differs from the area to area and it varies due to the change in land (Soil Conditions) and the atmospheric conditions.

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The surface water may contain the more pollutants than the ground level water because the chemicals or the pollutants or any oils mixed with the water floats on the water surface and it is not easily identified due to different reasons at that place. The surface water changes its nature in different conditions according to the soil conditions and the surrounded area etc. The water was tested according to the several conditions based on the soil conditions at the particular area and the geographical conditions [5]. Testing the quality of the water in the fields and in the wells is a very difficult task. The reason is we have to collect a sample of water in the particular area we have to take it to the lab for testing. It's a long process difficult for everyone and the cost for testing the water sample is high. In order to test the quality in the private lands the water was tested at its place and we may know about the availability chemicals such as nitrate etc., and we can get the pH value of the water and we can get the pollutants available in the water instantly. The advantages of testing the water in by our own reduces the cost and time taken to test the water at the lab and we can find out where the pollutants are high and low in the area [6]. We can include the multi sensors for a single device and can get the pollutant levels accurately and easily with the help of a single device. We can include the sensors to find the variables such as dissolved oxygen, chemicals present in the water and the pH level present in the water and the temperature of the water at that location [7]. The inland water quality can be measured using the wave lengths. The objects or particles present in the water is shown to be no bigger than the usual in the large wave length and the reflectance of the water is shown to be bigger than the zero size in the short-wave length [8]. There are 30 variables in the water quality testing, and they are used and changed according to the place to place and geological conditions of the area [9].

II. LITERATURE SURVEY AND RELATED TECHNOLOGIES

2.1 FPGA board and ZigBee Technology

The authors Cho Zin Myint, Lenin Gopal, Yan Lin Aung states about the interfacing of some smart sensors for the water quality monitoring system setup in the environment of Iot. The WQM system consists of FPGA boards, sensors, ZigBee wireless communication module and PC. The FPGA board plays the main role in the setup and it uses the VHDL and C languages using Quartus II software and Qsys tool. This proposed system collects the different parameters such as pH, water level, turbidity, carbon dioxide (CO2) on the surface of water and water temperature [10].

2.2 Remote Sensing Technique

The authors N. Prasad, K. A. Mamun, F. R. Islam, H. Haqva states about the IOT and Remote Sensing (RS) techniques that are used in different areas of research for monitoring, collecting and analyzing the data from remote locations. Due to the increase of polluted wastes from the industries and the over usage of natural resources the water available now is deteriorated greatly. The over usage of chemicals and fertilizers in the agricultural farms have polluted the water mostly. Water plays a main role in the human body so, it should be maintained in a good condition and we have to continuously monitor the lakes, canals and the water tanks available around the city. Fiji Islands are located in the vast Pacific Ocean requires frequent data collecting network for the water quality monitoring system. IOT and RS can improve the existing measurement. This paper mainly represents the usage of this device for the Fiji island [11].

2.3DOM Technique

The authors MasoumehHeibati Colin et.al. states about Detecting the elevated DOM which requires the potential contamination events to be distinguished from natural fluctuations in the system, but how much natural variation to expect in a stable distribution system is unknown. In this study, relationships between DOM optical properties, microbial indicator organisms and trace elements were investigated for the house-holds and this system mainly focuses on the detection of the elements in the water and biological bacterial. This setup also detects the water quality of the soil water/underground water. Smaller infiltrations would be detectable with the help of this setup [12].

2.4 TCP/IP Protocols.

The authors N. An and Y. An states about a water quality monitoring system built with the both hardware and software configurations and sends the data through the network which measures the all the configurations of the connected devices and checks the TCP/IP protocols which are useful in monitoring and transferring the data through the network. The telemetry network is used to improve the performance of the water quality monitoring system which is controlled by the network. The data that can reflect water quality in real time is sent to the computer control center and analyzed. Environmental protection agencies can easily get the data from the device and they can take the effective measure to manage the quality of the water [13].

2.5 Floating Platform.

The authors Gayathri Surendran; Ganesha Udupa; G.J. Nair states about the system where water quality parameters such as pH of the water, turbidity of the water and temperature of the water are collected with the sensors automatically by installing the setup on the platform which is floating on the water and the data which is collected by the sensors are transmitted to the control room to analyze the data. All the sensors which are used to detect the values are installed into a box and are connected to a cable to the floating platform and another mechanism name winch which is automatic is used to for dipping the sensor box into the water and to raise from the water. The two microcontrollers named ATMEGA 328 which is called as Arduino is used to collect the data from the sensors and to transmit the data to the control room and for controlling the sensor box. We can keep track of the depth of the sensor box in the water by using the equations called dynamic equations and by using the ultrasound sensor. The data collected by the sensor box is sent to the control room by using the bi directional Wi-Fi technology [14].

2.6 Satellite Remote Sensing.

The author David Cotton, states that using the remote sensing technique we can detect the oil spill and water quality in the marine lands of Europe. With the help of this setup they can continuously monitor the data from the satellite, and they can simplify their duties regarding the marine lands and it

helps in getting the accurate values and it is easy to continuously monitor the marine lands [15].

2.7 IDACC System.

The authors Mohammad Shahidul Islam, James S. Bonner, Temitope Ojo, and Cheryl Page states that the dissolved oxygen levels reach very low to the ground level in the water and it causes corrosion in that area and leads to the pollution of the water. It raises the hypoxic problem which is raised during the low oxygen level [16].

2.8 GPRS technique.

The authors Cao Jian1 , Qian Suxiang , Hu Hongsheng , Yan Gongbiao states that they have used the gprs module to transfer the data of the water quality. They have used C++ and Matlab software to develop the software. They have used the SQL server to store the values in the database [17].

2.9 Wireless sensor network.

The authors B O'Flynn, Rafael MartínezCatalà, S. Harte, C. O'Mathuna, John Cleary, C. Slater, F. Regan, D. Diamond, Heather Murphy states that they are using a network of sensors which is wireless to transmit the data and the parameters they have considered for testing the water quality are pH, turbidity, dissolved oxygen, temperature, phosphate, conductivity and water level. They are implementing the water framework directive [18].

2.10 Remote Robust Sensor Network.

The authors Tuan Le Dinh. Et.al states that they are going to collect the data about the water which is being pumped out of the underground and they monitor the quality of the water and the impacts on the current irrigation system [19].

III. PROPOSED SYSTEM MODEL

The block diagram of the proposed water quality monitoring system is shown in the figure 1. The system consists of different sensor like pH sensor which determines the pH values of the water, conductivity sensor and turbidity sensor that give the appropriate values of the water to the system. The system consists of a microcontroller, all the sensors are connected to the microcontroller. The microcontroller acquires the sensor data in analog form and convert the data in digital format using the ADC (Analog to digital convertor). After the conversion of the data it is processed according to the condition define in the software in co-operated in the system. It displays the determined water values on the LCD display and send SMS to the end user. For transmitting the water quality data, the system in co-operates a GSM module through that the information is given to the end-user. The microcontroller will TURN ON the buzzer if the waters quality is decreases than the predefined level.

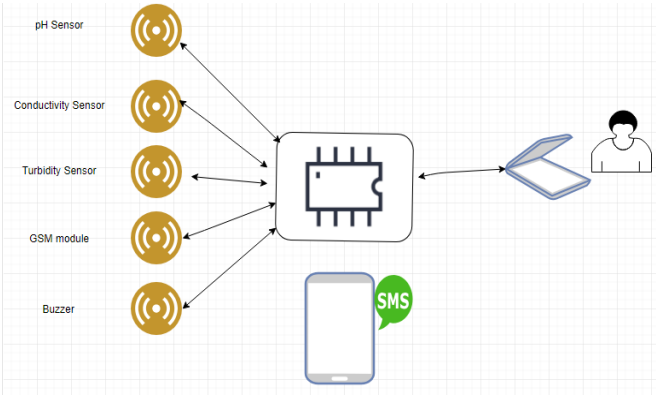

Figure 1: Block Diagram of the proposed system model

IV. HARDWARE IMPLEMENTATION OF THE PROPOSED SYSTEM

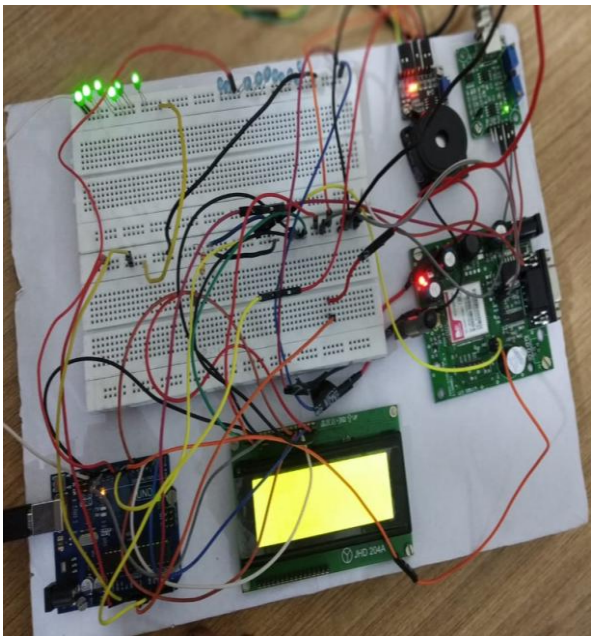

Figure 2: Hardware implementation of the water quality monitoring system

We are using the ATMEGA 328 microcontroller for this setup and the pH sensor, turbidity sensor, GSM module, conductivity sensor, buzzer is connected to the microcontroller. The display screen was connected to the microcontroller which will continuously displays the values of the sensors to the pass by people. All these values are continuously monitored by the operator by connecting the computer to the microcontroller. The values are continuously acquired from the sensors and analyzed. If the values are in the specified range then the green led bulbs will be turned on automatically and if the values are not in the specified range then the blue led bulbs will be turned on automatically, buzzer starts making the sounds and the GSM module will start sending the SMS to end-user about the water conditions and alerts the end-user.

V. FLOW CHART

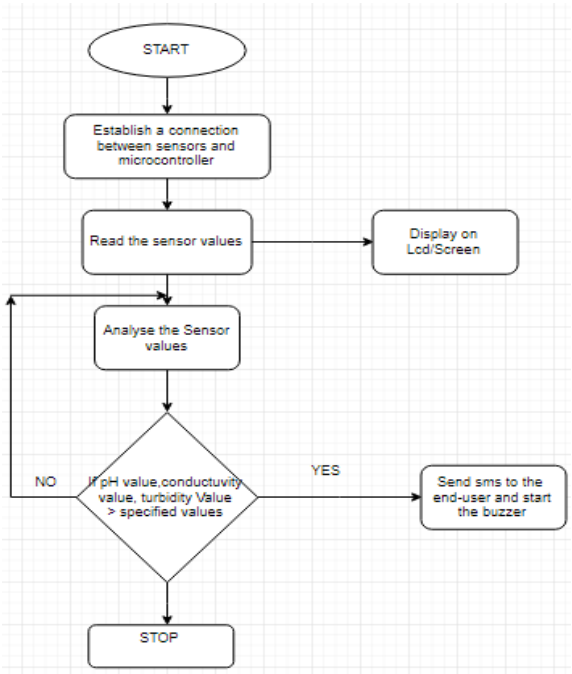

Figure 3: Flowchart of the proposed model

VI. REQUIRED SENSORS

6.1 pH Sensor:

PH (potential of hydrogen) is a scale of acidity from 0 to 14. More acidic solutions(pH<7) have lower pH. More alkaline solutions(pH>7) have higher pH. Pure water has a pH of 7 Water which is acidic cannot be used for drinking and agricultural purposes.

Figure 4: PH Sensor

6.2 Conductivity:

Conductivity is defined as the process of finding the amount of dissolved salts present in the water. As the greater number of salts in the water increased the salinity increases. So, that the amount of salinity increases the conductivity of the water increases.

Figure 5: Conductivity Sensor

6.3 Turbidity:

Turbidity is defined as the cloudiness or the laziness of the water. If the water is having more algae or the suspended particles floating on the water, then the turbidity value will be increased. As the turbidity value increases the risk of drinking that water raises.

Figure 6: Turbidity Module

6.4 GSM:

GSM (Global System for Mobile Communications, originally Grouped Special Mobile) is defined as the system which is used to send the alerts and make calls to alert without using the mobile and this system will be automatically turns on when the specified conditions are satisfied.

Figure 7: GSM module

6.5 Buzzer:

A buzzer is also called as a beeper which is used to make alerts by making the beep sounds and it is mostly used to alarm when the specified conditions are satisfied.

Figure 8: Buzzer

VII. RESULTS AND DISCUSSIONS

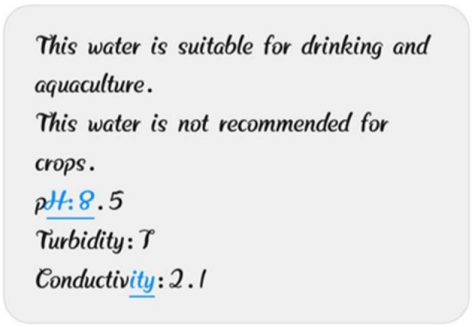

Figure: 9: SMS received from the prototype

The proposed system is developed and deployed to test different water samples. Considering the pH value of pure water i,e 7. The pH value of the drinking water should be between 6.5-8.5, 6.5-9.0 should the pH value for safe aquaculture and for crop it should be between 5.5-7.0. First the protype is tested using the drinking water samples, the systems have delivered a notification SMS as shown in the figure 9 to end user stating the water is not suitable for crops and is suitable for drinking and aquaculture only.

As the next sample the water sample as taken from pond in the village and it is observed that the pH value is 7 so the water is suitable for drinking, aquaculture and crops. The notification is shown in the figure 10

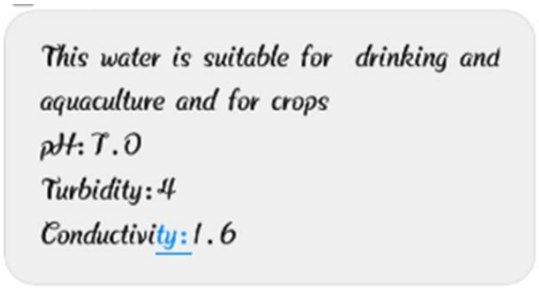

Figure 10: SMS notification for water samples taken form pond

The third water sample is taken from the tap water and pH value of 9 is observed and the water is suitable for drinking and aquaculture but not suitable for agriculture.

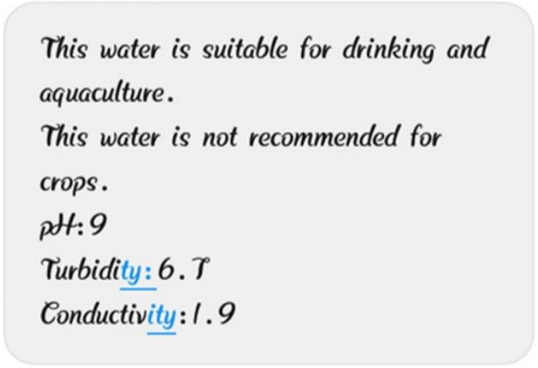

Figure 11: Notification pH value of the tap water

VIII. CONCLUSION

A low-cost Remote water quality monitoring system is designed and implemented using Arduino as the central processing systems and SIM 900A act as communication module for send the notification to the end user receives the through SMS. As this is a portable, we can carry it very easily to check the water quality at different places.

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