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IoT Based Water Quality Monitoring System

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Abstract

Water pollution is the biggest problem nowadays. It is increasing as new technology evolves and human population increases. Evolving technologies makes human life easy. But they have huge impact on the environment, and one of the main problems is water pollution, which causes various diseases and other issues in living beings. So, it has to be monitored continuously and reduced as much as possible to ensure the provision of clean drinking water. This research presents the solution to monitor the water quality parameters like water conductivity, turbidity, pH continuously and send these values to the LCD and nearby devices using Wi-Fi module. Moreover, this system is designed to measure the quantity of water being monitored using water flow sensor. Water quality parameters are measured by different sensors such as pH, TDS, and Turbidity, which are connected to microcontroller (Arduino Uno). The proposed system uses GSM module to send the message to the officials during abnormal conditions. Hardware results of the proposed system are also provided in this work.

Keywords: Water pollution, pH, turbidity, conductivity, TDS sensor, LCD, Wi-fi module, Arduino Uno, GSM module.

1. Introduction

Water is an essential natural resource for living. As the population on earth increases, the need for the water increases. All the living beings require clean water for better life. Increased use of new technologies in industries create various pollutants in the environment. The pollutants like chemical wastes, organic pollutants, medical wastes are the major causes of pollution in water. The pollution in water has direct impact on life of every living being. Water pollution causes many health hazards. So, the pollution must be reduced and the water should be monitored continuously for the pollution level.

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The laboratory based testing methods are appropriate but they can test only a limited amount of water at a time and are time consuming as well. It is not an efficient way for monitoring the running water and huge quantity of drinking water. This research is a water quality monitoring system based on Internet of Things (IoT). It is mainly designed for monitoring the water continuously. The proposed system includes sensors to monitor the turbidity, pH, Total Dissolved Solids (TDS), and the water flow. Other major components of the system are Arduino UNO , LCD, Wi-Fi module and GSM module. Sensors, Wi-Fi module, GSM module, LCD are connected to the microcontroller. Measured pH value, turbidity, conductivity level, quantity of water in litres per minute are given to the microcontroller. Microcontroller sends these values to the LCD of the nearby devices using Wi-Fi module. If the water parameters read are not in the accepted levels, the alert message is sent to the authorities with the help of GSM module. This system gives assurance to the drinking of clean water.

1.1 Overview

The proposed system aims to introduce the efficient solution for watching over the water quality parameters. It enables a continuous monitoring of drinking water and ensures the consumption of good water. This research uses sensors for TDS, pH, turbidity, and water flow. All the sensors are connected to the microcontroller. Microcontroller reads the sensor values and sends the values to the LCD and IoT platform cayenne using Wi-Fi module. It can also send the alert message to the authorities using GSM module.

1.2 Objectives

The main objective is to design an efficient water quality monitoring system using Internet of Things, and to ensure the provision of good drinking water for the lives. Additionally, for the human who is consuming the water, to know the quality of water he is drinking through the display and officials to know the supply of polluted water through message.

2. Literature Review

2.1 IoT in Monitoring

This research discusses the design of water quality monitoring system installed in municipal water resource to detect water quality parameters at low cost. It uses sensors and Raspberry pi-module. This system monitors pH, conductivity, turbidity and temperature of water. The detected parameters are uploaded to the cloud and then examined by the authorities. IoT helps to improve the speed and efficiency of the system. It reduces the time for testing the water quality. Uploading values to the cloud helps the users to access the information easily.

2.2 Smart Monitoring employing IoT

This work is designed for testing separate water samples and classify them according to the WHO standards. It uses Arduino UNO and different sensors to measure different water parameters like temperature, conductivity, turbidity and pH. The measured parameters are transmitted to the application developed in .NET platform. Then the transmitted parameters are compared with WHO standard limits. It uses fast forest binary classifier to classify the water samples.

2.3 The use of Zigbee and GPRS in monitoring

This work explains about the method that uses ZigBee and GPRS communication technologies in water quality monitoring system. And it uses TinyOS for data collection and transmission purposes. The collected data are processed using LabVIEW and the processed data are stored using MySQL software. LabVIEW is used for displaying the sensor data.

3. Proposed Work

IoT based water quality monitoring system includes sensors, microcontrollers, LCD, Wi-Fi module, GSM module. These components work together to monitor water quality and ensure good drinking water supply. Components' description and working of the system are given in detail below.

3.1 Block Diagram

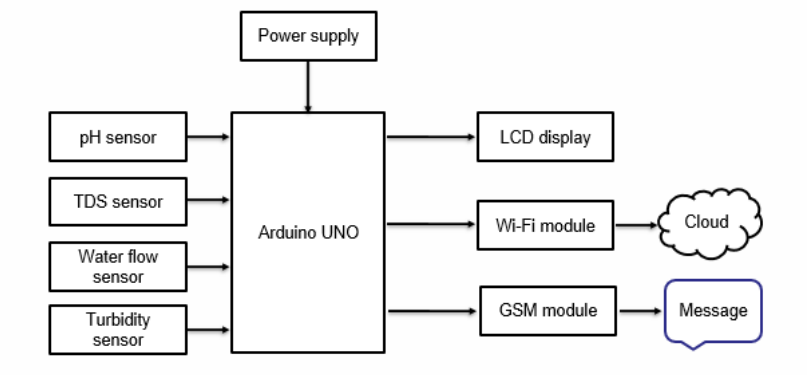

Figure 1. Block diagram of the proposed system

3.2 Components Used

3.2.1 Arduino UNO

Arduino UNO is one of the low cost microcontroller boards based on ATmega328P used recently to get the real world parameters as analog or digital input and give digital output. It consists of USB port to connect it to the computer. And it has fourteen I/O Pins(digital), six input pins (analog), extra power jack port and also a reset button. In order to interface the computer to the Arduino, a software called Arduino IDE is used. The software supports programming languages like C, C++, etc.

3.2.2 pH Sensor

pH sensor plays a vital role in monitoring the quality of the water. pH sensor used in the proposed system is PH 4502C. pH sensor is used to measure the pH value of the water. pH value is in the range of 0-14 which depends on the H^+ ions present in the solution. The pH value less than 7 indicates the acidic nature of water , pH value 7 indicates the neutral water, pH value is more than 7 for basic water. Water with pH range 6.5 to 8.5 is good to drink as per World Health Organization. The potential difference measured across the reference and pH is known as pH value.

3.2.3 Water Flow Sensor

This measures the water quantity flowing through the pipe. Water flow sensor works on the Hall Effect principle. The range of the used water flow sensor YF-S201 is 1-30 L/min. When the water flows through the sensor, the rotor inside the sensor rotates. The speed of the rotor depends on the water flow rate. The pulse is generated according to the rotor rotation. With the generated pulse, the quantity of water is measured.

3.2.4 TDS sensor

It measures the amount of solids dissolved in water from which the conductivity of water can be found. Total dissolved solids include ionized salts, minerals, heavy metals, and some organic compounds. It gives the output in parts per million. Water with TDS value below 300ppm is good for drinking.

3.2.5 Turbidity Sensor

This sensor is used to find the transparency of water. It determines the amount of light that is passed through the water and amount of light that is scattered. It depends on the soil present in the water. The increase in soil content increases the scattering of light. Turbidity is measured in NTU. The turbidity level of drinking water should not be greater than 5NTU.

3.2.6 16X2 LCD

16X2 LCD is used along with the I2C, which is used to reduce the difficulty in the connections. With I2C, LCD can be connected with Arduino UNO only using 4 pins. 16X2 LCD is an electronic display module that uses liquid crystals for operation. The main advantage of this LCD is that they are inexpensive, and easy to program. LCD consists of ground pin, VCC pin, data pins, read write pins, back light enable pins, and contrast adjustment pins for the operation. LCD is used to display the output as numeric and alphanumeric values to the users.

3.2.7 Wi-Fi Module (ESP8266)

It is one of the standalone wireless transceivers used to connect to the internet. It primarily uses the TCP/UDP communication protocol for connecting to the server. Wi-Fi module communicates with the IoT platform Cayenne. In Cayenne platform, water quality parameters are displayed in a graph.

3.2.8 GSM Module

It forwards the message to the officials when the water quality falls below the accepted range. GSM module is connected to the Arduino UNO using digital pin. Whenever the water quality does not meet the necessary conditions, microcontroller communicates with the GSM module with AT commands command and sends an SMS using AT+CMGS at command.

3.3 Working

IoT based Water Quality Monitoring System mainly consists of different types of sensors such as TDS, pH, and Turbidity for measuring the water quality parameters. In addition to these sensors, water flow sensor is used to monitor the water quantity through the pipe. Each sensor is connected to the different analog input pins of the microcontroller Arduino UNO. Sensors measure the water parameters continuously and sends those data to the connected analog pin of Arduino UNO. The microcontroller has the digital output pins to which LCD is connected. It can also support modules like Wi-Fi module. The microcontroller processes the input signals from the sensors and the output is displayed in the LCD and using Wi-Fi module the sensors data is stored in the Cayenne platform. Sensor readings are continuously monitored by this system. When the parameters exceeds the predetermined limits, the alert message is sent to the authorities using GSM module. So, this system ensures the supply of clean drinking water to the consumers.

4. Results and Discussion

Hardware implementation of the proposed solution is designed and the results are obtained in LCD and IoT platform Cayenne, and the alert message is also received successfully.

4.1 LCD Output

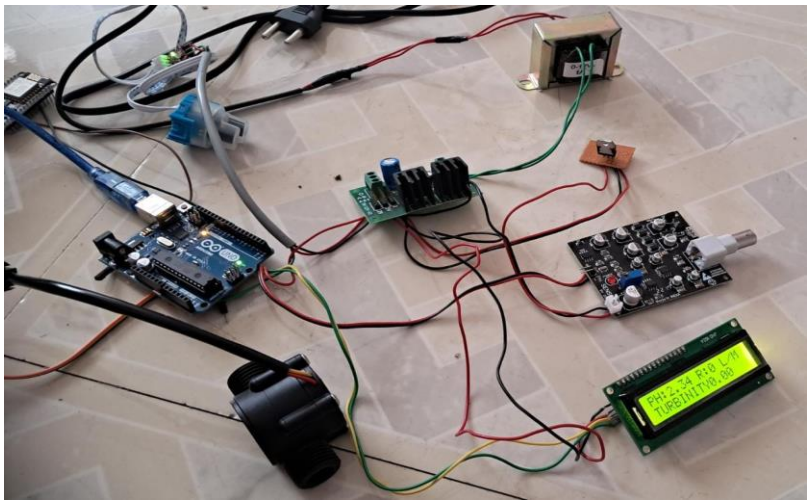

Figure 2. Hardware Implementation with LCD

The above figure shows the hardware implementation of the proposed system. And the parameter values received from the sensors are shown in the LCD used.

4.2 Cayenne Results

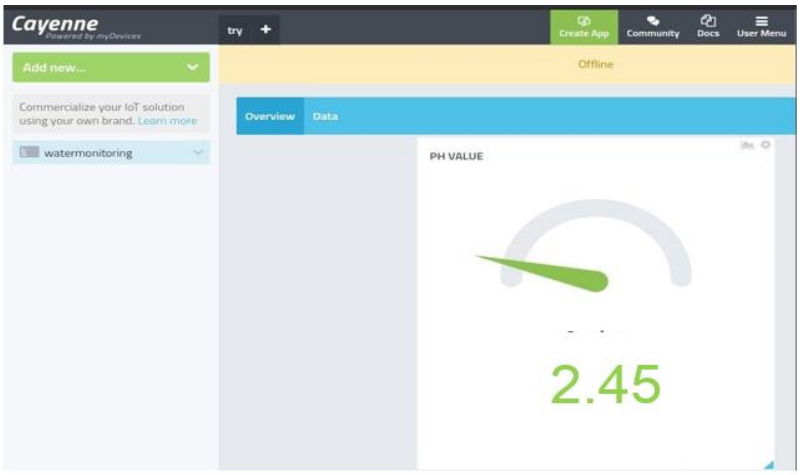

Figure 3. Result obtained in IoT Platform

4.3 SMS

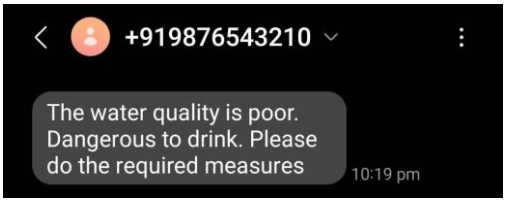

Figure 4. SMS Output

This figure shows the SMS received from the system. SMS will be received when any one of the parameters is not in the recommended limit. The authority can know the abnormal value either from the display or from the IoT platform.

4.4 Advantages

i. Continuous monitoring of water quality.

ii. Fast and efficient monitoring.

iii. Transparency of water quality parameters.

iv. Immediate messaging system for poor quality water.

v. The system ensures good water supply.

vi. Cost effective system.

5. Conclusion and Future Scope

The water quality monitoring system design put forth has been tested successfully. The system is designed with all necessary sensors and output devices. All the objectives of the project were achieved. The system can send the data and the message to the IoT platform successfully. So, the system can monitor water quality, and the system is of low cost and reduces manual efforts. The proposed system is economical and convenient in terms of speed and flexibility. Due to its simplicity, the operation could be easily extended to various applications in the future.

In future, the system can be expanded to monitor dissolved oxygen level, different chemicals, and biological pollutants present in the water. It can also be altered to detect the hydrologic, air pollution, industrial and agricultural pollutions and so on. In addition to this, the system can be added with water treatment system, if the water quality does not meet the required parametric specifications.

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