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Real Time Water Resource Quality Monitoring System Using Wireless Sensor Network

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ABSTRACT

Water is one of the most supreme and valuable natural resources known on earth .It is important to all living organism most which includes ecological system , human health ,food production and economic development. Today industrialization water sources combined with ever growing population has been responsible for water pollution as it is increasingly contaminated with sewage ,agriculture chemicals ,oils, heavy metals ,radioactive material ,detergents and many other synthetic products. Thus water quality monitoring is a necessary requirement for many industries and human beings .The purpose of this paper is to generally overview the water quality monitoring testing performed. The monitoring of water is performed for process control ,or to maintain discharge limits established by governmental agencies and humans . There is need to develop a water quality monitoring system to check whether the given water is suitable for use or not. The system is developed using a wireless sensor network (WSN), to check water quality remotely. Sensors like pH, TDS, conductivity, turbidity are deploy into water bodies. Continuous reading of this parameter is taken by the system if there are any changes in given parameters, it is reported to user. Critical battery issue is solved using solar panel. This system will establish online sensor data analysis; it has advantages like power optimization, portability and easy installation.

Keywords: Water quality monitoring, real time, solar panel, wireless sensor network (WSN).

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I. INTRODUCTION

Each and every human being on the earth needs pure and drinkable water to survive. Thus the water to be drinkable need to be monitored on regular basis so as to prevent the waterborne diseases. As we have many of the traditional methods of monitoring the quality of water such as testing the water samples in the laboratory etc, but these methods are time consuming .Thus we have implemented our system which is capable of monitoring the system within less time by using the concept of WSN(Wireless Sensor Network).Using the WSN we can obtain real time data continuously . This project mainly focuses to develop a reliable, flexible water quality monitoring system using WSN . The system consists of a solar panel to provide a power to the sensor node, which solves the critical battery issue problem .

The system consists of Arduino Uno, WiFi Module , pH sensor, turbidity sensor, LCD, buzzer, conductivity sensor, MQTT server, solar panel and android application. All the sensors needed for water quality monitoring such as pH sensor, turbidity sensor and conductivity sensor are mounted in the water which detects the all the required parameters Ph, turbidity, conductivity etc. output of the sensors is given to the ADC pins of the Arduino. Power supply to the Arduino

will be provided by using solar panel and battery. Arduino takes decision about the increased parameter levels and through Wi-Fi module the data will be sent to android app and gmail in which we can set threshold levels or the parameters and also, we can provide details about the water quality level parameters in the form of graphs. When these parameters levels go above their set thresholds, buzzer will get on and msgs and mail will be sent . If android app is subscribed to the MQTT server then only msgs will be sent to android application.

II. RELATED WORK

In [1] paper briefly describes various sensors for sensing the physical and chemical properties of water ,and system which includes wireless communication module. This system uses UART protocol for the transmission of data. The main module is connected to the transmission module for the communication as well through the universal asynchronous receiver transmitter (UART) .

In [2] paper the system has been proposed and designed for water quality monitoring of aquaculture industry. This system enables monitoring of water quality remotely via GSM module. Conventional method used by aqua farms requires technical staff to visit ponds at designated time and perform manual testing on the water quality. This system is used to monitor the data from the sensors such as pH, dissolved oxygen, and temperature ,also it would be able to send the alert message upon detecting degradation of water quality via SMS.

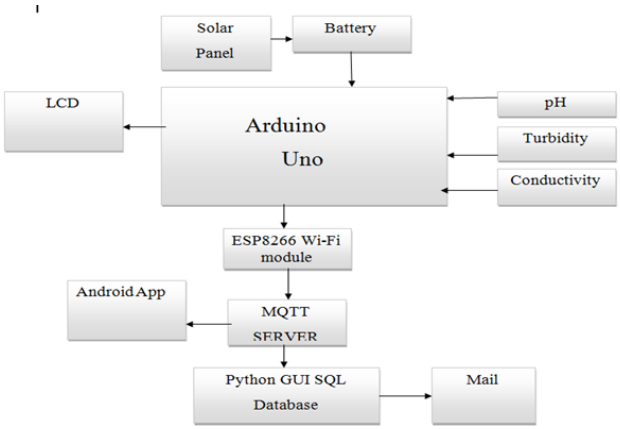
In [3] paper the system has implemented a systematic approach of building micro solar power subsystem for wireless sensor network nodes.

In [7] paper the objective of project is to develop an automatic wireless system to intimate the message to concerned authority when the waste water from industries are mixed with river illegally. This system is monitoring the data from the sensor such as temperature and pH sensor .It uses the GSM SIM 300 for sending the data remotely. Use of Arduino UNO R3 is used for interfacing all the sensors and GSM SIM.

In [9] This paper presents the application of Wireless Sensor Network (WSN) technology for real time online Water quality monitoring. Each sensor node consists of an Arduino Microcontroller, Xbee module and water quality sensors ,the Sensor probes shall continuously measure the different water Quality parameters like pH , Temperature, Conductivity.

III. SYSTEM ARCHITECTURE

The implemented system monitors the real time data remotely using WiFi module. Various sensors are used to detect the quality of the water . The resources such as rivers, lakes, ponds, tank consist of various types of disease causing bacteria's, so it is essential to constantly monitor the water resources. The System consist of following components for monitoring the water quality, they are:



Hardware Specification:
PH sensor, Conductivity Sensor, Turbidity Sensor, WI-Fi Module Arduino Uno, Battery, Solar Panel, MQTT Server, LCD display (16*2), Switch, Buzzer.

Software Specification :
Python 3.4.4 , Arduino studio 3.2, Arduino IDE.

Arduino IDE :

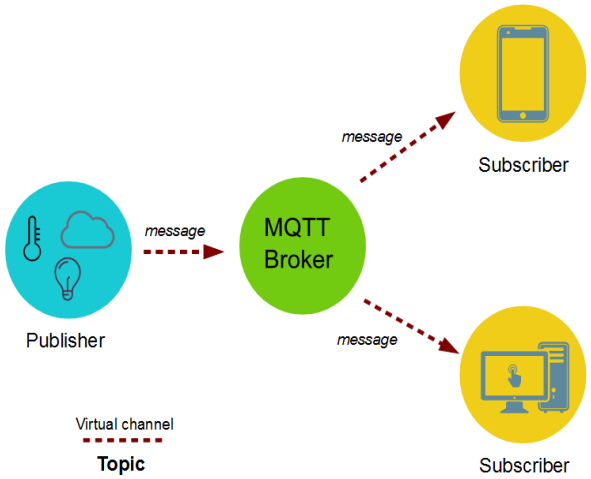
The open-source Arduino Software (IDE) makes it easy to write code and upload it to the board. It runs on Windows, Mac OS X, and Linux. The environment is written in Java and based on Processing and other open-source software. This software can be used with any Arduino board.

Python Software :
Python is an easy to learn, powerful programming language. It has efficient high-level data structures and a simple but effective approach to object-oriented programming. Python's elegant syntax and dynamic typing, together with its interpreted nature, make it an ideal language for scripting and rapid application development in many areas on most platforms.

Android Studio

Android Studio is the official integrated development environment (IDE) for Google's Android operating system, built on Jet Brains' Intelli JIDEA software and designed specifically for Android development. It is available for download on Windows, MacOS and Linux based operating systems. It is a replacement for the Eclipse Android Development Tools (ADT) as primary IDE for native Android application development.

MQTT Vesrion 3.1.1
MQTT is a Client Server publish/subscribe messaging transport protocol. It is light weight, open, simple, and designed so as to be easy to implement. These characteristics make it ideal for use in many situations, including constrained environments such as for communication in Machine to Machine (M2M) and Internet of Things (IoT) contexts where a small code footprint is required and/or network bandwidth is at a premium. The protocol runs over TCP/IP, or over other network protocols that provide ordered, lossless, bidirectional connections.

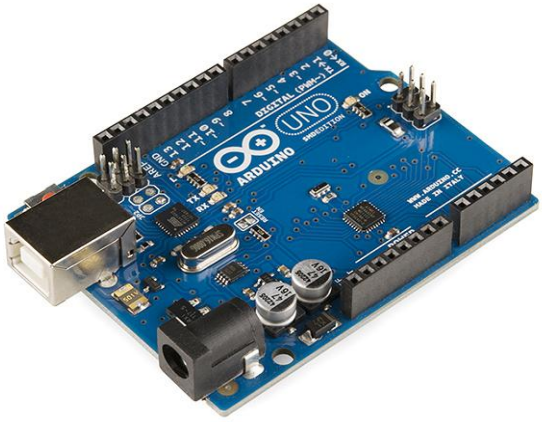


SQLite in Python :

SQLite3 is a very easy to use database engine. It is self-contained, serverless, zero-configuration and transactional. It is very fast and lightweight, and the entire database is stored in a single disk file. It is used in a lot of applications as internal data storage. The Python Standard Library includes a module called "sqlite3" intended for working with this database. This module is a SQL interface compliant with the DB-API 2.0 specification.

Arduino Uno:

The Uno is a microcontroller board based on the ATmega328P. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16 MHz quartz crystal, a USB connection, a power jack, an ICSP header and a reset button. It contains everything needed to support the microcontroller; simply connect it to a computer with a USB cable or power it with a AC-to-DC adapter or battery to get started. "Uno" means one in Italian and was chosen to mark the release of Arduino Software (IDE) 1.0



Power:

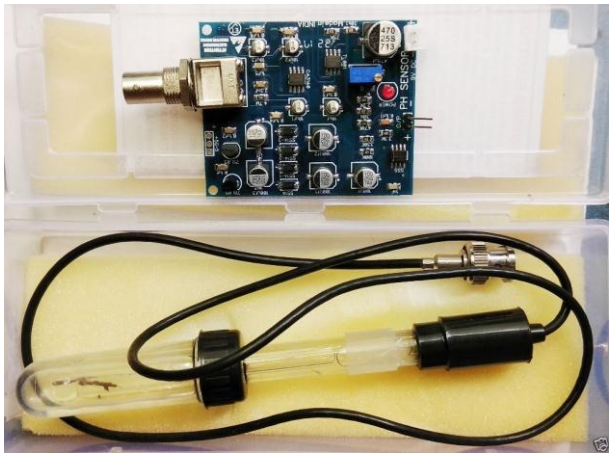
The Uno board can be powered via the USB connection or with an external power supply. The power source is selected automatically.

Technical Specification :

Microcontroller	ATmega328P
Operating Voltage	5V
Input Voltage (recommended)	7-12V
Input Voltage (limit)	6-20V
Digital I/O Pins	14 (of which 6 provide PWM output)
PWM Digital I/O Pins	6
Analog Input Pins	6
DC Current per I/O Pin	20 Ma
DC Current for 3.3V Pin	50 mA
Flash Memory	32 KB (ATmega 328P)of which 0.5 KB used by boot loader
SRAM	2 KB (ATmega328P)
EEPROM	1 KB (ATmega328P)
Clock Speed	16 MHz
Length	68.6 mm
Width	53.4 mm
Weight	25 g

Ph Sensor KIT with Ph electrode and Ph Sensor Board BNC :

This is an Analog pH Meter Kit with industrial real-time online electrode, specially designed for Arduino and other Microcontrollers. It uses an industry electrode and has built-in simple, convenient, practical connection and long life (up to 1 year), which makes it very suitable for long term online monitoring.



Input and Output:

The mapping between Arduino pins and ATmega328P ports is as following. The mapping for the Atmega8, 168, and 328 is identical. Each of the 14 digital pins on the Uno can be used as an input or output, using pinMode(), digitalWrite(), and digitalRead() functions. They operate at 5 volts. Each

pin can provide or receive 20 mA as recommended operating condition and has an internal pull-up resistor (disconnected by default) of 20-50k ohm. A maximum of 40mA is the value that must not be exceeded on any I/O pin to avoid permanent damage to the microcontroller.

pH Sensor:
PH [7] is important parameter for measuring and controlling water quality hence use of pH sensor has been done i.e. if the water is acidic, basic or neutral. The scaling of the pH sensor ranges from 1 to 14, the range between 1 to 6 is considered as acidic while the range between 8 to 14 is considered as alkaline id basic nature and 7 indicates that the water is neutral.

Turbidity Sensor:
Turbidity sensor is used for measuring the amount of haziness/cloudiness in the water. The cloudiness of water causes due to mud, soil or suspended plants and animals.

Fig : IR Transmitter

Fig : IR Receiver

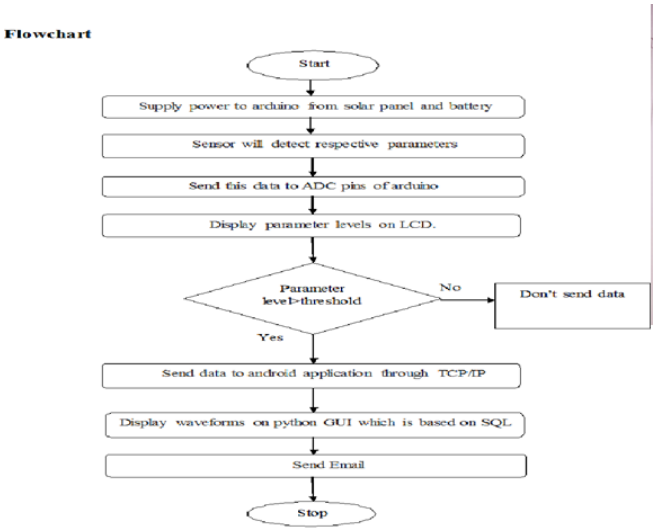
Conductivity sensor:
Conductivity of water is directly related to the measurement of ions present in the water. An electric current is passed through water to check the number of ions present in it. These ions mainly come from salts, inorganic materials such as alkalis, chlorides, sulphides and carbonate.

Solar Panel:
Solar Panels [9] are used to generate the electricity or heat. The electricity is generated by the solar panels by absorbing the sunlight which is a source of energy

LCD:
LCD is used for displaying monitored water quality parameters.

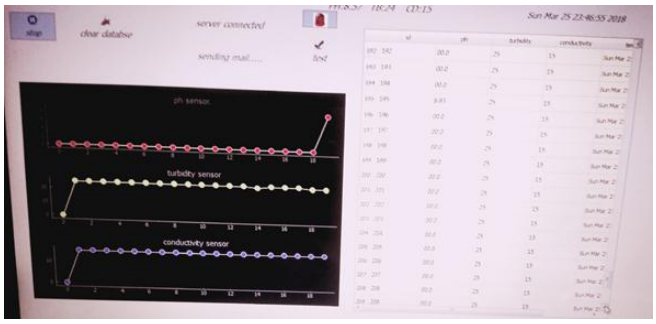
SQL Database:
The monitored water quality parameters are send to python GUI SQL database through FTP server from their we can mail this data to a mail.

Android App
Arduino takes decision about the increased parameter levels and through GSM data will be send to android app in which we can set threshold levels or the parameters. Buzzer:
When the parameters levels go above their set thresholds buzzer will get on and switch is also provided to send data.



In the proposed system , when sensor board is switched on ,the sensor activated to detect the individual water parameter data. Water quality parameters are sensed by using the PH ,Turbidity ,TDS and conductivity sensors and send to the microcontroller. Arduino UNO is programmed to read the parameter values .After , Arduino displays the parameter value on LCD . The Threshold is set for the every parameter . Arduino detects the increased levels of parameter than the set threshold values. when the value of parameters are more than threshold values then data will be send to android application , python GUI and to email. The buzzer will on when and parameters data will be displayed in the form of waveform in the GUI.

IV. RESULTS



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Department of computer engineering at JSCOE for their support and feedback . The author also wish to thank support received by Head of department .

VI. CONCLUSION

We began this work with the goal of creating the system for a many real-time issues regarding the water quality are identified. Proposed system consists of Arduino uno, ESP8266 Wi-Fi module, pH sensor, turbidity sensor, LCD, buzzer, conductivity sensor, solar panel and android application. Arduino uno board is powered through solar panel and battery. pH, turbidity and conductivity sensors will detect the detect pH, turbidity and conductivity in the water respectively. This sensor data is given to ADC pins of the arduino. Arduino is programmed to read and display parameter values on LCD. It will also detect increased levels of parameter than the set threshold values. When parameter values are more than threshold values data will be send to android application, python GUI and to an email. Parameter data will be plotted in the form of waveforms in the GUI. Through this system water department can check level of quality parameters occurring in water and sends alert. Critical power issue is solved by using the solar panel. System continuously monitors water quality with low power and low cost. Manual testing is reduced.

VII.FUTURE SCOPE

Further work will involve considering the number of sensors, possibly taking into account sensor of different types and characteristics, as an additional objective function to be minimized, as well as applying this approach in real-world settings. Appling the advanced WSN technology and wide coverage of GPRS technology for data collection and transmission, it can solve numerous difficulties such as intermediate-range transmission of water quality monitoring system and can realize real-time remote monitoring on the water quality and remote data sharing. In a future research , it is planned to extend the proposed system in sensor location in water distributed network to detect contamination event solving issue of path loss ,multipath corrosion. Marine biology and color sensor issue will be further investigated in future.

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