

Low-Cost Sensor Network for Contamination Detection in Drinking Water

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Abstract

This paper deals with the low cost and holistic approach to the water quality monitoring for drinking water distribution systems. Our approach is based on the development of low cost sensor nodes for real time water contamination monitoring using web based technology. The main sensor node consists of several electrochemical and optical sensors and emphasis is given on low cost, light-weight implementation, and reliable long time operation. We will interface the values of sensors to the internet by using the software python. The internet network would be used to monitoring the results of drinking water values.

Index Terms— Turbidity sensor, PH sensor, Electronic conductivity sensor, flow sensor, temperature sensor.

I. INTRODUCTION

Clean drinking water is a critical resource, important for the health and well-being of all humans. Drinking water utilities are facing new challenges in real time world. Because of more population and limited water resources.

Traditional methods of water quality control involve the manual collection of water samples at various locations and at different times, followed by laboratory analytical techniques in order to characterize the water quality. Such approaches are no longer considered efficient. Although, the current methodology allows a thorough analysis including chemical and biological agents, it has several drawbacks: such a

- a) The lack of real-time water quality information to enable critical decisions for public health protection (long time gaps between sampling and detection of contamination)
- b) Poor spatiotemporal coverage (small number locations are sampled)
- c) it is labor intensive and has relatively high costs (labor, operation and equipment). Therefore, there is a clear need for continuous on-line water quality monitoring with efficient spatio-temporal resolution.

US Environmental Protection Agency (USEPA) has carried out an extensive experimental evaluation of water quality sensors to assess their performance on several contaminations. The main conclusion was that many of the chemical and biological contaminants used have an effect on many water parameters monitored including Turbidity (TU), Oxidation Reduction Potential (ORP), Electrical Conductivity (EC) and pH. Thus, it is feasible to monitor and infer the water quality by detecting changes in such parameters.

There is a need for better on-line water monitoring systems. Rapid detection (and response) to instances of contamination is critical due to the potentially severe consequences to human health.

II. SYSTEM OVERVIEW

Our approach is to measure physico-chemical water parameters that can be reliably monitored with low cost sensors and develop low cost networked embedded systems (sensor nodes) as well as contamination detection algorithms.

1. ARDUINO MICROCONTROLLER

In our project we are using Arduino microcontroller to take the values from sensors and for doing ADC operation and for processing those sensor values. In Arduino we have so many families among them we are using Arduino UNO for our project.

The Arduino Uno is a microcontroller board based on the ATmega328. It has 14 digital input/output pins (of which 6 can be used as PWM outputs), 6 analog inputs, a 16MHz crystal oscillator. The Uno is the latest in a series of USB Arduino boards, and the reference model for the Arduino platform for a comparison with previous versions. The diagram of the Arduino micro- controller would be shown below.



Fig. 1 Arduino Microcontroller

- Microcontroller ATmega328
- Operating Voltage 5V
- Input Voltage (recommended) 7-12V
- Input Voltage (limits) 6-20V
- Digital I/O Pins 14 (of which 6 provide PWM output)
- Analog Input Pins 6
- DC Current per I/O Pin 40 mA
- DC Current for 3.3V Pin 50 mA
- Flash Memory 32 KB

- SRAM 2 KB
- EEPROM 1 KB

The Arduino Uno can be powered via the USB connection or with an external power supply. The power source is selected automatically. External (non-USB) power can come either from an AC-to-DC adapter or battery. The adapter can be connected by plugging a 2.1mm center-positive plug into the board's power jack. Leads from a battery can be inserted in the Gnd and Vin pin headers of the POWER connector.

The board can operate on an external supply of 6 to 20 volts. If supplied with less than 7V, however, the 5V pin may supply less than five volts and the board may be unstable. If using more than 12V, the voltage regulator may overheat and damage the board. The recommended range is 7 to 12 volts.

2. TURBIDITY SENSOR

Turbidity is the cloudiness or haziness of a fluid caused by large numbers of individual particles which are invisible to the naked eye. The measurement of turbidity is a key test of water quality.

Turbidity (or haze) is also applied to transparent solids such as glass or plastic. In plastic production haze is defined as the percentage of light that is deflected from the incoming light direction.

TURBIDITY MEASUREMENT

Turbidity can be measured electronically using opto-electronic devices. Infra-red light is transmitted

and reflected back by suspended solids and the reflected light is received by sensors. By comparing the source and received light intensity, an electronic sensor is able to determine the turbidity concentration and output the measurement as a calibrated electrical signal.

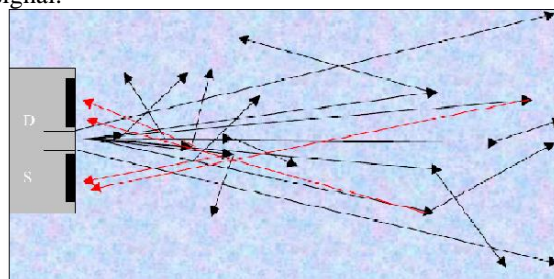


Fig. 2 Turbidity Principle

Here the infrared light is transmitting from light emitting diode (LED), when this light hits the particles the light will reflect back and receives by the photo-diode sensor.

This sensor sends these values to the microcontroller for further process

3. PH SENSOR

PH sensor would be used to determine the chemical solution in the water. Here by this sensor we can determine whether the water solution is base or acid

To be more exact, pH is the measurement of the *hydrogen ion concentration*, [H⁺]. Every water solution can be measured to determine its pH value. This value ranges from 0 to 14 pH. Values below 7 pH exhibit acidic properties. Values above 7 pH exhibit basic solution. If solution value is 7 then it is consider as "neutral".

The diagram of the PH sensor would be shown below.

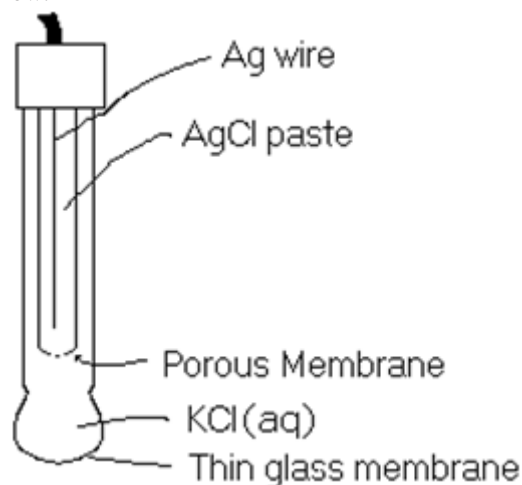


Fig. 3 PH meter.

PH MEASUREMENT

The PH sensor is made with glass which contains Probe. The probe is a main part in this sensor. While we are measuring the PH value we need to dip this probe completely into water.

4. EC SENSOR

An electrical conductivity meter (EC meter) measures the electrical conductivity in a solution. By this sensor we can measure the salinity in the water.

Here the sensor is made with glass which contains two electron probes by this probes we will measure the voltage the input voltage and output voltage must be same.

The conductivity sensor diagram would be shown below



Fig . 4 EC Sensor

Here in above figure the two probes will calculate the voltage of the circuit near op-amp.

5. FLOW SENSOR

Flow sensor is for measuring of water flow. By this flow sensor we can measure the fluidic flow through pipes and turbines. The unit of the flow sensor is cubic milliliters. Here we send the water only through one direction. From the sensor we send it to beaker to calculate future operation. In this flow sensor we have three pins one is for measuring signal and other for input voltage and other for ground.

The flow sensor diagram would be shown below



Fig. 5 Flow Sensor

6. TEMPERATURE SENSOR

Here we use LM35 temperature sensor for sensing Temperature in water. Here in this sensor we have three pins one for the voltage(Vin), ground(GND), other for Output.

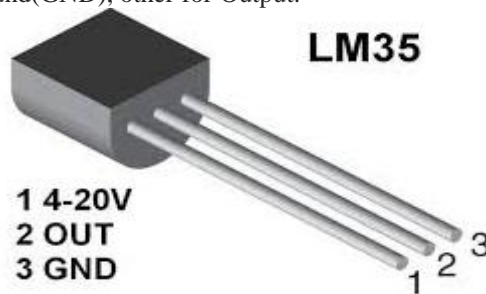


Fig. 6 Temperature sensor.

III.PROJECT DESIGN METHODOLOGY

Now we will see the architecture diagram of this project

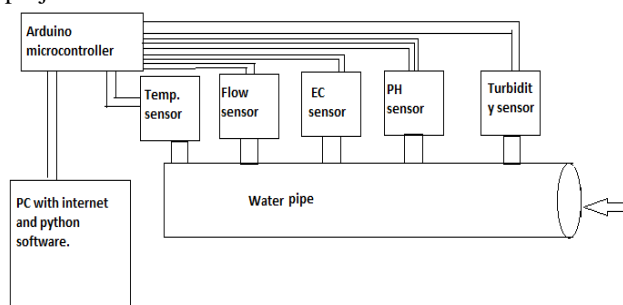
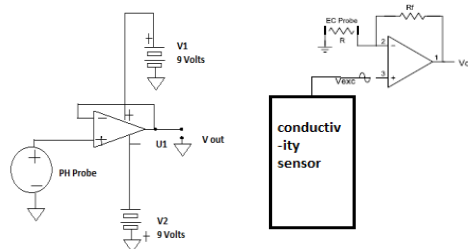


Fig. 7 Architecture diagram.

Here in this diagram we will send the water into pipe and then we will measure the turbidity sensor value, ph sensor value, ec sensor value, flow sensor value and temperature sensor value.

These sensor values will be sending to the Arduino microcontroller using serial communication wire. To get the efficient result we use the op- amp circuits which will be used for increasing gain. The circuit diagrams would be shown below



Here PH probe will detect the values and send to the Op-amp which is a pre-amplifier circuit to get accurate output. By this op-amp we will amplify the ph sensor values.

Also the output EC sensor with Op-amp would be send to microcontroller.

Here by using Arduino microcontroller we will convert the analog values into digital values (ADC)

and then we will interface to the pc to send to internet here we will interface by using python software. In the internet we will watch the results by creating web page.

To create the web page we use JAVA Script language

1. PYTHON SOFTWARE

By using python we interface the ADC values to the webpage by using some command.

Some of the commands are

1. `Arduino = serial.Serial('COM16',38400)`

By using the above command we will set the arduino baud rate to send the values.

2. local time =

`time.asctime(time.localtime(time.time()))`

By using the above one we will update the time in web page to use these commands we will import all libraries by using “import” command in the code

2. JAVA SCRIPT

Here in this project we create the web page. In this web page we showed the result by using Gauge meters. And also we were created the QR scanner to display the result in the mobile phones by using this system we can watch result from any where we want.

The result of the project would be shown below

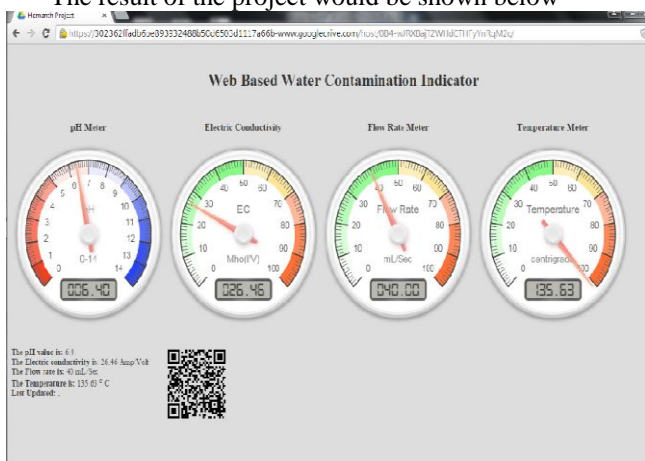


Fig. 8 Result of the project

III. CONCLUSION

In this article, the design and development of a low cost sensor node for real time monitoring of drinking water quality at consumer sites is presented. The proposed sensor node consists of several in-pipe water quality sensors which will be used to determine the water quality. And also we saw the result which will be shown in the web page.

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