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The Real Time Water Quality Monitoring System Based On IoT Platform

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ABSTRACT

Good water quality is essential for the health of our aquatic ecosystems. Continuous water quality monitoring is an important tool for management authorities, providing real-time data for environmental protection and tracking pollution sources; however, continuous water quality monitoring at high temporal and spatial resolution remains prohibitively expensive. In this system we present a design and development of a low cost system for real time monitoring of the water quality using IOT(internet of things).The system consist of four sensors is used to measuring physical and chemical parameters of the water. The parameters such as temperature, turbidity, PH and water flow can be measured. The measured values from the sensors can be processed by the core controller. The Raspberry Pi can be used as a core controller. Finally, the sensor data can be viewed on internet using cloud computing.

Keywords : Cloud computing, Internet of Things, Raspberry Pi, Water quality monitoring.

I. INTRODUCTION

In economics, the bottom of the pyramid (BOP) is the largest, but poorest socio-economic group. In global terms, water crisis is regarded as the number one global risk, based on the impact to society, and ranked global risk based on likelihood (likelihood of occurring within 10 years as announced by the World Economic Forum, January 2016 Nearly 600 crore people around the world lack access to safe water which approximates to 1 in 9 people. Also, Diarrhoea which is caused by inadequate drinking water, sanitation, and hand hygiene kills an estimated 842,000 people every year globally, or approximately 2,300 people per day. Unsafe water kills nearly 200 children per day filling about half of the hospital beds.

Apart from this, 82% of those who lack access to improved water live in rural areas, while just 18% live in urban areas. It is evident that the above mentioned numbers are staggering and alarming. But what's more astonishing is the fact that in the rural India, there are more number of mobile users than those who have access to safe drinking water and sanitation. Also, in desert places, the poor people have to sometime travel long distances and return empty handed due to unavailability of water. All these facts dawned upon after seeing the poor condition of sanitation and water in villages.

A solution in this regard is extremely important and this project focuses on the above mentioned issues catering to all the technical and economic aspects. The project highlights the entire water quality monitoring methods, sensors, embedded design, and information dissipation procedure, role of government, network operator 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.

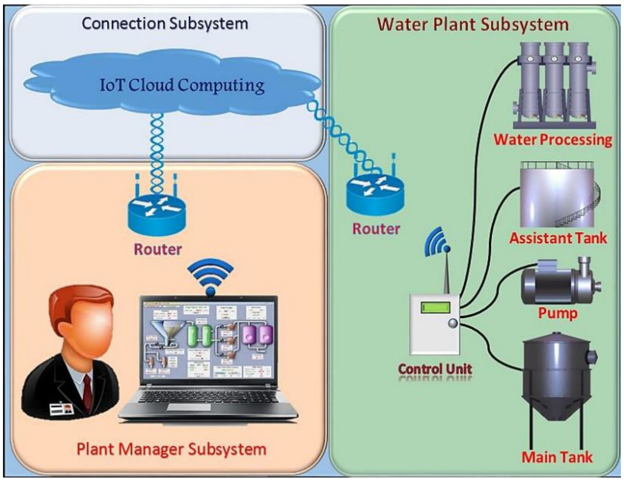


Figure 1.1: Water monitoring using IOT

In existing traditional water quality monitoring systems, the contaminants, and pathogen in the water generate frequently since they have been used for many years. Thousands of people die world-wide every year especially in Africa due to the drinking of contaminated water. Even in Walkerton, Canada (2000), seven people died and over 2,300 people were affected for drinking contaminated water by Escherichia coli. Similar incident occurred in North Battle ford, Canada in 2004 where, 7,000 people were affected. Thus, developing a real-time online monitoring system in water distribution is highly important to prevent the future water-related diseases. A water supply system consists of the water source, water treatment, and water distribution system. Existing water source and water treatment systems suffice to get purified water.

However, monitoring water quality in distribution system is the most important because the purified water flows to the distribution system that is directly connected to the human drinking water, industrial use. Using traditional approaches of monitoring water quality in the water distribution system are not safe. Chlorinating in distribution system is usually used to protect microorganisms. However, drinking too much chlorinated water leads to Cancer and other diseases. Thus, chlorine is considered as another contaminant as well as pathogen and viruses. Moreover, there is no single instrument that can detect all the possible water parameters such as pH, turbidity and so on.

II. REVIEW OF LITERATUTE

(1) Water Quality Monitoring for Rural Areas- A Sensor Cloud Based Economical Project by Nikhil Kedia in 978-1-4673-6809-4/15/$31.00 ©2015 IEEE.

In this paper author comparing the WSNs with the Sensor-Cloud, arrived at the decision of choosing Sensor-Cloud Infrastructure for high-end deploys. He also gave solution to the security issues based of earlier research papers and finally a fully analyzed and tested economic model was given for the project. Further scope of development is there, but there can be no denying the fact that it is the need of the hour to propose something on water quality monitoring given the current condition.

(2) An IoT based 6LoWPAN enabled Experiment for Water Management by Anjana, Sahana M, Ankith, K Natarajan, K R Shobha, in1570912963 ©2015 IEEE.

In this paper, they present an IPv6 network connected IoT design for real-time water flow metering and quality monitoring. In this prototype implementation uses CoAP for monitoring and control approach which supports internet based data collection. They also measure the quality of water distributed to every household by deploying pH and ORP sensors. They propose to do this with the aid of CC2538 motes programmed using ContikiOS to monitor the water consumption and communicate the data to a gateway wirelessly.

(3) An Efficient Wireless Sensor Network-based Water Quality Monitoring System by Nidal Nasser1, Asmaa Ali, Lutful Karim, Samir Belhaouari in 978-1-4799-07922/13/$31.00 ©2013 IEEE.

In this paper Wireless Sensor Networks (WSNs) have been achieved widespread applicability in water quality monitoring. However, existing WSN-based monitoring systems are not adequate or monitoring pond and lake water, city water distribution and water reservoir. Moreover, these frameworks cannot be reused in other monitoring applications since they use static and application specific sensor nodes and are not dynamic to the changing requirements. The testbed and simulation results show that the framework can monitor the water quality in real-time and the sleep scheduling mechanism increases the network lifetime, respectively.

(4) A Mote Interface for Fiber Optic Spectral Sensing With Real-Time Monitoring of the Marine Environment by Eoin O'Connell, Michael Healy, Sinead O'Keeffe, Thomas Newe, and Elfed Lewis in 1530-437X/$31.00 © 2013 IEEE.

The system presented in this paper demonstrates how a novel fibre optic based sensing platform, capable of detecting minute changes in the level of impurity in a liquid, can be incorporated onto a Mote-based platform enabling real time monitoring of a body of water. How these features can be used to detect representative samples, such as hydro-carbons and chlorophyll within a maritime environment, is demonstrated.

III. PROBLEM STATEMENT

The low cost System for real time monitoring of water quality by measuring Temperature, Turbidity, Ph and water flow meter in water using Raspberry Pi 3B and different sensors in IoT Environment and notifying respective authorities about their water quality.

- Existing water treatment systems cannot detect the dissolved contaminants such as chemicals.
- To conduct extensive literature survey to identify both scientific and technical gap in the current scenario.
- To analyze the physical chemical parameters of the water samples using background data.
- To develop suitable sensors system in order to measure the physical chemical parameters such as pH, temperature, turbidity and water flow.
- To analyze the data obtain from the study using core controller system i.e. Raspberry Pi 3B model.
- To transfer the data to cloud computing system through sensor and core controller system.

IV. PROPOSED WORK

4.1 OVERVIEW

In this section, present the theory on real time monitoring of water quality in IoT environment. The overall block diagram of the proposed method is explained. Each and every block of the system is explained in detail.

The general objective of this project is to design the monitoring and study system of industrial parameters using IOT. This project is used to reduce the high manpower requirement in industries by monitoring the overall parameters through a single mobile by with the help of IOT communication. And also study the parameters without any manual operation. Basically, this project is designed with raspberry pi and various sensors such as PH sensor, turbidity sensor, temperature sensor and water flow sensor.

4.2 BASIC BLOCK DIAGRAM OF THE SYSTEM

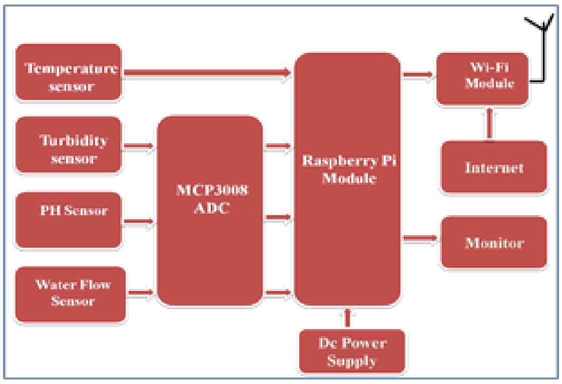


Figure.4.1: Basic block diagram of the system

The block diagram consists of several sensors such as temperature, pH, turbidity and water flow sensor is connected to Raspberry Pi. The core controller are accessing the sensor values and processing them to transfer the data through internet. Raspberry pi is used as a core controller. The sensor data can be viewed on the internet using cloud computing with a separate IP address.

- Ds18B 200 is a digital temperature sensor provides digital serial output to Raspberry pi. It is connected to GPIO 4 pin of Raspberry pi. GPIO 4 pin supports one wire communication and this sensor also works on one wire communication.
- It has unique ID through which we can get the value of water sample. Temperature ranges from -55C to 125C.
- PH having led which works as power indicator, BNC connector and PH2.0 interface. Measuring range from 0 to 14 PH with accuracy of +-0.1 PH.
- Sensor provides analog output voltage to convert output into digital form MCP3008 ADC is used. PH sensor is connected on channel1 of MCP3008.
- YFS201 Water flow sensor is used to measure the flow of liquid. This sensor basically consists of plastic valve body, rotor and a Hall Effect sensor. Pinwheel rotor rotates when water flow through the valve and its speed will directly proportional to flow of rate. The Hall Effect sensor will provide an electrical pulse with every revolution of Pinwheel rotor.
- Sensor provides analog output voltage to convert output into digital form MCP3008 ADC is used. Sensor is connected on channel2 of MCP3008.
- MCP3008 is 10 bit analog to digital converter with on board sample and hold circuit. It is 8 Channel A to D converter. It has low power CMOS technology and used to interface sensors.
- It provides 10Bit output to Raspberry Pi .
- 16*2 LCD is connected to GPIO pins of Raspberry Pi directly no intermediate required connecting LCD to Raspberry Pi. LCD display all Sensed parameters of water sensed by Sensors.
- Values from sensor and read by Raspberry Pi and after that read value are stored in Raspberry Pi.
- The Raspberry pi will upload these values on website with the use of Internet Connection.

4.2.1 Raspberry Pi

A Raspberry Pi is a credit card-sized computer originally designed for education, inspired by the 1981 BBC Micro. Creator Eben Upton's goal was to create a low-cost device that would improve programming skills and hardware understanding at the pre-university level. But thanks to its small size and accessible price, it was quickly adopted by tinkerers, makers, and electronics enthusiasts for projects that require more than a basic microcontroller (such as Arduino devices).

The Raspberry Pi is slower than a modern laptop or desktop but is still a complete Linux computer and can provide all the expected abilities that implies, at a low-power consumption level. The Raspberry Pi is open hardware, with the exception of the primary chip on the Raspberry Pi, the Broadcom SoC (System on a Chip), which runs many of the main components of the board–CPU, graphics, memory, the USB controller, etc. Many of the projects made with a Raspberry Pi are open and well-documented as well and are things you can build and modify yourself. One advantage of using the Raspberry Pi over some other alternatives is the size of the community. If you have a question regarding a project you are working on, there are a lot of people who might be able to help you because of the large reach of the community.

The Raspberry Pi 3 is the third generation Raspberry Pi. It replaced the Raspberry Pi 2 Model B in February 2016. Compared to the Raspberry Pi 2 it has:

- A 1.2GHz 64-bit quad-core ARMv8 CPU
- 802.11n Wireless LAN
- Bluetooth 4.1
- Bluetooth Low Energy (BLE) 1GB RAM
- 4 USB ports

- Full HDMI port
- 40 GPIO pins
- Combined 3.5mm audio jack and composite video
- Camera interface (CSI)
- Display interface (DSI)
- Micro SD card slot
- Video Core IV 3D graphics core
- Ethernet port

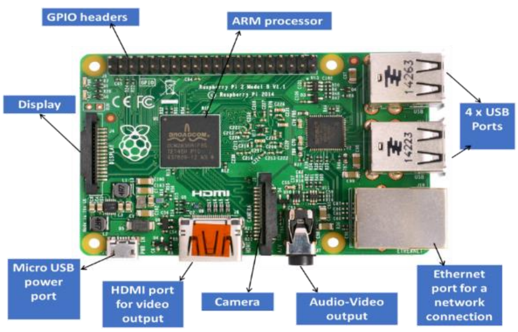


Figure 4.2: Raspberry Pi

4.2.2 4.2.2 MCP 3008 IC

Features:

- 10-bit resolution
- ± 1 LSB max DNL
- ± 1 LSB max INL
- 4 (MCP3004) or 8 (MCP3008) input channels
- On-chip sample and hold
- SPI serial interface (modes 0,0 and 1,1)
- Single supply operation: 2.7V - 5.5V
- Low power CMOS technology
- 5 nA typical standby current, 2 µA max.
- 500 µA max. active current at 5V

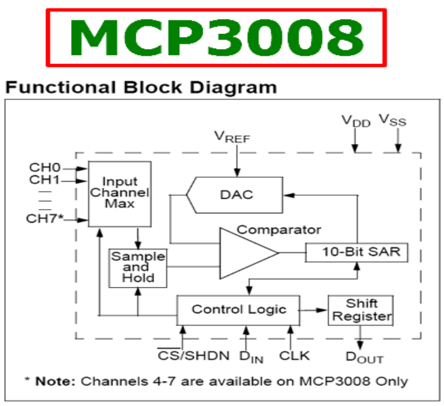


Figure 4.3 : Functional block diagram of MCP 3008

4.2.3 PH sensor

Need to measure water quality and other parameters but haven't got any low cost pH meter? Find it difficult to use with Raspberry Pi? Here comes an analog pH meter, specially designed for Raspberry Pi controllers and has built in simple, convenient and practical connection and features. If pre-programmed, you will get the pH value easily. Comes in compact plastic box with foams for better mobile storage.

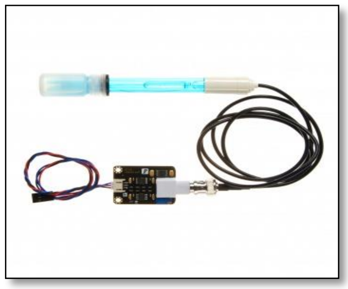


Figure 4.4: PH Sensor

Equation of PH Sensor:

Ph level = Ph level*0.0193

PH = Ph – 1.889

- Applications
  - Water quality testing
  - Aquaculture
  - Specification
  - Module Power : 5.00V
  - Measuring Range:014PH
  - Measuring Temperature :0-60
  - Accuracy : ± 0.1pH (25 °C)
  - Response Time : ≤ 1min
  - Gain Adjustment Potentiometer

4.2.4 DS18B20 Temperature Sensor

This is a pre-wired and waterproofed version of the DS18B20 sensor. Handy for when you need to measure something far away, or in wet conditions. While the sensor is good up to 125°C the cable is jacketed in PVC so we suggest keeping it under 100°C. Because they are digital, you don't get any signal degradation even over long distances! These 1-wire digital temperature sensors are fairly precise

(±0.5°C over much of the range) and can give up to 12 bits of precision from the onboard digital-to-analog converter.

Equation of Temperature sensor:

T =temp/ 1000

- **Technical Details**

- Stainless steel tube 6mm diameter by 30mm long
- Cable is 36" long / 91cm, 4mm diameter
- Contains DS18B20 temperature sensor
- If your sensor has four wires - Red connects to 3-5V, Black connects to ground and White is data. The copper wire is soldered to the wire shielding
- Unique 64 bit ID burned into chip
- Multiple sensors can share one pin

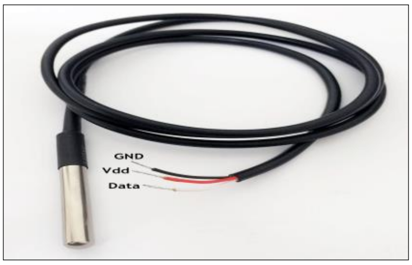


Figure 4.5: DS18B20 Temperature Sensor

4.2.5 Turbidity Sensor

Turbidity is a measure of the cloudiness of water. Cloudiness is caused by suspended solids (mainly soil particles) and plankton (microscopic plants and animals) that are suspended in the water column. Moderately low levels of turbidity may indicate a healthy, well-functioning ecosystem, with moderate amounts of plankton present to fuel the fuel the food chain. However, higher levels of turbidity pose several problems for stream systems. Turbidity blocks out the light needed by submerged aquatic vegetation.

Equation of Turbidity sensor:

Vtg = tb * 0.0048875

TB=100.00 – (vtg / 2.41)*100.00

Backscattering). Potable water, for example, should not have turbidity exceeding 0.5 NTU. There is growing need for a turbidimeter for use in the detection of algae or other ocean borne particles in the context of environmental monitoring and especially in fish farms. Turbidimeteris useful to the port authorities in general and can be integrated into existing oceanographic metering buoys. Turbidimeter can be also used to monitor sediment and particle pollution. As the turbidimeter in discussion, called hereafter turbidity sensor 3612, in the context of this paper, is planned to be integrated in oceanographic metering buoys and other oceanographic instruments.

Figure 4.6: Turbidity Sensor

Turbidity as measured using photometric techniques is defined as «reduction of transparency of a liquid caused by the presence of undissolved matter.

4.2.6 Water Flow Sensor

YF-S201 Water Flow Sensor can be used to measure the flow of liquids in both industrial and domestic applications. This sensor basically consists of a plastic valve body, a rotor and a Hall Effect sensor.

Figure 4.3.6: Water flow Sensor

- **Features**
    - Working Voltage: 5 to 18V DC (min tested working voltage 4.5V)
    - Max current draw: 15mA @ 5V
    - Output Type: 5V TTL
    - Working Flow Rate: 1 to 30 Liters/Minute
    - Working Temperature range: -25 to +80?
    - Working Humidity Range: 35%-80% RH

- Accuracy: ±10%
- Output fall time: 0.18us
- Flow rate pulse characteristics: Frequency (Hz) = 7.5 * Flow rate (L/min)

V. METHODOLOGY AND IMPLIMENTATION

Water quality monitoring system project base on hardware and software. There are different types of hardware required like Raspberry pi 3B module and sensors like ph sensor, turbidity sensor, temperature sensor and water flow sensor and software like Raspbian, python, pcb artist and win32 disk imager.

5.1 CIRCUITE DIAGRAM

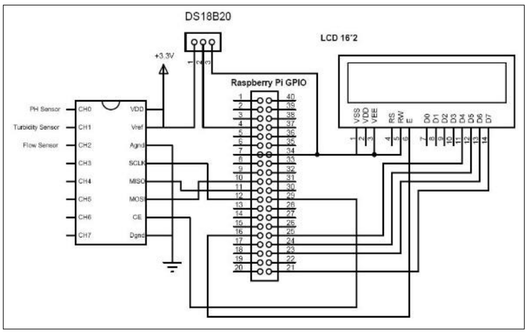


Figure 5.1: Circuit Diagram

- The pH sensor, turbidity sensor and flow sensor are connected to the MCP 3008 analog to digital converter.
- As we know raspberry pi 3B has 40 GPIO pins. The GPIO means general purpose input output.
- The Raspberry Pi has no built in analogue inputs which mean it is a bit of a pain to use many of the available sensors.
- The MCP3008 is a 10bit 8-channel Analog-to-digital converter (ADC).
- It is cheap, easy to connect and doesn't require any additional components.
- It uses the SPI bus protocol which is supported by the Pi's GPIO header.
- This particular chip makes use of the SPI (Serial Peripheral interface bus) which means it will only require 4 pins and is relatively easy to communicate to thanks to the SPIDev library for python.
- The CH0->CH7 pins (Pins 1-8) are the analog inputs for the MCP3008.
- The MCP3008 connects to the Raspberry Pi using a SPI serial connection.
- You can use either the hardware SPI bus, or any four GPIO pins and software SPI to talk to the MCP3008.
- Software SPI is a little more flexible since it can work with any pins on the Pi, whereas hardware SPI is slightly faster but less flexible because it only works with specific pins.
- These are the analog sensor, which means they gives an analog output of sensing parameters.
- Hence they are connected to the MCP3008 IC, which will be converted into the digital value when read by the raspberry pi.
- The LCD is connected to GPIO pins of raspberry pi directly.
- No intermediate is require to connect to LCD with raspberry pi. DS18B20 temperature sensor is works on the base of one wire communication, hence it is connected to GPIO 4 pin which has inbuilt one wire communication function.
- Here we connect the 1 ohm resistance for controlling the brightness of the LCD display.
- Brightness is inversely proportional to the resistance connected across the LCD.

5.2 DEVOLOPEMENT OF LOGIC FOR SENSOR AND IOT

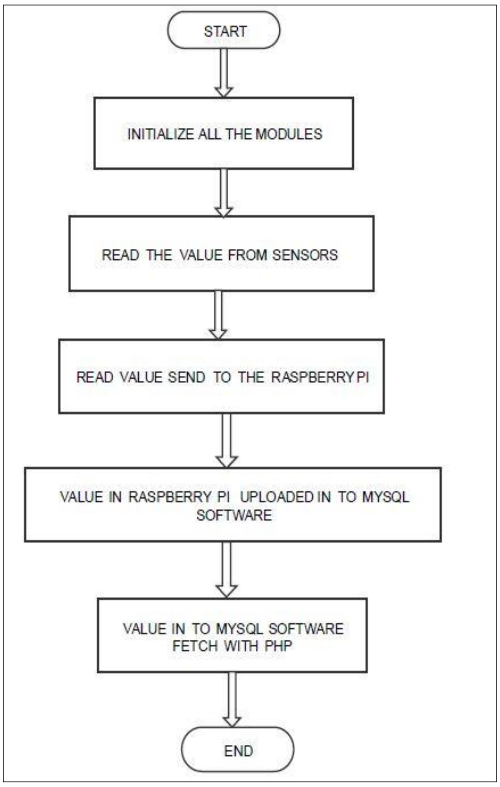


Figure 5.2: Data Flow Diagram

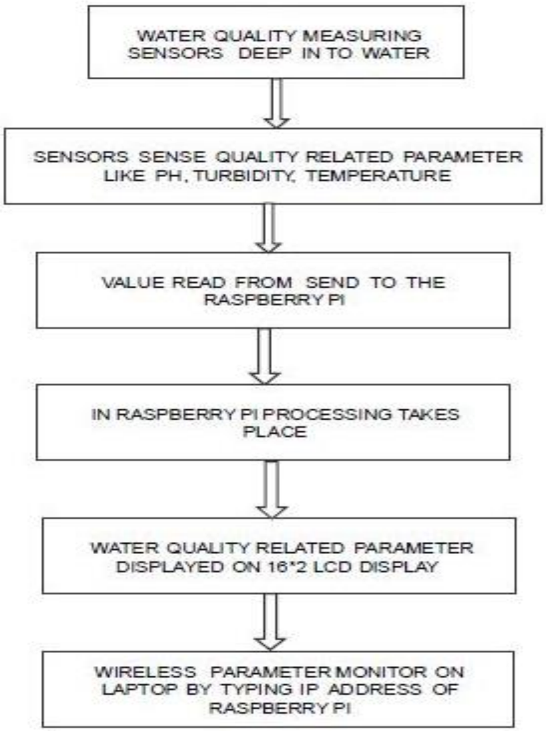


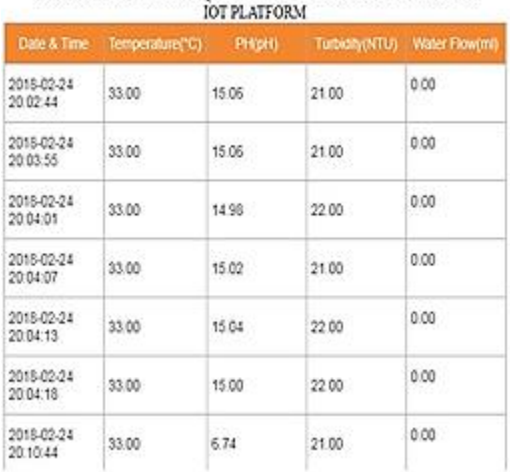
Figure 5.3: Project Flow

VI. RESULT ANALYSIS

The Water quality monitoring is important not only for the water department, it is low cost system this system can be used by the common people who care about the water, and it is useful to know whether the water is good for drinking etc. Such application need separate methods for water quality management. Setup of project is shown below.

Figure 6.1: Project Setup

This figure shows Turbidity sensor, Temperature sensor, PH sensor and water flow sensor are connected to the Raspberry pi board .These Sensor will read the value and stores them in the raspberry pi. The Raspberry pi will upload these values on website with the use of internet.



THE REAL TIME WATER QUALITY MONITORING SYSTEM BASED IOT PLATFORM

Date & Time	Temperature(°C)	PH(pH)	Turbidity(NTU)	Water Flow(ml)
2018-02-24 20:02:44	33.00	15.06	21.00	0.00
2018-02-24 20:03:55	33.00	15.06	21.00	0.00
2018-02-24 20:04:01	33.00	14.98	22.00	0.00
2018-02-24 20:04:07	33.00	15.02	21.00	0.00
2018-02-24 20:04:13	33.00	15.04	22.00	0.00
2018-02-24 20:04:18	33.00	15.00	22.00	0.00
2018-02-24 20:10:44	33.00	6.74	21.00	0.00

Figure 6.2: Result Window

The results are shown in the system screen. The data from the nodes will be continuously monitored to the central station.

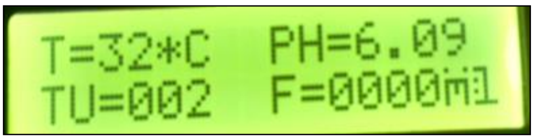


Figure 6.3: Results on LCD

Above Fig. 6.5 show result on LCD of system. From above reading it is conclude that quality of water is good. Because water temperature is normal and Ph of surface water with in the range 6 to 8.5 and turbidity is less than 10.

VII. CONCLUSION

From the above work it can be concluded that the system is ready for the analysis. The interfacing of hardware is in properly working condition with accuracy. We get the result of some parameter at the output such as PH, temperature, turbidity and flow of water. In view of an investigation of existing water quality observing framework and situation of water we can state that management is more appropriate to screen water quality parameters continuously. This project is very useful for monitoring the various water sample in industry, we can observe the result very accurate. System is easy to handle, low cost with precise output. Project presents remote sensor organizing utilizing a few sensors to quantify water quality, microcontroller and IOT module which influence sensor to arrange straightforward, ease and all the more proficiently.

VIII. REFERENCES

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