

TO DESIGN TAMPER RESISTANT HARDWARE BASED EMBEDDED SYSTEM

Project report submitted in partial fulfillment of the requirement for the degree of Bachelor of
Technology

in

Computer Science and Engineering/Information Technology

By

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Candidate's Declaration

Hereby, I declare that the work done in this report entitled "**TAMPER RESISTANT HARDWARE BASED EMBEDDED SYSTEM**" in partial fulfillment of the requirements for the degree of **Bachelor of Technology in Computer Science and Engineering/Information Technology** submitted in the department of Computer Science & Engineering and Information Technology, Jaypee University of Information Technology Waknaghat is an authentic record of my own work carried out over a period from August 2016 to December 2016 under the supervision of **Ms.Ruchi Verma** .
The matter presented in the report has not been submitted for the award of any other degree or diploma.

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This is to certify that the above statement made by the candidate is true to the best of my knowledge.

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Dated: 1-5-2017

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ABSTRACT

The conventional method of checking impurity in water is to collect those samples by hand and then forward them to laboratory for further testing and analysis. Even then, it has not been able to match up with the requirements of “water quality monitoring” in day to day life. The continuous increasing rate of water pollution makes the quality of drinking water very vulnerable and poses a major threat to human life.

The Ministry of Drinking Water and Sanitation claimed that, in year 2012 three thousand eight hundred and eighty three people died. These casualties were because of the diseases caused due to consumption of contaminated water.

This clearly indicates that the need of the hour is to make each and every household in the country aware of consuming clean water. Therefore this project aims to provide to the users a simple interface (android application) that indicates the purity of water being consumed. This project uses the concept of Internet Of Things(IoT) to remotely control the flow of water and water conductivity to determine the contamination level(parts per million) in the water being consumed.

So a set of closely linked modules for testing the “water quality” has been flourished. The arrangement basically consists of –a water quality testing module, - an information transmission module, -a monitoring center and other related modules. The flow and purity of water are detected automatically and displayed on the application under the continuous control of the system. Therefore making it very easy for the management to take actions in a punctual manner and to detect the quality of water in real-time.it was made to operate remotely. The arrangement has done the automation of “water quality monitoring” intelligence of analyzing data and transferring of information.

Chapter-1 INTRODUCTION

1.1 Introduction

Tamper resistance can be defined as the process of trying to prevent or offer resistance to any form of tampering. Tampering is the process of malfunctioning or sabotaging something. Now it can either be intentional or unintentional .Tampering can be implemented by:

- The users of any product or system
- Other users who have physical access to the product or system

This project takes into consideration “water tampering” which means that this project deals with finding out the internal tampering in water in the form of contamination and then further warning the users if the water is contaminated above a set threshold level.

The project uses the concept of Internet of Things (IoT) which can be defined as a system of interrelated computing devices and the ability to transfer information through a network without any human to computer interaction or any human to human interaction.

The user starts by turning on the “SmarTank” application i.e. an android application. The application offers a simple interface through which the user can remotely turn on the water tank. By clicking the ON button on the application, the water contamination sensor comes into play and checks the level of water contamination (parts per million).A threshold of 150 ppm has been set in the program. If the output in ppm is greater than 150, then it means that the water is unsafe for drinking. In this case a message is displayed on the application warning the user about the water not being fit for consumption and also the tank automatically does not dispense the water. And if not then a warning is sent to the user on the application and the unsafe water is not dispensed.

1.2 Problem Statement

With the fast pace of the developing economy and serious issues like urbanization and migration, problems regarding the environment are on its zenith. Degrading water quality is one of these issues.

The conventional method of checking impurity in water is to collect those samples by hand and then forward them to laboratory for further testing and analysis. Even then, it has not been able to match up with the requirements of “water quality monitoring” in day to day life. The continuous increasing rate of water pollution makes the quality of drinking water very vulnerable and poses a major threat to human life.

So, the need of the hour is to devise such a system that continuously monitors the water quality and informs the user whether the water is safe for consumption or not.

Also the system should be simple and convenient to use so that all users can handle it remotely over the network.

1.3 Objectives

This project aims at providing clean drinking water to the consumer by remotely controlling the flow of water and determining the contamination level in the water being consumed and also not dispensing the water if the contamination in the water above a set threshold(that is when the water is unsafe for drinking).

1.4 Methodology

Monitoring water quality by using the concept of water conductivity. A self made sensor based on the concept; more the contamination (parts per million), more conducting particles

present in water leading to more flow of current through it. Hence contaminated water allows more current to flow through it.

TDS basically means the measurement of the amount of salts in a solution. Many a times the amount of salt indicates the levels of auxiliary particles in a given solution. TDS/PPM meters calculate the amount of salt in the units- Parts per Million by the measurement of the Electrical Conductivity of the solution under test. Therefore a PPM or a TDS meter can be defined as an EC meter whose function is to convert the EC value into PPM values.

EC basically is a measure of Electrical Conductivity using two probes that are somewhat 1cm apart. One EC is equal to one microsiemens. So in order to convert EC to Siemens we multiply EC by $(1E-6)$ and on multiplying EC by 500 we can convert it into PPM.

500 is a conversion factor used for conversion between PPM and EC. Different salts have different conversion factors due to different conductance. NaCl's conversion factor i.e. 500 is used as it is the most common standard.

Since EC or PPM is a measure of the Conductance, therefore a volt meter can also be used directly because they pass a DC (direct) current through the probes. It is not possible to measure the conductivity of salts (with DC current) as it will split the molecules further, and since the molecules are the conductors of electricity you get a reading that is constantly changing. This can be overcome by using an AC (alternating) signal. If the frequency is high enough (>1 kHz) the molecules will not get the apt time to move away before they are pulled in the alternate direction.

1.5 Organization

Monitoring of water contamination is designed and developed using a simple interface of an android application named as "SmarTank".

The user can remotely control the water tank using the application. When the user switches on the tank the control passes on to the self made sensor which monitors the current flow indicating the purity level. If impure the water will not be dispensed else the water is dispensed and count is monitored by using the flow sensor.

Chapter-2 LITERATURE SURVEY

2.1 Research papers

2.1.1 Designing of a Low-cost Autonomous system for Water Quality Monitoring System

2.1.1.1 Abstract

Good water quality is essential for healthy aquatic ecosystems. Constant monitoring of water quality is a very important tool to provide real-time data analysis for environment protection, management authorities and tracking the pollution resources. However, the process of continuous monitoring of water quality at high spatial and temporal resolution is expensive. So there is a need of an aquatic monitoring system which is affordable that will be able to enable water quality data collection that is cost-effective, and help catchment managers for the maintenance of the well being of oceanic ecosystems. This presents a cost - effective and wireless physio-chemistry sensing system for water. The results of this system indicate that with proper calibration, a dependable monitoring system can be established, allowing the catchment managers to constantly monitor the quality of the water at greater spatial resolution, and to maintain it over a long period of time. Also, it helps to analyze the behavior of marine animals relative to water pollution with the use of data analysis.

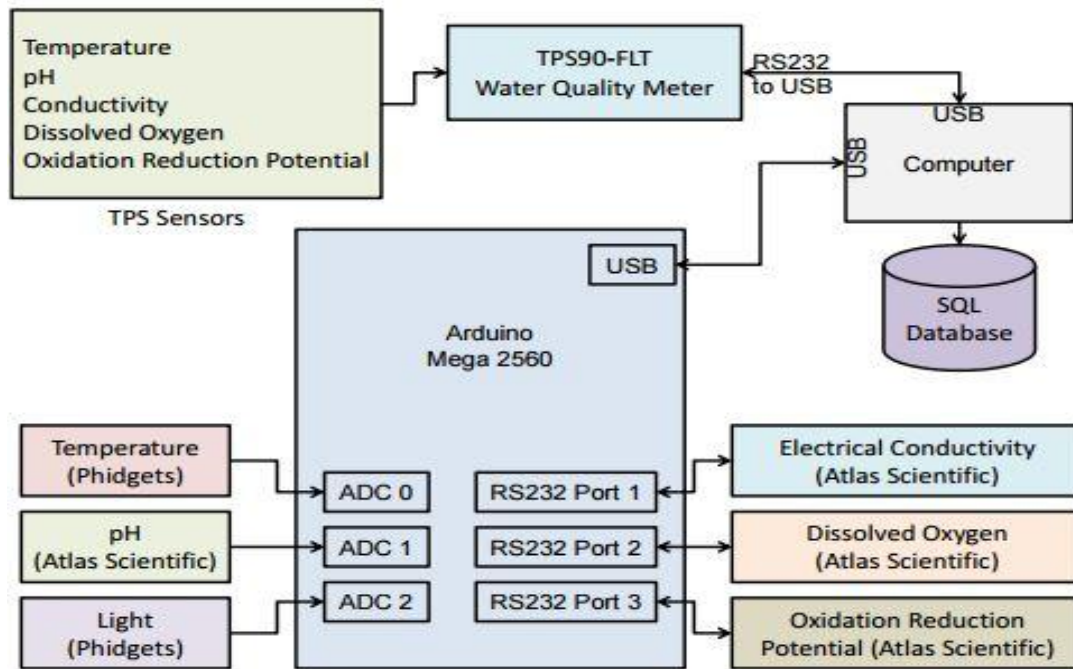


Fig. 1

2.1.1.2 Information about Sensors

1) pH: The given system basically uses pH sensors from Phidgets for measuring the full range of pH that is 0 - 14 and operates in the temperature range of 0 ° to 80° C. The sensor is ended via BNC connection. “Phidgets” also acts as a supplier of adaptor in order to convert BNC to analog voltage after sensing. This adaptor uses the pH sensor data that is read at Arduino analog pin.

2) Light: as in the pH sensor, light sensor from Phidgets is used in the prototype which can operate at 3.3Volts and 5Volts. In the system all the sensors are being operated at

5Volts.Light intensity range can be measured from 0 to 1000 lx and sensor output is “non-ratio metric”.

- 3) Temperature: temperature sensor used here is from Atlas Scientific, having a wide temperature range of -20° - 133° C, with accuracy of ± 1 C and can operate up to 5.5V. The reason behind choosing it is a field-ready temperature and as it is water tight and nonreactive to the salt waters that are very important properties for sensors placed in water. This sensor is connected directly to the Arduino analog pin.
- 4) Electrical Conductivity: the Scientific-grade platinum conductivity sensor from Atlas Scientific is used for electrical conductivity with $K = 1$. This sensor measures the conductivity starting from 1, 300 to 40, 000 μS .

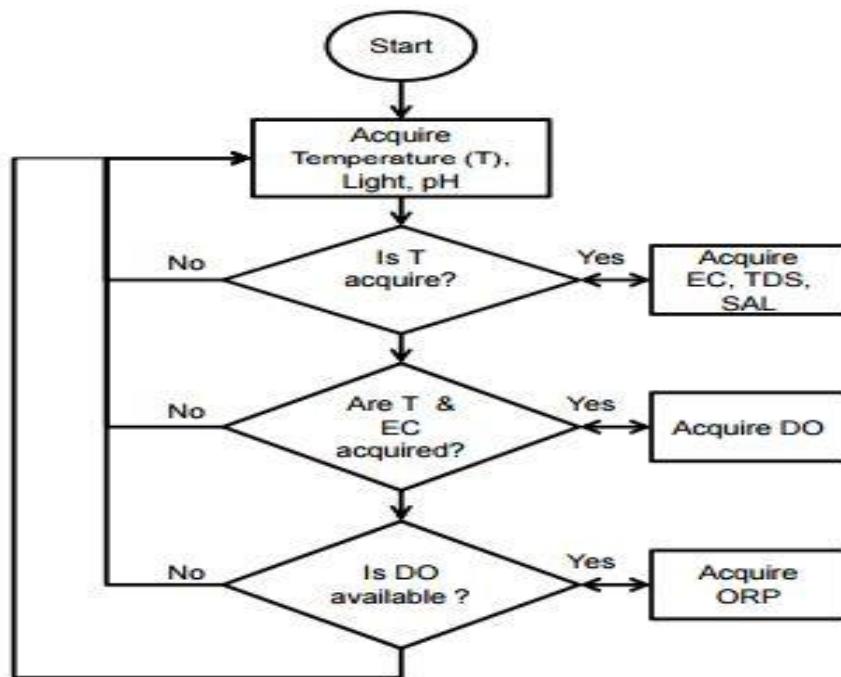


Fig. 2

2.1.1.3 Conclusion

The system is apt for field deployment for providing constant long term water quality measurement, either as a stand-alone instrument or a component of the alarm biosensor.

2.1.2 Study of TDS Monitoring Using IoT

2.1.2.1 Abstract

With the growing modern technology and Android Smart phones, Smart water purifier is gradually changing the life of people. Wi-Fi technology, whose aim is to fetch notified data wirelessly in a short distance using system on chip that is integrated with TCP/IP protocol to give any microcontroller access to the Wi-Fi network which is providing an important technology to provide control ability, convenience and intelligence. This paper works towards the development of an android application interfaced with RO hardware and eventually notifying the TDS value of water on the hardware by using a Wi-Fi module. In the rapidly growing times of developing science and technology, people have also started producing those things which are very helpful for others. This project develops a system that measures TDS of an RO system in a smart way. There are sensors through which TDS is measured smartly and information is displayed on a Wi-Fi based application or on web server. The interaction between device and this system is through networking and using Micro-Controller. All messages are programmed and controlled by the Arduino Uno. The main control system implements wireless Wi-Fi technology giving remote access from any computer or smart phone.

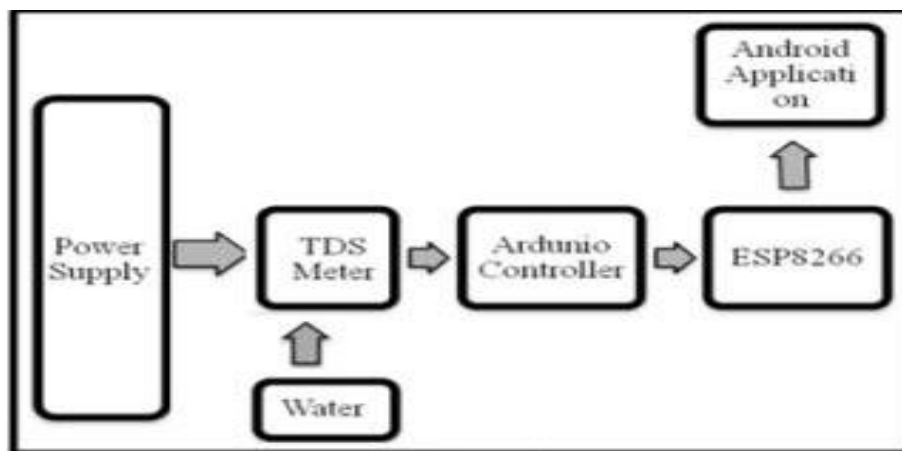


Fig. 3

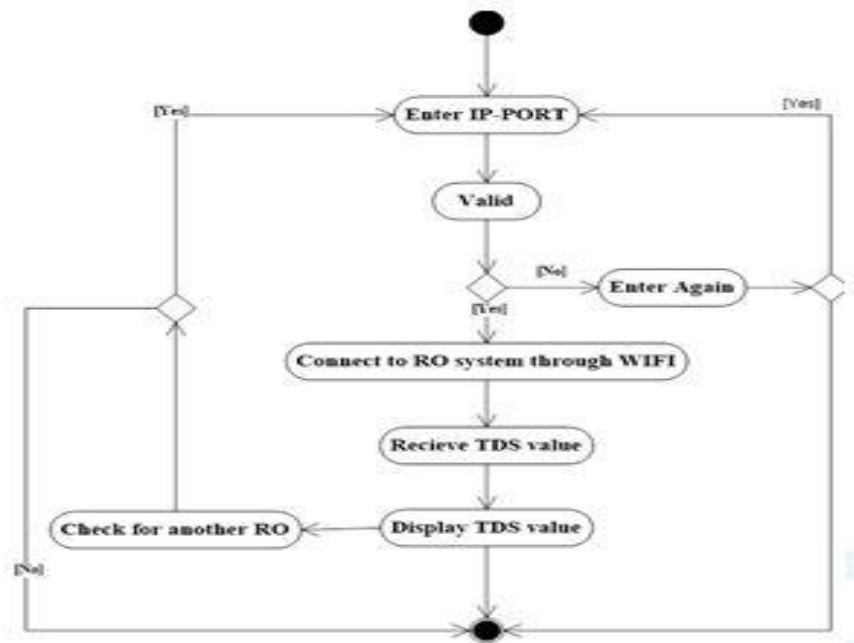


Fig. 4

2.1.2.2 Activity Diagram

1) If YES in application, then

- Connect to the RO system through Wi-Fi
- Receive TDS value
- Display the TDS value

2) If NO in application

- Enter IP-PORT detail again

3) Enter all details required further for checking the TDS values for another RO system

2.1.3. Raspberry Pi Based Liquid Flow Monitoring and Control System

2.1.3.1 Abstract

In industries there are many big pipelines carrying various types of liquids that might include corrosive liquids and flammable liquids. Therefore it is important to control the rate of flow of the liquid for advancing the processes and to prevent related accidents. This paper proposes a method to monitor and control the flow of liquid in the pipeline of industries through web server. There are various systems to do the same, but this one is to monitor and control the flow of liquid using the web with the help of “Raspberry pi” and “Arduino”. The flow rate of the liquid is measured using the Hall Effect sensor based flow meter. Arduino reads the pulses from the flow meter sending them to Raspberry pi, i.e. a microcomputer for controlling the electro valve that is connected to the pipeline.

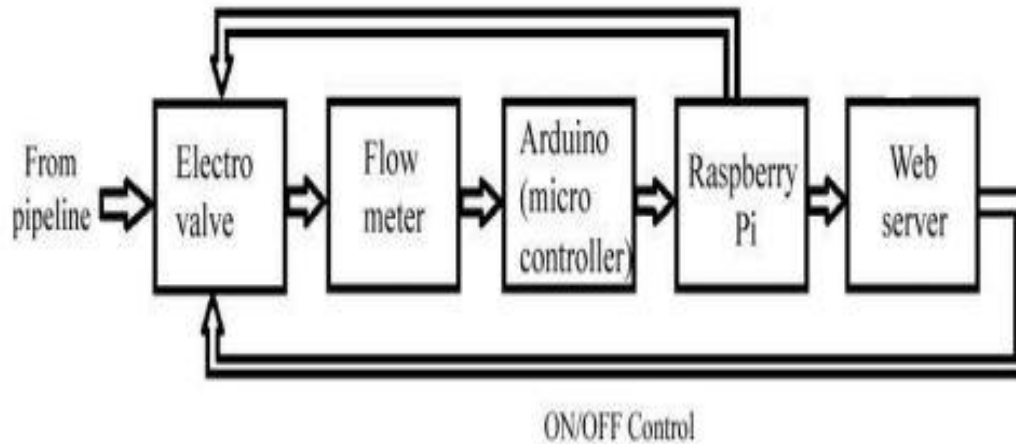


Fig. 5

The proposed system monitors the flows of liquid .Parts are:

- An electro-valve
- A flow meter

- A microcontroller microcomputer
- Web server.

2.1.3.2 Block diagram

For the measurement of the flow rate of the liquid, the sensor used is a Hall Effect sensor. Arduino act as microcontroller where as Raspberry Pi as a microcomputer. Electro valve is a device fitted to the pipeline where the flow is to be controlled. Electro valve is fitted with the flow sensor. The flow sensor measures the flow, generating an analog pulse. The flow sensor is connected to arduino to read the pulses from the flow sensor. Arduino reads the pulse from the flow sensor that is analog, sending the signal to the raspberry pi that controls the electro valve. The valve is further connected to the raspberry pi. Raspberry pi is programmed to collect the Arduino signal and to control this electro valve. It is also designed to act as a Web server by means of which the electro valve is controlled using the Local Area Network (LAN), or internet connection. Arduino is responsible to collect the data from the flow meter and send it to the raspberry pi. The Flow meter is directly interfaced with Arduino.



Fig. 6

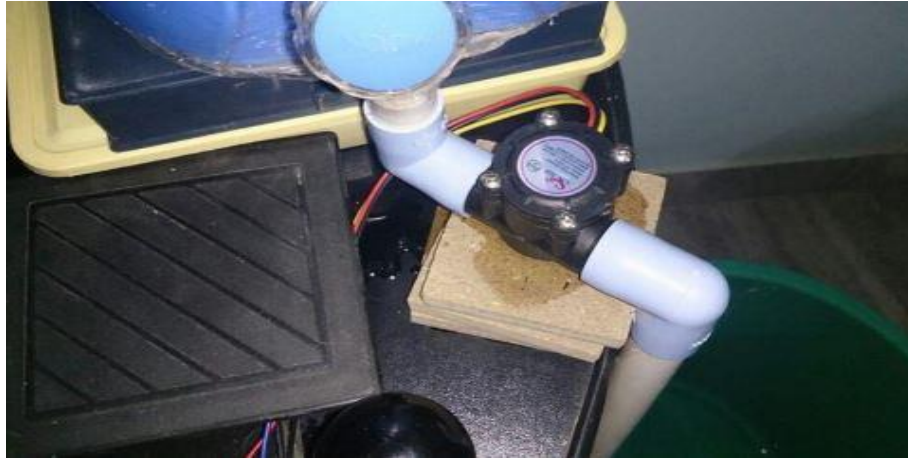


Fig. 7

2.1.4 Exploring IOT Application Using Raspberry Pi

2.1.4.1 Abstract

There are many sensors in an industry with different uses, such as, flow meter, pressure transmitters, level transmitters, temperature transmitters, etc. Wired networks are used to transfer the data to base station by the connecting sensors. It has an advantage as it provides stable and reliable communication system but the cables are very costly. So low cost wireless networks are the ones needed by customers. For example, temporary instrument networks, non-critical permanent sites that require low data rate and long battery life. In the client/server model, file server act as a parent node that allows multiple child nodes to interact with them. It is responsible for data management and central storage so that other computers can access the file under the same network. This system uses Raspberry Pi to function as a server where several laptops are connected to it to copy, save and remove the file over network. IT requires authentication of the user login before providing access to files to ensure data security and integrity. File server is widely used in various areas, for example in education to upload study note in the server and enabling students to immediately

download it into their computer. Also the system explores the use of Raspberry Pi B+ model and XBee to show communication data transmission that is wireless, therefore proving validity of usage as a low-power mobile wireless network communication. The basic purpose of this is to explore the method of using Raspberry Pi to do client-server communication using the wireless communication scenario such as Wi-Fi and ZigBee.



Fig.8

2.1.5. Raspberry Pi for Automation of Water Treatment Plant

2.1.5.1 Abstract

Clean water is a major human necessity. So, automation has a vital role in the reliable and safe operation of a water treatment plant for providing clean drinking water. This paper concentrates on intelligent and an innovative control and monitoring the system for Water Treatment Plant using Raspberry Pi as basically an alternative to the use of PLCs for the

automation of the water treatment plants. Raspberry Pi is basically a minicomputer that has an ability to control the system.

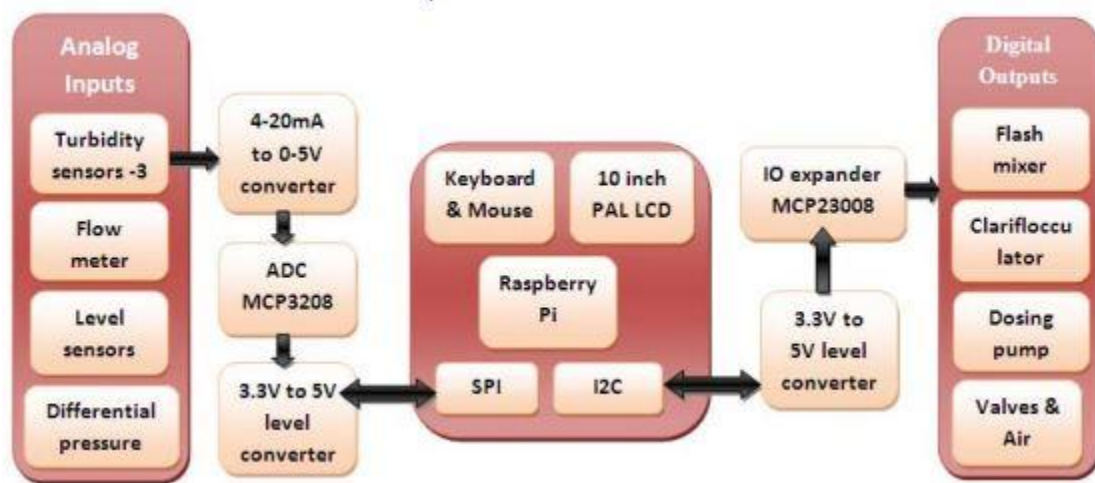


Fig. 9

2.1.5.2 Role played by Raspberry Pi in the Automation of Water Treatment Plant

Raspberry Pi has a set of general purpose input outputs or in short the GPIO pins. These pins are accessed for controlling various hardware devices such as LEDs, relays and motors, which are all outputs. In case of inputs, raspberry pi can read the status of switches, buttons, or various sensors. Some GPIO pins of Raspberry Pi have alternate function such as SPI, UART, and I2C etc. “Water treatment plant automation” involves different types of actuators, sensors and motors that can be connected with these pins.

Chapter-3 SYSTEM DEVELOPMENT

3.1 Water Contamination Sensor

To monitor water quality using the concept of water conductivity. A self made sensor based on the concept; more the contamination (parts per million) , more conducting particles present in water leading to more flow of current through it. Hence contaminated water allows more current to flow through it.

TDS basically means the measurement of the amount of salts in a solution. Many a times the amount of salt indicates the levels of auxiliary particles in a given solution. TDS/PPM meters calculate the amount of salt in the units- Parts per Million by the measurement of the Electrical Conductivity of the solution under test. Therefore a PPM or a TDS meter can be defined as an EC meter whose function is to convert the EC value into PPM values.

EC basically is a measure of Electrical Conductivity using two probes that are somewhat 1cm apart. One “EC” is equal to one microsiemens. So in order to convert EC to Siemens we multiply EC by $(1E-6)$ and on multiplying EC by 500 we can convert it into PPM.

500 is a conversion factor used for conversion between PPM and EC. Different salts have different conversion factors due to different conductance. NaCl's conversion factor i.e. 500 is used as it is the most common standard.

Since EC or PPM is a measure of the Conductance, therefore a volt meter can also be used directly because they pass a DC (direct) current through the probes .It is not possible to measure the conductivity of salts (with DC current) as it will split the molecules further, and since the molecules are the conductors of electricity you get a reading that is constantly

changing. This can be overcome by using an AC (alternating) signal. If the frequency is high enough (>1 kHz) the molecules will not get the apt time to move away before they are pulled in the alternate direction.

3.1.1 Requirement

- Three/two pin plug: only two pins are required, therefore in case of a three pin plug, one pin can be disconnected.
- 1K resistance : brown black red
- Connecting wires
- Arduino nano:

Arduino can be defined as an open source company used for manufacturing [microcontroller](#) kits that are meant to build interactive objects and digital devices that are capable of sensing and controlling objects in real time.

Arduino boards comprise a LED ([light-emitting diode](#)) and load resistor that is connected between the pin number 13 and ground. A basic program for a beginning Arduino programmer blinks an LED light repeatedly.

Arduino's program can be written in any [programming language](#) for a compiler that produces binary machine code for the target processor. Arduino [integrated development environment](#) (IDE) is what an Arduino project aims to provide. This is [cross-platform](#) that is written in the C programming language.

The Arduino Nano can be powered through a mini USB connection of 6 to 20Volts, either by an unregulated external power supply on pin number 30, or 5 Volts regulated external power supply on pin number 27. The source of the power is automatically selected to the highest voltage source.

The Arduino Nano is a tiny, complete board that is based on the Arduino Nano 3.x (ATmega328) or Arduino Nano 2.x (ATmega168).

Arduino reads the output value from the given analog pin. Arduino board contains 6 channel i.e, 8 channels on the Mini and Nano, 16 on the Mega, 10-bit analog to digital converter. therefore it will map input voltages between 0 - 5 volts to integer values between 0 -1023 yielding a resolution between readings of $5 \text{ volts} / 1024 \text{ units}$ or, .0049 volts (4.9 mV) per unit.

3.1.2 Working

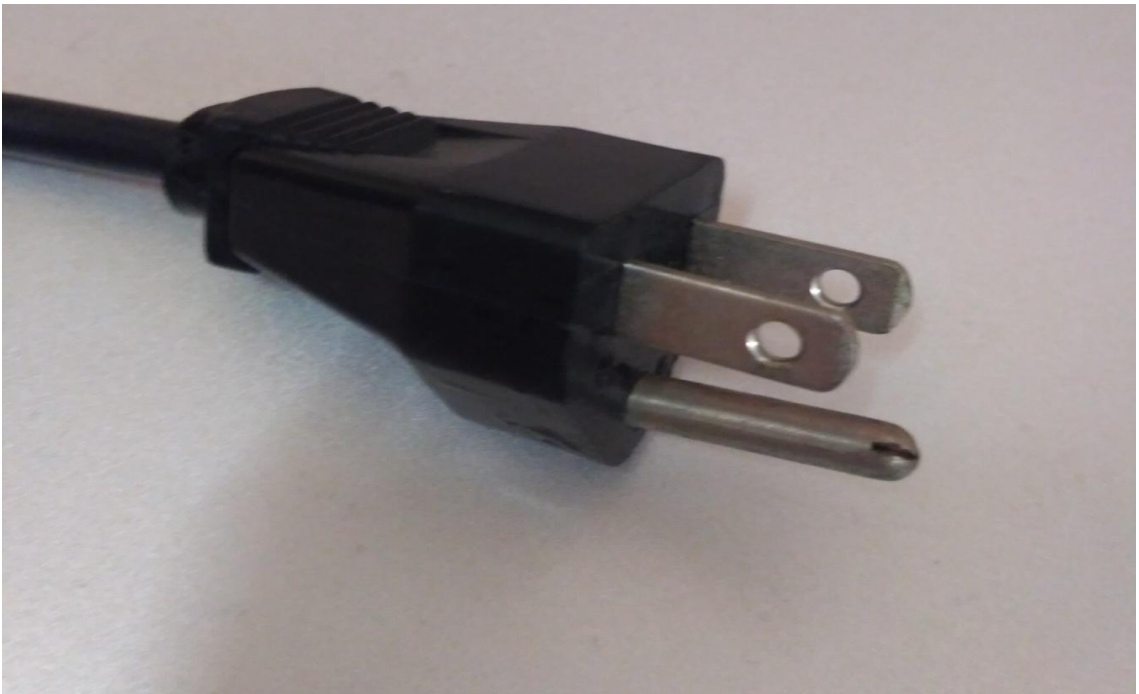


Fig.10

One pin of the plug is set as ground (A1) and voltage is applied on the second pin (A0) through the program using the pin A4. The resulting voltage is read at pin A0 by applying a resistance of 1k ohm between A1 and A4. The resistance is applied to prevent overloading. On applying voltage, current flows between the two pins of the plug. The contamination of water is determined by the rate of flow of current. Contamination level is directly proportional to the current.

TDS basically means the measurement of the amount of salts in a solution. Many a times the amount of salt indicates the levels of auxiliary particles in a given solution. TDS/PPM meters calculate the amount of salt in the units- Parts per Million by the measurement of the Electrical Conductivity of the solution under test. Therefore a PPM or a TDS meter can be defined as an EC meter whose function is to convert the EC value into PPM values.

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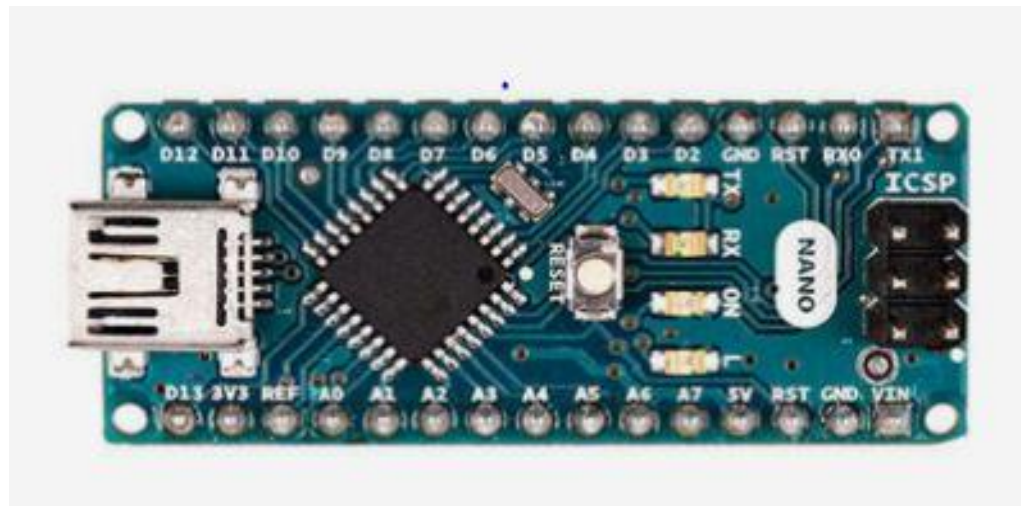


Fig. 11

ARDUINO NANO Version 3.0 Pin Layout

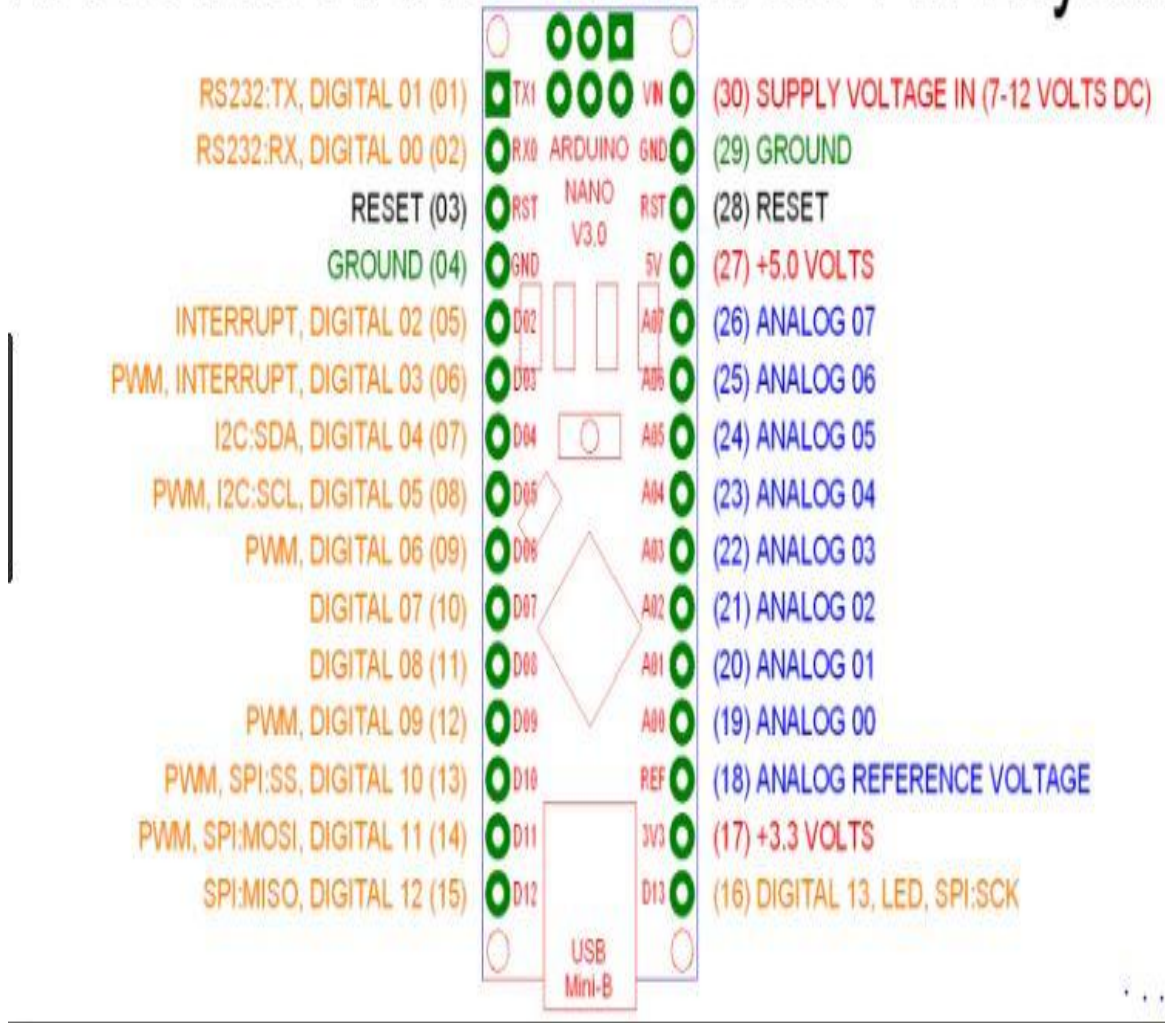


Fig. 11

3.2 Raspberry Pi3

3.2.1 Basic Information

The **Raspberry Pi** is a series of tiny [single-board computers](#) equivalent to the size of that of a credit card (approximately 9cm x 5.5cm). Also called a microcomputer since it functions as

a fully featured computer system with the only difference of its small size. It has following components:



Fig. 12

- Power supply 5V micro-USB power supply
- USB keyboard
- USB mouse —Bluetooth keyboard and mouse can also be used.
- microSD card — The microSD card must have at least 8 GB of storage.
- microSD USB card reader
- A monitor or TV that supports HDMI
- An HDMI cable also called as a composite video cable, depending on the type of screen one uses.

- An Ethernet cable— A connection to the Internet is not necessary for setup, but most of the Raspberry Pi projects requires web.

The GPIO pins on a Raspberry Pi are used to interface physical devices like LEDs and buttons.

Pin#	NAME		NAME	Pin#
01	3.3v DC Power		DC Power 5v	02
03	GPIO02 (SDA1 , I ² C)		DC Power 5v	04
05	GPIO03 (SCL1 , I ² C)		Ground	06
07	GPIO04 (GPIO_GCLK)		(TXD0) GPIO14	08
09	Ground		(RXD0) GPIO15	10
11	GPIO17 (GPIO_GEN0)		(GPIO_GEN1) GPIO18	12
13	GPIO27 (GPIO_GEN2)		Ground	14
15	GPIO22 (GPIO_GEN3)		(GPIO_GEN4) GPIO23	16
17	3.3v DC Power		(GPIO_GEN5) GPIO24	18
19	GPIO10 (SPI_MOSI)		Ground	20
21	GPIO09 (SPI_MISO)		(GPIO_GEN6) GPIO25	22
23	GPIO11 (SPI_CLK)		(SPI_CE0_N) GPIO08	24
25	Ground		(SPI_CE1_N) GPIO07	26
27	ID_SD (I ² C ID EEPROM)		(I ² C ID EEPROM) ID_SC	28
29	GPIO05		Ground	30
31	GPIO06		GPIO12	32
33	GPIO13		Ground	34
35	GPIO19		GPIO16	36
37	GPIO26		GPIO20	38
39	Ground		GPIO21	40

Fig. 13

3.2.2 Language used: Python

Python is an interpreter, high-level, interactive and object-oriented scripting language. It is designed keeping in mind the fact that it should be highly readable. English keywords are used frequently in place where other languages use punctuation, and also it has lesser syntactical restrictions in comparison to other languages.

3.3 RELAY

A relay is a driver circuit which can operate or drive a relay in order to function appropriately in a circuit. The driven relay can also operate as a switch in the circuit that can open or close, depending on the needs of the circuit and its operation.

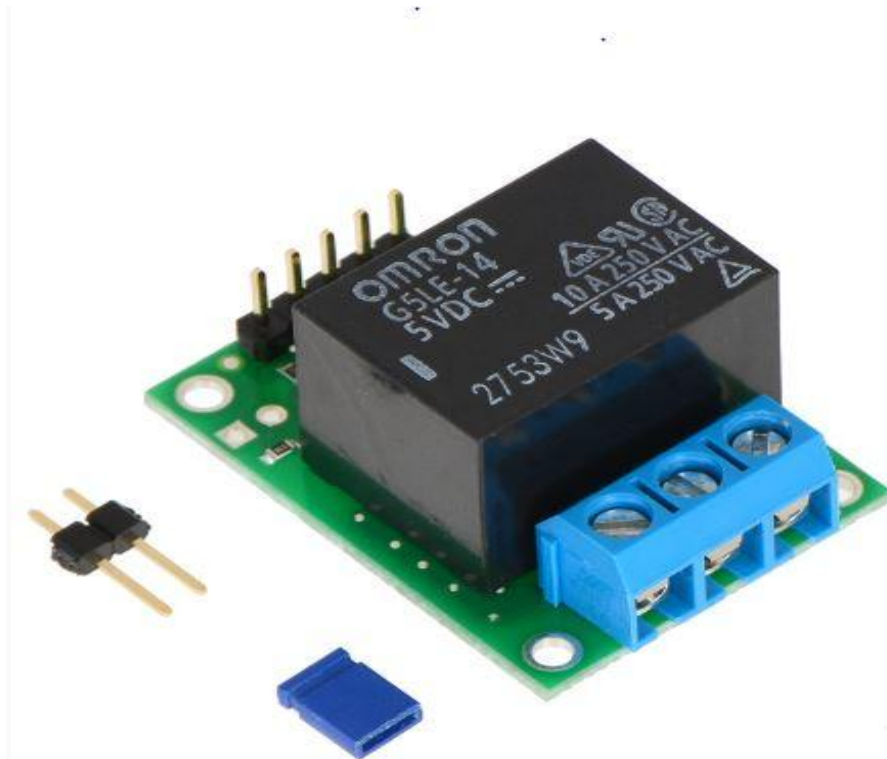


Fig. 14

3.4 Water flow sensor

Water flow sensor is used for measuring water flow in terms of pulses generated by water that flows through it. It is made up of a plastic valve body, a water rotor, and a hall-effect sensor. The rotor present inside the flow sensor rotates with the pressure of the water flow. The speed is determined by the rate of flow of water passing through it. The third part of the flow sensor i.e. the Hall Effect sensor is responsible for giving the output in the form of pulse signals.



Fig. 15

3.5 Submersible pump

A submersible pump or an electric submersible pump, is a pump capable of being fully submerged in water. The motor is properly sealed and closely coupled/attached to the body of the pump.

It pushes water to the surface by the conversion of rotary energy to kinetic energy into pressure energy, which is done by the water being pulled into the pump as follows:

- Water is taken in the pump, where the rotating impeller forces the water through the diffuser and from there, it goes to the surface.

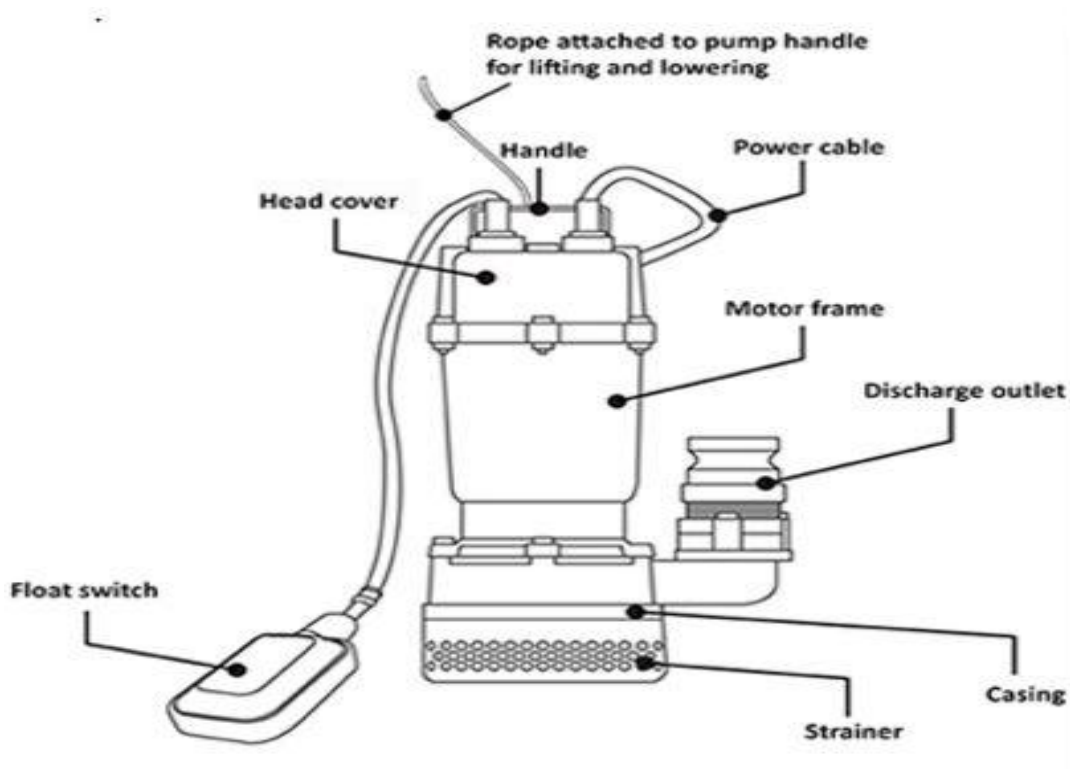


Fig. 16

3.5.1 Advantages

- The major advantage is that there is never a need to prime the pump, as it is already submerged in the fluid.
- [Submersible pump is very efficient](#) as energy is not wasted for moving water into the pump. The pressure of water pushes the water into the submersible pump, thus saving a lot of the pump's energy.
- Submersible pumps do not generate much sound as they are under water.

3.5.2 Disadvantages

There are a few disadvantages of submersible pumps.

- The seals can corrode with time and when this happens, water seeps into the motor, making it useless until it is repaired
- The Seal makes it difficult to repair the pump.
- One pump does not fit all uses, [pumps can either work with thin liquids](#) like water, or viscous ones like sewage.
- Selection of pump certainly is versatile. Some can easily handle solids, while others are better for liquids only

Caution - they must be fully submerged as the surrounding water around the pump helps to cool the motor. Else it can overheat



Fig. 17

3.6 BLOCK DIAGRAM

The flow is given below

1. WATER SOURCES
2. WATER TANK
3. ALERT SYSTEM
4. DISTRIBUTION OF WATER

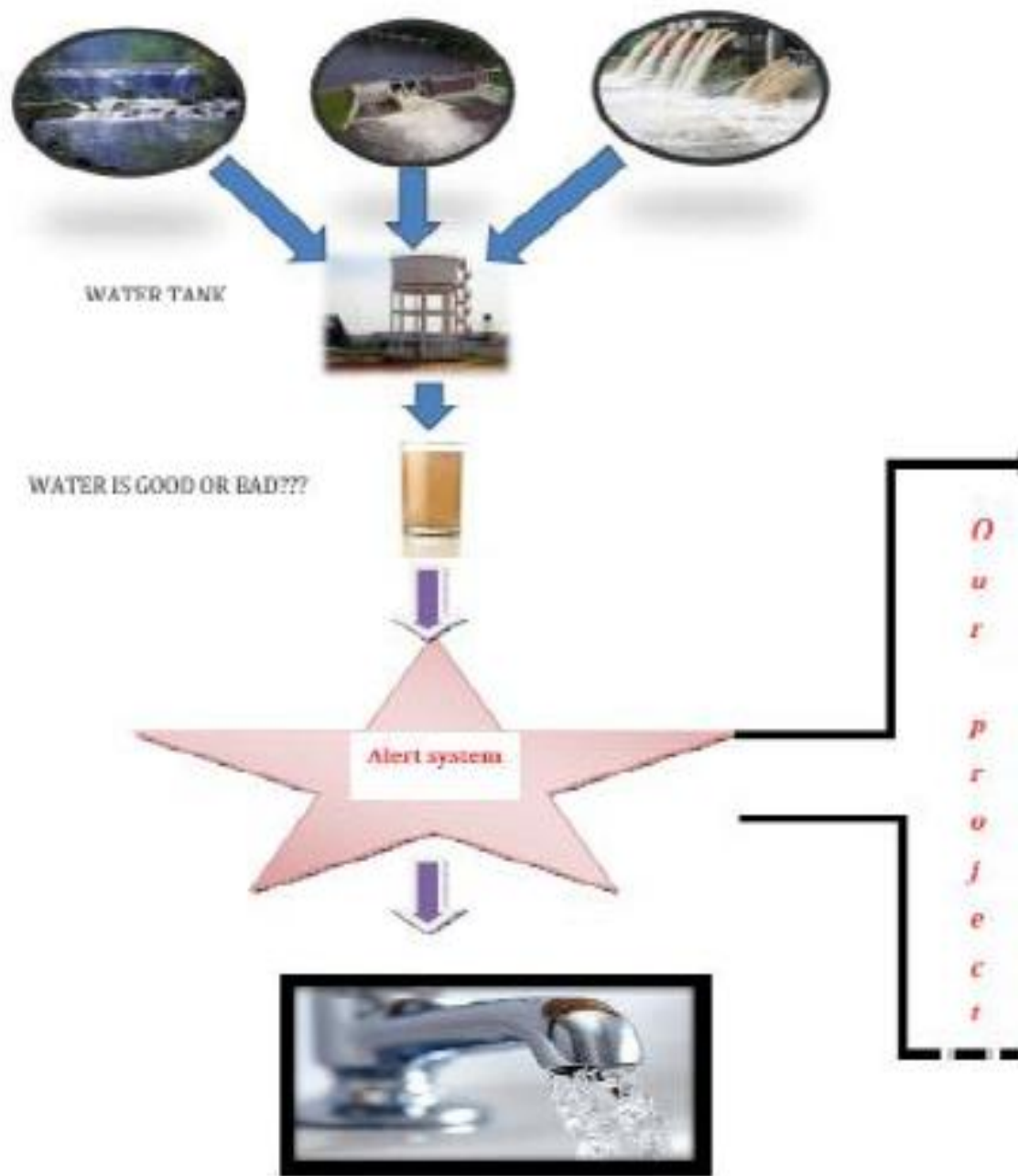


Fig.18

3.6.1 Our Process (working of the model):

The user starts by turning on the SmarTank application i.e. an android application. The application offers a simple interface through which the user can remotely turn on the water tank. By clicking the ON button on the application, the water contamination sensor comes into play and checks the level of water contamination (parts per million). A threshold of 150 ppm has been set in the program. If the output in ppm is greater than 150, then it means that the water is unsafe for drinking. In this case a message is displayed on the application warning the user about the water not being fit for consumption and also the tank automatically does not dispense the water.

If the output is less than 150ppm, then the water is safe for drinking. In this case the water is dispensed with the following mechanism:

The output of Arduino nano that indicates the purity of water is given as input to the raspberry Pi. If the water is safe for drinking then the program switches on the water motor than starts dispensing the water. As soon as the water starts to flow the program detects the flow and `countpulse()` is called. This method starts to measure the amount of water that is being dispensed, therefore displaying the amount of water dispensed in litres on the application.

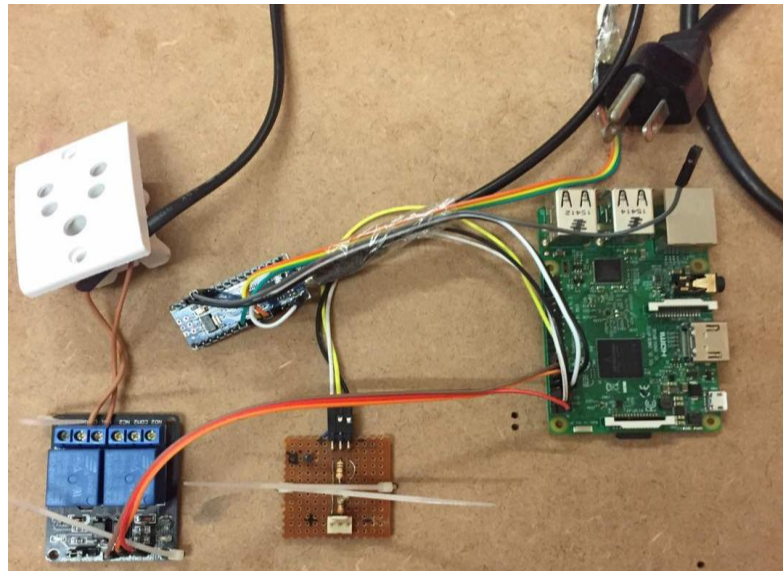
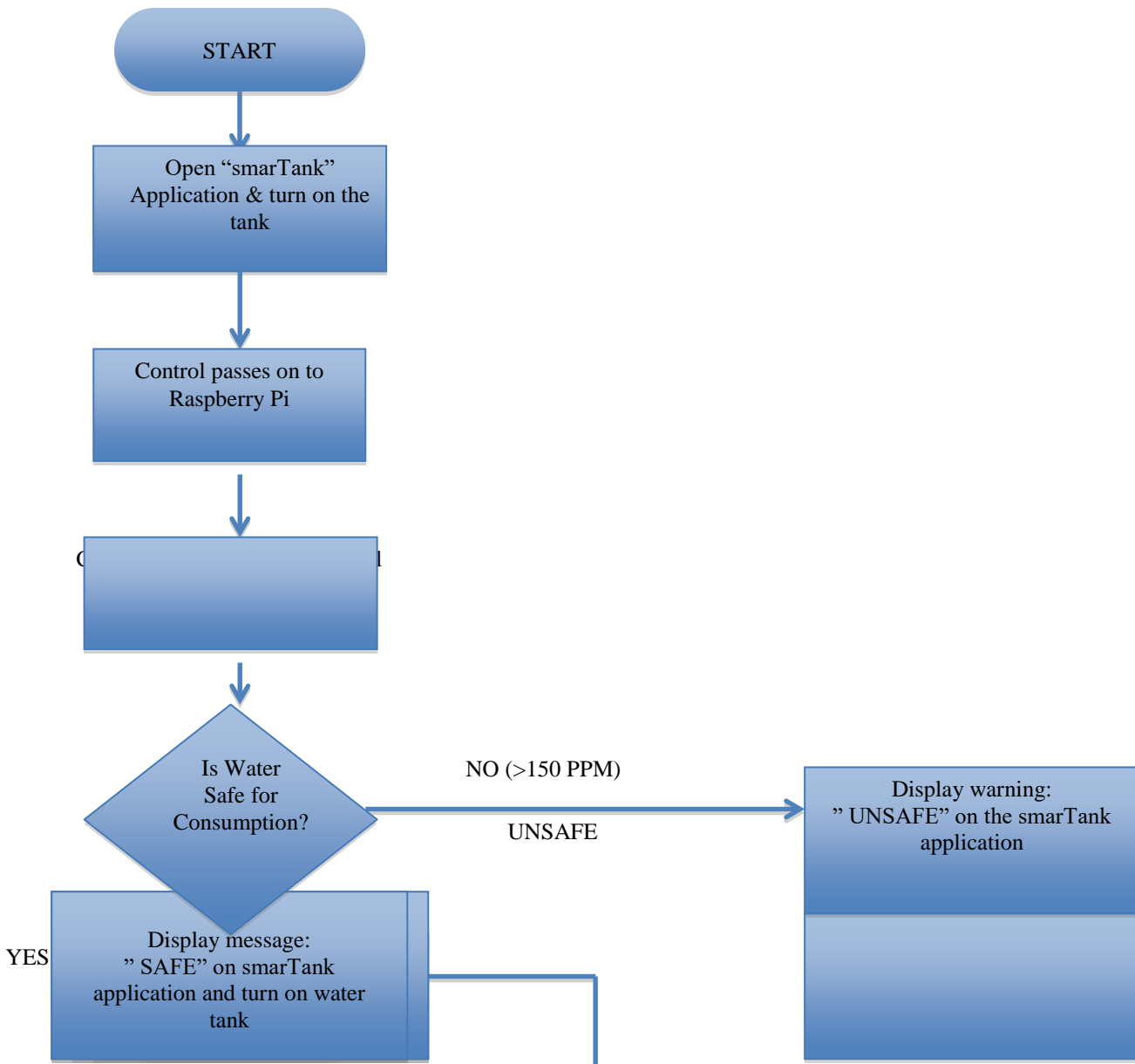


Fig.19



Fig,20



ARDUINO NANO CODE

```
#include <DallasTemperature.h>
int R1= 1000;
int Ra=25; //Resistance of powering Pins
int ECPin= A0;
int ECGround=A1;
int ECPower =A4;

//***** Converting to ppm [Learn to use EC it is much better*****//
// Hana [USA] PPMconversion: 0.5
// Eutech [EU] PPMconversion: 0.64
//Tranchen [Australia] PPMconversion: 0.7
// Why didnt anyone standardise this?

float PPMconversion=0.5;

//*****Compensating for temperature
*****//
//The value below will change depending on what chemical solution we are measuring
//0.019 is generally considered the standard for plant nutrients [google "Temperature
compensation EC" for more info
float TemperatureCoef = 0.019; //this changes depending on what chemical we are measuring

//***** Cell Constant For Ec Measurements
*****//
//Mine was around 2.9 with plugs being a standard size they should all be around the same
```

//But If you get bad readings you can use the calibration script and fluid to get a better estimate for K

//float K=2.88;

float K=0.98;

//***** Temp Probe Related

*****//

#define ONE_WIRE_BUS 10 // Data wire For Temp Probe is plugged into pin 10 on the Arduino

const int TempProbePositive =8; //Temp Probe power connected to pin 9

const int TempProbeNegative=9; //Temp Probe Negative connected to pin 8

//***** END Of Recomend User Inputs

*****//

OneWire oneWire(ONE_WIRE_BUS);// Setup a oneWire instance to communicate with any OneWire devices

DallasTemperature sensors(&oneWire);// Pass our oneWire reference to Dallas Temperature.

float Temperature=10;

float EC=0;

float EC25 =0;

int ppm =0;

float raw= 0;

float Vin= 5;

float Vdrop= 0;

float Rc= 0;

```
float buffer=0;
```

```
//*****Setup - runs Once and sets pins etc
```

```
*****//
```

```
void setup()
```

```
{
```

```
  Serial.begin(9600);
```

```
  pinMode(TempProbeNegative , OUTPUT ); //seting ground pin as output for tmp probe
```

```
  digitalWrite(TempProbeNegative , LOW );//Seting it to ground so it can sink current
```

```
  pinMode(TempProbePossitive , OUTPUT );//ditto but for positive
```

```
  digitalWrite(TempProbePossitive , HIGH );
```

```
  pinMode(ECPin,INPUT);
```

```
  pinMode(ECPower,OUTPUT);//Setting pin for sourcing current
```

```
  pinMode(ECGround,OUTPUT);//setting pin for sinking current
```

```
  digitalWrite(ECGround,LOW);//We can leave the ground connected permanantly
```

```
  delay(100);// gives sensor time to settle
```

```
  sensors.begin();
```

```
  delay(100);
```

```
  /** Adding Digital Pin Resistance to [25 ohm] to the static Resistor *****//
```

```
  // Consule Read-Me for Why, or just accept it as true
```

```
  R1=(R1+Ra);// Taking into acount Powering Pin Resitance
```

```
  Serial.println("ElCheapo Arduino EC-PPM measurments");
```

```
  Serial.println("By: Michael Ratcliffe Mike@MichaelRatcliffe.com");
```

```
  Serial.println("Free software: you can redistribute it and/or modify it under GNU ");
```

```
  Serial.println("");
```



```

Serial.println("Make sure Probe and Temp Sensor are in Solution and solution is well
mixed");
Serial.println("");
Serial.println("Measurments at 5's Second intervals [Dont read Ec morre than once every 5
seconds]:");
};
//***** End of Setup
*****//

//***** Main Loop - Runs Forever
*****//

//Moved Heavy Work To subroutines so you can call them from main loop without cluttering
the main loop
void loop()
{
  GetEC(); //Calls Code to Go into GetEC() Loop [Below Main Loop] dont call this
more that 1/5 hhz [once every five seconds] or you will polarise the water
PrintReadings(); // Cals Print routine [below main loop]

delay(5000);

}
//***** End Of Main Loop
*****//

//***** This Loop Is called From Main Loop*****//
void GetEC(){

```

```

//*****Reading Temperature Of Solution *****//
/*
sensors.requestTemperatures();// Send the command to get temperatures
Temperature=sensors.getTempCByIndex(0); //Stores Value in Variable
*/

Temperature= 30;

//*****Estimates Resistance of Liquid *****//
digitalWrite(ECPower,HIGH);
raw= analogRead(ECPin);
raw= analogRead(ECPin);// This is not a mistake, First reading will be low beause if charged
a capacitor
digitalWrite(ECPower,LOW);

//***** Converts to EC *****//
Vdrop= (Vin*raw)/1024.0;
Rc=(Vdrop*R1)/(Vin-Vdrop);
Rc=Rc-Ra; //acounting for Digital Pin Resitance
EC = 1000/(Rc*K);

//*****Compensating For Temperaure*****//
EC25 = EC/ (1+ TemperatureCoef*(Temperature-25.0));
ppm=(EC25)*(PPMconversion*1000);

;}

```

```
//***** End OF EC Function *****//
```

```
/**This Loop Is called From Main Loop- Prints to serial usefull info **//
```

```
void PrintReadings(){  
  Serial.print("Rc: ");  
  Serial.print(Rc);  
  Serial.print(" EC: ");  
  Serial.print(EC25);  
  Serial.print(" Simens ");  
  Serial.print(ppm);  
  Serial.print(" ppm ");  
  Serial.print(Temperature);  
  Serial.println(" *C ");
```

```
/*
```

```
//***** Usued for Debugging *****
```

```
Serial.print("Vdrop: ");  
Serial.println(Vdrop);  
Serial.print("Rc: ");  
Serial.println(Rc);  
Serial.print(EC);  
Serial.println("Siemens");
```

```
//***** end of Debugging Prints *****
```

```
*/
```

```
};
```

MAIN CODE :

```
import RPi.GPIO as GPIO
import time, sys
import pyrebase
GPIO.setmode(GPIO.BCM)
GPIO.setup(18, GPIO.OUT)
GPIO.output(18, GPIO.LOW)
time.sleep(2)
GPIO.output(18, GPIO.HIGH)
FLOW_SENSOR = 23
GPIO.setup(FLOW_SENSOR, GPIO.IN, pull_up_down = GPIO.PUD_UP)
global db
global count
global starttime
global flow
global litre
count = 0
starttime = 0
flow = 0
litre = 0
    config = {
        "apiKey": "AIzaSyDBDOEJ_yuZjTgbgrKZn_QX4oCfMV7srv0",
        "authDomain": "smartpurifier.firebaseio.com",
        "databaseURL": "https://smartpurifier.firebaseio.com",
        "storageBucket": "smartpurifier.appspot.com",

    }
firebase = pyrebase.initialize_app(config)
```

```

def wait_internet():
    while True:
        try:
            res = urllib2.urlopen('http://google.com',timeout=1)
            return
        except urllib2.URLLError:
            pass

def stream_handler(post):
    print(post["data"])

    global db
    dat = db.child("12348765").child("state").get()
    print (dat.val())

    if(dat.val() == "OFF"):
        print "MOTOR off"
        GPIO.output(18, GPIO.HIGH)
    if(dat.val() == "ON"):
        print "MOTOR on"
        GPIO.output(18, GPIO.LOW)

def main():
    global db
    global litre
    db = firebase.database()
    #db.child("12348765").child("state").set("OFF")
    test = db.child("12348765").child("state").stream(stream_handler)

def countPulse(channel):
    global count

```

```
global starttime
global flow
global litre

count = count+1
print count
cflow = float(count) / 100
count=0
flow = flow + cflow

print round(flow, 2)

if(flow > 1):
    count=0
    flow = 0
    litre = litre + 1
db.child("12348765").child("Consumption").set(litre)
GPIO.add_event_detect(FLOW_SENSOR, GPIO.FALLING, callback=countPulse)
main()
datalitre = db.child("12348765").child("Consumption").get()
litre = datalitre.val()
while True:
    try:

        time.sleep(1)

    except KeyboardInterrupt:
```

```
print '\ncaught keyboard interrupt!, bye'  
GPIO.cleanup()  
sys.exit()
```

Chapter-4 PERFORMANCE ANALYSIS

4.1 initial database (firebase) output

Firebase was the initial interface prior to the development of the android application. Firebase is a web and mobile application platform which provides the apt tools to help developers develop good quality applications. It is a real time database application.

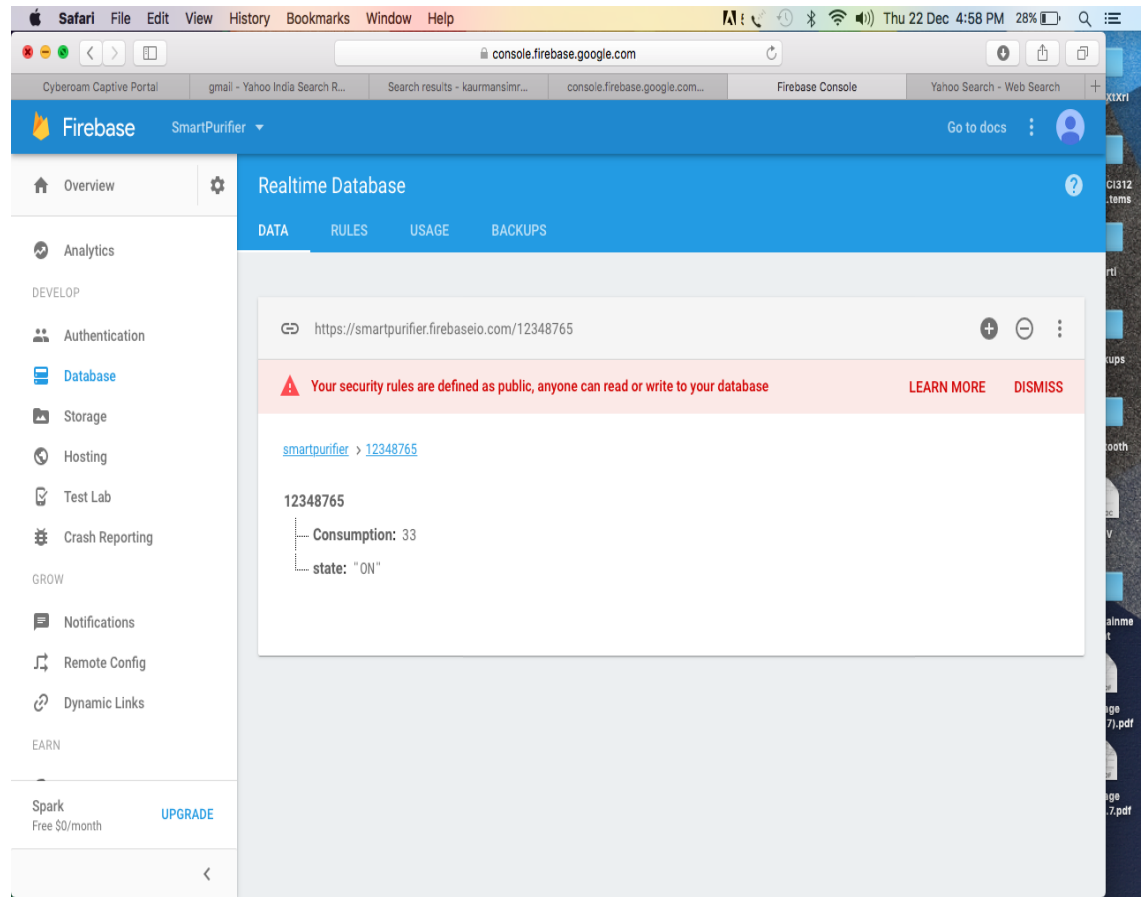


Fig.21

The snapshot shows that we have created a real time database by the name of 'smartpurifier'.12348765 is the unique as it is a number that is given uniquely to every smart purifier. This forms a parent node having two children

- STATE
- CONSUMPTION

STATE indicates the current state of the purifier which tells whether the purifier is on or off. By changing the state in this database one can remotely access the smart Tank.

CONSUMPTION indicated the amount of water dispensed (in litres) till date.

4.2 Selection of a Sign In method for the authentication while using the app.

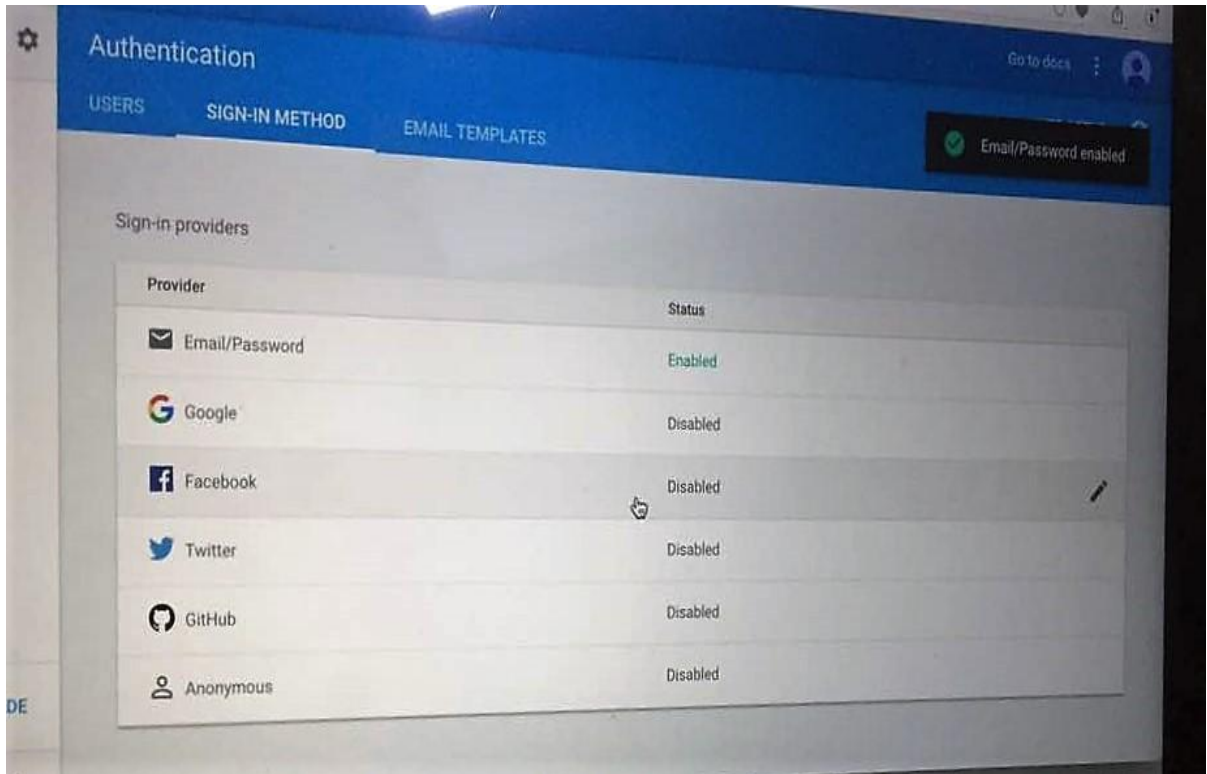


Fig.22

This snapshot shows the initial phase of setting up the android application 'smarTank'. This authentication enables the android application to access the firebase therefore enabling the user to make changes in the database through the application. It can be seen that we have enabled the 'email/password' method as a Sign In method.

4.3 default setup of email and password for testing

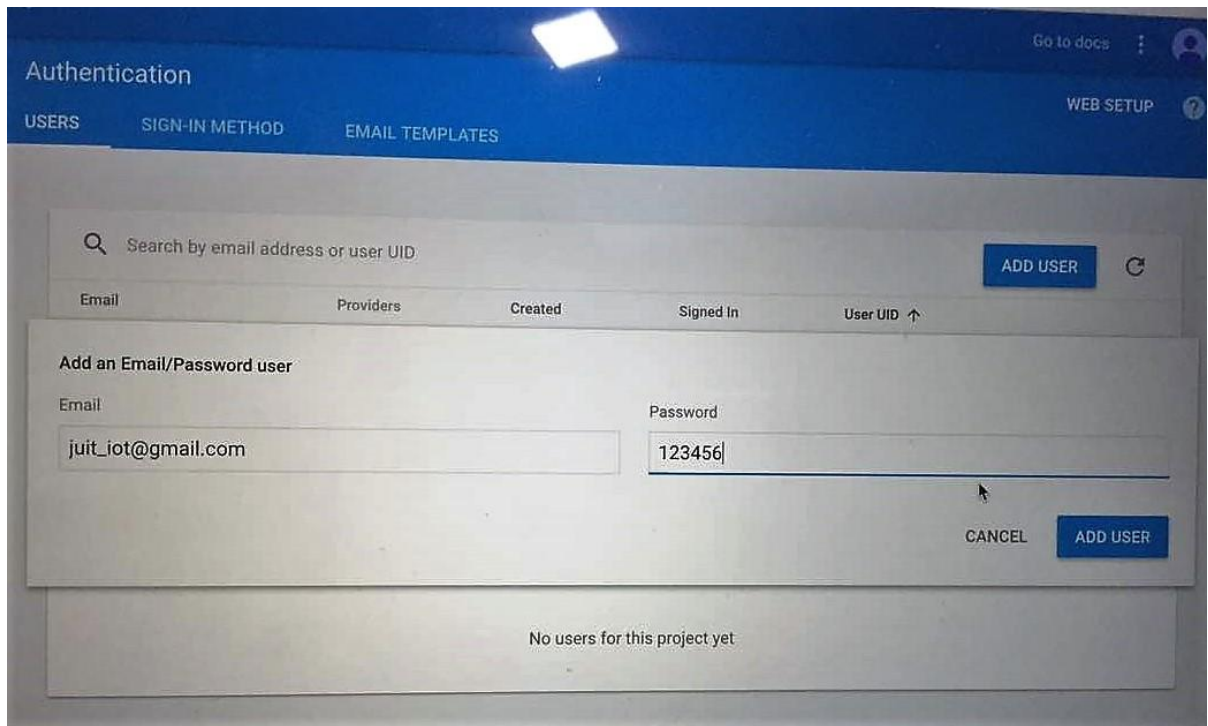


Fig.23

The snapshot shows that the email and password have already been set by default. This was done to avoid entering the email and password for testing purpose.

In case of multiple user accessing the firebase, ADD USER option can be selected and their respective email and passwords can be added. Only the users that are added here will be able to access the firebase.

4.4 The final result showing the contamination level

The snapshot shows the contamination level in parts per million (ppm) for different water samples: tap water, mineral water and aqua guard water



Fig.24

- WATER SAMPLE- aqua guard water
116ppm
(116<150)- fit for drinking
- WATER SAMPLE- mineral water
78 ppm
(78<150)- fit for drinking
- WATER SAMPLE- tap water
283 ppm
(283>150)- NOT fit for drinking

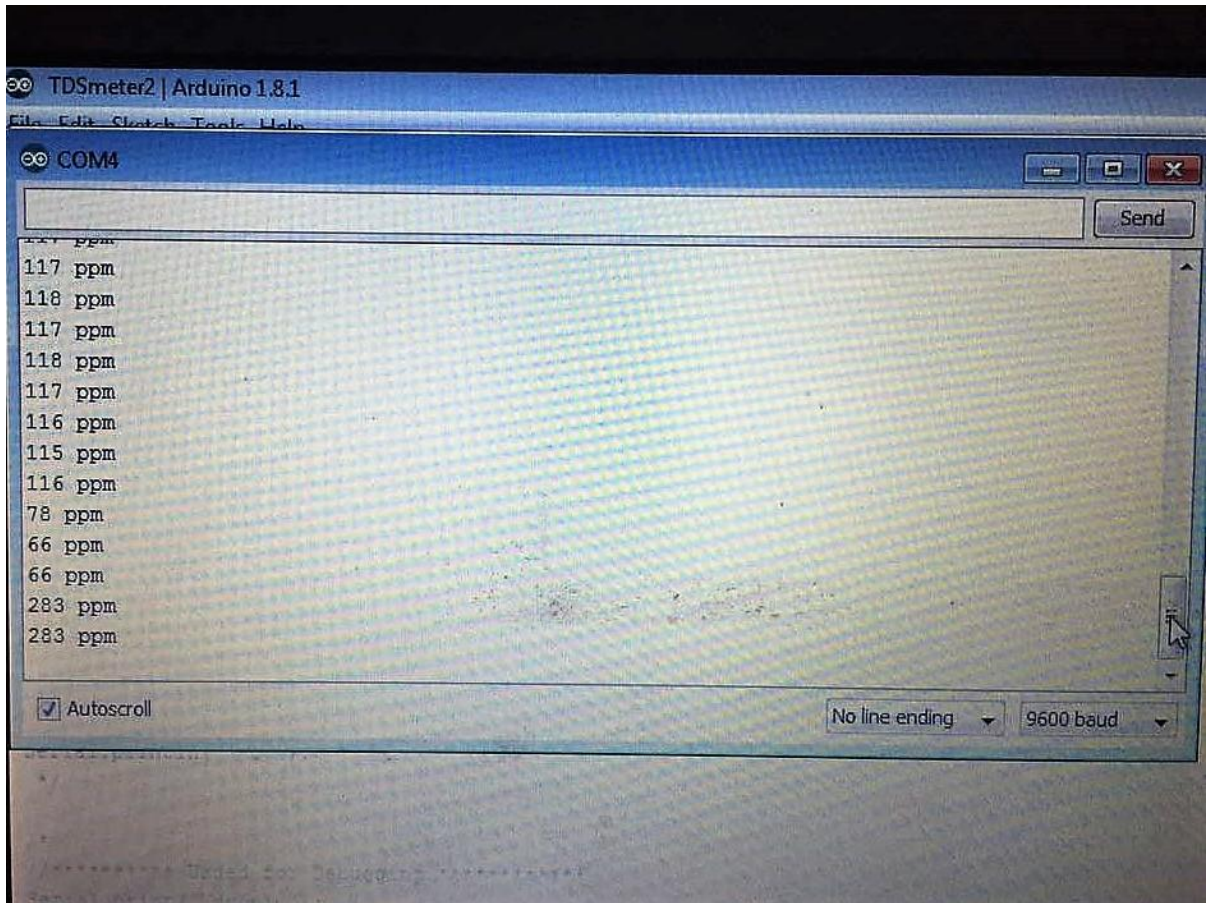


Fig.25

Chapter-5 CONCLUSIONS

5.1 Conclusions

The conventional method of checking impurity in water is to collect those samples by hand and then forward them to laboratory for further testing and analysis. Even then, it has not been able to match up with the requirements of “water quality monitoring” in day to day life. The continuous increasing rate of water pollution makes the quality of drinking water very vulnerable and poses a major threat to human life.

So, the project deals with a system that continuously monitors the water quality and informs the user whether the water is safe for consumption or not.

Also the system is simple and convenient to use so that all users can handle it remotely over the network.

5.2 Future Scope

Can be extended in the field of hardware tampering , where if there is any leakage or breakage in the water system, then the user can be made aware of it through the application.

Also it can be made into a very sophisticated device by fitting other water sensors such as temperature, turbidity, pH ,etc.

5.3 Applications Contributions

1. This system can be used in commercial and domestic use.
2. Water supply agencies can use the system.
3. This system can be used by health department to identify the cause of water diseases.

5.4 Advantages

1. Due to automation it will reduce the time to check the contamination parameters.
2. This is affordable for common people.
3. Has low maintenance.
4. Caution from water borne diseases.
5. Continuous monitoring of water quality.

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