REAL TIME MONITORING OF A WATER TREATMENT PLANT AND INFORMATION SYSTEM

A PROJECT REPORT

Submitted by

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ANNA UNIVERSITY: CHENNAI-600 044

BONAFIDE CERTIFICATE

Certified that this project report **“REAL TIME MONITORING OF A WATER TREATMENT PLANT AND INFORMATION SYSTEM”** is the bonafide work of **N.R.NANJAYAN (2012505546), J.PRIYANKA (2012505518), L.K.RAKESH (2012505551)** who carried out the project work under my supervision.

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ABSTRACT

The conventional technique of measuring the quality of water is to gather the samples manually and send it laboratory for analysis, but this technique is time overwhelming and not economical. It is difficult to take the water sample after every hour to the laboratory for measuring its quality. Hence, we propose an Automatic water quality measuring system , which can measure the essential qualities of water such as Temperature, pH, Total Dissolved Solids(TDS), conductivity in real time. The system consists of multiple sensors to measure the standard of water, Arduino Uno processor and GSM to send the information to the watching centre. It is a true time system which is able to endlessly measure the standard of water and can send the measured values to the watching centre at each predefined time. The abnormality in the water quality is reported to the monitoring center and management mobile to take the corresponding corrective measures immediately.

Keywords – Arduino Uno, Water Quality, Monitoring centre, GSM

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF ABBREVIATIONS

ADC	Analog to Digital Convertor
BOD	Biochemical Oxygen Demand
COD	Chemical Oxygen Demand
DO	Dissolved Oxygen
GSM	Global System for Mobile communications
LCD	Liquid Crystal Display
SMS	Short Message Service
TDS	Total Dissolved Solids

CHAPTER 1

INTRODUCTION

With the rapid development of the economy, more and more serious problems of environment arise. Water pollution is one of these problems. Routinely monitored parameters of water quality are temperature, pH, turbidity, conductivity, dissolved oxygen (DO), chemical oxygen demand (COD), biochemical oxygen demand (BOD), ammonia nitrogen, nitrate, nitrite, phosphate, various metal ions and so on.

The most common method to detect these parameters is to collect samples manually and then send them to laboratory for detecting and analyzing. This method wastes too much man power and material resource, and has the limitations of the samples collecting, long-time analyzing, the aging of experiment equipment and other issues. Sensor is an ideal detecting device to solve these problems. It can convert no power information into electrical signals. It can easily transfer process, transform and control signals, and has many special advantages such as good selectivity, high sensitivity, fast response speed and so on.

According to these characteristics and advantages of sensors, Monitoring of Conductivity, pH & Temperature of Water is designed and developed. It bases on SMS (Short Messaging Service) in the GSM (Global System for Mobile Communications) network to instantaneously transfer the collected data. It also can remotely monitor the water quality on line. The system implements automation, intelligence and network of water quality monitoring, and uses manpower, material and financial resources sparingly.

1.1 NEED FOR THE PROJECT

The conventional technique of measuring the quality of water in water treatment plant is to gather the samples manually and send it to the laboratory for analysis. This technique is time consuming and is not economical. It is also not feasible to take the water sample to the laboratory for measuring its quality continuously. The proposed system targets at measuring the water quality at regular intervals, in real time.

1.2 OBJECTIVES OF THE PROJECT

The specific objectives of this project are

1.2.1 PRIMARY OBJECTIVE

- To monitor a water treatment plant in real time instead of testing samples in laboratory.

1.2.2 SECONDARY OBJECTIVE

- This project also reports abnormal conditions to the watching center in the form of short time message.

1.3 ORGANIZATION OF THE THESIS

- **Chapter 1:** This chapter deals with importance of Water Quality indication. It introduces the domain of the problem considered and also the objective of the project. It outlines the existing systems, their advantages and disadvantages and henceforth the motivation of the project work. This chapter deals with the time organization of this project in the span of six months. It also includes the scope of the project.

- **Chapter 2:** This chapter deals with the methodology with which the project has been proceeded. It also includes the schematic representation of the project. It includes the best suited components for water quality measurement after analyzing various other possibilities.

- **Chapter 3:** This chapter deals with the software simulation of the project. The software part of the project has been done using the proteus software.

- **Chapter 4:** This chapter deals with the results of the proposed technique. The performance of the project has been included.

- **Chapter 5:** This chapter deals with the conclusion and scope for future work of the project. It also includes the summary of the project.

1.4 LITERATURE REVIEW

1.4.1 WABAG WATER TREATMENT PLANT

The conventional system of water sample testing is followed in Wabag. The waste water in Wabag plant is treated at different stages as shown in Figure 1.1. First Raw water is primarily treated by sedimentation. Next, it is fed into secondary treatment which employs aeration tank using microorganisms. At last the treated water is let into the ponds for the removal of microorganisms where sunlight is exposed to the treated water. A literature survey of the pH and TDS measurement was made (shown in Figure 1.2 and 1.3). Parameters of different samples (as mentioned in Table 1.1) are tested in the laboratory as shown in Figure 1.4.

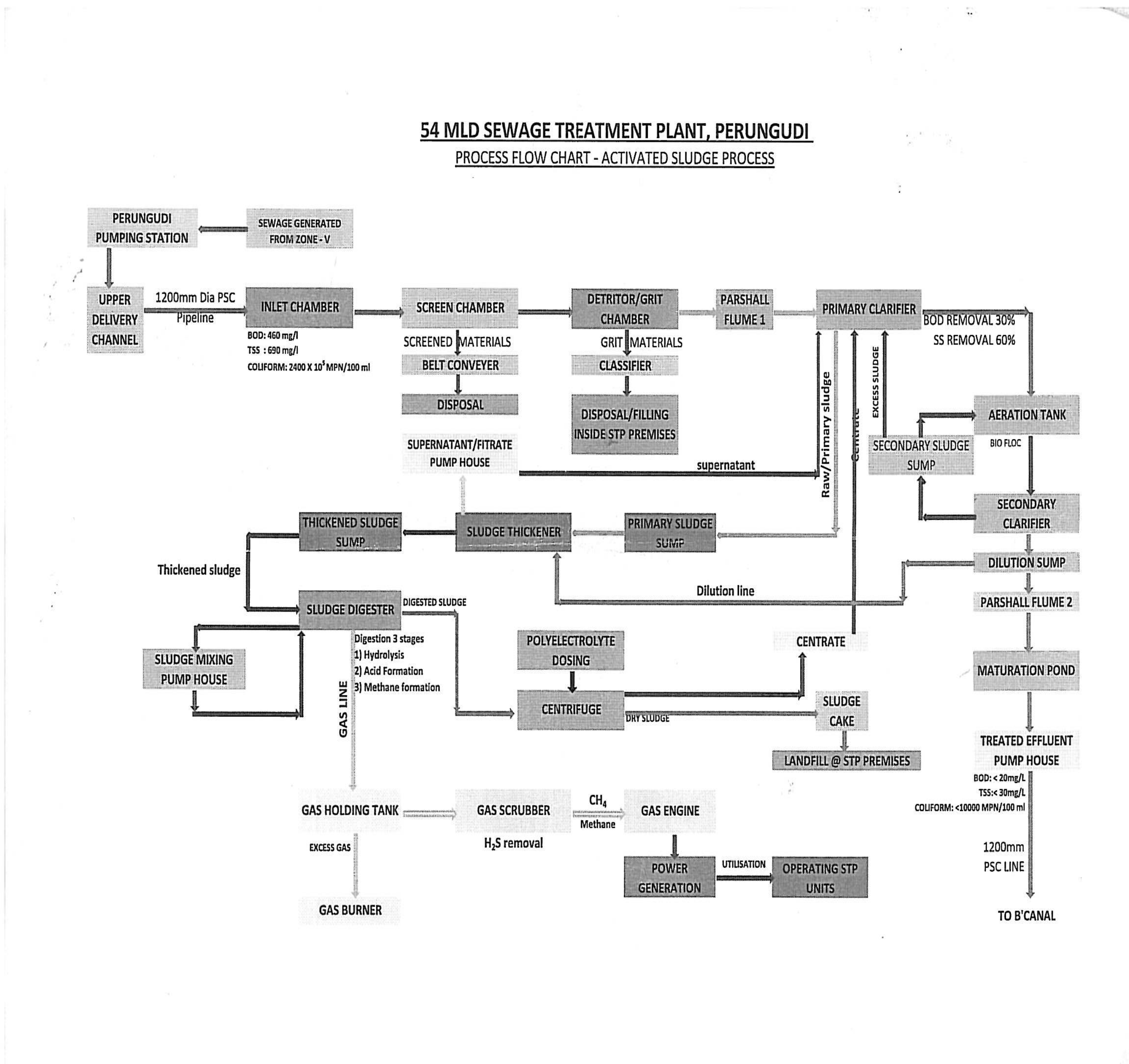

Figure 1.1 Overview of WABAG Waste Water Treatment Plant

Source : V.A.Tech Wabag

Sewage Treatment Plant, Perungudi

Figure 1.2 Conductivity Meter

Figure 1.3 pH Meter

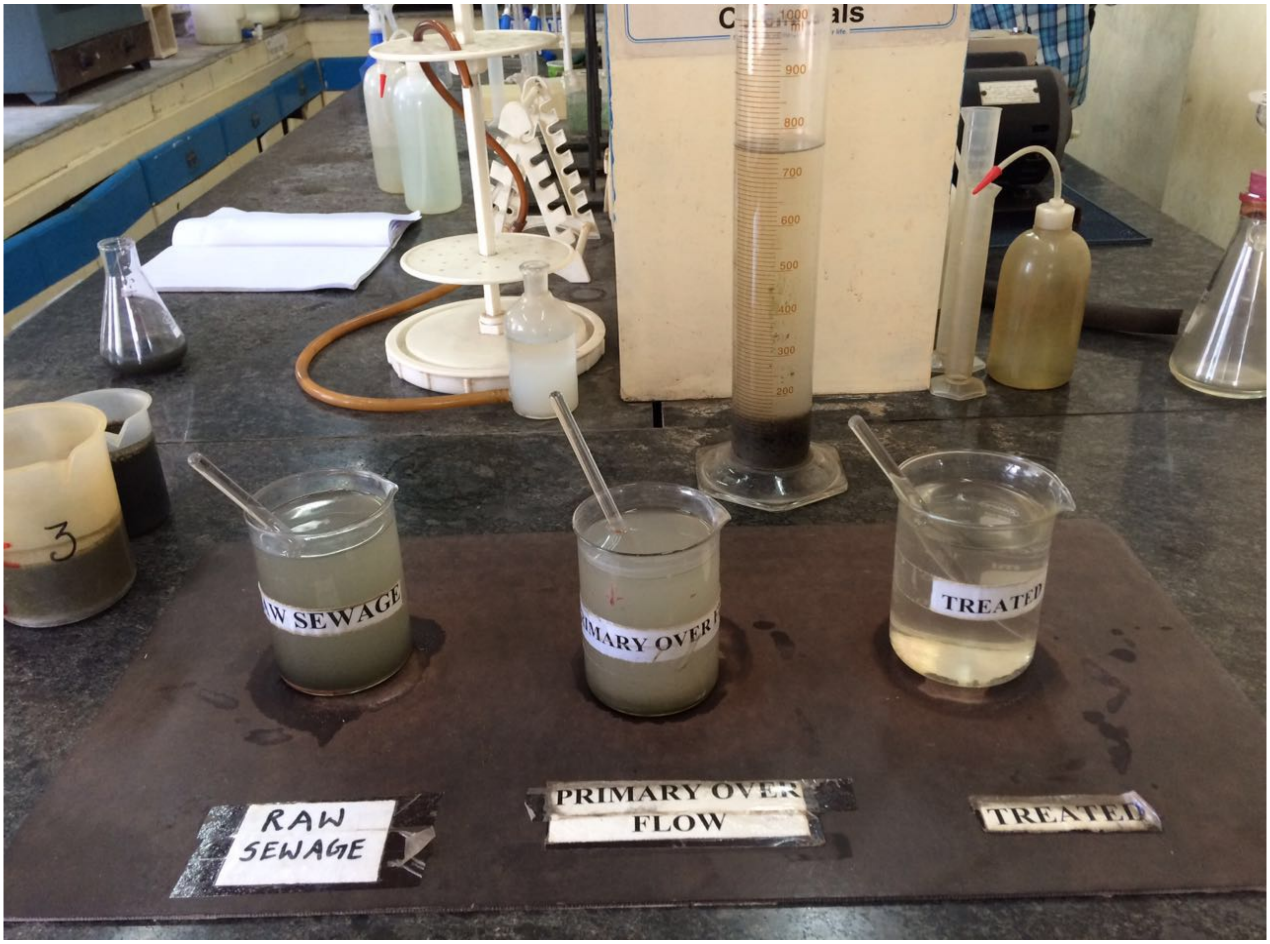

Figure 1.4 Samples Testing Arrangement in the Laboratory

Table 1.1 Parameters Tested in Wabag Plant

Stage	TDS	pH
Raw sewage	1290	6.80-7.10
Primary treatment	1115	7.10-7.28
Secondary treatment	1050	7.50-7.68
Treated water	990	7.79

1.4.2 MICROCONTROLLER (ARDUINO UNO)

"Uno" means one in Italian and is named to mark the upcoming release of Arduino 1.0. The Uno and version 1.0 will be the reference versions of Arduino, moving forward. 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,

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. The Uno differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip.

1.5 ORGANIZATION

1.5.1 SCOPE OF THE PROJECT

The scope of the project work is explained in the figure 1.5.

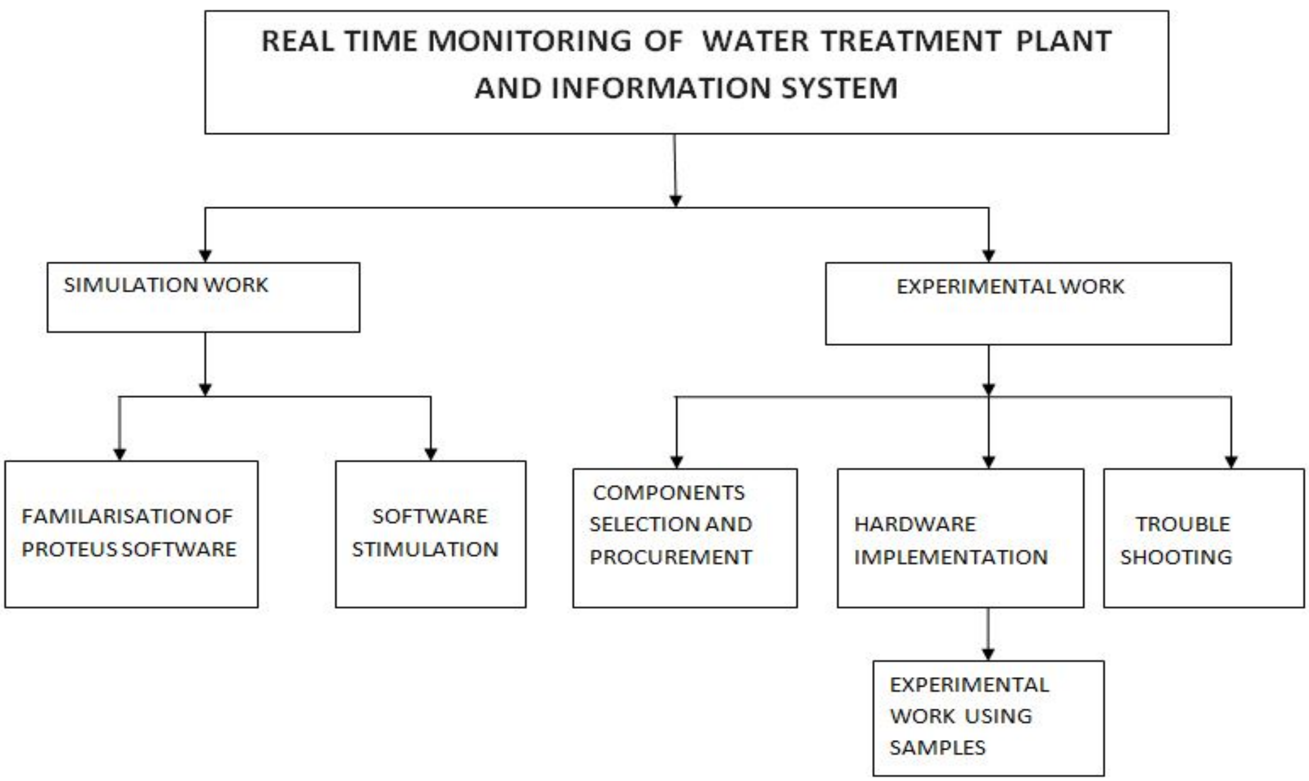

Figure 1.5 Scope of the Project

1.5.2 ACTION PLAN

The action plan of this project in the span of six months is shown in Table 1.2.

Table 1.2 Action Plan

WEEK	DATE	CONTENTS
1	15/01/16	Literature survey
2	29/01/16	Guide first meeting
3	01/02/16	Title submission
	01/02/16	Preparation of Extended abstract
	03/02/16	Review by Guide
4	10/02/16	ZEROTH REVIEW
5	12/02/16	Application software package : Proteus Software Learning
6	24/02/16	Software stimulation
	24/02/16	Review by Guide
7	28/02/16	Procurement of Components
8	02/03/16	FIRST REVIEW
9	18/03/16	Hardware implementation
	18/03/16	Review by Guide
10	26/03/16	Trouble shooting
11	06/04/16	SECOND REVIEW
12	16/04/16	Internal Report
	16/04/16	Review by Guide
13	27/04/16	PROJECT DEMONSTRATION
14	02/05/16	VIVA FOR PROJECT

CHAPTER 2

METHODOLOGY

This system (represented in Figure 2.1) consists of assorted water quality measuring sensors like pH, conductivity, temperature and other electronic components such as microcontroller and GSM module. The measured parameters from the water treatment plant are sent to the microcontroller for further processing. The microcontroller verifies the measured value with the preset standard value and in case of a mismatch, an alert message is sent using a GSM module, which is interfaced with the microcontroller.

2.1 BLOCK DIAGRAM

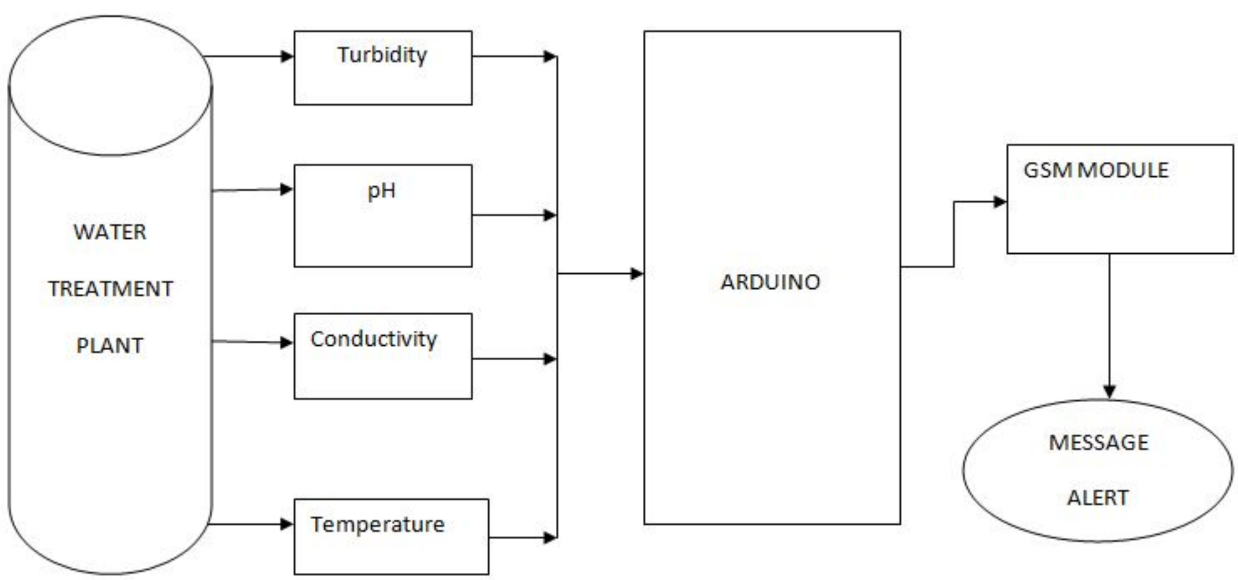

Figure 2.1 Block Diagram of the Project Work

The stage wise monitoring of a process (as shown in Figure 2.2) can also be done. The parameters are fed into the proposed system. The normal conditions are graphically represented in Figure 2.3. If there is an abnormality, an alert message is sent to the monitoring center. It also helps to find which stage of the process is causing the abnormality. Hence, particular region can be confined instead of the entire process.

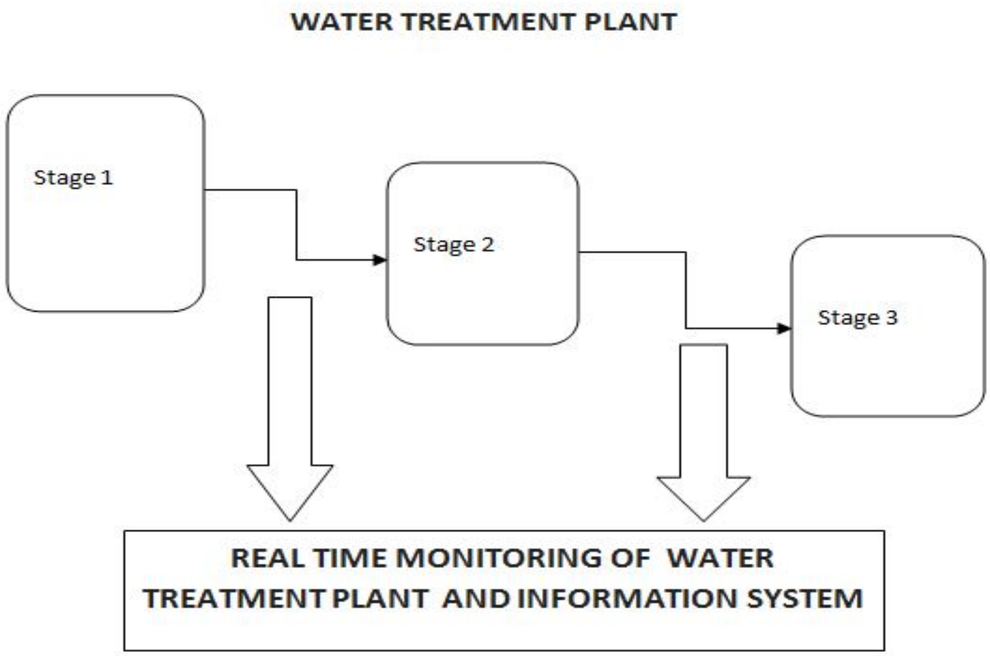

Figure 2.2 Stage Wise Monitoring

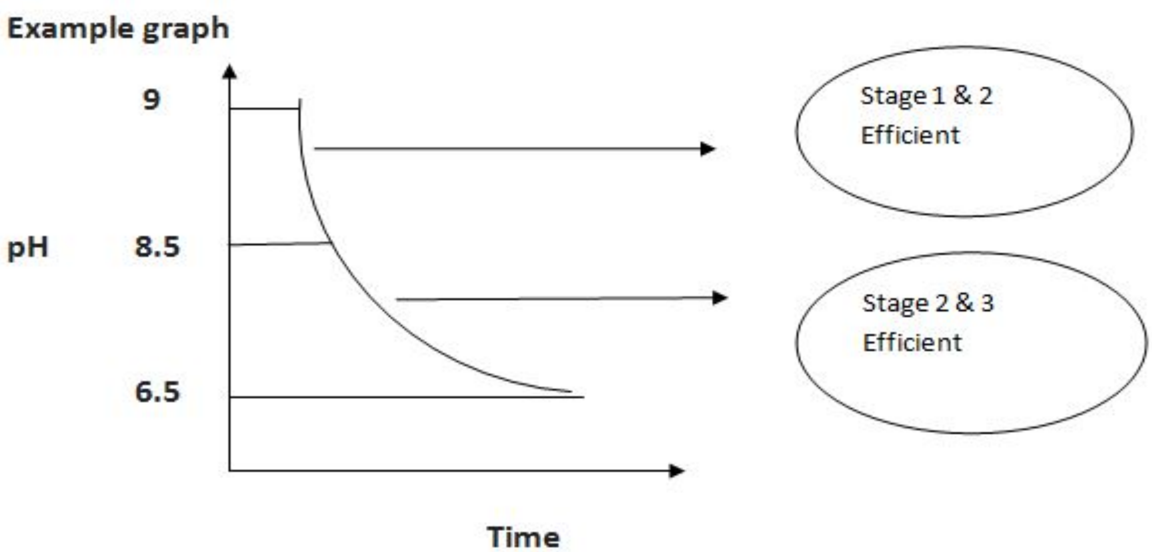

Figure 2.3 Graphical Representation

2.2 PRINCIPLE OF WORKING

The water quality measuring system uses pH, conductivity and temperature device to measure the standard of water. This device then measures the corresponding values of the water. Since the outputs of the sensors measured are analog in nature and microcontroller will handle solely digital signals thus there's a necessity of a tool that converts analog signals into digital signals. The system makes use of ADC for this purpose. The outputs of sensors are directly given to ADC, which converts the analog signals into the corresponding digital signals. These digital signals are then given to the microcontroller 8051. System uses GSM module for communication. GSM module makes use of interface of the microcontroller 8051 for communication. Microcontroller sends the measured values to the watching centre by SMS via the GSM module. Since it is a true time system thus microcontroller can send the measured values to the watching centre after the particular time as per the program. With the information to the watching centre the microcontroller conjointly displays the values of the measured quantities on the LCD. It is a true time system thus it doesn't need any man machine interaction for activity the standard of water.

The system uses sensors to measure four qualities of water particularly pH, conductivity, total dissolved solid and temperature.

- pH may be a measure of the acidity or basicity of associate solution. It is measured by the help of electrical potential.
- Conductivity defines the power of the water to conduct electricity. Pure water has poor conductivity thus for water to be pure its ability to conduct current should be poor. Conductivity is measured with the help of two conducting plates.

- Total dissolved solid (TDS) determines the quantity of minerals and salts that reside within the water. Total dissolved solid in water will be determined by multiplying the conductivity by a factor and typically this factor is taken as 0.67.

$$TDS = 0.67 \times \text{conductivity}$$

- Temperature has a vital influence on water. The system uses LM35 to measure the temperature of water. LM35 is a high precision temperature device.

2.3 DESIGN AND DEVELOPMENT

2.3.1 COMPONENTS DETAILS

i)ARDUINO

The Arduino Uno (shown in Figure 2.4) 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 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button. The datasheet specifications of Arduino Uno Processor are mentioned in figure 2.1.

Table 2.1 Specifications Of Arduino Uno

Parameter	Values
Operating voltage	5 V
Input voltage	7-12 V
Analog Input pins	6
DC current	40 mA
SRAM	2 Kb
EEPROM	1 Kb
Clock speed	16 MHz
DC current for 3.3 V pin	50 mA

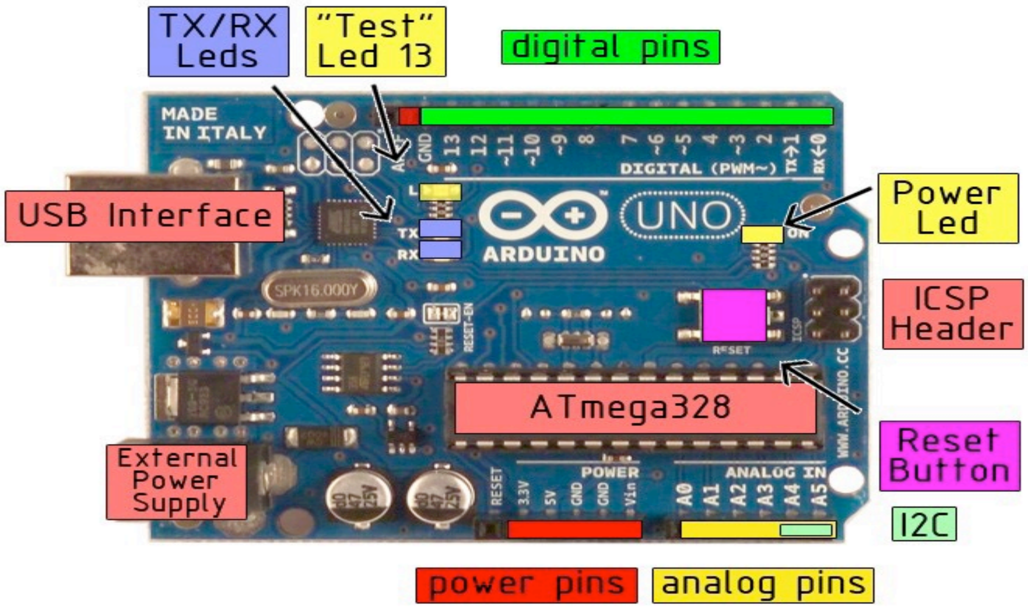

Figure 2.4 Arduino Uno

ii)LM 35 TEMPERATURE SENSOR

The operating temperature range is from -55°C to 150°C. The output voltage varies by 10mV in response to every ºC rise/fall in ambient temperature, *i.e.,* its scale factor is 0.01V/ºC. The Pin configuration of the Temperature sensor is mentioned in Table 2.2.

Table 2.2 Temperature Sensor LM35 Pin Configuration

Pin number	Pin Description	Voltage Values
1	Supply voltage (Vcc)	5V
2	Output voltage	+6V to -1V
3	Ground	0V

The LM35 can be applied easily in the same way as other integrated-circuit temperature sensors. It can be glued or cemented to a surface and its temperature will be within about 0.01˚C of the surface temperature. This presumes that the ambient air temperature is almost the same as the surface temperature. If the air temperature were much higher or lower than the surface temperature, the actual temperature of the LM35 die would be at an intermediate temperature between the surface temperature and the air temperature.

Table 2.3 Temperature Characteristics of LM35

Model	**TO-46**	**TO-46***	**TO-92**	**To-92***	**So-8**	**So-8****	**To-220**
Substances	No heat sink	Small heat fin	No heat sink	Small heat fin	No heat sink	Small heat fin	No heat sink
Still air	400C/W	100C/W	180C/W	140C/W	220C/W	110C/W	90C/W
Moving air	100C/W	40C/W	90C/W	70C/W	105C/W	90C/W	26C/W
Still oil	100C/W	40C/W	90C/W	70C/W	-	-	-
Stirred oil	50C/W	30C/W	45C/W	40C/W	-	-	-

iii) GSM

GSM (Global System for Mobile communications) is an open, digital cellular technology used for transmitting mobile voice and data services. GSM (Global System for Mobile communication) is a digital mobile telephone system that is widely used in Europe and other parts of the world. GSM (as shown in Figure 2.5) uses a variation of Time Division Multiple Access (TDMA) and is the most widely used of the three digital wireless telephone technologies (TDMA, GSM, and CDMA. It operates at either the 900 MHz or 1,800 MHz frequency band. It supports voice calls and data transfer speeds of up to 9.6 kbit/s, together with the transmission of SMS (Short Message Service).

The message sending module is SIM900, it is a Tri-band GSM/GPRS that works on frequencies EGSM 900 MHz, DCS 1800 MHz and PCS1900 MHz. SIM900 provides GPRS multi-slot class 10/ class 8 (optional) capability and supports the GPRS coding schemes. The SIM900 provides RF antenna interface with two alternatives, antenna connector and antenna pad. The antenna connector is MM9329-2700. And customer's antenna can be soldered to the antenna pad. The SIM900 is designed with power saving technique, the current consumption to as low as 2.5mA in SLEEP mode. The SIM900 is integrated with the TCP/IP protocol, Extended TCP/IP AT commands are developed for customers to use the TCP/IP protocol easily, which is very useful for data transfer applications.

Figure 2.5 GSM Module

This module will settle for any GSM network operator SIM card. Advantage of this module is that we are able to use RS232 port to speak. This GSM electronic equipment is extremely versatile plug and play quad band GSM electronic equipment for direct and simple integration to RS232 applications. GSM module uses customary AT commands which are mentioned in Table 2.4.

Table 2.4 Commands Of GSM Module

Command	Description
ATA	Answer a call
ATD	Dial a number
AT+CMGD	Delete message
AT+CSMS	Send short message

iv) pH ELECTRODE - PC 22

The pH probe is a combination electrode, which combines both the glass and reference electrodes into one body. The combination electrode consists of the following parts

- A sensing part of electrode, a bulb made from a specific glass
- Internal electrode, usually silver chloride electrode or calomel electrode
- Internal solution, usually a pH = 7 buffered solution of 0.1 mol/L KCl for pH electrodes or 0.1 mol/L MeCl for pMe electrodes
- When using the silver chloride electrode, a small amount of AgCl can precipitate inside the glass electrode
- Reference internal solution, usually 0.1 mol/L KCl
- Junction with studied solution, usually made from ceramics or capillary with asbestos or quartz fiber.

The bottom of a pH electrode (shown in figure 2.6) balloons out into a round thin glass bulb. The pH electrode is best thought of as a tube within a tube. The inner tube contains an unchanging $1\times10-7$ mol/L HCl solution. Also inside the inner tube is the cathode terminus of the reference probe. The anodic terminus wraps itself around the outside of the inner tube and ends with the same sort of reference probe as was on the inside of the inner tube. It is filled with a reference solution of KCl and has contact with the solution on the outside of the pH probe by way of a porous plug.

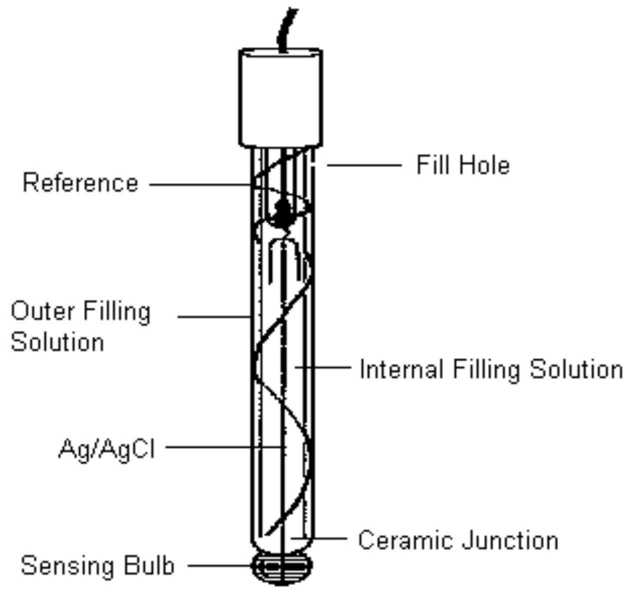

Figure 2.6 pH Electrode

The measuring part of the electrode, the glass bulb on the bottom, is coated both inside and out with a ~10 nm layer of a hydrated gel. These two layers are separated by a layer of dry glass. The silica glass structure (that is, the conformation of its atomic structure) is shaped in such a way that it allows Na+ ions some mobility.

H+ does not cross through the glass membrane of the pH electrode, it is the Na+ which crosses and allows for a change in free energy. When an ion diffuses from a region of activity to another region of activity, there is a free energy change and this is what the pH meter actually measures. All glass pH electrodes have extremely high electric resistance from 50 to 500 MΩ. Therefore, the glass electrode can be used only with a high input-impedance measuring device like a pH meter, or, more generically, a high input-impedance voltmeter which is called an electrometer.

CHAPTER 3

SIMULATION STUDIES

The software simulation of the project is done with the help of proteus. The Arduino Code has been ported and the result is shown in the Figure 3.1.

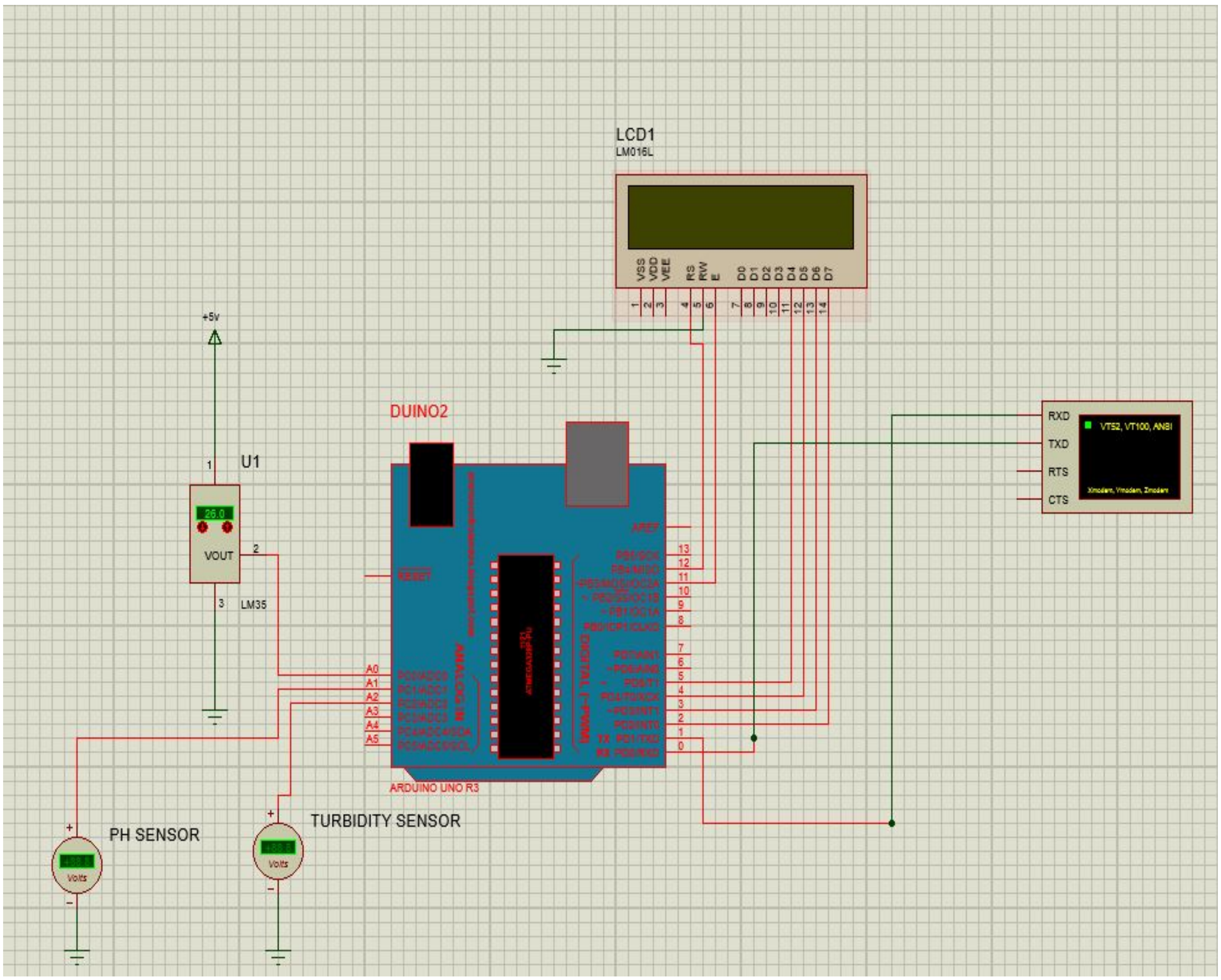

Figure 3.1 Proteus Simulation

CHAPTER 4

RESULTS AND DISCUSSION

4.1 HARDWARE IMPLEMENTATION

The parameters of water are measured and displayed on LCD DISPLAY. The calibration and testing of processor, sensors and output displays are shown in Figures 4.1, 4.2, 4.3 and 4.4. The laboratory setup arrangement is displayed in Figure 4.5.

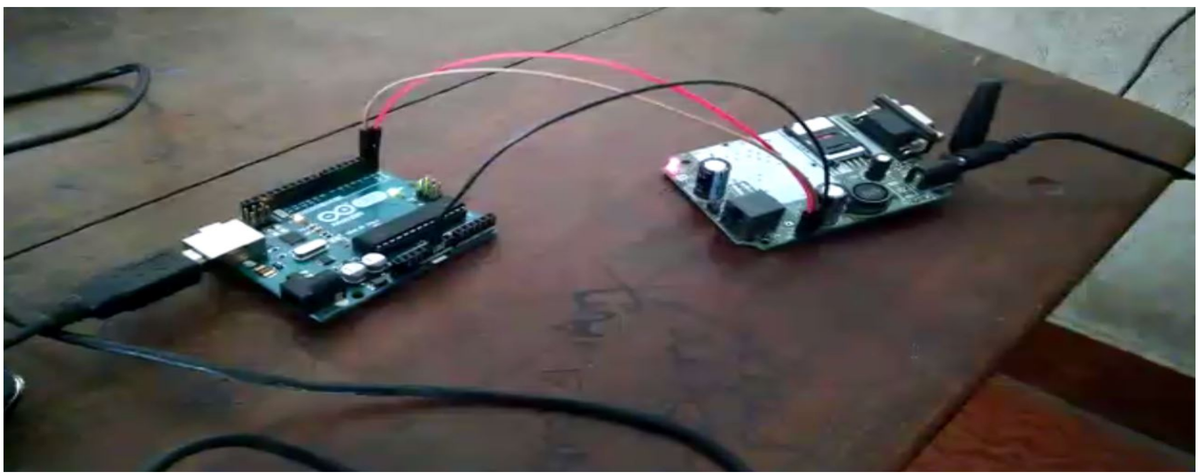

Figure 4.1 Interfacing of GSM with Arduino

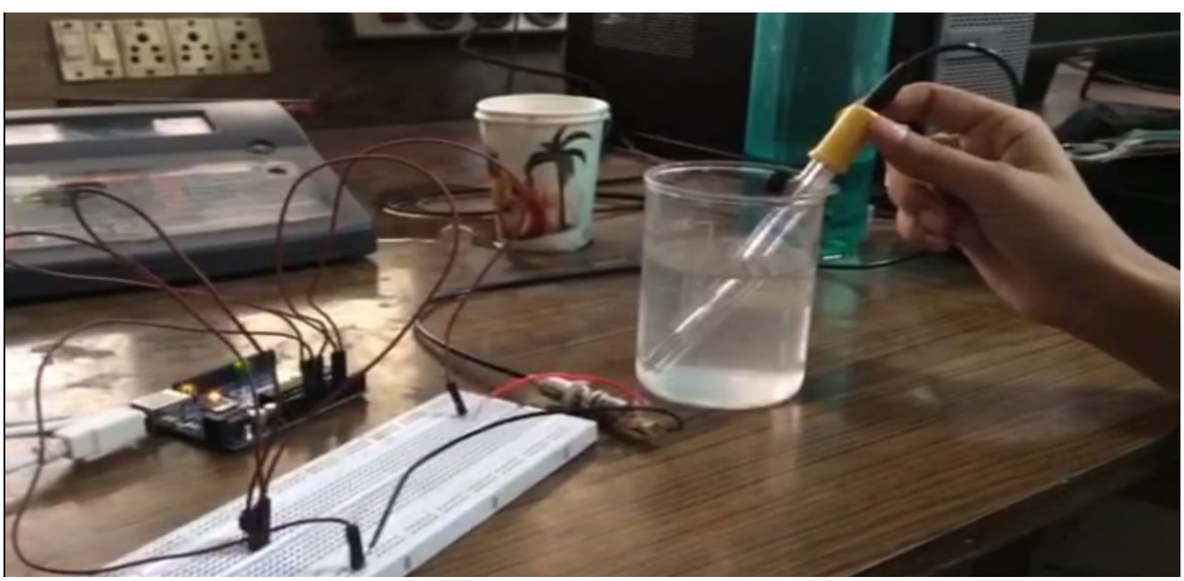

Figure 4.2 Calibration of pH Sensor with Different Samples

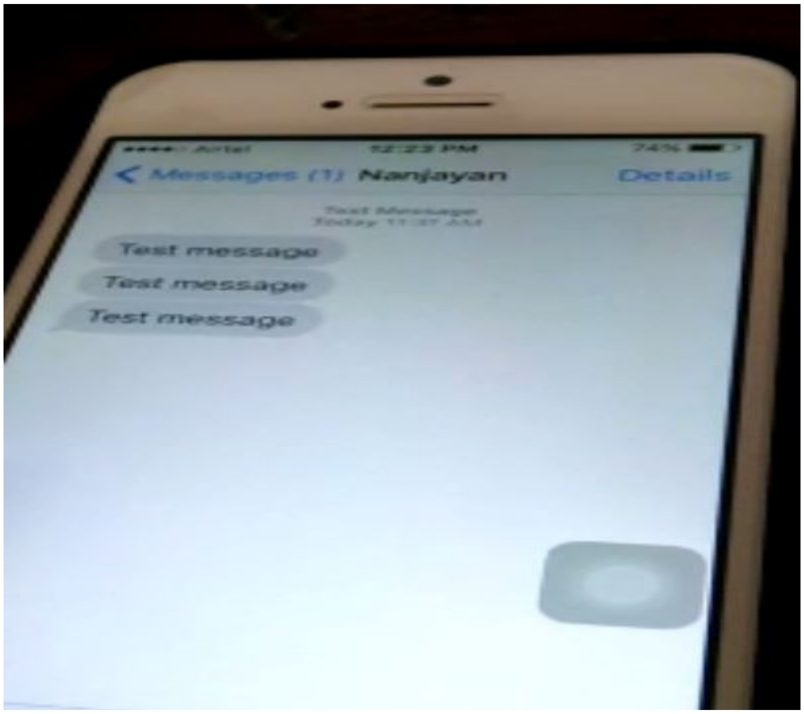

Figure 4.3 Alert Message Testing

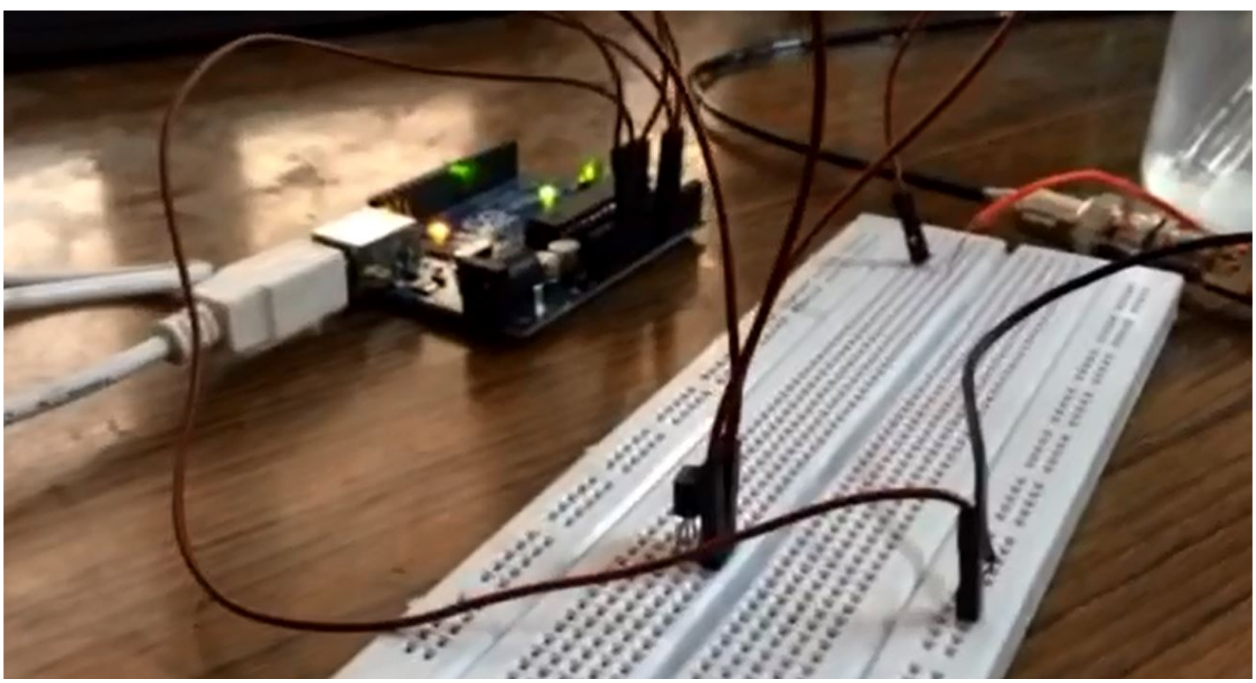

Figure 4.4 LM35 Temperature Sensor Interfacing

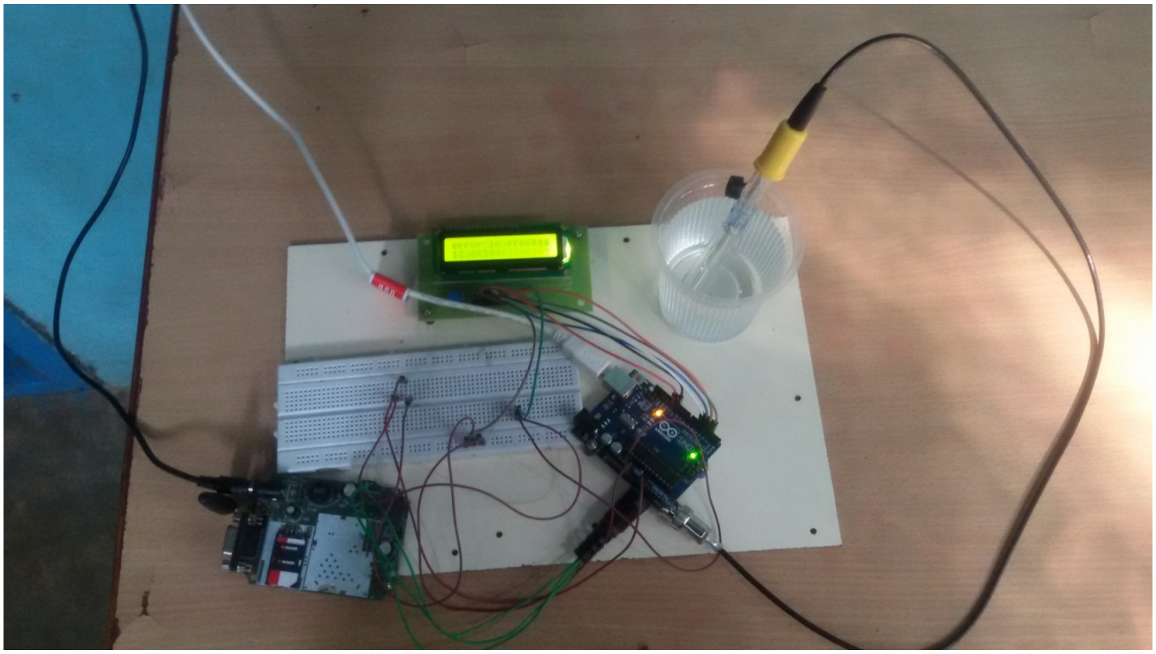

Figure 4.5 Laboratory Setup

4.2 PERFORMANCE OF THE PROJECT

4.2.1 DISPLAY OF WATER QUALITY PARAMETERS

The performances of the project work such as Temperature, pH, Conductivity indication are displayed in Figure 4.6, 4.7 and 4.8 respectively.

Figure 4.6 Temperature Indication

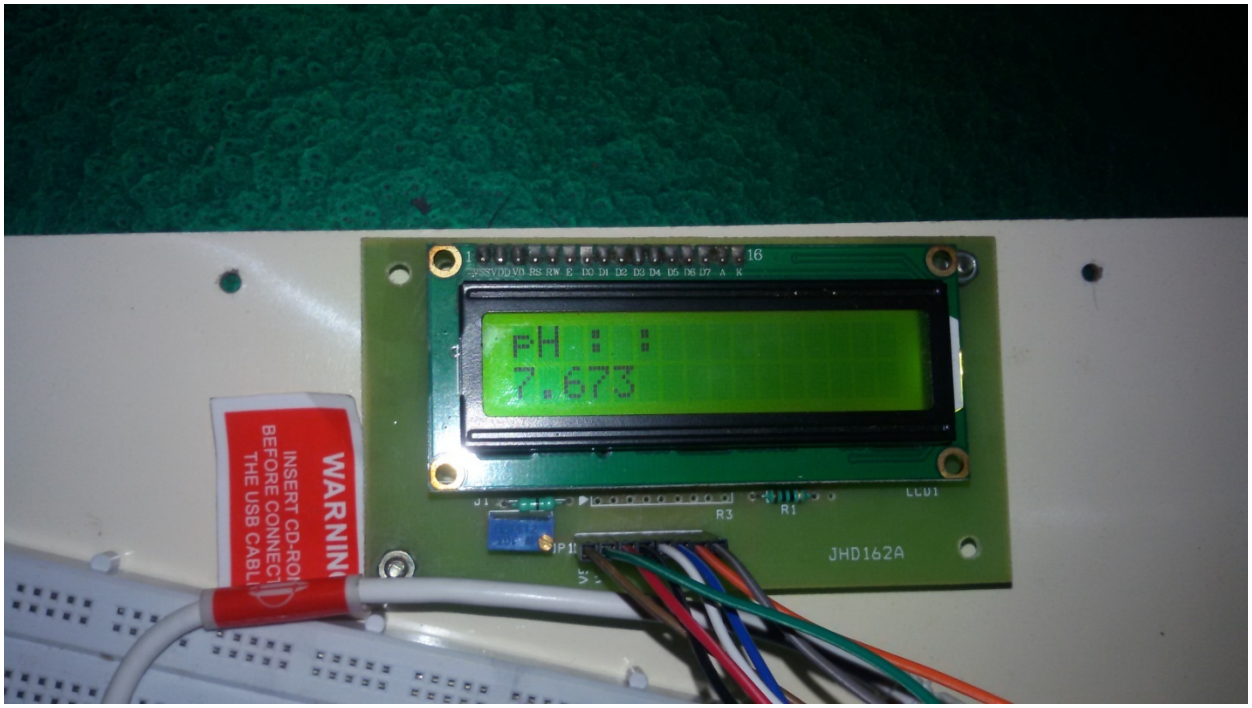

Figure 4.7 pH Indication

Figure 4.8 TDS and Conductivity Indication

When the parameters are in the nominal values, display indicates to discharge treated water as shown in Figure 4.9. If it fails, an alert message and indication will be shown as seen in Figure 4.10.

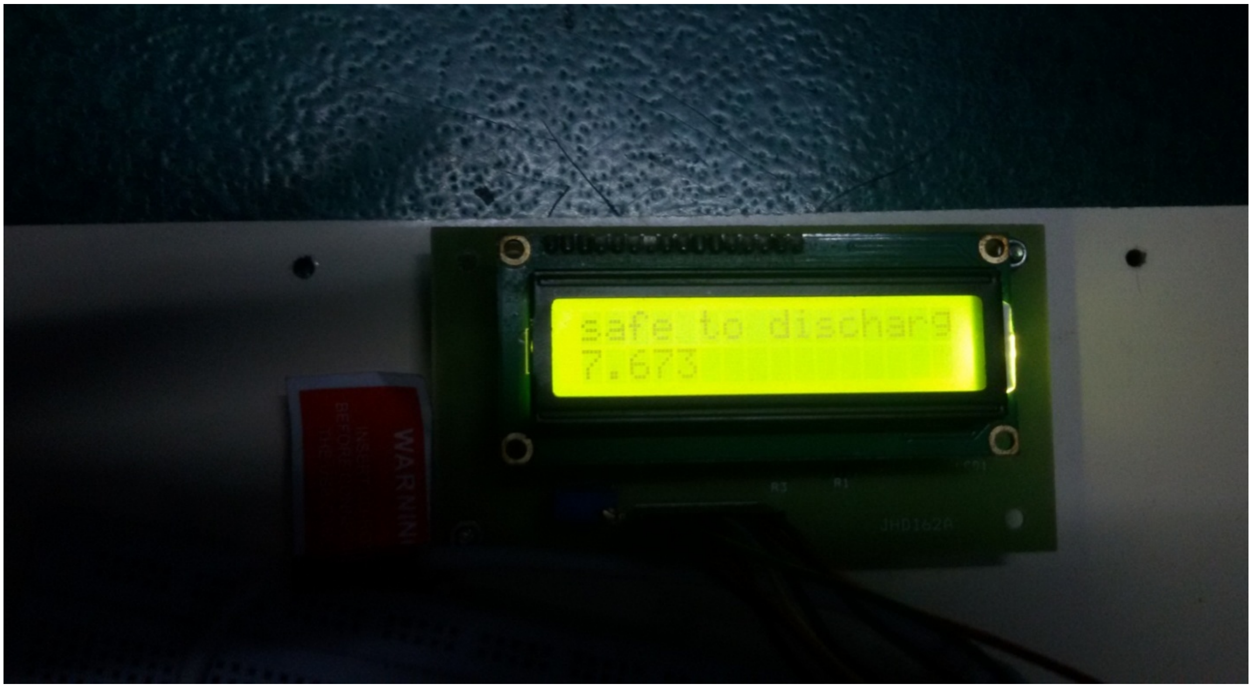

Figure 4.9 Normal Conditions [pH 6.5-8.5]

Figure 4.10 Abnormal Conditions [pH more than 8.5]

CHAPTER 5

5.1 SUMMARY

At present, water monitoring is done manually by testing of samples periodically. This lead to the idea of a real time monitoring of water quality analysis which automatically indicates whether the sample is at desired value. After learning about the process and collecting essential information from Wabag Sewage Treatment Plant, software simulation of the project work was done. Parameters such as temperature, pH, conductivity and TDS (total dissolved solids) were measured using their respective sensors which were then given to the processor Arduino uno, which was already programmed with the desired values. pH sensor was calibrated against numerous samples such as distilled water, a basic solution and an acidic solution. Then, LM35 temperature sensor was interfaced with Arduino processor and an algorithm to convert the voltage values into corresponding pH, Temperature and TDS values was ported. Interfacing of Arduino processor with the GSM module was performed. After initial testing, desired values were assigned so that the GSM module sends an alert message in case of any abnormality.

5.2 CONCLUSION

Real time monitoring of water treatment plant and information system is an associate economical system that uses numerous water detection device and GSM network. The system is incredibly versatile and economical. It is real time system that measures numerous parameters present within the water with the assistance of device and send them to the watching centre mechanically. It doesn't need individuals on duty. The system is reliable and easy and it will be extended to measure water pollution so on. It has a widespread application. Government can also implement this system to continuously monitor the discharge of water flowing from a production unit. It is very helpful in places where monitoring alone is necessary. Hence, it can reduce the investment of huge amounts proving to be economical and feasible.

5.3 FUTURE SCOPE

Current project deals only with the indication of the water quality. The project may be extended by giving the user an option for controlling the quality. We can also implement the proposed system for multiple stage process. Additional parameters of water like Turbidity can also be added. Turbidity sensor make-s use of LDR and LED. Hence an alert system can be used to caution the process flow. In the same way it can be used to alert government officials in case of abnormal conditions of outflow water.

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APPENDIX – ARDUINO CODE

CODE

```
int reading = analogRead(A0);
float voltage = reading * 5.0;
voltage /= 1024.0;
float Temperature = (voltage - 0.5) * 100;
Serial.println(Temperature);
lcd.setCursor(0,0);
lcd.print("Temp :");
lcd.setCursor(0,1);
lcd.print(Temperature);
 for(i=1;i<=100;i++)
 {
  Y=analogRead(A1);
  X=(7.0+(Y/59.16));
  delay(100);

if(i<=100)
 {
  Z=Z+X;
 }
  if(i==100)
```

```
  {T=Z/100;
Serial.println(T);
lcd.setCursor(0,0);
lcd.print("pH :");
lcd.setCursor(0,1);
lcd.print(T);
  // put your main code here, to run repeatedly:
  }
}
delay(5000);
    if(T>=6.5&&T<=8.5)
     {
lcd.setCursor(0,0);
lcd.print("safe to discharge");
 delay(5000);
lcd.setCursor(0,0);
lcd.print("conductivity: (voltage/27)*1.063");
lcd.setCursor(0,1);
lcd.print("TDS =(conductivity/2)ppm");
  }
else{
  lcd.setCursor(0,0);
lcd.print("error in process");
//message delivering//
int timetosend=1;
```

```
int count=0;
char phone_no[]="9840535901";
Serial.begin(9600);
delay(2000);
Serial.println("AT+CMGF=1");
delay(200);
 while(count<timetosend)
 {
  delay(1500);
  Serial.print("AT+CMGS=\"");
  Serial.print(phone_no);
  Serial.println("\"");
  while(Serial.read()!='>');
  {
   Serial.print("Error in process");
   delay(500);
   Serial.write(0X1A);
   Serial.write(0X0D);
   Serial.write(0X0A);
   delay(5000);
  }
  count++;
  }
void loop() {
}
```