Hard Water Treatment System using TDS Sensor

A Research submitted in partial fulfilment for the requirements of the degree of B.Sc (Honor) in Electrical Engineering (Power)

Submitted by:

Barakat Essamelden Hassan
Ethar Alsajad Abdallah
Mazen Mamoun Mohamed
Mohamed Algazaly Saad Ibrahim

Supervised by:

Mr. Nizar Ali Alhaj

Electrical Engineering Department

Faculty of Engineering

Elshaikh Abdallah Elbadri University

March 2022

الايه

بسم الله الرحمن الرحيم

قال تعالي :

{هَلْ أَتَى عَلَى الْإِنْسَانِ حِينٌ مِنَ الدَّهْرِ لَمْ يَكُنْ شَيْئًا مَذْكُورًا (1) إِنَّا خَلَقْنَا الْإِنْسَانَ مِنْ نُطْفَةٍ أَمْشَاجٍ نَبْتَلِيهِ فَجَعَلْنَاهُ سَمِيعًا بَصِيرًا (2) إِنَّا هَدَيْنَاهُ السَّبِيلَ إِمَّا شَاكِرًا وَإِمَّا كَفُورًا (3)}

سوره الانسان

صدق الله العظيم

الاهداء

الي من تجرع الكاس فارغا ليسقيني قطره حب
الي من كلت انامله ليقدم لنا لحظه سعاده
الي من حصد الاشواك من دربي ليمهد لي طريق العلم
الي القلب الكبير (ابي العزيز)

الي القلوب الطاهره الرقيقة والنفوس البريئة الي رياحين حياتي (اخوتي)

الي الروح التي سكنت روحي فلان

تفتح الاشرعة وترفع المرساة لتنطلق في عرض بحر واسع مظلم وهو بحر الحياة وفي هذه الظلمة لا يضئ الا قنديل الذكريات ذكريات الاخوة البعيدة الي الذين احببتهم واحبوني (اصدقائي)

Acknowledgement

We would like to express our gratitude to our primary supervisor, Mr. Nizar Ali Alhaj, who guided us throughout this project.

We would like to thank our family who believed and supported us

Into this long journey.

We would like to thank who ever held us a hand, motivate and inspired us to make this project done.

Thanks to our classmates and friends for every advice they gave for the sake of improving the project.

We deeply appreciate the help provided by the technical and support staff in electrical engineering department,

Elshaikh Abdallah Elbadri University

المستخلص

المياه هي عمود الحياه و عدم توفرها يعتبر تهديد للاكائنات الحيه. لذلك يجب المحافظه عليها و استثمارها بصوره جيده . المياه العذبه هي الاكثر استهلاكا لكن في المقابل نسب توفرها قليله مقارنه بالمياه العسره .و في هذا المشروع نقوم بالاستفاده من التجارب الكيميائيه لتقليل نسب الضرر للمياه العسره و ذلك عن طريق مزجها او خلطها بالمياه العذبه وعدم الاعتماد علي نوع مياه واحده . و من هنا جاءت فكرة تصميم نظام هندسي لمراقبة و تحكم ذاتي في خزان موصل مع مصدري مياه عذبه و مياه عسره ، حيث تتم فيه عمليه المزج تحت قيم و مقاييس تعطي عن طريق حساس ، بحيث يقوم المتحكم باخذ قراءه حساس قياس نسبه الأملاح المذابه في المياه و بناءا علي هذه القراءه يتم تشغيل مضخات المياه لتتم عمليه المزج في مدي المياه الصالحه للشرب حتي يمتلئ الخزان ، يتم معرفه مستوى المياه في الخزان عن طريق حساس الموجات فوق الصوتية ، يتم عرض كل المعلومات في شاشه عرض .

Abstract

Water is the pillar of life and its lack of availability is considered a threat to living organisms. Therefore, it must be preserved and invested in a good way. Fresh water is the most consumed, but on the other hand, its availability is low compared to hard water. This project take the advantage of chemical experiments to reduce the rates of damage of hard water by mixing it with fresh water and not depending on one type of water. Hence the idea of designing an engineering system for self-monitoring and control that connect a tank with two sources of fresh water and hard water, in which the mixing process takes place under values and standards given by a TDS sensor, so that the controller takes the readings of the TDS and based on this reading The water pumps are operated to mix in the appropriate range until the tank is full. The water level in the tank is known through the Ultrasonic water level sensor. All information is displayed in the LCD display**.**

Table of contents

List of tables:

List of figures:

List of Abbreviations:

USB	Universal serial bus
WHO	World health organization
IOT	Internet of things
TDS	Total dissolved solids
LCD	Liquid crystal display
Ph	Potential of hydrogen
FAO	Food and agriculture organization
EDTA	Ethylene diamine tetraacetic acid
IDE	Integrated development environment
LED	Light –emitting diode
GSM	Global system for mobile

Chapter One

Introduction

Chapter One

Introduction

1.1 Overview

Water is the foundation and the most important element for life, Water makes up 60-75% of human body weight. A loss of just 4% of total body water leads to dehydration, and a loss of 15% can be fatal. The planet contains a 70% of non-drinking water which means searching for the reliable sources for drinkable water for example rivers, rain and springs, but some areas suffer from scarcity in these sources, so they resort to take advantage of wells, but groundwater classifies as hard water.

There are no serious adverse health problems Trusted Source associated with drinking hard water. However, hard water can contribute to dry skin and hair. Washing your hair frequently with hard water can leave your scalp feeling itchy. The minerals in hard water can also change the pH balance of your skin, weakening it as a barrier against harmful bacteria and infections. People with eczema may be especially vulnerable. But hard-water can have some benefits too, humans need minerals to stay healthy. WHO states that drinking-water maybe a contributor of calcium and magnesium in diet and could important for those who are marginal intake, but should not be above standards.

There are different ways to soften water such as filters, distillation and mixing with fresh water, the last one considered as the cheapest, easiest and most affordable way.

1.2 Problem statement

People suffer every summer from the shortage of drinking water, and the government affords a lot of resources and time to provide them with soft water, trying to solve this problem, other available resources are examined, one of them is groundwater which is always obtainable, but it can't be used as a main source because of its hardness.

- Time consumed to provide a drinkable water is increased if there are no taking benefits of other resources
- Both quantity of water that are mixed are not measured.
- Tanks monitoring is not supported in many systems.

1.3 Proposed Solution

This project based on taking advantage of unusable resources to help covering the shortage by designing a system that mix hard water with soft water to provide a suitable drinking water.

1.4 Objectivities

- To design a monitoring system for the intended tank using ultrasonic sensor to shows the level of water.
- To design a measuring system that controls the amount and the quality of each water using a TDS sensor.
- To design a mixing system with two pumps, one for the soft water and the other for hard water to fill the tank.

1.5 Methodology

Experimental methodology has been used in this project; the first phase is to define the main aim, the technique which has been used to achieve those objectivities. the second stage is to describe the problems that associated with water hardness ,and this is done by studying the issue and its causes also examine related researches ,this exploration reveal some papers in different fields but using the same techniques and ideas , however it added more helpful thoughts .the third stage is writing the expected scenario from the moment soft water meets the hard water and the operation of mixing , depending on experiences that done inside the laboratories shows the effective and the accurate measures that gives the ideal quality , alternative solution is used inside the tank which provide the same results .

The system mass diagram and the simulation is the fourth stage, which helps to build, connect, operate the project, and avoiding any chance of failing or collapsing, after confirming all the stages the project is ready to contract.

Chapter Two

Literature Review

Chapter Two

Review of Literature

2.1 Theoretical background:

Water hardness, in scientific terms is generally the amount of dissolved calcium and magnesium in water, in layman's terms, you may notice water hardness in taste or when washing your hands and clothes. Hardness is caused by compounds of calcium and magnesium, and by variety of other minerals. General guidelines for classification of water are: 0 to 60 mg/L classified as soft, 61 to 120 mg/L as moderately hard, 121 to 180 mg/L hard, and more than 180 mg/L as very hard

Hard water is famous of its pungent taste; therefore this project is looking for ways to solving this issue, in a scientific respect to determine hardness EDTA solution has been used.
Determinations of hardness of water by EDTA method:

- Ammonia buffer procedure.
- Borate buffer procedure.
- Low hardness procedure.
- Calcium hardness procedure.

Hard water has been measured and the results came out very high, one of the solutions is to add fresh water and measure it again, to observe any different. The following experiment Clearfield the theory.
In the laboratory, 50 ml of hard water was titrated with 50 ml of fresh water and the proportions of following elements were obtained:

Table (2.1): Laboratory elements results

Element	**Quantity**
Sulphate	22.3 mg/l
Chloride	64 mg/l
Ph	5.55 – 6.22
Conductivity	60.7%
Carbonate	0
Bicarbonate	44.4 mg/l
Turbidity	11%

TDS ranges:

Table (2.2): TDS ranges

TDS value	Present value	Water quality
Less than 300	0% up to 20%	An ideal water
300 - 600	20% up to 40%	A good water
600 - 900	40 % up to 60%	an acceptable water
900 - 1200	60% up to 80%	unwanted water
More than 1200	80% up to 100%	unacceptable water

2.3 Related Works:

In this paper [1] the author concluded that two liquids of different volume can be mixed with one another by using one Arduino Uno board. The speed of the motor can be controlled by varying the input voltage of the pump. On the other hand, the volume of water taken from both beakers 1 and beaker 2 can be changed by further programming into the Arduino.(Banerjee, Mukherjee et al. 2017)

In this project [2] IOT Liquid Level observance system could be a very innovative system that will inform the users regarding the amount of liquid and can stop it from overflowing. To demonstrate this system makes use of four containers. For this, the system uses ultrasonic sensors placed over the containers to observe the liquid level and compare it with the container's depth. The system makes use of AVR family microcontroller, LCD screen, wireless local area network electronic equipment for causing knowledge and a buzzer. The system is steam-powered by a 12V electrical device. The liquid crystal display LCD digital display alphanumeric display screen is employed to display the standing of the amount of liquid within the containers. Whereas an online page is made to indicate the standing to the user observance it. The net page provides a graphical read of the containers and highlights the liquid level in color order to indicate the amount of the liquid. The liquid crystal display screen shows the standing of the liquid level. The system puts on the buzzer once the amount of liquid collected crosses the set limit. So this method helps to stop the wastage of water by informing regarding the liquid levels of the containers by providing a graphical image of the containers via an internet page.3(Malche and Maheshwary 2017)

In this paper [3] there is a proposed system that can be used to classify the organic and inorganic substances dissolved in portable water. This module includes a conductivity meter, a TDS meter and Arduino board where the process is carried out. The application is based on the statistical algorithm implemented. To provide an easy interface to the user, the Arduino is interfaced to a LCD display. The accuracy of the proposed system can be further enhanced by further classifying the salts more accurately through machine learning. This work can be extended in the future by developing an algorithm that can tell the user about the application of the water sample, for e.g., agriculture, industrial use and etc.(Rose and Mary 2018)

In this paper [4] the main aim is to identify quality of water using internet of things. Here executing, system for monitoring the water quality through sensors – TDS meter, DC motor, LM35 temperature sensor, GSM. The Microcontroller Avenue the value which is monitor by using of sensors. The accessed data are collected in the centralized database server. If the water quality is below the TDS meter values, alert Message is sent to land owners using GSM. The atmosphere can have adaptable good water.(Jayalakshmi and Hemalatha 2019)

In this paper [5] they used proposed system water with appropriate TDS level is obtained for drinking. Also the wastage of water is reduced by using this system. As Arduino is used as the main microcontroller, it results in low cost and it is reliable. Using the IOT cloud, the data of TDS and pH can be monitored from anywhere at any time. This proposed system could be a better solution for the arisen problem, as our model provides water with TDS range above 500mg/liter which is prescribed by the world health organization.(Jayanthi, Mathumitha et al. 2020)

In this paper [6] a set of high-level water tank monitoring system based on internet of things is designed. The system adopts TDS sensor and ultrasonic sensor to monitor the water quality and water level of the water tank respectively, and transmits the data back to the monitoring center for real-time monitoring through ZigBee - a wireless communication protocol. The system can control water level automatically and alarm when water is polluted. It has strong practical value

and significance that ensures the safety and stability of household water, and provides data support for the improvement of water tank water supply in the future(Zhou and Jiang 2020)

In [7] a report from FAO reveals that more than 2 billion people live in countries experiencing high water stress, with western and central Asia, and northern Africa being the most affected regions. A high level of water stress is linked to negative effects of social and economic development, increasing competition and potential conflict among users. Based on an analysis of the period between 1996 and 2016, the report concludes that water stress has increased for most countries in the world and has more than doubled in 26 countries, 15 of which are in Africa. Among likely reasons for these trends, the report highlights increased economic activities ,growing populations and improved ways to measure water usage , along with effects of climatic changes

2.3 Block diagram :

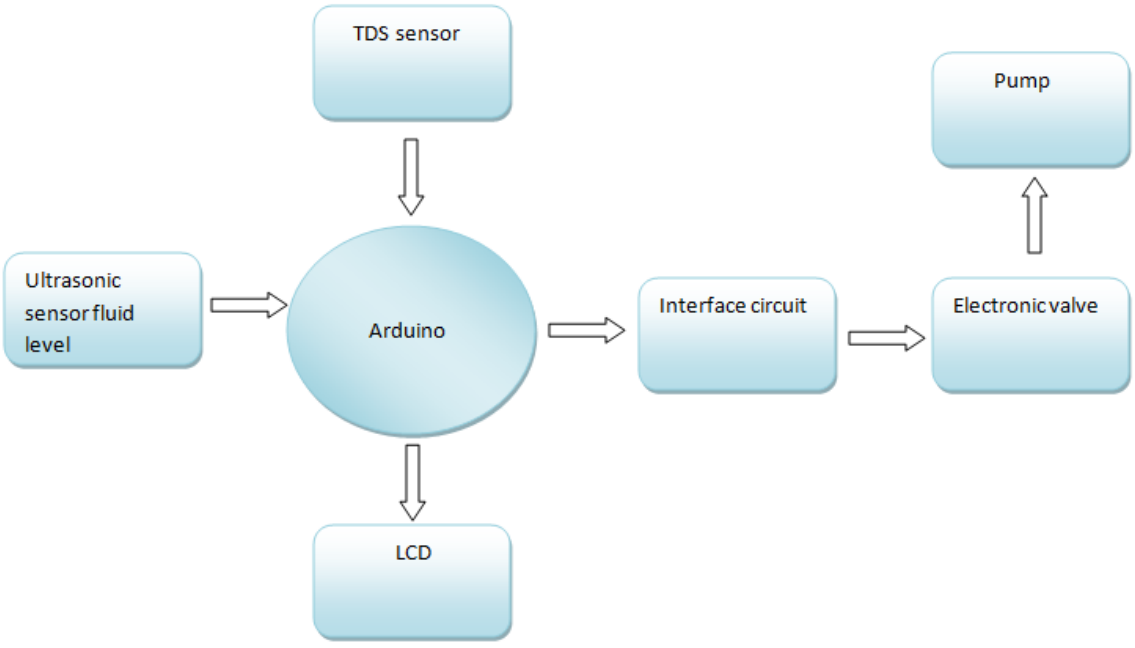

Fig (2.1) block diagram

Chapter Three

System Design and Implementation

Chapter Three

System Design

3.1 Proposed system

This chapter contains the mechanism and the conditions of the project that shows in the flow chart, also all the components that has been used.

3.1. 1 the Flow Chart:

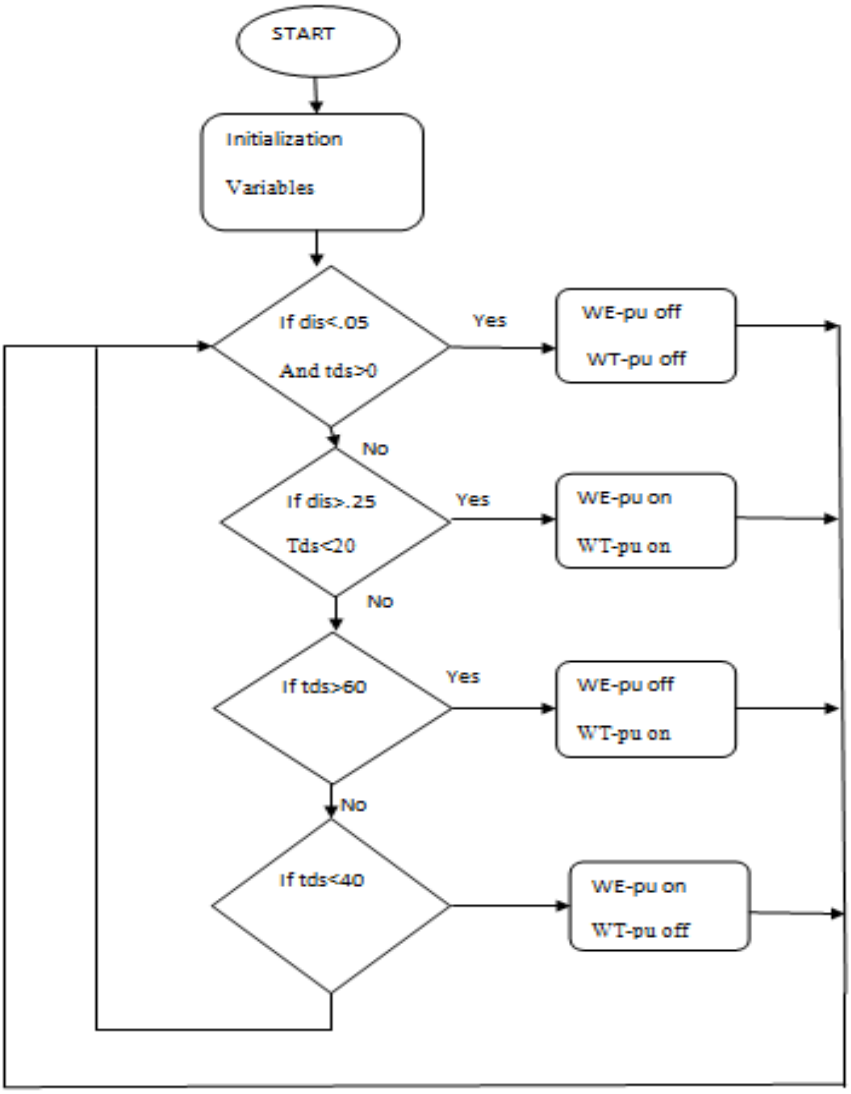

Fig (3.2) flow char

3.2 Components:-

Different components has been used in this project such as An Arduino , two sensors A TDS and An Ultrasonic sensor , two pumps connected to relays and LCD to display all the results and cases.

3.2.1 Arduino UNO

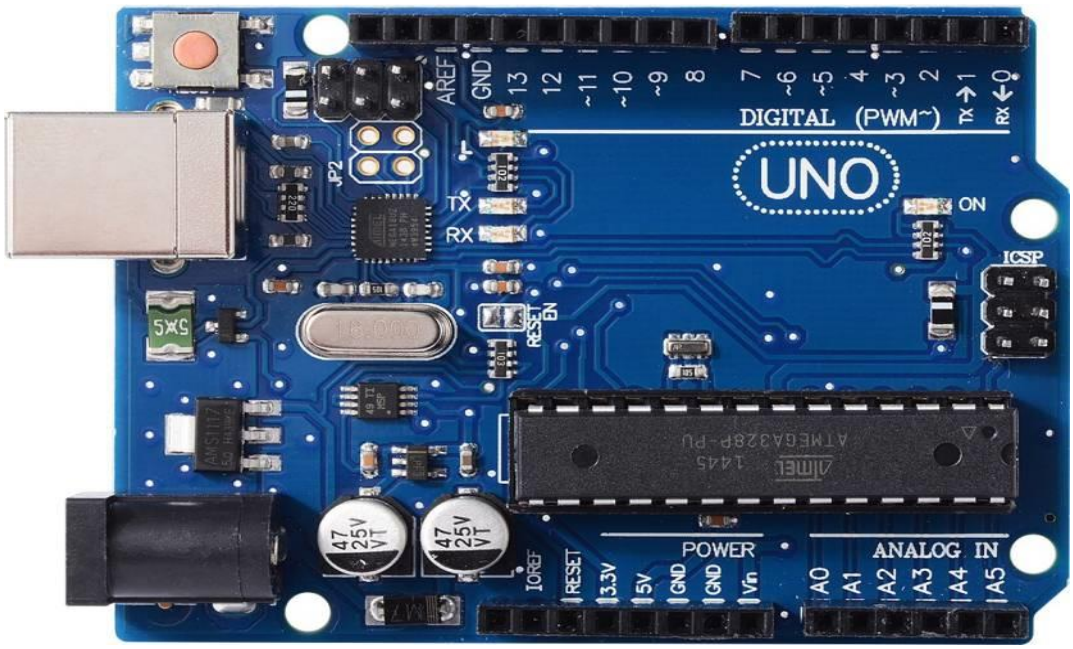

Fig (3.3) Arduino

Arduino is a prototype platform (open source) based on an easy to use hardware and software. It consists of a circuit board, which can be programmed (referred to as a microcontroller) and a readymade software called Arduino IED, which is used to write and upload the computer to the physical board.

The key features are – Arduino board are able to read analog or digital input signals from different sensors and turn it into an output such as activating a motor ,turning LED on/off ,connect to the cloud and many other actions.

You can control your board functions by sending a set of instruction to the microcontroller on the board via Arduino IDE (referred to as uploading software). Unlike most previous prog.rammable

circuit board, Arduino does not need an extra piece of hardware (called a programmer) in order to load a new code onto the board simply use a USB cable. Additionally, the IDE uses a simplified version of C++, making it easier to learn to program.

Board types: various kinds of Arduino board are available depending on different microcontrollers used. However, all Arduino boards have one thing in common: they are programmed through the Arduino IDE.

The differences are based on the number of inputs and outputs (the number of sensors, LEDs, and buttons you can use on a single board), speed, operating voltage, form factor etc. Some boards are designed to be embedded and have no programming interface (hardware), which you would need to buy separately. Some can run directly from a 3.7V battery, others need at least 5V.

3.2.2 DC water pump

Fig (3.4) DC water pump

Refers to a small water pump built by 12v, 24v, 5v, 6v, 9v, 3v, mini electric brushed DC motor or brushless DC motor. It powered by a dc power supply, solar dc power supply, or battery operated. Usually used as a dc booster pump, dc submersible pump, dc solar pump, dc circulation

pump to pressurize, transport and circulate liquids. Such as water, oil, acid and alkali liquids, food grade liquids. Emulsions, etc. compares with AC water pumps driven by 120v, 220v, 240v, 380v AC motors, DC pump has characteristics of small size, safety, high efficiency, low noise, portable, etc. As a low voltage electric water pump, DC water pumps are widely used for applications that requires low price, safety, quiet, low power consumption. Such as applications for: home appliance, vehicle, pool, well, pet water fountain, aquarium, fish tank, dc fountain, water heater, water circulation system, automotive heat management system, etc.

The main advantage of DC (direct current) pumps over AC (alternating current) pump is that they can operate directly from a battery, making them more convenient and portable. They are easier to operate and control, since AC systems typically require a controller to manage speed.

3.2.3 TDS Sensor:-

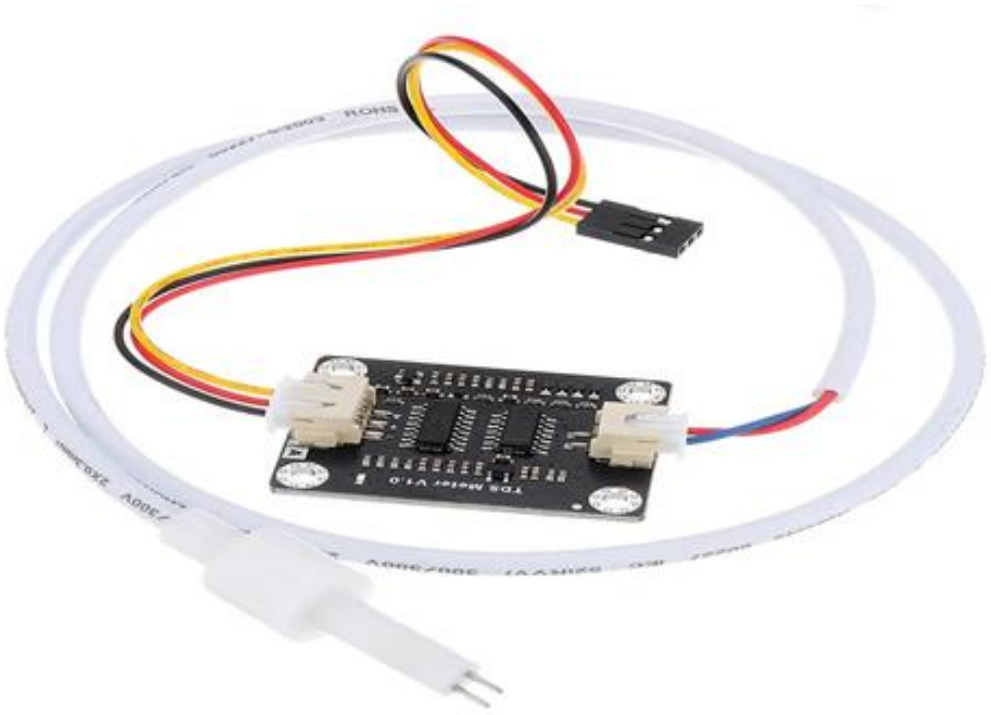

Fig (3.5) TDS sensor

Description:

The grove – TDS sensor detects the total dissolved solid (TDS) levels in the water which can be used to indicate the water quality , the grove –TDS can be applied in water quality applications as TDS meter , will water , aquarium , hydroponics , etc.

It supports 3.3v/5v input voltage and 0 to 2.3v output voltage making it easy to be compatible with all Arduino boards. The sensor also provides a water proof probe, making the testing process much easier to handle.

What is the TDS:-

TDS = total dissolved solids , is a measure of the dissolved combined content of all inorganic and organic substances present in water , typically the higher the TDS value , the more substances dissolved in water , hence , higher level of total dissolved solids (TDS) can indicate that water has more contaminants can pose health risks .

APPLICATIONS:-

- TDS METER /TDS TESTOR
- Swimming pool
- Will water
- Hydroponics

Specifications:-

- Input voltage : 3.3 / 5v
- Output voltage : 0 to 2.3 v
- Working current : 3 to 6 ma
- TDS measurement rang : 0 to 1000 ppm
- Power indication LED
- Connection interface : grove 4-pins / XHP 2.54mm 2P

Water proof probe:

- Cable length : 60cm
- Connections interface : XHB 2.54mm 2P

3.2.4 .Ultrasonic Sensors:

With ultrasonic sensors, we can find the water depth calculation by finding the distance between the transceiver and the surface of the water. The sensor will transmit a short ultrasonic pulse, and we can measure the travel time of that pulse (the echo) to the liquid and back

When an electrical pulse of high voltage is applied to the ultrasonic transducer it vibrates across a specific spectrum of frequencies and generates a burst of sound waves.

Whenever any obstacle comes ahead of the ultrasonic sensor the sound waves will reflect back in the form of echo and generates an electric pulse. It calculates the time taken between sending sound waves and receiving the echo. The echo patterns will be compared with the patterns of sound waves to determine the detected signal's condition.

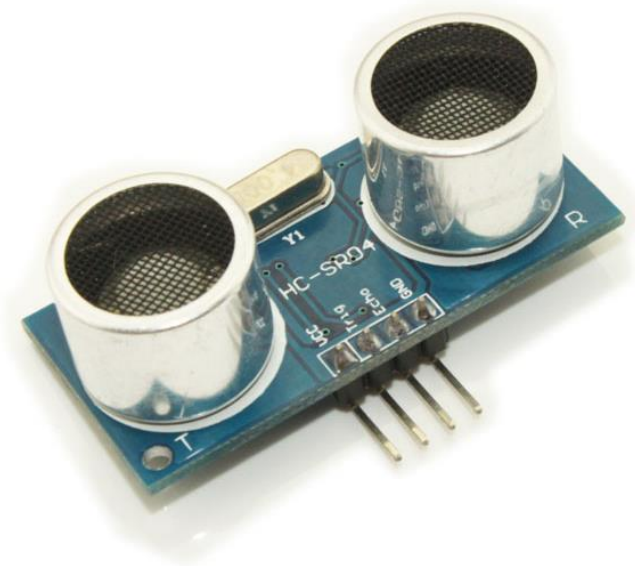

Fig (3.6) Ultrasonic

3.2.5 Relay :

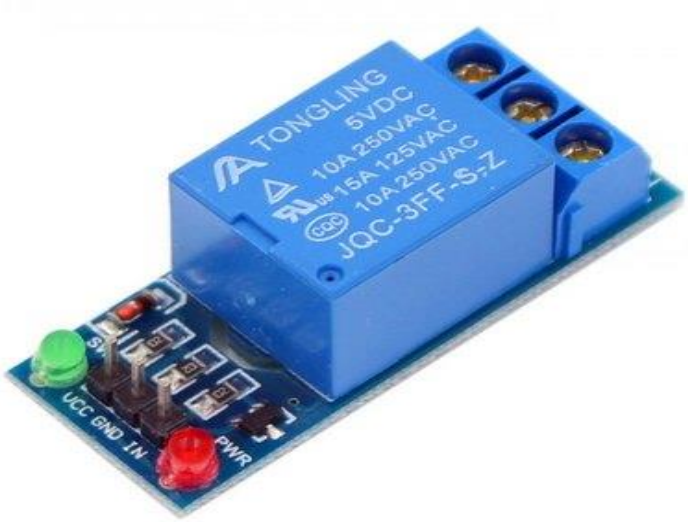

Fig (3.7) Relay

The relay is the device that opens or closes the contacts to cause the operation of the other electric control. It detects the undesirable condition with an assigned area and gives the commands to the circuit breaker to disconnect the affected area through ON or OFF.

Every electromechanical relay consists of

1. Electromagnet
3. Mechanically movable contact
3. Switching points and
4. Spring

Pin out of relays are:

COM: common pin

NO: normally open – there is any contact between the common pin and the normally open pin. So, when you trigger the relay, it connects to the COM pin and power is provided to the load.

NC: Normally closed – there is contact between the common pin and the normally closed pin.

There is always connection between the COM and NC pins, even when the relay is turned off. When you trigger the relay, the circuit is opened and there is no supply provided to the load.

WORKING PRINCIPLE OF RELAY:

It works on the principle of an electromagnetic attraction. When the circuit of the relay senses the fault current, it energizes the electromagnetic field which produces the temporary magnetic field. This magnetic field moves the relay armature for opening or closing the connections. The small power relay has only one contact, and the high power relay has two contacts for opening the switch.

The inner section has an iron core which is wound by a control coil. The power supply is given to the coil through the contacts of the load and the control switch. The current flows through the coil produce the magnetic field around it. Due to this magnetic field, the upper arm of the magnet attracts the lower arm. Hence close the circuit, which makes the current flow through the load. If the contact is already closed, then it moves oppositely hence opens the contacts.

Types of Relay Based on the principle of operation:

1. Electro thermal relay:
2. Electromechanical relay:
3. Solid State relay:
4. Hybrid relay:

3.3 LCD display

The term stands for liquid crystal display. It is one kind of electronic display module used in extensive range of application like various circuits & devices like mobile phones, calculator's computers, TV set, etc. The main benefits of using this module are inexpensive; simply programmable, animations, and there are no limitations for displaying custom characters, special and even animations, etc.

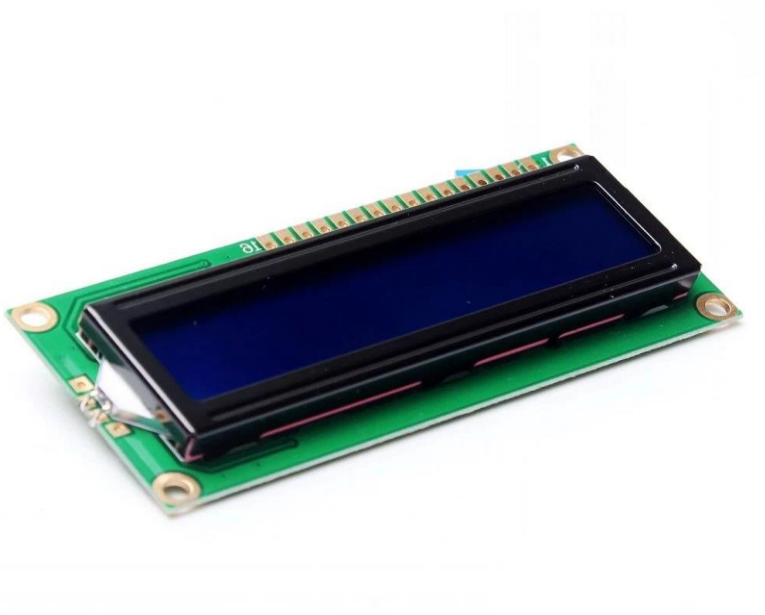

Fig (3.8) LCD

Chapter Four

Results and Discussions

Chapter Four

Result and Discussions

4.1 System Simulation:

Before implementing the project practically, a simulation of the project was made on the protues program, where the simulation shows all the components used and the functioning of it , all the elements were linked with the Arduino controller

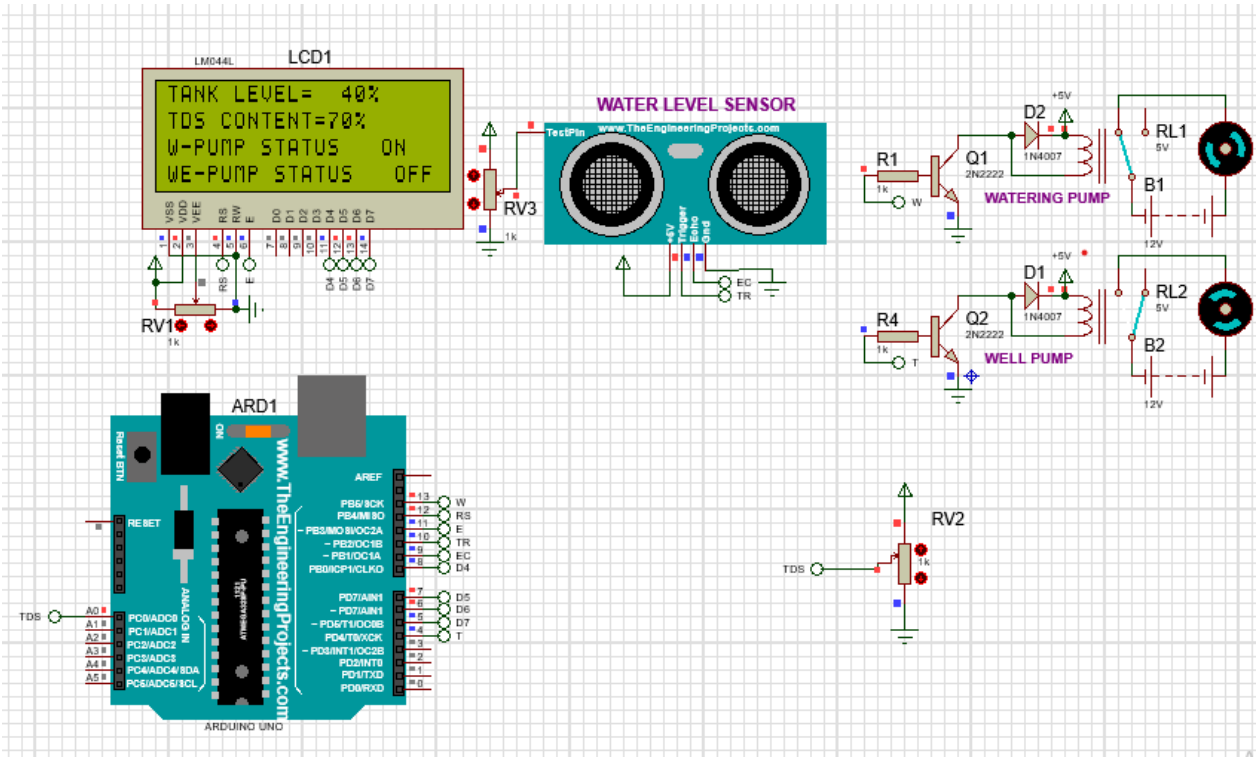

Fig (4.1) simulation

4.1 discussions:

Water level sensor is used to measure the dimension of the tank and the volume of water in it, then send it to the controller as a signal, depends on these signal the controller takes necessary steps.

In case the tank was totally empty both pumps are turned on, then the TDS begins to take its readings, when the sensor reaches a rate of 50 the controller turns the well pump off.

If the sensor gives a reading in a ratio of 0-20 it means that it's ideal water so the well pump will continue pumping and the other pump won't be needed. The ultrasonic sensor continuously records the readings and compares them with the TDS sensor, and thus the controller determines the operation of the appropriate pump.

First case:

When the LCD shows that the ultrasonic is less than 5cm that's mean the tank is full, the controller turns the pumps off, and the TDS values will be ignored.

Fig (4.2) case 1.1

Fig (4.3) case 1.2

Second case:

When the **ultrasonic** record readings more than 30cm, the TDS is less than 30, it is considered a good water, which means the two pumps will be needed to fill the tank. .

Fig (4.4) case 2.1

Fig (4.5) case 2.2

Third case:

In this case the controller ignore the ultrasonic readings unless it was similar to the first case , and TDS sensor is more than 50 the controller turn the watering pump immediately on to balance the hardness in the tank .

Fig (4.6) case 3.1

Fig (4.7) case 3.2

The fourth case:

This case is different from the other because the TDS is less than 30, it means the water is nearly perfect so we only need the well pump, it will continue pumping till the TDS value increase.

Fig (4.8) case 4.1

Fig (4.9) case 4.2

4.4 Results:-

1. All the information are shown in the LCD screen.
2. Water level can be found at any time.
3. The system treated the hard water to fit to drink in a simple and economical way.

For watching system results check the link or scan the QR code below.

https://www.facebook.com/101400022027738/videos/542826293932787/

Chapter Five

Conclusion and Recommendations

Chapter Five
Conclusion and Recommendations:

5.1 Conclusion:

Hard water treatment system has been designed and tested successfully to do its major purpose of monitoring and mixing water to help solving water scarcity. The results showed that the TDS values determine which operation; the water level which has been detected by the ultrasonic sensor gives the start signal to the controller. The pumps works depends on the different cases.
Arduino is the main controller that connect all the elements of the system and processing the reading to give the required output and display it in the LCD screen.

5.2 Recommendations:

1. Use other controllers that support WI-FI to remote the system and connect it through an application.
2. Put flow water sensors inside water supply pipes to know if there is a running water.

References

References

[1] Banerjee, N., et al. (2017). "Arduino based liquid dispensor system using peristaltic pump." BS Project, West BengalUniversity of Technology, Kolkata.

[2] Jayalakshmi, S. and P. Hemalatha (2019). Measuring the Water Quality in Bore well Using Sensors and Alerting System. 2019 IEEE International Conference on System, Computation, Automation and Networking (ICSCAN), IEEE.

[3] Jayanthi, G., et al. (2020). Smart Monitoring and Control of Water Filtration System Using IOT. 2020 International Conference on Power, Energy, Control and Transmission Systems (ICPECTS), IEEE.

[4] Malche, T. and P. Maheshwary (2017). Internet of things (IoT) based water level monitoring system for smart village

[5] Rose, L. and X. A. Mary (2018). TDS Measurement Using Machine Learning Algorithm. 2018 International Conference on Circuits and Systems in Digital Enterprise Technology (ICCSDET), IEEE.

[6] Zhou, C. and P. Jiang (2020). A design of high-level water tank monitoring system based on Internet of things. 2020 7th International Forum on Electrical Engineering and Automation (IFEEA), IEEE.

[7] FAO report: FAO Report Analyzes Global Trends in Water Stress | News | SDG Knowledge Hub | IISD

[8] For materials WIKIPEDIA: Search - Wikipedia

Appendix

Appendix:

```
#include <LiquidCrystal.h>

#define well_pump 6
#define watering_pump 13
#define tds A0
int trigger= 10;
int echo=9 ;
int tds_value;
int tds_percent;
float time=0,distance=0;
int temp=0;
const int rs = 12, en = 11, d4 = 5, d5 = 4, d6 = 3, d7 = 2;
LiquidCrystal lcd(rs, en, d4, d5, d6, d7);

void setup()
{
  lcd.begin(20,4);
  pinMode(trigger,OUTPUT);
  pinMode(echo,INPUT);
  pinMode(tds,INPUT);
  pinMode(watering_pump,OUTPUT);
  pinMode(well_pump,OUTPUT);
```

```
  lcd.print("  starting ");
  lcd.setCursor(0,1);
  delay(1000);
}
void loop()
{
  lcd.clear();
  digitalWrite(trigger,LOW);
  delayMicroseconds(2);
   digitalWrite(trigger,HIGH);
  delayMicroseconds(10);
   digitalWrite(trigger,LOW);
  delayMicroseconds(2);
  time=pulseIn(echo,HIGH);
  distance=time*340/2000000;
  tds_value= analogRead(tds);
  tds_percent=map(tds_value,0,500,0,100);
  lcd.clear();
  lcd.print("TANK LEVEL=");
  lcd.print(distance);
  lcd.print("m");
  lcd.setCursor(0,1);
  lcd.print("TDS CONTENT =");
  lcd.print(tds_percent);
```

```
  lcd.print("%");
  delay(5000);



if (distance>.25 &&tds_percent<20 )
{
    lcd.clear();
    digitalWrite(well_pump,LOW);
    digitalWrite(watering_pump,LOW);
     lcd.print("W-P STATUS");
     lcd.print(" ON");
     lcd.setCursor(0,1);
     lcd.print("WE-P STATUS");
     lcd.print(" ON");
     delay(5000);
    temp=0;
  }
else if (distance<0.05&& tds_percent>0)
{
  lcd.clear();
  digitalWrite(well_pump,HIGH);
  digitalWrite(watering_pump,HIGH);
     lcd.print("W-P STATUS");
     lcd.print(" OFF");
```

```
    lcd.setCursor(0,1);
    lcd.print("WE-P STATUS");
    lcd.print(" OFF");
delay(5000);
temp=0;
}
 else if (tds_percent>60 &&temp==0 )
 {
  lcd.clear();
  digitalWrite(watering_pump,HIGH);
  digitalWrite(well_pump,LOW);
      lcd.print("W-P STATUS");
    lcd.print(" OFF");
    lcd.setCursor(0,1);
    lcd.print("WE-P STATUS");
    lcd.print(" ON");
   delay(5000);
  }
 else if ( tds_percent<40 &&temp==0 )
{
  lcd.clear();
   digitalWrite(well_pump,HIGH);
   digitalWrite(watering_pump,LOW);
    lcd.print("W-P STATUS");
```

```
    lcd.print(" ON");
    lcd.setCursor(0,1);
    lcd.print("WE-P STATUS");
    lcd.print(" OFF");
   delay(5000);
}



}
```