

ASSESSMENT AND PURIFICATION OF TOTAL DISSOLVED SOLIDS IN WATER

A project Report Phase – II

Submitted in partial fulfilment of the requirements for the award of Bachelor of
Engineering degree in Electronics and Communication Engineering.

by

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SATHYABAMA

**INSTITUTE OF SCIENCE AND TECHNOLOGY
(DEEMED TO BE UNIVERSITY)**

**Accredited with Grade “A” by NAAC
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DEPARTMENT OF ELECTRONICS AND COMMUNICATION ENGINEERING

BONAFIDE CERTIFICATE

This is to certify that this Project Report is the bonafide work of **JERMANUS ALONZO.A (39130186)** and **GOPINATH.K (39130145)** who carried out the project entitled "**ASSESSMENT AND PURIFICATION OF TOTAL DISSOLVED SOLIDS IN WATER**" under my supervision from November 2022 to April 2023

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We **JERMANUS ALONZO.A (39130186)** and **GOPINATH.K (39130145)** Report entitled "**ASSESSMENT AND PURIFICATION OF TOTAL DISSOLVED SOLIDS IN WATER**" done by us under the guidance of **Dr. T. THAJ MERY DELSY M.E.,Ph.D.**, at Sathyabama Institute of Science and Technology, Chennai- 600119 is submitted in partial fulfilment of the requirements for the award of Bachelor of Engineering in Electronics and Communication.

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ABSTRACT

According to the World Summit of Sustainable Development, the major reason for lack of safe water is either scarcity of water or contamination of water sources. Lack of safe drinking water is due to both lack of investment in water systems and inadequate maintenance of existing systems. TDS (Total Dissolved Solids) indicates how many milligrams of soluble solids are dissolved in one liter of water. In general, the higher the TDS value, the more soluble solids are dissolved in water, and the less clean the water is. Therefore, the TDS value can be used as one reference point for reflecting the cleanliness of the water. This can be applied to domestic water, hydroponic and other fields of water quality testing and monitoring. In this project, we will interface Gravity Analog TDS Sensor with arduino Microcontroller and read the value in 16x2 LCD Display. Since TDS Value depends upon the temperature. The measured temperature is used with TDS Sensor to compensate for the reading with high calibration and high accuracy. After the assessment of the water sample and assigning the water quality – if the water sample is not suitable for human / animal consumption it is automatically sent to a water purification system to get purified water which is suitable for consumption. The main objective of this project is to create a smart and low-cost water quality indication and management system which can be effectively used in an household.

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CHAPTER 1

INTRODUCTION

Water is a substance that can be seen everywhere in our daily life and is an indispensable resource for the human life and the development of industry and agriculture. With the rapid development of social economy, the water quality problem has been exposed gradually. Excessive discharge of industrial sewage leads to water pollution, and then the quality of domestic water is also affected by the environment. Therefore, it is necessary to monitor the water quality. The water quality monitoring system consists of water quality measuring equipment, data acquisition equipment and data transmission system. Water quality measurement equipment is mainly based on all kinds of sensors. Data acquisition equipment is usually controlled by an MCU. Data transmission system is mainly divided into wired transmission and wireless transmission. For a general scenario such as the household environment, TDS (Total Dissolved Solids) are usually monitored to assess the water quality comprehensively, which can basically reflect the water condition.

According to the World Summit of Sustainable Development, the major reason for lack of safe water is either scarcity of water or contamination of water sources. Lack of safe drinking water is due to both lack of investment in water systems and inadequate maintenance of existing systems. TDS (Total Dissolved Solids) indicates how many milligrams of soluble solids are dissolved in one liter of water. In general, the higher the TDS value, the more soluble solids are dissolved in water, and the less clean the water is. Therefore, the TDS value can be used as one reference point for reflecting the cleanliness of the water. This can be applied to domestic water, hydroponic and other fields of water quality testing and monitoring. In this project, we will interface Gravity Analog TDS Sensor with Microcontroller and read the value in 16x2 LCD Display. Since TDS Value depends upon the temperature. The measured temperature is used with TDS Sensor to compensate for the reading with high calibration and high accuracy. After the assessment of the water sample and assigning the water

quality – if the water sample is not suitable for human / animal consumption it is automatically sent to a water purification system to get purified water which is suitable for consumption. The main objective of this project is to create a smart and low cost water quality indication and management system which can be effectively used in an household.

1.1 OBJECTIVE

To design and implementation of water quality monitoring system. The measure of Total Dissolved Solids, also known as TDS, is a measurement of the combined total of the inorganic and organic substances dissolved in a given water source. A TDS test can be used to determine the general quality of the water. A high TDS level is an indicator of potential concerns , The main application of TDS is in the study of water quality for streams/rivers and lakes. It is used as an indication of characteristics of drinking water and as an aggregate indicator of the presence of a broad array of chemical contaminants.

1.2 PROBLEM STATEMENT

The estimate of water quality is realized through laboratory analysis which is time consuming and requires specialized installation, equipment and personnel.

CHAPTER 2

LITERATURE REVIEW

An innovative real-time online water quality monitoring system was built by Chengcheng Zhang(2020)et.al, and the effects is suggested as a solution to the issues with the existing water quality discovery method. This outcome combines the WiFi wireless transmission, the STM32 single-chip microcomputer design, detectors, and remote monitoring application.The system employs detectors to measure factors such as temperature, pH level, and turbidity of the water, and it wirelessly transmits the data to the control centre.. In accordance with the findings of the analysis, the quality of the water terrain was assessed, and water quality issues were forewarned in order to prevent contamination further.. This system can be pushed and used in the future to encourage the development of water terrain monitoring since it has good real-time performance and strong practicability.

Qiuchan Bai (2020) et.al, infers that water is the source of all life and the most essential element for human survival. Water is essential for life and all mortal products. Water is essential to civic life, agricultural irrigation, and the production of artificial goods. China has one of the largest populations in the world, but its per-capita water supply is barely one-fourth of the global average, and its rapid-fire economic development is at the demitasse stage. This study suggests using wireless detector network technology to develop a water contamination monitoring system due to the poor real-time performance, secondary contamination, high cost, and other difficulties. The system has robust real-time, online monitoring capabilities and collects data on a variety of parameters that have an impact on water quality. It also provides timely and direct coverage of water quality-related information and assists in reducing the effects of water pollution.

Nikhil Kumar Koditala and Purnendu Shekar Pandey (2018) presents that Drinking water scarcity is one of the top global threats, according to the World Economic Forum, and it contributes to the daily deaths of 200 children worldwide. Every year, almost 3.4 million people die by consuming contaminated water. Despite

technological advancements there aren't enough quality measures available to assess drinking water quality. Focusing on the following topic, this study suggests a low cost water quality monitoring system that can replace the conventional method of quality monitoring by utilising emerging technologies such as IoT, Machine Learning, and Cloud Computing.. This aids in protecting residents of rural areas from hazardous disorders like fluorosis, bone scars, etc. The suggested model also has the ability to regulate water temperature and modifies it to match terrain temperature with a R-squared score of 0.933.

L. Lakshmanan (2020) et.al, infers that Many people today are suffering from severe ailments that are brought on by contaminated water. The researchers conducted an analysis for a water quality monitoring system in the design, which provides information about the quality of water on a website. Using colourful devices such as PH detectors and turbidity detectors connected to microcontrollers, the quality of water is assessed.. The GSM module is attached to the Arduino, and the Arduino programme is built in embedded C. With a microcontroller and wifi, data will be continuously transferred from the remote detection organisation. Data is sent to the webpage connected to the microcontroller through the internet using the wifi module. The website presents the complete data regarding the chastity of water and analyses it using graphs, pie charts, and numbers that are listed in a table. We transfer this information to Pall, where visitors can access it using a web browser. Customers from anywhere can view the data at any time

Shadman Rafid,et.al (2019) in this composition presented the monitoring of water quality by means of wireless detector technology that's powered by solar energy. The different factors necessary for water quality is measured using detectors with solar efficiency. The information from the detectors are inferred and subsequently transferred to the pall garçon e. The collected data is further anatomized, to be presented in visual format in TV and visual appreciation is demonstrate via Thing Speak

Abílio C. Da Silva Júnior, et al., concludes that in many countries and international realities are concerned about the failure of the earth's water reserves. With improvements in communication technology, smart findings for water quality monitoring are becoming more and more important. The main goal is to create the Internet of Water impacts, a new online system to cover and manage water resources (IoWT). Control and management of raw water coffers would be the optimum function of the suggested system. Hence, it has created a platform built on a serverless architecture and the Internet of effects. Architectural Reference Model, in which a simulated terrain is used, a number of electronic biases are taken into account to verify its performance. An electrical device records the data every nanosecond, and it is sent to the IoWT system hourly. A device installed in the well is connected to the platform where the IoWT system is being installed and data is relayed over a 3G network and also reused there. As a result the proposed model will support decision-making for the operation in water facilities

According to Libu Manjakkal, et.al (2019) The water quality monitoring (WQM) detection technology has improved recently. despite those advancements there is a gap between the quality of the data collected and its analysis because there are no defined methods for doing so, key water body metrics vary spatiotemporally, and there are new pollutants. Such gaps can be filled using a network of independent vehicles stationed in water bodies to expand the data content in space and time. Similarly, intelligent algorithms (such as those based on artificial intelligence (AI)) could be used for uniform data analysis

It can be concluded in Gehad Hassan,Mohamed E. Goher,Masoud, et.al model that both wealthy and developing nations face significant challenges when it comes to monitoring water quality.. In order to address the issue of insufficient samples and reduce the time and expense associated with sample gathering , this research provides a new automated approach for constantly monitoring water quality. Using guard- 2A data, the model calculates both optical and non-optical water quality characteristics. The association between uprooted reflectance values from guard- 2A pictures and anatomized samples is ascertained using a mongrel

model comprising a double Whale Optimization Algorithm (BWOA) and Artificial Neural Network (ANN) (BWOA- ANN). This model is new in that it solves the issues of weak connection and low non-optical parameter sensitivity in distant water quality monitoring

Shuangyin Liu, et.al., presented that For water quality to operate in ferocious monoculture, it is crucial to rule out errors in detectors, wireless transmitters, and gateways. To obtain high fault individual delicacy of bias control and water quality monitoring is this study suggests a mongrel model based on rule-based decision trees and multiclass support vector machines (MSVM) (RBDT). An RBDT is used in the modelling process to simultaneously analyse the wireless transmitter and gateway faults as well as a point selection tool to minimise the number of features. Due to its reliability and design, a multiclass support vector machine classifier is used to identify the problems with quality detectorsThe experimental findings demonstrate that the suggested model, RBDT-MSVM, outperforms the other three fault opinion styles by achieving bracket delicacy as high as 92.86. The outcomes clearly demonstrate the created model's superiority in terms of bracket delicacy and demonstrate that it is an appropriate and efficient approach for faulty perception of water quality monitoring bias in aggressive monoculture

Thaine H. Assumpcao,et.al., infers that in the past, wireless sensor networks and advanced seeing technologies have shown their utility in protecting municipal water systems, whose operation is largely centralized within water mileage associations. Environmental water coffers, marked by additional diverse stakeholders and overlapping operation liabilities of several authorities, present further more difficult conditions for enforcing modern seeing technologies. It has been suggested that citizen crowd sourcing is a crucial strategy for data gathering that can increase the volume of data collected and bring together residents and other stakeholders for more inclusive processes for operating water resources. The first part of this composition discusses the difficulties in constructing citizen juggernauts for environmental data collection. The field prosecution of citizen juggernauts in the Romanian Danube Delta and the Greek Kifissos catchment is

given, together with lessons acquired from the tasks. Two of the juggernauts are focused on gathering data on water conditions and water speed, while two are focused on gathering information on land use and land cover. Notwithstanding data losses caused by poor raw data quality, a distinctive and sizable dataset for quantitative water measures was nonetheless obtained. The applicability of this dataset for original authorities needs to be evaluated further effort.

Nur Aqilah Paskhal Rostam, et.al., proposed A comprehensive framework approach for Harmful Algal Bloom (HAB) growth vaticination is essential for water operations, particularly when it comes to imposing reliable prophetic modelling of HAB to reduce water pollution. These research are important for discussing both the Internet of Things and the vaticination system in relation to the ecology of algae. In order to provide a more comprehensive overview of the end-to-end process, this paper includes information on the assembly and integration of detectors, data access, and prophetic modelling using data-driven approaches, as well as examples of machine literacy, deep literacy, and deep time series soothsaying algorithms for mitigating unborn algal bloom outbreaks. This essay considers it crucial to discuss everything from a broad perspective that is based on the execution of each stage. Also, it provides a thorough grasp of the vaticination issues and elements that affect algae development in order to develop a reliable vaticination algorithm. The vaticination of chlorophyll- a (Chl- a), a powerful indicator of algal presence for littoral studies, using Long Short- Term Memory (LSTM), one of the listed algorithms, has surpassed other beginning machine literacy approaches in directly prognosticating algal growth

According to Kunyi Zhang, et.al., the water coffers, which are becoming increasingly precious as a result of population development, an increase in the demand for clean water sources, and environmental degradation, can operate more efficiently with the help of finely granular data on water quality. There is an urgent need for independent, dependable, cost-efficient, and reusable water-sighting technology that can provide precise quality measurements. This study offers a detector array for microwave ovens that operates at various frequencies in the broad frequency range of 1 GHz to 10 GHz. Standard published circuit board (PCB)

technology can be used to create the detector array in an economical manner. Afterwards, it is tested with water to determine the parameter values and outcomes of colored contaminants.

2.1 LITERATURE SUMMARY

Water purification for human consumption purposes consists in the removal of different contaminants as chemicals (i.e., pollutants, toxic metals), biological contaminants (algae, bacteria, fungi, parasites, viruses), suspended solids, and gases.

- There are several methods used in the water purification process, which include: physical processes, such as filtration, sedimentation, or distillation;
- biological processes, such as sand filters, active carbon;
- chemical processes, such as flocculation, chlorination, the use of ultraviolet light.

these methods process all kinds of water without knowing the purity, which is main reason for the wastage of resource.

CHAPTER 3

AIM AND SCOPE

3.1 AIM OF THE PROJECT

Assessment and purification of total dissolved solids (TDS) in water is an important project as high levels of TDS in drinking water can affect its taste, color, and odor. It can also have negative effects on human health if consumed in excessive amounts. The aim of this project is to develop a method for assessing the level of TDS in water and purifying it to safe levels.

The following are some steps that can be taken to carry out this project:

- Assess the level of TDS in water: A reliable method for measuring TDS should be established. This can be done using a TDS meter or by gravimetric analysis. The water samples should be collected from different sources, such as tap water, well water, and groundwater.
- Identify the sources of TDS: The sources of TDS in water can be natural or man-made. The natural sources include dissolved minerals such as calcium, magnesium, and sodium, while man-made sources include industrial waste, agricultural runoff, and sewage. The source of TDS in the water should be identified to develop an effective purification method.
- Purify the water: There are different methods of purifying water, such as reverse osmosis, distillation, and ion exchange. The most suitable method for purifying the water should be selected based on the source and level of TDS in the water. The purified water should be tested to ensure that it meets the standards set by regulatory bodies.
- Monitor the TDS level in the purified water: Regular monitoring of the TDS level in the purified water should be done to ensure that it remains within safe limits. This can be done using a TDS meter.
- Evaluate the effectiveness of the purification method: The effectiveness of the purification method should be evaluated to determine if it is capable of purifying water with high levels of TDS. The cost-effectiveness of the method should also be evaluated to determine if it is a viable option for large-scale purification

In conclusion, the project on assessment and purification of total dissolved

solids in water is an important one as it aims to ensure that the water, we consume is safe and free from harmful contaminants. The project requires a thorough understanding of the sources of TDS in water and the various purification methods available. With proper assessment and purification methods, it is possible to ensure that the water we consume is safe and free from harmful contaminants.

3.2 SCOPE OF THE PROJECT

Assessment and purification of total dissolved solids in water is a critical area of research that has significant scope for future development. Here are a few potential areas of focus for the project:

- Development of new purification technologies: There is a need for the development of new technologies for the purification of water with high total dissolved solids. Researchers can explore new purification methods such as adsorption, membrane filtration, reverse osmosis, and electrodialysis.
- Use of nanotechnology for purification: Nanotechnology is emerging as a promising field for water purification. Researchers can explore the use of nanoparticles for removing dissolved solids from water.
- Development of low-cost purification methods: Water purification is a costly process, especially in developing countries. Researchers can focus on developing low-cost purification methods that are affordable for everyone.
- Advanced monitoring and analysis: Monitoring and analysis of water quality are essential to ensure the effectiveness of purification methods. Advanced monitoring and analysis techniques, such as remote sensing, real-time monitoring, and machine learning, can help identify the sources of contamination and improve the purification process.
- Treatment of industrial wastewater: The discharge of industrial wastewater is a significant contributor to water pollution. Researchers can focus on developing new treatment methods for industrial wastewater to reduce the level of dissolved solids in the water.

Overall, there is a significant scope for the assessment and purification of total dissolved solids in water.

CHAPTER 4

MATERIALS AND METHODOLOGY

4.1 EXISTING METHODOLOGY

Total dissolved solids (TDS) is a measurement of the amount of inorganic and organic substances dissolved in water. High TDS levels can indicate the presence of contaminants in water, which can affect its quality and suitability for various uses.

There are several technologies available for measuring and reducing TDS levels in water:

- **Conductivity Meters:** These are simple and inexpensive devices that measure the electrical conductivity of water, which is directly proportional to the TDS level. Conductivity meters are widely used in laboratory settings and can provide accurate and reliable TDS measurements.
- **Reverse Osmosis (RO) Systems:** RO systems are widely used in water treatment facilities to remove dissolved solids from water. In an RO system, water is forced through a semi-permeable membrane that traps dissolved solids while allowing pure water to pass through.
- **Distillation Systems:** Distillation is another effective method for removing dissolved solids from water. In a distillation system, water is heated until it turns into steam, which is then condensed and collected as pure water. This process removes most dissolved solids from the water.
- **Ion Exchange Resins:** Ion exchange resins are used in water softening systems to remove dissolved minerals that contribute to hardness. These resins work by exchanging ions with the dissolved minerals, effectively removing them from the water.
- **Electrodeionization (EDI) Systems:** EDI systems use a combination of ion exchange resins and an electrical current to remove dissolved solids from water. The process removes both positively and negatively charged ions.

Overall, the technology used for measuring and reducing TDS levels in water varies depending on the specific application and the level of TDS present. With the right technology and treatment process, it is possible to achieve safe and high-quality water for various uses.

4.2 PROPOSED METHODOLOGY

Firstly, the module will consist of a microcontroller. A microcontroller is a small computer that is used to control and manage electronic devices. It will serve as the brain of the system and will be responsible for processing the data collected by the sensors and controlling the motor.

The TDS sensor will be used to identify the purity of the water. TDS stands for Total Dissolved Solids, and the sensor will measure the concentration of dissolved solids in the water. If the sensor detects that the water is impure, the system will automatically initiate the filtering process to remove any contaminants before filling the tank with clean water. On the other hand, if the water is pure, it will be directly filled into the tank.

The ultrasonic sensor will be used to control the automatic water opening system. The sensor will detect the presence of a user or an object in front of the water outlet and trigger the DC motor to open the valve, allowing water to flow out. This will eliminate the need for manual operation of the valve and make the system more convenient and efficient to use.

Finally, the LCD will serve as the display unit for the system. It will provide real-time information about the water quality, water level in the tank, and other relevant parameters. This will enable users to monitor the system easily and ensure that it is functioning correctly. Overall, the intelligent prototype module for a water quality monitoring system will be a highly efficient and convenient system for monitoring and maintaining water quality. It will utilize advanced technology to ensure that the water supplied to the user is clean and safe for consumption.

4.3 FLOWCHART

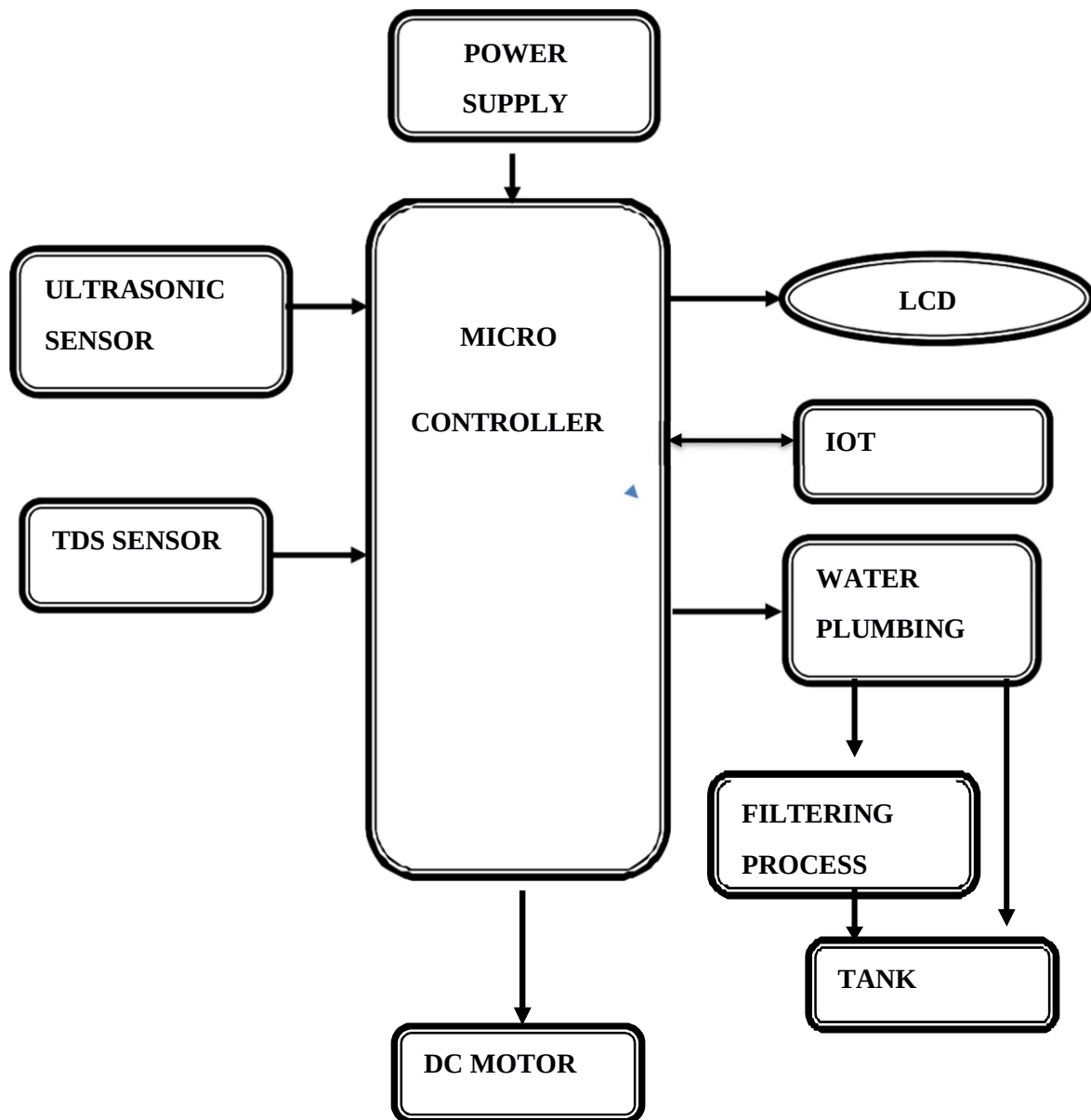


Fig:4.1: Flowchart of The Module

Microcontroller ESP32 is the center of the setup. Power supply is given to the microcontroller. Ultrasonic sensor and TDS sensor are connected to the microcontroller through the pins. DC motor is connected. Not to store the data and process. LCD display is connected and receive values from ESP32 to display, water pump connected to the ESP32 sucks the water and pump to the tent for filtration process.

4.4 DIFFERENCE BETWEEN EXISTING AND PROPOSED METHODOLOGY

In existing system, requires people on duty and does not automatic checking of water quality, so it takes more time consuming.

In proposed system monitor water quality automatically by using sensors and does not requires people on duty. so the system is likely more economical, convenient, fast.

Hardware Requirements:

- Micro controller
- Power supply
- TDS sensor
- Ultrasonic sensor
- Dc motor
- Lcd

Software Requirements:

- Embedded C
- Arduino IDE

4.5 MICROCONTROLLER – ESP32

Arduino is a great platform for beginners into the World of Microcontrollers and Embedded Systems. With a lot of cheap sensors and modules, you can make several projects either as a hobby or even commercial.

As technology advanced, new project ideas and implementations came into play and one particular concept is the Internet of Things or IoT. It is a connected platform, where several “things” or devices are connected over internet for exchange of information.

In DIY community, the IOT projects are mainly focused on Home Automation and Smart Home applications but commercial and industrial IoT projects have far complex implementations like Machine Learning, Artificial Intelligence, Wireless Sensor Networks etc.

The important thing in this brief intro is whether it is a small DIY project by a hobbyist or a complex industrial project, any IoT project must have connectivity to Internet. This is where the likes of ESP8266 and ESP32 come into picture.

If you want to add Wi-Fi connectivity to your projects, then ESP8266 is a great option. But if you want build a complete system with Wi-Fi connectivity, Bluetooth connectivity, high resolution ADCs, DAC, Serial Connectivity and many other features, then ESP32 is the ultimate choice.

ESP32 is a low-cost System on Chip (SoC) Microcontroller from Espressif Systems, the developers of the famous ESP8266 SoC. It is a successor to ESP8266 SoC and comes in both single-core and dual-core variations of the Tensilica's 32-bit Xtensa LX6 Microprocessor with integrated Wi-Fi and Bluetooth.

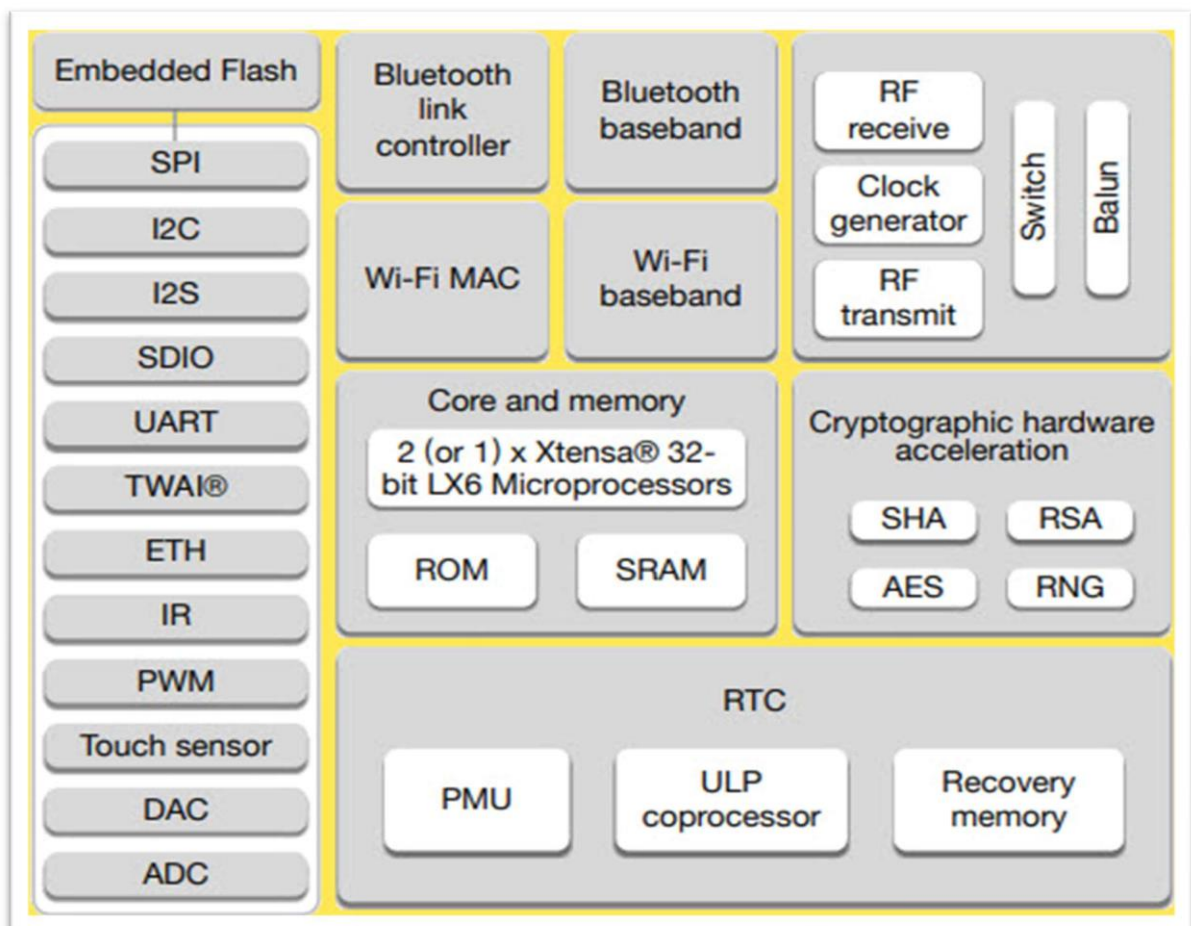


Fig:4.2: Esp32 Block diagram

The good thing about ESP32, like ESP8266 is its integrated RF components like Power Amplifier, Low-Noise Receive Amplifier, Antenna Switch, Filters and RF Balun. This makes designing hardware around ESP32 very easy as you require very few external components. Another important thing to know about ESP32 is that it is manufactured using TSMC's ultra-low-power 40 nm technology. So, designing battery operated applications like wearables, audio equipment, baby monitors, smart watches, etc., using ESP32 should be very easy.

4.5.1 General Description

ESP32 is a series of low-cost, low-power system on a chip microcontrollers with integrated Wi-Fi and dual-mode Bluetooth. The ESP32 series employs either a Tensilica Xtensa LX6 microprocessor in both dual-core and single-core variations, Xtensa LX7 dual-core microprocessor or a single-core RISC-V microprocessor and includes built-in antenna switches, RF balun, power amplifier, low-noise receive amplifier, filters, and power-management modules. ESP32 is created and developed by Espressif Systems, a Shanghai-based Chinese company, and is manufactured by TSMC using their 40 nm process.



Fig:4.3: Esp32 Chip Module

4.5.2 Specifications of ESP32

ESP32 has a lot more features than ESP8266 and it is difficult to include all the specifications in this Getting Started with ESP32 guide. So, I made a list of some of the important specifications of ESP32 here. But for complete set of specifications, I strongly suggest you to refer to the Datasheet.

- Single or Dual-Core 32-bit LX6 Microprocessor with clock frequency up to 240 MHz.
- 520 KB of SRAM, 448 KB of ROM and 16 KB of RTC SRAM.
- Supports 802.11 b/g/n Wi-Fi connectivity with speeds up to 150 Mbps.
- Support for both Classic Bluetooth v4.2 and BLE specifications.
- 34 Programmable GPIOs.
- Up to 18 channels of 12-bit SAR ADC and 2 channels of 8-bit DAC
- Serial Connectivity include 4 x SPI, 2 x I²C, 2 x I²S, 3 x UART.
- Ethernet MAC for physical LAN Communication (requires external PHY).
- 1 Host controller for SD/SDIO/MMC and 1 Slave controller for SDIO/SPI.
- Motor PWM and up to 16-channels of LED PWM.
- Secure Boot and Flash Encryption.
- Cryptographic Hardware Acceleration for AES, Hash (SHA-2), RSA, ECC and RNG.

4.6 POWER SUPPLY

- The ac voltage, typically 220V rms, is connected to a transformer, which steps that ac voltage down to the level of the desired dc output. A diode rectifier then provides a full-wave rectified voltage that is initially filtered by a simple capacitor filter to produce a dc voltage. This resulting dc voltage usually has some ripple or ac voltage variation.
- A regulator circuit removes the ripples and also remains the same dc value even if the input dc voltage varies, or the load connected to the output dc voltage changes. This voltage regulation is usually obtained using one of the popular voltage regulator IC units.

4.6.1 Block Diagram

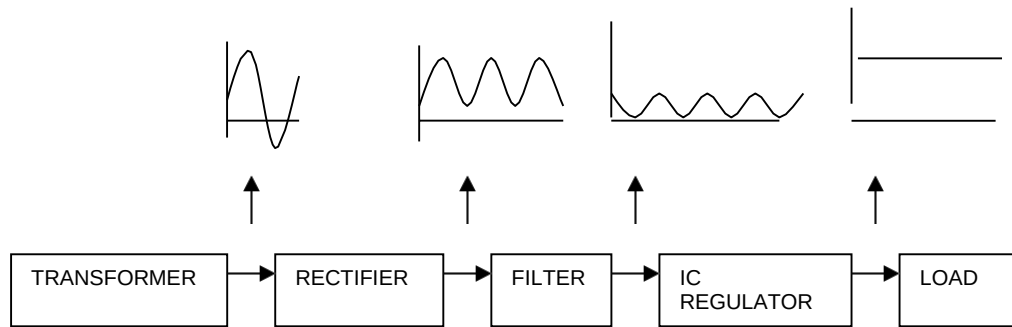


Fig:4.4:Block Diagram of Power supply

- The potential transformer will step down the power supply voltage (0-230V) to (0-6V) level. Then the secondary of the potential transformer will be connected to the precision rectifier, which is constructed with the help of op-amp. The advantages of using precision rectifier are it will give peak voltage output as DC, rest of the circuits will give only RMS output.
- When four diodes are connected as shown in figure, the circuit is called as bridge rectifier. The input to the circuit is applied to the diagonally opposite corners of the network, and the output is taken from the remaining two corners.
- Let us assume that the transformer is working properly and there is a positive potential, at point A and a negative potential at point B. The positive potential at point A will forward bias D3 and reverse bias D4.
- The negative potential at point B will forward bias D1 and reverse D2. At this time D3 and D1 are forward biased and will allow current flow to pass through them; D4 and D2 are reverse biased and will block current flow the path for current flow is from point B through D1, up through RL, through D3, through the secondary of the transformer back to point B. This path is indicated by the solid arrows. Waveforms (1) and (2) can be observed across D1 and D3.
- One-half cycle later the polarity across the secondary of the transformer reverse, forward biasing D2 and D4 and reverse biasing D1 and D3. Current flow will now be from point A through D4, up through RL, through D2, through the secondary of T1, and back to point A. This path is indicated by the broken

arrows. Waveforms (3) and (4) can be observed across D2 and D4. The current flow through RL is always in the same direction. In flowing through RL this current develops a voltage corresponding to that shown waveform (5). Since current flows through the load (RL) during both half cycles of the applied voltage, this bridge rectifier is a full-wave rectifier. One advantage of a bridge rectifier over a conventional full-wave rectifier is that with a given transformer the bridge rectifier produces a voltage output that is nearly twice that of the conventional full-wave circuit.

- This may be shown by assigning values to some of the components shown in views A and B. assume that the same transformer is used in both circuits. The peak voltage developed between points X and y is 1000 volts in both circuits. In the conventional full-wave circuit shown—in view A, the peak voltage from the center tap to either X or Y is 500 volts. Since only one diode can conduct at any instant, the maximum voltage that can be rectified at any instant is 500 volts.
- The maximum voltage that appears across the load resistor is nearly-but never exceeds-500 volts, as result of the small voltage drop across the diode. In the bridge rectifier shown in view B, the maximum voltage that can be rectified is the full secondary voltage, which is 1000 volts. Therefore, the peak output voltage across the load resistor is nearly 1000 volts. With both circuits using the same transformer, the bridge rectifier circuit produces a higher output voltage than the conventional full-wave rectifier circuit.
- Voltage regulators comprise a class of widely used ICs. Regulator IC units contain the circuitry for reference source, comparator amplifier, control device, and overload protection all in a single IC. IC units provide regulation of either a fixed positive voltage, a fixed negative voltage, or an adjustably set voltage. The regulators can be selected for operation with load currents from hundreds of milli amperes to tens of amperes, corresponding to power ratings from milli watts to tens of watts.

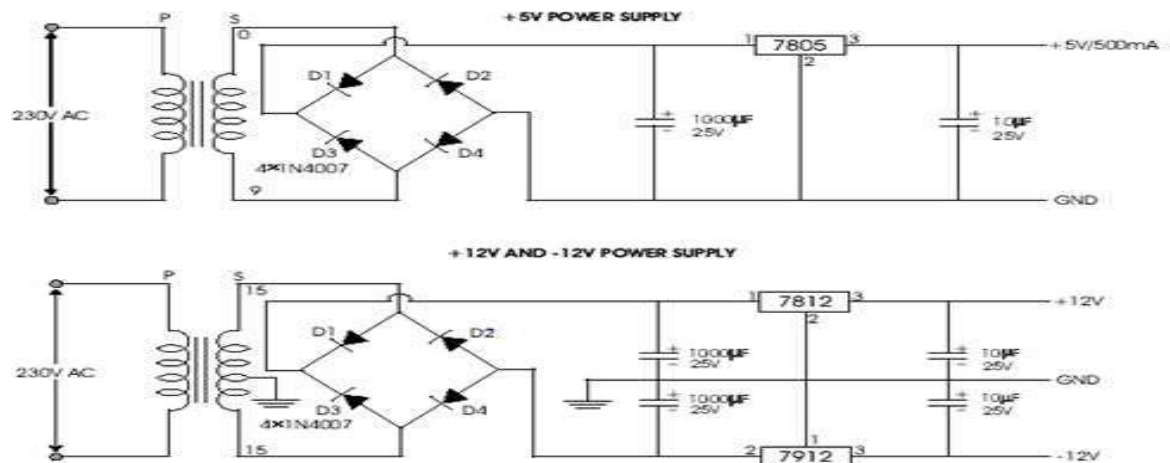


Fig:4.5:Circuit Diagram Of Power Supply

- A fixed three-terminal voltage regulator has an unregulated dc input voltage, V_i , applied to one input terminal, a regulated dc output voltage, V_o , from a second terminal, with the third terminal connected to ground.
- The series 78 regulators provide fixed positive regulated voltages from 5 to 24 volts. Similarly, the series 79 regulators provide fixed negative regulated voltages from 5 to 24 volts.

4.7 16×2 LCD

LCD stands for liquid crystal display. They come in many sizes 8x1 , 8x2 , 10x2 , 16x1 , 16x2 , 16x4 , 20x2 , 20x4 , 24x2 , 30x2 , 32x2 , 40x2 etc . Many multinational companies like Philips Hitachi Panasonic make their own special kind of LCD'S to be used in their products. All the LCD'S performs the same functions (display characters numbers special characters ASCII characters etc). Their programming is also same and they all have same 14 pins (0-13) or 16 pins (0 to 15). Alphanumeric displays are used in a wide range of applications, including palmtop computers, word processors, photocopiers, point of sale terminals, medical instruments, cellular phones, etc.

This is an LCD Display designed for E-blocks. It is a 16 character, 2-line alphanumeric LCD display connected to a single 9-way D-type connector. This allows the device to be connected to most E-Block I/O ports. The LCD display requires data in a serial format, which is detailed in the user guide below. The display

also requires a 5V power supply. Please take care not to exceed 5V, as this will cause damage to the device. The 5V is best generated from the E-blocks Multi programmer or a 5V fixed regulated power supply. The 16 x 2 intelligent alphanumeric dot matrix displays is capable of displaying 224 different characters and symbols. A full list of the characters and symbols is printed on pages 7/8 (note these symbols can vary between brand of LCD used). This booklet provides all the technical specifications for connecting the unit, which requires a single power supply (+5V).



Fig:4.6:LCD Display

4.7.1 Features:

- Input voltage: 5v
- E-blocks compatible
- Low cost
- Compatible with most I/O ports in the E-Block range
- Ease to develop programming code using Flow code icons
- Monitoring

4.8 ULTRASONIC SENSOR

Ultrasonic sensor emit ultrasonic pulses, and by measuring the time of ultrasonic pulse reaches the object and back to the transducer. The sonic waves emitted by the transducer are reflected by an object and received back in the transducer. After having emitted the sound waves, the ultrasonic sensor will switch to receive mode. The time elapsed between emitting and receiving is proportional to the distance of the object from the sensor.

Ultrasonic transmitter emitted an ultrasonic wave in one direction and started timing when it launched. Ultrasonic spread in the air and would return immediately when it encountered obstacles on the way. At last the ultrasonic receiver would stop timing when it receives the reflected wave. The distance of sensor from the target object is calculated. It offers excellent non-contact range detection with high accuracy and stable readings in an easy-to-use package. Its operation is not affected by sunlight or black material. The supply voltage to the sensor is 5VDC. The sensor has two pins namely trig and echo which is connected to the controller to give digital input.



Fig:4.7:Ultrasonic Sensor

4.8.1 Features

- Working Voltage: 5VDC
- Quiescent Current: <2mA
- Working Current: 15mA
- Detecting Range: 2cm - 4.5m
- Trigger Input Pulse width: 10uS

4.8.2 Applications

- Robot navigation
- Obstacle avoidance
- Engineering measurement tools
- Industrial control system

4.9 DC MOTOR

The relationship between torque vs speed and current is linear as shown left; as the load on a motor increases, Speed will decrease. The graph pictured here represents the characteristics of a typical motor. As long as the motor is used in the area of high efficiency (as represented by the shaded area) long life and good performance can be expected. However, using the motor outside this range will result in high temperature rises and deterioration of motor parts. A motor's basic rating point is slightly lower than its maximum efficiency point. Load torque can be determined by measuring the current drawn when the motor is attached to a machine whose actual load value is known.



Fig :4.8: DC MOTOR

Geared dc motors can be defined as an extension of dc motors. A geared DC Motor has a gear assembly attached to the motor. The speed of motor is counted in terms of rotations of the shaft per minute and is termed as RPM .The gear assembly helps in increasing the torque and reducing the speed. Using the correct combination of gears in a gear motor, its speed can be reduced to any desirable figure. This concept where gears reduce the speed of the vehicle but increase its torque is known as gear reduction. A DC motor can be used at a voltage lower than the rated voltage. But, below 1000 rpm, the speed becomes unstable, and the motor will not run smoothly.

4.9.1 Features

- Supply voltage: 12VDC
- Speed: 60rpm
- Long Lifetime, Low Noise, Smooth Motion
- Equipped with high efficiency

4.9.2 Applications

- Coin Changing equipment
- Peristaltic Pumps
- Damper Actuators
- Fan Oscillators

4.10 ARDUINO SOFTWARE (IDE)

Get the latest version from the download page. You can choose between the Installer (.exe) and the Zip packages. We suggest you use the first one that installs directly everything you need to use the Arduino Software (IDE), including the drivers. With the Zip package you need to install the drivers manually. The Zip file is also useful if you want to create a portable installation.

When the download finishes, proceed with the installation and please allow the driver installation process when you get a warning from the operating system.

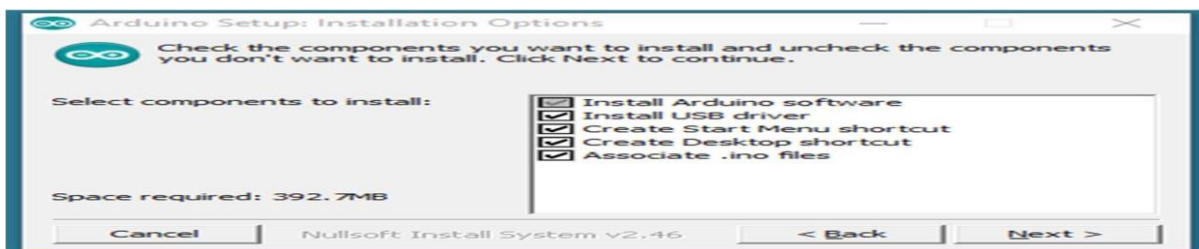


Fig:4.9:Choose The Components To Install

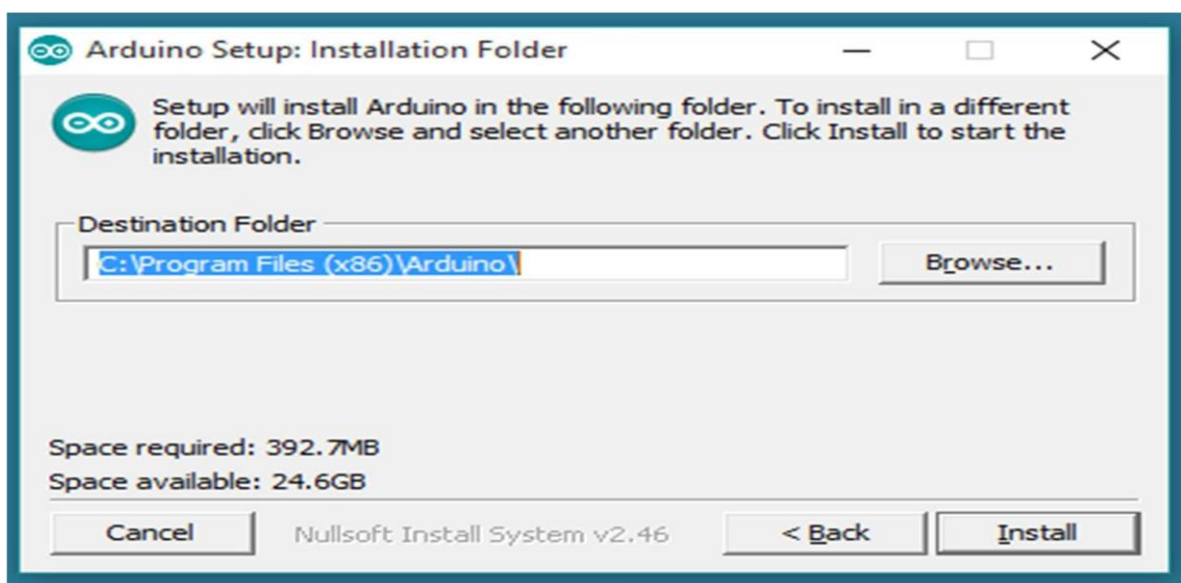


Fig:4.10:Choose The Installation Directory

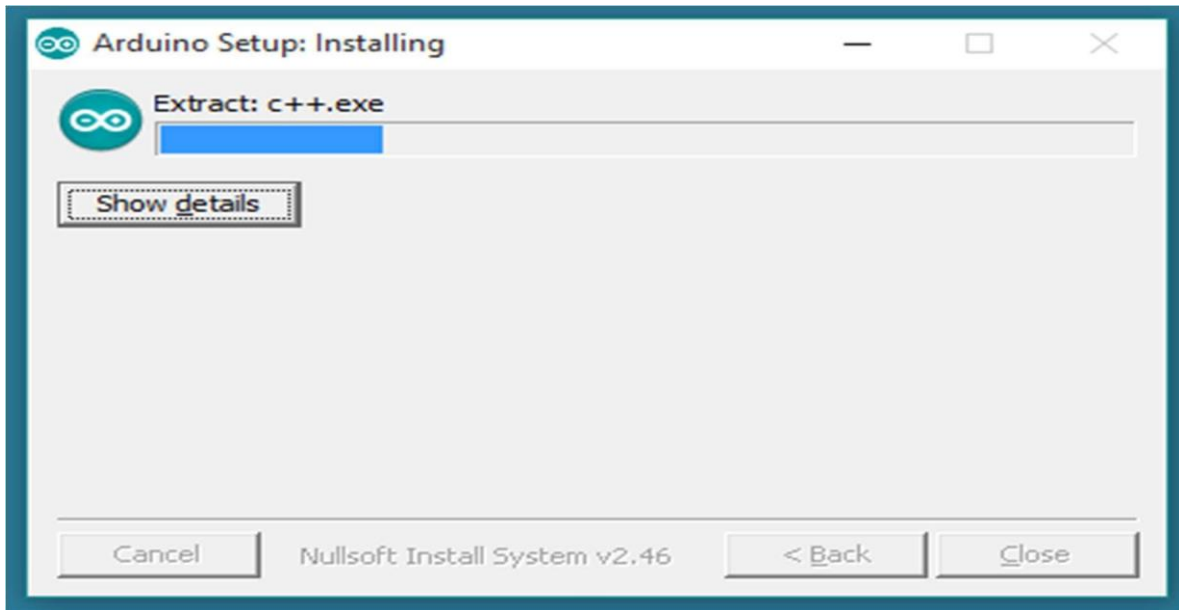


Fig:4.11: Extraction and Installation

This process will extract and install all the required files to properly the Arduino Software (IDE)

Arduino Boot loader Issue

The current boot loader burned onto the Arduino UNO is not compatible with ROBOTC. In its current form, you will be able to download the ROBOTC Firmware to the Arduino UNO, but you will not able to download any user programs.

The reason for this is because there is a bug in the Arduino UNO firmware that does not allow flash write commands to start at anywhere but the beginning of flash memory (0x000000). See the bottom of this page for more technical details.

Because ROBOTC is not able to burn a new bootloader as of today, you will need to use the Arduino's Open Source language with a modified bootloader file to re-burn your bootloader on your Arduino UNO boards. The enhanced bootloader is backwards compatible with the original one. That means you'll still be able to program it through the Arduino programming environment as before, in addition to ROBOTC for Arduino.

Using an AVR ISP (In System Programmer)

- Your Arduino UNO (to program)

- An AVR Programmer such as the AVR Pocket Programmer
- An AVR Programming Cable (the pocket programmer comes with one)

If you have extra Arduino boards, but no ISP programmer, SparkFun.com has a cool tutorial on how to flash a bootloader using an Arduino as an ISP.

Using another Arduino as an ISP

- Your Arduino UNO (to program)
- A Working Arduino (doesn't matter what kind)
- Some Male-to-Male Jumper Cables

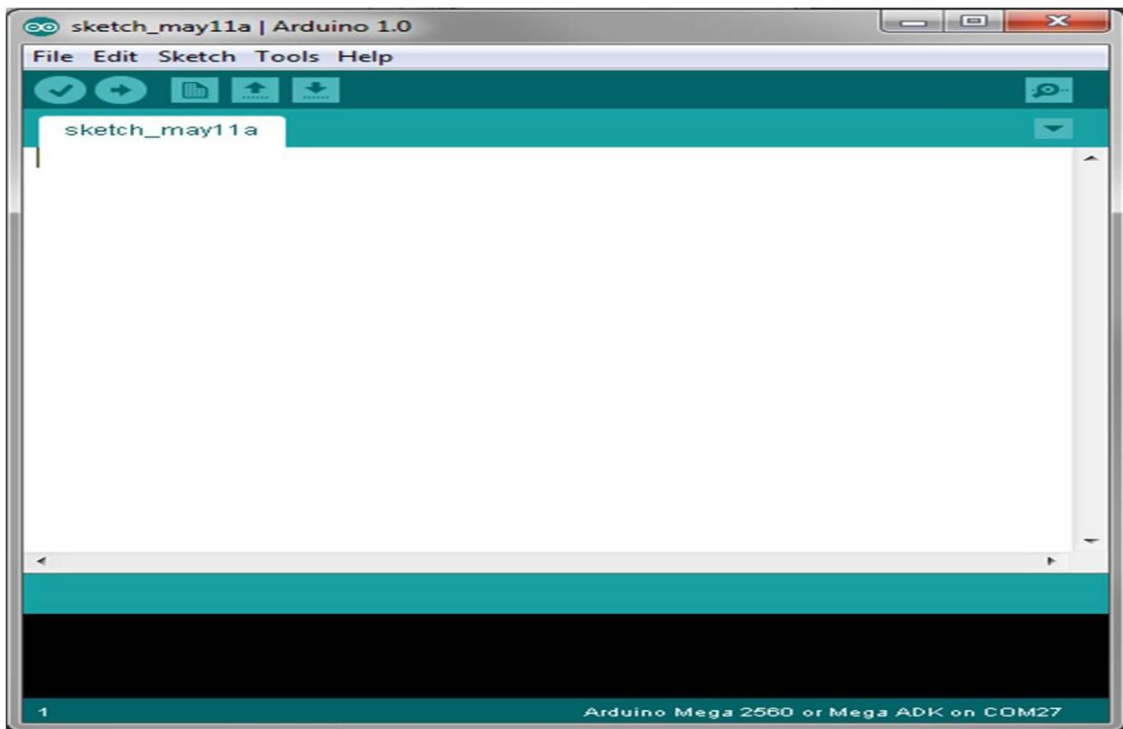


Fig:4.12:Arduino New Page

- Change your settings in the Arduino Software to look for an Arduino UNO
- Change your settings in the Arduino Software to select your ISP Programmer Type (Check your programmer's documentation for the exact model)

Select the "Burn Bootloader" option under the "Tools" menu. The modified bootloader will now be sent to your Arduino. This typically take a minute or so.

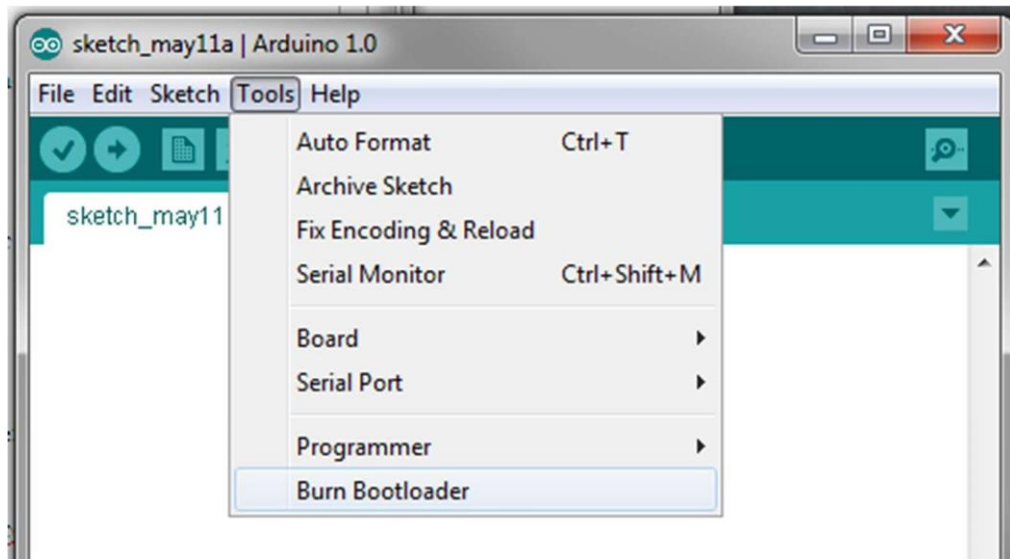


Fig:4.13: Arduino Tools

You should be all set to download ROBOTC firmware and start using your Arduino UNO with ROBOTC

4.10.1 Technical Details

The Arduino Boot loader sets the "erase Address" to zero every time the boot loader is called. ROBOTC called the "Load Address" command to set the address in which we want to write/verify when downloading program.

When writing a page of memory to the arduino, the Arduino boot loader will erase the existing page and write a whole new page.

In the scenario of downloading firmware, everything is great because the Erase Address and the Loaded Address both start at zero.

In the scenario of writing a user program, we start writing at memory location 0x7000, but the Boot loader erases information starting at location zero because the "Load Address" command doesn't update where to erase.

Our modification is to set both the Load Address and the Erase Address so the activity of writing a user program doesn't cause the firmware to be accidentally erased.

4.10.2 Specification

Microcontroller	Arduino UNO
Operating Voltage	5V Input Voltage (recommended)
Input Voltage (limits)	6-20V
Digital I/O Pins	54 (of which 14 provide PWM output)
Analog Input Pins	16
DC Current per I/O Pin	40mA
DC Current for 3.3V Pin	50mA
Flash Memory	256 KB of which 8 KB used by bootloader
SRAM	8KB
EEPROM	4KB
Lock Speed	16MHz

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

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

They differs from all preceding boards in that it does not use the FTDI USB-to-serial driver chip. Instead, it features the programmed as a USB-to-serial converter.

The power pins are as follows,

- VIN: The input voltage to the Arduino board when it's using an external power source (as opposed to 5 volts from the USB connection or other

regulated power source). You can supply voltage through this pin, or, if supplying voltage via the power jack, access it through this pin.

- 5V: The regulated power supply used to power the microcontroller and other components on the board. This can come either from VIN via a non-board regulator, or be supplied by USB or another regulated 5V supply.
- 3V3: A 3.3V supply generated by the on board regulator. Maximum current draw is 50mA.
- GND: Ground pins.

The ATMEGA has 256 KB of flash memory for storing code (of which 8 KB is used for the bootloader), 8 KB of SRAM and 4 KB of EEPROM (which can be read and written with the EEPROM library).

Each of the 54 digital pins on the Mega can be used as an input or output, using `pinMode()`, `digitalWrite()`, and `digitalRead()` functions. They operate at 5 volts. Each pin can provide or receive a maximum of 40 mA and has an internal pull-up resistor (disconnected by default) of 20-50k Ohms. In addition, some pins have specialized functions:

- Serial: 0 (RX) and 1 (TX); Serial 1: 19 (RX) and 18 (TX); Serial 2: 17 (RX) and 16 (TX); Serial 3: 15 (RX) and 14 (TX). Used to receive (RX) and transmit (TX) TTL serial data. Pins 0 and 1 are also connected to the corresponding pins of the ATMEGA USB-to-TTL Serial chip.
- External Interrupts: 2 (interrupt 0), 3 (interrupt 1), 18 (interrupt 5), 19 (interrupt 4), 20 (interrupt 3), and 21 (interrupt 2). These pins can be configured to trigger an interrupt on a low value, a rising or falling edge, or a changing value. See the `attachInterrupt()` function for details.
- PWM: 0 to 13. Provide 8-bit PWM output with the `analogWrite()` function.
- SPI: 50 (MISO), 51 (MOSI), 52 (SCK), 53 (SS). These pins support SPI communication, which, although provided by the underlying hardware, is not currently included in the Arduino language. The SPI pins are also broken out on the ICSP header, which is physically compatible with the Duemilanove and Diecimila.

- LED: 13. There is a built-in LED connected to digital pin 13. When the pin is HIGH value, the LED is on, when the pin is LOW, it's off.
- I²C: 20 (SDA) and 21 (SCL). Support I²C (TWI) communication using the Wire library (documentation on the Wiring website). Note that these pins are not in the same location as the I²C pins on the Duemilanove.

The Arduino UNO has 16 analog inputs, each of which provide 10 bits of resolution (i.e. 1024 different values). By default they measure from ground to 5 volts, though it is possible to change the upper end of their range using the AREF pin and `analogReference()` function.

There are a couple of other pins on the board:

- AREF: Reference voltage for the analog inputs. Used with `analogReference()`.
- Reset: Bring this line LOW to reset the microcontroller. Typically used to add a reset button to shields which block the one on the board.

Communication:

The Arduino UNO has a number of facilities for communicating with a computer, another Arduino, or other microcontrollers. The Arduino UNO provides four hardware UARTs for TTL (5V) serial communication.

An ATMEGA on the board channels one of these over USB and provides a virtual com port to software on the computer (Windows machines will need a .inf file, but OSX and Linux machines will recognize the board as a COM port automatically). The Arduino software includes a serial monitor which allows simple textual data to be sent to and from the board. The RX and TX LEDs on the board will flash when data is being transmitted via the ATmega8U2 chip and USB connection to the computer (but not for serial communication on pins 0 and 1).

A SoftwareSerial library allows for serial communication on any of the digital pins.

The Arduino UNO also supports I²C (TWI) and SPI communication. The Arduino software includes a Wire library to simplify use of the I²C bus; see the documentation on the Wiring website for details. To use the SPI communication,

please see the Arduino UNO datasheet.

Programming:

The Arduino UNO can be programmed with the Arduino software (download). For details, see the reference and tutorials.

The Arduino UNO on the Arduino UNO comes preburned with a bootloader that allows you to upload new code to it without the use of an external hardware programmer. It communicates using the original STK500 protocol (reference, C header files).

4.10.3 Automatic Software Reset

Rather than requiring a physical press of the reset button before an upload, the Arduino UNO is designed in a way that allows it to be reset by software running on a connected computer. One of the hardware flow control lines (DTR) of the ATmega8U2 is connected to the reset line of the Arduino UNO via a 100 nanofarad capacitor. When this line is asserted (taken low), the reset line drops long enough to reset the chip. The Arduino software uses this capability to allow you to upload code by simply pressing the upload button in the Arduino environment. This means that the bootloader can have a shorter timeout, as the lowering of DTR can be well-coordinated with the start of the upload.

This setup has other implications. When the Arduino UNO is connected to either a computer running Mac OS X or Linux, it resets each time a connection is made to it from software (via USB). For the following half-second or so, the bootloader is running on the UNO. While it is programmed to ignore malformed data (i.e. anything besides an upload of new code), it will intercept the first few bytes of data sent to the board after a connection is opened. If a sketch running on the board receives one-time configuration or other data when it first starts, make sure that the software with which it communicates waits a second after opening the connection and before sending this data.

The Mega contains a trace that can be cut to disable the auto-reset. The pads on either side of the trace can be soldered together to re-enable it. It's labeled "RESET-EN". You may also be able to disable the auto-reset by connecting a 110 ohm resistor from 5V to the reset line; see this forum thread for details.

The Arduino UNO has a resettable poly fuse that protects your computer's USB ports from shorts and over current. Although most computers provide their own internal protection, the fuse provides an extra layer of protection. If more than 500mA is applied to the USB port, the fuse will automatically break the connection until the short or overload is removed.

The maximum length and width of the UNO PCB are 4 and 2.1 inches respectively, with the USB connector and power jack extending beyond the former dimension. Three screw holes allow the board to be attached to a surface or case. Note that the distance between digital pins 7 and 8 is 160 mil (0.16"), not an even multiple of the 100 mil spacing of the other pins.

The UNO is designed to be compatible with most shields designed for the Diecimila or Duemilanove. Digital pins 0 to 13 (and the adjacent AREF and GND pins), analog inputs 0 to 5, the power header, and ICSP header are all in equivalent locations. Further the main UART (serial port) is located on the same pins (0 and 1), as are external interrupts 0 and 1 (pins 2 and 3 respectively). SPI is available through the ICSP header on both the Mega and Duemilanove / Diecimila.

Arduino can sense the environment by receiving input from a variety of sensors and can affect its surroundings by controlling lights, motors, and other actuators. The microcontroller on the board is programmed using the Arduino programming language (based on Wiring) and the Arduino development environment (based on Processing). Arduino projects can be stand-alone or they can communicate with software on running on a computer (e.g. Flash, Processing, MaxMSP).

Arduino is a cross-platform program. You'll have to follow different instructions for your personal OS.

Once you have downloaded/unzipped the arduino IDE, you can plug the Arduino to your PC via USB cable.

4.11 EMBEDDED C

High-level language programming has long been in use for embedded-systems development. However, assembly programming still prevails, particularly for digital-signal processor (DSP) based systems. DSPs are often programmed in assembly language by programmers who know the processor architecture inside out. The key motivation for this practice is performance, despite the disadvantages of assembly programming when compared to high-level language programming.

If the video decoding takes 80 percent of the CPU-cycle budget instead of 90 percent, for instance, there are twice as many cycles available for audio processing. This coupling of performance to end-user features is characteristic of many of the real-time applications in which DSP processors are applied. DSPs have a highly specialized architecture to achieve the performance requirements for signal processing applications within the limits of cost and power consumption set for consumer applications. Unlike a conventional Load-Store (RISC) architecture, DSPs have a data path with memory-access units that directly feed into the arithmetic units. Address registers are taken out of the general-purpose register file and placed next to the memory units in a separate register file.

A further specialization of the data path is the coupling of multiplication and addition to form a single cycle Multiply-accumulate unit (MAC). It is combined with special-purpose accumulator registers, which are separate from the general-purpose registers. Data memory is segmented and placed close to the MAC to achieve the high bandwidths required to keep up with the streamlined data path. Limits are often placed on the extent of memory-addressing operations. The localization of resources in the data path saves many data movements that typically take place in a Load-Store architecture.

The most important, common arithmetic extension to DSP architectures is the handling of saturated fixed-point operations by the arithmetic unit. Fixed-point arithmetic can be implemented with little additional cost over integer arithmetic. Automatic saturation (or clipping) significantly reduces the number of control-flow instructions needed for checking overflow explicitly in the program. Changes in technological and economic requirements make it more expensive to continue programming DSPs in assembly. Staying with the mobile

phone as an example, the signal-processing algorithms required become increasingly complex. Features such as stronger error correction and encryption must be added. Communication protocols become more sophisticated and require much more code to implement. In certain markets, multiple protocol stacks are implemented to be compatible with multiple service providers. In addition, backward compatibility with older protocols is needed to stay synchronized with provider networks that are in a slow process of upgrading.

Today, most embedded processors are offered with C compilers. Despite this, programming DSPs is still done in assembly for the signal processing parts or, at best, by using assembly-written libraries supplied by manufacturers. The key reason for this is that although the architecture is well matched to the requirements of the signal-processing application, there is no way to express the algorithms efficiently and in a natural way in Standard C. Saturated arithmetic.

For example, is required in many algorithms and is supplied as a primitive in many DSPs. However, there is no such primitive in Standard C. To express saturated arithmetic in C requires comparisons, conditional statements, and correcting assignments. Instead of using a primitive, the operation is spread over a number of statements that are difficult to recognize as a single primitive by a compiler.

4.11.1 Description

Embedded C is designed to bridge the performance mismatch between Standard C and the embedded hardware and application architecture. It extends the C language with the primitives that are needed by signal-processing applications and that are commonly provided by DSP processors. The design of the support for fixed-point data types and named address spaces in Embedded C is based on DSP-C. DSP-C [1] is an industry-designed extension of C with which experience was gained since 1998 by various DSP manufacturers in their compilers. For the development of DSP-C by ACE (the company three of us work for), cooperation was sought with embedded-application designers and DSP manufacturers.

The Embedded C specification extends the C language to support freestanding embedded processors in exploiting the multiple address space functionality, user-defined named address spaces, and direct access to processor

and I/O registers. These features are common for the small, embedded processors used in most consumer products. The features introduced by Embedded C are fixed-point and saturated arithmetic, segmented memory spaces, and hardware I/O addressing. The description we present here addresses the extensions from a language-design perspective, as opposed to the programmer or processor architecture perspective.

4.11.2 Multiple Address Spaces

Embedded C supports the multiple address spaces found in most embedded systems. It provides a formal mechanism for C applications to directly access (or map onto) those individual processor instructions that are designed for optimal memory access. Named address spaces use a single, simple approach to grouping memory locations into functional groups to support MAC buffers in DSP applications, physical separate memory spaces, direct access to processor registers, and user-defined address spaces.

The Embedded C extension supports defining both the natural multiple address space built into a processor's architecture and the application-specific address space that can help define the solution to a problem.

Embedded C uses address space qualifiers to identify specific memory spaces in variable declarations. There are no predefined keywords for this, as the actual memory segmentation is left to the implementation. As an example, assume that X and Y are memory qualifiers. The definition:

```
X int a[25] ;
```

Means that a is an array of 25 integers, which is located in the X memory. Similarly (but less common):

```
X int * Y p ;
```

Means that the pointer p is stored in the Y memory. This pointer points to integer data that is located in the X memory. If no memory qualifiers are used, the data is stored into unqualified memory.

For proper integration with the C language, a memory structure is specified, where the unqualified memory encompasses all other memories. All unqualified

pointers are pointers into this unqualified memory. The unqualified memory abstraction is needed to keep the compatibility of the **void *** type, the **NULL** pointer, and to avoid duplication of all library code that accesses memory through pointers that are passed as parameters

Embedded C allows direct access to processor registers that are not addressable in any of the machine's address spaces. The processor registers are defined by the compiler-specific, named-register, storage class for each supported processor. The processor registers are declared and used like conventional C variables (in many cases volatile variables). Developers using Embedded C can now develop their applications, including direct access to the condition code register and other processor-specific status flags, in a high-level language, instead of inline assembly code.

Named address spaces and full processor access reduces application dependency on assembly code and shifts the responsibility for computing data types, array and structure offsets, and all those things that C compilers routinely and easily do from developers to compilers.

4.11.3 I/O Hardware Addressing

The motivation to include primitives for I/O hardware addressing in Embedded C is to improve the portability of device-driver code. In principle, a hardware device driver should only be concerned with the device itself. The driver operates on the device through device registers, which are device specific. However, the method to access these registers can be very different on different systems, even though it is the same device that is connected. The I/O hardware access primitives aim to create a layer that abstracts the system-specific access method from the device that is accessed. The ultimate goal is to allow source-code portability of device drivers between different systems. In the design of the I/O hardware-addressing interface, three requirements needed to be fulfilled:

- The device-drive source code must be portable.
- The interface must not prevent implementations from producing machine code that is as efficient as other methods.
- The design should permit encapsulation of the system.

The design is based on a small collection of functions that are specified in the <iohw.h> include file. These interfaces are divided into two groups; one group provides access to the device, and the second group maintains the access method abstraction itself.

To access the device, the following functions are defined by Embedded C:

```
unsigned int iord( ioreg_designator );  
  
void iowr( ioreg_designator, unsigned int value );  
  
void ioor( ioreg_designator, unsigned int value );  
  
void ioand( ioreg_designator, unsigned int value );  
  
void ioxor( ioreg_designator, unsigned int value );
```

These interfaces provide read/write access to device registers, as well as typical methods for setting/resetting individual bits. Variants of these functions are defined (with *buf* appended to the names) to access arrays of registers. Variants are also defined (with *l* appended) to operate with long values.

All of these interfaces take an I/O register designator *ioreg_designator* as one of the arguments. These register designators are an abstraction of the real registers provided by the system implementation and hide the access method from the driver source code. Three functions are defined for managing the I/O register designators. Although these are abstract entities for the device driver, the driver does have the obligation to initialize and release the access methods. These functions do not access or initialize the device itself because that is the task of the driver. They allow, for example, the operating system to provide a memory mapping of the device in the user address space.

```
void iogroup_acquire( iogrp_designator );  
  
void iogroup_release( iogrp_designator );  
  
void iogroup_map( iogrp_designator, iogrp_designator );
```

The *iogrp_designator* specifies a logical group of I/O register designators; typically this will be all the registers of one device. Like the I/O register designator, the I/O group designator is an identifier or macro that is provided by the system

implementation. The map variant allows cloning of an access method when one device driver is to be used to access multiple identical devices.

4.11.4 Embedded C Portability:

By design, a number of properties in Embedded C are left implementation defined. This implies that the portability of Embedded C programs is not always guaranteed. Embedded C provides access to the performance features of DSPs. As not all processors are equal, not all Embedded C implementations can be equal. For example, suppose an application requires 24-bit fixed-point arithmetic and an Embedded C implementation provides only 16 bits because that is the native size of the processor. When the algorithm is expressed in Embedded C, it will not produce outputs of the right precision.

In such a case, there is a mismatch between the requirements of the application and the capabilities of the processor. Under no circumstances, including the use of assembly, will the algorithm run efficiently on such a processor. Embedded C cannot overcome such discrepancies. Yet, Embedded C provides a great improvement in the portability and software engineering of embedded applications. Despite many differences between performance-specific processors, there is a remarkable similarity in the special-purpose features that they provide to speed up applications.

Writing C code with the low-level processor-specific support may at first appear to have many of the portability problems usually associated with assembly code. In the limited experience with porting applications that use Embedded C extensions, an automotive engine controller application (about 8000 lines of source) was ported from the eTPU, a 24-bit special-purpose processor, to a general-purpose 8-bit Freescale 68S08 with about a screen full of definitions put into a single header file. The porting process was much easier than expected. The exercise was to identify the porting issues and it is clear that the performance of the special-purpose processor is significantly higher than the general-purpose target.

CHAPTER 5

RESULTS AND DISCUSSION

5.1 IMPLEMENTATION OF THE MODEL

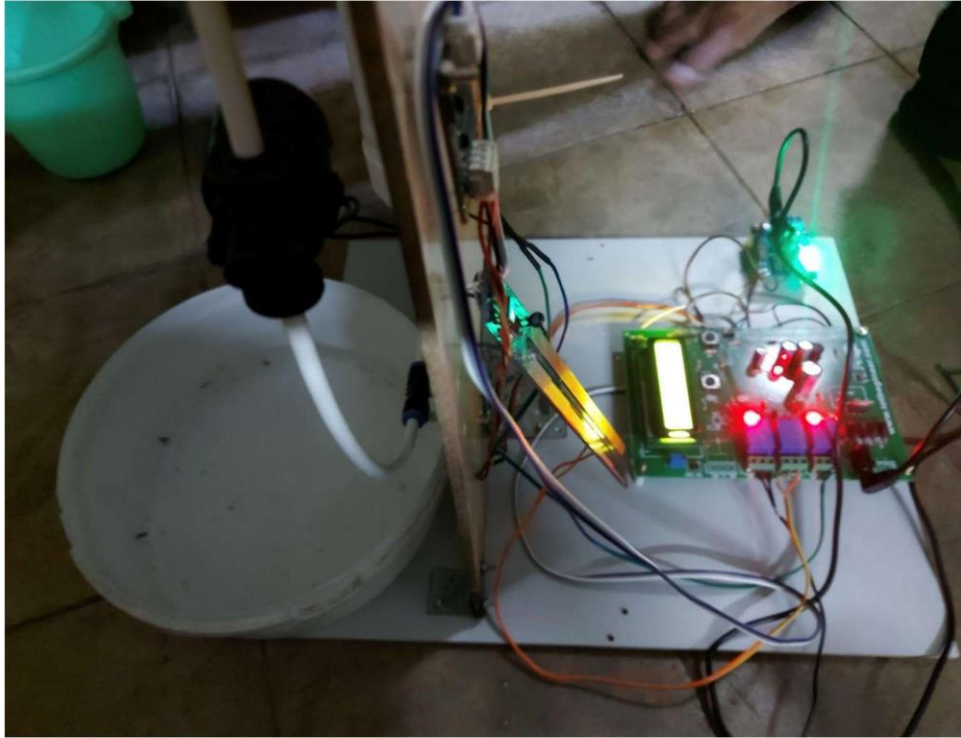


Fig :5.1:Working Module

The LCD display which is connected with Microcontroller to display the TDS level and water level of the water we stored in the storage unit. The microcontroller we using here in ESP32. Two sensors have been connected with the microcontroller . The TDS sensor which is connected with the microcontroller and the metal strip wich is into watertank to measure the TDS value. And a water level sensor to know the water level.

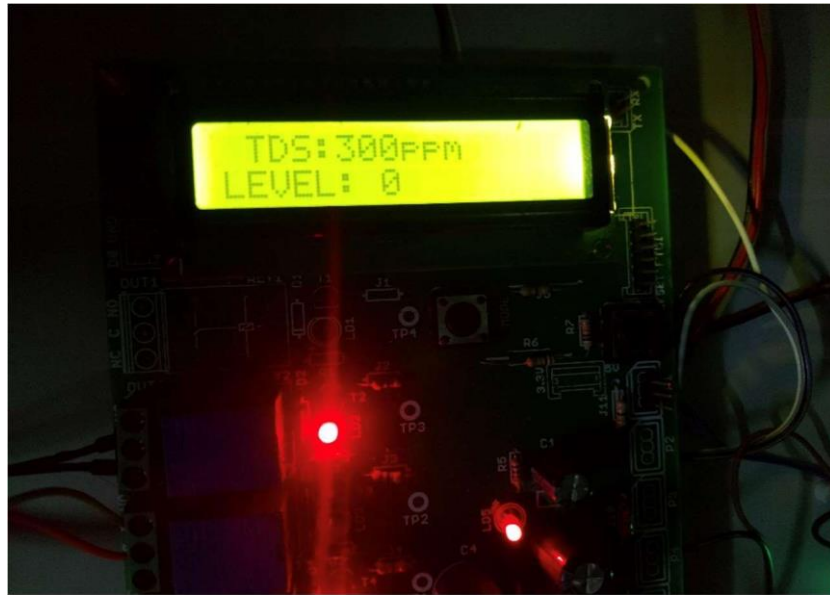


Fig:5.2: LCD Display Readings

when the water is sucked through the DC motor and get filled in the water tank . Then water is released through volve where water flows through two solenoids . when the TDS value is measured in the tank then its displayed in the LCD display ,when the TDS value is above 150 -200 PPM then the water will be released into second solenoid which routes the water to filter for further filtration purpose . If the TDS level is lower than the mentioned PPM value then water directly flows through the solenoid one and released.

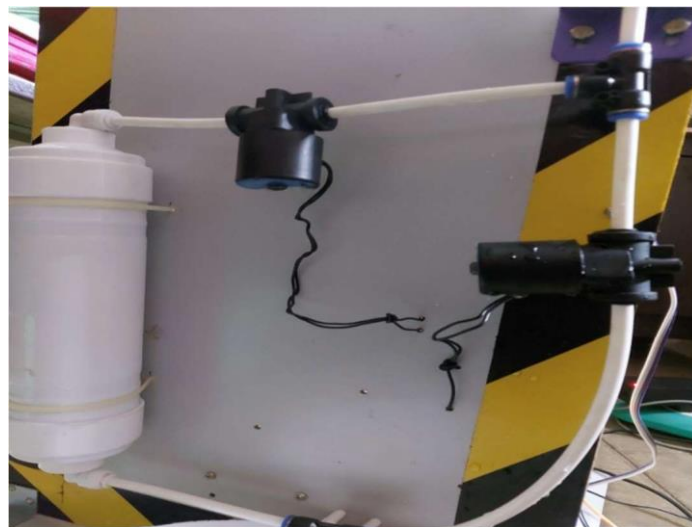


Fig:5.3 :Water Tank Connection

ESP32 is connected with WIFI in order to provide the cloud service. were using a subscribed portal which was coded with the microcontroller . Each and every time the TDS value readings are noted then is stored in the cloud portal in order to further monitoring purpose , and these are data's are more confidential depending on the industries or platform where this monitoring system is used . so we have made the cloud service with high security to protect the data.

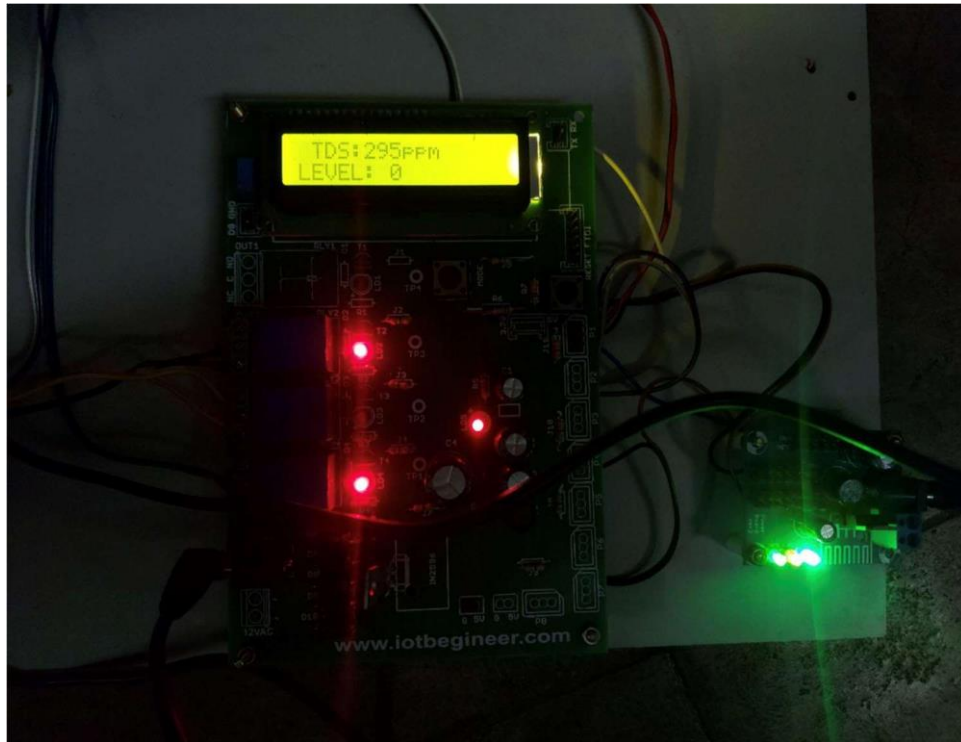


Fig:5.4:Esp32 Connected With WiFi

The TDS value displayed in an IoT device provides a measure of the total amount of dissolved solids in the liquid being monitored. This value is typically expressed in parts per million (ppm) or milligrams per liter (mg/L), and can be used to monitor the quality of water in various applications, such as in drinking water, aquariums, hydroponics, and industrial processes. In general, a higher TDS value indicates a higher concentration of dissolved solids, which can be a sign of poor water quality if the dissolved solids are undesirable contaminants, such as heavy metals, pesticides, or pathogens. However, a higher TDS value can also be desirable in some applications, such as in hydroponics, where the dissolved nutrients are necessary for plant growth.

# ↑↓	TDS VALUE ↑↓	WATER STATUS ↑↓	WATER LEVEL ↑↓	Date & Time ↑↓	Action ↑↓
1	286	WATER ABNORMAL	0	2023-02-24 16:00:29	
2	283	WATER ABNORMAL	0	2023-02-24 16:00:13	
3	*****	*****	*****	2023-02-24 15:59:58	

Fig:5.5: TDS Value Displayed in IoT Device

It's important to note that the TDS value alone cannot provide a complete picture of water quality, and additional testing may be necessary to identify specific contaminants and assess their potential health risks.

CHAPTER 6

CONCLUSION

In conclusion, the assessment and purification of total dissolved solids (TDS) in water is an important issue that needs to be addressed in order to ensure the safety and quality of drinking water. TDS can be a major source of contaminants in water, which can lead to health hazards and other problems. In this project, various methods for assessing and purifying TDS in water were explored, including filtration, reverse osmosis, and distillation. Each of these methods has its advantages and disadvantages, and the choice of method will depend on the specific circumstances and requirements. This process consumes more resources and energy of all forms, this has wastage of energy and resource. This is reduced in assessment and purification process. Which saves large amounts of energy and resource and gives us data for future purpose. Overall, it is important to regularly monitor TDS levels in water and take appropriate measures to purify the water as needed. This used for industrial purpose and can be installed in a living community, so the community is provided a quality of water. This can help to prevent health issues and ensure that safe and clean water is available for drinking and other purpose.

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