IoT BASED WATER PURIFICATION SYSTEM USING SOLAR ENERGY

An UndergraduateCAPSTONE Project
By

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Faculty of Engineering
American International University - Bangladesh

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A CAPSTONE Project submitted to the Faculty of Engineering, American International University - Bangladesh (AIUB) in partial fulfillment of the requirements for the degree of Bachelor of Science in their mentioned respective programs.

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DECLARATION

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APPROVAL

The CAPSTONE Project titled IoT **BASED ON WATER PURIFICATION SYSTEM USING SOLAR ENERGY** has been submitted to the following respected members of the Board of Examiners of the Faculty of Engineering in partial fulfillment of the requirements for the degree of Bachelor of science in the respective programs mentioned below on **August 2022** by the following students and has been accepted as satisfactory.

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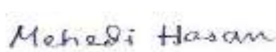

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ABSTRACT

A new conception for Solar Base a water purification and electrical IoT base monitoring system to fulfill the wants for clean water and electricity in one integrated, autonomous and efficient system is bestowed during this project. The sublimate water and power receiver contain 2 devices one is the charge controller and the another is the voltage-current sensor. Then the battery is connected to the Arduino with another voltage sensor. The water purifier is connected to a battery to consume power for purifying the unpurified water.Using the water flow sensor for how much water purifies through the water purifierthe water flow sensor is connected to Arduino and also uses a pH sensor for the purified water pH measurement. If the water purifier level is not pure then the relay was on the solenoid valve for mixed purifier solution to purify the water which is purity by the purifier. All the sensors and relays are connected to the Arduino for processing all the data from the sensor. For the IoT monitoring system use the wifi, Blynk server, and mobile Apps. All processing data send to the web server for remote monitoring. purifier water is unsafe than having to get a notification for mixing the pH solution. Potential sites for Solar Power and water purification systems embrace both rural and urban areas. An initial analysis of this potential has been conducted for the development country case. This system work perfectly here got well power source from solar and a backup to the battery. Better to monitor pH solar voltage, battery charge, output voltage, output current, and how much water has been used.

Chapter 1

INTRODUCTION

1.1. Overture

When there is a shortage of pure water supplies or other environmental calamities, having access to clean drinking water in rural areas becomes a major issue. The population of these places frequently has health problems as a result of the lengthy transport times for fresh water. In this project, a solar-powered water filtration system employing Internet of Things-based water purification is proposed to create clean drinking water in those impacted locations where pure water is difficult to obtain. The purification process used by this water purification system uses an automated valve that fills a purifier with purified water. The contaminated water is collected and directed into a purification system with storage. This initiative might be a viable way to supply those areas with clean drinking water.

1.2. Significance of the Project / Research Work

Water is essential for human life and therefore the health of the surroundings. To ascertain the honest quality of water, it's needed an observation system that developed based mostly on wireless sensing element networks work and IoT. Wireless sensing element networks are accustomed to live water quality by sensing the modification of the water purification system by solar power, to further purify the water, it is necessary to measure the pH of the water. During this project IoT based element interface with the microcontroller device. Arduino receives the mega data and transmits the data via Wi-Fi to the IoT server so that it can be analyzed remotely. Here blynk server is used as a server where data can be stored and analyzed very easily. Here pH sensor is used to see whether the water is good or bad.

1.3. Engineering Problem Statement

Many people in rural areas are getting sick and dying from waterborne diseases due to not drinking pure water. Therefore, we want to develop a renewable energy-based water purifier and IOT-based water purification and power monitoring. This system purifier uses an existing market purifier kit because we can’t make an RO Purifier kit in a short time. We will assemble the kit purifier kit for water filtering. This system is powered up using a Solar system. This Solar system uses a 20W solar panel. The battery uses a 9 Ah battery for backup power. This backup power is used for nighttime or cloudy weather. Since this

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system will be far away from us, so it is not possible to see the device everyday by going there. So, we will add IoT based monitoring system with this device that will show the device status. Like Water pH level, solar power, battery charge, device power consumption, etc. Here we continuously measure the water pH level using a pH level Sensor. Here if the pH level falls or it's over the required level then we will add a pH solution using remote IOT controlling. To monitor the power consumption, we are using voltage and current sensor. Using current and voltage data, we can determine how much power is coming from the solar system. By measuring the power,we can determine the amount of power needed to run the system. Here, wewill also measure the battery charge. For real time data monitoring and controlling, we will use Blynk Server(third-party web server) because it is a fast server for controlling and monitoring. This server use graph for future research. This system controller uses Arduino Controller. Here we will use embedded C as the programming language.

1.4. Objective of this Work

Highlight the deliverables of the project work, these objectives also needed to be aligned with the project management and Gantt Chart (milestones).

1.4.1. Primary objectives

- This project vision is in rural area water purification which is impurity
- Development low-cost water purification system
- Using Renewable energy because of reduce cost and no harm for people and environment
- Every one used it easily and understand how the device working

1.4.2. Secondary Objectives

- A monitor for a potable purification system encompasses a microcontroller that controls the general method of the purification system, LCD indicating circuit that tell the data to maintenance person, a detection implies that analyses knowledge for determinant the healthy condition of the filtration parts.

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- A warning suggests that produces message or sound for warning shoppers concerning the unhealthy condition of the water purify parts, and an influence change device suggests that through electricity provide to the purification system.

- In process, the system parts are going to be detected by impurities when being employed for an amount of time. If the system parts are IoT, the monitor can build a sound to warn of such condition of the purification. The observation of water purification method by the web server and monitoring.

1.5. Comparison with Traditional Method

To ensure the accountability of the solar energy facilities, IoT system maintenance is crucial. New information collecting technologies are required because of the plants' growing length to increase their maintenance efficiency. Unmanned craft with tailored equipment result in a decrease in operational risks and maintenance costs. This project's biggest contribution might be a fresh method for boosting rural areas' productivity, ensuring that all equipment is measured with the necessary accuracy, and consuming less time and energy. This method depends on the determination of the reading area and the inspection goal for electrical equipment. The sites of examination are found using an explicit optimization model.These IoT provide reasonable operation parameter outcomes. The method is validated and proved by a real solar panel. Although the concept has been prototyped, the system will eventually be implemented for commercial use.

1.6. Organization of Book Chapters

Briefly discussed how the contents of the book have been arranged chapter-wise. Provide details on how the contents are continued and interconnection between the chapters.

Chapter 2: Literature Review with in-depth investigation

Chapter 3: Project Management

Chapter 4: Methodology and Modeling

Chapter-5: Implementation of Project

Chapter-6: Results Analysis & Critical Design Review

Chapter-7: Conclusion

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Chapter 2

LITERATURE REVIEW WITH IN-DEPTH INVESTIGATION

2.1. Introduction

In developing nations, waterborne infections are responsible for up to ten million annual fatalities and several billion cases of illness, at least half of which are in children. Boiling is the method most frequently employed in rural areas of developing nations to clean water for use in cooking and drinking. Boiling, however, is rather expensive, uses a significant quantity of fossil fuels, and the associated wood harvesting depletes forests. One of the most promising options for an energy-efficient, cost-effective, durable, and trustworthy solution to these problems is star water sterilization. There is a valid and pressing need to provide environmentally responsible technology for the provision of drinking water in rural areas.One of the many valuable and necessary natural resources for humanity is water. However, the rapid societal growth and diverse human endeavors accelerated pollution and harmed the water resources. The most prevalent liquid on earth is water. Drinking pure liquids is crucial to human life. Water or surface water is the beverage installation. Sediments and other materials are present in all water supplies.

2.2. Related Research Works

2.2.1. Earlier Research

The commercial viability of MSF and RO as large-scale desalination techniques has been demonstrated. The cost of pre-treatment is significantly influenced by the type of seawater intake. For open channel intake, more rigorous measures are taken for MSF or RO. Strict measures have been implemented to reduce deep water pipe inflow. The MSF product water is bitter and caustic since the salt content is virtually zero [1]. A photovoltaic-powered reverse osmosis (PV-RO) desalination system's construction and testing are given. The device runs on seawater and doesn't need batteries because the amount of freshwater produced changes throughout the day depending on the amount of solar energy available. With the UK's meager solar resource, the system initially tested out at 1.5 m3/day of freshwater production.With a PV array only 2.4 kWp closer to the equator, a software model estimates year-round output of more than 3 MW/day. In combination with a variable water recovery ratio and a Clark pump brine-stream energy recovery mechanism, the system achieves a specific energy consumption of less than 4 kWh/m3 over a wide range of operation [5]. To boost the effectiveness of the entire system, a maximum power point tracking (MPPT) derivation is being used to power the reverse osmosis facility. A specific set of rules is used to merge feedforward and feedback voltage control systems in the control technique. Comparable to other algorithms, the MPPT method proved cost-effectiveness, simplicity, and good efficiency [6].Jordan uses a photovoltaic-powered reverse osmosis (RO) desalination system. The components of the RO unit include a polypropylene sediment filter with a 5-micron pore size, two active carbon filters with holes that are 1-2 micrometers in diameter, and a polyamide TFC membrane. A series of two PV arrays with a 32° southward slant is connected to one another. A one-axis east-west tracking flat plate photovoltaic is built in order to investigate how tracking affects the system's performance. Results analysis reveals that adopting this tracking system in comparison to a fixed flat plate could result in gains of 25 and 15% in electrical power and pure water flow, respectively [7].

2.2.2. Recent Research

applications at the village level in rural India. It was estimated that the ideal system would cost $23,420, 42% cheaper than a system created using standard engineering methods. Flexible water production that accommodates daily variations in solar irradiance with overproduction on sunny days was a crucial factor in cost reduction. In India, small-scale reverse osmosis (RO) systems are frequently used to measure the salinity of groundwater. [2] We describe recent membrane desalination technologies that use renewable energy. Recent research have primarily focused on wind and solar energy as sources of renewable energy. In rural and distant places without access to energy or water infrastructure, small-scale solar-powered devices are appealing for the generation of fresh water. Membranes powered by wind energy have also been found to be more affordable than traditional systems running on fossil fuels [4].The current synergistic evaluation aims to assess the suitability of using solar energy-based water purification technologies. The focus of the review is on both traditional and contemporary methods of desalination and waste water treatment. The selective absorption of UV and infrared radiation can be accomplished using hybrid materials such as core shells and blended nanofluids. This can be used to speed up diffusion through thin membranes and sterilize specific types of dangerous bacteria. [3]

2.3. Validity and Accuracy of Existing Solution

In the whole world, solar energy-based devices and power generation are increasing day by day. This renewable energy gets very easy and free of cost. This power is used for lot of developing thinking which is to comfort human life. Solar already produces energy, in this project used solar power for purifying water which is so important in human life. Already many areas in the whole world use solar energy for water purification but lot of devices are used manually and pH checking manually that's very costly and time waste. In this case, the device will be shifted to a base monitoring system for developing water purification. This is possible, and the device will be comfortable and economical.

2.4. Wide RangeofConflicting Research Works

Water deficiency is becoming one of the foremost issues in the world. It risks the health, economy, surroundings, and food provisions of the world. Nowadays, the price of purified water has skyrocketed. To meet the demand for water, a small-scale solar energy-based water purification system is organized. The novelty of the planned work is to provide water endlessly with no interruption and minimize the price of water purification. During this work with the electrical device, Despite the lack of solar power, the mechanical energy of the water is used for the purification method. The gap and shutting of the valves area unit controlled by the microcontroller supported the sensing element outputs with the web server. The energy potency and water quality of the system are analyzed and compared with the traditional water purification system on a very short-run basis.

2.5. Critical Engineering Specialist Knowledge

The utilization of alternative energy to drive water purification processes may be a potential solution to the world's water purification issue. In recent years, important efforts have been dedicated to developing and testing innovative IoT-based, mostly water purification technologies, which are comprehensively reviewed during this project. Recent developments and applications of technologies are solar power-based IoT-based water purification systems. The potential development of IoT technologies and chemical action processes are summarized. By aggregation and analyzing performance knowledge from recent studies, the standing of productivity, energy consumption, and water production prices of various technologies are critically reviewed. Presently, most of the solar energy-based water purification processes are still underrated and have limited real-world applications. This project used a web server, called blynk server

Arduino Mega is one of the important devices which is operated using the Computer language C++/C. Again, how all sensors read data.

2.6. Stakeholders from Research Literatures

The solar power-based water purification system is connected to the RO water purification system. It serves to meet the demand of clean drinking water in rural areas. It takes solar energy as a connected energy supply and stores it in a good battery that could be a free supply of energy. Then there was the victimization of this energy, a cheap source of power for purified water. During this stage, water is condensed once more and provided to any area, both rural and urban. Through this method, we tend to get a pure drink. We tend to follow most of the phases of a development method that started with grouping client needs and complete with finalizing the planning. The analysis had conjointly been done from the point of view of the production of the device. We tend to optimize the general method by utilizing a metaheuristic approach for the heating method, cooling method, and purifying method. This product, if used properly, will eradicate the shortage of pure drinking water. This purification method is so standard because of the pH measurement system if the pure water after purification the pH level is not good then the pH solution is mixed with the water for purity the water. It happens automatically.

2.7. Summary

In Asian countries, waterborne diseases are terribly common due to the insufficiency of pure water. Most of the population endures unsafe water. The energy crisis is another vital issue. Standard energy sources are restricted, and they cause environmental pollution. By employing a solar energy supply as an alternative energy source to purify water, these issues will be avoided. Solar power and IoT-based water purification setups are an advancement of the current water purification system. The methodology of the solar-powered water setup is imparted during this project. IoT based using solar energy water setup takes alternative energy as energy supply and stores energy in a well battery. Main parts of IoT based using solar power water purification setup are solar panel, battery, purifier, filtering chalk, double layer condenser and a number of other water vessels, Arduino, Some sensor, web server, current-voltage sensor, pH solution. This setup uses a filtering mechanism to get rid of dirt from water and a purifying mechanism to kill organisms. Through this method, pure water is achieved.

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Chapter 3

PROJECT MANAGEMENT

3.1.Introduction

Technology has made life easier. Researchers are creating a lot of new gadgets for our use. Solar-powered water purification systems and IoT monitoring systems are helpful technology for our country. This will be a blessing for people who live in remote areas without electricity.

3.2.S.W.O.T. Analysis of the Project

SWOT is an acronym that stands for Strengths, Weaknesses, Opportunities, and Threats. Each topic should be covered briefly, with a clear representation of the project's Strengths, Weaknesses, Opportunities, and Threats.

We need some planning strategies for a project. SWOT analysis is one of the greatest strategic planning approaches for a project to overcome weaknesses, reduce threats, and make better use of opportunities. We may examine the strengths, weaknesses, opportunities, and dangers on the route to finishing a project using this approach. As a result, the project's future development route has been established. This is a wholly internal project study that might be based on surveys.

3.2.1. Strengths

The project has the following advantages, which are listed below:

- For this project, a look was anticipated. This project will eventually be used worldwide.
- The cost of our project is reasonable.
- The power will have unparalleled access.

3.2.2. Weaknesses

Below is a list of our project's weaknesses:

- The server had no individual owner.
- This prototype is web-based.
- Ineffective operation due to bad weather.

- Insufficient electricity because of poor weather

3.2.3. Opportunities

Opportunities are outside factors that can give you a competitive advantage.
Each year, water-borne illnesses impact a large number of people and cause many deaths. The cost of treating it is high. This is frequently out of reach for most individuals. In many locations, it is not feasible to install deep tube wells for pure water. This system was created to protect people from water-borne illnesses and to provide clean water for their use.

3.2.4. Threats

Since we have used green energy here, there is no risk of environmental pollution. But since we will be using it in rural areas and there will be frequent visits for maintenance, it may cause damage to the system for inexperienced people.

3.3. Schedule Management

Schedule management refers to the tactic of implementing the project, maintaining the project, and interacting with project schedules for time and a few assets. and therefore, arranged schedule management refers to the method of crucial methods for the project, some techniques of implementing and documenting the project for designing, managing, corporal punishment, and dominance. The project will be enforced properly with the assistance of schedule management. tons of issues will be solved simply by dominant schedule management.

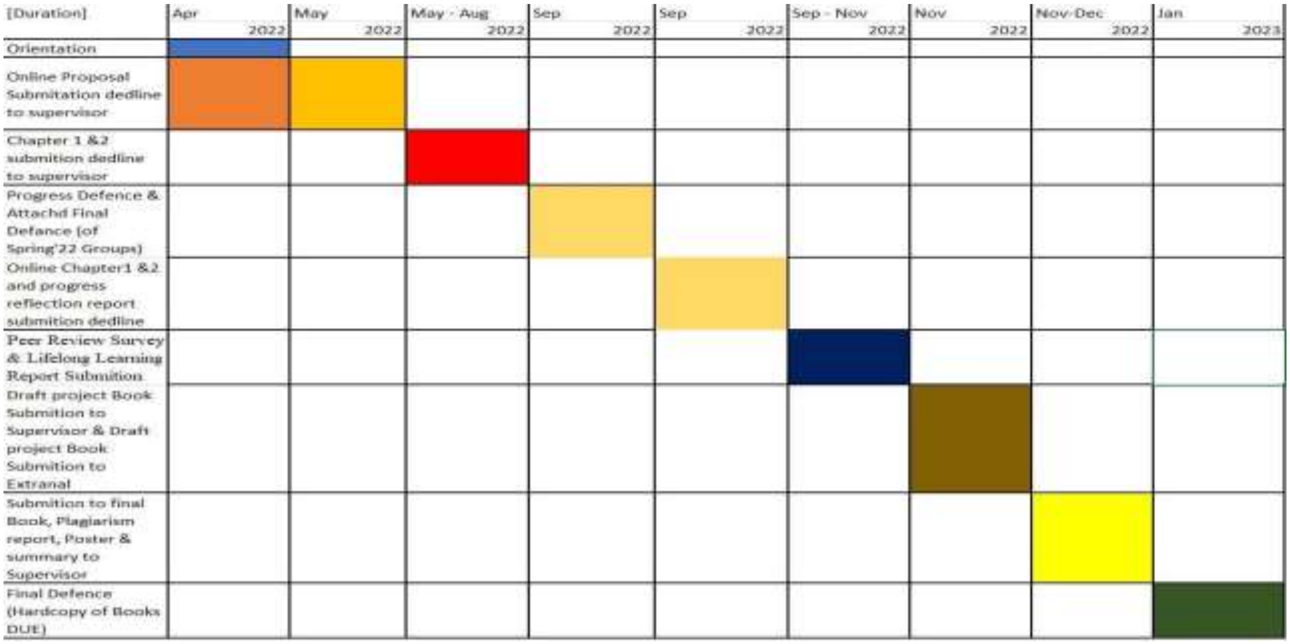

Figure 3.1 Schedule Management

3.4. Cost Analysis

Table 3.1 Cost Analysis

Name of the components	Qnt. and unit price	Real cost (TK)
1. purifier	6000*1	6000
2. Costume Frame	3000*1	3000
3. PH Sensor	3000*1	3000
4. Solar panel 20 Watt	1200*1	1200
5. Solar Charge Controller	1000 *1	1000
6. 12V lead acid Battery	1500*1	1500
7. Arduino Mega	2000*1	2000
8. DC voltage Sensor	150*2	300
9. Current Sensor	250*2	500
10. Wi-Fi Module	300*1	300
11. Relay module	90*1	90
12. Solenoid valve	700*1	700
13. water flow sensor	700*1	700
14. Solar Inverter	1000*1	1000

15. LM2596 Buck converter	120*1	120
16. ZMPT101B AC Voltage Sensor	300*1	300
17. Other	1000	1000
TOTAL	**=**	**22,710**

3.5.P.E.S.T. Analysis

Tormenter analysis may be a crucial technique for assessing macroeconomic factors. This analysis can provide a truly clear strategy for the effects of political, economic, social, and technological factors on a project.

3.5.1. Political Analysis

This project has no political controversy. Because this initiative will benefit the general public while boosting a nation's electricity capability.

3.5.2. EconomicAnalysis

Given that any nation must complete this project, a precise cost analysis will reveal that this system's implementation is cost-effective. Additionally, this project incorporated IoT in consideration of the growing time and intelligent demand, as a result, we don't need to go and monitor every day and the cost is reduced. Here we use solar PV, here we don't use grid power so our cost here will be reduced.

3.5.3. SocialAnalysis

Given that the project is intended to benefit society's citizens, this issue cannot be ignored. This endeavor cannot benefit society if it is unable to do so. Because of this, the project's possibilities are all influenced by the problems that society's citizens are facing. We genuinely believe that this endeavor will benefit our society. The waste water after filtering can be used for fish farming. Because high TDS is available from this water which is beneficial for fish farming.

3.5.4. TechnologicalAnalysis

The world is watching how quickly new technologies will replace older ones due to the rapid advancement of technology. Because of this, contemporary products ought to be able to improve and change as new technologies are developed. Future additions of new features and options to our product could be made easily. In the future, packages and mobile applications might be developed so that users could access the system from anywhere. This project allows access to a wide range of technological capabilities.

3.6. Professional Responsibilities

3.6.1. Norms of Engineering Practice

We initially attempted to carry out our project as usual, with no IoT processing. Later, however, it became clear that the IoT would make this project more appealing and advantageous for simple system monitoring and maintenance. This endeavor is wholly devoted to our own contemplation, thoughts, and reasoning. Today, after giving it our best effort, we are about to put this project into action. afterwards to complete the project.We know clean water helps keep people healthy. This system safe because it does not use any harmful chemical.

3.6.2. Individual Responsibilities

As it is a capstone project work, we are doing the work as a team. We divide the whole work in part and complete every individual part finally the whole task will be completed successfully. We are four in numbers and we have mainly focused on some specific point individually.

Member 1:

Contributed in writing the thesis book chapter- 5, 6, 7. Moreover, Research Analysis of thesis book has done. The whole simulation part and hardware has been done.

Member 2:

Contributed in writing the thesis book chapter-2, 4 and contributed in hardware preparing as well.

Member 3:

Contributed in writing the thesis book chapter-1, 3. Research analyzing of this project and collections of all the components from different places has done successfully.

3.7. Management principles and economic models

It has been globally acknowledged that energy storage is a key part of the future for purified water and renewable energy (PWRE) systems. Recent studies concerning the disciplinary action of purified water and energy storage for achieving high PWRE penetration have gained raised attention. This paper presents an in-depth review of IoT based water purification system using solar energy. It conjointly discusses the role of water purification, future analysis, and technical challenges related to the utilization of this storage within the context of renewable energy-based systems. This review paper considers the economic, environmental, and technical aspects of water purifying systems that are mentioned within the project printed over the last ten years. in addition, studies area units categorized with relevancy objective, the approach used, location, and key findings. mirrored from the literature, IoT-based Solar energy-based water purification technology has once more emerged as a technologically and economically viable choice. This review is helpful for researchers to explore IoT-based Solar energy-based water purification systems within the fields of modeling and techno-economic optimization.

3.8. Summary

In this chapter, the SWOT analysis, PEST analysis, Cost analysis, and Schedule Management have been discussed. Also, the individual accountabilities, multidisciplinary components management, and project lifecycle are discussed in this chapter. SWOT analysis represents the internal factors of this project and PEST analysis represents the external factor of this project. On the other hand, cost analysis represents the comparison between the estimated cost and final expenditure. This chapter is basically for project management and all the necessary components overview.

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Chapter 4

METHODOLOGY AND MODELING

4.1. Introduction

The World Health Organization (WHO) estimates that by 2025, half of the world's population will live in water-stressed regions. To ensure clean and secure access to potable water, alternative energy water purification may be a healthy and profitable option. Water evaporation is one of the main processes in the majority of alternative energy-driven chemical process systems. Due to their improved thermo-physical properties and optical tunability, we incline to suggest that adding nanoparticles to water may significantly boost the evaporation rate and, thus, the supply of clean water.

4.2. Block Diagram and Working Principle

4.2.1. Working principle

Because we are unable to produce RO Purifier kits quickly, purifiers in this system use pre-made purifier kits from the market. We'll put together the water filtering kit purifier kit. Solar energy is used to power this system. A 20W solar panel is used in this solar system. For backup power, the battery employs a 9Ah battery. In the event of bad weather or at night, this backup power is used. Since this system will be far from us, it won't be possible to watch the device move there every day. Therefore, we will pair this device with an IoT-based monitoring system that will display the device status. such as the PH of the water, solar energy, battery charge, device power usage, etc.Here, a PH level sensor is used to continuously measure the water's PH level. Here, we will apply a PH solution using remote IOT regulating if the Ph level falls below or rises over the desired level. Voltage and current sensors are used for Power Monitoring. We can calculate the number of solar-derived powers using current and voltage data. The amount of power required to run those systems is determined by device power measurement. Remove the amount that Manny Watt solar needs from this comparison. This approach also measures battery charge to determine how frequently the battery is recharged. Here Use Blynk, a third-party web server, for data control and monitoring because it is a quick server for those tasks. To aid with future study, this service uses graphs. The Arduino Controller is used by this system controller. Programming will be done in embedded C in this case.

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4.2.2. Block Diagram

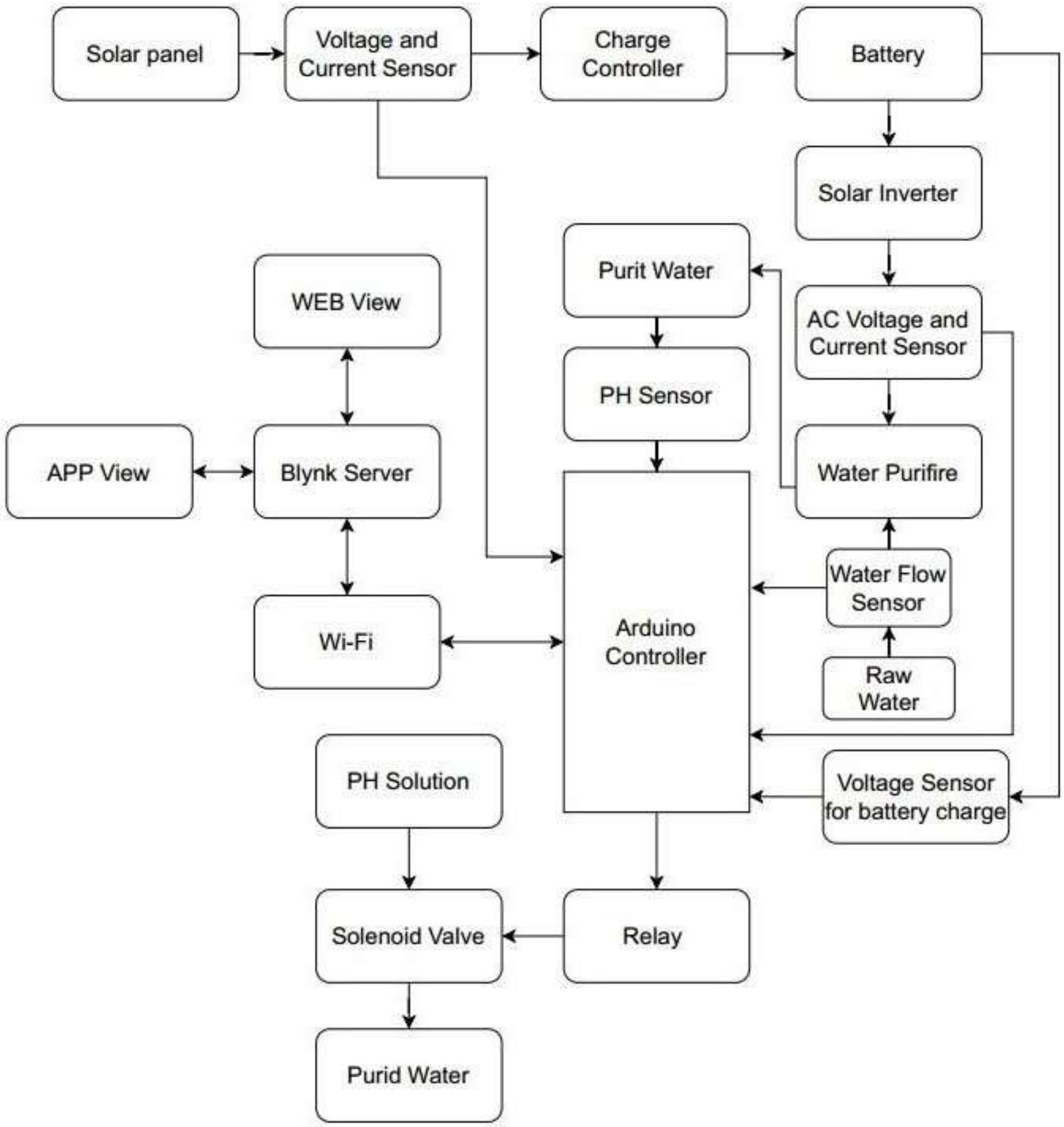

Figure 4.1 System Block Diagram

4.2.3. Flowchart

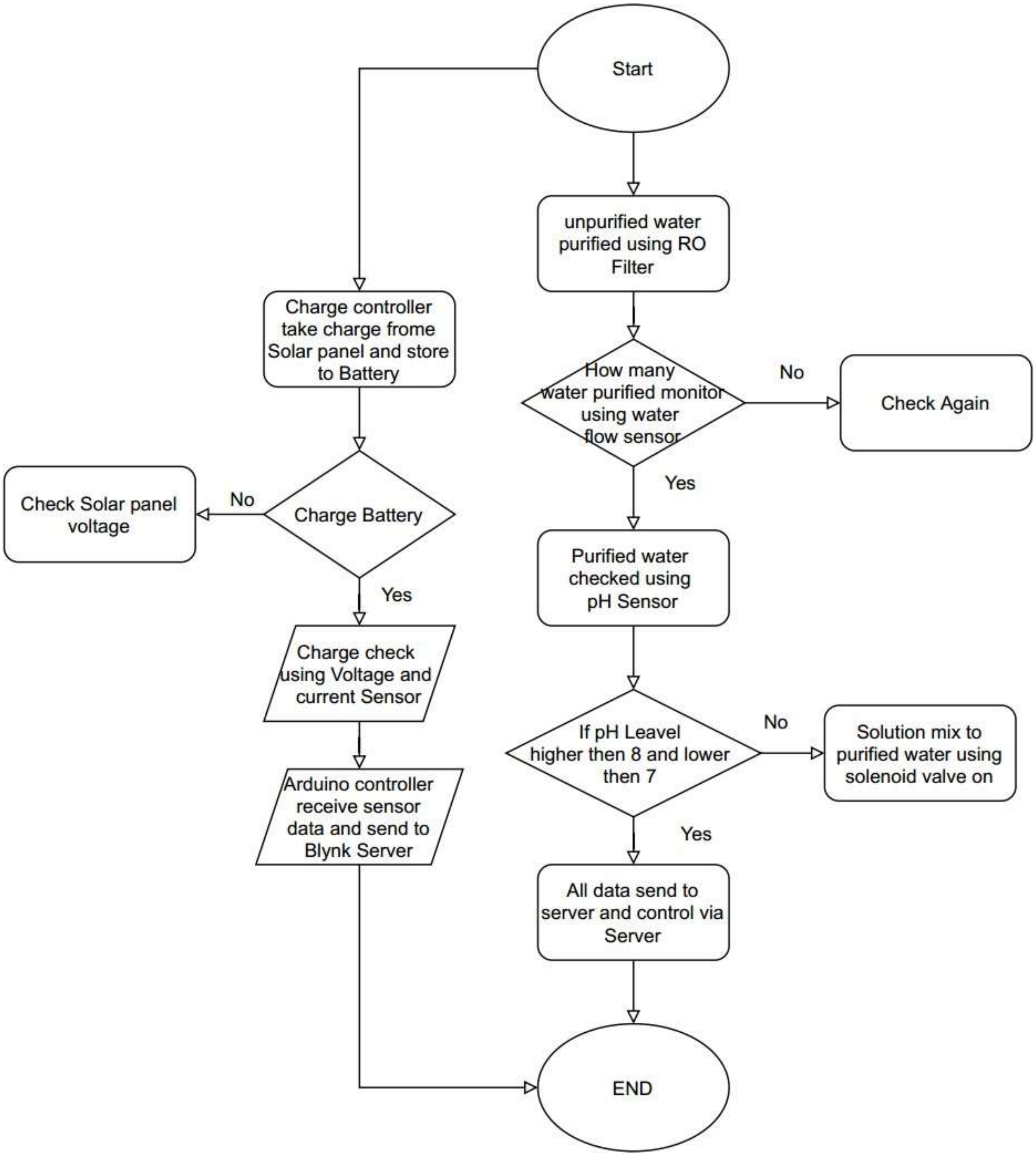

Figure 4.2 System Flowchart

4.3. Modeling

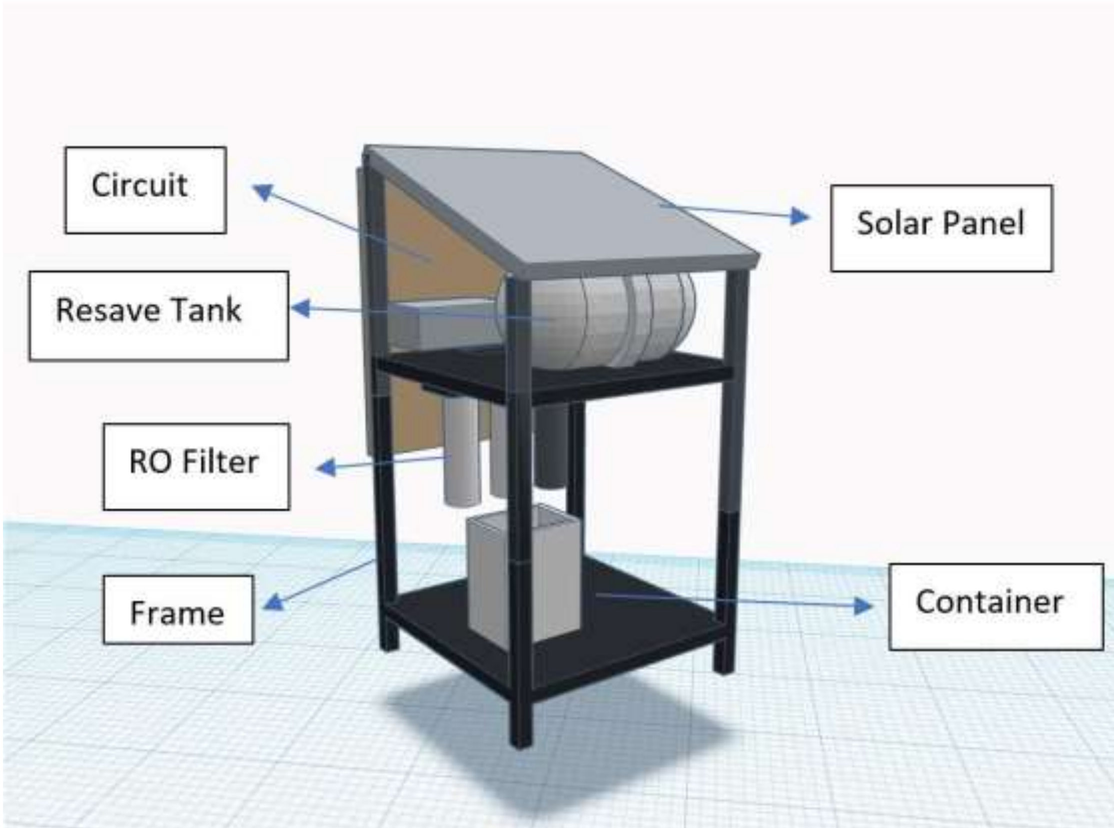

Figure 4.3 System 3D Model

Here in this system solar panel use for power generation. Ro filter use for filter water. Resave tank use for store purified water. Container use for measure water pH and store some water.

4.4. Summary

When the fundamental building blocks are close to becoming ideal, the accomplishments are seen to be close. The goal in this chapter was to construct structures that were as close to ideal as possible. This chapter mainly emphasizes the gap framework technique along with the block diagram and flowchart. This chapter's objective was to demonstrate the project's methodology and guiding principles. Through the examination of the system block diagram and flow chart, we have demonstrated that. The chapter also discusses how the flow chart and block diagram were analyzed.

Chapter 5

PROJECT IMPLEMENTATION

5.1. Introduction

We will talk about the model, approach, and working principle in this chapter. We have put in place an IOT-based system for water purification that will be totally powered by solar energy. In this study, various types of sensors have been employed. such as charge controllers, pH sensors, water flow sensors, voltage sensors, current sensors, etc. For power generation in this project, a 20W solar cell is being used. Through a solar charge controller, a solar cell will charge the battery.

5.2. Required Tools and Components

5.2.1. Water purifier

Figure 5.1 Water purifier

Water purifiers remove dangerous particles and harmful chemicals from the water and help us drink safe water. Nowadays direct clean water isn’t easy to find or hardly seen.

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5.2.2. pH Sensor

Figure 5.2pH Sensor [17]

Water is acidic or alkaline it can be measured by the pH sensor. If the pH level is higher than 7 or alkaline it can cause different types of illnesses like kidney failure, gastric suctioning, etc. If the pH level is very low then 7 or acidic can cause drowsiness, coma, etc. whereas a pH level of 7 or natural is a safe level of drinking water. pH sensor helps to keep the pH level balance.

5.2.3. Solar panel

Figure 5.3Solar panel [13]

Sunlight energy is captured by solar panels, also known as photovoltaics, which then transform it into electricity that can be utilized to power buildings or residences. These panels can be used to extend a building's electrical supply or offer power in outlying areas.

5.2.4. Solar Charge Controller

Figure 5.4Solar Charge Controller [14]

In order to prevent overcharging of the batteries, the charge controller controls the voltage and amps given to the loads. Any extra power is then delivered to the battery system.

5.2.5. Arduino Mega

Figure 5.5Arduino Mega [16]

A microcontroller board called the Arduino Mega depends on the ATmega2560. It contains 16 simple information sources, 4 equipment sequential ports (UARTs), a 16 MHz precious stone oscillator, 54 computerized input/yield pins (14 of which can be used as PWM yields), a USB connector, a power jack, an ICSP header, and a reset button. It accompanies everything expected to help the

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microcontroller; to utilize it, simply plug in a USB link, an air conditioner to-DC connector, or a battery to drive it. The Mega likewise accompanies a plastic base plate to cover it, so there's compelling reason need to stress over an inadvertent electrical release.

Alongside the AREF, the Mega 2560 R3 likewise adds SDA and SCL pins. Moreover, two new pins have been situated near the RESET pin. One such part is the IOREF, which empowers the safeguards to change in accordance with the voltage provided by the board. The other is inconsequential and saved for a future use. The Mega 2560 R3 is viable with all presently accessible safeguards and is versatile to new safeguards that use these additional pins.

5.2.6. DC voltage Sensor

Figure 5.6Voltage Sensor [15]

Dc voltage sensor we use for calculating and monitoring the voltage supply. This voltage sensor works by using voltage divider rule.

5.2.7. ACS712 Current Sensor

Figure 5.7 Current Sensor [18]

The ACS712 is a completely integrated linear current sensor that uses the hall effect. It has an integrated low-resistance current conductor and 2.1kVRMS voltage isolation. Leaving aside technical jargon, it is simply described as a current sensor that determines and measures the amount of applied current using its conductor

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5.2.8. Esp8266 Wi-Fi Module

Figure 5.8Esp8266 Wi-Fi Module [19]

This Wi-Fi module is used for IoT applications where SOC microchips are mainly used at the endpoint of an IoT application. It is very inexpensive and can be used for a variety of purposes.

5.2.9. Relay module

Figure 5.9Relay module [20]

Relays are electrically powered switches that operate by receiving electrical signals from other sources to open and close circuits. By turning the switch on and off, they receive an electrical signal and transmit it to other pieces of equipment.

5.2.10. Solenoid valve

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Figure 5.10Solenoid valve [21]

A solenoid valve, which is powered by DC, is used to regulate the flow of liquid or gas. The electromagnetic field causes that armature to move, and when it does, it opens and closes valves or switches, converting electrical energy into mechanical motion and force.

5.2.11. Water flow sensor

Figure 5.11Water Flow Sensor [22]

The pinwheel sensor that makes up the water flow sensor counts the amount of liquid that has gone through it. The YFS201 water flow sensor's operation is straightforward to comprehend. The hall-effect theory underlies the operation of the water flow sensor.

5.2.12. Solar Inverter

Figure 5.12Solar Inverter

By using a solar inverter, we can convert DC current to AC current, making it usable for home and office appliances. It is frequently referred to as the brain of a solar system and is one of the most important parts of a solar power system since it transforms energy from the sun into more usable energy.

5.2.13. LM2596 Buck converter

Figure 5.13LM2596 Buck converter [23]

This converter has an input voltage range of 4V to 35V and an output voltage range of 3V to 35V, with a maximum rated current of 2A or 3A and a maximum output power of 15W.

5.2.14. ZMPT101B AC Voltage Sensor

Figure 5.14 Current Sensor [24]

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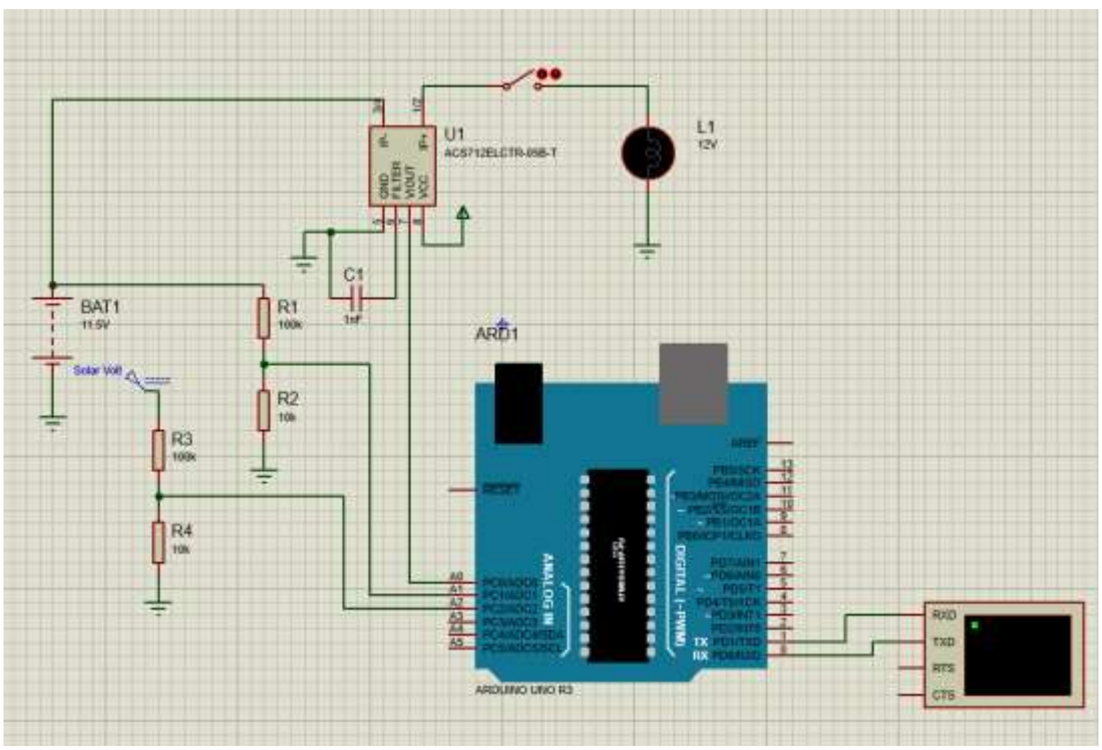
The ZMPT101B module, manufactured by Qingxian Zeming Langxi Electronic, is a small single-phase AC voltage sensor module based on a tiny 2mA/2mA precision voltage transformer. A voltage range of 250 volts alternating current can be used to change the appropriate output analog quantity.

5.3. Implemented Models

We've already finished the hardware prototype and simulation for our project. We will gain a comprehensive understanding of the precise operation of our system via our simulation model. The simulation model and hardware prototype will explicitly list every component that will be used in our system.



5.3.1. Simulation Model

Figure 5.15Simulation Model

5.3.2. Hardware Model

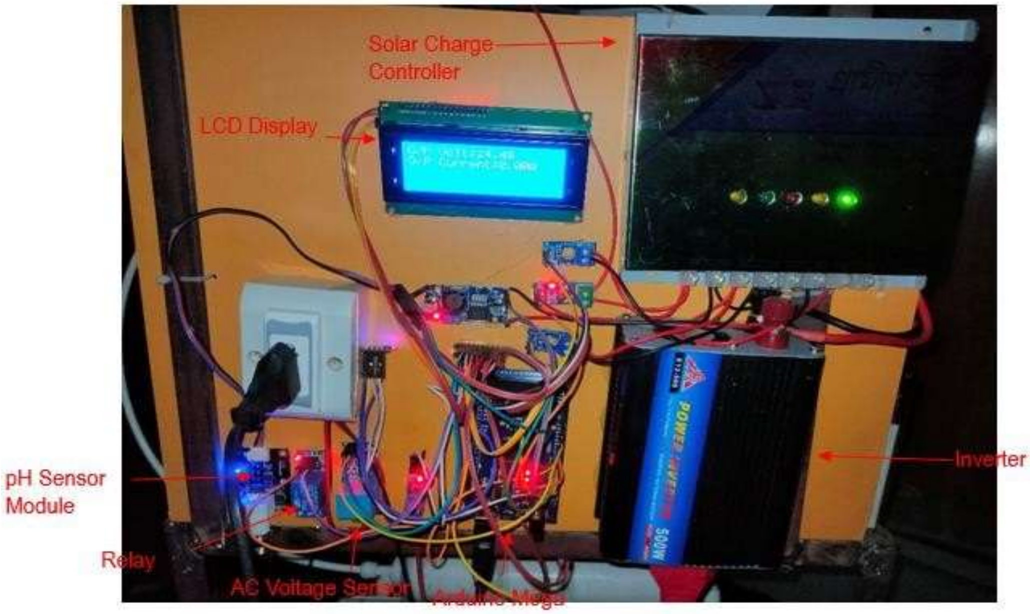


Figure 5.16 Hardware Model main control Panel

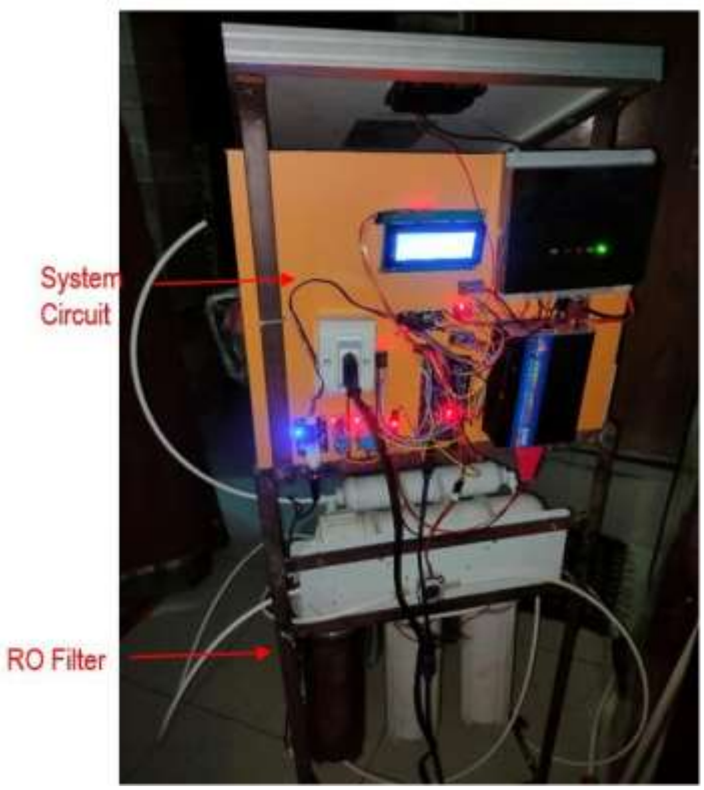


Figure 5.17 Hardware Model Back Side

Figure 5.18 Hardware Model Front Side

5.4. Summary

This chapter focuses on a specific piece of equipment and how the project was carried out with it. The microcontrollers used in this project. The devices are all displayed above with complete model details and images. A prototype model for carrying out the primary and secondary project goals is also included in this chapter. It makes perfect sense to use this kind of machinery to accomplish the project's objectives.

Chapter 6

RESULTS ANALYSIS & CRITICAL DESIGN REVIEW

6.1. Introduction

Briefly discuss how the results were obtained and map the parameters that was required to measure to verify the proposed model successfully provides the required solution.

6.2. Results Analysis

6.2.1. Simulated Results

Here Arduino UNO, an Acs712, a 100k resistor, and a 10k resistor in this simulation model to measure voltage and current, respectively. Here, load-bearing lamps have been mounted, and the virtual interface lets us view the data.

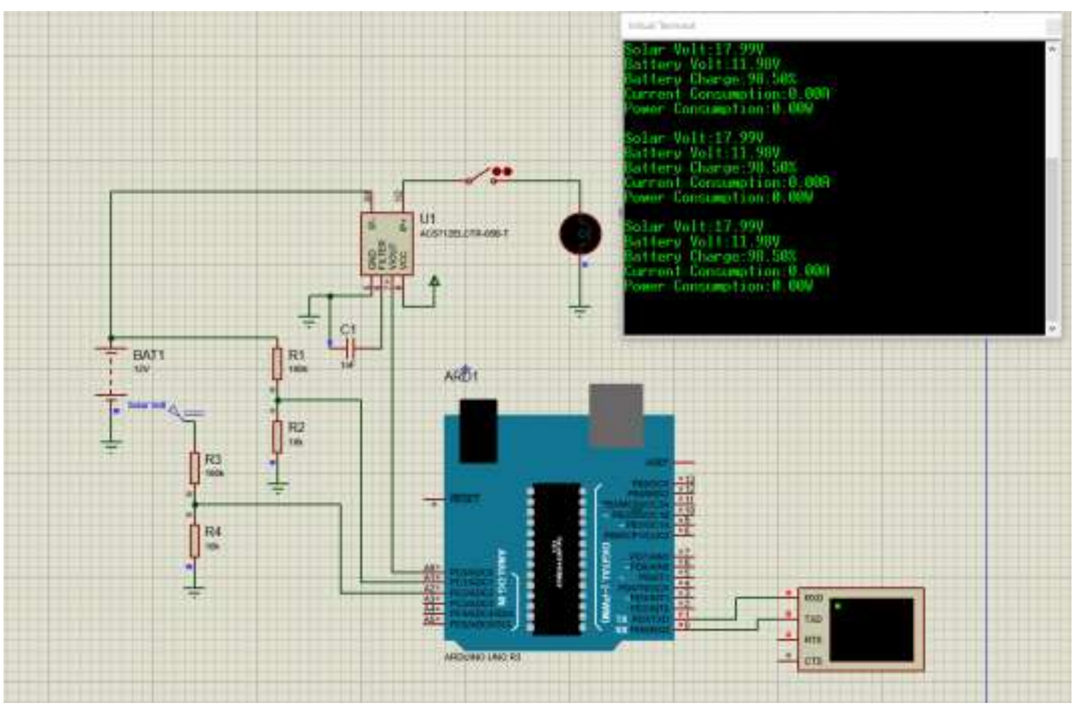


Figure 6.1 full Solar volt and battery charge

In this figure 5.17 simulation circuit, the virtual monitor displays 17.99 volts when the solar voltage is 18 volts. The display indicates 11.98 when the battery voltage is 12 volts, 98.5 percent charge, and 0.00 amps and 0 watts when the load is off.

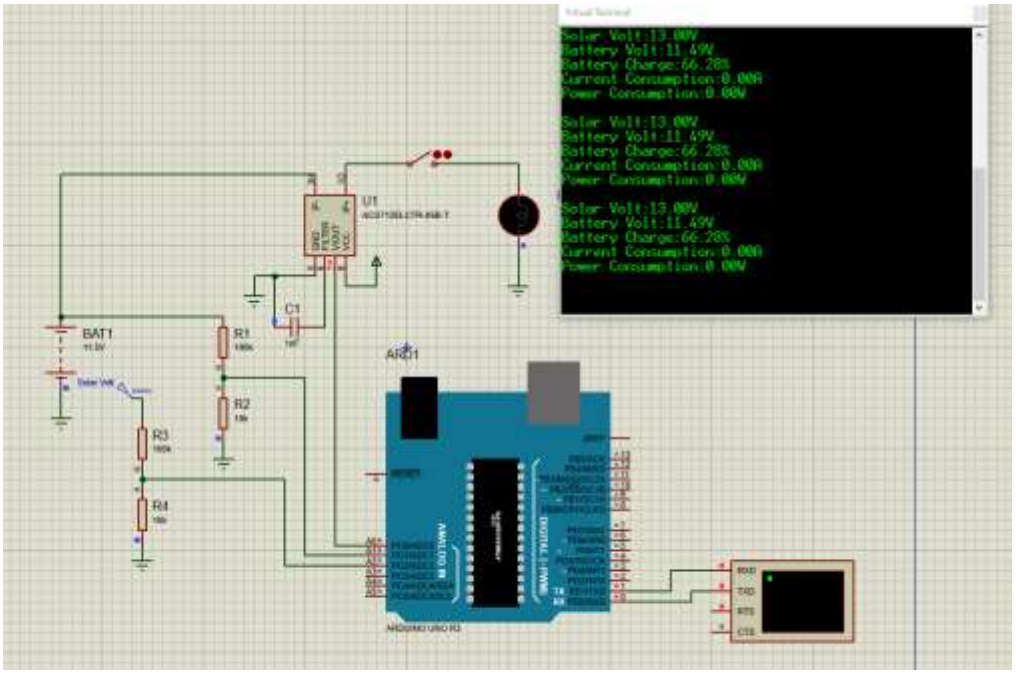


Figure 6.2Solar volt Low and battery charge low

In this figure 5.18 simulation circuit, When the battery voltage is decreased, the charge is also decreased, which is visible in the virtual thermal, and the display indicates 13 volts when the solar voltage is decreased to 13 V.

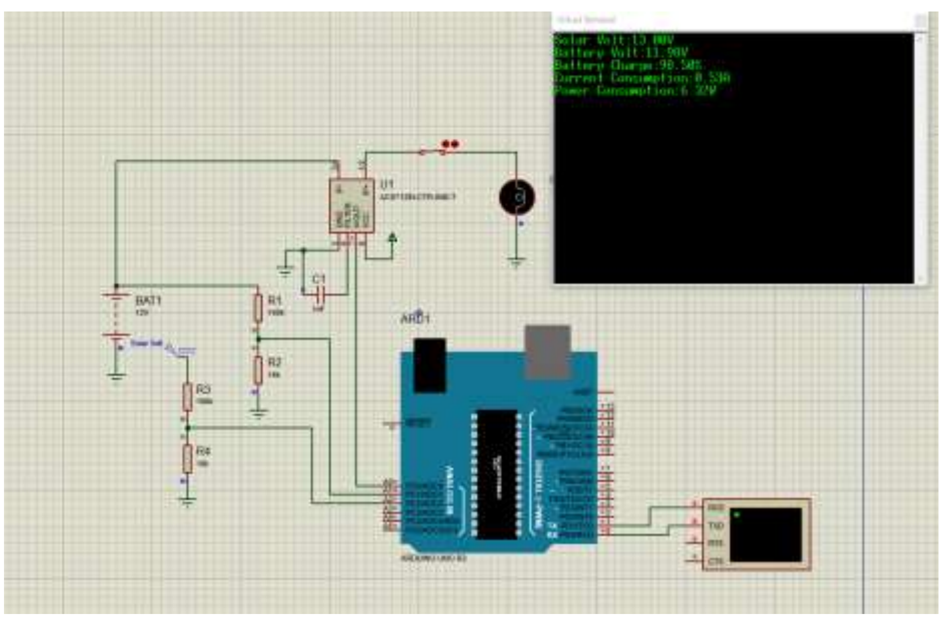


Figure 6.3Solar volt Low and battery charge ok and load on

In this figure 5.19 simulation circuit,the lamp turns on when the load is turned on and off, and the ACS712 measures the current flowing via the current sensor as seen in the virtual display. Additionally, the measured current and voltage are multiplied to determine the amount of power utilized.

6.2.2. HardwareResults

This component's implementation of the sensor is well-thought-out. The sensors used water filtration to measure the current. The pH sensor and water flow sensor outputs were measured for current, voltage, and power. The theoretical and practical components do, however, differ slightly. If the battery voltage falls to 7.4% or the current rises as the battery charge falls, the sensor won't function properly. When the solar panels are functioning properly, the battery is charged and provides reliable backup.

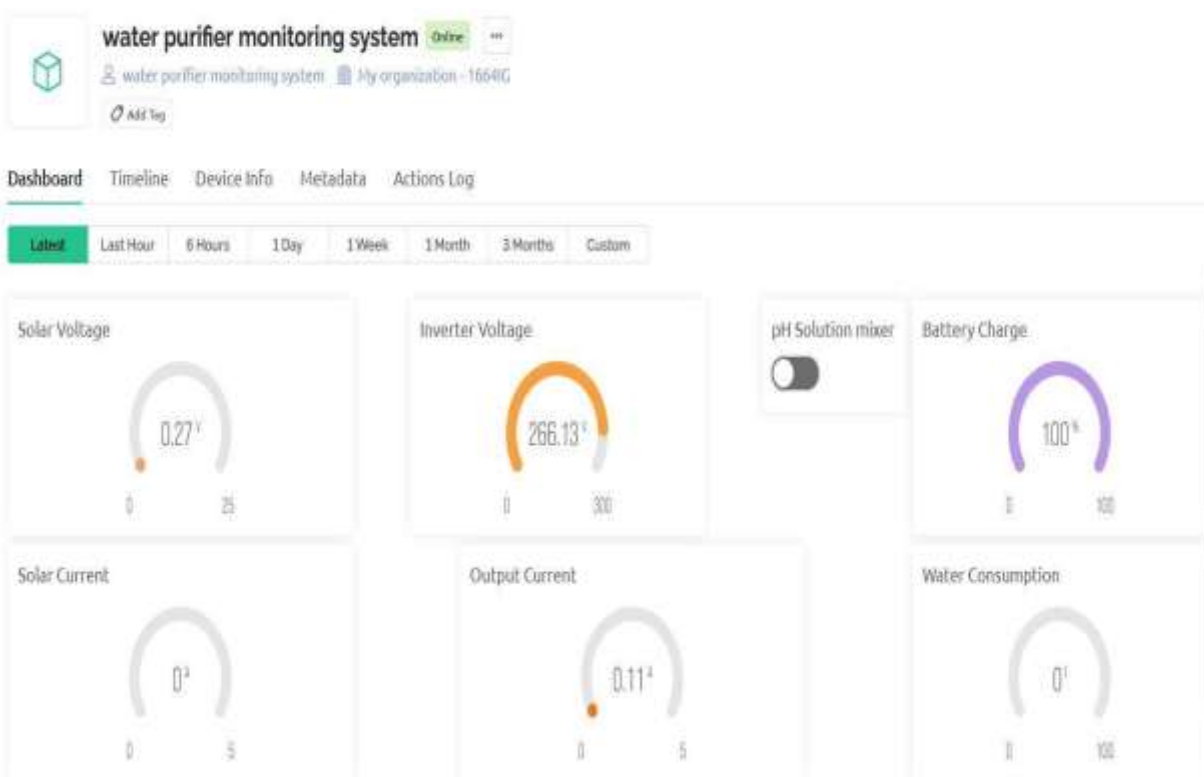


Figure 6.4 Blynk Server Data

Figure 6.5 LCD display data 1

Figure 6.6 LCD display data 2

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In this graph we can monitor solar previous voltage. When solar voltage rises and down, we can analysis it.

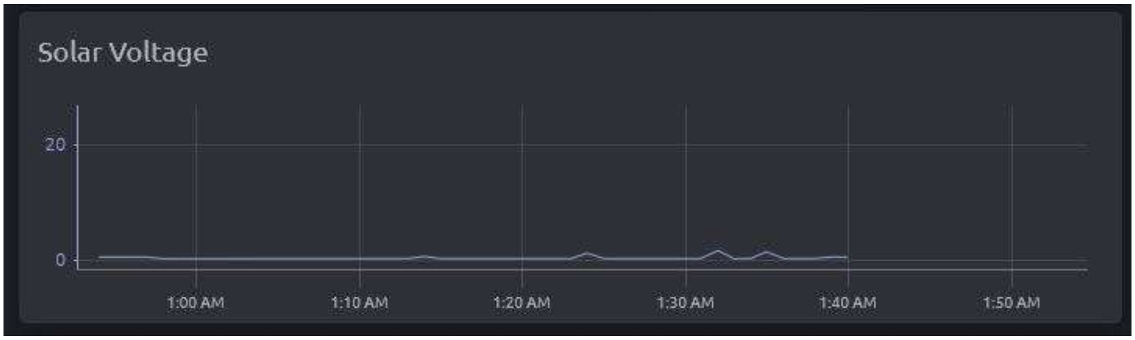

Figure 6.7 Solar voltage graph from blynk website data

In this graph we can monitor solar previous Current. When solar Current rises and down, we can analysis it.

Figure 6.8 Solar Current graph from blynk website data

In this graph we can monitor Output Voltage. By using this data, we can know whether the inverter has ever given or voltage drop.

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Figure 6.9Inverter Voltage graph from blynk website data

In this graph we can monitor Output Current. Using this data we can know when and how much power the filter is consuming.

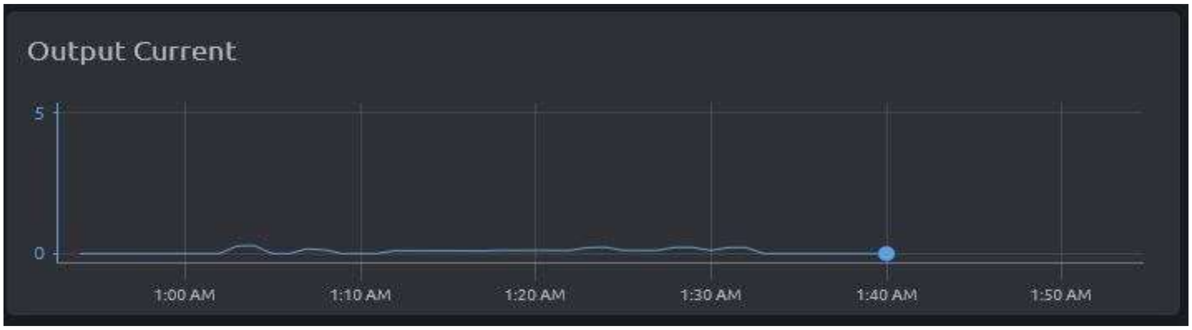

Figure 6.10 Purifier consume current graph from blynk website data

In this graph we can monitor Battery charge. We can use this data to know the battery status.

Figure 6.11 Battery Charge graph from blynk website data

In this graph we can monitor Water Consumption. Using this data we can know how much water has been filtered and when we need to do filter maintenance.

Figure 6.12 Water consume graph from blynk website data

6.3. Comparison of Results

Electronic circuit projects are subject to a number of limitations, and there is no universally applicable solution to any problem. There are numerous viable answers for every issue. We attempted to use the thorough engineering approach. We concentrated on extensive modeling, hardware analysis, and the design of the proposed solution throughout the initial study. A circuit simulation program called Proteus has a lot of electrical and electronic parts. A British software company named Lab-Center Electronics Ltd. created the program. In our hardware and simulation, many sensors are used. It took place since it can be challenging to find every element that is identical in practice and simulation. The main justification for using this sensor is the same. The models used in simulation and practice are different, but the sensors are all the same. In the simulation, we treated the sensors as a load for a particular resistor that uses energy. To build the system, we simply combined all of the sensors and microcontrollers utilizing our significant engineering expertise.

6.4. Summary

The goals, progress, and results of the project are covered in this chapter. When this project was tested, it was found to be functioning in compliance with the design requirements. The functional requirements were fulfilled. The necessary system design, data analysis, and result comparison and interpretation were provided in this chapter. The information review led to the discovery and correction of a number of discrepancies. The data must be running numerous times in order to obtain the desired outcome. The overall impression of the project was provided last.

Chapter 7

CONCLUSION

7.1. Summary of Findings

In order to provide a temporary layer of security, you must understand each project component in the context of system behavior. The project's main objective is to develop a water purifying system powered by renewable energy. The proposed project will make sure that users may watch their daily water, solar power, and other energy usage as well as the electricity needed for this system using the website and applications. They can examine their real-time data on our website and through our applications. Their lives will be safer and easier thanks to this method. A power consumption monitoring system and a water purifying system based on the Internet of Things are the goals of this project. This system will be able to complete a number of duties, such as detecting voltage, current, pH, and water flow, among other things, to improve the effectiveness and efficiency of the project design. However, the hardware & simulation results show that the intended project effort will be good for society. The conclusions drawn from each simulation's results and hardware model thus suggest that the suggested system would be useful and important for people to use on a daily basis.

7.2. Novelty of the work

Every project has a few standout characteristics that make it more intelligent and effective. The project's distinctive qualities could make it extraordinary. In the project mentioned, we attempted to demonstrate how exclusive characteristics may be combined with a standard water purification system to provide an IoT-based system for measuring water and electricity usage. Even while the project may seem well-known in today's world, it is not available in Bangladesh and is consequently out of the reach of the average person. The main goal of the project is to increase access to clean water for everyone while also educating the public on its uses and significance. It can also keep an eye on how much power that particular device is using. The suggested work provides a variety of distinctive features that are advantageous to the user and guarantee their safety and security. To run successfully and efficiently, the project makes use of a variety of sensor states. The sensors can monitor voltage, current, pH, and water flow. Admins are informed of their real-time data via websites and apps. By using the development of contemporary technologies, a straightforward, conventional water purifying system could be transformed into an IoT-based water and power monitoring system that shows dynamic features. The people will benefit from these distinctive traits by having flexible, straightforward daily existence.

7.3. Cultural and Societal Factors and Impacts

7.3.1. Cultural and Societal Factors Considered in Design

The users of this equipment experience the effects of this endeavor in a number of different ways. Economic and cultural factors are taken into account during the entire design process. We also investigated the various elements that this initiative took into account. To produce the best results possible in terms of the collection and usage of data from each sensor. The initiative will have a wide range of additional long-term implications. The society will benefit from technologies that provide a wide range of comforts and conveniences. This project's user interface needs to be enhanced. We have also studied intricate engineering problems utilizing a variety of models or sub-problems in order to address the difficulties. Engineering concepts were created using a rigorous, theory-based technique.

7.3.2. Cultural and Societal Impacts of the Proposed Design

This project has the potential to enhance the current conditions of the housing, people, and economy. Working in this profession will help members strengthen their self-assurance, willpower, and curiosity. The model was created to provide the user with extremely accurate results. Monitoring from all the sites may be useful to get an accurate result. It is obvious that this project will boost the ability to quickly identify the quantity, quality, and consumption of water utilizing a variety of sensors depending on effectiveness and operating method at a reasonable cost.

7.4. Proposed Professional Engineering Solution

This initiative offers a technique for using solar energy for water purification in remote areas. It talks about several expert engineering fixes as well as different engineering problems that have been solved. Engineering solutions frequently have a big impact on society. The Arduino board, various measuring sensors, and websites and applications that record the data obtained make up the project's primary parts.

We can quickly determine whether the data we have received is accurate or not by comparing the measured data with the information allowed from this sector.

7.5. Limitations of the Work

Every study project on development has some restrictions. Nothing about our project differs from that. The entire project has been implemented in both hardware and software. Both the hardware and the simulation models have provided us with the measured values. Although we designed this project with rural locations in mind, we were unable to test it there. Using tap water, we manually tested it in our room. We must make this prototype smaller, like a chip, even if it cannot be used in rural areas. After that, we can use this in rural areas.

There are various restrictions when it comes to constructing a project because this is a university final assignment. Several challenges come up as the project develops. The factors that are the root cause are as follows:

- A time limit.
- Advice from a qualified electrical engineer is necessary.
- A robust network will be necessary.
- There aren't many big data storage facilities where you can keep old data.

7.6. Future Scopes

Before releasing this prototype model for sale, more testing is necessary. In the near future, it might be used outside the home to measure water filtration and track operations with solar power. This approach will be most frequently used in rural regions. System administrators may thus keep an eye on and be aware of how data is used in real time.

7.7. Standard Requirements and Ethical Concerns

There were several ethical issues that needed to be handled when this project was being developed. The technique was reviewed ethically in order to make decisions that would respect the ethics of the work. There were certain rules that had to be followed.

7.7.1. Related Code of Ethics and Standard Requirements

In light of the importance of our technologies in enhancing the quality of life in sports analysis as well as our own commitment to our profession, its members, and the communities we serve, we commit ourselves to the highest standards of ethical behavior.

- Uphold the greatest standards of integrity, responsibility, and morality in all of your professional pursuits.
- In your professional endeavors, uphold the highest standards of integrity, responsibility, and ethical conduct.
- While carrying out the experiment, all parties involved must be aware of the rules and guidelines that must be followed in order to complete the task.
- All participants in this experiment must go through certain practice sessions before engaging in practice with humans.

7.7.2. Health and Safety

No one's health is at danger as a result of this project approach. The ethics of health and safety have been correctly upheld in this endeavor. No dangerous instrument exists that could endanger your health. The standards and principles of engineering are upheld in this project in order to uphold ethical obligations while providing an engineering solution. Because they can utilize this research to determine the quality of the water, individuals will be better able to take care of their health. Public safety and health shall be ensured.

7.7.3. Economy, Environment and Sustainability

No one's health is at danger as a result of this project approach. The ethics of health and safety have been correctly upheld in this endeavor. No dangerous instrument exists that could endanger your health. The standards and principles of engineering are upheld in this project in order to uphold ethical obligations while providing an engineering solution. Because they can utilize this research to determine the quality of the water, individuals will be better able to take care of their health. Public safety and health shall be ensured.

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7.8. Conclusion

The project's philosophy and purpose were both successfully realized. To get the most of our technology, we put in a lot of effort and conducted extensive research. The suggested project effort is in line with current science's and technology's mission to make life easier and more comfortable for the less fortunate. The main objective of this project is to provide people freedom and autonomy. The structural designs for this project were modeled using programs like PROTEUS, with Arduino serving as the main control element. Additionally, hardware has been used to implement the design. The suggested configuration combines a number of useful elements to produce a real-time system that can detect power, pH, voltage, current, and water flow. Additionally, we created a website and apps to track the data collected; these additions enhance the system's intelligence, safety, and security. Because all of these programs are integrated, users of this device can track their daily usage in a way that is particular to them.

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[24] https://www.electroschematics.com/wp-content/uploads/2022/02/5-ZMPT101B-Module-Overview.jpg?w=700

Appendix A

SURVEY QUESTIONNAIRE

1. Do you think that Solar based water purifier is needed for rural places,flood affected area or industry?	Yes
	No
	Maybe
2. Do you think that this project has a positive impact on the environment?	Yes
	No
	Maybe
3. Do you think that this project is more economical than other system?	Strongly Agree
	Disagree
	Neutal
	Maybe
4. Do you think that this project will be helpful to reduce drinking water crisis in rural or coastal areas?	Yes
	No
	Maybe
5. Do you want it in your service?	Yes
	No

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Appendix B

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