STUDY OF POWER CONSUMPTION OF DIFFERENT IOT SENSORS: WATER QUALITY MEASUREMENT IN AQUACULTURE CASE

An Undergraduate CAPSTONE Project
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Faculty of Engineering
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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

This is to certify that this project is our original work. No part of this work has been submitted elsewhere partially or fully for the award of any other degree or diploma. Any material reproduced in this project has been properly acknowledged.

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APPROVAL

The CAPSTONE Project titled **"Study of power consumption of different IoT sensors: water quality measurement in aquaculture case"** 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 **January 2023** by the following students and has been accepted as satisfactory.

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TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

ABSTRACT

Sensors play a critical role in the development of digital systems. We must research and learn about the sensors. Since they collect the data needed to manage the parts and operations, sensors play a crucial part in the Internet of Things (IoT). A system's sensors are like its brain. The lifespan of IoT systems, which is mostly dependent on how much power the sensors use, poses the biggest problem. In this study, we looked at how much power various sensors used. The sensors that we took into consideration in the work are used to monitor the purity of the water. We took into account the aquatic instance since it is important to be concerned about growing fish productivity. Initially, the TDS, pH, DO (dissolved oxygen), temperature, and hardness sensors allowed us to successfully measure the quality. Then, using both manual measurement and voltage and current sensors, we determine the power consumption of the sensors. The results we obtained using both techniques matched exactly. Along with the Arduino uno microcontroller, we also utilized an LCD screen to provide the user measurement data for quality, quantity, voltage, current, and power. The IoT server, website, and applications received all data so that consumers can monitor their systems.

Chapter 1

INTRODUCTION

1.1 Overture

The Internet of Things (IoT) is used a lot in our culture and all over the world right now. Sensors are the backbone of the Internet of Things. As the sensors are electronic devices, they need power sources to operate. Even though sensors require incredibly minimum power and are supplied by a variety of compact batteries, the lifecycles of IoT systems using different types of sensors are still a matter of debate. Rechargeable batteries are often used in such systems since they provide more consistent performance, but their lifecycles are still not as long as most would like [1].

Good quality water is essential to our aquaculture. Effective water quality management is one of the most significant issues in aquaculture, as it helps to ensure high fish production and quality. For fish to maintain optimal health, productivity, and quality, the water quality must be regulated on a regular basis. This is the case because farmed fish are more vulnerable to the detrimental effects of low water quality on their health Agriculture, particularly aquaculture, has experienced a number of technological advances in recent years. The Internet of Things (IoT) offers tremendous technical advancements for fish aquaculture [2].

Power is another vital component. Any time we use a device or system, we should be aware of the amount of energy it consumes. The majority of systems and devices, however, lack such components for determining power usage. This project proposes an IoT-based water quality measuring system and the power consumption of the sensors utilized in this measurement system. This system provides each farm owner with information on their aquaculture water and energy use. It will assist them in maintaining the quality of aquaculture water and in monitoring the system's lifecycle.

1.2 Engineering Problem Statement

Maintaining a proper pond fish culture environment is crucial for the growth of healthy fish, the achievement of satisfying production, and the improvement of the efficiency of the culture. Aquaculture refers to the cultivation of aquatic creatures and the provision of appropriate conditions for a variety of reasons, including commercial, recreational, and public. The environmental limits that necessitate the development of new equipment and technologies have been one of the most significant challenges lately addressed by the fish and aquatic farming business. Traditional fish farming confronts a number of obstacles, including water pollution, temperature imbalance, feed, space, cost, etc.

Aquaculture solutions based on the Internet of Things that improve efficiency and production are offered as a remedy for this difficult issue. This system permits the real-time collection of Internet data. The cultivation and processing of fish entail a vast array of technology. Aquaculture engineering is primarily concerned with water concerns, including water circulation and water quality. Others deal with the biology of ecosystems (including bio-manipulation via the introduction of fish) or the biology of cultivated species (so-called "bio-technologies"). Aquaculture engineering is primarily concerned with water concerns, including water circulation and water quality. Each consumer is provided with accurate data. This enables the client to check their water usage at any moment inside the applications. The suggested work will be reflected in software via the use of engineering management skills, and the hardware structure will be implemented afterwards. All anticipated consequences will be examined upon completion of the hardware framework [8].

1.3 Related Research Works

This research focuses on the water quality parameters pH sensor, TDS sensor, DO sensor, temperature sensor, voltage sensor, and current sensor in order to determine the power consumption rate of each sensor. A system has been created to automate the collection of sensor data and the analysis of water quality and device status. In bio floc aquaculture, the implementation of IoT makes it simpler to monitor the water and preserve the ecosystem.

1.3.1Earlier Research

Design of Remote Monitoring System for Aquaculture Cages Based on 3G Networks and ARM-Android Embedded System:

This author proposes a remote monitoring system for open-ocean-aquaculture cages to improve the level of controlling the operation on aquaculture cages. The system is based on the combination of two key technologies: a 3G wireless communication platform and an embedded system based on the ARM-Android system. It has three components: an aquaculture-cage detection terminal, a portable monitoring terminal, and remote data centers. Detecting terminals collect real-time seawater parameters and video data, which are transferred to portable monitor terminals via 3G wireless networks; portable monitor terminals send commands based on the information received, which are then transmitted to remote data centers via Wi-Fi wireless networks [3].

Remote Monitoring System based on Ocean Sensor Networks for Offshore Aquaculture:

The objective of this work is to develop a remote monitoring system based on ocean sensor networks for offshore aquaculture, and to verify the effectiveness of the developed system. The remote monitoring system consists of two main components: ocean sensor networks installed on fish cages deployed in the ocean and a monitoring center located on land. The ocean sensor networks installed on fish cages consist of gateways, sensor nodes, and sensor interface nodes. The fish cages are located approximately 2 km offshore. Thus, the data sensed in the fish cages are transmitted to the monitoring center through RS-485, Zigbee, and CDMA communications in the ocean sensor networks, and displayed in the monitoring center. In particular, in order to perform underwater experiments, gateways and sensor nodes are enveloped in a plastic container, and sensor interface nodes are enveloped in a waterproof container. The used sensors can include different sensors that measure environmental parameters, such as, temperature, dissolved oxygen (DO), pH, and CO2 [4].

Power Consumption of IoT Access Network Technologies:

Many analysts have praised the "Internet of Things" (IoT) as the next stage in the internet's growth during the last few years. The alternatives for constructing a network of "things" and connecting them through their gateways into the Internet or a business network are examined in this article from the perspective of energy usage. It focuses primarily on the access network that connects customer premises to the central office and the effects transporting uplink-dominant IoT traffic has on this network. For a variety of IoT traffic and background network traffic levels, the power consumption of a number of alternative access network technologies and architectures is simulated. It has been shown that if Wi-Fi background traffic is kept to a minimum, a shared corporate Wi-Fi network with PON backhaul might be the most energy-efficient solution. If the site's IoT traffic level is modest, up to around 100 kb/s, a 4G wireless (LTE) connection is also highly effective. A GPON connection offers the most energy-efficient option at premium prices [5].

1.3.2 Recent Research

A standalone photovoltaic/battery energy-powered water quality monitoring system based on narrowband internet of things for aquaculture, Design and implementation:

This research provides a standalone NB-IoT (narrowband internet of things) for aquaculture driven photovoltaic (PV)/battery energy storage (BES) water quality monitoring system. The primary energy source for the monitoring system was a PV/BES system. In order to supply the monitoring system with continuous electrical power, the PV and BES capabilities were adjusted based on two techno-economic criteria: a minimal levelized energy cost (LCOE) and a maximum reliability index (RI). In order to increase the resilience of the PV/BES system, sensitivity assessments were also carried out to look into the implications of changes in PV production and system consumption on the RI. To aggregate water quality indicators such dissolved oxygen, hydrogen potential, temperature, turbidity, and salinity and to offer early warning of severe water quality, the NB-IoT-based remote monitoring system was built. The water quality appropriateness index was then calculated using the data on water quality (WQSI). Electrical measurement equipment was also installed to measure important electrical characteristics including PV power, system usage, BES power, and charge condition. The end users were then provided with real-time processing and visualization of these electrical and water quality information using Grafana. In Thailand's Rayong Province, an aquaculture pond was used to test the suggested technique. From the perspective of the energy system, it was established that a PV system should have a capacity of 50 Wp and a BES system should have a capacity of 480 Wh, with a RI of 100% and a minimum LCOE of 0.61 $/kWh. The results of the trial showed that the system could run steadily and constantly without losing power. Additionally, the results revealed that the recommended system attained sufficient communication steadiness, with a packet loss rate of 0.89%, providing dependable close to real-time WQSI monitoring [6].

Power Consumption Analysis of NB-IoT and eMTC in Challenging Smart City Environments:

The forthcoming Internet of Things will provide massive sensor networks comprised of devices with vastly different propagation properties and power consumption requirements. 5G intends to meet these objectives by mandating a minimum battery lifetime of 10 years. IoT communication systems must also enable extremely deep coverage in order to accommodate the integration of smart devices placed under demanding propagation circumstances. These standards are intended to be met by NB-IoT and eMTC, paving the way for 5G. With the power-saving choices of Discontinuous Reception and Power Saving Mode, as well as the use of a high number of repetitions, NB-IoT and eMTC bring new ways to satisfy the needs of 5G IoT. This article evaluates the performance of NB-IoT and eMTC. Consequently, data rate, power consumption, latency, and spectral efficiency are analyzed under various situations of coverage. Despite the fact that both technologies employ the same power-saving strategies and repetitions to expand the communication range, the study indicates that they perform differently in terms of data size, rate, and coupling loss. While eMTC has a 4% longer battery life than NB-IoT when considering 144 dB coupling loss, NB-IoT has an 18% longer battery life when considering 164 dB coupling loss. Overall, the research indicates that in coverage regions with a coupling loss of 155 dB or less, eMTC performs better but needs a great deal more bandwidth. Taking spectrum efficiency into consideration, NB-IoT is the superior option for future networks with a large number of devices in all examined scenarios [7].

IoT Based Smart Water Quality Prediction for Bio-floc Aquaculture:

Traditional aquaculture is faced with a number of difficulties, such as water pollution, temperature imbalances, feed, limited area, high costs, etc. The manual in aquaculture is transformed into a cutting-edge system by Bio-floc technology, which turns leftover feed into microbial protein and permits the reuse of it. The study's goal is to provide an IoT-based aquaculture solution that boosts production and efficiency. The article described a system that uses sensors to gather data, machine learning to evaluate it, and artificial intelligence (AI) to provide judgments and alerts to the user. To validate the suggested system and provide a suitable outcome, it has been put into practice and tested [8].

Water Quality Monitoring and Reporting System for Aquaculture with Solar Energy Harvesting:

For long-term, continuous monitoring, a water quality monitoring (WQM) system with solar energy harvesting is suggested. The system uses a solar charge controller to charge a lithium battery from a solar panel. Every time there is enough sunshine, the system utilizes solar energy, and the lithium battery stores the energy for use later when it is cloudy, rainy, or nighttime. By using the proper charging technique and reducing the frequency of battery charge-discharge cycles, the solar charge controller guarantees the lithium battery a long life. Small power equipment may be used to deploy this system, making it particularly ideal for Internet of Things wireless sensor nodes that are located outdoors (IoT). The ultimate goal of this project is to create a water quality monitoring system for aquaculture that is continuously powered, reducing the need for routine maintenance like battery replacement or recharging. The lifespan of this WQM system may be extended by the energy harvesting system created for this study, which has been experimentally confirmed [9].

1.4 Critical Engineering Specialist Knowledge

This project's objective is to develop an Internet of Things (IoT)-based water quality monitoring and power consumption measuring system that will allow individuals to determine the water's quality via the usage of IoT sensors. This gadget will tackle the problem of real-time water monitoring. To accomplish the project's objectives, one must have specific technical expertise and the capacity to overcome any challenging circumstances. This project will employ several sensors to make it more advantageous for aqua-firm owners. It will use an Analog Dissolved Oxygen Sensor that will be able to detect if the oxygen level in the water is healthy or unhealthy, and will then offer an output. In addition, it will use a Current sensor and a DC Voltage sensor that can measure the device's current and voltage. The PH value will be determined using a PH sensor so that people may determine whether or not the water is safe to drink. Total dissolved solids (TDS) & Temperature sensor will also be utilized to assist people in determining which types of water are ideal for aqua fishing based on the quantity of dissolved solids present as well as the temperature. As our project requires an ARDUINO UNO and knowledge of ARDUINO programming, it will also demand knowledge of ARDUINO. In this project, ARDUINO will serve as the primary controller. It will also need familiarity with WEBSITE and APP, since all data will be saved in WEBSITE and APP. Using this application, users may get the most recent data. This project will extensively test the output of several sensors utilized in the project, such as the Oxygen sensor, TDS sensor, PH sensor, Temperature sensor, AC Current sensor, and AC Voltage sensor, all of which are controlled by Arduino. In addition, it will design the project's hardware circuit inside the program and validate various output data as necessary. A sufficient understanding of this equipment and software will contribute to the success of this project, allowing it to reach its desired objective. Increase its value to aqua-firm owners. It will use an Analog Dissolved Oxygen Sensor that will be able to detect if the oxygen level in the water is good or poor, and then offer an output. It will also have a Current sensor and a DC Voltage sensor that can measure the device's current and voltage. The PH sensor will be used to determine the PH value so that people can determine whether the water is safe to drink. A total dissolved solids (TDS) & temperature sensor will also be utilized to assist people in determining which types of water are ideal for aqua fishing based on the quantity of dissolved solids present and the temperature. It will also need knowledge of ARDUINO, since our project requires an ARDUINO UNO and ARDUINO programming skill. Arduino will serve as the primary control unit in this project. It will also be necessary to be familiar with the website and app, as all data will be saved there. Using this application, individuals may get the most recent information. This project will extensively test the output of the many sensors used in the project, including the Oxygen sensor, TDS sensor, PH sensor, Temperature sensor, AC Current sensor, and AC Voltage sensor, all of which are controlled by Arduino. In addition, the program will design the hardware circuit of the project and validate various output data as necessary. A sufficient understanding of this equipment and software will aid in making this project successful and achieving its desired objective.

1.5 stakeholders:

The primary stakeholders are proprietors of aquatic farms and NGOs. Their needs include accurate monitoring of water quality, device dependability, and the capacity to make appropriate decisions without harming aquaculture fish. According to the introduction and the literature review, interaction with stakeholders is a crucial success factor. Among many developing technologies, the water and power consumption system aids people by informing, actively helping, or assuming a part of the water consumption responsibility. There are now devices available on the market that assist with water ph detection, dissolved oxygen levels, water temperature, total dissolved solids (TDS) of water, and so on. Being developed are more sophisticated versions of these systems and systems that incorporate several capabilities. Water and Energy Consumption Evaluation Systems are intended to especially contribute to measuring water usage. This system has not yet been applied on a large scale. As a result, the key stakeholders involved in the installation of water and power consumption measuring systems have diverging perspectives on many aspects of these systems, preventing their rapid and widespread adoption. As a result, policymakers and others are reluctant to install water and power consumption measuring systems. To choose which policy to pursue, officials need to be knowledgeable about stakeholder preferences. Changes in the political environment have a substantial effect on federal rules and planning. The flexibility of governments and the assistance they obtain while establishing such rules also play an important role in the introduction of innovative technology. The bystanders' expectation is that the system will not damage them while they are working. They think it is the corporate and social duty of businesses and governments to ensure the safety and well-being of all bystanders. They place a significant amount of emphasis on the idea that sensor manufacturers and owners will be found culpable for any harm caused by their equipment.

There are presently a large number of technological solutions in this field that serve a range of social purposes. It may be feasible to integrate additional stakeholders, such as non-governmental organizations, in the existing processes. In parallel, consultative committees might be developed to assess not only the technological requirements and improvements, but also the social, environmental, and legal ramifications of the enhanced usage of Water & Power Consumption measuring systems. This would include evaluating not just the technology itself, but also its social, environmental, and regulatory ramifications. According to the study literature, the many stakeholders include of users, governments, businesses, sensor manufacturers, water supply companies, energy supply corporations and owners, and non-governmental organizations.

1.6. Object of this work:

The primary objective of this research is to investigate the power consumption of IoT sensors. We examined water quality and usage monitoring systems in this project. For many individuals, searching for water use data is a waste of time. Many farm owners are unable to manage their aquaculture water as a result of not doing this study. Our mission is to monitor aquaculture water quality and give the user reliable data.

1.6.1 Primary objectives:

The primary objective is to display the power consumption by the sensors that is utilized in the system & deliver the data to the user in the append to out how much power our sensors are using. For instance, if a user understands how much power he needs and how much power he has used for a system, he may avoid worrying about excessive power usage. It is a technology in development that allows customers to access their power use statistics via applications and determine how much energy their sensors are using.

1.6.2 Secondary Objective:

The secondary objective of this project is to inform farm owners about aquaculture water quality. IoT technologies may be deployed independently and do not require extra costs from a mobile network provider. However, power consumption, real-time data, and obtaining measured data that is transmitted to a cloud database restrict their practical application. This device, which is photovoltaic (PV) or battery energy storage (BES)-powered, is the primary energy system for monitoring water quality. Using the WQSI (water quality suitability index) to evaluate if the water quality is suitable for aquaculture. With this project, there will be a website and an app that enable the user to see the power usage of sensors and check water quality from any place and at any time. This allows farm owners to monitor their aquaculture water and the amount of power the sensors utilize.

1.7 Organization of Book Chapters

Chapter-2: Project Management: The project's administration is the subject of this chapter. This chapter discusses the strengths and weaknesses of people's perspectives.

Chapter-3: Methodology and Modeling: This chapter has demonstrated the project's concept. It describes the information and strategies that will enable the project to achieve its main goal.

Chapter-4: Project Implementation: The chapter provides an overview of the types of equipment, as well as a block diagram, flowchart, and the project's working method.

Chapter-5: Results Analysis & Critical Design Review: This chapter will discuss detailed study of the project outcomes.

Chapter-6: Conclusion: This chapter overviews all the chapters.

Chapter 2

PROJECT MANAGEMENT

2.1. Introduction:

The state of technology is ever-changing. Growth and change lead to technological evolution. The discovery of new, superior materials or methods of construction is responsible for many of the changes. The lives of people and the aquatic industry have both benefited from advances in science and technology. All of the innovative and varied developments were made with the sole intention of advancing humanity. Additionally, the project's name aims to raise the standard of water monitoring in aqua cases. The results of the hardware implementation of the proposed model were also realized. The project's hardware will be implemented using numerous sensors and a microcontroller. Making assumptions about the precise future implementation and its impact requires early analysis of project outcomes. The effects of the project will be briefly discussed in this chapter.

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

The abbreviation SWOT represents strengths, weaknesses, opportunities, and threats. The strengths, weaknesses, opportunities, and dangers of the project should be outlined succinctly for each area. For a project, we need planning methods. SWOT analysis is one of the most effective techniques for strategic planning a project's weaknesses, threats, and opportunities. Using this method, we may evaluate the project completion path's strengths, weaknesses, opportunities, and threats. Consequently, a future development path for the project has been determined. This is an entirely internal project that may have been based on surveys, but we conducted it using internet-accessible data.

2.2.1 Strengths

Strengths signify what an organization excels at and what distinguishes it from the competition, such as a stable balance sheet or exclusive technology. To keep up with modern technology, Bangladesh has lately introduced a number of digitalization-promoting activities. Considering all present efforts, the most important advantage of the proposed initiative is that it can be provided to the majority of Bangladeshis. We are attempting to develop a digital water quality monitoring system that will provide us with information for aquaculture, including the condition of the water and whether it is suitable for aquatic life, the temperature of the water, the oxygen level of the water, the PH of the water, and how much power all of the sensors require during this operation, as well as the use of batteries to extend the lifespan of our project. We have created a smartphone application that shows all internet-based information.

2.2.2. Weaknesses

A group’s inadequacies inhibit its optimal performance. To stay competitive, the work must be enhanced in these areas. This project has various flaws despite its tremendous strengths. We were required to acquire some sensors from China since they were unavailable in Bangladesh. And the delayed shipping slowed down our job progress. Our project’s monitoring of the water’s quality in real time is minimal. Consequently, the water quality will improve in a short amount of time.

2.2.3 Opportunity

This research aims to help identify answers to problems aquaculture or fish pond owners face, notably the declining and sluggish production of fishes in aqua-firms and ignorance of the pond's present water quality. Consequently, we must focus our research on the relationship between fish development and aquatic conditions. For this reason, the owner of an aqua-firm who wants to know whether the dissolved oxygen, pH, TDS, and temperature levels are appropriate in real time, as well as persons interested in establishing an aqua-firm for commercial objectives.

2.2.4 Threats

If we supply a rechargeable battery, if there are any dangers, the battery will shut down, the gadget will not operate effectively, and any additional dangers will be neutralized. After one month, we must replace the oxygen sensor probe's solution, which is a challenging task.

2.3 Schedule Management:

Tasks / Date	16-April	16-April–9-May	9-May-15-Aug	15-Aug-22-Aug	7-September	22-September	22-Sep-27-Nove	27-Nove-28-Dec	5-January	8-January	14-January	18-January
Orientation												
Proposal submission												
Hardware & research and chapter 1&2 writing												
Submit chapter 1,2 & progress report to the supervisor to review												
Attend final defense of fall-21 groups												
Progress defense												
Online chapter 1,2 and progress reflection report submission deadline												
Lifelong leaning report & Peer review submission												
Preparing & Submission of draft project book to Supervisor												
Submission of poster, summary & revised project book to supervisor												
Submission of project book to external for review												
Submission of final book, plagiarism report, poster & summary to Supervisor												
Final Defense												

Table-2.1: Project Schedule (Gantt Chart)

2.4 Cost Analysis

The following equation is used to calculate a standard deviation based on our predicted total project cost and final implementation cost, as shown in table 2.2:

$$\sigma = \sqrt{\frac{1}{N}\sum_{i=1}^{n}[x_{\mathrm{i}} - \mu]^2}$$

Where N represents the size of the population and represents the population's average.

The following is an approximation of the materials required to complete this project:

SL NO.	Equipment	Quantity	Estimated Cost per unit (BDT)	Final Cost per unit (BDT)	Total Estimated Cost (BDT)	Total Final Cost (BDT)
01	Arduino Mega	1	1600	1800	1600	1800
02	AC Current Sensor	1	210	215	210	215
03	Voltage Sensor	1	90	90	90	90
04	Oxygen Sensor	1	14,000	18,000	14,000	18,000
05	TDS Sensor	1	1200	1300	1200	1300
06	pH Sensor	1	3000	2500	3000	2500
07	Temperature Sensor	1	630	700	630	700
08	Battery	1	900	1200	900	1200
09	Wi-Fi Module	1	250	275	250	275
10	Adapter	1	550	520	550	520
11	Breadboard	1	50	80	50	80
12	Connecting Wires	60 pcs	100	120	100	120
	Total Cost (BDT)		22,580	26,800	22,580	26,800
	Standard Deviation				3,743.312	4,810.386

Table-2.2: Total Cost

As a result, the overall standard deviation is 4,810.386 BDT, which is reasonable.

Here, we can see that the difference between the estimated and actual costs is nearly 4,220 BDT.

2.5 PEST Analysis:

PEST Analysis is a measuring method used to examine markets for a certain product or business over a specific time period. Political, Economic, Social, and Technological (PEST) Analysis is a management technique that enables a company to look at significant outside factors affecting its operations in order to increase its competitiveness in the market. These four aspects are crucial to this concept, as indicated by the acronym.

2.5.1 Political Analysis:

This project's main purpose is to increase fish production in aquaculture and determine its energy consumption. The Bangladeshi government has long focused on increasing fish production. The primary objective of monitoring water quality is to provide information regarding water quality and electricity usage. Due to a lack of fuel, you have been compelled to implement planned load shedding, despite the fact that the government of Bangladesh has already taken considerable steps to reduce power waste. Therefore, the Bangladeshi government may be more stringent about aquaculture fish production.

2.5.2 Economic Analysis:

The major users of this initiative are fish farm operators. This undertaking is financially secure for us. Essentially, there are no negative environmental repercussions. The price of the sensors and other electrical components is reasonable. Additionally, they are readily available in local markets. Again, the cost of the technologies we deploy is not exorbitant. As a consequence, the technology is inexpensive and readily available to the general public.

2.5.3 Social Analysis:

When a new device is launched to the market, it creates significant public curiosity, regardless of its reception. This project is predicted to create positive comments and have a positive impact on society. This initiative will contribute in increasing fish productivity and aquaculture water monitoring. It will make aquaculture farmers more conscientious.

2.5.4 Technological Analysis:

The proposed solution tries to address the issue of aquaculture water. The incorporation of several sophisticated sensors, which will increase its efficiency and effectiveness, is one of the most important technical components of the work. However, if more modern sensors with shorter delay time and greater sensitivity are used, the concept may be implemented in a greater perspective. We used a pH sensor, a Total Dissolved Solids (TDS) sensor, a Temperature sensor, a Dissolved Oxygen sensor, a voltage sensor, and a current sensor in our project. This device uses a lithium-ion portable battery so that it can run without electricity.

2.6 Professional Responsibilities

Innovations in engineering and technology are never produced in a vacuum; rather, they are produced in response to a particular societal need. These needs could be quite varied, ranging from application areas to leisure pursuits. The high quality of our country's water has a positive impact on fish production. It is our duty as social beings to produce enough fish to meet our protein needs without depleting the resources for future generations. Through this initiative, we want to use engineering technology to monitor the quality of the water used in aquaculture as well as the power used by the monitoring equipment.

2.6.1 Norms of Engineering Practice

Getting the appropriate professional assistance is a crucial step in resolving any technological issue. Engineering principles make it much simpler to address any potential issues. This activity must be completed according to the proper standards at all times. The highest moral and ethical standards must be followed by engineers. The quality of life for everyone is impacted by engineering. When this water quality monitoring and measuring power consumption system project is finished, the public's health and welfare will be safeguarded, creating a safer driving environment. The project's aim was established first. During their talk, group members discussed mind map concepts. A design prototype was then made and tested after that. The project's results were all pleasing, and it did an admirable job overall. To guarantee the project's success, all required engineering standards must be followed.

2.6.2 Individual Responsibilities and Function as Effective Team Member

The certain task could produce fruitful results if cooperation is handled properly. Each team member needs to understand their share of responsibility if the team is to produce the desired results. Since we needed to go through several stages to make the project stand out, our project team consisted of four group members, and each member played a different leadership role for a particular phase of the project. To make the project stand out, we needed to start off with the right preparation, which included coming up with project ideas, discussing them in meetings, writing and researching books, looking into the points in the required book template, organizing the books properly, checking for plagiarism, and fixing issues. The following lists each team member's individual responsibilities, along with their leadership and other performance responsibilities:

MEHEDE HASAN RAFSUN: He has been involved in this project's hardware component. He also completed the hardware implementation, including the circuit. He contributed to Results Analysis as well.

ASNAD JAHAN NOOR: He worked on the book's writing and also reviewed the software components. Introduction, Literature Review, Methodology and Modeling, and Project Implementation were among the sections he wrote.

MD EMAMUL HASAN: He has been working on both the hardware and wireless components. He has also contributed to the tables and graphs. And also contributed in result analysis.

SHEFAT HOSSAIN: He has primarily worked on the book's writing portion. He wrote the sections on project management, results analysis, conclusion and also manage all required component for this project .

2.7 Management Principles and Economic Models

We need to do a lot of research, study, and learn how to use Microsoft Word as well as the proper method for writing a book and summary in order to build a project. Additionally, we must comprehend Gantt charts, flow charts, block diagrams, how to conduct surveys, and other similar tools. To come up with fresh ideas for the project, we first had to read a ton of vintage research papers and browse through vintage related papers. In order to write the book and summary, we also had to gather antiquated data and documents. Research skills are improved by reading a variety of conference papers, journals, thesis papers, research papers, and topic-relevant work papers. Our writing abilities have improved as a result of using Microsoft Word to create the aforementioned project. Both the writing style and the organization of the paragraphs were enhanced. Another improvement is the ability to write anything using one's own knowledge. Then, in order to upgrade the project by obtaining dated information, we had to review the literature. To analyze the results, a Google survey must also be carried out. A project management or engineering management course was also required of us. In that course, we covered a variety of subjects, including teamwork, deadlines, planning, mapping, goals, and cost analysis. As this study came to a close, Gannt charts were also covered. Additionally, we learned how to inspect the sensors. We must compare and assess the outcomes after the device has been used.

2.8. Summary

This chapter's objective was to construct a framework that was as close to perfect as possible. Few individuals move from a virtual simulation to reality. The policies of the entire system are the main topic of this chapter. The goal of our project is to use IoT-based technology to monitor device power usage and water quality. A variety of sophisticated sensors and control systems have been used throughout the project to demonstrate how smart technology can be used to achieve the improvement.

Chapter 3

METHODOLOGY AND MODELING

3.1 Introduction

This chapter will cover our suggested block diagram for the system, followed by the flowchart for this project. This chapter will also describe the tools required to configure the hardware and the overall structure of our project. The necessary hardware for this project will also be discussed. All technical details will be included in this chapter.

3.2 Block Diagram and Working Principle

Water quality and energy assessment systems are growing in importance. The prevalence of filthy and hazardous water is increasing, and as a consequence, some characteristics of the aquatic ecosystem have altered, putting aquatic species at risk. Obtaining real-time data updates on water conditions and providing the real-time water condition for monitoring purposes. Consequently, we will construct a water quality (WQM) and power consumption measuring system to examine the DO, TDS, pH, and temperature levels of the water. When we provide input to our system, such as giving battery power, the sensor will send it to the Arduino. Among the sensors are DO (dissolved oxygen), pH, TDS (total dissolved solids), temperature, voltage, and current sensors. Using these sensors, we will be able to detect the state of the water, such as whether or not it has a sufficient amount of oxygen. Additionally, the pH sensor will tell if the value is enough for fish development and production, as well as the amount of energy required for this water monitoring. These sensors will transmit data to an Arduino. Arduino will receive the data and show it on the LCD screen so that we can see the output. Thus, the data from the display will be sent to the Wi-Fi module and ultimately the server. To see data online, a website and application showing the results must be created. Using Thingspeak IoT server, we've created a website. The display will send data to the NodeMCU Wi-Fi module, which will then send the data to the server. To see online data, a website displaying the findings must be developed. Employing Thingspeak IoT server Water quality and energy assessment systems are growing in importance. The prevalence of filthy and hazardous water is increasing, and as a consequence, some characteristics of the aquatic ecosystem have altered, putting aquatic species at risk. Obtaining real-time data updates on water conditions and providing the real-time water condition for monitoring purposes. Consequently, we will construct a water quality (WQM) and power consumption measuring system to examine the DO, TDS, pH, and temperature levels of the water. When we provide input to our system, such as giving battery power, the sensor will send it to the Arduino. Among the sensors are DO (dissolved oxygen), pH, TDS (total dissolved solids), temperature, voltage, and current sensors. Using these sensors, we will be able to evaluate the quality of the water, such as if the oxygen level is low or high.

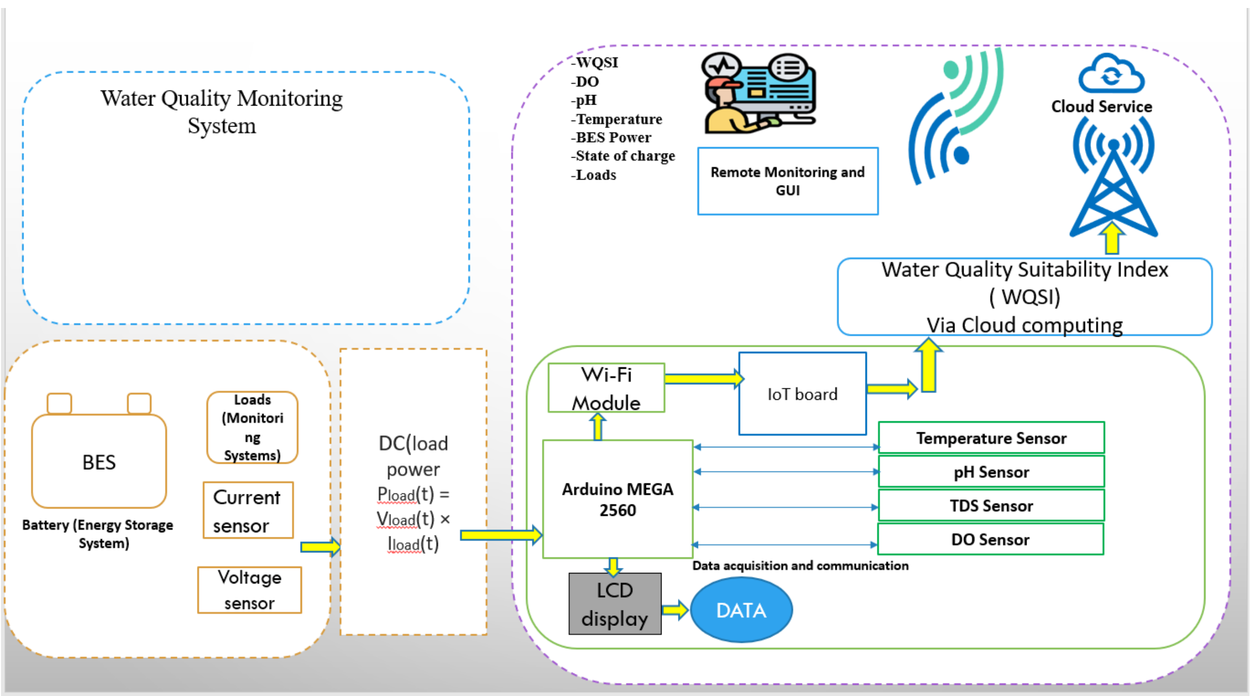


Figure 3.1: Working Principal Diagram of proposed project

3.2.1 Working Principle of Proposed System:

The primary objective of the project is to monitor the water's quality and the amount of energy spent once they are utilized. The graphic reveals that input data will be received first, followed by the activation of all sensors (DO (dissolve oxygen), TDS (total dissolvable solids), Water, pH, temperature, Voltage & Current). Each sensor will measure the various water level circumstances. The voltage and current sensor will measure the voltage and current utilized by the system as well as the power consumption of each sensor using the equation P=VI. Other sensors will measure their data as well. The measured data will subsequently be sent to the Arduino and shown on the LCD display. The LCD display will transmit data to the Wi-Fi module, which will subsequently transmit the information to the Thingspeak IoT-server. The IoT server will transmit the information to the IoT website and application. The user is then able to see the data from that website and app.

Water Quality & Power Consumption Measurement System: Each sensor's data will be sent to Arduino. Data will be sent to the LCD display. The Arduino uno will broadcast data to mobile phone applications and websites via the Wi-Fi module and the IoT server.

IoT-server: Blynk is an IoT platform for iOS and Android smartphones that enables Internet-connected Arduino, Raspberry Pi, and Wi-Fi module control. Our system connects to the Wi-Fi module via this IoT-server. This program is used to create a graphical user interface or a human-machine interface by compiling and supplying the necessary address on the accessible widgets (HMI).

3.3 MODELLING

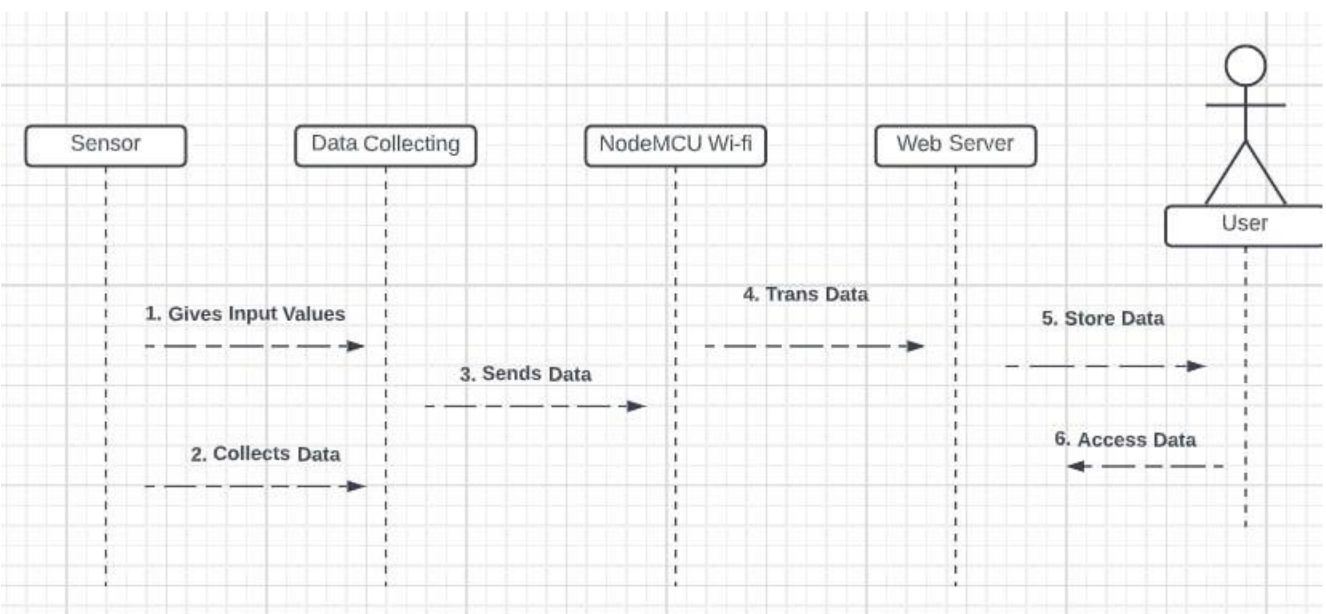


Fig. 3.2: Sequence Diagram of IoT Device

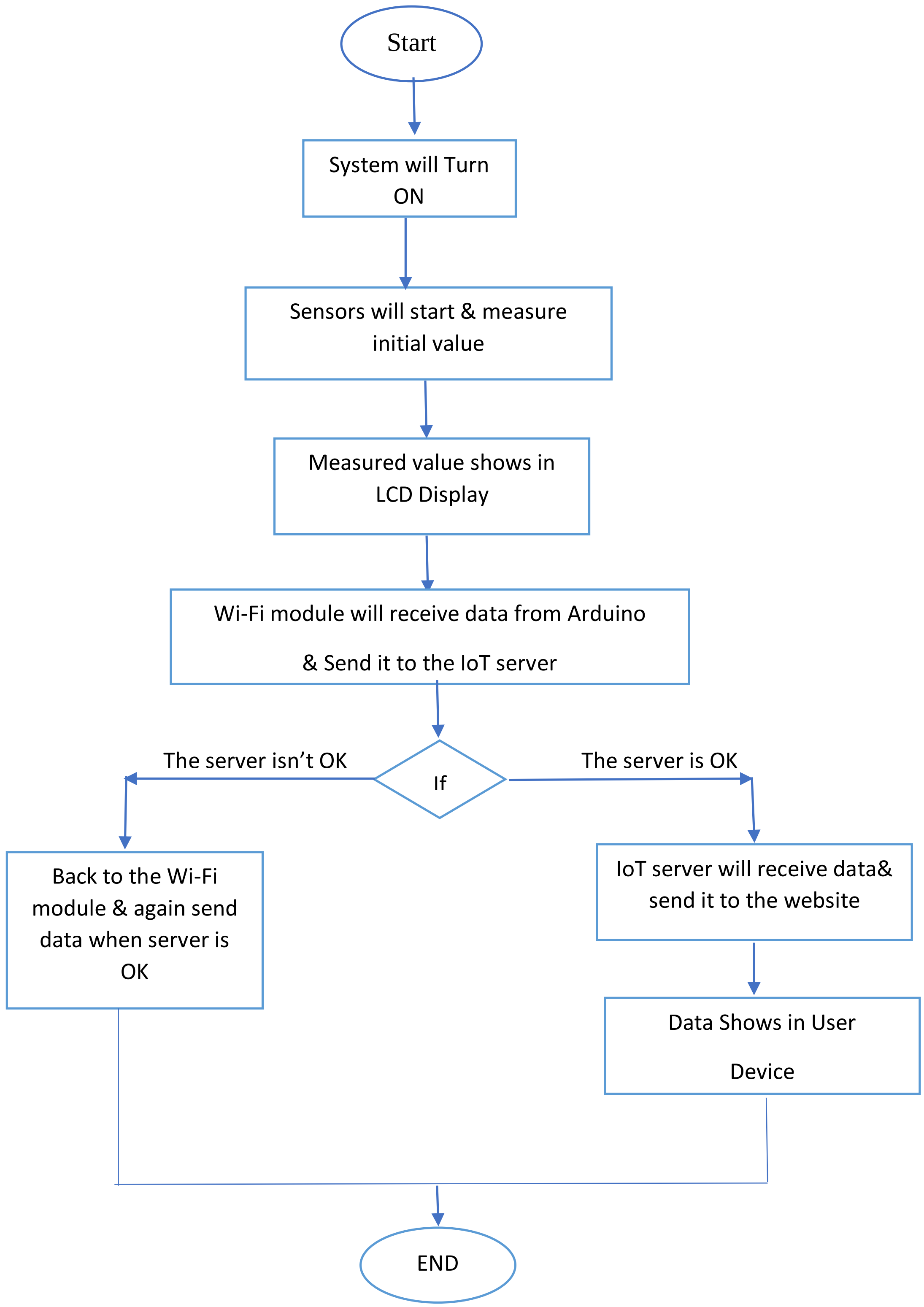


Fig. 3.3: illustrates the flowchart for our proposed project.

At the outset, the mechanism will be activated. After then, the sensors will activate and begin measuring the initial value. The sensor measurement will be shown on the LCD display. The Wi-Fi module will send the LCD screen's data to the IoT server after receiving the data from the LCD screen. After that, the Wi-Fi module will wait to verify whether or not the server is operating normally. If the IoT server is running correctly, it will get the data. The IoT server's data will subsequently be retrieved via a website. The website will also get the data and provide it to the mobile application. The app will receive and display the information. If the server is not running correctly, the data will be returned to the Wi-Fi module and resent when the server is operational. The identical procedure will occur when the IoT server gets the data. In this approach, the anticipated results of the project are verified.

3.4 Summary

When the key structures are close to reaching their optimum state, the achievements are said to be close. This chapter's objective was to design structures as near as feasible to perfection. This chapter stresses the methodology of the gap framework with the block diagram and flowchart. The purpose of this chapter was to describe the project's guiding concepts and approach. Through the examination of the system's block diagram and flowchart, we have shown this. The study of the flowchart and block diagram concludes the chapter.

Chapter 4

PROJECT IMPLEMENTATION

4.1 Introduction

The project mainly helps farmers who grow fish but cannot always measure the quality of their aquaculture water. This chapter explains the hardware architecture of the described project in terms of the electrical components used and the prototype's structural design. The software-based implementation of the project will be described and briefly explored section by section in this chapter.

4.2 Required Tools and Components

Equipment that may be required to implement the hardware structure of this proposed project in the future is described below:

- Arduino UNO
- Analog Dissolved Oxygen Sensor
- pH sensor
- Temperature sensor
- TDS sensor
- Current sensor
- Voltage Sensor
- NodeMCU WiFi
- Battery

4.2.1 Arduino UNO

Arduino UNO is an ATmega328P-based microcontroller board. It has 14 digital input/output pins (6 of which can be used as PWM outputs), 6 analog inputs, a 16 MHz ceramic resonator, a USB port, a power jack, an ICSP header, and a reset button. It includes everything needed to support the microcontroller; simply connect it to a computer via USB or power it with an AC-to-DC adapter or battery to get started.

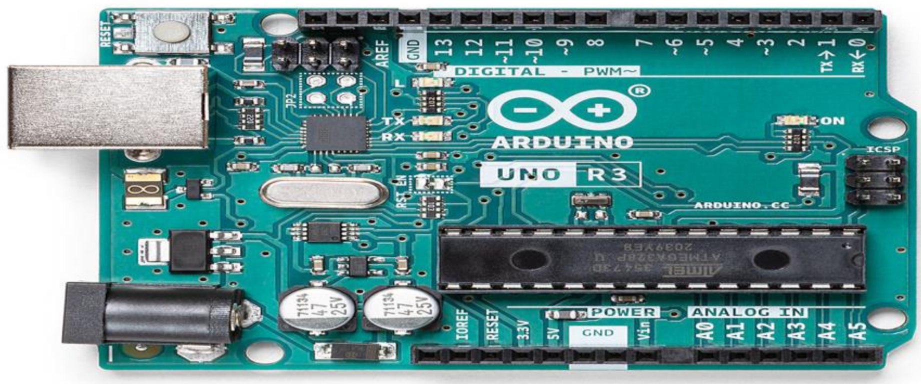


Fig 4.1: Arduino UNO

It comprises 14-digit I/O pins. Six of these pins may be utilized as PWM outputs. This board has 14 digital input/output pins, 6 analog inputs, a USB connection, a 16 MHz quartz crystal, a 16 MHz resonator, a power jack, an ICSP header, and a RST button.

An external power supply can be used to power the Arduino, or a USB connection can be used. The external power supply (6 to 20 volts) consists primarily of a battery or an AC to DC adapter. Connecting an adapter is as simple as inserting a center-positive plug (2.1mm) into the board's power jack. The battery terminals can be connected to the Vin and GND pins. An Arduino board's power pins include the following. The input voltage or Vin to the Arduino when it is powered by an external power supply is the inverse of the volts from the USB connection or else RPS (regulated power supply). This pin can be used to supply voltage. The RPS can be used to power the microcontroller as well as the components found on the Arduino board. This can be approached by passing the input voltage through a regulator. The onboard regulator can generate a 3.3 supply voltage, and the maximum draw current is 50 mA.

4.2.2 Analog Dissolved Oxygen Sensor

Fig 4.2: Analog Dissolved Oxygen Sensor

This sensor kit for dissolved oxygen is compatible with Arduino microcontrollers. This product is used to determine the quality of water by measuring the dissolved oxygen content. Numerous water quality applications, including aquaculture, environment monitoring, natural science, etc., make extensive use of it. There is an old proverb regarding the care of fish that states, "Good fish deserve good water." Aquatic organisms place a high value on water quality. Dissolved oxygen is one of the most important water quality indicators. Low levels of dissolved oxygen in the water will make it difficult for aquatic organisms to breathe, endangering their lives.

This is a brand-new, Arduino-compatible, open-source dissolved oxygen sensor kit. This product is used to measure the amount of dissolved oxygen in water to determine the quality of the water. This sensor kit enables us to construct our own dissolved oxygen detector quickly. The probe is galvanic, does not require polarization time, and is accessible at all times. The replaceable nature of the filling solution and membrane cap reduces the cost of maintenance. Plug-and-play and compatible, the signal converter board is simple to install. It can be seamlessly incorporated into any control or detection system.

The filling solution is a NaOH solution of 0.5 mol/L. This Oxygen sensor has a detection range of 0 to 20 mg/L and a response time of 90 seconds (at 25 degrees Celsius). The Pressure Range of this sensor is 0-50PSI. Operating Voltage for this dissolved oxygen sensor is 3.35.5V and Output Signal is 03.0V.

4.2.3 pH sensor

Fig 4.3: pH sensor

A pH sensor is a critical device that is frequently used for water measurements. This type of sensor can detect the amount of acidity and alkalinity in water and other liquids. When used correctly, pH sensors can ensure the safety and quality of a product as well as the operations that take place in a manufacturing or wastewater facility. The pH scale is typically represented by a number ranging from 0 to 14. When the pH of a material is seven, it is considered neutral. Compounds with pH values greater than seven are thought to have higher levels of alkalinity, whereas compounds with pH values less than seven are thought to have higher levels of acidity. For example, the pH of toothpaste is typically between 8 and 9. The pH of stomach acid, on the other hand, is two. Any company that uses a cooling tower, boiler, industrial procedures, swimming pool regulation, or other types of environmental monitoring must understand the distinction between alkaline and acidic materials. The pH range for aquaculture water is 7.5-8.5. The average pH of the human body is 7.4, which is required for proper body function. If the body's composition ever shifts too far in either direction, it will attempt to return to its neutral state (too acidic or too alkaline).

This pH sensor has a 5v input voltage and an accuracy of 0.1pH. That sensor has a measuring range of 0 - 14PH and an operating temperature range of 0 to 60°C (c).

4.2.4 Temperature sensor

Fig 4.4: Temperature sensor

A water temperature sensor measures the temperature of water or another medium. The probes are typically resistive thermal devices (RTD). Based on electrical resistance, RTDs forecast temperature changes. Temperature sensors work by sending electrical impulses containing temperature readings. Sensors are made of two metals that produce an electrical voltage or resistance whenever there is a change in temperature by detecting the voltage across the diode terminals. The temperature rises in tandem with the voltage.

The supply voltage for this sensor is 3.0 - 5.5V. This sensor has a 0.5°C accuracy range of -10°C to +85°C.

4.2.5 TDS sensor

The TDS sensor kit is Arduino-compatible, plug-and-play, and simple to use. It can be used to measure the TDS value of water in order to determine the water's cleanliness. Total Dissolved Solids (TDS) indicate 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 dirtier the water is. Therefore, the TDS value can be used as one of the indicators of the cleanliness of the water. Measuring the TDS value in water is equivalent to measuring the total amount of various organic or inorganic substances dissolved in water, expressed in ppm or mg/l.

This product is compatible with the 5V and 3.3V control systems due to its wide voltage supply of 3.3 to 5.5V and analog signal output of 02 to 3V. This sensor has a working current of 3 to 6mA and a TDS measurement range of 0 1000ppm. Also, the measurement accuracy of this sensor is 10% F.S. (25 °C).

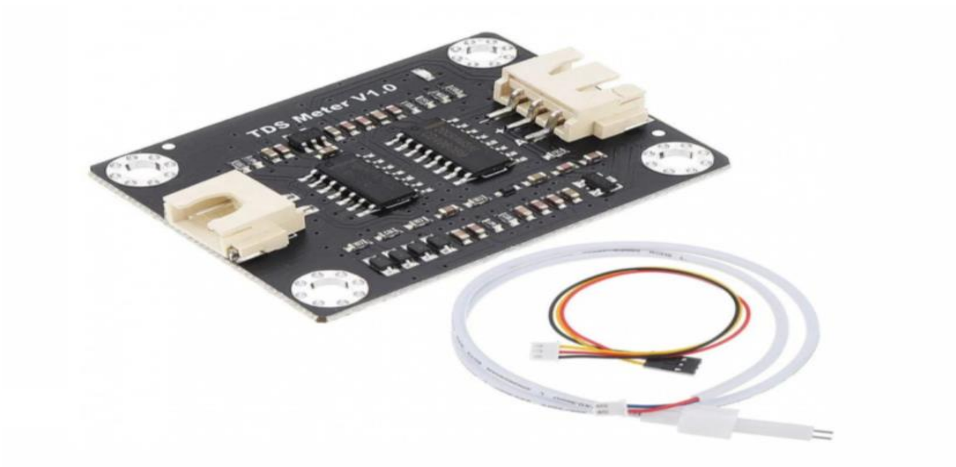


Fig 4.5: TDS sensor

4.2.6 Current sensor

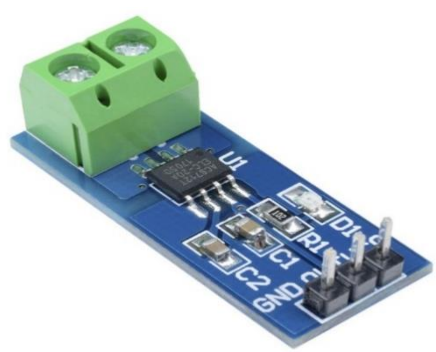


Fig 4.6: Current sensor

AC current sensor is an isolation and conversion device appropriate for AC current. It converts the current signal to a standard signal that AD, DSP, and PLC can collect and receive directly, enabling transmission, processing, storage, display, recording, and control of the current signal.

The operating voltage of this sensor is 4.5V to 5.5V DC. the Measure Current Range for this sensor is -20 to +20A, and its Sensitivity is 100mV/A.

4.2.7 Voltage Sensor

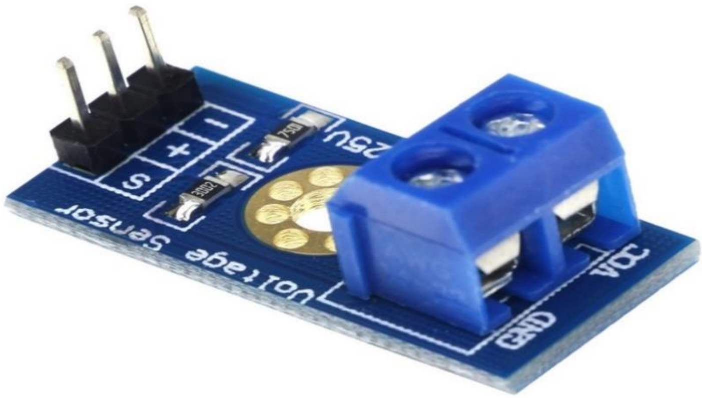


Fig 4.7: Voltage sensor

Voltage sensors measure and communicate electric currents in tools, gadgets, batteries, and other sensors. This could help a maintenance crew locate areas that need immediate attention or warn them of an impending problem. Voltage sensors are wireless devices that can be attached to a variety of machinery, equipment, or real estate. They provide 24-hour monitoring and constantly look for voltage data that may indicate a problem. Other assets may be jeopardized when the voltage is too high, whereas low voltage may indicate a problem. Alerts are quickly sent to a centralized computer system when thresholds are exceeded. In addition, voltage sensors detect magnetic, electromagnetic, and contact voltage. This information can help maintenance teams better understand their tools and assets.

Based on the resistive voltage divider design principle, this module can reduce the red terminal connector input voltage by five times. The Arduino analog input voltage is limited to 5 volts, and the voltage detection module input voltage is limited to 5Vx5=25 volts. Because Arduino AVR chips have a 10-bit AD, this module simulates a resolution of 0.00489V (5V/1023), so the input voltage detection module's minimum voltage is 0.00489Vx5=0.02445V. The input voltage range is DC0-25 V, and the detection voltage range is DC0.02445 V-25 V. This sensor's analog voltage resolution is also 0.00489 V.

4.2.8 NodeMCU WiFi

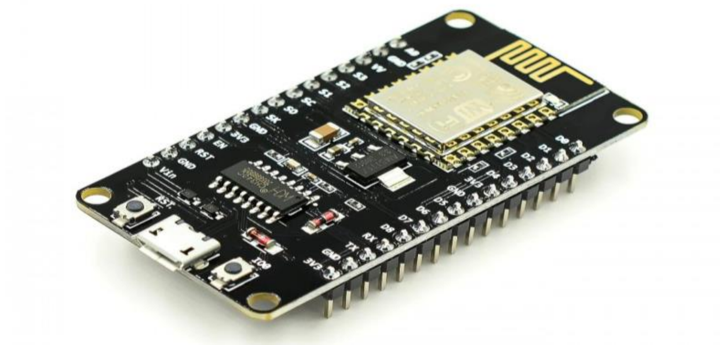


Fig 4.8: NodeMCU

The brand-new NodeMcu ESP8266 V3 Lua CH340 wifi Development Board is a low-cost cutting-edge wifi technology. Modern, mature, high-level LUA-based technology. It is an integrated unit that carries all available resources. NodeMCU has an ESP-12-based serial wifi chip built right into the board, giving you easy access to GPIO, PWM, ADC, I2C, and 1-WIRE resources. It also has a built-in USB-TTL serial port with a super-reliable, industrial-strength CH340 chip for better stability on all supported platforms. This sensor's Power Input(V) ranges from 4.5 to 9 V. It is Communication Interface Voltage is 3.3V, its Operating Temperature (°C) ranges from -40 to 125, and its Flash size is 4 MB.

4.3 Implemented Model

In our project, we have completed our hardware prototype. From our hardware prototype, we will get a clear idea of how exactly our system will work. All the components which will use in our system will be clearly mentioned in the simulation model and hardware prototype

4.3.1. Hardware Model

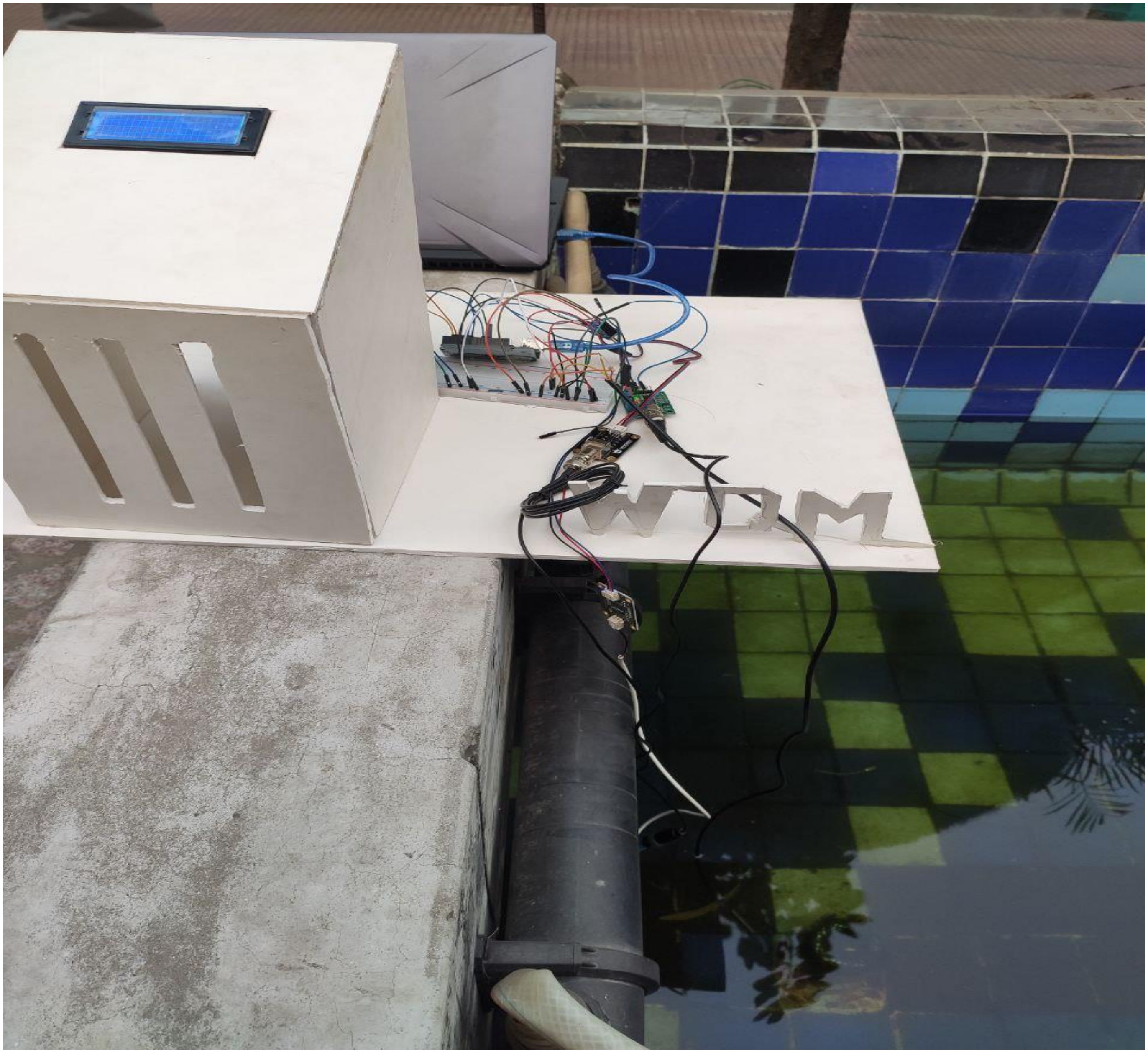


Fig. 4.9: Main Hardware Part

4.4. Summary

This chapter focuses on a specific equipment model and the execution of the project using that equipment. This project is based on microcontrollers. All of the gadgets are shown with correct model information and accompanying images. This chapter also contains a model prototype for achieving both the primary and secondary project objectives. The use of this sort of technology to accomplish the project's objective is intuitive.

Chapter 5

RESULTS ANALYSIS & CRITICAL DESIGN REVIEW

5.1 Introduction

This chapter discusses outcomes and methods. This project was completed using widely available hardware. In addition, procedures were used to determine the project's ultimate outcome. Information is stored on the IoT-server. Multiple data were also detected with the aid of various sensors. The hardware implementation of the project was completed after extensive testing, refinement, and modification. Then, we estimated the overall power consumption of the system and realized that individual power consumption could also be calculated. All of these efforts have culminated in the effective completion of the project. The hardware implementation work was successfully finished, and the values were collected. This chapter includes photographs depicting both the installation of gear and the collecting of data from different aquaculture water samples.

5.2 Results Analysis

5.2.1 Hardware Results

The sensor implementation of this component has been carefully considered. By detecting the water, the pH, DO (dissolved oxygen), TDS (total dissolved solids), and temperature were detected by the sensors. The pH sensor, the temperature sensor, the conductivity sensor, and the water flow sensor had their current, voltage, and power tested. However, there is a separation between the theoretical and practical sections. We were able to construct the water quality index (WQI) by collecting many samples of aqua pond water with varying levels of components. Following this, we measured the total voltage and current using a voltage sensor and a current sensor, respectively. Finally, it is simple to determine the individual power consumption of each sensor, as indicated in this chapter's explanation.

Time (Sec)	Temperature(^{0}C)	pH	TDS Parts per million (PPM)	DO (mg/L)
20	23	7.51	135	4
40	23	7.63	136	6
60	23	7.82	137	5
80	23	8.2	140	5
100	23	7.5	125	6
120	23	7.18	141	6
140	23	7.19	143	7
160	23	7.6	148	5
180	23	7.62	142	5

Table 5.1: Fresh water sample

We are collecting samples of fresh water, chloride water, and pond or muck water. The data in the table above demonstrates that all of the sensors are functioning correctly and are able to detect the quality of the fresh water every 20 seconds. From this, we can see that the pH value has increased somewhat over time, and that TDS has fluctuated with time due to the flow of water, causing TDS to either grow or decrease, while the oxygen sensor provides an accurate reading for fresh water.

Time (Sec)	Temperature(^{0}C)	pH	TDS Parts per million (PPM)	DO (mg/L)
20	23.7	10.39	921	5
40	24.2	10.16	1069	4
60	23.8	10.39	1095	6
80	23.8	10.24	1103	5
100	24.6	9.98	1156	3
120	25.8	10.1	1179	3
140	25.7	9.66	1225	5
160	24.8	10.13	1236	5
180	23.7	9.13	1247	4

Table 5.2: Marine water sample

Table 5.2 illustrates chloride water using the same sensor data gathered for monitoring various parameter values as table 1, and this table's data is likewise collected at a 20-second period. Because the pH of chloride water is much higher than that of fresh water, the pH values vary over time, TDS levels rise, and the oxygen content is low, rendering it unsuitable for aquatic life.

Time(Sec)	Temperature(^{0}C)	pH	TDS Parts per million(PPM)	DO (mg/L)
20	23.7	10.39	921	5
40	24.2	10.16	1069	4
60	23.8	10.39	1095	6
80	23.8	10.24	1103	5
100	24.6	9.98	1156	3
120	25.8	10.1	1179	3
140	25.7	9.66	1225	5
160	24.8	10.13	1236	5
180	23.7	9.13	1247	4

Table 5.3: Aqua-pond water sample

Finally, we acquired data from the aqua pond's sample water, which provided us an idea of the water's overall suitability for aquaculture. These data were taken with the same interval, and the average perfect value of each sensor represents the real state of the aqua pond water.

5.2.2Water Quality Index (WQI):

Water Quality Index Equation:

$$W_n = \frac{K}{S_n}$$

Where,

K = constant for proportionality.

$$K = \frac{1}{\sum S_n}$$

Where S_n is standard desirable value of the parameters.

On summation of all selected parameters unit weight factor, Wn = 1

Where, Q_n is sub index value,

$$Q_n = \frac{V_n - Standard\_ideal}{Standard-ideal}$$

V_n = mean concentration of the n^{th} parameter

$$\text{Over all WQI} = \frac{\sum W_n Q_n}{\sum W_n}$$

Following is a table containing the mean values of each sensor, which must be divided into the three divisions shown in the table: temperature, pH, TDS, and DO sensors,

sensors	Fresh water	Chloride water	aqua-pond water
Temp.(c)	23.23333	24.2833	23.2
pH	7.61	9.41722	7.84
TDS (ppm)	141.787	1200.11	321.889
DO (mg/L)	5.16	4.38889	3

Table 5.4: Mean value of each sensor [10].

	Site-1									
	Parameters	Sn	1/Sn	∑1/Sn	k=1/(∑1/Sn)	Wi =K/Sn	Ideal Value (V0)	Mean Cons. Valu (Vn)	Qn	WnQn
	T	25	0.04	0.329314	3.03661804	0.121465	0	23.23333333	92.9333333	11.28812146
	pH	8.5	0.117647	0.329314	3.03661804	0.357249	7.5	7.651	15.1	5.394462638
	TDS	200	0.005	0.329314	3.03661804	0.015183	0	141.7777778	70.8888889	1.076312395
	DO	6	0.166667	0.329314	3.03661804	0.506103	5	5.166666667	16	8.09764811
			0.329314			1				25.85654461
	QpH= [(Vph-Ideal)/(Sn-Ideal)]*100									

Table 5.5: Index Calculation [10].

From this location, we can observe the fresh water WnQn calculation of 25.8565, which is outstanding. In addition, the WnQn value for sea water is 72.72, which is considered acceptable. For aqua pond water WnQn, which is -75.00, the quality of the water is considered to be of low quality.

Total Voltage (v)	Total current, I (A)	Total power, P (watt)
4.67	0.2	0.93

Table 5.6: Total power Consumption (Hardware)

We retrieved the total system voltage from the implemented system, which was 4.67v, and the total system current, which was 0.2A. We then calculated the entire system power, which was 0.93 watts.

List of individual energy consumption of each sensor describe in the following table,

Sensors	Current A	Voltage V	Power consumption w	Energy consumption in hr(p×t) Watt-hr
pH	0.09	4.67	0.4203	1513.08
DO (dissolved oxygen)	0.07	4.72	0.3304	1189.44
TDS (total dissolved solids)	0.06	4.94	0.2964	1067.04
Temperature	0.06	4.80	0.288	1036.8
			Total	4806.36

Table 5.7: Hardware Result Analysis

Due to the prevalence of Internet of Things (IoT) devices, power consumption and security of IoT systems have become crucial concerns. Table 3 displays the voltage and current readings of the separate sensors when the complete system is operational, with voltage and current sensors measuring the voltage and current suitably. From there, we can determine the total power consumption of each sensor, such as DO (dissolved oxygen), pH, TDS, and temperature, and because we've accomplished our aim, we can easily determine the overall power consumption of the whole system, which is 1.33watt. The study enables us to compute the system's energy usage, which is 4.8 kilowatt-hour. As a consequence, we say that our system requires 4.8 kW of energy per hour to operate optimally.

5.2.3 Estimated Battery Life:

Equipment's	Current mA	Battery capacity(mAh)	Battery Lifecycle (hrs)
pH	90	1100	So, Lifecycle = (Battery capacity/Total current) (1100/280) hrs =3.92 hrs
DO (dissolved oxygen)	70		
TDS (total dissolved solids)	60		
Temperature	60		
Total	280mA		

Table: 5.8: Battery life cycle

The expected battery life is computed as follows based on the data in the table above: Battery life = total current / battery capacity, where we used a 1100mAh battery and our system drew 0.28A. Consequently, based on this estimate, our battery will continue to function for 3.92 hours. In 3.92 hours, the gadget will be switched off.

5.3 Comparison of the Result:

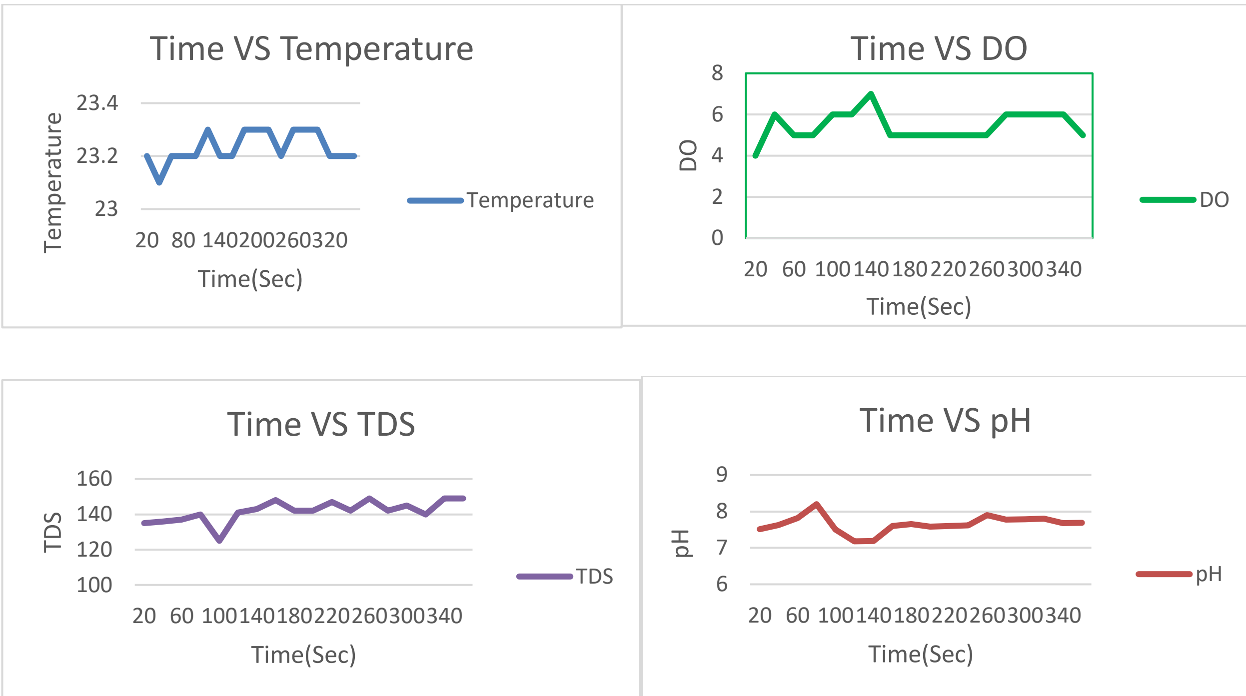
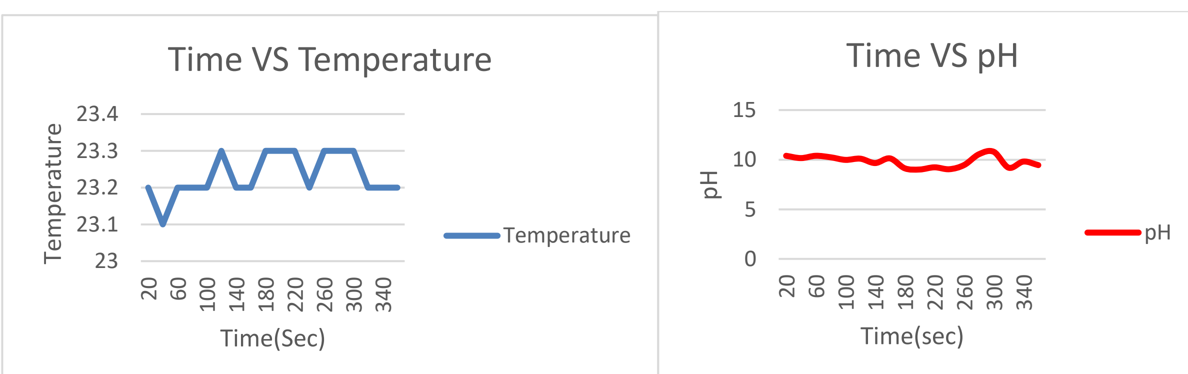


Fig 5.1: Comparison for sample 1(fresh water)



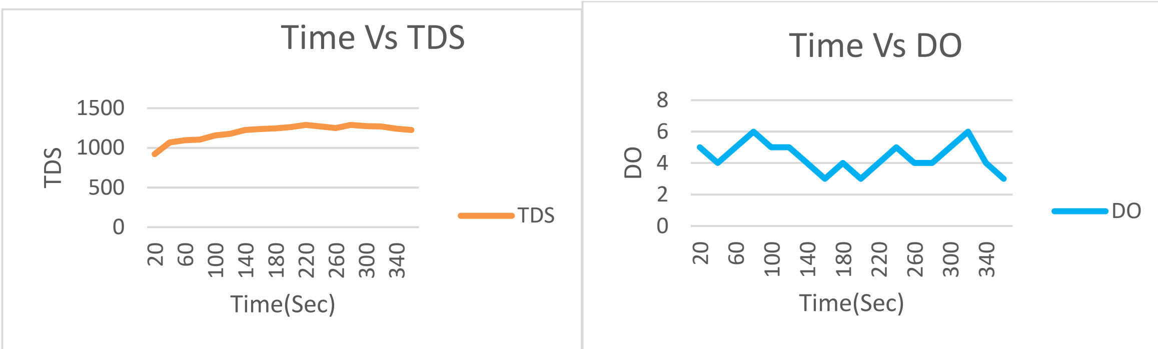


Figure 5.2: Comparison for sample 2(marine water)

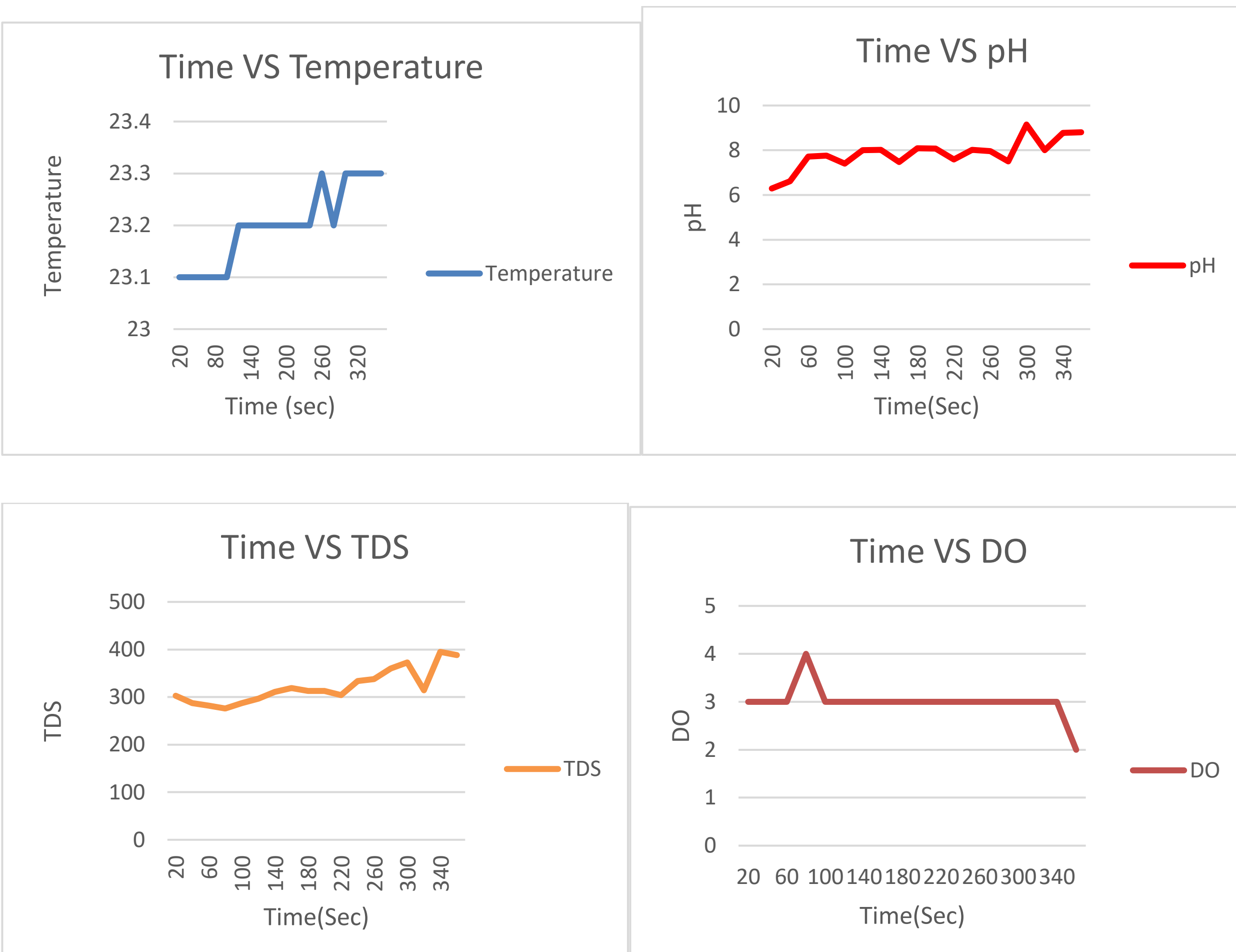


Fig 5.3: Comparison for sample 2(mud or aqua-pond water)

The graph above illustrates all of the characteristics detected by the water sensor over time. Some parameters are modified for constantly flowing water; as a result, sensor-sensed values alter over time. The graph depicts the water quality based on the instantaneous data observed by the sensor that we have previously gathered and plotted for pH, TDS, DO, and temperature over time. According to the research, fresh water quality has all of the naturally excellent parameter values, in contrast to marine water and aquatic pond water, which are in a poor state.

The format in which Thing Speak server data are presented is seen below. In this section, sensors were used with care to gather data. The Wi-Fi module collected sensor data and sent it to the Thing Talk IoT server, where it was subsequently delivered to the website and apps.

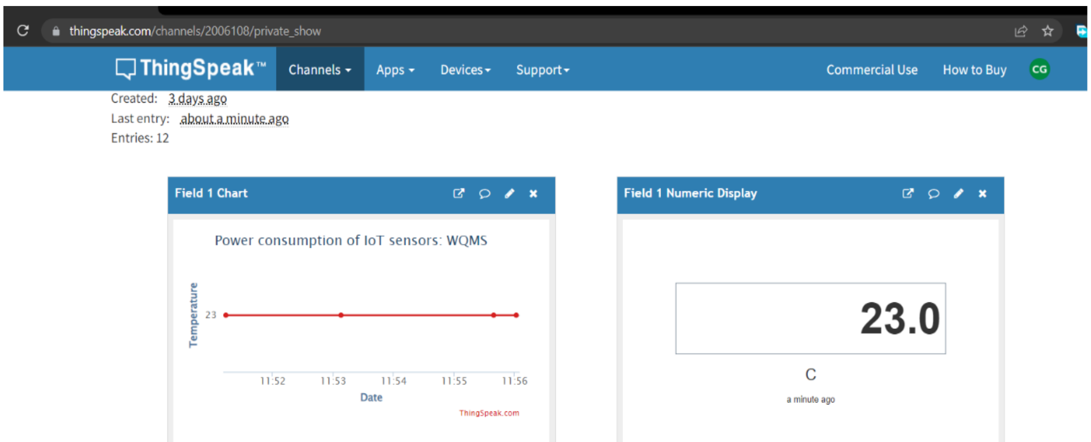


Fig 5.4: Water Temperature graph from Thing speak website data

Fig 5.4 depicts the water temperature graph. Because we utilized several kinds of water (fresh water, sea water, and aqua water), the graph shows some fluctuation. It was provided via the Thing-speak server.

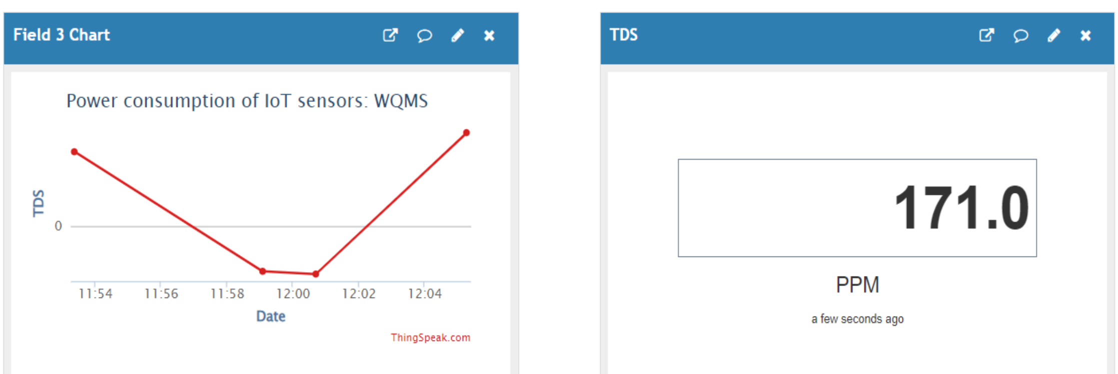


Fig 5.5: Water TDS graph from Thing speak website data

Fig. 5.5 displays the TDS graph for water. The graph fluctuates due to the usage of several types of water (fresh water, sea water, and aqua water). It was made available via the Thing-speak server.

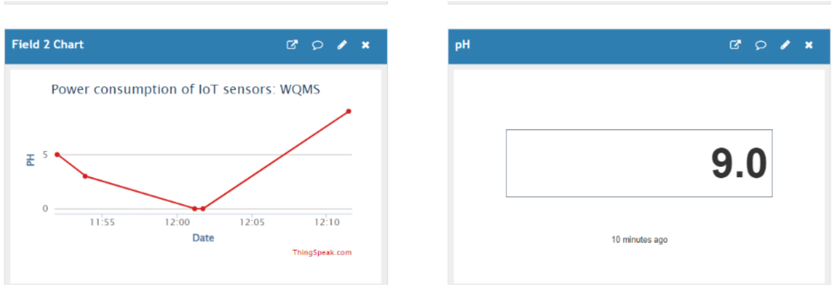


Figure 5.6: Water pH graph from Thing speak website data

Fig 5.6 represents the water pH graph. As a result of our use of various water types (fresh water, sea water, and aqua water), the graph displays fluctuations. It was delivered by means of the Thing-speak server.

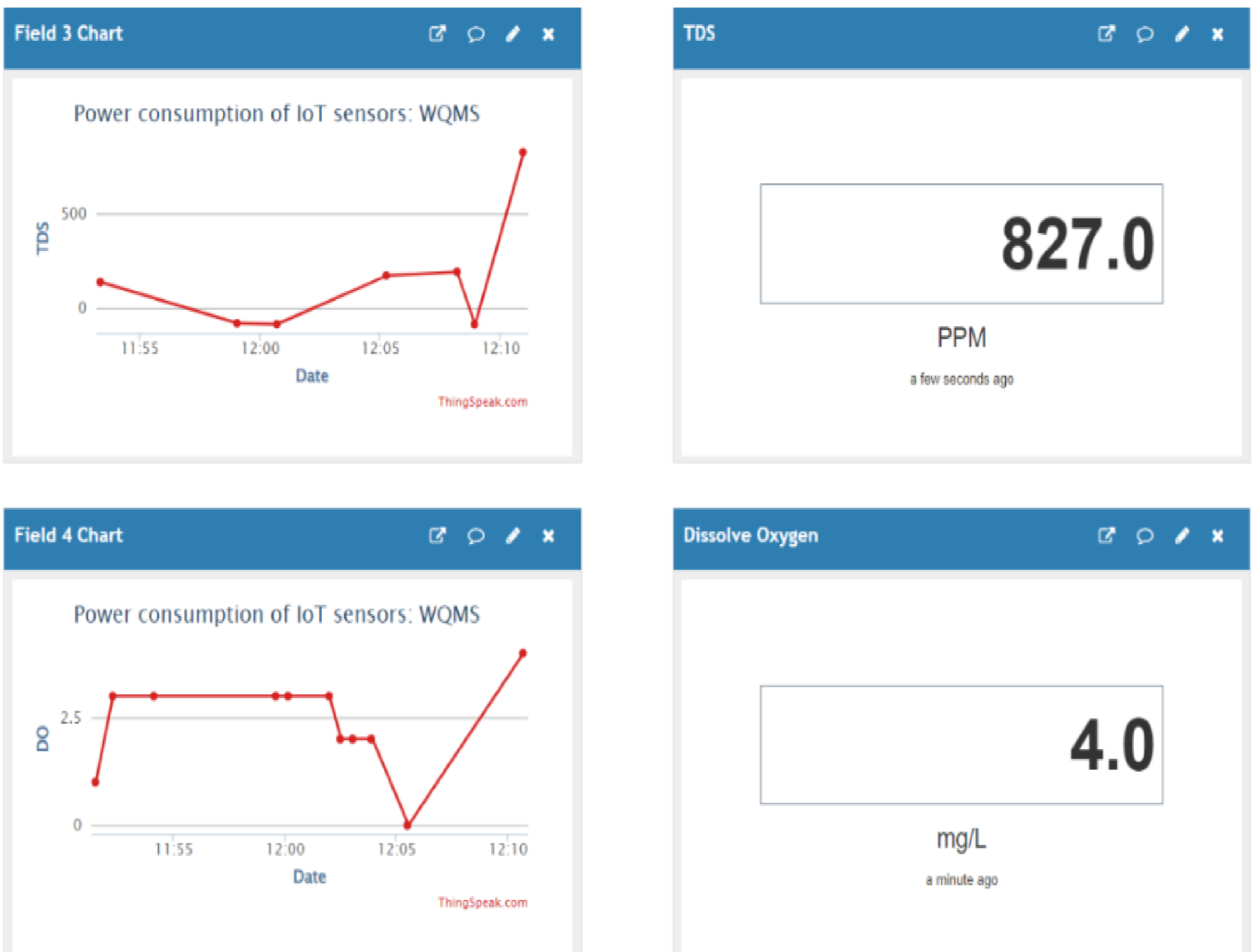


Figure 5.7: combine data from Thing speak server

Fig. 5.7 illustrates the merged graph. The graph fluctuates due to the usage of several types of water (fresh water, sea water, and aqua water). It was given via the Thing-speak server, and this is how we know the water quality and monitor the water's status.

5.4 Summary

This chapter discusses the project's goals, progress, and results. Upon testing, it was found that the project was performing in line with the design requirements. It complied with the functional requirements. This chapter provided the system design, data analysis, and result comparison and interpretation that were needed. Throughout the assessment of the material, a number of discrepancies were found and fixed. Data must be running numerous times in order to get the desired outcome. The last part of the report provided the overall impression of the project.

Chapter 6

CONCLUSION

6.1 Summary of Findings

For interim data encryption, you must understand each project component and system behavior. The project's main objective is to figure out how much energy different sensors require, what kind of water is often used in aquatic instances, and what the user has to be aware of while using them. The proposed project will make sure that users can monitor their daily water use as well as the amount of power needed for this system on the website and apps. They may examine their real-time data on our website and via our apps. Their lives will be safer and simpler thanks to this method. In order to assess the power and water consumption of the numerous sensors employed in this project, an IoT-based water consumption measuring system was developed. To improve the effectiveness and efficiency of the project design, this system will be able to carry out a number of duties, including monitoring TDS, pH, DO, temperature, voltage, and current, among other things. The anticipated design had been implemented via modeling and hardware. However, the hardware and simulation results show that our society will benefit from the projected project effort. The conclusions drawn from each simulation's results and hardware model therefore suggest that the suggested system would be useful and important for people to use on a daily basis.

6.2 Novelty of the work

Every project has a few distinctive qualities that elevate its intelligence and effectiveness. The project may be special due to its particular features. In the aforementioned project, we made an effort to show how special features may be added to a traditional water consumption measuring system to create an Internet of Things (IoT)-based water quality and power consumption monitoring system. Despite the fact that the project could seem widely recognized in today's world, it is seldom accessible in Bangladesh and consequently out of the reach of the average individual. The project's primary objectives are to promote fish farming and monitor device performance in order to educate the public about the value of water and the quality of fishing water. Regular users of this gadget will be able to monitor their daily consumption thanks to the suggested project effort. You can also see how much electricity the gadget is using. The recommended work offers a number of standout characteristics that benefit the user and ensure their safety and security. The concept uses a broad range of sensors to work successfully and efficiently. TDS, pH, DO, temperature, voltage, and current may all be measured using the sensors. Websites and mobile applications allow users to obtain real-time data. An IoT-based, dynamic water quality and power measuring system might be created from a basic, traditional water quality measurement system by employing the advancement of modern technology. These distinguishing traits will enable people to have simple, flexible lifestyles.

6.3 Cultural and Societal Factors and Impacts

6.3.1 Cultural and Societal Factors Considered in Design

The operators of this device experience the consequences of this endeavor in a number of different ways. Economic and cultural factors are taken into account during the whole design process. We also investigated the many elements that this initiative took into account. Decide how information from each sensor may be acquired and utilized to provide the greatest results. The initiative will have a wide range of additional long-term implications. Society will benefit from technologies that provide a broad range of comforts and conveniences. This project's user interface needs to be enhanced. We have also studied intricate engineering issues, utilizing a variety of models or sub-problems in order to address the difficulties. Engineering ideas were created using a rigorous, theory-based technique.

6.3.2 Cultural and Societal Impacts of the Proposed Design

The economy, people, and fisheries might all benefit from this work. Working in this profession will help members strengthen their self-assurance, willpower, and curiosity. The model was created to be able to provide the user with very precise results. Monitoring from all the sites may be useful to get an accurate result. This project will undoubtedly improve the ability to quickly identify the amount, quality, and consumption of water by utilizing a variety of sensors based on their effectiveness and operating method at a reasonable cost.

6.4 Proposed Professional Engineering Solution

The project emphasizes the need for using exact technical solutions to guarantee accurate measurements and provide an accurate comprehension of the data gathered. It talks about several expert engineering fixes as well as different engineering problems that have been handled. Engineering solutions often have a big impact on society. The Arduino board, several measuring sensors, and websites and apps that record the data obtained make up the project's primary parts. We can quickly determine if the data we have received is accurate or not by comparing the measured data with the information allowed from this sector.

6.5 Limitation of the Work

Every area of development-related research has limitations. Our project is not any different in that regard. Both hardware and software have been used to bring the whole concept into action. The measured findings have been made available to us by both the hardware and the simulation model. This project was intended to be utilized in an aquaculture system, but because we couldn't test it there, we had to rely on sample data. We personally tried it in our room using aqua water, ocean water, and drinking water. Even though this prototype can't be utilized with the fishing method, we still need to make it smaller, like a chip. We could then use this in an aquatic setting.

As this is a university final project, there are several limitations when it comes to developing a project. Several difficulties arise during the project's development. The following are the elements that are the primary cause:

- Time constraint.
- Consultation with a specialized electrical engineer is required.
- You'll need a strong network.
- There is a scarcity of large data storage centers where past data may be stored.

6.6 Future Scopes

Before releasing this prototype model for sale, further testing is necessary. It may be used in the near future to measure the water quality and power use of various batteries in industries, fisheries, private and governmental buildings. Aquatic scenarios will be one of this system's most frequent applications. People are able to monitor and understand the usage of data in real-time as a consequence.

6.7 Standard Requirements and Ethical Concerns

Throughout the course of this project's development, a number of ethical questions came up that needed to be resolved. To make choices that would respect the ethics of the work, the technique was examined from an ethical standpoint. There were a number of guidelines that had to be observed.

6.7.1 Related Code of Ethics and Standard Requirements

In view 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.

- In professional endeavors, uphold the highest standards of honesty, responsible behavior, and ethical conduct.
- Maintain the highest standards of honesty, responsible behavior, and ethical conduct in your professional pursuits.
- While doing the experiment, the people who are associated with this experiment must understand that there are some rules and regulations which should be maintained to finish the work.
- Before going practice with human being all the members of this sectors who will do this experiment must go through some practice sessions.

6.7.2 Health and Safety

There are no health risks associated with this project concept. The ethics of health and safety have been appropriately upheld in this endeavor. No dangerous instrument exists that might endanger your health. Engineering standards and principles 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.

6.7.3 Economy, Environment and Sustainability

The economics, the environment, and appropriateness are all covered by numerous ethical principles. In this project, a number of economic models and analysis have been applied. Safety for the environment was taken into consideration. There is no such thing as a component that harms the ecosystem. In addition, long-term goals were accomplished. Sustainability indicates that high-quality civilizations have a responsibility to make decisions that will allow both present and future societies to reach a standard of living that satisfies their most fundamental needs.

6.8 Conclusion

The project's objective and philosophy were accomplished as intended. To get the most out of our technology, we exerted tremendous effort and conducted extensive research. The proposed project effort aligns with the objective of contemporary science and technology, which is to make life easier and more pleasant for those in need. The fundamental objective of this initiative is to provide individuals with freedom and autonomy. Additionally, the design has been implemented in hardware. The proposed combination of functional components creates a real-time system capable of detecting water temperature, pH, dissolved oxygen, total dissolved solids, voltage, current, and power. The monitoring system combined water quality metrics gathered from water quality sensors (such as DO, pH, TDS, and temperature sensors) and collected this data remotely in the Thing Talk server database using Node-mcu communication. The WQI was calculated using Microsoft Excel. Considered were the key electrical variables of voltage and current, from which we derived demand power, and battery life. In addition, we have created a website and a monitoring system for the collected data, which make the system more intelligent, safe, and secure. Due to the integration of all of these applications, users of this gadget are able to check their daily water quality in their own unique ways.

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APPENDIX B

ITHENTICATE PLAGIARISM REPORT

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ORIGINALITY REPORT

14%
SIMILARITY INDEX

PRIMARY SOURCES

1	www.researchgate.net Internet	206 words — 2%
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