IoT BASED AUTONOMOUS INTEGRATED FISH, PLANT AND POULTRY FARMING

An Undergraduate CAPSTONE Project
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Fall Semester 2022-2023
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Faculty of Engineering
American International University - Bangladesh

IoT BASED AUTONOMOUS INTEGRATED FISH, PLANT AND POULTRY FARMING

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 **IoT Based Autonomous Integrated Fish, Plant And Poultry Farming** 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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ABSTRACT

The Internet of Things (IoT) based autonomous is a rapidly expanding technology that is currently expanding its reach in all fields. Through the development of computers like Arduino and NodeMCU, innovation is reaching the grassroots with its use in agriculture and aquaculture. In this work, we've described and implemented a monitoring system for aquaculture water quality that makes use of Microcontrollers, different sensors, various motors and an IoT platform. TDS value, moisture, temperature, pH, humidity, detection of Methane, Propane etc combustible gas and cleans the other gases adsorbed under low temperature which were used in this study. Arduino handles the sensor acquisition, and the IoT platform thingspeak serves both as a server and a data monitoring device. The terminal device of this project is being used as a serial monitor. Anywhere in the world, a user can use a personal computer to check the state of sensors via Wi-Fi while within Wi-Fi range. The values of the seven parameters are analyzed to identify the estimated general state of the water and the necessary course of action. Every feature on this testing device can operate properly and with ease. The pH, moisture, and MQ9 sensor data, among others, are used to apply automation. The value of ph recorded by the ph sensor determines how automatically the selected chemicals in the pond water balance the ph level. Depending on the theoretical values of the soil's moisture, the soil around the pond receives water automatically.

Chapter 1

INTRODUCTION

1.1. Overture

The world desperately requires high-quality dietary protein, and the demand will grow as the world population grows. The protein gap (the shortfall in protein production) is already projected to be over 2.5 million tons of animal protein per year [26]. In 2021, 828 million people were impacted by hunger, and around 2.3 billion people (29%) were moderately or severely food insecure. In 2020, over 3.1 billion people will be unable to afford a balanced diet (SOFI, 2022). In 2021, an estimated 45 million children under the age of five were wasting, 149 million had stunted development, and 39 million were overweight (JME, 2021). These statistics will climb unless systemic improvements are implemented and nutrition is incorporated into national and global crisis response strategies [27]. Eating a variety of foods and consuming less salt, sugars and saturated and industrially-produced trans-fats, are essential for a healthy diet. To fulfill these needs, the world needs to grow a certain amount of food and bread fishes in an updated way. An integrated farm can handle all of this. However analog agriculture cannot provide a sufficient amount of crops and proteins against overpopulation. That's why the integrated farming method is not only efficient but also helpful for the world. This integrated farming, it provides carbohydrates with protein at the same time in a small area. Time and labor will both be reduced in this particular farming. This system is fully automated and IoT based. One of the major drawbacks of a smart agriculture system is having an automated system for monitoring the selected data from the sensors and data can be recovered easily by the IoT system. Recent IoT-based devices can do this better. When used with IoT devices, it automatically collects and graphs various data. The cost of this integrated system is efficient with respect to the number of outcome goods. In this mass-populated world, integrated farming will bring a new era for agronomy.

1.2. Engineering Problem Statement

Even though IoT is more cost-effective than traditional methods, it is possible to monitor data that is found in this project at a lower cost. Daily consumption reports are generated, which the user can monitor through a web portal. It's a more reliable system, with devices collecting accurate reading values from different sensors. An online web portal can be used to view real-time device readings. The readings are also available to view online. Human interference is avoided, and the central server records every sensor's values. The communication channel is secure, and tampering with sensors or IoT device, theft can be easily detected. The value in the central server will not be updated if a mistake occurs within the system. The reports can be accessed from anywhere in the world because the values are stored in a central database. In addition, the server is available 24 hours a day, seven days a week. A large number of employees are required to perform data reading and other related tasks suggesting that a large number of employees are required. There will be some reading errors if so many people's involvement in this section. This IoT-based project can eliminate all of these problems very precisely. A theoretical understanding of basic electronics and electrical parts is required to develop this IoT-based autonomous integrated farming system. For this project, we needed in-depth engineering knowledge of programming languages, microcontrollers, signal processing, data analysis, electrical machines and equipment, and basic DC and AC circuits, which allows an engineering fundamentals-based, principles analytical approach, conceptually mathematics-based knowledge, numerical analysis, and analyzing the validity and accuracy of existing solutions for complex engineering problems and design systems. To complete the prototype design, the project requires a wide range of technical and engineering issues, such as mechanical and electrical requirements. There are a lot of math calculations to be done. Different engineering fundamental systematic formulation things are essentially required. The project is governed by professional engineering standards and codes of practice, such as the highest health and safety standards, which will be met throughout the development process. Many component parts or sub-problems will be required for the research work, such as electrical component simulation, electrical component design, knowledge of different software, knowledge of different sensors and how they work, knowledge of different communication systems. To complete the project, specialized engineering knowledge is required.

1.3. Related Research Works

1.3.1. Earlier Research

Here is a thorough analysis of some of the applicable work, with an emphasis on the methodology employed and its advantages and disadvantages. There are numerous ways to connect to the server, including cable networks, wireless or wired networks, and various GSM technologies, which are well-known to researchers. Many nations are attempting to put this idea into effect. Our innovative idea has been the subject of a variety of study projects from various articles [18]. S. Usha Kiruthika and Dr. S. Kanaga Suba Raja published a paper in 2017 on an embedded system for automatic control of fish farming. The suggested work provides Internet of Things (IOT)-based remote monitoring of the fish farming system for real-time monitoring and control of a fish farming system. The purpose of this publication is to offer a fish farming monitoring system that is automatic, saving the farmer time, money, and power. The country's farm production has been transformed by IOT technologies. We use a variety of sensors during the fish farming process, including pH, temperature, and level sensors. All of the work is automated by employing these sensors, and it will be simple to remotely monitor the fish farming from another location. A 32/16 bit ARM7TDMI-S CPU with real-time emulation, the LPC2141/2/4/6/8 microcontroller used in this study combines a microcontroller with flash memory that ranges from 32 kB to 512 kB [19]. In 2019, Lalbihari Barik published a paper on IoT based Temperature and Humidity Controlling using Arduino and. In this paper, The temperature, moisture content, pressure, and height of the devices are all measured using an Arduino controlling system. The setup consists of a measuring or controlling instrument and a device for measuring height. An effective and reliable system for tracking agricultural factors is provided by an IoT-based temperature and humidity sensing device. The system also offers a system for decision-making or remedial movement. IoT-based area monitoring is the most practical, but it also enables users to research the correct changes in their surroundings and to take action if necessary. It costs little money and uses a lot less electricity.

1.3.2. Recent Research

Technology has developed into a key component in bettering lifestyles, increasing productivity at work, and fostering economic progress. The Internet of Things (IoT) and connected nodes have become much more valuable in recent years. The objective of this project is to create, test, and deploy an inexpensive monitoring and control system based on the Internet of Things. Electrical appliances can now be monitored and controlled remotely thanks to internet of things technologies. To accomplish this, a full front-end to back-end system is suggested, consisting of hardware development, a smart device application (iOS platform), and a cloud-based database. A compact, customized computing device called Proteus has been employed for testing. for its comfort and features, such as its built-in wifi chip and general-purpose pins, this smart junction was taken [20]. In 2019, Nikitha Rosaline and Dr. S. sathyalakhsimi published a paper on IoT based aquaculture monitoring and control system. This study introduces an IOT-based remote monitoring system for aquaculture water quality. In the future, the entire agricultural system's sensors will be submerged in water since the data they collect will be useful before harvest, and other significant sensors may be added as needed to accommodate the environment. Since the Nodemcu only has one analog pin and serves as a communication coordinator for five analog sensors, data processing for sensor communication with the Nodemcu requires an additional ADC channel multiplexer. The 74HC4067 is a 16 channel analog multiplexer. It is possible to utilize the 74HC4067 with 3.3V and 5V microcontrollers and boards like Arduino because it can function on voltages between 2 and 6V DC [21]. In 2021, Dr. ldar Rakhmatulin published a paper on Raspberry PI for control compact autonomous home farm. In this paper, The autonomous home farm described in this publication can forecast metrological qualities, automate the process of growing crops, and, thanks to artificial intelligence, greatly increase the farm's production. The developed farm keeps an eye on and controls the following variables: lighting, soil PH, air temperature, soil temperature, humidity, carbon dioxide concentration, and soil wetness. The farm may be used to monitor various weather conditions and estimate the ideal temperature range for various crops. Only a fan can minimize the amount of CO2 in a farm. DHT 11 humidity and temperature control sensor. To regulate soil temperature, use pt100. Ceramic heater for raising the temperature. Analog equipment to regulate soil moisture A dosing pump was utilized to irrigate. Broadcom BCM2837B0 (ARM Cortex-A53) and the Raspberry Pi 3.

1.4. Critical Engineering Specialist Knowledge

From diverse sources, a significant amount of fundamental engineering concepts were acquired. For this special project, a great deal of identical code was provided. Despite the fact that research authors rarely describe this kind of endeavor in their papers, quite a few issues were discovered when studying the research papers. This project required a lot of research and laborious labor due to its distinctiveness. The microcontroller used in this project, an Arduino Mega, collected the data from the sensors. The data must be transmitted over a networking medium, which the Arduino Mega lacks. We chose ESP Nodemcu as a networking medium to transport data from the microcontroller to the server because of this. IoT platform required for data display. For this aim of displaying information, "ThingSpeak" was used. The conventional farming techniques have been severely constrained. In that type of farming, no intelligent equipment was added. It will take a lot of time and work. Additionally, rain had been anticipated for irrigation purposes. However, with the help of an IoT-based autonomous integrated plant, fish and poultry farming, these kinds of issues can be quickly resolved. Additionally, efficiency can be increased exactly.

1.5. Stakeholders

Farming is one of the most important sectors for human livelihood and it plays the most important role in human existence. Our farmers grow food and crops throughout their whole lives with heart & soul. Although they have all the experience they need but they lack behind due to technological disadvantages. Our farmers don’t have all the knowledge and technology they need for a proper farming methodology. In the traditional way of farming, the farmers are unable to mitigate the required food demand and hence they need urgent support from modern farming technology. Our project titled “IoT Based Autonomous Integrated Fish, Plant and Poultry Farming” is a system that focuses on proper farming within a small area with the help of modern IoT and autonomous system. The system has the ability to transform the traditional way of farming into a modern user-friendly farming where labor cost will be drastically reduced. Marketers play a vital role in delivering the produced goods by the farmers to the consumers. Consumers will be benefitted by getting an adequate food supply due to the system being autonomous. As a result, the agricultural economy of the country can be benefited due to the continuous cyclical process of the IoT-based autonomous system.

1.6. Objectives

The rate of population growth in the modern world is alarming. As a result, the agriculture industry experiences a labor deficit. Although skilled, traditional farmers lack the necessary farming knowledge. There is a desire to build better technology that combines agriculture management since new developing technologies are having a greater impact on people's lives. This project uses various sensors, Arduino mega, esp 8266, Wi-fi to monitor and control sensor readings. This proposed system uses IoT to provide accurate data about various sensors. This project’s goal is to eliminate labor work, increase food supply, and to utilize the available land. Our project will alter the situation given the energy crisis that is now affecting our nation.

1.6.1. Primary Objectives

Primary objectives of this project to save labor cost and reduce the necessity of cultivation land.

- To design and implement an integrated farming model for efficient farming
- Monitoring the moisture, temperature , humidity, water level, ph of water
- To monitor real time data of the sensors used by using an IoT platform
- To make the system autonomous by machine learning

1.6.2. Secondary Objectives

- To eliminate the labor
- To utilize availble cultivation land
- To make the system user friendly
- Ensure food demand by providing adequate food supply
- Data will be easily accessible from anywhere by anyone

1.7. Organization of Book Chapters

Chapter-2: Project Management

This chapter describes the engineering management principles that were applied to the project's planning and management. This chapter of the book discusses the professional obligations of engineers in relation to the project's subject as well as the engineering management models and concepts applied to this project to provide a cost-efficient and economical solution.

Chapter-3: Methodology and Modeling

The engineering concepts and techniques used in the project are introduced in this chapter. We talked about methodology in this chapter. Regarding the suggested prototype model, this chapter illustrates the various 2D or 3D design and modeling processes. Here is a description of the project's block diagram, flow chart, and working method. Modeling may include both software and hardware elements.

Chapter-4: Project Implementation

The project's timeline is described in this section. This illustration uses the simulation technique. Here are the working model and procedures for the project. a thorough breakdown of the key hardware and software components, with illustrations and graphs. The simulation method has been made more prominent.

Chapter-5: Results Analysis & Critical Design Review

This chapter will discuss the important design, assess the results, and explain errors. It will show whether or not we were successful. The simulation findings are examined in this chapter. The calculations and equations are displayed. The design is addressed in this chapter. Also included is a thorough comparison of data from hardware prototypes and published simulations.

Chapter-6: Conclusion

This chapter summarizes the findings and dictates the novelty of the work. It will show the cultural and societal factors and their impacts as well as the engineering solution in accordance with professional practices. Besides the limitations and future scopes have also been addressed in this chapter. Also, a thorough discussion about the social, economic, cultural and environmental aspects have been demostrated here.

Chapter 2

PROJECT MANAGEMENT

2.1. Introduction

Proper project management is required to focus attention and efforts on a limited set of performance targets within a schedule and budget constraints. Projects are anticipated to be completed based on time, cost, and performance criteria. Goals and priorities must be set sooner to achieve this. Tasks must be identified and time estimates made. Budgets and resource requirements must be prepared. The project's progress must be reviewed constantly to ensure success. Taking all of this into account, the project was managed from start to finish. Complete project management was done to finish this project on time and on budget. Using certain good strategic planning tools, all of these aspects can be examined. SWOT and PEST analysis are two of the most prevalent planning techniques and both were used in this chapter. When considering the benefits and downsides of a project, SWOT and PEST evaluations are helpful decision-making tools. They both supply essential information that will help us finish the projects effectively. Using a strategic planning technique known as S.W.O.T. analysis, the project's strengths, weaknesses, opportunities, and threats were determined. A timetable was prepared to carry out and combine all of the project's duties. Both the expected and ultimate costs of the project were calculated. To acquire a better knowledge of the different quantitative elements that must be considered while working on the project, an external analysis included a P.E.S.T. study. It was decided that each person would be responsible for fulfilling different responsibilities. It was an interdisciplinary project. It was also required to keep track of those. The project's lifespan has been evaluated.

2.2. S.W.O.T. Analysis

The evaluation of some aspects of the project was critical through making a decision on different strategies. It was important to determine which aspects of the project were functioning properly and which were not. While it was necessary to highlight practical issues and future possibilities, it was also necessary to comprehend the drawbacks and possible risks so that decisions could be made to resolve them [1]. SWOT analysis is the most appropriate analytical method in this situation. SWOT analysis is a simple but effective method for identifying positive and negative forces at work that can have an impact on a project's success. SWOT stands for Strengths, Weaknesses, Opportunities and Threats. SWOT analysis is a type of strategic planning technique that project teams can use to determine a project's strengths, weaknesses, opportunities, and threats. It involves specifying the project's goal and identifying the internal and external factors that help or hinder the achievement of that goal [2]. The strengths and weaknesses of a project, as well as the opportunities and threats coming from external sources, are usually discovered within the project. Internal and external factors, as well as current and future potential, are all evaluated in a SWOT analysis. The term "strength" referred to the project's various advantages that would ensure its preference and acceptance in a competitive market. The advantages we have over the competition in this project are referred to as strengths. As for the advantages, there were some disadvantages that could be considered inherent to the project. Weaknesses referred to our internal disadvantages when compared to our competitors. It was necessary to analyze them and concentrate on improvement. The term "opportunities" refers to current external trends that can be taken advantage of [3]. Identifying and exploiting them could make a significant difference in the company's ability to compete and take the market lead. The potential threats, which include adverse external effects and impediments to the project, were analyzed. External movements that may cause a problem and have a negative impact on our project are termed as threats. Anticipating them was critical in order to take action prior to being impacted. It is possible to identify any internal disadvantages or advantages that could benefit or hinder the outcome of a planned project by going over each of these points. This method, in addition to evaluating the state internally, can also identify external factors that may impact a project's success or failure.

2.2.1. Strengths

- The system has the technology to sense solid particles in water via TDS sensor
- It can detect the presence of any harmful or toxic gas via MQ-9 sensor that might be present on the surface water
- It can measure the pH value of the pond water with the help of an analog pH meter
- It can detect the level of moisture and humidity with the aid of a moisture sensor
- It can read and transfer all available sensor data to a local server via IoT integration
- This system is easy to operate and convenient.

2.2.2. Weaknesses

- In order to send the data to the cloud, we must maintain a connection to the Wi-Fi network at all times. It is unable to transfer data without a Wi-Fi network
- The gas sensor (MQ-9) and the microcontroller (Arduino Mega) used in this system are not waterproof and these might easily get damaged if it comes in contact with any form of water
- The system is not entirely user friendly for a particular group of people such as people with language barriers

2.2.3. Opportunities

- We might be able to create our own server and website portal
- We might be able to improve the device for commercial use
- We might be able to implement the humidity sensor to monitor the moisture and humidity of our plants

2.2.4. Threats

- Environmental issues such as rainfall, excessive heat from sunlight, abnormal humidity can all affect our microcontroller which runs the entire system. This type of issue can result in short circuits and damage to the autonomous system components.
- Since networking systems such as ESP8266 module and Wi-Fi have been integrated into this device, we may encounter issues with it, as with all other networking devices, in the event of lightning Strike.

2.3. Schedule Management

Schedule management includes the processes required necessary to ensure the project is completed on time. Scheduling is the process of recording activities, deliverables, and milestones within a project in project management. Additionally, a schedule typically includes a planned start and end date, duration, and resource allocation for each activity. Project implementation scheduling is critical to time management performance. A Gantt chart is the most commonly used type of project schedule. Schedule management encompasses the entire process of organizing project tasks in a systematic manner, including the distribution of labor and equipment, as well as the maintenance of a timetable. Schedule management has several objectives, including efficient utilization of project members, equipment, and facilities, and time minimization [4]. A well-planned schedule results in increased productivity [5]. Appropriate schedule management is critical to the successful completion of any project. A schedule was created and applied to in order to complete all project tasks on time, as illustrated in figure 3.1. Each task was assigned a time limit, and the tasks were tried to be completed within that time limit. The development and documentation of the project were completed through effective schedule management.

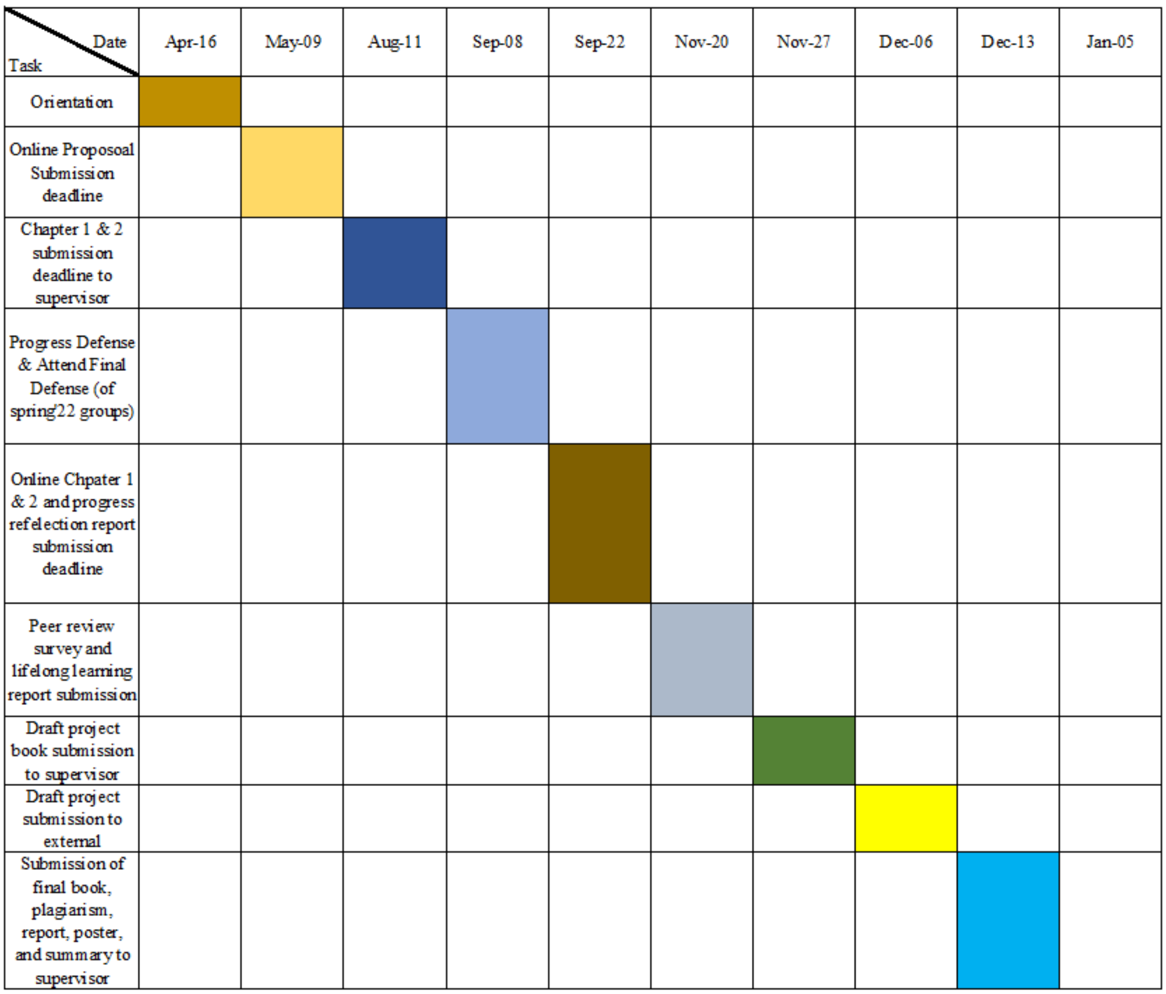

Fig-2.1: Gantt Chart

There were tasks with distinct submission deadlines, as well as tasks that were related to one another. Taking these factors into consideration, tasks were scheduled and assigned to members. The project supervisor was kept informed on a regular basis. The tasks were completed and reviewed as necessary with proper collaboration among the members, in accordance with the project supervisor's instructions and guidance.

2.4. Cost Analysis

Cost analysis was developed in project management to evaluate the project proposal's costs in relation to its benefits. We perform this analysis during the proposal stage of the project. The analysis compares the costs and benefits of a proposed project. This process begins with a list of all the project's expenses, as well as the benefits that will accumulate once the project is successfully completed. The difference between the costs and benefits determines whether the effort, cost, and resources are justified. The necessary components for implementing the project are listed in Table below, along with their estimated costs and total cost. Originally, this project's objective was to develop an IoT-based autonomous integrated fish, plant and poultry farming. The cost analysis presented here is based on the estimated costs and final expenditures for the project's implementation, along with the standard deviation. Cost estimation was accomplished by conducting a search for the components on the Online Websites of various manufacturers and sellers. Several components were found at varying prices. Prices were chosen in such a way that they would most likely cost the same as or less than the estimated price.

Table 2.1: List of components used

Serial	Component Name	Quantity	Estimated cost (BDT)	Expense (BDT)
1	Arduino Mega	1	2200	2000
2	TDS Sensor	1	3200	3000
3	MQ-9 Gas Sensor	1	250	180
4	2 Channel 5V Relay	3	450	490
5	Analog pH Sensor	2	5500	5000
6	5V Battery	1	500	450
7	Water pump	5	900	800
8	Soil Moisture Sensor	1	120	100
9	Waterproof Temperature Sensor	1	300	270
10	Humidity Sensor	1	170	155
11	NodeMCU	1	500	420
12	Fan	1	400	320

11	Others		1500	1180
	Total		15,990	14,075

2.5. P.E.S.T. Analysis

PEST analysis is a well-known management approach for analyzing project external variables. The explanation is kept basic and precise to assist people grasp a notion that is used by managers all around the world. This strategic analysis was conducted to determine the macroeconomic factors that could affect the project. Political, Economic, Social, and Technological factors are illustrated in Figure 3.4. It was critical to understand the political and legal implications of the project, such as associated laws, government policies, and regulations, while conducting the project. Economic analysis aided in determining the project's position within the current economic trend and the extent to which the project may be impacted by macroeconomic forces. Social factors such as societal norms and trends, as well as customer appreciation for this project were examined. Numerous technological factors, such as infrastructure, competitor technologies, and technological incentives, all of which were analyzed, would have an effect on the implementation and marketing of this project. A summary of the significant external influences on the project was discovered through the P.E.S.T. analysis. This framework identified the forces affecting the project and guided the development of a strategic plan.

2.5.1. Political Analysis

This project is directly related with Ministry-of-Information-and-Communication-Technology. The government took the initiative to utilize all available resources to increase agricultural production in order to mitigate food crisis. So, this project is very lucrative for the government. This project does not violate any rule of government organization. Commercial production of this product will create job opportunity which helps to increase employment.

2.5.2. Economic Analysis

By implementing this project, food production cost can be reduced at a significant rate compared to the traditional cost of production. The sensors that were integrated to the system were cheap so it does not require large investments. This project is close to the mass people purchase range. So, this acceptable priced project has a substantial economic impact.

2.5.3. Social Analysis

A large number of people in this country are young. The youth population is familiar with smart devices and the internet. By using this tendency of using smart IoT systems and the internet, this project can be launched vastly. This project can help to change the socio-economic condition.

2.5.4. Technological Analysis

We live in a highly developed technological era. Every day, people witness novel and fascinating things that they did not anticipate. Therefore, operating a firm nowadays and staying competitive are challenging tasks. To develop our product swiftly and deliver it on time to our target customers, we shall implement the most modern production equipment. The reason being that if demand increases and we are unable to provide it, our target customers will search for a new supplier. We will also make use of cutting-edge technology to reach specific markets, including television advertisements and social media. We'll try to contact with them through this channel because people in Bangladesh are more active on online platforms. In Bangladesh, 30 million people actively use Facebook, according to stat counter. As a result, Facebook will make it simpler for us to connect with customers and promote our products.

2.6. Professional Responsibilities

This project's professional tasks include: scheduling, coordinating, and monitoring the project; completing it by organizing and directing project parts; and developing project objectives by reviewing project proposals and plans and communicating with the team.

2.6.1. Norms of Engineering Practice

This project follows standard engineering practice and engineering rules to complete the project. This process is a customized and harmonized version of ISO IEC/IEEE 12207:2017 processes aimed at meeting the requirements of IoT systems: Processes for defining business or mission requirements, stakeholder needs and requirements, and system/software requirements [6]. System life cycle processes are described in ISO/IEC/IEEE 15288:2015 [7], an international standard for systems and software engineering. The software life cycle process is described in ISO/IEC/IEEE

12207:2017 [6], another worldwide standard for systems and software engineering. It refers to both standalone software systems and software systems that are part of larger, more complicated systems, such as IoT systems. This standard describes a process reference model in terms of process purpose and process outcomes as a result of the process activities being carried out. However, because this standard is meant to be generic, it will not be able to meet the needs of all systems. In Annex A of ISO/IEC 12207:2017, a tailoring procedure is described. The Tailoring process' goal is to change or develop new processes in order to accomplish specific goals and objectives. The ISO/IEC/IEEE 15288:2015 and ISO/IEC/IEEE 12207:2017 standards work together to give a unified picture of the system and software life cycle processes. With one exception, ISO/IEC/IEEE 12207:2017's System/Software Requirements Definition process is renamed from ISO/IEC/IEEE 15288:2015's System Requirements Definition process.

2.6.2. Individual Responsibilities and Function as Effective Team Member

The contributions of each of our members are shown periodically in the below table.

Table 2.2: Individual responsibilities of group members

Name of Member	Assigned & Successfully Completed Responsibilities
MAHI TAZWAR	Hardware coding
	Analyzing Project Feasibility, Conducting Necessary Surveys
	Writing chapter: 1,2,3,4,5,6
	Project Reflection report writing
	Hardware implementation
SAKIB AHMED	Design circuit diagram
	Hardware implementation
	Simulation and coding
	Analyzing Project Feasibility, Conducting Necessary Surveys
	IoT Platform development

MD. RIAZUL HASAN	Identifying and Listing Project Components
	Hardware implementation
	Writing chapter: 1,2,3,4,5,6
	Analyzing Project Feasibility, Conducting Necessary Surveys
	Project Reflection report writing
MOTASIM BILLAH	Analyzing Project Feasibility, Conducting Necessary Surveys
	Simulation and coding
	Hardware implementation
	Iot Platform development
	Design circuit diagram

2.7. Management Principles and Economic Models

Management principles state that when issues do develop, everyone involved works to resolve them. While working on the simulation, numerous issues were encountered. So, two individuals acquired C++ programming knowledge and the remaining two members learnt about the proteus software and Arduino libraries. The simulation issue was resolved in this manner. Many issues arose as soon as the hardware component implementation began. Four members of the group scheduled meetings on the supervisor's advice for multiple times whenever required. The entire hardware project was divided into two phases. Two of the group's members acquired the knowledge on how a microcontroller operates. Remaining individuals gained knowledge about the hardware components. All of the members watched numerous technical videos and sought seniors' guidance and advice when they encountered problems. Each team member sought for the least expensive material to complete the project.

2.8. Summary

Strategic planning, scheduling, cost analysis, socio-economic analysis, establishing individual accountability, preserving multidisciplinary components, and researching the project's lifetime were all handled comprehensively from the outset. The most efficient use of resources and timely completion of all tasks were achieved by scheduling project tasks in conjunction with allocating work, equipment, and maintaining a timetable. The strategic study considered a number of elements in order to have a better understanding of the project's internal workings and future prospects. Economic and financial analysis facilitated the assessment of critical external variables and decision-making in light of them. The proper use of expertise was made possible by the dispersion of responsibility. When it comes to completing tasks, the effective use of multidisciplinary components proved advantageous. The project was finished effectively, with all goals and objectives accomplished, thanks to excellent project management.

Chapter 3

METHODOLOGY AND MODELING

3.1. Introduction

This chapter includes a description of the project modeling along with the methodology. In the first instance, the methodology with the flowchart was explained. Individual flowcharts visualized the methodology of the IoT-based autonomous integrated fish, plant and poultry farming. After explaining the methodology, the basic concept was proposed, and some significant block diagrams were also displayed. The overall model design was split into two different sections: Autonomous system and IoT-based platform. First, the autonomous system has been illustrated. The orientation of the automation system has been shown in two-dimensional. After describing the software simulation, the electrical circuitry design of the system was constructed. The electrical circuit for the autonomous and IoT system was designed with the necessary components. The system had been modeled to provide a conceptual idea of the complexity of the architecture.

3.2. Block Diagram and Working Principle

The title of our project is "IoT-based autonomous integrated fish, plant and poultry farming". In the project, mainly two things are implemented, automation and IoT. Utilizing a TDS sensor, the device is equipped to detect solid particles in water. MQ-9 sensor, which may be present on the surface water, can be used to detect the presence of any dangerous or harmful gas. Using an analog pH meter, it can determine the pH of the pond's water. With the use of a moisture sensor, it can measure the amount of moisture and humidity. Through IoT connectivity, it can read and send all available sensor data to a local server. This system is convenient and simple to use. We might be able to build our own web gateway and server. We might be able to make the device better for usage in the industry. To keep track of the moisture and humidity of our plants, we might be able to use the humidity sensor. Lastly, In the IoT platform(ThingSpeak), the data will be shown and from there, anybody can monitor it.

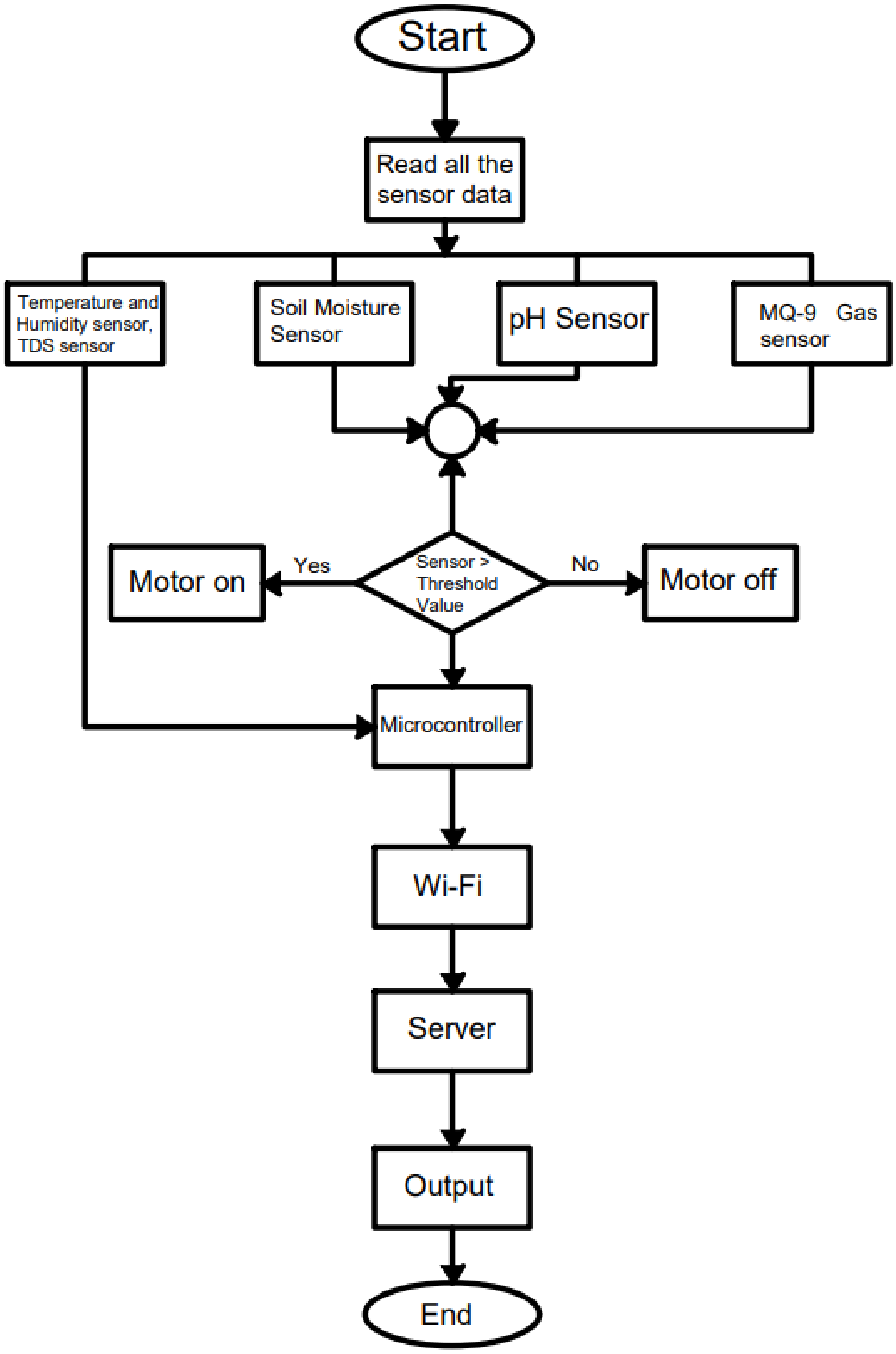

Figure-3.1: Flow Chart of System Process

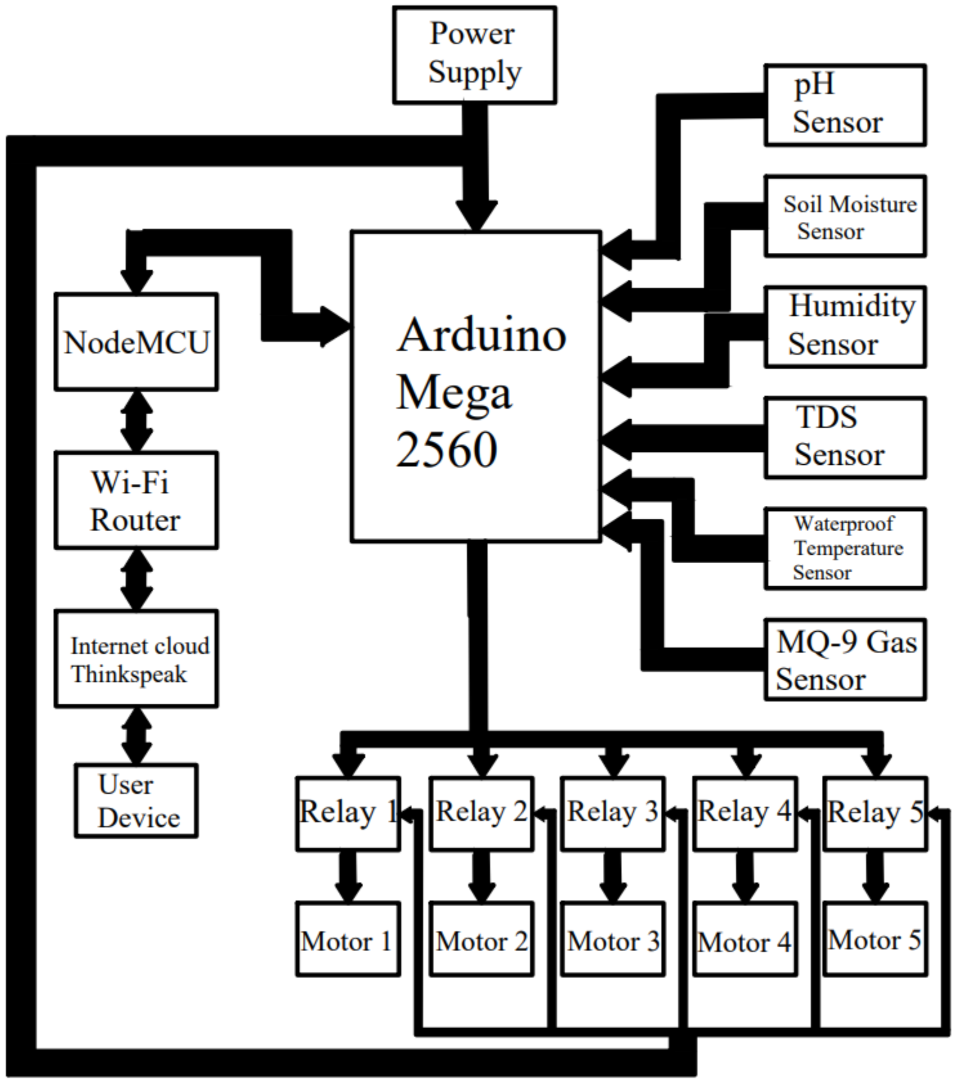

Figure-3.2: Block Diagram of System

3.3. Modeling

Here, the demonstration of 3D modeling of our IoT based autonomous fish, plant and poultry farming given below. Mainly the SketchUp software is used here for creating the 3D architectural view. At first a pond is created where the fish will occupy. Then a reservoir tank successfully added above the pond where the pond water will be filtered. After that the chemical container which is mainly alkaline and acidic substance, will be situated overhead. The reservoir and the pond are connected through uPVC fittings. When the pH value fluctuates, with the help of the chemical, the pH value will be ideal again. Around the pond, there is the plant bed which will be watered from the pond when needed. Mainly this 3D architectural design is a prototype model of our project.

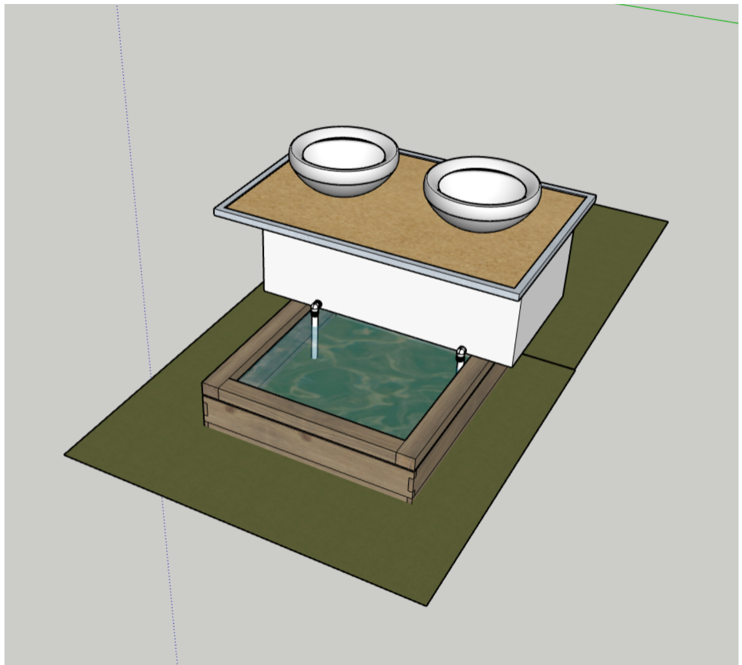

Figure-3.3: 3D perspective of proposed prototype model

3.4. Summary

The methodology of designing the IoT-based autonomous system was explained in this chapter. The methodology showed the process and steps of conducting the project systemically by specifying the tasks. Necessary software requirements were examined. The relevant flowcharts were illustrated and analyzed. The modeling of the systems autonomous system was first done separately and then the overall combined system integrated with IoT was modeled. The block diagrams showed the architecture of the systems, including the main elements. The dimensional parameters of the device were selected.

Chapter 4

PROJECT IMPLEMENTATION

4.1. Introduction

The project that we are implementing here is IoT Based Autonomous Integrated Fish, Plant and Poultry Farming. The implementation of this project was done by preparing the designs and simulating them using the necessary software. After completing the schematic design of the system, the autonomous part was simulated. The simulation was held on automation accurately. Then the second part, which is IoT, requires Wi-Fi connectivity. For observing the system remotely, it is necessary to use a web browser that shall display all the available readings from the sensor.

4.2. Required Tools and Components

4.2.1. Software Required

4.2.1.1. Proteus

In this project proteus 8.12 is used. Simulation and circuit design is completed by this software. The Proteus 8.12 software tool package is a proprietary application suite primarily used for electronic design automation. Electronic design experts and technicians mostly use the software to develop schematics and electronic prints for the purpose of producing printed circuit boards. Lab center Electronics Ltd. created it in Yorkshire, England [24].

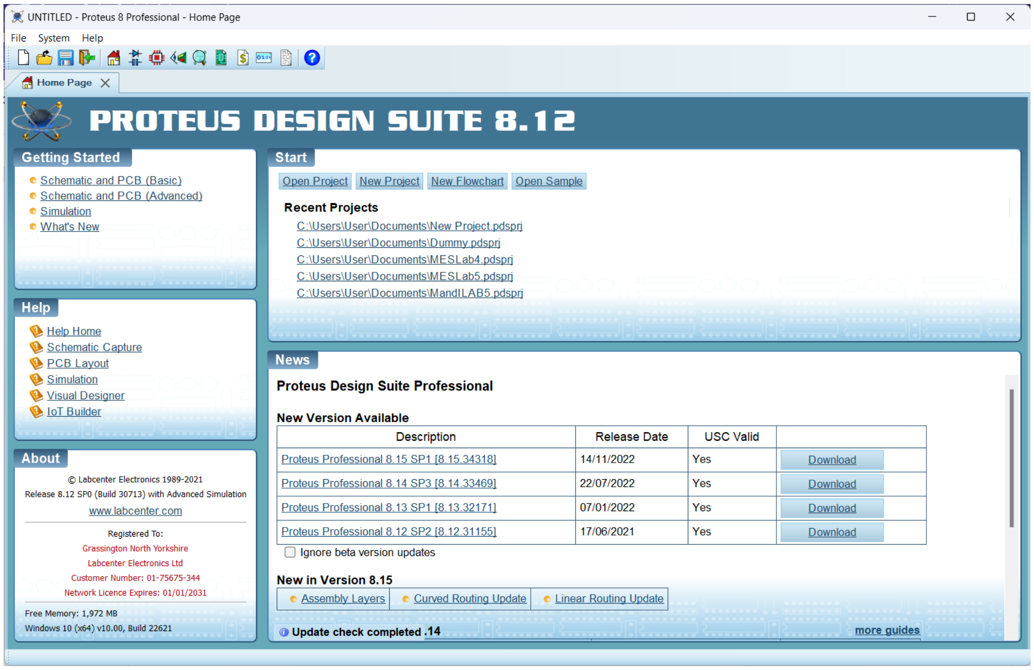

Figure-4.1: Proteus 8.12 Interface

4.2.1.2. Arduino IDE

The code used in this project is generated in Arduino IDE (1.8.19)

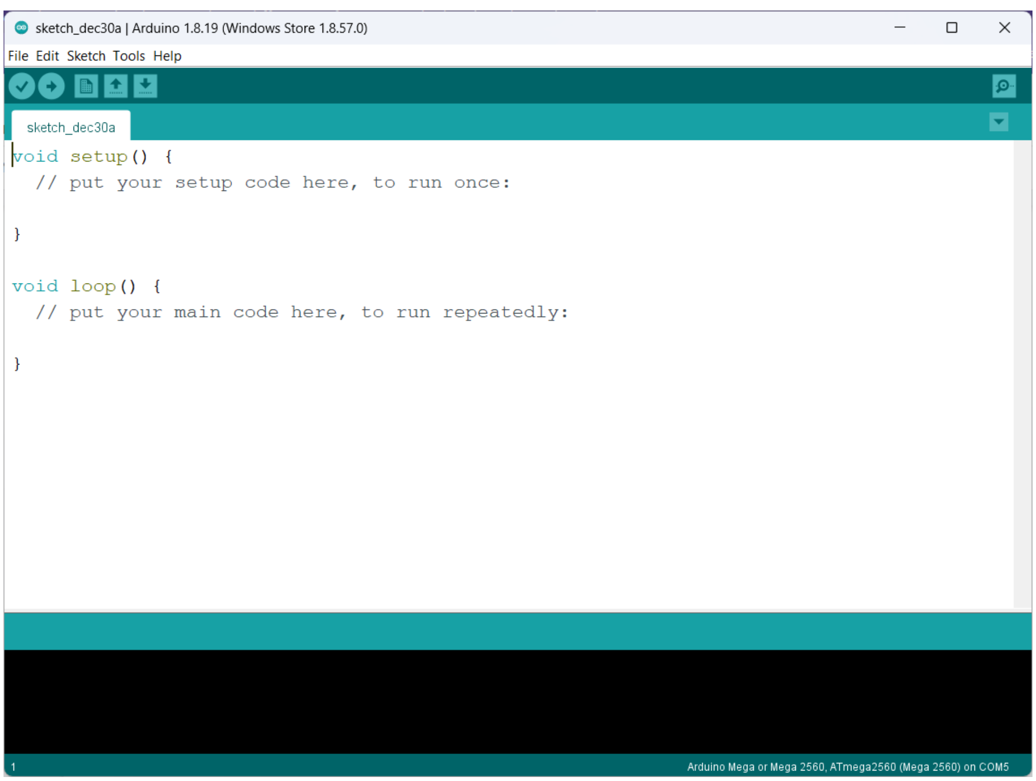

Figure-4.2: Arduino IDE (1.8.19) Interface

4.2.1.3. AutoCAD 2021

Architecture of the smart meter and the controlling device is done in AutoCAD 2021. AutoCAD 2021 is an incredible application for 3D modeling and 2D drawing. One can develop both simple and complicated designs with the assistance of great features and tools. Utilize AutoCAD to create something incredible. This version of the application includes several new tools. All new features and enhanced capabilities are included in the latest version of the application. Architects frequently utilize this application [25].

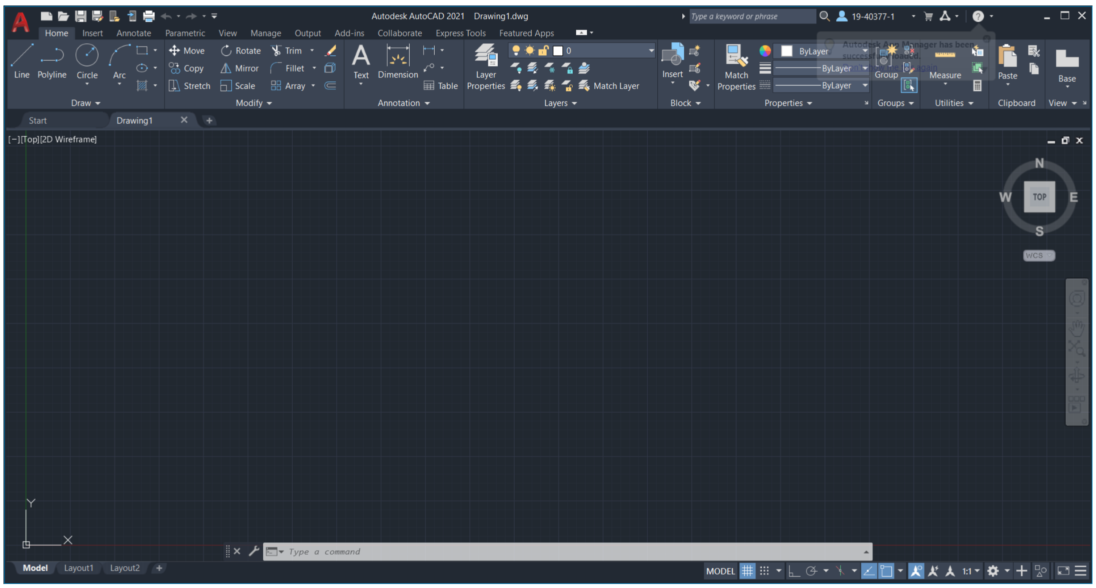

Figure-4.3: AutoCAD 2021 Interface

4.2.1.4. ThingSpeak

ThingSpeak is a cloud-based IoT analytics tool that allows a user to gather, display, and analyze live data streams. Data can be sent from devices to ThingSpeak, generate quick visualizations of live data, and send alerts [23].

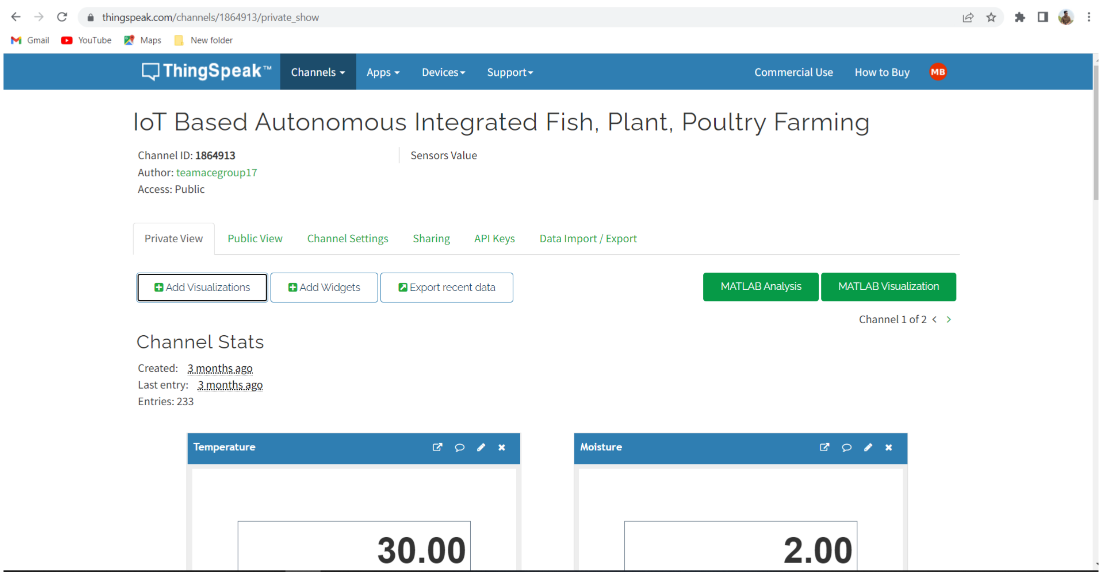

Figure-4.4: Cloud-based IoT Platform ThingSpeak

4.2.2. Hardware

4.2.2.1. Arduino Mega

The ATmega2560 is the basis for the Arduino Mega 2560 microcontroller board. It contains 54 digital input/output pins, 16 analog inputs, 4 UARTs (hardware serial ports), a 16 MHz crystal oscillator, a USB connection, a power jack, an ICSP header, and a reset button [32].

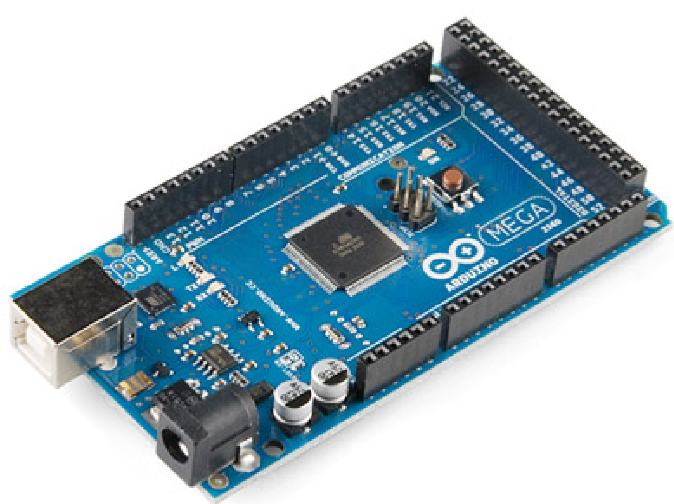

Figure-4.5: Arduino Mega 2560 [32]

4.2.2.2. NodeMCU

NodeMCU is an opensource Lua-based firmware that employs an on-module flash-based SPIFFS file system for the Espressif ESP8266 Wi-Fi SOC. The Espressif NON-OS SDK is used to layer NodeMCU, which is written in C. The firmware was originally created as a companion project to the popular ESP8266-based NodeMCU development modules, but it is now community-supported and may be used with any ESP module [8].

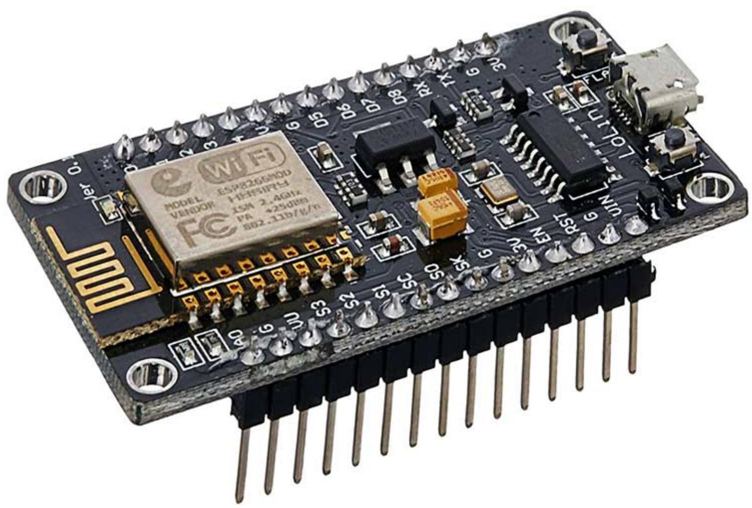

Figure-4.6: NodeMCU [8]

4.2.2.3. MQ-9 Gas Sensor

Sensitive material of the MQ-9 gas sensor is SnO_2, which has lower conductivity in clean air. It detects carbon monoxide (1.5V) by method of cycle high and low temperature. At high temperature (5.0V), it can detect CO as well as clean the other gasses adsorbed at low temperature. The sensor’s conductivity gets higher along with the CO and CH_4 gas concentration rising. Users can convert the change of conductivity to correspond to the output signal of gas concentration through a simple circuit [9].

Figure-4.7: MQ-9 Gas Sensor [9]

4.2.2.4. pH Sensor

pH meter is an electric device used to measure hydrogen-ion activity (acidity or alkalinity) in solution. Fundamentally, a pH meter consists of a voltmeter attached to a pH-responsive electrode and a reference (unvarying) electrode. The pH-responsive electrode is usually glass, and the reference is usually a silver–silver chloride electrode, although a mercury–mercurous chloride (calomel) electrode is sometimes used. When the two electrodes are immersed in a solution, they act as a battery. The glass electrode develops an electric potential (charge) that is directly related to the hydrogen-ion activity in the solution (59.2 millivolts per pH unit at 25 °C [77 °F]), and the voltmeter measures the potential difference between the glass and reference electrodes [10].

Figure-4.8: Analog pH Sensor [10]

4.2.2.5. Waterproof Temperature sensor

This is a pre-wired and waterproofed version of the DS18B20 sensor. Handy for when you need to measure something far away, or in wet conditions. While the sensor is good up to 125°C the cable is jacketed in PVC so we suggest keeping it under 100°C. Because they are digital, you don't get any signal degradation even over long distances! These 1-wire digital temperature sensors are fairly precise (±0.5°C over much of the range) and can give up to 12 bits of precision from the onboard digital-to-analog converter. They work great with any microcontroller using a single digital pin, and you can even connect multiple ones to the same pin, each one has a unique 64-bit ID burned in at the factory to differentiate them. Usable with 3.0-5.0V systems [11].

Figure-4.9: Waterproof Temperature Sensor [11]

4.2.2.6. Moisture Sensor

The moisture of the soil plays an essential role in the irrigation field as well as in gardens for plants. As nutrients in the soil provide food to the plants for their growth. Supplying water to the plants is also essential to change the temperature of the plants. The temperature of the plant can be changed with water using a method like transpiration. And plant root systems are also developed better when rising within moist soil. Extreme soil moisture levels can lead to anaerobic situations that can encourage the plant’s growth as well as soil pathogens. This article discusses an overview of the soil moisture sensor, its working and its applications [12].

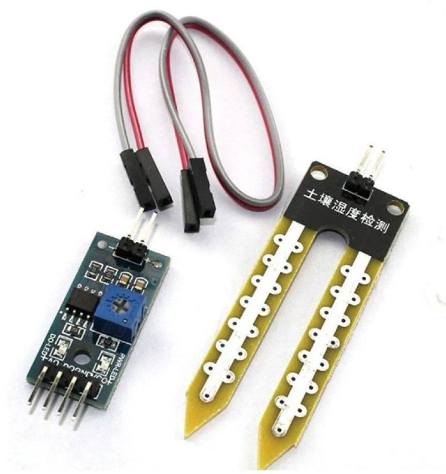

Figure-4.10: Soil Moisture Sensor [12]

4.2.2.7. DHT 11

A typical temperature and humidity sensor is the DHT11. The sensor includes a dedicated NTC for temperature measurement and an 8-bit microprocessor for serial data output of temperature and humidity information. Additionally factory calibrated, the sensor makes it simple to integrate with other microcontrollers. The sensor has an accuracy of 1°C and 1% and can measure temperature from 0°C to 50°C and humidity from 20% to 90%. So this sensor might be the best option for anyone wishing to measure in this range [13].

Figure-4.11: DHT 11 Sensor [13]

4.2.2.8. 2 Channel Relay Module

This isolated 2 Channel 5V 10A relay module for Arduino PIC ARM Optocoupler. It can be used to regulate a range of appliances and other powerful equipment. It is directly controllable by 3.3V or 5V logic signals coming from a microcontroller (Arduino, 8051, AVR, PIC, DSP, ARM, ARM, MSP430, TTL logic) [14].

Figure-4.12: 2-Channel Relay Module [14]

4.2.2.9. TDS Sensor

The amount of soluble solids that are dissolved in one liter of water is measured by TDS (Total Dissolved Solids). Generally speaking, the more soluble solids that are dissolved in water and the higher the TDS value, the less pure the water is. As a result, the TDS value can be used as a benchmark for measuring the water's purity. This is applicable to the testing and monitoring of water quality in hydroponics, residential water, and other areas [15].

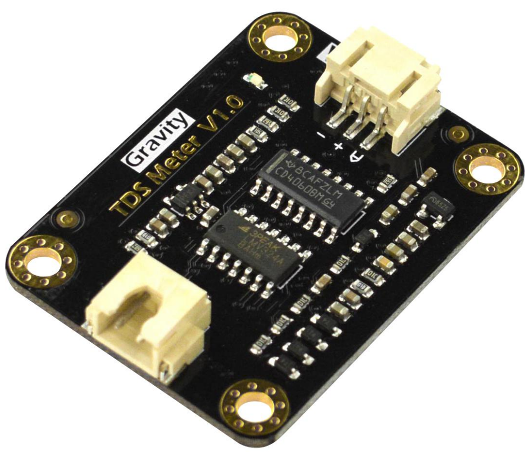

Figure-4.13: TDS Sensor [15]

4.2.2.10. 5 V DC mini submersible pump

This DC 3-6 V Mini Micro Submersible Water Pump is a compact, inexpensive submersible pump motor that runs from a 2.5 – 6V power source. It can use up to 120 liters per hour and only use 220 mA of current. The motor outlet must only be connected to the tube pipe before being powered and submerged in water [17].

Figure-4.14: 5 V DC mini submersible pump [17]

4.3. Implemented Models

In terms of the electrical sensors and microcontrollers employed, we talked about the simulation and hardware model implementation of IoT-based autonomous integrated fish, plant, and poultry farming. We'll briefly go through the portion of our project that deals with hardware-based implementation. The complete project is put together using the Arduino IDE. Also, give a brief explanation of the methodology and implementation process for the hardware model. and make advantage of every component that is used to implement the hardware. Additionally, include the programming code used on the Arduino IDE for hardware implementation. Additionally covered were the hardware requirements, how to execute the simulation, and which parts serve which functions.

4.3.1. Simulation Model

This is the simulation model of our project which has been done by Proteus Software. At First, we took an Arduino Mega as our main microcontroller. Then we add our pH sensor to the analog pin. Similarly, we add the MQ-9 gas sensor, the humidity sensor, The waterproof temperature sensor and the moisture sensor all together with the arduino mega. Then we used a total of 5 motors and they are connected by 2 channel relays. Mainly relays are used here for switching the motor pumps. also DHT11 was connected to the microcontroller. A 5V DC power supply is used to generate the power for the microcontroller, sensors and the pumps. We also used a NodeMCU here to transfer data to IoT cloud.

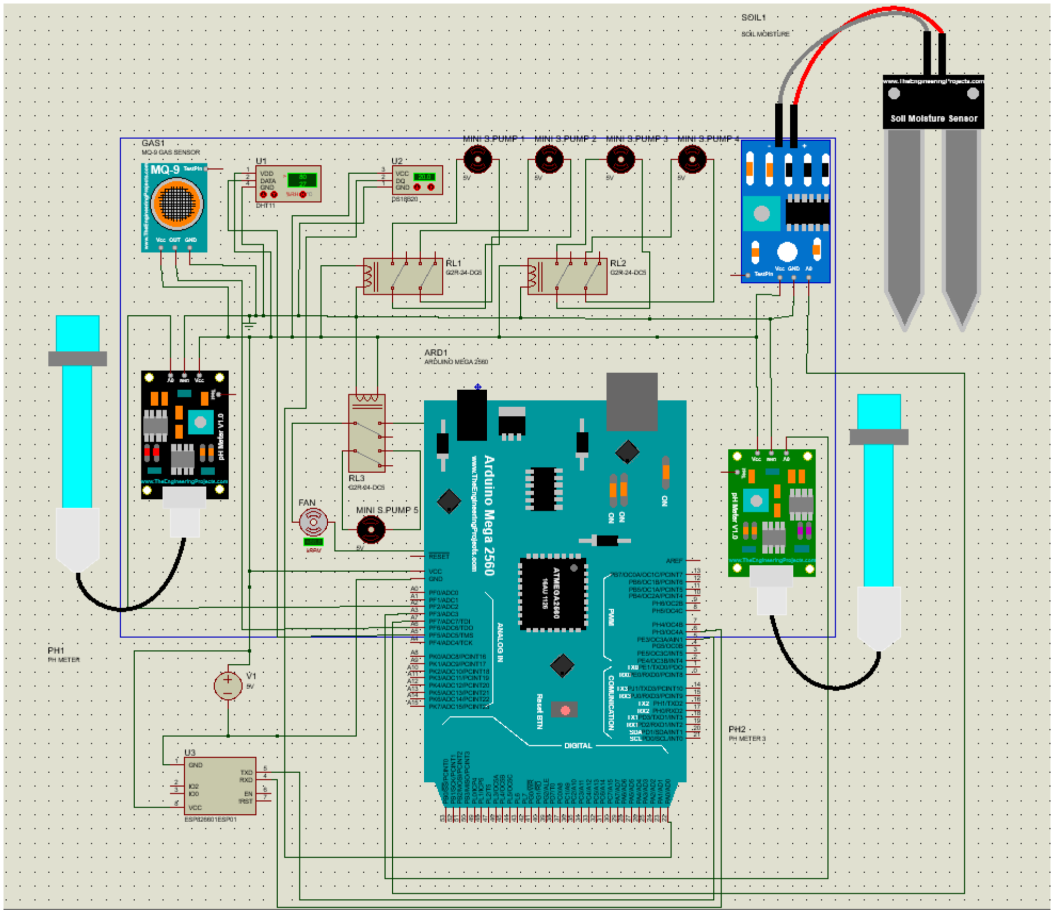

Figure-4.15: Circuit Diagram of Implemented Model

4.3.2. Hardware Model

After numerous challenges and abnormalities, the project model was created, and the intended result was obtained. As seen in fig., all of the sensors were first linked to the Arduino mega. The electricity from the Arduino Mega was insufficient to power the motors. So the motors were powered by a 5 V DC supply. Some of the sensors used in the project only read data and display it, such as the DHT11 sensor, which only measures the temperature and humidity of the air, the waterproof temperature sensor, which measures the water's temperature, the MQ-9 gas sensor, which detects the presence of CO2 and other gaseous substances, and the TDS sensor, which measures the presence of any solid particles. Additionally, there are some other sensors that read data and take appropriate action, which is essentially the project's automation component. For instance, the project's pH sensors can determine the pH of pond water and, if necessary, utilize submersible pumps to transfer the water to a reservoir tank when the pH of the water shifts from neutral to acidic or basic (below 7 or greater than 7 respectively). Additionally, the soil moisture sensor measures the soil's moisture content and, if it drops below 80%, uses submersible pumps to irrigate the soil near the pond.

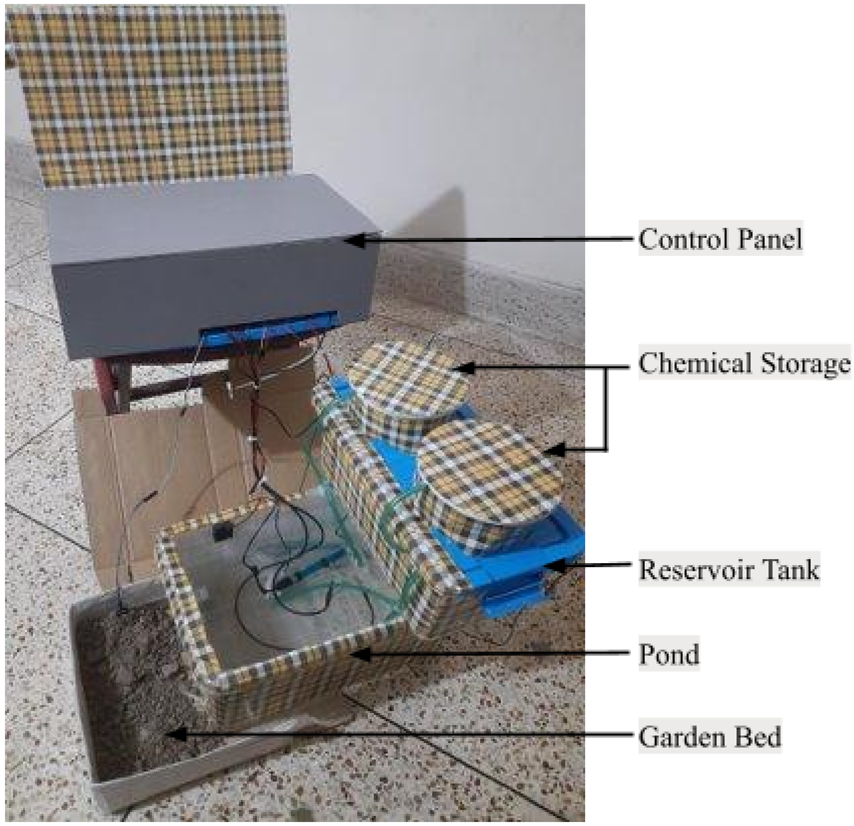

Figure-4.16: Construction of Pond, Reservoir Tank & Chemical Storage

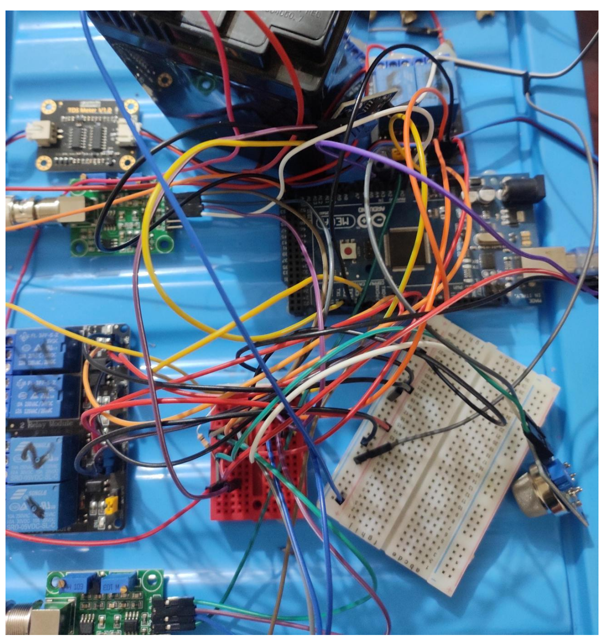

Figure-4.17: Integration of Sensors with Microcontroller

4.4. Summary

All of the schematic diagrams for both the simulation and practical hardware implementation of the project have been included in this chapter, as well as a discussion of how the simulation and system work. Also, all of the components that were used in the simulation are shown as well as a brief discussion of the working principles of all the components that were used to create a practical hardware prototype. This chapter covers system design, which is one of the most important tasks that must be completed before beginning to build a system. A competent system design will ensure a smooth start and the ability to meet system requirements.

Chapter 5

RESULTS ANALYSIS & CRITICAL DESIGN REVIEW

5.1. Introduction

This project simulated the design of an IoT-based autonomous integrated fish, plant and poultry farming system. The best outcomes were found after numerous trials of the simulation followed by calibration, which were analyzed in the results analysis section. A variety of output data were used to analyze the results. Various project performance parameters, such as operating specifications, working capability, efficiency, and so on, were analyzed as part of the analysis of the result. The entire project was then subjected to a critical design review to confirm that it was applicable to the tested quality, cost, and timeline.

5.2. Results Analysis

The project prototype has been developed after many difficulties and irregularities and the desired output was achieved. At first, all the sensors were connected to the Arduino mega as shown in figure-5.1. A 5 V DC supply was utilized to power up the microcontroller as well as the sensors and the motors. In the project, there are some sensors that only reads data and displays them such as the DHT11 sensor that only reads the temperature and humidity of the atmosphere, the waterproof temperature sensor that reads the temperature of the water, the MQ-9 gas sensor that detects the presence of CO_2 and other gaseous substances as well as the TDS sensor that detects the presence of any solid particles. Besides, there are some other sensors that reads data and takes action for it, which is basically the automation part of this project. For example, the pH sensors used in the project detects the pH level of the pond water and sends the water to the reservoir tank with the help of submersible pumps installed if the pH of the water becomes acidic or basic (Below 6.5 or greater than 9 respectively) [28]. In addition, the soil moisture sensor reads the moisture level of the soil and waters the soil around the pond area with the help of submersible pumps installed if it falls below 80%.

The main aim was to automate the purification of pond water for aquatic life by keeping the pH of the water balanced at all times and watering the soil around the pond area along with sending all data to the IoT cloud platform. In order to achieve that the pH sensor plays the major role in doing so. At first, calibrating the pH sensor was a hectic process to do. After that getting it to work accurately, i.e. the sensor should detect the pH value of the water without any error was the main challenge. The pH sensor is very sensitive and shows irregularities if not properly calibrated. Besides, the moisture sensor and waterproof temperature sensor also showed irregularities in displaying the values which were later solved after many trials and errors and rewriting the entire code for it. Finally, after all irregularities, the desired output was achieved.

Figure-5.1: Testing of prepared prototype

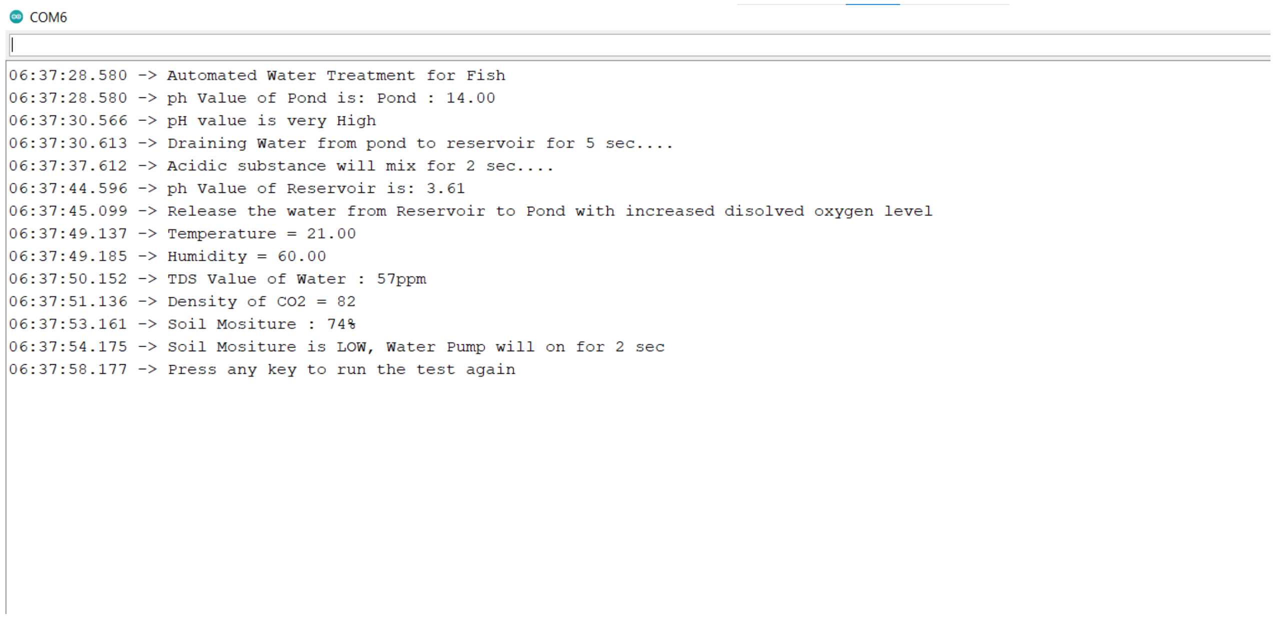

Figure-5.2: Initial output on serial monitor of Arduino IDE

5.2.1. Simulated Results

The data obtained from the serial monitor after running the project has been presented altogether in table 5.1 based on different situations or scenarios. All the data has been obtained from the utilization of all 7 sensors. In order to verify the accuracy or authenticity of the obtained data, the project has been test run multiple times.

Table 5.1: Data Sheet of Obtained values

Category	Sensor Category	Sensor Reading	Standard Value
When pond water is acidic	Pond water pH	0.64	6.5-9.0 [28]
	Reservoir water pH (After adding chemical)	3.12	6.5-9.0
	Pond water temperature	19℃	22-28 ºC [29]
	Humidity	72%	>60% [31]
	TDS value of pond water	252 ppm	146-200 ppm [30]

	Density of CO_2	49	
	Soil Moisture	65%	depends on the soil type
When pond water is highly basic	Pond water pH	12.64	6.5-9.0 [28]
	Reservoir water pH (After adding chemical)	8.53	6.5-9.0
	Pond water temperature	18.5℃	22-28 ºC [29]
	Humidity	72%	>60% [31]
	TDS value of pond water	252 ppm	146-200 ppm [30]
	Density of CO_2	47	
	Soil Moisture	75%	depends on the soil type
When pond water is neutral (acceptable for fish)	Pond water pH	7.53	6.5-9.0 [28]
	Reservoir water pH (After adding chemical)	____________	6.5-9.0
	Pond water temperature	19℃	22-28 ºC [29]
	Humidity	72%	>60% [31]
	TDS value of pond water	252 ppm	146-200 ppm [30]
	Density of CO_2	48	
	Soil Moisture	78%	depends on the soil type

5.2.2. Hardware Results

In the hardware section, Arduino Mega is the main microcontroller of the project. All the sensors are connected one by one to the microcontroller.

With the help of the pH sensor, the pH value of the pond water is read which is followed by actions depending on the pH value. Whenever the pH value of the pond water gets high or low (greater than 9 or below 6.5 respectively) pond water is transferred to the reservoir tank with the help of submersible pumps [28]. Then and there chemicals are added to the reservoir tank depending on the pH value. For low pH, Calcium Carbonate ($CaCO_3$) is added whereas for high pH Citric acid ($C_6H_8O_7$) is added to the reservoir water. The chemicals are dissolved in a chamber partially filled with water. The chemicals are then added to the reservoir as per requirement or according to the pH of the water.

When the moisture of the soil falls below 80%, the soil moisture sensor detects it and water from the pond is poured into the soil with the help of a submersible pump.

The MQ-9 gas sensor detects the presence of any CO2 or other gaseous substances on the surface water.

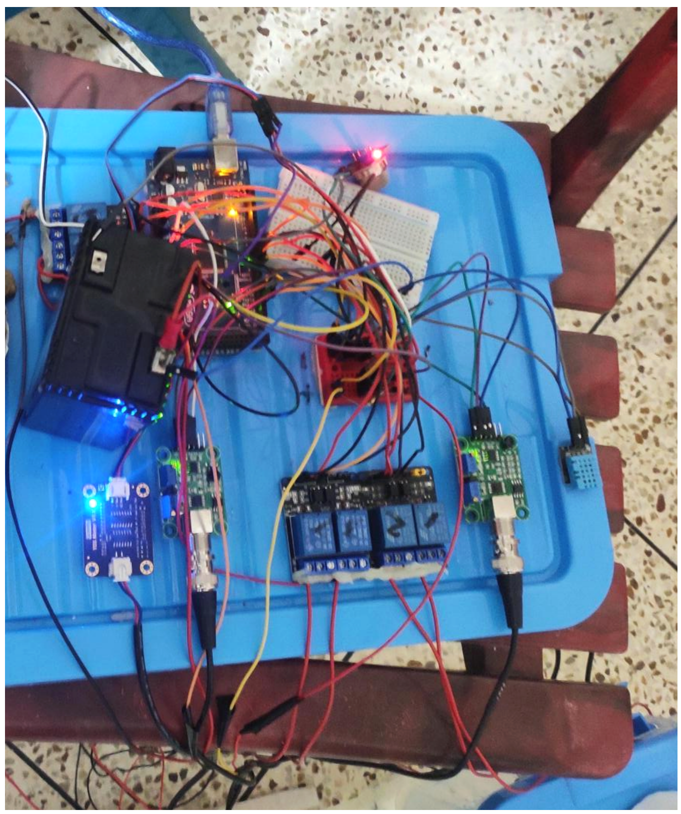

Figure-5.3: Hardware Implementation (Control Panel)

5.3. Comparison of Results

In this project, the hardware has been implemented with great difficulties and after many fault analyses. Since the project has no obvious solution and no simulation hence it cannot be compared. Although it can be said that the results obtained from hardware implementation are quite satisfactory. Starting from the implementation of system automation to the integration of the IoT platform into the system, the overall outcome of the project was successfully achieved that almost corresponds to the goal initially set.

5.4. Summary

This chapter examines all of the findings and results, including data from the hardware implementation and IoT cloud. The total performance of the designed IoT-based autonomous integrated fish, plant and poultry farming was investigated using theoretical knowledge, various calculations, and simulation results. Each performance metric was subjected to a detailed investigation. The system's efficiency was also determined. Finally, a critical design assessment was conducted to demonstrate the project's applicability with various tested performances while considering the available facilities as well as potential risk factors and problems.

Chapter 6

CONCLUSION

6.1. Summary of Findings

After running the prototype project, the automation part was somewhat achieved. In the project, a total of 8 sensors were utilized but not all the sensors were working accurately so it was difficult to bring everything under automation. It was found that not all sensors were getting the required triggering voltage. As a result, a 2-channel relay was introduced in the circuit so that all of the sensors get their exact triggering voltage as required. The analog pH sensor used in this project was not providing any instant result because the change in pH takes time to adjust. The Arduino Mega 2560 serves as the system's brain and is essential for the system's primary functions, which include control of the sensor's working principles. The motors which were used in the project cannot be run from the 5V DC supply of Arduino Mega because it is already powering up and controlling all the sensors. So a 5V DC supply was integrated into the circuit which shall run all the motors.

6.2. Novelty of the work

Since the system is IoT based so data is continuously updated to the cloud. As a result, any form of updates or changes can be easily viewed or monitored remotely via a smartphone or computer that has access to the internet. This project makes a significant difference in the agricultural sector because it enables an individual to check their agro updates on their phones. Apart from that, there are several distinctive features. For instance, the system can detect the presence of Carbon dioxide (CO_2) and methane (CH_4) on the surface of the water via the gas sensor. Besides, any sort of excess solid particles will also get detected via the TDS sensor which shall indicate its removal. Moreover, the humidity and temperature of the atmosphere as well as the temperature of the pond can also be viewed. The system being autonomous makes it hassle-free agricultural production. The system is not only cost-effective but also time-saving. This system is more affordable compared to other smart agro-farming devices available on the market.

6.3. Cultural and Societal Factors and Impacts

Cultural and societal factors are integral components of any project, as they have a lasting impact on the way projects are designed, developed and managed. Understanding of cultural and societal norms in each context helps to ensure that projects conducted in different cultures or societies will be successful from both financial and human resources perspectives. More effective communication between team members can be established when those working on the project understand the culture and society where it's being implemented. IoT technologies are now widespread, with a variety of applications and services. An IoT-based autonomous integrated fish, plant and poultry farming, for example, is an integrated solution for agro farming. The system is not only autonomous but also IoT-based that transmits data to the cloud. Both the automation and IoT based portion operates and shows data 24 hours a day, 7 days a week without any kind of disturbance. As a result, the elected project which is IoT based autonomous integrated fish, plant and poultry farming can provide many advantages to users in a variety of ways. This project provides the users full automation facility with microcontrollers and sensors by combining themselves together. It provides better control and handling for societal individuals. The cost of the project is a little bit elevated but it is considerable because of having quite a lot of advantages.

6.3.1. Cultural and Societal Factors Considered in Design

The contriving of our project also impacts both the social and cultural factors of Bangladesh. Considering social factors, the invention of this project is for all the local and rural households/residents of Bangladesh. As the cost of the project is quite adequate, anybody can afford it. This will change the traditional social factors that local people tend to follow. Besides this reason, there are other several factors that will affect the social factors in Bangladesh by the project. The prototype project is able to send the data to an IoT server with the help of automated features and techniques. The procured data will be displayed in an IoT platform so that anybody can access and monitor that. The operation cost is very cheap and easily bearable. this project is simple to operate, convenient and affordable and it can be used to monitor the data remotely from anywhere in the world via smartphone or computer. So, here only the wireless control is applicable. The MQ9 gas detector sensor is used here so that the poisonous gas will easily be detected from the surface of the pond and gives the user the data. the consumers will be able to view the progress at any time via the internet. As this whole project runs by Direct Current(DC), the energy consumption of the project is very low. the project can find various parameters like it can detect moisture from the soil, Temperature from the water, detect solid particles from the pond water, detect hazardous gasses from the water surface, it can measure the pH value from the water and make it ideal when needed. Additionally, this project can be monitored remotely. The invention of modern projects will change the cultural attributes from an old era to modern ways. This in fact will create a huge number of future opportunities for the Agricultural field to make it more smart and modern, Which will create a new era of agriculture.

6.3.2. Cultural and Societal Impacts of the Proposed Design

As we all know, technology advances at a sprightly speed, resulting in a slew of new inventions and innovations, including the IoT based technology. It is an internet-connected communication system that connects all electrical and electronic devices with the primary goal of exchanging data. Why should we exchange data? It means that before the IoT, it was possible to remotely monitor electrical appliances in our homes and offices, as well as in a variety of fields.But the IoT thing is, It allows data to be exchanged and monitored over the internet. Without a doubt, the IoT will transform technology in the future. Consider how helpful it would be if the doctor could conduct an examination of the patient while on the way to the hospital. Even the tiniest objects can be monitored for the benefit of the IoT. It's important to remember that nothing is possible without the help of other things. We use the internet for a variety of purposes, including browsing, social networking, and data exchange. It is also a significant advancement in data exchange; it offers numerous advantages in terms of security, economy, and time consumption; it simplifies, accelerates, and secures work; and it eliminates cost and natural resource waste. In this project, we designed an IoT based autonomous fish, plant and poultry farming where the data will exchange over the internet. It allows us to remotely monitor the gathered data via the internet from anywhere in the world. Now the next part is automation. Automation is generally understood to be a technology that involves carrying out a process using programmed commands along with automatic feedback control to assure proper execution of the instructions. The system that is created can function without human input. Almost 8 sensors with a microcontroller is used for automated our project. So the labor cost will be reduced. In the traditional way of farming in Bangladesh, labor costing causes most of the costing so our project is moderately cost-efficient. The design of our project is compacted. Having these features, this project met all the requirements of cultural and societal factors.

6.4. Engineering Solution in accordance with professional practices

A professional code of ethics is intended to guarantee that workers are acting in a way that is respectful of others and socially acceptable. It provides the guidelines for conduct and communicates to every employee that complete compliance is required. It also lays the foundation for an early warning if staff members violate the code. A code of ethics can be useful both internally as a professional manual and externally as a declaration of a company's commitments and ideals. Therefore, a significant number of engineering issues in this project were resolved with the aid of best practices. According to the NSPE, "Engineers shall hold foremost the safety, health, and welfare of the public in the performance of their professional obligations." The definition of what it means to prioritize the welfare of the public will depend on the situation, much like the best interests of the patient or customer. Different ethical systems may be the source of engineers' social duty for environmental preservation. From an anthropocentric perspective, it is simple to comprehend that protecting the environment ultimately protects human life.

6.5. Limitations of the Work

In this project, an IOT Based Autonomous Integrated Fish, Plant and Poultry Farming was done with possible finest performance characteristics. Efforts were put in to make the work feasible and efficient. Despite that, there were some limitations to work, which is very usual for any project. The first limitation of the work was that when the water needs to be purified, it will go to the auxiliary reserve tank but the problem is when this process begins, the consequence of the fish. Fishes need to be transferred to an extra reservoir tank but it will raise the cost of the project. Then secondly, when the plants area outside the reservoir need water from the reservoir tank it will affect the aqua life. The IoT device can be damaged from lightning. This device needs a large area for implementation so that it cannot be allowed in the city area. Furthermore, this particular kind of project needs a little bit of knowledge of modern science equipment which will be a slight problem for the less educated village farmers. They need to learn the process first. In the end, without the above limitations, hopefully our project will work successfully. The following are the limitations of the project in brief:

- pH of a portion of the pond water can be balanced instead of a continuous process
- No data was considered for pH balancing i.e., amount of chemical needed to balance pH

- Manual calibration can be done for pH meter
- Non-availability of continuous data on IoT cloud
- Not tested with real aquatic life
- Project was designed without any poultry & fish culture data like TDS & pH value of water for fish excretion, change of pH & TDS after manure dump into pond

6.6. Future Scopes

Although we have successfully completed the implementation of this device, we will get many updates in the future. Although the project is only a prototype, it will add a lot of features in the future. As such, we will bring many more updates to this technology in the future. Some of the future updates will be discussed here. It's possible that we'll be able to build our own server and website portal. We could use the automation system for transferring the fish in another reservoir while purifying the pond water. We might be able to develop the project in a compact area so that it can be used in the city area. Any form of accident, such as a short circuit, or a lightning strike, could be prevented by incorporating a protection mechanism into our system. The availability of sensors and microcontrollers will make this project very cost efficient for everyone. If the handiness of Water Dissolve Oxygen Meter can be assured then the project will be more developed. The following factors can be considered for future scopes of the project that includes but are not limited to:

- Implementation with real aquatic & poultry life
- Continuous pH & TDS balancing using real data
- Integration of dissolved oxygen meter in pond for oxygen monitoring and balancing
- Poultry management (Poultry feeding, egg & manure collection and dumping manure into pond as fish food)

6.7. Social, Economic, Cultural and Environmental Aspects

6.6.1. Sustainability

The 2030 Agenda for Sustainable Development, agreed upon in 2015 by all United Nations Member States, presents a shared roadmap for peace and prosperity for people and the planet today and in the future. The 17 Sustainable Development Goals (SDGs) are at the core of it, and they represent an urgent call for action by all nations, developed and developing, in a global partnership. They know that eradicating poverty and other deprivations must be accompanied by policies that promote health and education, decrease inequality, and stimulate economic growth – all while combating climate change and striving to protect our seas and forests [16].

Figure-6.1: Sustainable Development Goals (SDG)

The project partially meets some of the requirements of the SDGs. These are mentioned herewith:

i. Zero hunger
ii. Good health & well being
iii. Gender equality
iv. Clean water & sanitation
v. Affordable & clean energy
vi. Industry, Innovation & Infrastructure
vii. Reduced Inequalities
viii. Sustainable cities & communities
ix. Responsible consumption & production
x. Life below water
xi. Life on Land

With the help of our project which is “IoT based autonomous integrated fish, plant and poultry farming”, this project can be terminated in a compact area, so it can fulfill the hunger of a lot of people. Then in this project, a water treatment plant is initiated, that is why it meets the 2nd SDG where life below water will be much more comfortable than traditional way of living. Lastly, the last goal has been met which is life on land. A mini submersible pump was attached in the pond water, when the moisture level of the land is less than 80%, then automatically the water will flow towards the land where the plant lives.

6.6.2. Economic and Cultural Factors

IoT based autonomous integrated fish, plant and poultry farming provides us with a better picture of economic aspects. This project needs low labor which can be almost zero. So in this way, our project will be economically considerable to everyone. In our project, the total area needed is very compact, that is why it can provide more protein for a vast amount of people and fulfill their demand easily. By the help of our project, both poultry farming and aquaculture have been done in the same area altogether, so for this reason, the demand for food will easily be mitigated. These factors will play a vital role in the economic systems of this country. Then it comes to our cultural factors. From the statistics of the rural population of Bangladesh in 2021, the rate is 61.05% [22]. By the help of these statistics, The rural cultural factors affect this continent quite a lot. Mainly our project is based on rural area because the cities are overcrowded in bangladesh. This project does not have any kind of emission or radiation, so for the rural cultured people, this project will be easily acceptable for them. Though the maximum percentage of rural area people are involved in agriculture or aquaculture related works, our projects will make their work efficient so that’s why this project will have a noticeable amount of cultural factors.

6.8. Conclusion

All of the project's objectives have been achieved. Despite various limits, all conceivable efforts resulted in the project's effective completion. The project's innovative aspects were investigated. The final implications were examined in order to determine future scopes and make development recommendations. The findings of the experiment, surveys, and numerous further analyses all point to large-scale implementation of IoT based autonomous integrated fish, plant and poultry farming. This could result in a revolution in both the smart automated farming and modern monitoring and control system and the economy.

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Appendix A

Datasheet of the ICs used

Code

```
#include <dht.h>
#define RLOAD 22.0
#include "MQ135.h"
dht DHT;
MQ135 gasSensor = MQ135(A2);
#include "GravityTDS.h"
#define TdsSensorPin A3
GravityTDS gravityTds;
#define DHT_PIN 14

#define MOTOR_1 2
#define MOTOR_2 3
#define MOTOR_3 4
#define MOTOR_4 5
#define MOTOR_5 16

#define FAN 6

int sensor_pin = A4;
int output_value ;

#include <OneWire.h>
#include <DallasTemperature.h>
const int SENSOR_PIN = 15;

OneWire oneWire(SENSOR_PIN);
DallasTemperature tempSensor(&oneWire);
```

```
float tempCelsius;
float temperature = 25,tdsValue = 0;
double ph_value_pond()
{
  int sensorValue = 0;
  unsigned long int avgValue;
  float b;
  int buf[50],temp=0;
  int anaPh=0;

 for(int i=0;i<50;i++)
 {
  anaPh = analogRead(A1);
  buf[i]=anaPh;
  delay(10);
 }
 for(int i=0;i<49;i++)
 {
  for(int j=i+1;j<50;j++)
  {
   if(buf[i]>buf[j])
   {
    temp=buf[i];
    buf[i]=buf[j];
    buf[j]=temp;
   }
  }
 }
 avgValue=0;
 for(int i=25;i<35;i++)
 {
```

```
 avgValue+=buf[i];
 }

 float pHVol=(float)avgValue*5.0/1024/6;
 float phValue = -5.70 * pHVol + 40.2;         //30-40

 if ( phValue <0)
 {
  return 0;
 }
 else if( phValue >14)
 {
  return 14;
 }
 else{
 return phValue;}
}



double ph_value_res()
{
  int sensorValue = 0;
  unsigned long int avgValue;
  float b;
  int buf[50],temp=0;
  int anaPh=0;

 for(int i=0;i<50;i++)
 {
  anaPh = analogRead(A0);
  if (anaPh>=0){
```

```
 buf[i]=anaPh;
 delay(10);
 }
}
for(int i=0;i<49;i++)
{
 for(int j=i+1;j<50;j++)
 {
  if(buf[i]>buf[j])
  {
   temp=buf[i];
   buf[i]=buf[j];
   buf[j]=temp;
  }
 }
}
avgValue=0;
for(int i=25;i<35;i++)
{
avgValue+=buf[i];
}

float pHVol=(float)avgValue*5.0/1024/6;
float phValue = -5.70 * pHVol + 42.5;

if ( phValue <0)
{
 return 0;
}
else if( phValue >14)
{
```

```
  return 14;
 }
 else{
 return phValue;}
}
void setup() {

  Serial.begin(9600);
  Serial.parseFloat();

  pinMode(MOTOR_1, OUTPUT);
  pinMode(MOTOR_2, OUTPUT);
  pinMode(MOTOR_3, OUTPUT);
  pinMode(MOTOR_4, OUTPUT);
  pinMode(MOTOR_5, OUTPUT);

  pinMode(FAN, OUTPUT);

  digitalWrite(MOTOR_1, HIGH);
  digitalWrite(MOTOR_2, HIGH);
  digitalWrite(MOTOR_3, HIGH);
  digitalWrite(MOTOR_4, HIGH);
  digitalWrite(MOTOR_5, HIGH);

  digitalWrite(FAN, HIGH);

  gravityTds.setPin(TdsSensorPin);
  gravityTds.setAref(5.0);
  gravityTds.setAdcRange(4096);
  gravityTds.begin();
  tempSensor.begin();
```

```
}

void loop() {
   Serial.println("Automated Water Treatment for Fish");
   Serial.print("ph Value of Pond is: ");
    Serial.print("Pond : ");
   Serial.println(ph_value_pond());
   delay(1000);

   double phValue = ph_value_pond();

   if (phValue >8)
   {
      Serial.println("pH value is very High");
      Serial.println("Draining Water from pond to reservoir for 5 sec.... ");
      digitalWrite(MOTOR_1, LOW);
      delay(5000);
      digitalWrite(MOTOR_1, HIGH);
      delay(2000);
      Serial.println("Acidic substance will mix for 2 sec.... ");
      digitalWrite(MOTOR_2, LOW);
      delay(2000);
      digitalWrite(MOTOR_2, HIGH);
      delay(5000);
      Serial.print("ph Value of Reservoir is: ");
      Serial.println(ph_value_res());
      Serial.println("Release the water from Reservoir to Pond with increased
disolved oxygen level");
      digitalWrite(MOTOR_4, LOW);
      delay(2000);
      digitalWrite(MOTOR_4, HIGH);
      delay(2000);
```

```
    }
    else if (phValue < 5 )
    {
       Serial.println("pH value is very Low");
       Serial.println("Draining Water from pond to reservoir for 5 sec.... ");
       digitalWrite(MOTOR_1, LOW);
       delay(5000);
       digitalWrite(MOTOR_1, HIGH);
       delay(2000);


       Serial.println("Alkaline Substance will mix for 2 sec.... ");
       digitalWrite(MOTOR_3, LOW);
       delay(2000);
       digitalWrite(MOTOR_3, HIGH);
       delay(5000);
       Serial.print("ph Value of Reservoir is: ");
       Serial.println(ph_value_res());
       Serial.println("Release the water from Reservoir to Pond with increased
disolved oxygen level");
       digitalWrite(MOTOR_4, LOW);
       delay(2000);
       digitalWrite(MOTOR_4, HIGH);
       delay(2000);
    }
    else
    {
     Serial.println("pH value is Normal");
    }


  int chk = DHT.read11(DHT_PIN);
  Serial.print("Temperature = ");
  Serial.println(DHT.temperature);
```

```
Serial.print("Humidity = ");
Serial.println(DHT.humidity);
  delay(1000);
  gravityTds.setTemperature(temperature);
  gravityTds.update();
  tdsValue = gravityTds.getTdsValue();
  Serial.print("TDS Value of Water : ");
  Serial.print(tdsValue,0);
  Serial.println("ppm");
delay(1000);

int val = analogRead(A2);
Serial.print ("Density of CO2 = ");
Serial.println (val);
delay(1000);
if (val > 80)
{
    digitalWrite(FAN, LOW);
    delay (1000);
}
else
{
  digitalWrite(FAN, HIGH);
  delay (1000);
}

        output_value= analogRead(sensor_pin);
        output_value = map(output_value,550,0,0,100);
        Serial.print("Soil Mositure : ");
        Serial.print(output_value);
        Serial.println("%");
```



```
        delay(1000);

        if (output_value <=80){
        Serial.println("Soil Mositure is LOW, Water Pump will on for 2 sec");
        digitalWrite(MOTOR_5, LOW);
        delay(2000);
        digitalWrite(MOTOR_5, HIGH);
        delay(2000);
        }

    Serial.println("Press any key to run the test again");
    while (Serial.available() == 0) {}
    int a = Serial.parseFloat();
    Serial.println("Test will run in 5 sec...");
    delay(1000);
    Serial.println("Test will run in 4 sec...");
    delay(1000);
    Serial.println("Test will run in 3 sec...");
    delay(1000);
    Serial.println("Test will run in 2 sec...");
    delay(1000);
    Serial.println("Test will run in 1 sec...");
    delay(1000);
}
```

Appendix B

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