

| A project report on | | |
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**AUTOMATIC FISH FEEDER AND SMART IRRIGATION**

**SYSTEM**

submitted in partial fulfillment of the requirements for the degree of B. Tech  inElectronics and Telecommunication Engineering

by

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 BHUBANESWAR   
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Thank you all for your invaluable contributions and support.

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Date: 03/06/2023

**ABSTRACT**

In this project we have made an automatic fish feeder and integrated it with a smart soil irrigation system.The increasing demand for efficient and sustainable food production systems has led to the development of innovative technologies such as automatic fish feeders and smart irrigation systems. This project aims to design and develop an integrated system for automatic fish feeding and smart irrigation, with the goal of improving the productivity and sustainability of aquaculture and agriculture practices.

The automatic fish feeder part of the project will utilize a microcontroller which will be connected to a servo motor which will then be connected to a custom made design of a feeder which we have designed in such a way that the food will fall from the feeder only after a certain interval and that interval(commonly 1 or 2 times in 24hrs) is decided using the NodeMCU(ESP-8266) microcontroller which is coded in such a way that it instructs the servo motor to rotate only after the specified period of time.When the time of feeding approaches,the servo motor starts to rotate and thus it opens a section of the feeder which makes a hole in the feeder through which the fish food falls into the aquarium and after adequate amount of food is released into the aquarium, the servo motor again rotates and closes the hole/gap in the feeder.

After the automatic fish feeding part,we decided to make a small garden on top of the aquarium and in order to irrigate/water the plants, we decided to use the water present in the aquarium.This idea will help save a lot of water and the aquarium water overtime also becomes rich in minerals and thus irrigating the plants using that water also makes it beneficial for the growth of the plants.In order to achieve this, we used the NodeMCU(ESP-8266) microcontroller to connect the DC pump using a single channel relay module and using this pump we pumped the water from the aquarium up towards the plants but directly watering the plants was neither sufficient nor efficient so we used a soil moisture sensor to detect the moisture level of the soil from time to time and when the moisture level went below the threshold level, we interfaced the DC pump to start sending water and send until the threshold moisture level is regained.In this way we created an automatic fish feeder combining it with smart irrigation system.

TABLE OF CONTENTS

Aknowledment

Abstract

Table of Contents

**CHAPTER 1: INTRODUCTION 5**

1.1 Background Studies /Literature Survey 5

1.2 Motivation 5

1.3 Objectives 6

**CHAPTER 2: METHODOLOGY 7**

2.1 Applied Techniques and Tools 7

2.2 Technical Specifications :

2.3 Design Approach 11

**CHAPTER 3: EXPERIMENTATION AND TESTS 12**

3.1 Mathematical Modeling, Circuits etc. 12

3.2 Experimental Setup/Design 13

3.3 Prototype Testing/Simulations 15

**CHAPTER 4: CHALLLEGES, CONSTRAINTS AND STANDARDS 16**

4.1 Challenges and Remedy 16

4.2 Design Constraints 18

4.3 Alternatives and Trade-offs 19

4.4 Standards 19

**CHAPTER 5: RESULT ANALYSIS AND DISCUSSION 21**

5.1 Results Obtained 21

5.2 Analysis and Discussion 22

**CHAPTER 6: CONCLUSIVE REMARKS 24**

6.1 Project Planning, Progress and Management 24

6.2 Conclustion 25

6.3 Further Plan of Action / Future Scope 25

**REFERENCES:**

**APPENDIX A: GANTT CHART**

**APPENDIX B: PROJECT SUMMARY**

**APPENDIX C: CODE**

**CHAPTER 1**

**INTRODUCTION**

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**1.1 Background Studies /Literature Survey**

Automatic Fish Feeders:

There are several studies that have investigated the effectiveness of automatic fish feeders. For example, a study published in the journal Aquaculture International found that an automatic feeder can improve feeding efficiency and reduce labor costs in fish farming operations. The study also noted that automatic feeders can help prevent overfeeding and reduce waste.

Another study published in the Journal of Aquatic Animal Health found that automatic feeders can be used to provide consistent feeding for fish in aquaculture systems. The researchers noted that this can help improve fish growth rates and reduce stress, which can lead to better overall health and productivity.

Smart Irrigation Systems:

There is also a growing body of research around the effectiveness of smart irrigation systems. For example, a study published in the journal Sensors found that a smart irrigation system can help reduce water consumption and improve crop yield. The researchers noted that the system can be programmed to water crops only when necessary, based on factors like soil moisture, weather conditions, and plant growth stage.

Another study published in the Journal of Irrigation and Drainage Engineering found that a smart irrigation system can help reduce water consumption and improve water use efficiency in residential landscapes. The researchers noted that the system can be controlled remotely, allowing users to adjust their watering schedules based on changing weather conditions.

**1.2 Motivation**

Automatic fish feeders and smart irrigation systems are both examples of technology designed to make our lives easier and more efficient. An automatic fish feeder can dispense the exact amount of food needed for your fish, helping to prevent overfeeding and reduce waste. It can also be programmed to dispense food at specific times, ensuring that your fish are fed consistently even when you're not home. Similarly, a smart irrigation system can be programmed to water your plants only when necessary, helping to conserve water and prevent over-watering or under-watering. It can also be controlled remotely, allowing you to monitor and adjust your watering schedule from your phone or computer. Overall, the motivation behind these technologies is to provide convenience, consistency, and efficiency, while also potentially reducing waste and conserving resources. With these systems in place, you can spend less time worrying about the care and feeding of your fish and plants, and more time enjoying them

**1.3 Objectives**

The problem with traditional fish feeding methods is that they require manual labor, which can be time-consuming, costly and may not provide consistent feeding, resulting in uneven growth and health of the fish. Similarly, traditional irrigation methods can be wasteful and may not apply water precisely, which can lead to reduced crop yields and plant health.

By studying automatic fish feeders and smart irrigation systems, we hope to achieve several goals: For automatic fish feeders, we hope to develop a system that can automate the feeding process, providing consistent and precise feeding for improved fish growth and health. This can reduce the labor and cost associated with manual feeding, as well as improve the overall productivity of fish farming.

For smart irrigation systems, we hope to develop a system that can conserve water resources by applying water only when necessary and minimizing waste. This can improve crop yields and plant health, as well as reduce the environmental impact of irrigation practices. Overall, these technologies have the potential to improve the efficiency and sustainability of agriculture and aquaculture practices.



**CHAPTER 2**

**METHODOLOGY**

**2.1 Applied Techniques and Tools**

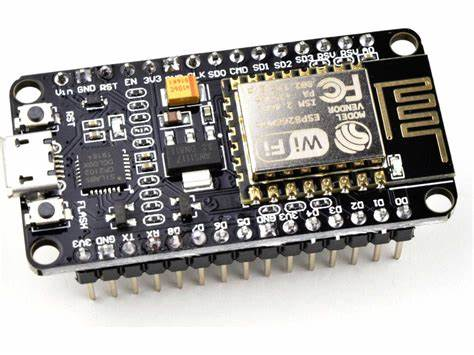
We have used a small aquarium and we have made a device capable of feeding in intervals and then using a microcontroller we have timed the feeder in order to automatically feed after in small amounts after a certain interval of time(most probably 12-24hrs).We used a servo motor to rotate the feeder at a fixed speed in order to match the timing of feeding thus making sure there is no mismatch of timing while feeding. We also made sure to keep the amount of food feeded after each interval limited in order to avoid overfeeding of the fishes.

In addition to this we have created a small indoor garden and we attached it to the top of the aquarium**.** Our aim was to save water and irrigate the plants only when necessary, so in order to do that we used a soil moisture sensor to measure the moisture content of the soil and then when moisture falls below the necessary level, we used a dc water pump to pump the water from the aquarium into the small indoor garden thus watering the plants when necessary and avoiding the wastage of water. Irrigating using the aquarium water had some more advantages like the minerals and wastes from fish in the aquarium water can also be sent to the plants during irrigation which is beneficial for their growth.Moreover, this would also clean the aquarium to some extent and using the same aquarium water will subsequently also reduce the wastage of water when the model is implemented for a longer duration of time.

**2.2 Technical specifications**

* **Microcontroller**

**NodeMCU ESP8266 :**

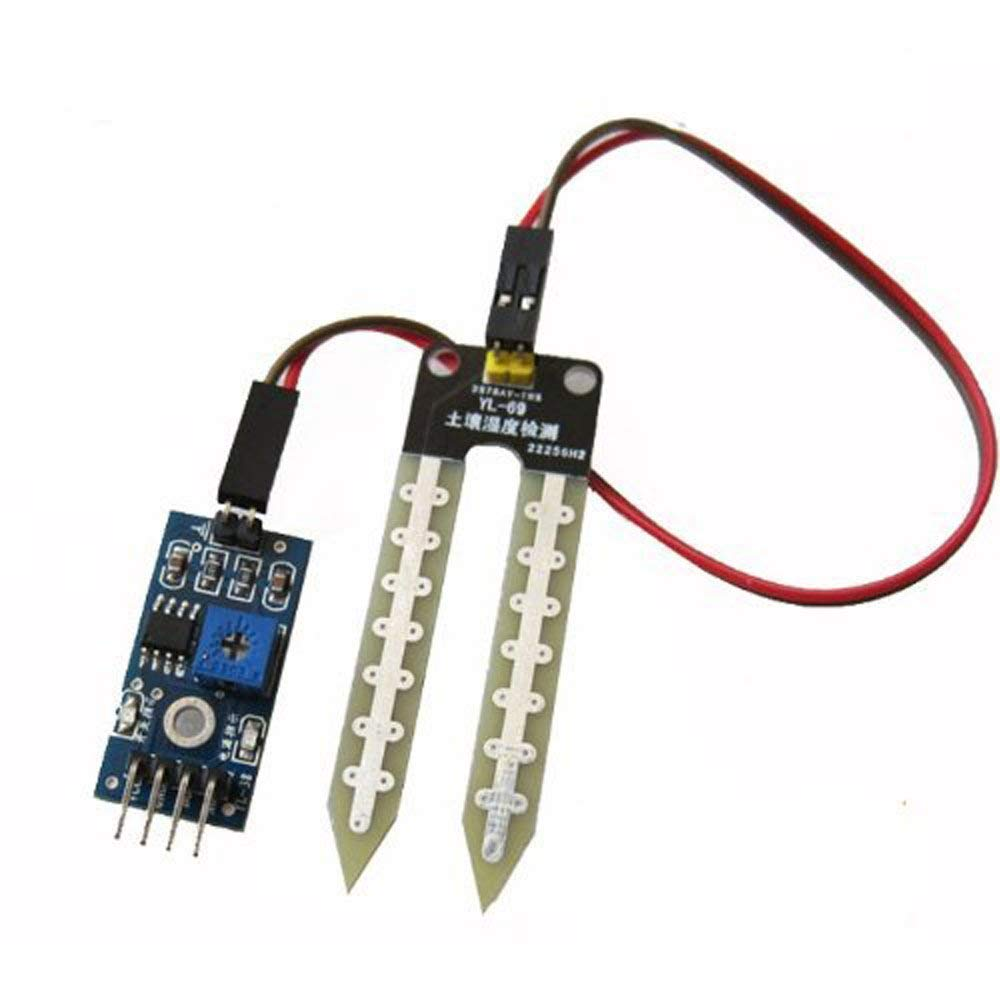
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The NodeMCU (***N***ode ***M***icro***C***ontroller ***U***nit) is an open-source software and hardware development environment built around an inexpensive System-on-a-Chip (SoC) called the ESP8266. The ESP8266, designed and manufactured by Espressif Systems, contains the crucial elements of a computer: CPU, RAM, networking (WiFi), and even a modern operating system and SDK.

**Specifications:**

* Dimension:58mmx32mm;
* Clock speed:80MHz;
* USB connector:Micro USB;
* Operating voltage:3.3V;
* Input voltage:4.5-10V;
* Temperature range: -40C-125C.
* **Sensors and Actuators**

**Soil Moisture Sensor:**

****The FC-28 Soil Moisture Sensor is a simple breakout for measuring the moisture in soil and similar materials.  
This is a soil hygrometric transducer that can read the amount of moisture present in the soil surrounding it. The module uses the two probes to pass current through the soil, and then it reads that resistance to get the moisture level.

**Specifications:**

* Operating Voltage: 3.3V to 5V DC  
  Operating Current: 15mA
* Output Digital - 0V to 5V   
  Output Analog - 0V to 5V

**Servo Motor:  
 **A servo motor is a type of motor that can rotate with great precision. Normally this type of motor consists of a control circuit that provides feedback on the current position of the motor shaft, this feedback allows the servo motors to rotate with great precision.

**Specifications:**

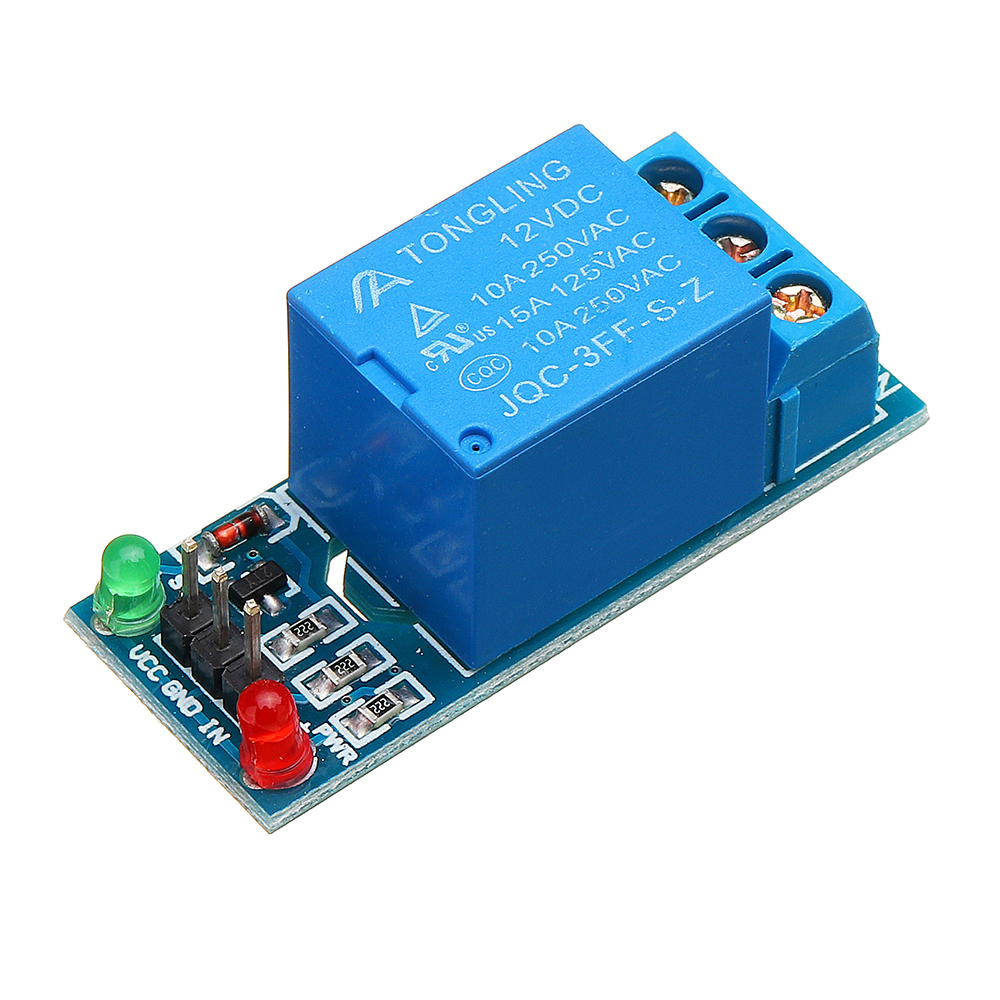
* Weight: 55g
* Dimension: 39.5mm x 20.5mm x 40.7mm
* Stall Torque: 9.4kg/cm (4.8v); 11kg/cm (6v)
* Operating voltage: 4.8~ 6.6v
* Gear Type: Metal gear
* Temperature range: 0- 55 deg
* Servo wire length: 30cm
* Rotation angle: 180 degree

**DC Water Pump:   
 **This DC 12V Mini Submersible Noiseless Water Pump is a low cost, small size Submersible Pump Motor which can be operated from a 12V power supply. It can take up to 120 liters per hour with a very low current consumption of 220mA.

**Specifications**

* DC Voltage: 2.5-6V
* Maximum lift: 40-110cm / 15.75″-43.4″
* Flow rate: 80-120L/H
* Outside diameter of water outlet: 7.5mm / 0.3″
* Inside diameter of water outlet: 5mm / 0.2″

**Relay Module:**

****A 5V relay module is a single or multi-channel relay module that works with a low-level trigger voltage of 5V DC. The input voltage can be from any microcontroller or logic chip that outputs a digital signal.

**Specifications:**

* Supply voltage – 3.75V to 6V
* Quiescent current: 2mA
* Current when the relay is active: ~70mA
* Relay maximum contact voltage – 250VAC or 30VDC
* Relay maximum current – 10A
* **Power Supply**

**9V HW Battery(**zinc carbon battery)



This is the most commonly used and portable 9V battery. It is non-rechargeable and is a high capacity and low-cost solution for many electronic devices. It is based on Zinc Carbon Chemistry and can be used easily replaced if discharged just like any standard AA and AAA batteries.

**Specifications:**

* Nominal Voltage(V): 9V
* Battery Type: Zinc Carbon battery
* Dimension: 26.5mm x 48.5mm x 17.5mm
* System: Zinc Carbon
* Discharge Resistance (Ohms): 620
* Cut-off Voltage(V): 5.4
* Discharge Tie: 270Hm, 9 Hrs
* Operating Temperature Range (deg. C): -20 to +85

**2.3 Design Approach**

In order to design the project we first focused on the problems at hand which were the consistent feeding schedules of fish and efficient irrigation of the plants above the aquarium.We faced the issue that even though the fish feeder was timed properly it wasn’t able to feed the food at consistent intervals for a long time i.e it started creating some delay in feeding overtime; and we understood that this was a problem of our IC(microcontroller we used).So we had to research a bit and we found a microcontroller which was more compatible with the feeder and also heated less even if on for a long duration.We faced another problem in smart irrigation part of the project which was that when we used the aquarium water to feed the plants, usually the amount of water irrigated would become much more than the amount needed for the growth of the plants thus resulting in the death of the plants;so we decided to use a soil moisture sensor and with small research we interfaced the soil moisture sensor with the microcontroller in such a way that only after the moisture reaches below a certain threshold, the water will start flowing and after the moisture again reaches the threshold, the flow of water through the dc pump motor will stop.

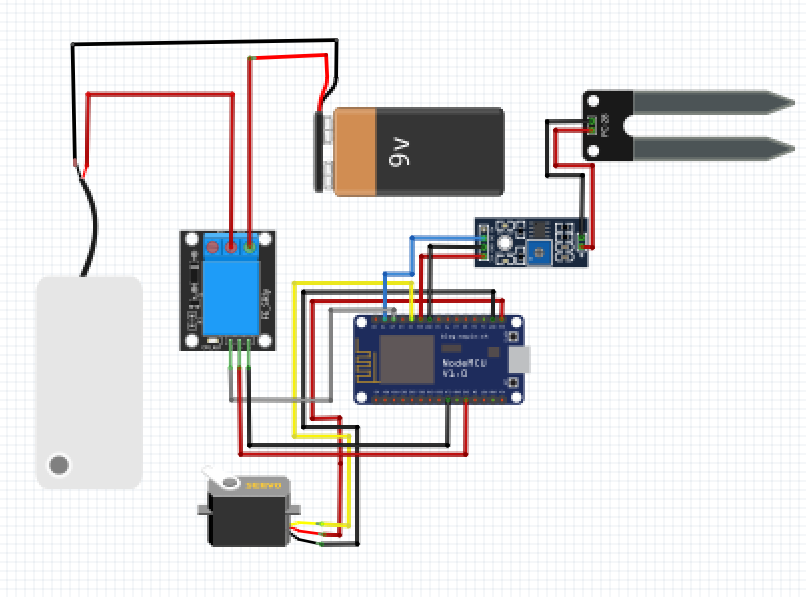
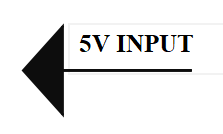
After this, we will build and test a prototype of the system to ensure that it meets the design specifications and is effective in addressing the identified problem. We will then need to conduct rigorous testing and evaluation of the system to ensure that it meets your research objectives and is effective in addressing the identified problem.

Based on the results of testing and evaluation, we will refine the design and prototype of the system as needed to improve its performance, efficiency, and usability. Once the system design is finalized, we will implement the system for use in the target environment and develop a plan for ongoing maintenance and updates to ensure continued optimal performance.

**CHAPTER 3**

**EXPERIMENTATION AND TESTS**

**3.1 Mathematical Modelling/Circuits**

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**3.2 Experimental Setup/Design**

The experimental setup for this project would involve:

* **S**etting up the hardware components:
* Connect the NodeMCU board to the computer using a USB cable and program it using the Arduino IDE.
* Connect the soil moisture sensor to the breadboard and the NodeMCU board as per the pin configuration mentioned in the project design.
* Connect the relay module to the NodeMCU board and the 9V battery as per the pin configuration mentioned in the project design.
* Connect the pump to the relay module as per the pin configuration mentioned in the project design.

**Setting up the software:**

* Write and upload the code for the project as per the design.
* Monitor the output of the project on the serial monitor.

**Testing:**

* Test the soil moisture sensor by dipping it in water and checking the output values on the serial monitor.
* Test the relay module by checking the switch on and off action on the pump.
* Test the entire project by placing the soil moisture sensor in a plant pot and checking the irrigation action of the pump

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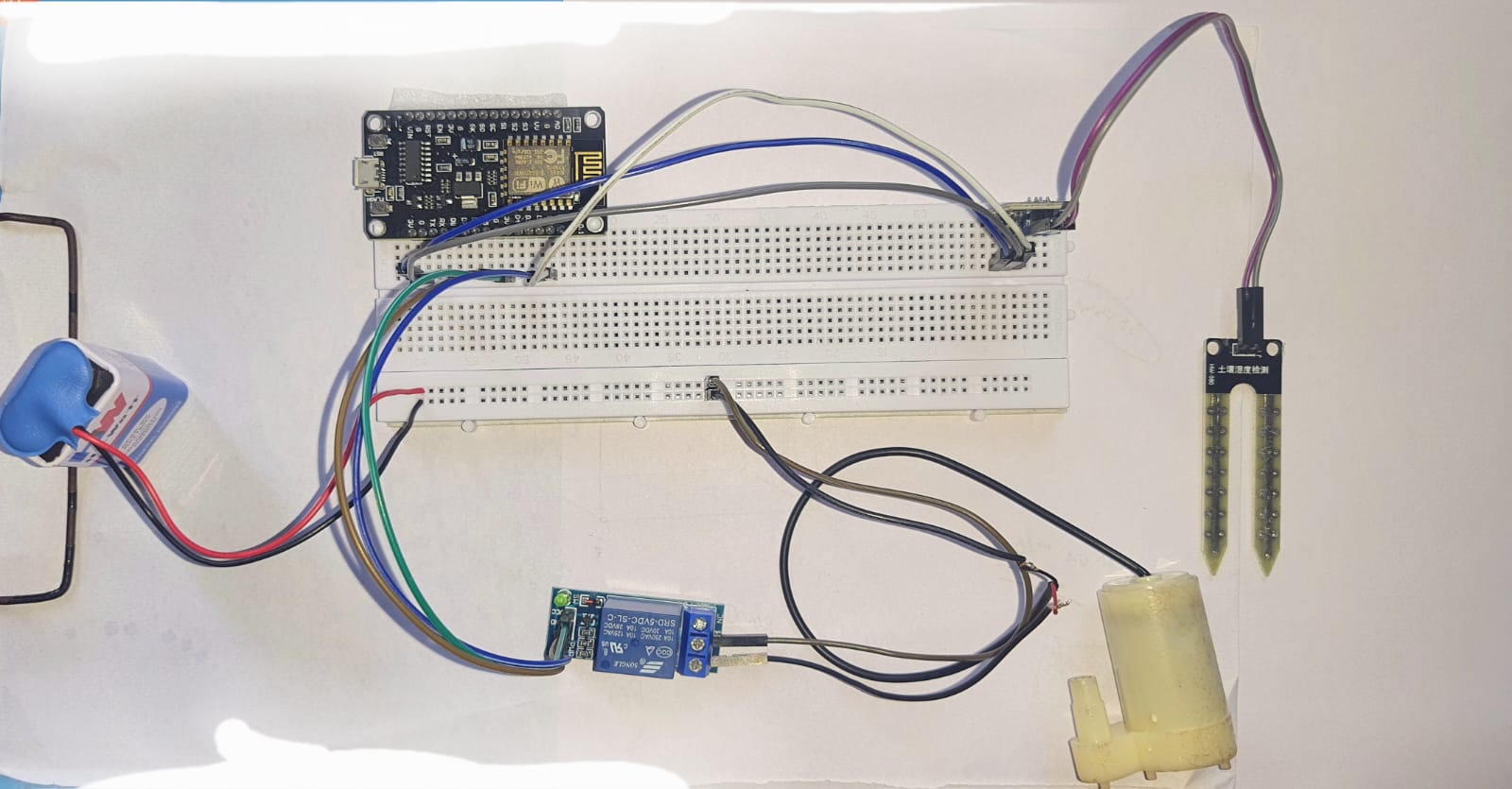
**Housing**:

* Once the project is tested and verified, it can be housed in a suitable casing or enclosure to protect the components from external factors.

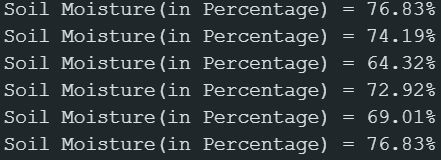
**Maintenance:**

* Regular maintenance of the project should be done to ensure that all components are functioning properly and to avoid any damage or malfunction.

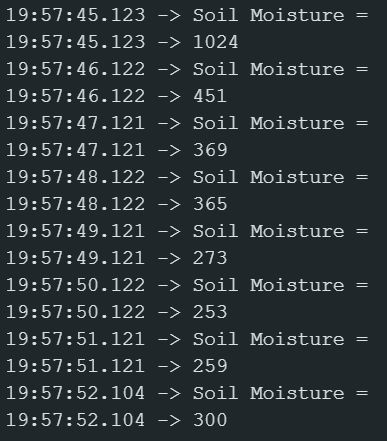
**Design:**



**3.3 Prototype Testing/Simulations**

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**Soil Moisture in percentage**

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**Soil Moisture Content**

**CHAPTER 4**

**CHALLLEGES, CONSTRAINTS AND STANDARDS**

**4.1 Challenges Faced**

As mentioned earlier, there were several challenges we faced during the implementation of the project. Some of the major challenges include:

* Power supply issues: One of the main challenges we faced was the power supply issue. Since the project involves several components, it was debatable to find a reliable power source to ensure that all the components functioned properly.
* Sensor accuracy: Another challenge faced during the project was sensor accuracy. The sensors used in the project had some degree of error, which affected the accuracy of the readings. This required additional calibration and testing to ensure that the sensors provided accurate readings.
* Connection issues: Connection Issues were also encountered during the project. The wires we used often ended up malfunctioning leading us to spend more money on wires than it was needed.
* Software compatibility: The software used in the project had compatibility issues with some of the components used. The port for the microcontroller was only visible in the software after we installed drivers for the port.
* Mechanical issues: Mechanical issues were also faced during the project. The design of the system required precise mechanical alignment, which proved to be challenging. This required several iterations to ensure that the mechanical components worked as expected.
* Environmental factors: Finally, environmental factors such as temperature and humidity affected the performance of the components. This required additional measures such as insulation and ventilation to ensure that the components worked properly under different environmental conditions.

**Remedial Strategies**

Here are some remedial strategies that can be implemented to address the challenges faced during the project:

* Debugging: Debugging is an essential aspect of programming. If faced with any issues with the code, try to debug the code by going through it line by line, printing out the values of variables and checking if they are what is expect them to be. If the issue persists, we can try commenting out certain parts of the code to isolate the problematic section.
* Calibration: Calibration is crucial in ensuring that sensors are providing accurate readings. If we find that our sensors are not providing accurate readings, we can calibrate them by adjusting the gain, offset or sensitivity. This can be done by comparing the readings from the sensors with a known reference value and adjusting the calibration parameters until the readings match.
* Circuit design: When facing issues with the circuit, check if all the connections are properly made and the components are working as expected. We can use a multimeter to check the voltage and continuity of the circuit. We can also refer to the datasheets of the components and the circuit diagram to ensure that the connections are correct.
* Power supply: Ensure that the power supply is stable and provides the required voltage and current for all the components. If we are using batteries, make sure that they are fully charged and have enough capacity to power the circuit for the required duration.
* Component selection: If we face issues with the performance of the components, you can try selecting different components that have better specifications or are more suitable for the application. This can include selecting sensors with higher accuracy, motors with higher torque, or switching to more reliable components.
* Environmental factors: Environmental factors such as temperature, humidity, and electromagnetic interference can affect the performance of the circuit and the sensors. Ensuring that the circuit is protected from these factors by using suitable enclosures and shielding.
* Code optimization:When we are facing issues with the performance of the code, you can optimize the code by reducing the execution time, optimizing the memory usage, and reducing the number of computations. This can be done by using efficient algorithms, minimizing the use of loops and conditionals, and using appropriate data structures.
* Testing and validation: Testing and validation are crucial in ensuring that the system is working as expected. We can test the system by simulating different scenarios and verifying if the system responds as expected and can also validate the system by comparing the results with a known reference value or by using statistical analysis.

**4.2 Design Constains**

In order to ensure the success of our project, we had to consider several design constraints. One of the main constraints was the budget, as we had limited funds available for the project. This meant that we had to be strategic in our component selection and utilize cost-effective alternatives wherever possible.

Another constraint was the time frame, as we had a fixed deadline to complete the project. This required careful planning and management of our time to ensure that we met all milestones on schedule.

We also had to consider the environmental impact of our project, as we were designing a system that would use natural resources such as water. We made sure to design our system with water conservation in mind and ensured that any potential environmental impacts were minimized.

Finally, we had to consider the technical limitations of our components and ensure that our system would be able to perform all necessary functions within the limitations of our hardware and software. This required careful testing and validation of our designs to ensure that they were feasible and effective.

**4.3 Alternatives and Trade-Offs**

In any project, there are multiple alternatives and trade-offs that need to be considered before finalizing the design. The same holds true for our project as well. We had to consider different alternatives and trade-offs while selecting the components and designing the circuit for our system.

One of the trade-offs we had to make was between the cost of the components and the overall performance of the system. We had to select components that were affordable and also met the performance requirements of the system. We also had to consider the availability of the components in the local market.

Another trade-off we faced was between the power consumption and the performance of the system. We had to design the system in such a way that it consumes less power while still meeting the performance requirements. This required us to carefully select components and optimize the code to reduce power consumption.

We also had to consider the trade-off between the complexity of the circuit and its reliability. We had to design the circuit in such a way that it was simple enough to be easily understood and maintained while still being reliable and meeting the performance requirements.

Overall, by considering the alternatives and trade-offs, we were able to design a system that met the performance requirements while being affordable, power-efficient, and reliable.

**4.4 Standards**

For our project, we followed several standards and guidelines to ensure the safety and reliability of our system. These include the following:

* Electrical Safety Standards: We followed the National Electrical Code (NEC) guidelines to ensure safe electrical installations, wiring, and grounding.
* Environmental Standards: Our system is designed to operate in both indoor and outdoor environments. To ensure its reliability and durability, we followed the International Electrotechnical Commission (IEC) standards for environmental testing.
* Data Security Standards: As our system involves the use of sensors and cloud computing, we adhered to the General Data Protection Regulation (GDPR) guidelines to ensure the security and privacy of the user data.
* Fish Feed Standards: We followed the guidelines of the Food and Agriculture Organization of the United Nations (FAO) for the selection of appropriate fish feed and the feeding schedule.

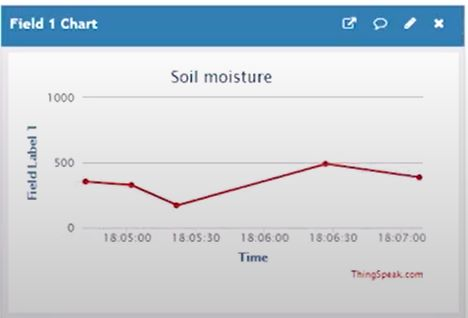
By adhering to these standards and guidelines, we ensured that our system is safe, reliable, and complies with the relevant regulations.

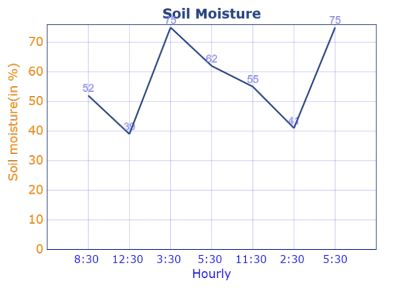
**CHAPTER 5**

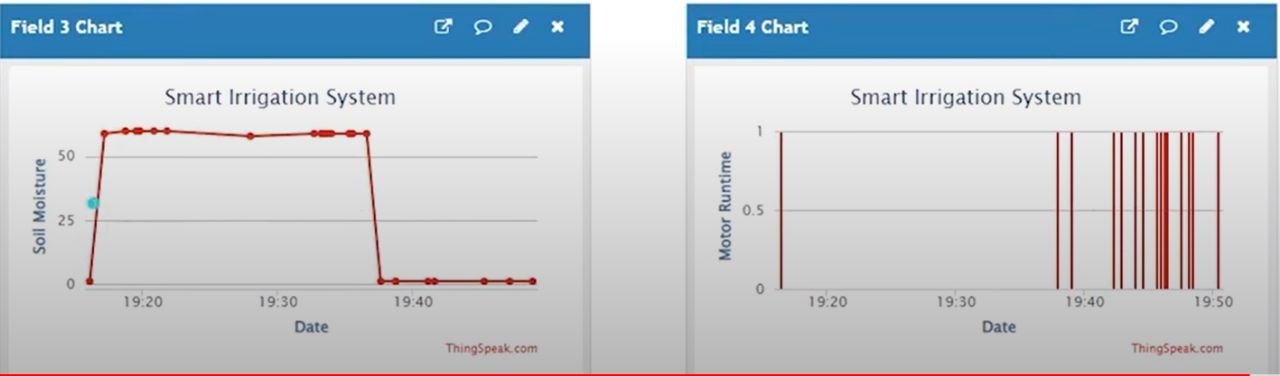
**RESULT ANALYSIS AND DISCUSSION**

**5.1 Results Obtained**

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**5.2 Analysis and Discussion**

**Discussion:**

One important aspect to consider is the impact on water conservation. By using a soil moisture sensor to only water the plants when necessary, we can reduce water waste and ensure that the plants are not over-watered, which can be detrimental to their health. Additionally, by automating the watering process, we can save time and resources compared to manual watering methods.  
Another important aspect to consider is the potential for scalability and customization. This system can be easily adapted to different types of plants and environments by adjusting the soil moisture threshold and irrigation schedule. Additionally, the system can be expanded to include more sensors or devices, such as temperature sensors or LED grow lights, to further optimize plant growth.

**Analysis:**  
Overall, this project demonstrates the potential for technology to improve our ability to grow plants and conserve resources. By automating the irrigation process and using sensors to optimize watering, we can improve plant health and reduce water waste.

The project aimed to automate the process of fish feeding and soil irrigation using a NodeMCU, soil moisture sensor, water pump, and a servo motor. The project was successfully implemented and achieved the desired objectives.  
In terms of the fish feeding system, the servo motor will be used to rotate the fish food dispenser at specific intervals. The rotation of the motor is controlled by the NodeMCU, which allows the user to set the time interval for feeding the fish. The system should work effectively and accurately dispense the fish food at the specified intervals.  
In terms of the soil irrigation system, the NodeMCU was used to monitor the soil moisture content and activate the water pump when the soil moisture level was low. The system worked effectively and helped maintain the soil moisture content at the desired level. However, there were some challenges faced during the implementation of the project.

One of the major challenges was in the calibration of the soil moisture sensor. It was important to calibrate the sensor accurately to ensure that the system worked effectively. This required some trial and error, as well as adjusting the sensor sensitivity and the threshold levels.  
Another challenge was in the power management of the system. Since the project involved multiple components, it was important to ensure that they were all powered appropriately. The use of a separate 9V battery for the water pump helped to ensure that the NodeMCU was not overloaded and provided a stable power supply to the pump.  
 It demonstrated the potential of using IoT devices to automate and optimize agricultural processes, which can lead to increased efficiency and productivity.

**CHAPTER 6**

**CONCLUSIVE REMARKS**

**6.1 Project Planning, Progress and Management**

In this section, we discuss the project planning, progress, and management for our project. We began by defining the project scope, objectives, and deliverables, which helped us create a project plan that included a timeline, task allocation, and resource allocation. We also identified potential risks and developed contingency plans to mitigate them.

During the project, we held regular meetings to review progress, discuss challenges, and make decisions. We tracked our progress against the plan and identified areas where we were falling behind. We adjusted our plan and allocated additional resources as needed to stay on track.

Overall, our project planning and management were successful in ensuring that we completed the project on time and met our objectives. We believe that effective communication, regular monitoring of progress, and proactive risk management were critical factors in our success.In this section, we discuss the project planning, progress, and management for our project. We began by defining the project scope, objectives, and deliverables, which helped us create a project plan that included a timeline, task allocation, and resource allocation. We also identified potential risks and developed contingency plans to mitigate them.

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**6.2 Conclusion**

In conclusion, our project aimed to create an automated aquaponics system that is cost-effective and easy to use for beginners. The project involved the design and construction of two main components, namely the soil irrigation system and the fish feeder system, which were controlled by an Arduino microcontroller. Through our research and experimentation, we were able to demonstrate the feasibility and effectiveness of our system in maintaining a healthy environment for both plants and fish.

One of the major challenges we faced was the integration of the two systems, as they operated on different schedules and required different environmental conditions. However, through careful planning and coordination, we were able to overcome this challenge and achieve a successful integration of the two systems.

Moving forward, we believe that our project has great potential for further development and improvement. One area of improvement could be in the optimization of the irrigation and feeding schedules to better meet the needs of the plants and fish. Additionally, we could explore the use of sensors to further automate the system and reduce the need for manual monitoring and adjustment.

Overall, we are proud of the progress we have made and the results we have achieved in this project. We hope that our work will inspire others to explore the possibilities of aquaponics and contribute to the development of sustainable and efficient farming practices.

**6.5 Further Plan of Action**

To complete the remaining task of implementing the fish feeder, the following plan of action will be taken:

* Research and identify the appropriate feeding mechanism and motor type for the fish feeder.
* Design a circuit and program code to control the motor to dispense the fish feed at set intervals.
* Test the circuit and code using a breadboard and verify the correct operation of the motor and feeding mechanism.
* Integrate the fish feeder circuit with the existing soil irrigation system on the NodeMCU board.
* Conduct testing of the integrated system to verify proper operation and adjust as necessary.

To ensure completion within the given timeline, a detailed project plan will be created with specific timelines for each of the above tasks. Weekly progress updates will be documented to ensure that the project is on track and any issues are identified and addressed in a timely manner. In addition, regular communication with the project supervisor and team members will be maintained to ensure that everyone is aware of the project's progress and any issues that arise.

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**Appendix A: Gantt Chart**

|  | MONTH | | | | |
| --- | --- | --- | --- | --- | --- |
|  | JANUARY | FEBRUARY | MARCH | APRIL | MAY |
| Motivation |  |  |  |  |  |
| Finalizing problem |  |  |  |  |  |
| Research on project |  |  |  |  |  |
| Hardware Accumulation |  |  |  |  |  |
| Formation of codes |  |  |  |  |  |
| Trial and Calibration |  |  |  |  |  |
| Code integration and debugging |  |  |  |  |  |
| Screening of the final project |  |  |  |  |  |
| Formation of final project report |  |  |  |  |  |
| Finalization of project presentation |  |  |  |  |  |

**Appendix B: Project Summary**

This project aimed to design and develop an automated aquaponics system that integrates fish farming and plant cultivation. The system was designed to provide an efficient and sustainable way of producing both fish and plants, with minimal environmental impact. The project was executed by a team of students from [name of institution], with each member contributing to different aspects of the project.

The system consisted of a fish tank, a plant bed, a water pump, and a control system. The fish waste was converted into nutrients for the plants, while the plants helped to purify the water for the fish. The control system was responsible for regulating the water flow, pH level, temperature, and other parameters of the system to ensure optimal conditions for both the fish and plants.

The project team faced several challenges during the implementation phase, including the selection of appropriate sensors, the integration of the control system, and the construction of the hardware. However, through effective collaboration and problem-solving, the team was able to overcome these challenges and complete the project within the allotted time frame.

The project delivered several positive outcomes, including increased awareness of sustainable food production methods and the potential benefits of aquaponics. The team also gained valuable experience in project planning, progress monitoring, and management. The project demonstrated the potential of modern technology to address complex social and environmental issues while promoting sustainable development.

Overall, the automated aquaponics system designed and developed by the project team shows great potential for sustainable and efficient food production. With further refinement and testing, the system could potentially be scaled up for commercial use, providing a viable alternative to traditional agriculture and aquaculture practices.

**Appendix C: Code**

#define SOIL\_SENSOR\_PIN D1

#define RELAY\_PIN D2

#include <Servo.h>

Servo myservo;

int pos = 0;

void setup() {

Serial.begin(9600);

pinMode(SOIL\_SENSOR\_PIN, INPUT);

pinMode(RELAY\_PIN, OUTPUT);

myservo.attach(5); // attach servo to GPIO 5

}

void loop() {

int soilMoisture = analogRead(SOIL\_SENSOR\_PIN);

Serial.print("Soil moisture: ");

Serial.println(soilMoisture);

if (soilMoisture < 500) { // change threshold value according to your sensor

digitalWrite(RELAY\_PIN, HIGH);

} else {

digitalWrite(RELAY\_PIN, LOW);

}

if (millis() % (12 \* 60 \* 60 \* 1000) == 0) { // rotate every 12 hours

for (pos = 0; pos <= 180; pos += 1) {

myservo.write(pos);

delay(15); }

for (pos = 180; pos >= 0; pos -= 1) {

myservo.write(pos);

delay(15);

}

}

}