Project Synopsis On

Optimized WiFi based Control System for Pond Aerators in Shrimp Farming

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Abstract

Aquaculture is one of the most capital intensive field today. In order to yield a healthy culture various parameters has to be closely monitored and controlled. In shrimp Farming like in many other aquacultures the monitoring and maintenance of an Optimum level of Dissolved Oxygen is crucial to the growth and health of the Shrimp. In order to provide the necessary Dissolved Oxygen Pond Aerators are used in the ponds, which is as of now operated manually. This Paper presents the implementation of a viable alternative to control the motor starters in the form of an Optimized WiFi based Control System for Pond Aerators using IoT. This Control System can also be customized to Automatically control the Pond Aerator starters based on the readings received from the Dissolved Oxygen(DO) sensors in the pond.

In shrimp farming, the environment should be well controlled for the optimum growth of the Shrimp in adequate time. At the core of this lies the rigorous monitoring and controlling of various factors amongst which Dissolved Oxygen is the most vital for the Culture's best health and optimal growth. For this aquaculture farms in India have Pond Aerators that must be operated on an average of 12-18 hours a day to maintain proper Dissolved Oxygen in the pond. Dissolved Oxygen below or above the optimal range is extremely harmful for the growth of Shrimps. These Pond Aerators are operated using a Motor Starter which protects the Aerator from low voltage or overcurrent. A motor starter basically controls the electrical power for starting a Motor. Thus this paper proposes and details the implementation of the prototype of an Optimized WiFi based Control System for Pond Aerators in Shrimp Farming

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List of Abbreviations

MCU	Micro Controller Unit
IoT	Internet Of Things
IC	Integrated Circuit

Chapter 1

Introduction

1.1 Overview

India is an agricultural Country which provides the primary livelihood for most of its population. It also covers a significant portion of our GDP. Thus Indian economy relies heavily on its agricultural Yield. Aqua-Culture in India contributes for 5.15% of Agricultural GDP. Thus Aquaculture is one of the most important sectors for India for livelihood as well as due to its export demands. In aquaculture, shrimp farming is continuously gaining a significant position because of it high export potential. At the same time its productivity is comparatively lower as compared to other countries.

In shrimp farming, the environment should be well controlled for the optimum growth of the Shrimp in adequate time. At the core of this lies the rigorous monitoring and controlling of various factors amongst which Dissolved Oxygen is the most vital for the Culture's best health and optimal growth. For this aquaculture farms in India have Pond Aerators that must be operated on an average of 12-18 hours a day to maintain proper Dissolved Oxygen in the pond. Dissolved Oxygen below or above the optimal range is extremely harmful for the growth of Shrimps. These Pond Aerators are operated using a Motor Starter which protects the Aerator from low voltage or overcurrent. A motor starter basically controls the electrical power for starting a Motor.

At present these Motor Starters have to be manually switched ON/OFF which increases manual labour. The farmlands are usually spread out in acres of land that increases the burden on the labourers. Another problem arises when the labourers occasionally forgets to switch ON/OFF the motor starter which could result in im-

mediate loss of the entire culture, which would impose a huge financial burden on the farmer. This calls for a Solution that introduces Smart Farming which also should be economical to the farmers.

We propose an optimized WiFi based Control System for Pond Aerators. This solution solves the problem of manually switching ON/OFF the motor starter. Making the motor starter operable using a mobile application would go a long way in ensuring that the starters are operated timely by the farmer himself/herself. This also reduces the hectic manual labour to cover the entire farmland to switch ON/OFF these starters. In addition with the implementation of Automatic Motor Starter, the Motor starter would automatically be switched ON/OFF by the microcontroller based on the readings received from the DO (Dissolved Oxygen) sensor in the pond.

1.2 Motivation

The primary objective behind developing this project is to solve a real life optimization problem faced by the Aqua Farmers. Namely, the hassle in manually operating a Motor Starter as detailed above. This Project aims at studying and implementing an Optimized Control System for operating the Pond Aerators in Shrimp Farming/ Aqua Farming.

Another motivating factor is the realization that with the correct implementation of this optimized Control System in an economical manner would go a long way in streamlining the operation of Pond Aerators which is used by millions of Aqua Farmers in India alone. This project not only integrates technology in farming but as in every new innovation tries to solve an old problem using new technologies.

The optimization of Pond Aerators also opens up a wide range of future implementations that would then be possible such as automation of the pond aerators via cloud services based upon the readings from the Dissolved Oxygen Sensors installed in the ponds. As this ensures that the Dissolved Oxygen is always maintained at the best levels, this would mean that the culture would be of highest quality. As we are aware Shrimps are highly known for their export potential. And with a very healthy culture the demand would only go up.

Thus this project opens up a way for farmers to integrate technology and use it to their benefit. More sensors can be added to the farm that would be connected to the cloud to perform more such optimization tasks thus leading to a robust farming process that would benefit the farmers as well as the nation at large.

1.3 Problem Statement

To Study various wireless technologies and implement an Optimized Control System for Pond Aerators using appropriate wireless technologies based on various parameters such as its range, number of nodes, cost per node etc, to remotely Control the Motor Starter that in turn controls the Pond Aerators in the Aqua Farm.

1.4 Organization and Contributions of the Report

This report outlines in detail about the research and progress with respect to producing a solution that would best fit as a viable solution for the problem outlined in the problem statement. It further details all the literature survey carried out in order to reach to a decision regarding the wireless technology to be used in this project so that it'd be efficient as well as economical keeping in mind that this implementation is basically intended to be used in Aqua Farms by farmers to increase the quality of their yield and to ensure proper growth of their yield. Initial research is included in this report that defines various technologies appropriate for specific use cases. On the basis of this research, a viable solution is also proposed and the implementation as far as possible till the date of writing this report is detailed. Future works along with the scope of the project and development of the product is outlined in this report as well.

Chapter 2

Review of Literature

2.1 Smart System for Automatic AC Motor starter based on GSM

In this paper, a smart system for automatic AC motor starter has been proposed based on GSM Technology. As we all know GSM is a widely used technology. A system is designed which can be used to switch the starter ON/OFF automatically and thereby the motor. This GSM Module based wireless motor starter is divided into three parts namely, Master Console, Slave/ Target Console and SEA-SAW transmission mechanism

This project aims at conserving and using water optimally in agriculture with the use of IoT. Also reducing the redundancy caused due to improper irrigation methods. It gives a system that automatically using GSM and with the help of Automatic AC Motor starters, will control the action of the Water irrigation systems. It also outlines the importance of efficient methods for irrigation in their field.

2.2 A Step towards Home Automation using IOT

This paper aims at developing a home automation system based on IoT using a WiFi based micro controller. So in this paper the authors have described in great length the importance of transforming our homes into smart homes by embedding our appliances such as TV, Fans, Lights, ACs etc with micro controllers thus making them smart appliances. The paper highlights the importance of moving away from physical switches to controlling all the electrical devices in our homes from one single mobile

application. This would bring in greater control and comfort to the user as they don't have to manually switch ON/OFF the buttons rather they can control the entire system, everything in their house through a few clicks on the Mobile Application.

It highlights the importance of minimizing human efforts to operate appliances such as Washing Machine, Water Heaters etc. The controlling device can instead even be a smart watch on your wrists.

The proposed system in this particular paper consists of web server, web interface, database, NodeMCU and Solid State Relays. The web server used here runs on NodeJS which in turn is running of AWS (Amazon Web Services) a cloud platform used by many people to automate as well as offload their work load. Initially the micro controller connects to the WiFi using the ssid and password and then as soon as it gets connected starts requesting for the operational status of the devices. The Server responds by fetching the switch state from the database. As soon as the data is fetched from the database, the server sends the data back to the NodeMCU in JSON format. Upon receiving data from the server, the NodeMCU parses the response and then triggers the relay to act that is in accordance with the control switch pressed by the user.

The user can very easily just loggin into the application and view the status of all the appliances in the home. With the click of just a button the user can control all the appliances, thus reducing manual labour. Useful also to check when the user is away from the house, that everything is infact in order back at home, which gives a great sense of relief to the user in the moment.

2.3 Research on water-saving irrigation automatic control system based on Internet of things

This paper focuses on irrigation water usage and using it effectively. The paper discusses the design of wireless sensor networks along with use of Internet on farmland for automated control of irrigation systems. In this paper the technology used in Wireless Sensor Networks along with ZigBee. A great amount of emphasis is on the routing protocol of sensor network nodes to achieve the system hardware and software design, middleware as well as applications namely mobile phone or wireless internet of things application.

The core technology mentioned in the paper discusses ZigBee. ZigBee is a low het-

erogenous, low power and data rate, low capital, highly reliable technology. It has a large network capacity along with two-way communication that is full-duplex communication. By using Zigbee technology the authors claim that they could bring down the exorbitant cost in cable communication. It brings in greater flexibility, and expansibility ultimately saving human resources according to the authors. The System uses singlechip control center, router nodes wireless. Many sensors are connected to the mcu such as temprature, humidity, soil moisture information etc. This is very crucial as all the values of the sensors are processed in the mcu and/or in the cloud and an appropriate action is performed on the basis of the evaluation of these readings.

The main achievement of the system is that it can record all the values from the sensor such as soil water content and based on these stored data further data analysis can be performed that may shed light on many of the hidden problems with the irrigation and help in proper sustainability of the soil. It also senses PH value, EC (Conductivity) value etc

Chapter 3

Report on The Present Investigation

3.1 Choosing a suitable Micro Controller Unit (MCU)

From the Literature Review Conducted, it is clear that inorder to implement a wireless control system to control the pond aerators, there is a need to choose an efficient, low-power, low-cost Micro-controller Unit (MCU).

3.1.1 What is a Micro Controller Unit (MCU)?

A microcontroller is a single integrated circuit (IC) that is usually used for a certain specific application which is designed to implement certain specific tasks. It is used in products and devices that must be enabled for automatic operations.

Essentially a microcontroller is capable of receiving many inputs from different sources like different sensors. A microcontroller processes all the information received from the sensors, makes appropriate decisions and outputs a certain action based on the input gathered. MCUs are generally designed to consume less power as they have to be embedded inside other devices that usually has greater power consumption.

A microcontroller has some essential components, specifically, a Central Processing Unit(CPU), a Random-Access Memory (RAM), a Flash Memory, a Serial Bus Interface, Input/Output ports (I/O Ports).

3.1.2 ESP32 WiFi and Bluetooth MCU

Based on the Literature Review and other comparisons of various Micro-controller Units available in the market, ESP32 MCU has been established as a suitable prospect for implementing the solution.

ESP32 is a Micro-controller Unit that has a WiFi Module (IEEE 802.11 Standard) as well as a Bluetooth Module (IEEE 802.15 Standard). ESP32 is in essence a successor of the ESP8266 MCU. ESP32 has a integrated WiFi and Bluetooth connectivity that enables it to be used for a wide range of applications.

ESP32 has a ton of new features such as a robust design with an operating temperature ranging from -40 Degree Celsius to +125 Degree Celsius. It can dynamically adapt to changes in external conditions. It as an Ultra-Low Power Consuming device as it is engineered for mobile devices and especially for IoT application. It has various power modes and dynamic scaling inbuilt within. ESP32 in heavily integrated with in-built antenna switches, filters, power management modules, low-noise receive amplifier and has a minimal Printed Circuit Board (PCB) requirements.

3.2 Configuring Motor Starter with an External Relay

3.2.1 What is a Motor Starter?

A Motor Starter is an electrical device which is used primarily to start and stop a motor safely. A Motor Starter is similar to a relay, which is used to Switch the power ON/OFF but also provides a low voltage and overcurrent protection to the motor to which it is connected. Simply put a Motor Starter protects the costly motors used in the farm as in if there is a voltage fluctuation or overcurrent the motor starter would be affected instead of the Motors thus protecting the Motor from being damaged. It simply is a safety measure used in the industry to protect costly motors from being damaged.

3.2.2 Connecting an External Relay to the Motor Starter

A Motor Starter basically has an internal relay which switches ON/OFF the Motor when the switch is pushed.

To implement our Wireless Control System, there needs to be a way to wirelessly control the Motor Starter which would in-turn be controlling the Pond Aerator. For

this we connect an external relay to the internal relay of the motor starter. This External Relay will also be configured with the Micro-Controller Unit mentioned in detail above. This would enable the MCU to give control signals to the External Relay which via the internal relay would operate the Motor Starter ultimately controlling the Pond Aerators.

A relay is like a switch which is operated electrically, it can be used for turning on or off any appliance by not letting the current pass on. It can be operated using microcontroller. It can be of different configurations 1,2,4,6,16 channels relay modules. Numbers of channels is decided based upon the number of appliances that can be controlled with it. The relay has two connectors with three sockets namely, Normally Open(NO), Normally Closed(NC), Common (COM).

NO: this configuration is used when relay is to be open by default. So, connection is open unless signal is sent through the microcontroller.

NC: this configuration is used when relay is to be closed by default. So, connection is closed unless signal is sent through the microcontroller.

COM: controls current of the connected appliance

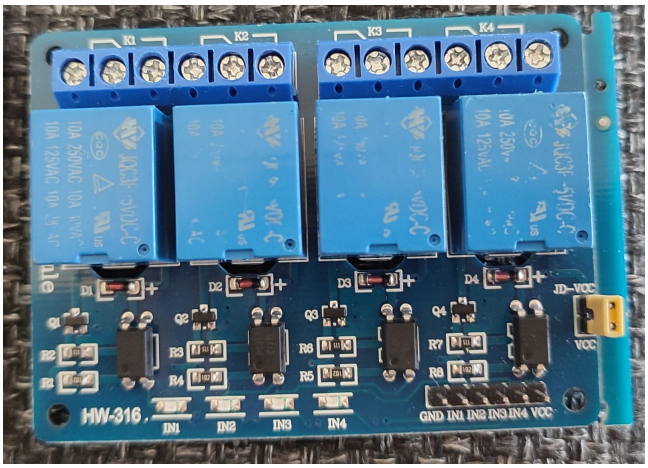

Figure 3.1: 4 channel Relay

3.3 Configuring External Relay to an ESP32 MCU Node

After the External Relay is connected to the Motor Starter, the next step is to connect this External Relay to a ESP32 MCU Node. By doing so a proper connection is set up

between the ESP32 Node and the External Relay. This connection would be a wired connection between the ESP32 Node and the External Relay. This would complete the circuit as a signal to switch ON/OFF the motor starter would be relayed by the ESP32 Node to the relay which would in turn Control the Internal Relay in the Motor Starter thus Controlling the Pond Aerator in a Wireless Fashion.

The External Relay has a GND and VCC pin which can be used to power relay through the microcontroller. IN1,IN2,IN3,IN4 pins can used to send signal to each relay separately through microcontroller. Controlling relay through esp32 board Connect the relay module to esp32 board using GPIO pins of esp32 and Vin and GND in esp32 board. Connect the relay according to the diagram.

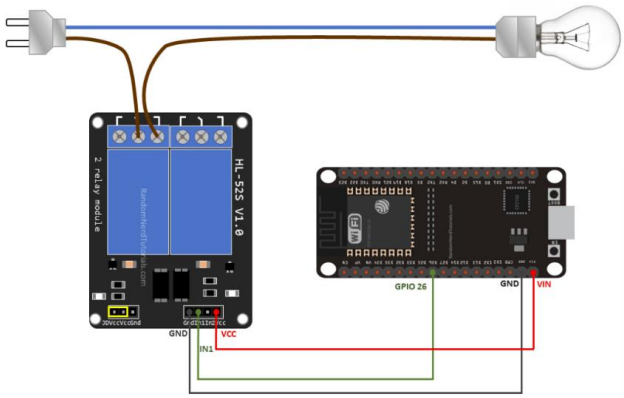

Figure 3.2: Connection with ESP32 Node

```
const int relay = 26;

void setup() {
  Serial.begin(115200);
  pinMode(relay, OUTPUT);
}

void loop() {
  digitalWrite(relay, LOW);
  delay(5000);
  digitalWrite(relay, HIGH);
  delay(5000);
}
```

Figure 3.3: Code Snippet for External Relay connection with ESP32 Node

3.4 Configuring the Gateway Node

In a Large Aqua Farm there would be a need for many pond aerators and thus there would be a need for many ESP32 Nodes to be configured to every motor starter which can then be operated from a Mobile Application via the Cloud.

For this we need two ESP32 Nodes, one ESP32 will be connected to the internet and other will be connected to the mesh network. These two ESP32 Nodes will be connected to each other serially via RX and TX pins. Therefore, these Node will be known as Gateway Nodes from here on out.

This Gateway Node would be connected to a WiFi Network using the ssid and password of the Internet Enabled WiFi Network. The gateway node as the name suggests is the main connection point between the cloud and the Mesh network. Gateways serve as an entry and exit point for a network as all data must pass through or communicate with the gateway prior to being routed. It is also known as the connection between networks which implements different transmission protocols. Gateway nodes will be responsible for transmitting and receiving the JSON data through a WebSocket connection which is a two way connection. The reason for using two ESP32 Nodes in the gateway node is to decrease the load on the node and to distribute the tasks between them. This increases the efficiency of the network. This Gateway Node would be connected to a cloud service. As soon as the command is sent by the user, the JSON data is transmitted to the gateway node connected to internet. This data is then passed serially to other node which is connected to the mesh network and then the data is transmitted inside the mesh network via a broadcast signal. This process reverses while receiving the acknowledgement.

3.5 MeSH Network

Now, After the connection and configuration of the Gateway Nodes, the MeSH Network needs to be configured.

Mesh network are a group of interconnected devices that can receive and transmit data directly to one another or through multiple hops. The significance of the MeSh Network is that it does not have any central connection point or a Hub. As the Aquaculture fields are quite huge, one cannot have a central Hub for the connection and hence a Mesh network is preferred as it has the capability of spreading over a wide area. Any failure of node do not result in failure of whole network as is the case with central Hub connections. A library called "PainlessMesh" is used for implementing a mesh network. It uses routing tables for transmitting the data efficiently. It uses broadcast method to transmit data to every node directly in the range. After the initial setup, it automatically tries to make a routing table to decrease the latency of the network. It is also known as self-organizing and self-healing network which means that it can work autonomously. If any node is removed from the network, it can automatically self-organize and make sure that the packet reaches the destination node.

This Completes the Connection Setup at the ground level. Now a connection to a cloud service is all that is remaining to complete the implementation details.

3.6 Setting up a Cloud Service Connection

Now there is a need to for a connection to a cloud service. This would provide the user with an Interface to interact with all the ESP32 Nodes that would be installed in the AquaFarm. Using this Interface, users will interact with the Nodes. There are many cloud services that provide these feature.

In this project we have implemented using Blynk. Blynk is an IoT platform that connects the ESP32 boards logically with the cloud. Using the Blynk platform, users can configure buttons to control the respective ESP32 boards.

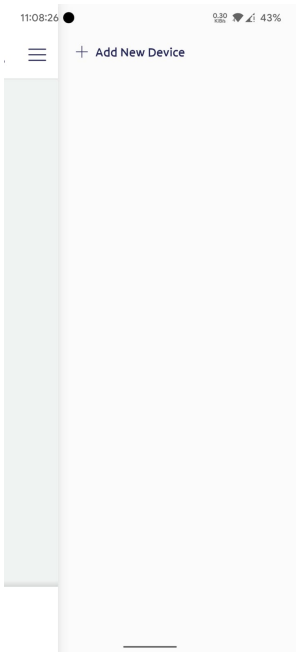

Figure 3.4: Add New device

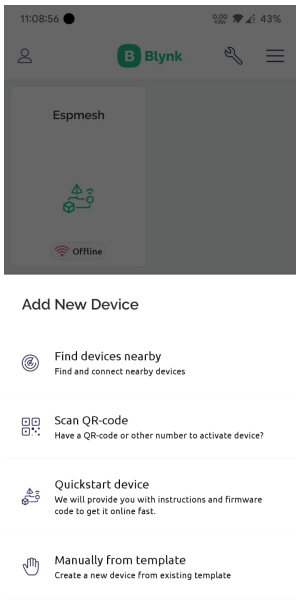

Figure 3.5: Manually create template

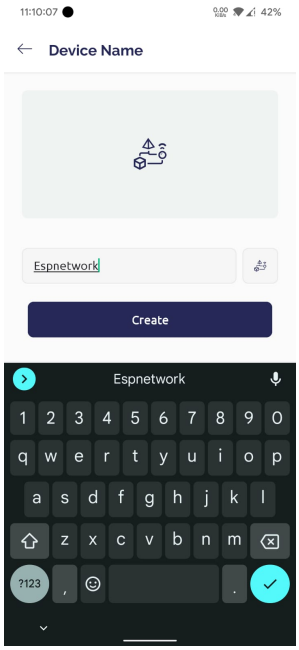

Figure 3.6: Name the template

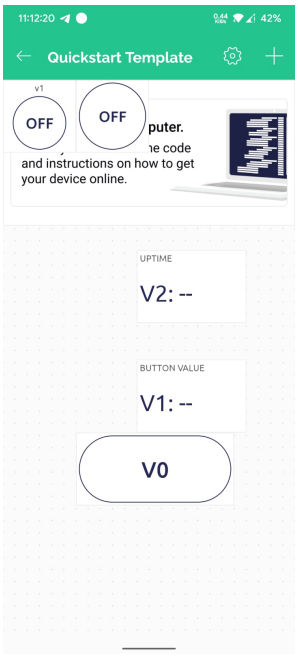

Figure 3.7: Edit the template

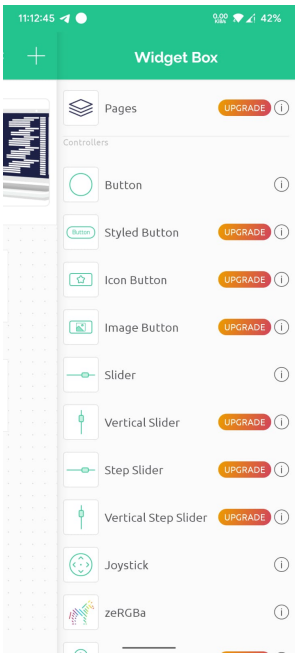

Figure 3.8: To add any widget, select any one and setup the connection

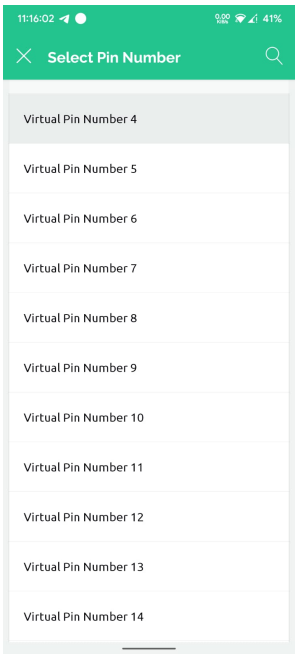

Figure 3.9: Select pin number and set default value to 0

Figure 3.10: This is the Dashboard View.

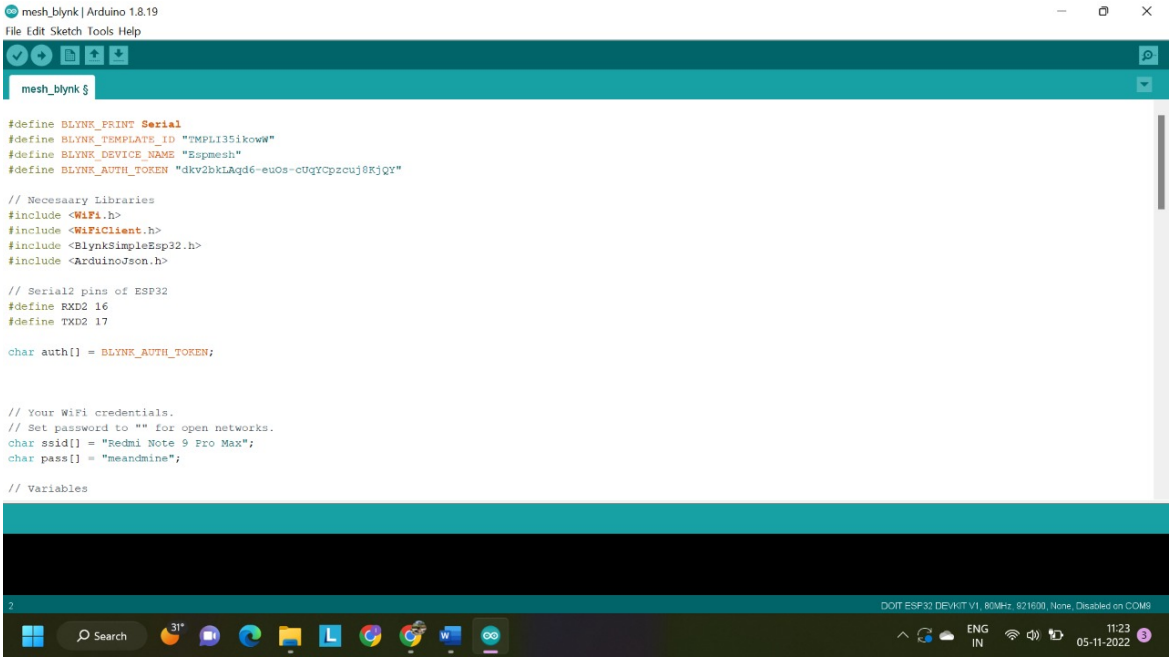

Figure 3.11: Add the unique blynk credentials in the code.

Chapter 4

Results and Discussions

As detailed in the above chapters, the implementation of the project is done using a number of ESP32 Nodes, Gateway Nodes, External relays connecting all of these through a Cloud Service, from where a User can control the different Motor Starters.

4.1 Ground Test 1

During the Test conducted in our college premises, we have noted certain readings as mentioned below.

The ESP32 Nodes are currently giving an operational range of about 30 meters in semi-open conditions. Although we have noticed a delay of 6 seconds for the relay to perform the control actions.

Chapter 5

Conclusion and Future Work

5.1 Conclusion

With the prototype that is ready with us for demonstrating the work done so far, we have concluded a few learnings and future works that would be necessary to be incorporated within our project for better enhancement of the features and functionality of the project.

In this semester, we have studied in detail about various technologies that can be used to implement the project. Through various discussions with our guides and subject expert teachers we have finalised our technology as WiFi based MCU. On the basis of this conclusion we have further tried to implement a prototype of our product that very closely resembles all the working of our actual product. This includes the MeSH Network and Gateway nodes configured, as well as the Cloud Service Used that can be used as is or a different Cloud service can also be implemented as a future work.

5.2 Future Work

In the process of developing the prototype for our project, we have come to the realization regarding a number of future implementation that can be done on our existing project framework to exponentially enhance the use case of our project.

This mainly includes the integration of Cloud Service with more number of various Sensors that can be implemented in the Farm so as to enhance as well as streamline the farming process. Various sensors such as Dissolved Oxygen (DO) Sensor if installed can open up numerous possibilities of streamlining the farming process. With the

installation of a DO sensor, a farmer can essentially acquire the data of the Oxygen Levels in the pond from his/her mobile application. With the collection of this data for a long period of time along with other parameters such as density of the culture, and various other things, a completely automatic system can be implemented. Which on the basis of the Sensor readings would automatically prompt the ESP32 Nodes to switch ON/OFF the motor starters. This would completely eliminate the need to look after the DO levels of the pond, which would free up more time for the farmers to concentrate on other aspects of growing higher yield culture.

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