Department of Computer and Communication Systems Engineering

Faculty of Engineering

Universiti Putra Malaysia

43400 UPM Serdang Selangor

COMPUTER & COMMUNICATION SYSTEM DESIGN PROJECT ECC4947

SMART FISH FARMING WITH IOT (FISH.NET)

FINAL REPORT

GROUP 3

Coordinator		
Dr. Nadiah Husseini Zainol Abidin		
Supervisor		
Assoc. Prof. Dr. Makhfudzah Mokhtar		
No.	**Group Member**	**Matric Number**
1	Ahmad Izzul Fakri Bin Jimi	197708
2	Muhammad Firdaus Bin Mazlan	196928
3	Najiha Binti Ramlan	197705
4	Nurul Aqilah Binti Muhammad	197782
5	Muhammad Zaki Bin Luhur Bambang Subiantoro	198772

TABLE OF CONTENTS

1.0 Executive Summary

This project is a new idea for this Integrated Developed Project which the main focus is on the agriculture industry. The project called Smart Fish Farming with IoT will maintain the water quality of the pond and monitor the water level of the fish pond. In this project, several systems have been proposed before starting to be implemented in the prototype. After the consultation of clients in the fish industry the finalised function of the system has been made. In order to make a system that will be reasonable and acceptable, some functions were revised a lot. The focus of this semester is to deliver a negligible rational product and system capable of performing fundamental functionalities of the proposed title. The engineering-oriented capstone design of computer and communication systems engineering is the most important part of project design, which includes market research, project preparation and implementation, modelling and simulation, cost estimation, prototype fabrication, and testing.

The purpose of this Integrated Developed Project is to help the fish farmer owner that faces challenges in producing a quality fish to be marketed. It is also to assist them in monitoring the fish pond and also maintain the water quality that can produce a better fish. Thus, it can prevent the fish from any disease that happens because of the dirty water or a bad lifestyle. The automated system is useful as it will automatically take an action toward the problem such as pH being too acidic.

The project began with surveys and interviews with clients in the fish farm industry. The targeted clients are the one who produces fish that can be eaten by humans and the production is on a large scale. The interviews help in checking on our objectives and function of the system to ensure that the work is on the necessary functionality that could be suitable for the user. It determines the most appropriate response approach that can be connected to aspects such as the fish pond environment and characteristics of water quality that fish should be living on. It ensures in achieving customer’s expectations, increase the profit and strengthen the product’s satisfaction in the market by gaining the real customers' feedback. There are a total of three clients that have been approached for this project which are, Taman Pertanian Universiti (TPU, UPM), AR Aqua and The Aquaculture Research Center (The ARC, Sungai Buloh). The team was able to gain a better understanding of market demand by engaging with the genuine clients. As a result, the quality of our products and, more significantly, the satisfaction of our customers are increased.

2.0 Problem Statement

In this Industrial Revolution 4.0 era, the fish farming industry struggles to become more environmentally friendly and moving toward the automatic system function. Most fish farming companies in Malaysia are using a manual system such as checking the water quality by using the sensor by themselves. This will take too much time and drain the worker's energy because the output for each function is different. The worker will need to do a lot of tasks in order to maintain the water quality for the fish pond. These problems also can reduce fish quality because there will be human error during checking the water quality and it will affect the growth of the fish. A lot of workers maintain the water quality just based on their own measurement and no specific value. They only see the changes of water by themself such as using their own hand to check the water temperature, which is not really appropriate and will lead to wrong action. The data challenges include different data formats, units of measurement and collection of techniques. Maintaining the fish pond is important because it can affect the productivity and quality of the fish. Thus, the aim of this project is to design a system that can automatically control the water quality of the ponds. It can ensure the accuracy of the action taken such as when the water is too acidic, the sensor will detect the quality of it and the system will try to adjust the water pH by automatically channelling the solution base to the water.

Next problem, the fish industry is also facing a lack of manpower to handle the pond at the one place. This happens because the workload such as feeding the fish and cleaning the fish tank at the same time is too much for human beings. If the companies used to save the data of the pond, the worker will need to jot down all the changes of information at one time. All three clients that have been approached were saying that they don't have enough manpower to do the task at fishponds. In Malaysia, the government does not give the attention to the fish industry as it is needed. This actually can boost the country's economy if there is good fish production. There is also a hope that fish farming would help provide the protein needs of world populations through locally produced products. The proposed system by our group can solve the problem of collecting and displaying the data. A coding system will be developed. One website will be collecting and displaying the data taken every time. This can cut the cost for the fishpond owner where a manual method used a lot of paper and other things. The project also can reduce the workload of the worker as they don't need to fully take care of the fishpond. This is because there is an automated system that will maintain the water quality and a same system that can monitor it. Moreover, the system can also provide the right value to the preferences such as pH and temperature. This can help to maintain the fish quality as the water was in good condition. Lastly, fish farming is an important industry that needs to be taken seriously as it can give many benefits to the people, country and the world.

3.0 Project Aim and Objectives

Below is the list of the project aim and objectives,

i. To create a better fish pool function that helps the fishpond owner and aquatic planters for them to monitor their pond.
ii. To create better environment that will produce high quality fish by maintaining the behaviour of the fish and the water condition.
iii. To improve the productivity of the fish by reducing the rate of the death of the fish.

4.0 Scope and Limitation of Project

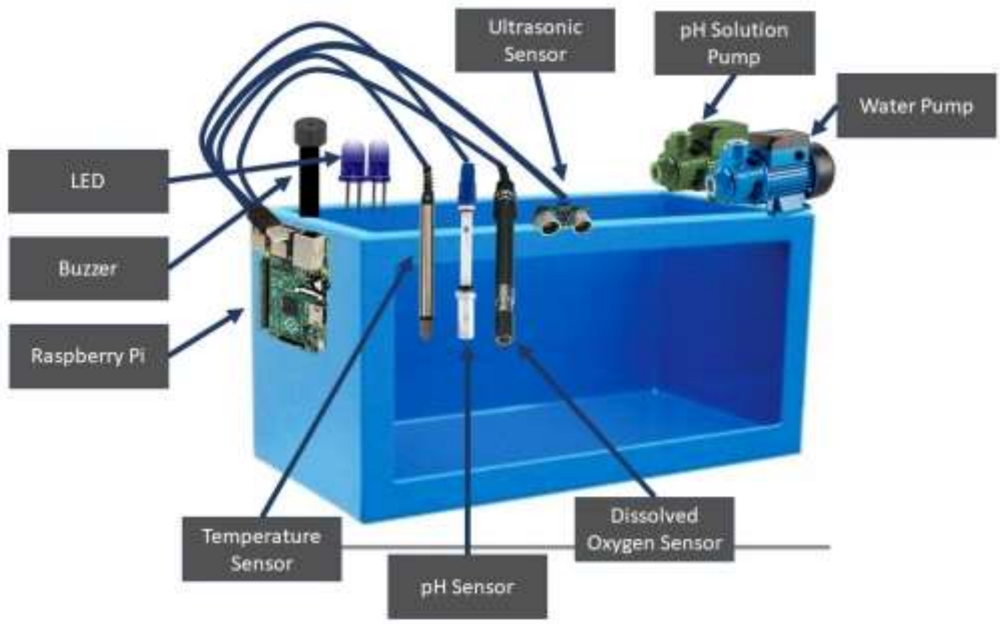


Figure 1: The proposed prototype of Fish.net

Figure 1 shows the proposed prototype of the Fish.net system that has been deliberate for the project. Initially, Fish.net will use a Raspberry Pi 3 as the microcontroller for the heart of the project. The sensor such as pH sensor, temperature sensor, dissolved oxygen sensor and ultrasonic sensor will be embedded to the Raspberry Pi board. The system features were to maintain the water quality and to monitor the fishpond. It will ensure a better growth rate for the fish as they live in an optimum environment. Moreover, the system will reduce the death rate of the fish in one pond. pH, temperature and dissolved oxygen sensor will be used to observe the water quality that is good for the fish to live on. The ultrasonic sensor will be used also for detecting the water level of the pond. This is to prevent the predator that will eat the fish. All the data collected from the sensor will be displayed on the website. This is to ensure that the user which is the fish pond owner is aware of the changes of their pond quality.

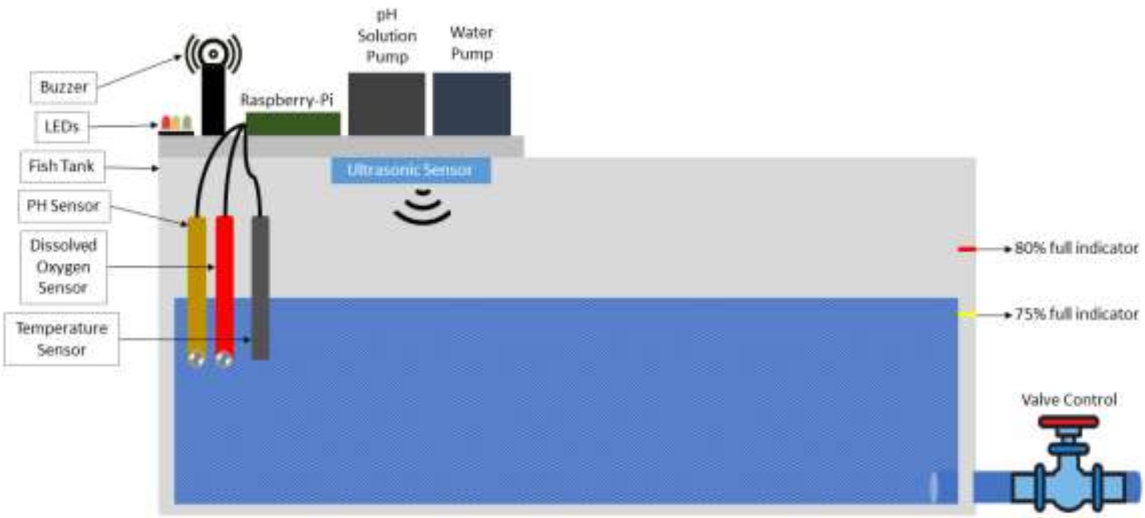


Figure 2: Initial sensors and components placement for fish tanks.

Figure 2 above shows the initial design placement standard for sensors and components. For the liquid sensors (temperature, pH and dissolved oxygen level sensor), the position is the most strategic since it provides the most exposure for the probes to be submerged in water and provides a clear reading. For the ultrasonic sensor, it is the best for it where the position is directly facing the fish tank's water surface, giving a straightforward reading of distance from the sensor to the water surface. Next, the electric water pump and pH solution pump are positioned above the tank to channel the tap water and pH solution automatically. Lastly, the LED and buzzer are placed on the top of the fish tank as output and indicators of the tank's situation; thus, the user can clearly see and hear the alarm.

There are some limitations during the development of Fish.net. First, Raspberry Pi 3 was replaced with Arduino as the microcontroller in order to convert analog to digital by transferring data using Wifi protocol through Node MCU to be displayed on Blynk. Next, dissolved oxygen feature was discarded because dissolved sensor is expensive which it exceeds the budget for this project. Initially, this project includes automatic fish feeding system based on information gained from clients but this feature was excluded due to lots of calculation and observation depends on the fish weight and behaviour involved which required someone that experts within the fish farming field itself since we want to ensure the system fully achieve clients' expectations and gives benefits in a long term.

5.0 Solution and Significance of Project

The significance of this project is to prove that it can significantly improve the quality of the fish farmers' management in terms of their business as well as their problems accordingly. The use of smart fish farming systems is still new in Malaysia as there are not many people exploring and commercialising this system. Most fish farmers use traditional or manual methods to monitor the condition of their fishponds in terms of water quality as well as water level, and this method necessarily uses manpower, which is one of the main problems faced by all fish farmers. By applying an automation system to the fishponds, it can reduce the amount of manpower used in the fishponds, hence providing benefits to the fish farm owners. Therefore, Fish.net provides a solution to the problem by providing a smart fish farming system with IoT, which uses technology to measure the parameters needed to maintain optimal performance pond conditions and provide a response to be taken if the pond is not in optimal condition.

The water quality of the fishpond is an essential factor that needs extra care in order to produce good quality fish to be sold on the market. There are many indicators of water quality: dissolved oxygen, pH, temperature, salinity, and ammonia [17]. Furthermore, the quality of the water has an impact on the health of the fish, as both are related to each other. If the water quality is poor, the health of fish will be significantly lower, thus increasing the rate of death of the fish. So, this system provides the water quality maintenance and monitoring features that focus on the pH as well as the temperature of the fishpond.

In addition, the water level of the ponds also has a significant impact on the fishponds. As long as the water level is maintained at its optimal level, it can reduce the presence of predators in the pond that eat fish. So, the system also provides a water level maintenance and monitoring feature to detect the water level of the ponds and give feedback if the water level is below or above the appropriate level.

The aim of this project is to implement a smart fish farming system in fishponds by applying water quality maintenance and monitoring, which involves pH and temperature, as well as the maintenance and monitoring of water level. The target users are the personal fish farmers and the company that is involved in providing fish farming equipment. The main objective is to create a better fish pool function that helps the fishpond owner and aquatic planters monitor their pond.

In summary, this project can provide value to the economy by reducing the use of money to pay salaries and being able to solve the problems faced by fish farmers, namely the lack of manpower. In addition, this project has opened up employment opportunities for young people in the country in exploring fishing-related technologies and improving this nation's technology and economy. Overall, this project can go into the market and, with some improvement, this project can be developed to have a huge impact on the fish industry in Malaysia.

6.0 Market Review and Client Validation Summary

Aquaculture in Malaysia has grown rapidly since its inception in the 1920s and is now a significant industry. A variety of cultural practices are employed. The most common type of aquaculture is brackish water, but there is also freshwater pond aquaculture and marine aquaculture. Shellfish, freshwater species, and marine finfish are among the many species farmed. Aquaculture is becoming increasingly essential as a means of enhancing local production and export revenue. In the government's most recent policy program for 1998-2010, the sector has been designated as a priority area. The goal is to boost aquaculture productivity by 200 percent by 2010.

Aquaculture is being prioritized for research due to its value as a fish supply option. Aquaculture as a rapidly expanding industry has the potential to make a significant contribution to food security. However, land acquisition issues, growing production costs, a scarcity of competent labour, and the possibility of disease are all impediments to aquaculture's growth. With technology advances, there has been a lot of innovation and technology developed recently geared toward the longevity and sustainability of the industry.

Below are some of the innovative technologies developed within the aquaculture industry that are similar with proposed system:

1. Fish Farming Facilities
   Automation system is customized to the client's specific needs. The system is developed by ABB and it is available within 100 different countries. The price differs based on the function since they offer a comprehensive range of traceability in integrated systems to ensure optimal performance with reduced risk and costs. Clients can connect with the system to assure safety, security and productivity through remote condition

monitoring and predictive analysis. Besides, a state-of-the-art communications system can be implemented to ensure everyone is on the same page in real time. Using an array of sensors, predictive maintenance and comprehensive environmental management are enabled to track parameters essential for maximum performance in real time.

2. HydroNeo Smart Aquaculture

   A smart shrimp management system that monitors and controls shrimp farms for higher productivity and less risk with aqua IoT technology. It is accessible only in two countries, Thailand and Germany. The system costs RM 8899.71 where it is constructed by HydroNeo. With this system, water quality can be monitored remotely and constantly using alarms and notifications through mobile phones in real time measurements of parameters dissolved oxygen, temperature, pH and energy consumption. Based on smart water quality algorithms from real time sensor data, the aerator can be controlled automatically via app and it will be activated after the siren alarm.

3. SENECT Aquaculture Technology

   It is a modular structure of the IoT aquaculture control system technology that consists of IoT control units that process the measured data and trigger relevant actions from sensors that measure water quality parameters and actuators which will carry out those actions such as valves, filters or automatic feeders. The system is connected to SENECT Control App which enable users to monitor sensor readings such as oxygen and water level in real time on a smartphone, tablet or PC, or interact in a controlled way. Other than that, the system has feeding automation, aeration and filter control, pump monitoring and temperature control. Due the system's standardised structure, it is easy to equip all sizes of aquaculture facilities and perform quick and straightforward alterations or conversions. Its modular architecture also makes it possible to control fish farming systems with a high degree of safety and cost-effectively.

Apart from that, three potential clients are being interviewed within the aquaculture industry, specifically fish farming about the technology used or involved in their farms. The first client is Taman Pertanian Universiti (TPU) UPM located in Puchong, Selangor. The second client is Mr Razak, an owner of AR Aqua in Pekan Nanas, Johor and the third client is Aquaculture Resource Centre (ARC) from Sungai Buloh, Selangor. Information received from the interviews are listed in the table below:

Table 1: Clients' problems and requirements specification.

Clients	Problems	Requirements
TPU UPM Puchong	• Lack of manpower. • Harvest fish using nets. • Check water quality manually. • Presence of fish's predators.	An automatic fish farming system to monitor water quality.
AR Aqua	• Lack of manpower. • Difficulty to control fish disease. • No high technology causes lack of accuracy in controlling water and fish quality.	A system to control water quality, pressure, temperature and pH value in order to avoid fish diseases.
ARC Sungai Buloh	• Lack of manpower. • Poor water quality and low water temperature causes a high death rate of fish. • Check fish condition manually.	An automatic system to clean the fish and control water quality.

From the information above (Table 1), it can be concluded that all of the clients are having problems with manpower in handling their pond as well as hassle to monitor water quality. Most of the routines are done manually without developed technology that leads to inaccuracy and difficulty in controlling the fish and water condition.

Based on the market research conducted, aquaculture technology has developed rapidly in the previous fifty years. They vary from very basic facilities in tropical nations such as family ponds for local consumption to high-tech systems such as intense closed systems for export production. Much of the technology used in aquaculture is relatively simple and is frequently focused on small changes that increase the target species' growth and survival rates such as improving the food, seeds, oxygen levels and predator protection. However, Malaysia still has a shortage of aquaculture technology with the information gained from the potential clients although it is ranked in 18th place in the world based on data in 2016 for the highest aquaculture production where new technology must be developed or current technology needs to be improved within the aquaculture industry.

7.0 Final Product Design

This part discussed Smart Fish Farming with IoT (Fish.net) hardware setup, software setup and prototype design and functionalities.

7.1 Hardware Setup

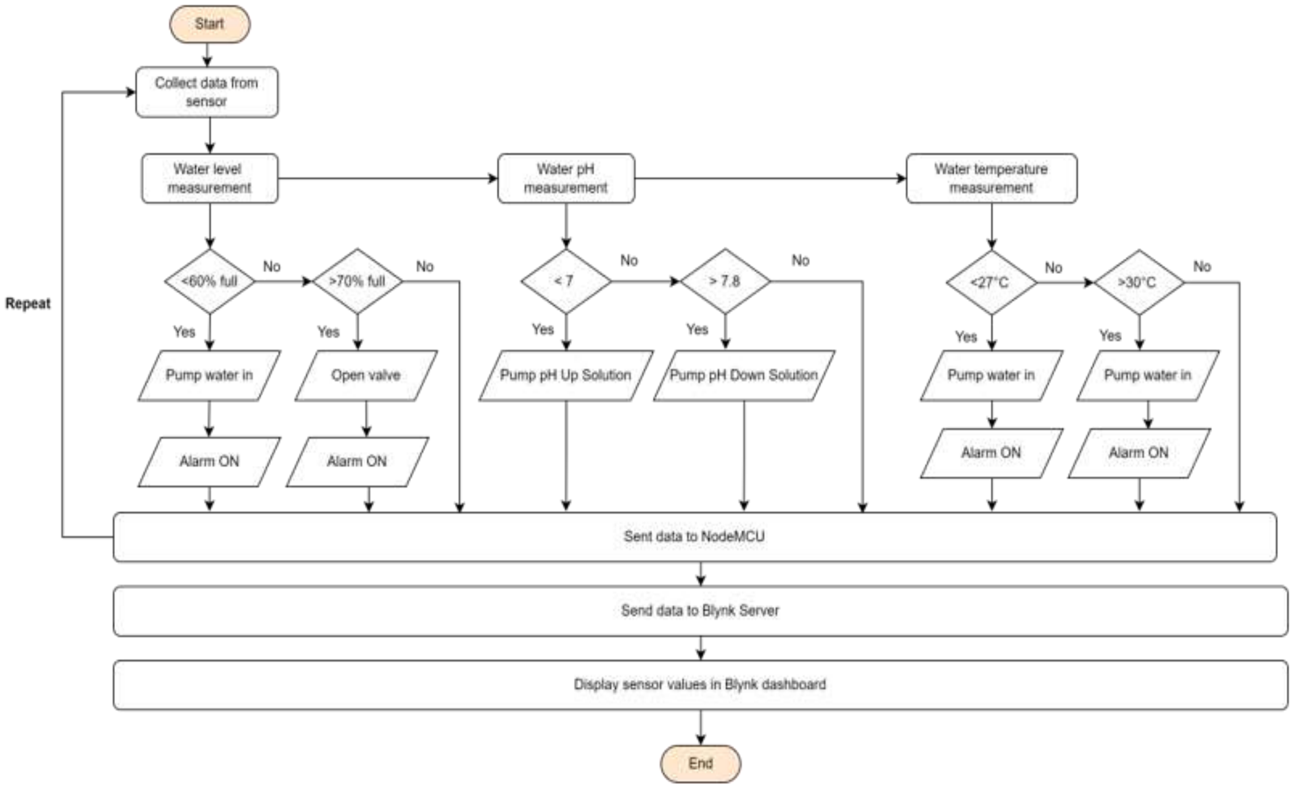


Figure 3: System flowchart.

Figure 3 shows the system flowchart for this project. The system started with the sensors collecting data from the sensor. After getting the data, water level, pH and temperature measurements will be measured at the same time. For water level measurement, if the water level was less 60%, the water will be pumped into the fish tank and the alarm will be on. When the water level was more than 70%, the valve will be opened for the water to flow out. At the same time, the alarm was on. In measuring the water pH, if the pH was less than 7, the pH up solution will be pumped. Meanwhile, when the pH above 7.8 the pH down solution will be pumped to stabilize the water pH value. The third sensor was water temperature sensor. Temperature lower than 27°C will cause the water to be pumped into the fish tank. The alarm was on. If the temperature exceed 30°C, the water will be also pumped and the alarm will be on. The data collected was sent to NodeMCU and to the Blynk server. Finally, the values were displayed in Blynk dashboard.

7.2 Software Setup

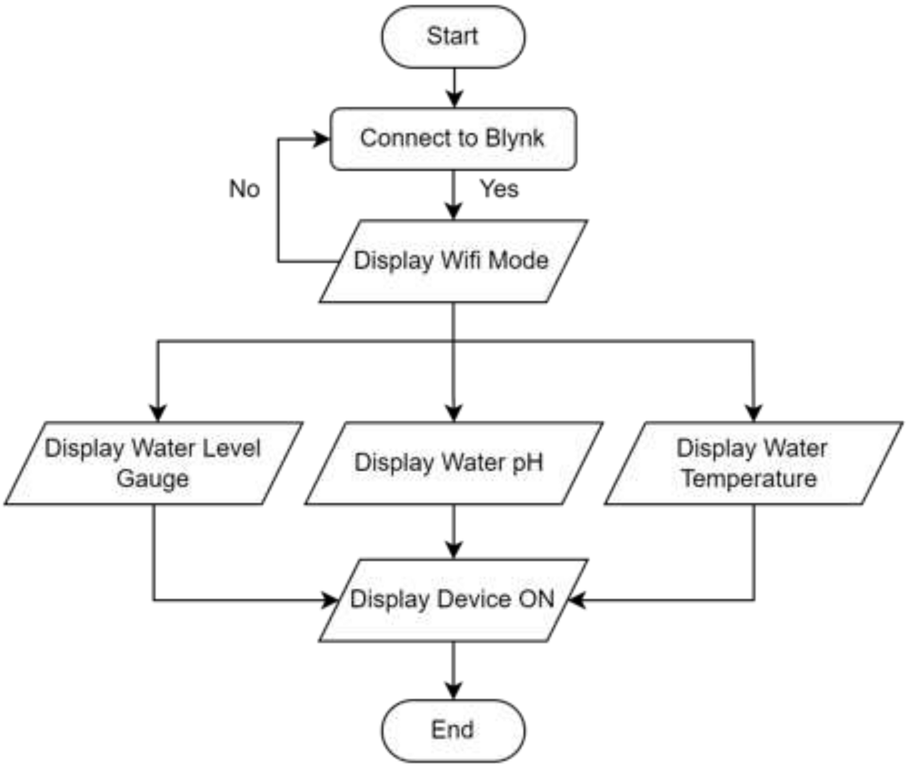


Figure 4: Blynk system flowchart.

For the Blynk system flowchart, it was started with connect to Blynk. After connecting the Blynk, the Wi-Fi mode will be displayed. Water level gauge, water pH and water temperature collected from NodeMCU will be displayed simultaneously. Finally, the ON device was displayed. This is shown in Figure 4.

7.3 Prototype Design and Functionalities

Figure 5: Prototype design of the system (Fish.net).

Figure 5 shows the prototype design of the system (Fish.net) to be implemented in real life situation. The prototype consists of Arduino Uno, NodeMCU, valve, pH sensor, water temperature sensor, ultrasonic sensor, buzzer, water tank, pH up solution and pH down solution. All these components and materials were necessary for the successful implementation of the system (Fish.net).

First, Arduino Uno act as a microcontroller for this project. It will collect data from the sensor to be sent to NodeMCU and then Blynk server. NodeMCU act as a Wi-Fi module to connect the system with the Blynk server. The three main sensors in the system were ultrasonic, temperature and pH sensor. Ultrasonic sensor detects any changes in water level. When the water level was low, the water pump will pump the water from the water tank into the fish tank and the alarm will be on. However, when the water level exceeds the optimum water level, the valve was opened and the water flow through the valve. The alarm was also on. This function was to make sure that the fish in best environment with sufficient water level. The data obtained was sent to Blynk server. From the application, the user can identify the current water level in the fish tank. The buzzer will make the user to be more aware of the water level in the fish tank.

Next, when water temperature sensor detects low and high temperature, the system collected the data and provide the feedback in the fish tank. When the water temperature was low, the water was pumped into the fish tank to stabilize the water temperature. Same goes to when the temperature was high. The optimum water temperature for the fish tank was between 27°C to 30°C. From this, the behaviour of the fish and the water condition can be maintained. The user can also monitor the water temperature from the Blynk application the data was also sent to Blynk server. The buzzer was also as extra feature to alert the user regarding the water temperature.

When the water pH value changed, the pH sensor detected the value of the current water pH. If the Ph was low, pH up solution was pumped into the fish tank. Otherwise, the pH down solution was pumped. Same as other sensors, user can determine the current pH value in the fish tank.

From all these features, a better environment for the fish was created. This will improve the productivity of the fish by reducing the rate of the death of the fish. At the same time, high quality fish can be produced by maintaining the behaviour of the fish and the water condition.

8.0 Data Collection Method and Result

This section consists of the data collection for method and the result obtained.

8.1 Method and Considerations

Table 2: Decision making for system.

Sensor	Condition	Action/Output
Ultrasonic	<60%	Alarm ON + Pump Water On (Water Pumping In)
	60%-70%	Optimal (No Action Taken)
	>70%	Alarm ON + Valve On (Water Pumping Out)
pH	<7.0	pH Up Solution Pumping In
	7.0-7.8	Optimal (No Action Taken)
	>7.8	pH Down Solution Pumping In
Temperature	<27°C	Alarm ON + Pump Water On (Water Pumping In)
	27°C-30°C	Optimal (No Action Taken)
	30°C	Alarm ON + Pump Water On (Water Pumping In)

Table 2 shows the condition for the test methodology. For the ultrasonic sensor, the water level in the fish tank was changed to obtain different water level. The test was done by using solenoid valve to pump in and out the water into the fish tank. As the water level changes, ultrasonic sensor was used to determine the current water level. The value obtained in the serial monitor was compared with the Blynk server monitor.

Next, pH sensor. This sensor was tested using the several different solutions. The pH solution was pumped inside the fish tank based on the current pH value. If the value was high, pH down solution was pumped and vice versa. The output value in Blynk indicates the accuracy of the pH sensor to detect any changes of pH in the fish tank. For the accuracy test purpose, the sensor was tested in three different solutions (soap water, lemon water and plain water). The results were compared with the real value from reliable website.

Finally, the temperature sensor was tested in the different water condition that is below and above the optimal value (27°C to 30°C) and the value in Blynk software was compared with the value displayed by serial monitor in Arduino.

8.2 Results

Demo video link: https://youtu.be/eM6BHVdnzvU

In this part, the result from the prototype was recorded and shown. The prototype was built for a smaller size due to the budget problem. Firstly, Figure 6 shows the plastic container that was filled with pH up and down solution. The tube was connected to the tank and there is one pump place inside each container. The tube will supply pH up and down solution to the fish tank to neutral the water pH.

Figure 6: Water pump for pH up and down.

Next, Figure 7 shows the valve that is connected to the tank. It supposedly supplies the water out of the tank straight to the drainage system. The valve will open automatically when the water level exceeds the normal level. The valve will open for sometimes and the system will recheck the water level and if the water level of the tank still not below the normal level, the valve will turn on.

Figure 7: Valve.

Figure 8 and 9 show the sensor that will be collected the value for the system. All sensors are pH, temperature and ultrasonic sensor. As in Figure 8, both pH and temperature sensor were embedded in the tank. This is because the probe sensor needs to touch the water in order to get function. PH sensor will detect what is the pH value for the water and temperature sensor will sense how cold and hot the water is to make sure the water quality is in good condition. Figure 9 show that ultrasonic sensor that face to the water tank. This is to let the sensor give the value of the sensor to the top of the water quantity. Then the value will be insert in the formula to get the value of the water level in percentage.

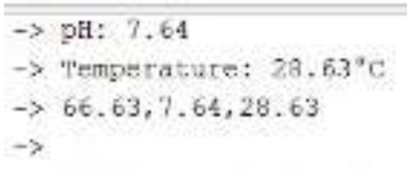
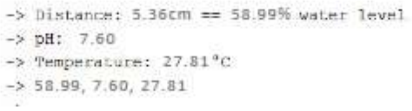
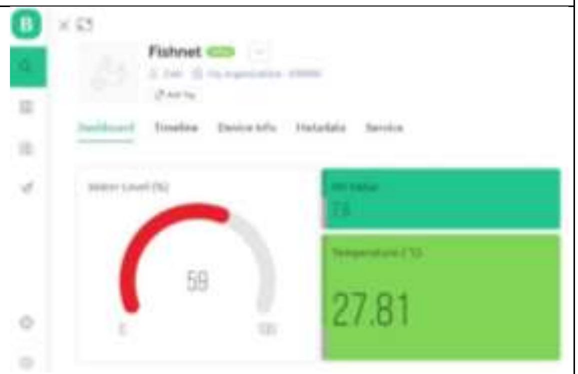
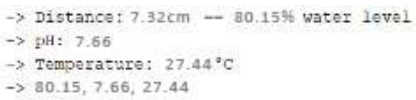
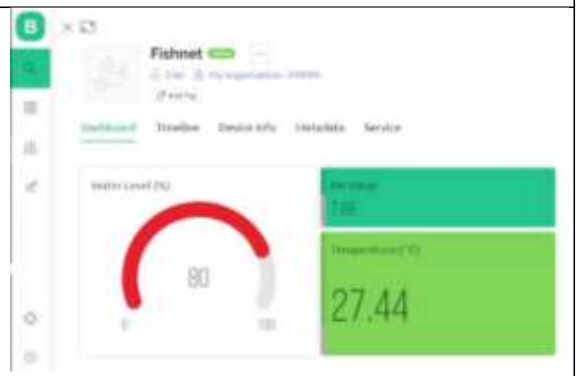
Figure 8: pH and temperature sensor.

Figure 9: Ultrasonic sensor.

Figure 10 below shows the water tank with pump. Pump was embedded inside the water tank to dispense the water inside the fish tank to provide suitable feedbacks based on the conditions of the system.

Figure 10: Water tank with pump.

Table 3: System functions and accuracy result.

Conditions	**Serial Monitor**	**Blynk Application**
Optimal fish tank Water level: 60% - 70% Water temperature : 27°C - 30°C pH value: 7.0 – 7.8		
Low water level (<60%)		
High water level (>70%)		

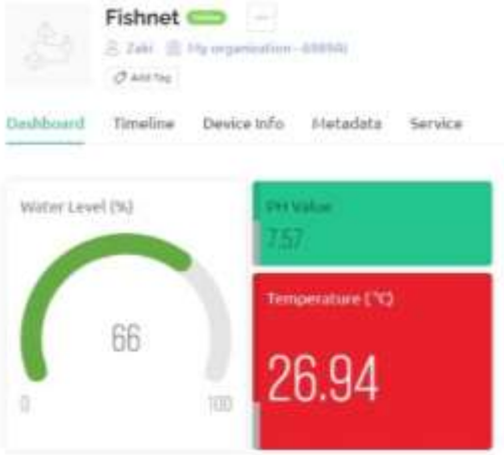
Low temperature (<27°C)	-> Distance: 6.02cm == 65.96% water level -> pH: 7.57 -> Temperature: 26.94°C -> 56.96, 7.57, 26.94	
High water temperature (>30°C)	-> Distance: 5.67cm == 62.11% water level -> pH: 7.57 -> Temperature: 32.31°C -> 62.11, 7.57, 32.31	
Low pH value (<7.0)	-> Distance: 5.83cm == 63.87% water level -> pH: 6.87 -> Temperature: 30.31°C -> 63.87, 6.87, 30.31	
High pH value (>7.8)	-> Distance: 5.83cm == 63.87% water level -> pH: 7.88 -> Temperature: 30.19°C -> 63.87, 7.88, 30.19	

Table 3 shows the system function and the accuracy result. From the table, it shows that the values displayed on the Blynk software were corresponding to the values detected by Arduino in serial monitor.

8.3 Performance Test/Validation

Table 4: System functions performance test.

Sensor	Condition	Action/Output	Validation
Ultrasonic	<60%	Alarm ON + Pump water ON (Water pumping in)	√
	60% - 70%	Optimal (No action taken)	√
	>70%	Alarm ON + Valve ON (Water pumping ou)	√
pH	<7.0	pH up solution pumping on	√
	7.0 – 7.8	Optimal (No action taken)	√
	>7.8	pH down solution pumping in	√
Temperature	<27°C	Alarm ON + Pump water ON (Water pumping in)	√
	27°C - 30°C	Optimal (No action taken)	√
	>30°C	Alarm ON + Pump water ON (Water pumping in)	√

Based on the results that were discussed, the system fulfils the objectives of implementing the project as all the sensors and software work perfectly fine. First, to create a better fishpond function that helps the fishpond owner and aquatic planters for them to monitor their pond. Second, to create better environment that will produce high quality fish by maintaining the behaviour of the fish and the water condition. Lastly, to improve the productivity of the fish by reducing the rate of the death of the fish.

Although the several functions were reduced due to clients need and limited budget, the system was still designed to give long term benefits to the user. Overall, the system provides suitable feedback and functions that can be used in fishpond.

9.0 Project Costing and Potential Profit

This section consists of the project costing and the potential profit of Fish.net.

Table 5: Costing.

	Cost Estimation			Cost Selling	
Project Work Element	**Unit Price (RM)**	**Unit**	**Total Price (RM)**	**20% Profit (RM)**	**Selling Cost (RM)**
Arduino Uno	25.00	1	25.00	5.00	30.00
Nodemcu Esp8266	14.40	1	14.40	2.88	17.28
PH Sensor	29.03	1	29.03	5.81	34.84
Ultrasonic Sensor	3.30	1	3.30	0.66	3.96
Alarm/Buzzer	2.00	1	2.00	0.40	2.40
Temperature Sensor	4.90	1	4.90	0.98	5.88
Water Pump	4.50	2	9.00	1.80	10.80
5V Water Pump	10.00	1	10.00	2.00	12.00
Water Tube 2m	4.00	1	4.00	0.80	4.80
4 Channel Relay Module	20.00	1	20.00	4.00	24.00
Breadboard	3.50	2	7.00	1.40	8.40
Jumper	3.70	3	11.10	2.22	13.32
Solenoid Water Valve 12V DC	30.00	1	30.00	6.00	36.00
Valve Connector	1.00	2	2.00	0.40	2.40
12V DC Adaptor	12.00	1	12.00	2.40	14.40
Adaptor Screw Convertor	3.00	1	3.00	0.60	3.60
Ph-Up Solution	10.90	1	10.90	2.18	13.08
PH-Down Solution	10.90	1	10.90	2.18	13.08
Total Direct Cost			208.53	41.71	250.24

Overhead Cost			42.80	8.56	51.36
Total (Overhead + Direct)			**251.33**		
G&A Overhead Cost (20%)				**50.27**	**301.60**
Contract Bid Summary				**60.32**	**361.92**

Table 5 shows the overall project costing used to in the project Fish.net. It includes details of project work elements such as the list of components used as well as the price and quantity required, total direct cost, overhead cost, overall cost, general and administrative and total bid. The table also shows the details on the 20% cost selling for each project work elements.

9.1.1 Contract Bid Summary

Table 6: Contract Bid Summary.

Direct Cost	RM 209
Overhead Cost	RM 43
Total	RM 251
G&A Overhead (20%)	RM 50
Total Cost	RM 302
Profit (20%)	RM 60
Total Bid	RM 362
Services (30%)	RM 109

Table 6 shows the summary of contract bid. The direct cost of the prototype is estimated to be roughly RM 209, which includes the overhead cost of shipping and invoices; RM 43. The overall cost of the system is the sum of direct and overhead expenditures, which comes to RM 251. The 20% general and administrative overhead cost is deducted from the total cost of the system, which is around RM 50, resulting in an ultimate total of approximately RM 302. To obtain a 20% profit, RM 60 must be deducted from the entire total cost of one system sold. As a result, the total bid for the selling cost of the product system is around RM 362. The services price is 30% of the total bid which resulting of RM 109 per session.

9.1.2 Profit Gain Assumption

The profit gain of this product is predicted based on the target to install this Fish.net system in Taman Pertanian Universiti, TPU fishponds. From the contract bid summary, the profit for each Fish.net is around RM 60. In order to get the total profit gain, the calculation is as below:

$$Total\ profit\ gain = Number\ of\ Fish.net\ x\ profit\ for\ 1\ Fish.net$$

There are also services contract of the system required for each client. The services contract is for one year in where the calculation is 30% of the total system price per customer and the services will be started on the second months until 12 months and it can be extended accordingly. Hence, the profit of this system is mostly gain from the services.

10.0 Conclusion

Smart Fish Farming with IoT (Fish.net) would impact the clients in terms of manpower and accurate detection of water quality control. Currently, the clients manage the farms manually. For example, they determined the water quality by observing the behaviour of the fish. Now, Fish.net provides accurate data of the water quality from the sensors used in the system. Other than that, Fish.net will alert the workers if there are any changes in water quality condition. This will allow the workers to monitor the fish pond without going to the site. They can also monitor the changes in water quality from the website and phone notifications.

Fish.net would make a great impact in the agriculture industry especially in the fishery industry. As the government is moving toward industrial revolution 4.0, Fish.net is a good initiative that can be done to help the country achieve their goal.

In conclusion, Smart Fish Farming with IoT (Fish.net) should enable fish farmers to monitor the quality of their ponds and solve the problem of managing ponds with a lack of manpower. Both customer needs and specifications are directly linked to the system design. As an added benefit, it gives the necessary feedback to help enhance current processes.

10.1 Reflections and Recommendations

Smart Fish Farming with IoT (Fish.net) was developed successfully within the planned timeline and achieved the clients' requirements which it is able to counter the manpower in the company and water quality issues as the system is full automation. During the development process of Fish.net, it is quite critical for cost savings and maintaining the optimal fish environment. Unavoidable events such as hardware failure and code errors did occur however with some improvements made, the product works efficiently according to the aim and objectives of this project. Some recommendations and feedbacks were taken into consideration which are being discussed below.

In this project, ultrasonic sensor was used to measure the water level of the fish tank because it can give a real-time reading by providing a continuous level measurement using the ultrasonic wave. It is a reliable and cost-effective instrument for this application. To determine the distance to the water, it broadcasts a sound pulse that is reflected off the water's surface and measures the time required for the echo to return.

For Fish.net's automatic water quality control feature, the feedback pumped the water into the tank if the temperature and water level were not optimal. Therefore, the fish tank was set up and calibrated with the suitable water level percentage threshold, which is 60% until 70% full. The water in the fish tank will be channelled out using the solenoid valve if the water level exceeds the threshold. As a result, the ultrasonic sensor is chosen rather than other tools like the floating ball valve. It can give the measurement value to the microcontroller, including the IoT platform, to remotely monitor the tank. Furthermore, ultrasonic level sensors are also used to detect, monitor, and manage liquid levels in closed containers such as vats in chemical plants that require great accuracy.

To summarize the product requirements specification, most of the clients' requirements match the proposed solutions to the identified problems except for automatic fish feeding system as it suits human actions than systems.

10.2 Benefits of Project

Smart Fish farming with IoT (Fish.net) offers automatic water quality control systems and will notify the users through a website application and the beeping sound at the site of the implemented system. These automation systems are expected to increase the effectiveness of controlling the fish pond water quality and provide a better environment for the fish inside the pond. Other than that, this system will reduce the manpower needed for the process of handling the fish pond. Currently, most of the management done at the fish ponds is handled manually. For example, the process of monitoring, feeding, cleaning the ponds, harvesting, and controlling the water quality. These methods are inefficient because it requires a lot of manpower and time. For example, the workers need to be near the pond to monitor the fish and control the water quality. Although more manpower is needed to handle the fish, people do not seem to have an interest in working in the fish industry due to the workload.

By implementing Smart Fish Farming with IoT, the company of the fish industry can tackle the lack of manpower problem because everything will be automatic and the workers can focus on other scopes of work that do not require an automatic system. Next, the pH sensor, temperature sensor, and ultrasonic sensor implemented in the system will make things easier. The sensors will automatically detect the changes in the fish pond and adjust them according to the fish optimum environment. For example, the system will detect the pH value in the fish pond and after getting the value, the feedback system will be pumping the appropriate amount of solution into the fish pond. The system feedback information will be stored on the website for the users to monitor. This enables the user to be more aware, efficient in their work, reduce manpower and the workers no longer have to control the fish pond manually.

As a result, the system is able to make a fish pond more practical and efficient. In order to produce healthy and good fish, it is crucial for the fish pond to be handled with the best method. Workload planning and allocation are also critical components of ensuring an equal and transparent approach to assigning work activities to fish pond workers. The workers cannot have many workloads at the same time to avoid being overwhelmed. As the country is leading toward Industrial Revolution 4.0, more methods in helping the country build technology are needed. We must step forward and assist the government in developing a futuristic country. Simultaneously, this will assist the country's industry in becoming more efficient. The number of fish produced will also increase and can be sold locally and internationally at the highest standard.

11.0 References

[1] "How to achieve good water quality management in aquaculture," *Thefishsite.com*, Dec. 2021. https://thefishsite.com/articles/how-to-achieve-good-water-quality-management-in-aquaculture

[2] "What is the Internet of Things (IoT)?," *Oracle.com*, 2020. https://www.oracle.com/internet-of-things/what-is-iot/

[3] "Arduino vs Raspberry Pi: Differences between the two," *Circuit Digest*, Jan. 27, 2016. https://circuitdigest.com/article/arduino-vs-raspberryp-pi-difference-between-the-two

[4] "Working Principle of pH Meter," *Pharmaguideline.com*, 2021. https://www.pharmaguideline.com/2015/08/principle-and-working-of-pH-probes.html

[5] "DS18B20 Programmable Resolution 1-Wire Digital Thermometer." [Online]. Available: https://datasheets.maximintegrated.com/en/ds/DS18B20.pdf.

[6] "D.O. Meter using Analog Dissolved Oxygen Sensor & Arduino," *How To Electronics*, Nov. 2020. https://how2electronics.com/dissolved-oxygen-sensor-arduino-interfacing-tutorial/

[7] "Gravity TM Analog Dissolved Oxygen Meter Percent saturation only DO Meter V2.0 Gravity A + − V 1.1 PATENT PROTECTED." Accessed: Dec. 02, 2021. [Online]. Available: https://www.atlas-scientific.com/files/Gravity_DO_datasheet.pdf.

[8] "What is an ultrasonic / level sensor? | Sensor Basics: Principle-based Guide to Factory Sensors | KEYENCE," *Keyence.com.my*, 2021. https://www.keyence.com.my/ss/products/sensor/sensorbasics/ultrasonic/info/

[9] "How Does a Submersible Water Pump Work? | Homesteady," *HomeSteady| The ultimate guide for all your household needs.*, 2017. https://homesteady.com/13417771/how-does-a-submersible-water-pump-work

[10] "5V Single-Channel Relay Module," *Components101*, 2020. https://components101.com/switches/5v-single-channel-relay-module-pinout-features-applications-working-datasheet

[11] "How to use a buzzer in arduino," *Ozeki.hu*, 2021. https://ozeki.hu/p_2977-how-to-use-a-buzzer-in-arduino.html

[12] "Documentation for Blynk, the most popular IoT platform for businesses.," Blynk.cc, 2021. https://docs.blynk.cc/

[13] ABB. (n.d.). *Fish Farming Facilities*. Retrieved from https://new.abb.com/food-beverage/segments/aquaculture/fish-farming-facilities

[14] HydroNeo. (n.d.). *HydroNeo Smart Aquaculture*. Retrieved from https://hydroneo.net/

[15] SENECT. (n.d.). *SENECT Aquaculture Technology*. Retrieved from https://www.senect.de/en/

[16] Food and Agriculture Organization. (2019). *Aquaculture production (metric tons) - Country Ranking*. Retrieved from https://www.indexmundi.com/facts/indicators/ER.FSH.AQUA.MT/rankings

[17] "Water Quality / Bioremediation", Biomin. [Online]. Available: https://www.biomin.net/species/aquaculture/water-quality-bioremediation/

[18] T. Site, "Tank culture of tilapia", Thefishsite.com, 2005. [Online]. Available: https://thefishsite.com/articles/tank-culture-of-tilapia#:~:text=The%20preferred%20temperature%20range%20for,by%20bacteria%2C%20fungi%20and%20parasites

[19] "Temperature and Low Dissolved Oxygen Tolerances for Tilapia", Mweafish.com, 2021. [Online]. Available: https://mweafish.com/aquaculture-articles/25-temperature-and-low-dissolved-oxygen-tolerances-for-tilapia.html#:~:text=Tilapia%20are%20able%20to%20survive,no%20fish%20mortality%20in%20tilapia.

Appendices A

Individual Contributions

Member	No. Matric	Contributions
Muhammad Firdaus Bin Mazlan	196928	- Project leader. - Contacting clients, writing Client Validation Report. - Writing project proposal, updating project progress in Jira - Developing prototype. - Prepare final report and final presentation slides.
Ahmad Izzul Fakri Bin Jimi	197708	- Writing Client Validation Report. - Writing project proposal, compile proposal, updating project progress in Jira - Developing prototype and code. - Prepare final report, compile final report and final presentation slides.
Najiha Binti Ramlan	197705	- Contacting clients, writing Client Validation Report. - Writing project proposal, updating project progress in Jira - Developing prototype, project cost. - Prepare final report, video and final presentation slides.
Nurul Aqilah Binti Muhammad	197782	- Contacting clients, writing Client Validation Report, compile CVR. - Writing project proposal, updating project progress in Jira - Developing prototype, claim form - Prepare final report and final presentation slides.
Muhammad Zaki Bin Luhur Bambang Subiantoro	198772	- Writing Client Validation Report. - Writing project proposal, updating project progress in Jira - Developing prototype and code. - Prepare final report and final presentation slides.

Appendices B

Arduino code

```
#include <SoftwareSerial.h>
SoftwareSerial nodemcu(2,3);
int data;

//pH Sensor
#define SensorPin 0          //pH meter Analog output to Arduino Analog Input A0
float avgValue;  //Store the average value of the sensor feedback
float b;
float buf[10],temp;
// for float value to string converstion
int f;
  float val; // also works with double.
  char buff2[10];
  String valueString = "";
  String Value = "";
  float phValue;

//Ultrasonic Sensor
#define echoPin 4 // attach pin D4 Arduino to pin Echo of HC-SR04
#define trigPin 5 //attach pin D5 Arduino to pin Trig of HC-SR04
// define variables (Ultrasonic Sensor)
long duration; // variable for the duration of sound wave travel
float distance; // variable for the distance measurement
String str;
float waterlevel;
float waterlevelValue;
String waterlevelValuestr;


// Arduino Water Temperature Sensor
#include <OneWire.h>
#include <DallasTemperature.h>
//define variables (Water Temperature)
const int SENSOR_PIN = 13; // Arduino pin connected to DS18B20 sensor's DQ pin
OneWire oneWire(SENSOR_PIN);         // setup a oneWire instance
DallasTemperature tempSensor(&oneWire); // pass oneWire to DallasTemperature library
float tempCelsius;    // temperature in Celsius
float tempFahrenheit; // temperature in Fahrenheit
float temperatureValue;
String temperatureValuestr;
//Buzzer
const int buzzer=12;

//WaterPump
const int waterpump = A5;  // the Arduino pin, which connects to the IN pin of relay
```

```
//phup
const int phup = A4;

//phdown
const int phdown = A3;

//solenoid
const int valve = A2;

//LED
const int red_led = 8;
const int green_led = 9;
const int yellow_led = 10;
const int blue_led = 11;

String cdata; //complete data, consisting of sensors value

void setup()
{
  //pinMode(13,OUTPUT);
  Serial.begin(9600);
  nodemcu.begin(9600);

  //Setup for ultrasonic
  pinMode(trigPin, OUTPUT); // Sets the trigPin as an OUTPUT
  pinMode(echoPin, INPUT); // Sets the echoPin as an INPUT

  //Setup for temp sensor
  tempSensor.begin();    // initialize the sensor

  //Setup buzzer
  pinMode(buzzer,OUTPUT);

  //Setup waterpump
  pinMode(waterpump, OUTPUT);

  //Setup phup
  pinMode(phup, OUTPUT);

  //Setup phdown
  pinMode(phdown, OUTPUT);

  //Setup valve
  pinMode(valve, OUTPUT);

  //Setup LED
  pinMode(red_led, OUTPUT);
  pinMode(green_led, OUTPUT);
  pinMode(yellow_led, OUTPUT);
  pinMode(blue_led, OUTPUT);
```

```
}

void loop()
{
  ultra();
  ph();
  temperature();

  cdata=cdata +waterlevelValuestr+ "," +valueString+ "," +temperatureValuestr;
 Serial.println(cdata);
  nodemcu.println(cdata);
  delay (1000);
  cdata = "";
  Serial.println ("");

  manual();
}

void ultra() {
    // Clears the trigPin condition
  digitalWrite(trigPin, LOW);
  delayMicroseconds(2);
  // Sets the trigPin HIGH (ACTIVE) for 10 microseconds
  digitalWrite(trigPin, HIGH);
  delayMicroseconds(10);
  digitalWrite(trigPin, LOW);
  // Reads the echoPin, returns the sound wave travel time in microseconds
  duration = pulseIn(echoPin, HIGH);
  // Calculating the distance
  distance = duration * 0.034 / 2; // Speed of sound wave divided by 2 (go and back)
  // Displays the distance on the Serial Monitor
  Serial.print("Distance: ");
  Serial.print(distance);
  Serial.print("cm");
  Serial.print(" == ");

  waterlevel = ((17.68-distance)/17.68) * 100;
  for(int i=0;i<10;i++)       //Get 10 sample value from the sensor for smooth the value
  {
    buf[i]=waterlevel; //initialize temp sensor
    delay(10);
  }
  for(int i=0;i<9;i++)        //sort the analog from small to large
  {
    for(int j=i+1;j<10;j++)
    {
      if(buf[i]>buf[j])
      {
        temp=buf[i];
        buf[i]=buf[j];
```

```
        buf[j]=temp;
      }
    }
  }

  avgValue=0;
  for(int i=2;i<8;i++)                      //take the average value of 6 center sample
    avgValue+=buf[i];
    //Serial.print(avgValue);
  waterlevelValue=avgValue/6; //convert the analog into millivolt                    //convert the
millivolt into pH value

  waterlevelValuestr= dtostrf(waterlevelValue, 4, 2, buff2);
  Serial.print(waterlevelValuestr);
  Serial.println("% water level");

  if(waterlevelValue>70){
    digitalWrite(buzzer, HIGH);
    digitalWrite(valve, HIGH);
    delay(15000);
    digitalWrite(buzzer, LOW);
    digitalWrite(valve, LOW);
    digitalWrite(waterpump, LOW);

  }
  else if(waterlevelValue<60){
    digitalWrite(buzzer, HIGH);
    digitalWrite(valve, LOW);
    digitalWrite(waterpump, HIGH);
    delay(3000);
    digitalWrite(buzzer, LOW);
    digitalWrite(valve, LOW);
    digitalWrite(waterpump, LOW);
  }
  else{
    digitalWrite(valve, LOW);
    digitalWrite(waterpump, LOW);
  }
}

void ph() {
  for(int i=0;i<10;i++)       //Get 10 sample value from the sensor for smooth the value
  {
    buf[i]=analogRead(SensorPin); //initialize pH sensor
    delay(10);
  }
  for(int i=0;i<9;i++)        //sort the analog from small to large
  {
    for(int j=i+1;j<10;j++)
    {
```

```
      if(buf[i]>buf[j])
      {
        temp=buf[i];
        buf[i]=buf[j];
        buf[j]=temp;
      }
    }
  }
  avgValue=0;
  for(int i=2;i<8;i++)                    //take the average value of 6 center sample
    avgValue+=buf[i];
  phValue=(float)avgValue*5.0/1024/6; //convert the analog into millivolt
  //Serial.println(phValue);
  phValue=3.5*phValue;                      //convert the millivolt into pH value

   Value =  dtostrf(phValue, 4, 2, buff2);  //4 is mininum width, 6 is precision
   valueString = Value;
   Serial.print("pH: ");
   Serial.println(valueString);
   //nodemcu.println(valueString);
  //valueString = "";

  if(phValue<7){
    digitalWrite(phup, HIGH);
    delay(300);
    digitalWrite(phup, LOW);
  }
  else if(phValue>7.8){
    digitalWrite(phdown, HIGH);
    delay(300);
    digitalWrite(phdown, LOW);

  }
  else{
    digitalWrite(phdown, LOW);
    digitalWrite(phup, LOW);
  }
 //delay(5000);
}

void temperature() {
  tempSensor.requestTemperatures();             // send the command to get temperatures
  //tempCelsius = tempSensor.getTempCByIndex(0);  // read temperature in Celsius

  for(int i=0;i<10;i++)       //Get 10 sample value from the sensor for smooth the value
  {
    buf[i]=tempSensor.getTempCByIndex(0); //initialize temp sensor
    delay(10);
    //Serial.println(buf[i]);
    //Serial.println(tempSensor.getTempCByIndex(0));
```

```
  }
  for(int i=0;i<9;i++)        //sort the analog from small to large
  {
    for(int j=i+1;j<10;j++)
    {
      if(buf[i]>buf[j])
      {
        temp=buf[i];
        buf[i]=buf[j];
        buf[j]=temp;
      }
    }
  }

  avgValue=0;
  for(int i=2;i<8;i++)                      //take the average value of 6 center sample
    avgValue+=buf[i];
    //Serial.print(avgValue);
  temperatureValue=avgValue/6; //convert the analog into millivolt                    //convert the
millivolt into pH value

  temperatureValuestr= dtostrf(temperatureValue, 4, 2, buff2);
  Serial.print("Temperature: ");
  Serial.print(temperatureValuestr);    // print the temperature in Celsius
  Serial.print("°C");
  Serial.println("");

  if(temperatureValue<27 || temperatureValue>30){
    digitalWrite(buzzer,HIGH);
    digitalWrite(waterpump, HIGH); // turn on pump 3 seconds
    waterpumpON();
    delay(3000);
    digitalWrite(buzzer, LOW);
    digitalWrite(waterpump, LOW);  // turn off pump 3 seconds
    delay(3000);
  }
  else {
    digitalWrite(buzzer,LOW);
    digitalWrite(waterpump, LOW);
  }

  //delay(500);
}

void manual(){
  if(nodemcu.available()>0)
  {
    data = nodemcu.parseInt();
    delay(100);
    Serial.println(data);
```

```
    if(data == 1)
    {
      waterpumpON();
      Serial.println("Waterpump ON");
      //delay(5000);
      //digitalWrite(waterpump, LOW);
    }
    else
    {
      digitalWrite(waterpump, LOW);
    }
  }
}

void waterpumpON(){
  digitalWrite(waterpump, HIGH);
}

void waterpumpOFF(){
  digitalWrite(waterpump, LOW);
}
```

Node MCU code

```
#define BLYNK_PRINT Serial

#define BLYNK_TEMPLATE_ID "TMPLeWyarDgM"

#define BLYNK_DEVICE_NAME "Fishnet"

#define BLYNK_AUTH_TOKEN "DYr7wWxW7G_NJozpn6eQN20ZxYkLrjPI"


#include <ESP8266WiFi.h>

#include <BlynkSimpleEsp8266.h>

#include <SoftwareSerial.h>


SoftwareSerial arduinoUno(2,3);

//#include <BlynkTimer.h>


// You should get Auth Token in the Blynk App.

// Go to the Project Settings (nut icon).
```

```
//WidgetLCD lcd(V2);
String data;
String I;
char auth[] = "DYr7wWxW7G_NJozpn6eQN20ZxYkLrjPI";

// Your WiFi credentials.
// Set password to "" for open networks.
char ssid[] = "Hotspot@PUTRA-2.4G";
char pass[] = "";

BlynkTimer timer;

String myString;
char rdata;

float firstVal, secondVal, thirdVal;

int pinValue1;

BLYNK_CONNECTED(){
  Blynk.syncVirtual(V5);
}

BLYNK_WRITE(V5){
  pinValue1 = param.asInt();
  Serial.print("Waterpump");
  Serial.println(pinValue1);
```

```
  arduinoUno.print(pinValue1);
}

void myTimerEvent()
{

  Blynk.virtualWrite(V1, millis() / 1000); //ph
  //Blynk.virtualWrite(V2, millis() / 1000); //temp
  //Blynk.virtualWrite(V3, millis() / 1000); //water level
  //Blynk.virtualWrite(V4, millis() / 1000); //
  //Blynk.virtualWrite(V5, millis() / 1000); //

}

void setup()
{
  // Debug console
  Serial.begin(9600);
  Blynk.begin(auth, ssid, pass);
  timer.setInterval(500L,sensorvalue1);
  timer.setInterval(500L,sensorvalue2);
  timer.setInterval(500L,sensorvalue3);
}

void loop()
{
  if (Serial.available() == 0 )
```

```
  {
 Blynk.run();
 timer.run(); // Initiates BlynkTimer
  }


 if (Serial.available() > 0 )
 {
   rdata = Serial.read();
   myString = myString+ rdata;
     Blynk.virtualWrite(V4, myString);


  //Serial.print(rdata);
   if( rdata == '\n')
   {
           String l = getValue(myString, ',', 0);
           String m = getValue(myString, ',', 1);
           String n = getValue(myString, ',', 2);


           firstVal = l.toFloat();
           secondVal = m.toFloat();
           thirdVal = n.toFloat();
       myString = "";


   }
 }
}
```

```
String getValue(String data, char separator, int index)
{
  int found = 0;
  int strIndex[] = { 0, -1 };
  int maxIndex = data.length() - 1;

  for (int i = 0; i <= maxIndex && found <= index; i++) {
    if (data.charAt(i) == separator || i == maxIndex) {
      found++;
      strIndex[0] = strIndex[1] + 1;
      strIndex[1] = (i == maxIndex) ? i+1 : i;
    }
  }
  return found > index ? data.substring(strIndex[0], strIndex[1]) : "";
}

void sensorvalue1()
{
//data = data + I;
//lcd.print(0,0,"pH Value:");
//lcd.print(0,1,data);
// data = "";
int sdata = firstVal;
Blynk.virtualWrite(V9, sdata);
}
```

```
void sensorvalue2()
{
float sdata = secondVal;
Blynk.virtualWrite(V1, sdata);
}

void sensorvalue3()
{
float sdata = thirdVal;
Blynk.virtualWrite(V2, sdata);
}
```