

Control - Monitoring System Of Oxygen Level, Ph, Temperature And Feeding in Pond Based on Iot

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ABSTRACT

Fish management systems have an important role in fish farming. One aspect of fish management is water quality which includes several things such as temperature, pH, oxygen levels and also feeding. So far, monitoring of water quality and feeding of fish has been done manually. This study aims to design a control-monitoring system for oxygen levels, pH, temperature and automatic feeding based on IoT. The reading data from the sensor and also the RTC will be forwarded by the microcontroller to the server to be displayed to the user. This system is automated with actuators in the form of aerators and motors, so that feeding and adding oxygen levels to the pond will be automatically carried out by the microcontroller. The results of this study indicate the system can work, temperature data, oxygen levels, pH can be monitored through the server and feeding can also be done.

Keywords: *IoT, pH, oxygen levels, temperature.*

1. INTRODUCTION

Indonesia is a country that is rich in fish-producing potential, especially since Indonesia is a water country, this makes fish farmers an easy business to find in Indonesia. The Ministry of Maritime Affairs and Fisheries (KKP) noted that aquaculture production from 2018 to September increased by 29% compared to the previous year. A good fish processing system is the main factor in obtaining quality fish (**Hidayatullah Himawan, 2018**). One of them is feeding, water quality must be monitored to match the needs of the fish. Poor water quality has an impact on the results of fish weight later, such as temperature, pH and oxygen levels. While feeding that is not as needed will cause fish to get sick and even die (**Rohadi, 2017**).

Until now, there are still many farmers who feed fish manually by spreading feed into the pond at certain hours, this is very inefficient, especially if the owner has other business which causes the feeding to be not on time. This can be one of the factors for the slow growth of fish (**Lina Anggriani, 2018**).

Monitoring of water quality such as oxygen levels, temperature, pH is also still mostly done manually so it is not effective and takes a long time. Oxygen levels, temperature, pH greatly affect the fish's body metabolism to produce energy, growth and reproduction (**Prabowo, 2020**). Based on this problem, an electronic device is needed for a monitoring system for temperature, pH, oxygen levels and automatic feeding that can be accessed in real time using the Internet of Things (IoT). In general, the Internet of Things can be interpreted as

objects around us that can communicate with each other through the internet network (**Farisqi Panduardi, 2016**). This IoT system has several advantages, there are the data obtained is real time, it can be accessed anywhere and anytime, this system also makes it easier for users without having to go to a place to turn on or turn off the aerator or feeding machine, it can reduce the risk of the impact of crowding, because everything can be done by remotely (**JAJA KUSTIJA, 2021**), This system is very economical, because it can reduce transportation costs and also reduce the number of workers needed (**J Kustija D. L., 2019**), and it can control multiple objects (actuators) at the same time. IoT also make easy user to control or monitoring something that they need (**Jaja Kustija, 2019**) (**J Kustija D. F., 2017**)

In this research, oxygen levels, temperature, and pH were monitored using an ESP32 microcontroller. Data from DO sensor, DS18B20 and pH sensor will be sent to the server using WIFI to be stored in the database and displayed to the user. As for automatic feeding, the RTC module is used as a reference for feeding fish. While the oxygen level will be controlled by the aerator, when the oxygen level is below 5 ppm, the microcontroller will send a signal to the aerator to fill oxygen in the air.

2. METHOD

The system design in this study uses a microcontroller with sensor inputs, there are DO (Dissolve Oxygen), pH sensor, DS18B20 (temperature sensor) and also RTC as a time reference. This system has 2 actuators, there are an aerator to increase oxygen levels and a motor to feed fish. This system will be integrated with the internet as a database so that it can be monitored and controlled remotely

2.1 Dissolve Oxygen (DO)

This sensor is used to detect oxygen levels in water, this sensor produces an analog output with a voltage of 0-3 volts DC. To get the ADC output from the microcontroller, use the Equation (1) (**Arif Sumardiono, 2020**):

$$ADC = \frac{V_{in} \times 1024}{V_{ref}} \tag{1}$$

ADC = value of ADC from microcontroller

V_{in} = input voltage

V_{ref} = voltage reference of microcontroller (esp32 use 3.3 volt)

Here is a table of dissolved oxygen levels that are good for fish in ponds (**Suryaningrum, 2015**).

Table 1. Oxygen Level for Fish

No	Fish	Oxygen Level (ppm)
1	Patin	4.5 – 6.5
2	Nila	4 – 6
3	Sidat	5 – 6
4	Gabus	4.2 – 5.6
5	Nilem	5 – 7
7	Mas	4 – 5
8	Bawal	4 – 6
9	Lele	3 – 5

Based on Table 1, it can be concluded that the mean value of oxygen level is 5 ppm.

2.2 pH Sensor

The pH sensor used is a liquid pH sensor. This pH sensor uses a BNC connector and able to measure between 0-14 Ph (**Arif Sumardiono, 2020**). To calculate the pH value of this sensor use Equation (2)

$$\begin{aligned} \text{Value} &= \text{ReadADC}(\text{Pin}) \\ \text{Voltage} &= \text{Value} \times 0.004887586 \\ \text{pH} &= 3.5 \times \text{Voltage} \end{aligned} \quad (2)$$

Value = value of ADC

Pin = pinout analog

Voltage = Value of voltage

pH = value of pH sensor

The ideal pH value in fish farming in ponds is in the range of 6-8 (**Apriyani, 2017**)

2.3 Temperature Sensor DS18B20

This sensor produces a 0-3.3 volt analog signal. This sensor was chosen because it has the advantage of being waterproof. Here is the circuit of this sensor

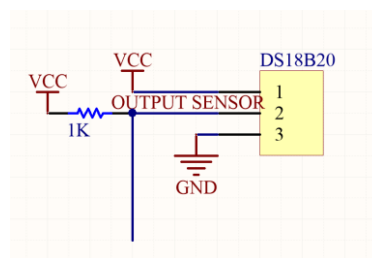


Figure 1. DS18B20 Circuit

The ideal temperature value in fish farming in ponds is in the range of 28-30 °C (**Rohadi, 2017**).

2.4 RTC (Real Time Clock)

RTC is used as a time reference to provide automatic feed, if the RTC reading is in accordance with a predetermined timer, then the motor will be ON to feed the fish. The circuit of RTC is as follows

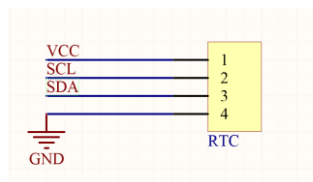


Figure 2. RTC Circuit

2.5 ESP32

ESP32 is a programmable microcontroller. ESP32 is used as the main controller of the whole system, all input to output processes will go through ESP32. This microcontroller already has a WIFI module in it, making it very easy to use. Here is the IO configuration on the ESP32

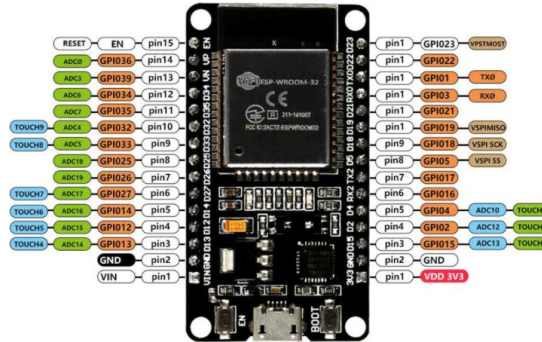


Figure 3 .GPIO of ESP32

2.6 Relay

Relay is used to connect the microcontroller with the output in the form of an actuator. This relay is capable of driving a voltage of 0-220 volts either AC or DC up to 10 amperes.



Figure 4. Relay Module

2.7 Motor and Aerator

The motor and aerator are actuators used in this system, the aerator can increase the oxygen level of the water, while the motor is used to open the cover of fish feed, this motor can be a servo motor or stepper motor, adjusted to the needs

2.8 Adafruit Server

Adafruit server is a server that has been integrated with the database. This server is used to accommodate sensor reading data and also gives orders to the microcontroller to perform the desired action. This server connects the user with the device. Adafruit server can be accessed by web or mobile phone. Adafruit server is also used to display all data sensor to user such as pH, temperature, oxygen level in graphic or table interface.

2.9 Block Diagram and Flowchart

The data from sensor will send to microcontroller, ESP32. Then the microcontroller will process all data to make decision to turn of or turn on the actuator, the microcontrlloler also send data to server. The microcontroller read data rtc to make time reference as timer. If timer is same to the feed time, motor will turn on to give feed to fish. If data of oxygen level is under or equals to 5 ppm, microcontroller will send signal to aerator to make it turn on, when aerator on it will increase value oxygen level in pond, and if value of oxygen level is higher than 5 ppm the aerator will turn off to keep pH in value that needed in farm fish pond. The microcontroller also always check connection to server, to make sure data is sent.

Control - Monitoring System Of Oxygen Level, Ph, Temperature And Feeding in Pond Based on lot

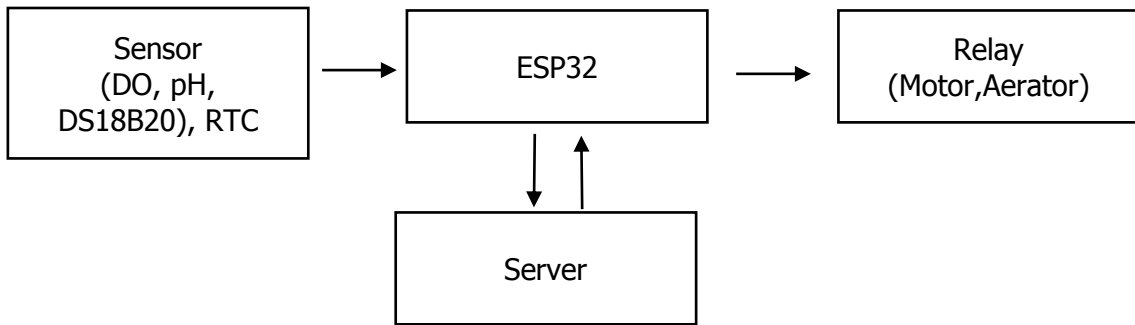


Figure 5. Block Diagram

The flowchart is as follows

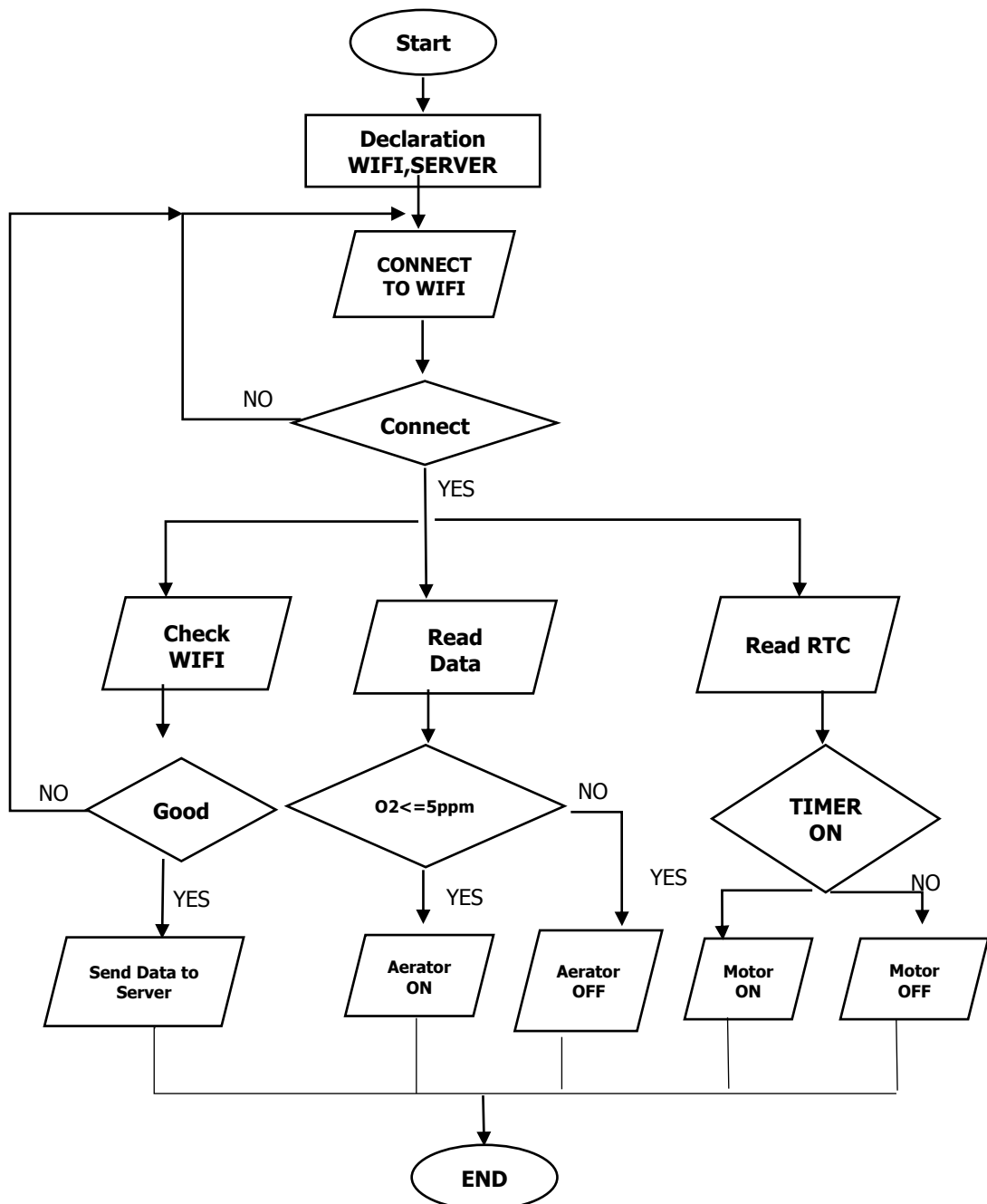


Figure 6. Flowchart

3. RESULT AND DISCUSSION

3.1 Hardware

The hardware mounted in one pcb with some socket. It powered by 12 volt power supply. Figure 7 show the hardware peripheral

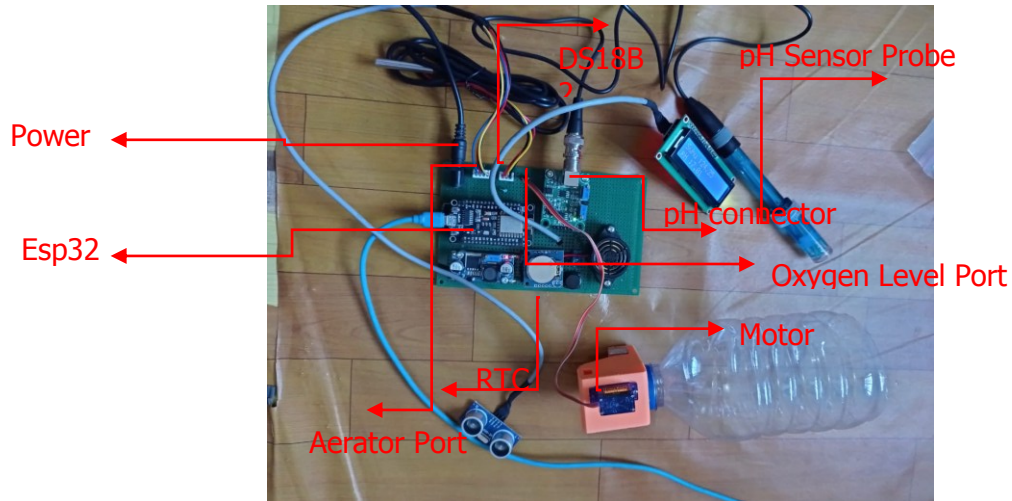


Figure 7. Hardware Peripheral

3.2 Sensor Stability Test

Sensor stability testing is carried out to determine the level of error on the sensor against the same object. Sensor reading data will be sent to the server using WIFI. Here are the results of testing the temperature sensor, pH and also oxygen levels.

3.1.1 Temperature Sensor

Temperature sensor reading is shown in Figure 7 and Table 2



Figure 8. Temperature Sensor Graphic Test

Control - Monitoring System Of Oxygen Level, Ph, Temperature And Feeding in Pond Based on lot

The following is a table of temperature sensor readings

Table 2. Temperature Sensor Reading

Iterations	Result (celcius)	Iterations	Result (celcius)
1	28.67	18	29
2	28.33	19	28.33
3	28.67	20	29
4	29	21	28.67
5	28.67	22	29
6	28.67	23	29
7	29	24	29
8	28.33	25	29
9	28.33	26	28.33
10	28.33	27	28.33
11	28.67	28	29
12	28.67	29	28.67
13	29	30	29
14	29	31	29
15	28.67	32	28.67
16	28.67	33	29
17	29		

From the data of temperature sensor reading, the sensor is stabil with temperature average in 28.74, it can be concluded, the temperature sensor is very stabil to keep temperature that needed.

3.1.2 pH Sensor

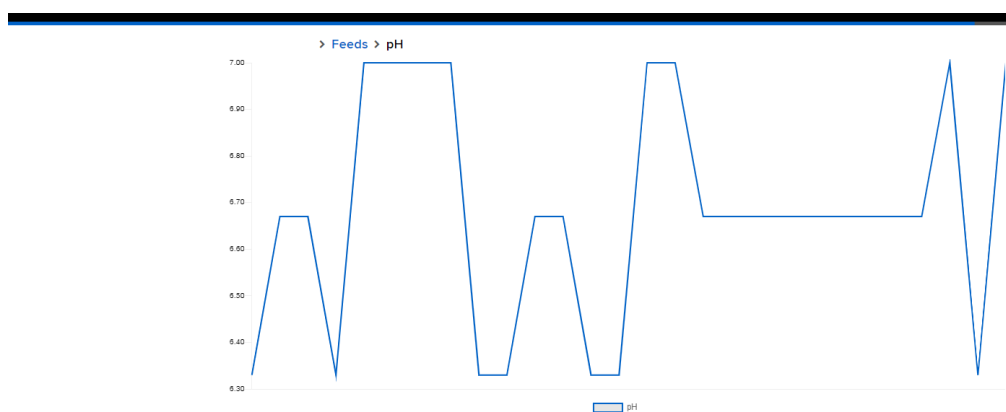


Figure 9. pH Sensor Readings

The following is a table of pH sensor readings

Table 3. pH Sensor Readings

Iterations	Result	Iterations	Result
1	6.33	18	6.67
2	6.67	19	7
3	6.67	20	6.33
4	6.33	21	7
5	7	22	6.33
6	7	23	6.33
7	7	24	6.67
8	6.33	25	6.33
9	6.33	26	6.67
10	6.67	27	6.67
11	6.67	28	6.67
12	6.33	29	7
13	6.33	30	6.33
14	7	31	6.67
15	7	32	7
16	6.67	33	6.33
17	6.67	34	6.67

From the data of pH sensor reading, the sensor is stabil with temperature average in 6.83, it can be concluded that this system can keep the pH value that needed in farm fish pond.

3.1.3 Oxygen Level Sensor (Dissolve Sensor)

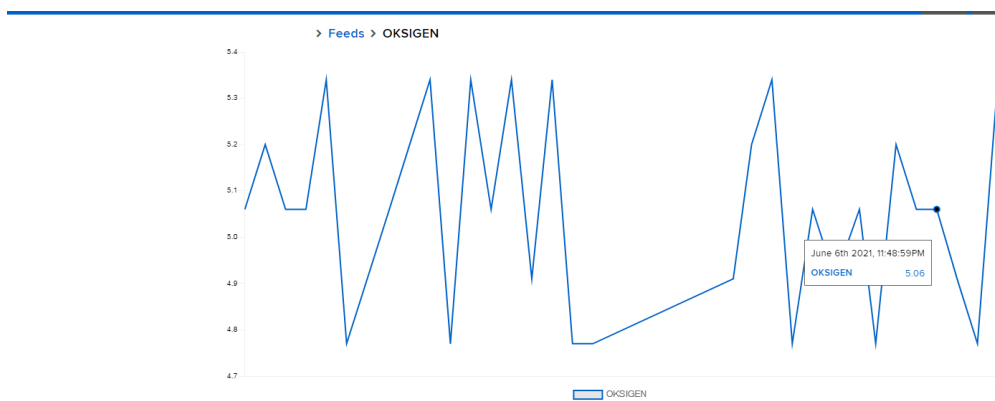


Figure 10. Oxygen Level Sensor Graphic

Control - Monitoring System Of Oxygen Level, Ph, Temperature And Feeding in Pond Based on Iot

Oxygen level readings is as follows

Table 4. Oxygen Level Sensor Readings

Iterations	Result(ppm)	Iterations	Result(ppm)
1	5.06	18	4.91
2	5.2	19	5.2
3	5.06	20	5.34
4	5.06	21	4.77
5	5.34	22	5.06
6	4.77	23	4.91
7	5.06	24	5.06
8	5.2	25	4.77
9	5.34	26	5.2
10	4.77	27	5.06
11	5.34	28	5.06
12	5.06	29	4.91
13	5.34	30	4.77
14	4.91	31	5.34
15	5.34	32	4.91
16	4.77	33	4.77
17	4.77	34	5.06

From the data of ph sensor reading, the sensor is stabil with temperature average in 5.2 (ppm), it can be concluded that this system can keep the oxygen level that needed in farm fish pond.

3.1.4 Data Transfer

The data displayed is realtime, via WIFI, this monitoring application displays sensor data readings, users can also take direct actions if needed through this server. The following is a display of the user interface of this system



Figure 11. Monitoring and Control Display

Based on the **figure 11** when oxygen is below 5 ppm the aerator will turn on automatically, users can also turn on or turn off the aerator or feeder motor manually through this system. The server shows the data of ph, oxygen level and also temperature. The system will automatically keep the value of ph, temperature and also oxygen level in needed value in farm fish pond by turning on or off the actuator there are motor and aerator. The server can be accessed by phone or web base.

4. CONCLUSIONS

Through this research, it can be concluded that temperature, pH and oxygen levels can be monitored remotely and in real time via a server with WIFI. When the oxygen level is below the specified value, the aerator automatically turns on and will turn off when the oxygen level is above the specified value. The feeding motor can also be controlled remotely either manually or automatically via a timer that is adjusted to the readable RTC value. This research can be applied in fish farming to help fish monitoring system.

LIST OF REFERENCES

- Apriyani, I. (2017). *Budidaya Ikan Lele Sistem*. Yogyakarta: Deepublish.
- Arif Sumardiono, S. R. (2020). Sistem Kontrol-Monitoring Suhu dan Kadar Oksigen pada Kolam Budidaya Ikan Lele. *JTERA (Jurnal Teknologi Rekayasa)*, 233.
- Farisqi Panduardi, E. S. (2016). WIRELESS SMART HOME SYSTEM MENGGUNAKAN RASPBERRY PI BERBASIS ANDROID. *Jurnal Teknologi Informasi dan Terapan*, 03, 321.
- Hidayatullah Himawan, M. Y. (2018). PENGEMBANGAN ALAT PEMBERI MAKAN IKAN OTOMATIS MENGGUNAKAN ARDUINO TERINTEGRASI BERBASIS IOT. *TELEMATIKA*.
- J Kustija, D. F. (2017). Smart home system to support Bandung smart city programme. *Pertanika*, 2.
- J Kustija, D. L. (2019). Development of Internet of Things (IoT) based learning media . *The Electrochemical Society*, 3.
- JAJA KUSTIJA, A. A. (2021). WEB-BASED AND THINVNC REMOTE LABORATORY IMPLEMENTATION TO SUPPORT STUDENTS SKILLS IN MECHATRONICS COURSE TO FACE THE INDUSTRIAL REVOLUTION 4.0. *Journal of Engineering Science and Technology*, 16.
- Jaja Kustija, N. J. (2019). Remote desktop system in IoT and HTML 5-based virtual . *The Electrochemical Society*, 3.
- Lina Anggriani, A. S. (2018). "SMART FISH POND" Kolam Ikan Pintar Berbasis Mikrokontroler ATmega8535 Sebagai Solusi Kegagalan Budidaya Ikan Lele.
- Prabowo, R. R. (2020). SISTEM MONITORING DAN PEMBERIAN PAKAN OTOMATIS PADA BUDIDAYA IKAN MENGGUNAKAN WEMOS DENGAN KONSEP INTERNET OF THINGS (IOT). *JURNAL DIGIT*, 2-3.
- Rohadi, E. (2017). SISTEM MONITORING BUDIDAYA IKAN LELE BERBASIS INTERNET OF THINGS MENGGUNAKAN RASPBERRY PI. *Jurnal Teknologi Informasi dan Ilmu Komputer (JTIK)*, 1.
- Suryaningrum, L. S. (2015). Pemanfaatan limbah budidaya ikan lele (*Clarias batrachus*) untuk ikan nila dengan sistem resirkulism. *Berita Biologi*, 14, 287-293.