**Telecommunications, Computers, and Electricals Engineering Journal (TELECTRICAL)**
Vol. 1, No. 3, February 2024, pp. 333~340
ISSN: 3026-0744, DOI: 10.26418/telectrical.v1i3.73567 

# Water Quality Monitoring And Control System In Fish Cultivation Pond Using Arduino Cloud

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**Article Info**

Received Dec 08, 2023
Revised Feb 08, 2024
Accepted Feb 13, 2024

***Keywords:***

Water Quality
Fish Growth
Internet of Things
Fish Farmer
Tilapia Fish

**ABSTRACT**

Water quality is an important factor in supporting the life of living creatures, one of which is fish. Failure to maintain water quality can result in slower fish growth and can cause mass death. In the process of monitoring water quality, several environmental value are detected, namely water pH, water turbidity and water temperature. With the Internet of Things (IoT), monitoring water quality can bedone using the Arduino Cloud application via a smartphone or computer anywhere in real time. These two parameters are given thresholds, the environmental water temperature threshold is between 28 - 30 °C and the water turbidity threshold is between 5 - 50 NTU. If one of the values exceeds the threshold, where the water temperature is higher than 30 °C or below 28 °C, the water turbidity is higher than 50 NTU or below 5 NTU, then a water change will occur as water quality control which starts with draining the water using a solenoid valve, then filling the water using a water pump. The measurement results showed that fish growth for 2 weeks was 17% with maintained water quality and the average percentage of error obtained in water temperature measurements was 0.314% and water turbidity was 2.769%.

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## 1. INTRODUCTION

Water is an important factor in supporting the life of living creatures on earth, one of which is fish. Fish can grow and reproduce well, influenced by good water quality [1]. Poor water quality, even though regular feeding is carried out, will still affect the growth and sustainability of fish [2].

Water quality in fish farming includes several things, namely water clarity/turbidity, water temperature, and water acidity or pH level, as well as oxygen levels in the water [3]. The parameters that determine the quality of the water must meet the quality standards (standards) issued by the Regulation of the Minister of Health of the Republic of Indonesia No. 2 of 2023.

However, to maintain good water quality based on standard standards in freshwater fish cultivation requires a lot of time and energy, and fish farmers must always monitor and control the water quality in ponds. If water quality decreases, fish farmers must control the water by changing the water or adding chemicals[4].

Research on water quality monitoring and control systems in farmed fish ponds using IoT has become quite popular in recent years. This is because the potential for using IoT is so large, considering that Indonesia has a population that tends to use cell phones every day. Water quality control in farmed fish ponds has various characteristics and parameters used depending on the water and the type of fish being cultivated, such as pH, oxygen levels, turbidity, amount of dissolved substances and water temperature.

Actions in the form of monitoring, changing water, or adding chemicals involve humans as fish farmers. Negligence in maintaining pond water quality can of course result in poor fish quality, and can even cause mass deaths [5].

To make it easier for humans as freshwater fish breeders to monitor and control water quality, a system was designed that can monitor various physical quantities such as water temperature and water clarity/turbidity [6]. If the water quality decreases from the standard standard, the system automatically replaces the water with new water[7]. To overcome this, a practical and flexible electronic device was developed that helps make it easier for humans to care for farmed fish, especially tilapia, which is currently a favorite among people.

## 2. THEORITICAL FOUNDATION

### 2.1. Water Parameters

Water quality is determined by several water parameters to ensure the level of clarity and fish suitability [8]. There are several factors to see how the water is categorized as good with predetermined standard standards starting from odor, TDS, turbidity, taste, temperature, color, and pH. These parameters can be measured using research methods on water quality[9]. Referring to the journal [10] as shown in Table 1.

Table 1. Water Quality Parameters

| Parameters | Unit | Measurement Method | Equipment |
|---|---|---|---|
| Smell | | Organoleptic | The sense of smell |
| TDS | Mg/L | Potentiometer | TDS meter |
| Turbidity | NTU | Turbidimetry | Turbidimeter |
| Flavor | | Organoleptic | Sense of Taste |
| Temperature | °C | Expansion | Thermometer |
| Color | TCU | Photometric | Colorimeter |
| pH | | Electrometrics | pH Meter |

Based on the regulation of the Minister of Health of the Republic of Indonesia Number 2 of 2023 concerning "Environmental Health Quality Standards and Health Requirements for Water for Sanitation Hygiene, Swimming Pools, Solus Per Aqua, and Public Baths" [11]. The maximum level of each parameter in farmed fish can be seen in Table 2.

Table 2. Maximum level of each parameter

| Parameters | Maximum level |
|---|---|
| Smell | Odorless |
| Amount of Dissolved Substance | 1000 mg/L |
| Turbidity | 5-50 NTU |
| Flavor | Tasteless |
| Temperature | 28°C - 30°C |
| Color | 50 TCU |
| pH | 6.5 – 8.5 |

### 2.2. Turbidity Level Parameters

Turbidity can be interpreted as a relative measure of water clarity. Turbidity is not a direct measure of suspended particles in water but on the contrary, namely a measure of the scattering effect of these particles on light [12], [13]. Turbidity measures how much the particles affect the light transmitted through the water, or how the light reflects off particles in the water[14]. To measure turbidity, you can use a turbidity meter with NTU units based on light passing through water.

Based on Minister of Health Regulation No. 2 of 2023 concerning environmental health standards and water health requirements [11] The data obtained can be seen in Table 3.

Table 3. Water specifications based on NTU meter

| NTU | Water specifications |
|---|---|
| 25 | Hygienic sanitation |
| 0.5 | Swimming Pool Water |
| 0.5 | Spa Water |
| 1.6 | Public Bathing Water |
| 6-9 | Wastewater |
| 400 | Fisheries and Livestock Water |

### 2.3. Arduino Cloud App

Arduino is a prototyping (open source) platform based on easy-to-use hardware and software. It consists of a circuit board, which can be programmed (referred to as a microcontroller) and ready-to-use software called Arduino IDE (Integrated Development Environment), which is used to write and upload computer code to the physical board [15] . Using the Arduino cloud requires an internet network and can be controlled remotely, so it can be called an internet of things device. The basics of Arduino Cloud circuit have been illustrated in Figure 1.

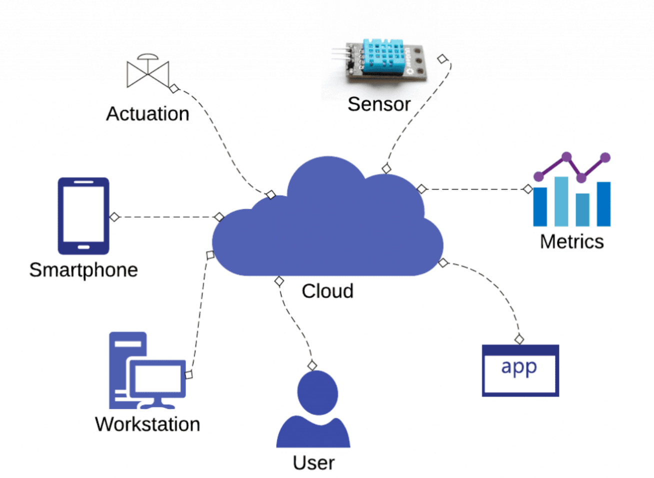



Figure 1. Circuit Basic Arduino Cloud App

The device must have a Things ID to connect the board with the application, the Things ID will be obtained randomly which will be carried out by the program so that Things ID do not match with other things. After connecting the microcontroller with the application, the microcontroller will send data to the application in the form of data. This data can be seen from anywhere as long as the application has an internet network. The application can not only be viewed on a cellphone but can also be accessed via a website browser with the account that has been created.

## 3. RESEARCH METHODOLOGY

The research method used is literature study, namely collecting and studying previous research and related to this research, namely monitoring systems with ESP32 and Arduino Cloud. Apart from that, by collecting and studying literature studies, you can prevent component damage by studying the datasheet of the components used.

Next, the monitoring system is designed. The circuit consists of two sensors, namely a turbidity sensorand a temperature sensor by programming the microcontroller so that it can read data from the sensors used. The next design is to make a solenoid valve and water pump that will open and close the water channel to drain water using a solenoid valve and water pump to fill the fish pond with water. Next, IoT programming is carried out to be able to connect to the internet using Arduino Cloud using the template program from the Arduino Cloud website. This program can also be monitored via smartphone with a similar application name. In addition, the program can activate and deactivate the control system using a widget on the Arduino cloud to change the water.

Data collection is carried out by taking the required data such as water turbidity and water temperature so that these data can then be processed as validation and calibration of the sensors used such as temperature and water turbidity sensors. Apart from that, the results of data collection will be used for analysis to answer the problem formulation. To determine the success of the tool that has been designed, fish growth data was also taken before and after the research. The research flow diagram is presented in Figure 2.

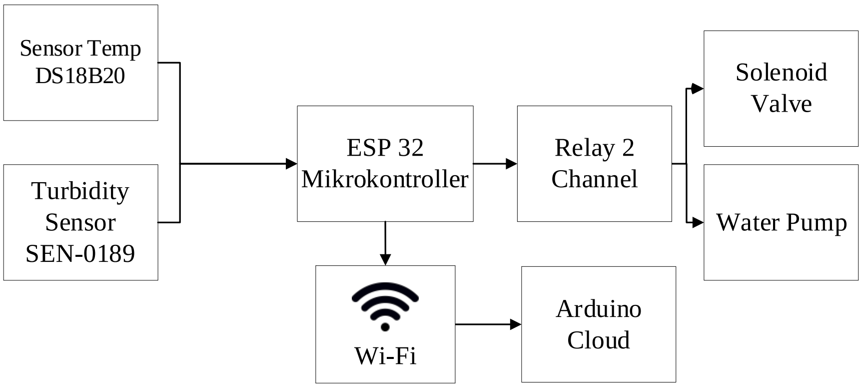
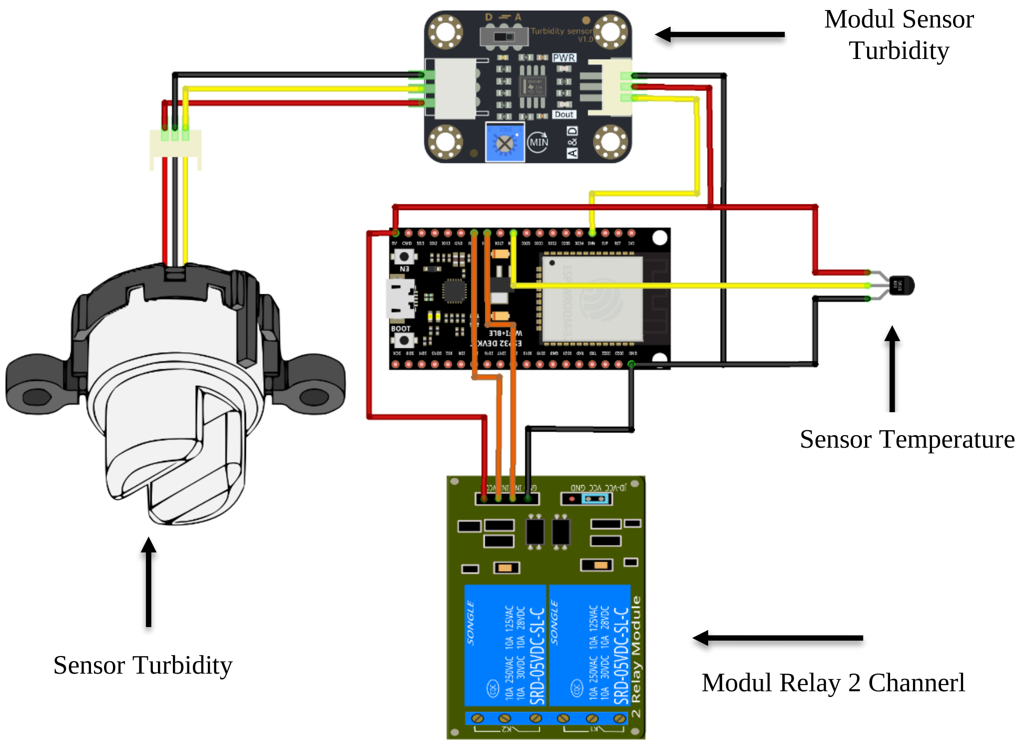


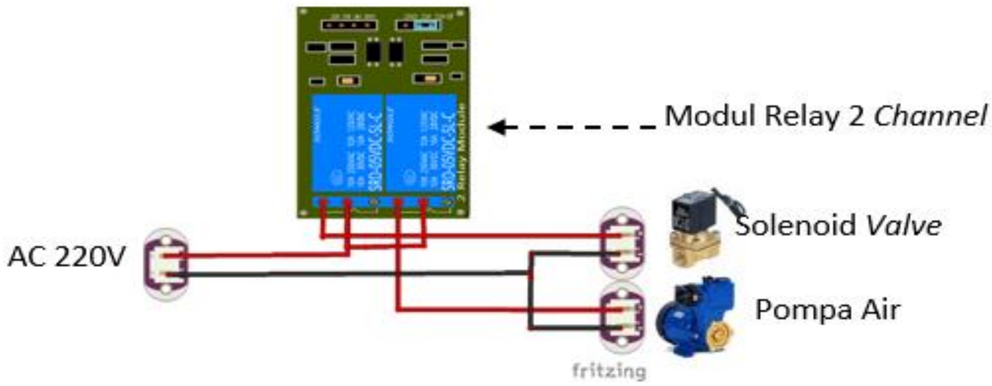

Figure 2. Research Flow Diagram

### 3.1. System Design

The system design carried out in the research is to design a system that is capable of monitoring and controlling water quality. In general, the interface of all components used is divided into 2 , namely the first is sensor circuit has illustrated in Figure 3(a) and output circuit has illustrstrated in Figure 3(b).




(a)




(b)

Figure 3. Circuit Diagram (a) Sensor Circuit and (b) Output Circuit

There are 2 sensor modules used for monitoring and controlling water quality, namely the DS18B20 temperature sensor module and the turbidity sensor module. So the parameters observed are temperature and turbidity. This parameter can determine whether the water quality is in good or bad condition. Physical water parameter data is detected by sensors to be processed into electrical signals that can be received by the microcontroller. The microcontroller analyzes the data obtained from the sensor based on the program that has been entered into the microcontroller. The results of data processing by the microcontroller will issue 2 decisions, namely activating the water pump and solenoid or not activating the water pump and solenoid.

Based on the standard parameters of raw water used for farming fish, there is standardization for water quality. Firstly, the water temperature based on standard standards ranges from 28°C - 30°C and finally the standard standard for turbidity levels ranges from 5 - 50 NTU. This water quality standard value is entered into the microcontroller in a computer program. So if the results of the analysis or input power process from several modules provide indicator numbers outside the standard standards, the microcontroller will activate the solenoid to release pool water and turn on the water pump to enter new water into the pool until the water quality is in accordance with the quality standards.

### 3.2. Programming Flow Diagram

The software used on the ESP32 is programmed using Arduino cloud software. The system design programming flow diagram can be seen in Figure 4.

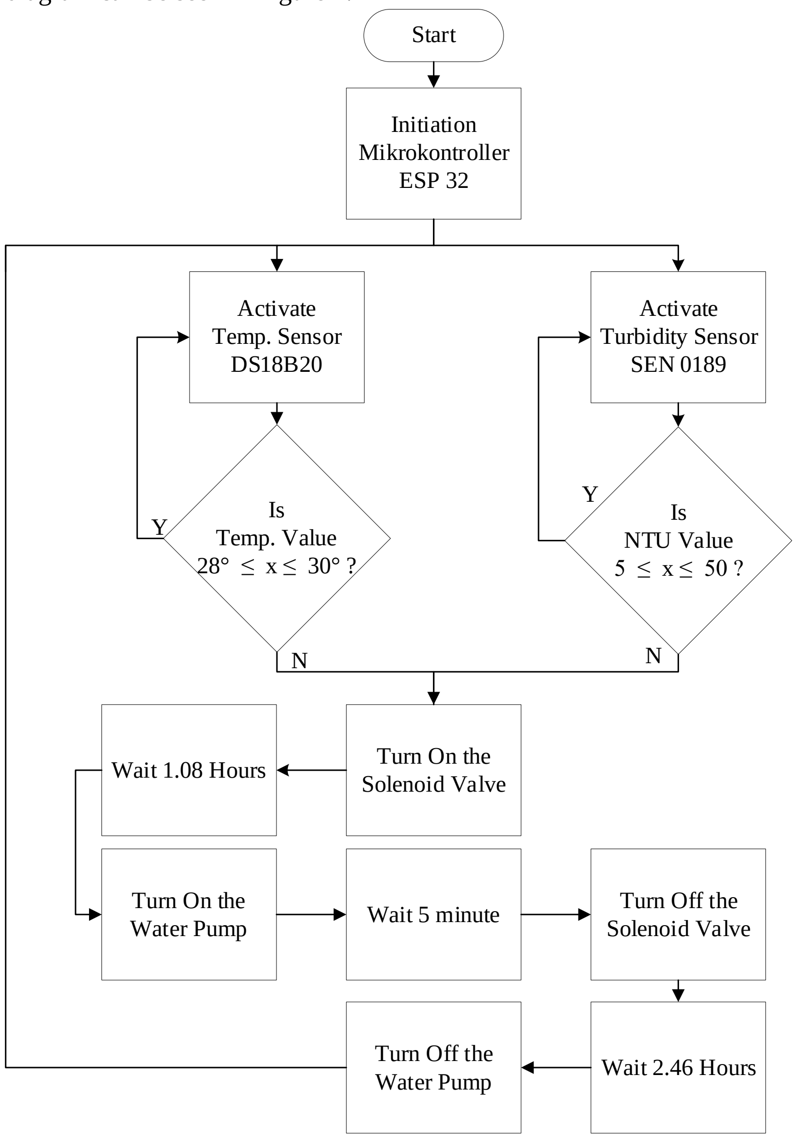



Figure 4. Programming Flow Diagram

## 4. ANALYSIS OF RESULT

### 4.1. Temperature Sensor Testing

The temperature sensor test aims to determine the accuracy of the temperature readings obtained from the DS1B20 temperature sensor compared to the temperature readings obtained from the thermometer. Temperature sensor testing is carried out by increasing the temperature around the sensor and displaying the temperature value on the application.

Sensor testing was carried out by immersing the thermometer sensor and DS18B20 sensor simultaneously without any additional behavior in the environment around the fish pond water.The temperature sensor testing process can be seen in Figure 5.


Figure 5. Sensor temperature testing process

The test results obtained 10 data on water temperature without any additional behavior on the temperature sensor as shown in Table 4.

Table 4. Temperature Sensor Test Results Using Matches and Water Temperature

| No | Censorship (°C) | Measuring instrument (°C) | Error (°C) | Error Percentage (%) |
|---|---|---|---|---|
| 1 | 28.2 | 28.2 | 0 | 0.000 |
| 2 | 28.2 | 28.2 | 0 | 0.000 |
| 3 | 28.3 | 28.2 | 0.1 | 0.355 |
| 4 | 28.3 | 28.3 | 0 | 0.000 |
| 5 | 28.5 | 28.3 | 0.2 | 0.707 |
| 6 | 28.4 | 28.4 | 0 | 0.000 |
| 7 | 28.3 | 28.4 | -0.1 | 0.352 |
| 8 | 28.2 | 28.2 | 0 | 0.000 |
| 9 | 28.3 | 28.2 | 0.1 | 0.355 |
| 10 | 28.3 | 28.2 | 0.1 | 0.355 |

Based on the results of the analysis and testing in the Table 4., the average error percentage is 0.544%. So the accuracy level of the DS18B20 sensor is 99.456%. It was found that the comparison between the DS18B20 temperature sensor and the thermometer had values that were close to the same and not much different, but at high temperatures there was quite a visible difference. It can be concluded that the DS18B20 sensor can be used to test the water quality temperature of tilapia ponds.

### 4.2 Turbidity Sensor Testing

The aim of testing the turbidity sensor is to determine the accuracy of the turbidity readings obtained from the dfrobot turbidity sensor model SKU-SEN0189 compared to the turbidity readings obtained from the turbidity meter. Turbidity sensor testing is carried out by taking a water sample using a turbidity tube and then inserting it into a turbidity meter to obtain the water turbidity value. The turbidity sample tube has ilustrated Figure 6(a) and turbidity meter Figure 6(b).

(a) (b)

Figure 6. The turbidity Meter (a) Sample Tube and (b) Turbidity Meter

From the application, 10 data can be used. The data will be compared with a turbidity meter which is measured simultaneously with a turbidity sensor for sensor calibration and data collection. The test was carried out without any additional behavior, only with a sample of the turbidity meter and turbidity sensor which was inserted into the fish pond. The data obtained can be seen in table 5.

Table 5. Fish Pond Water Tubidity Measurement Results

| No | Censorship (NTU) | Measuring instrument (NTU) | Error (NTU) | Error Percentage (%) |
|---|---|---|---|---|
| **1** | 29.8 | 31.2 | -1.4 | 4.487 |
| **2** | 29.9 | 31.1 | -1.2 | 3.859 |
| **3** | 29.5 | 31 | -1.5 | 4.839 |
| **4** | 29.8 | 30.8 | -1 | 3.247 |
| **5** | 29.3 | 30.5 | -1.2 | 3.934 |
| **6** | 29.4 | 30.1 | -0.7 | 2.326 |
| **7** | 29.6 | 30.2 | -0.6 | 1.987 |
| **8** | 30.1 | 30.4 | -0.3 | 0.987 |
| **9** | 30.2 | 31.3 | -1.1 | 3.514 |
| **10** | 30.4 | 31.2 | -0.8 | 2.564 |

Based on the results of the analysis and testing in the Table 5., the average error percentage is 2.769%. So the accuracy level of the turbidity sensor is 97.231%.It was found that the comparison between the turbidity sensor and the turbidity meter had slightly different values, because when measuring the turbidity sensor, there were small particles that could block the sensor. This causes the turbidity value to rise and fall at a position not far away. It can be concluded that the turbidity sensor can be used to test the turbidity of the water quality of tilapia ponds.

### 4.3. Fish Growth Testing

Fish growth testing is carried out to test whether the tool works well or not. If there is faster fish growth when using the tool, then it can be said that the tool is working well, but if there is no growth then the tool is not working well. Fish growth testing will be carried out by weighing the weight of the fish in fish ponds without equipment and in ponds with equipment. Fish growth data was obtained with measurement results between ponds with equipment and ponds without equipment with a weight of 2.05 kg and growth of 57% of the initial weight in ponds with equipment. Then in the pool without equipment with a weight of 1.75 kg and growth of 40%. This proves that the tool is working well and indicates that the fish are growing 17% heavier.

## 5. CONCLUSION

Based on the results of the tests that have been carried out, the following conclusions are obtained: a water quality monitoring and control system can reduce farmers' difficulties in monitoring and controlling water quality. A water quality monitoring and control system using Arduino Cloud can reduce the involvement of tilapia farming farmers.The Arduinio cloud application can be used as long as the internet network is connected to become an internet of things device.The sensors used are turbidity sensors and temperature sensors.The turbidity sensor has an accuracy rate of 97.231% with an error rate of around 2.769%. The temperature sensor has an accuracy rate of 99.456% with an error rate of around 0.544%. The water quality monitoring and control system resulted in faster fish growth by 17%. The sensors used have high accuracy, even though all sensors have accuracy above 95%.

## REFERENCES


[1] S. R. Fauzia and S. H. Suseno, “Resirkulasi Air Untuk Optimalisasi Kualitas Air Budidaya Ikan Nila Nirwana (Oreochromis niloticus) (Water Recirculation For Optimization The Water Quality Of Tilapia (Oreochromis niloticus) Cultivation).”

[2] S. Pradhana, H. Fitriyah, M. Hannats, and H. Ichsan, “Sistem Kendali Kualitas Air Kolam Ikan Nila dengan metode Jaringan Syaraf Tiruan berdasarkan PH dan Turbidity berbasis Arduino Uno,” 2021. [Online]. Available: http://j-ptiik.ub.ac.id

[3] A. Bhawiyuga and W. Yahya, “Sistem Monitoring Kualitas Air Kolam Budidaya Menggunakan Jaringan Sensor Nirkabel Berbasis Protokol LoRa,” *Jurnal Teknologi Informasi dan Ilmu Komputer*, vol. 6, no. 1, pp. 99–106, Jan. 2019, doi: 10.25126/jtiik.2019611292.

[4] Devi Puspitasari, “Kajian Kesesuaian Kualitas Air Untuk Budidaya Ikan Gurame Di Desa Ngranti Kecamatan Boyolangu Kabupaten Tulungagung,” *Mahasiswa S1 Pendidikan Geografi, Fakultas Ilmu Sosial dan Hukum, Universitas Negeri Surabaya.*, vol. 5, Nov. 2018.

[5] Y. Ari Sandy, B. Suprianto, and P. Wanarti Rusimamto, “Sistem Kendali Suhu dan Pengganti Air Otomatis pada Akuarium Menggunakan Fuzzy Logic Controller Berbasis Internet of Things.”

[6] K. Indartono, B. A. Kusuma, and A. P. Putra, “Perancangan Sistem Pemantau Kualitas Air Pada Budidaya Ikan Air Tawar,” *Journal of Information System Management (JOISM)*, vol. 1, no. 2, pp. 11–17, Jan. 2020, doi: 10.24076/JOISM.2020v1i2.23.

[7] A. Hartoyo, D. Purnomo, M. Faizal Bastiar, and E. Budihartono, “Rancang Bangun Alat Pengganti Air Aquarium Dan Pemberian Pakan Ikan Otomatis Berbasis Mikrokontroller.”

[8] N. Hassan Omer, “Water Quality Parameters,” in *Water Quality - Science, Assessments and Policy*, IntechOpen, 2020. doi: 10.5772/intechopen.89657.

[9] M. Machfudz Sa’idi, “Analisis Parameter Kualitas Air Minum (Ph, Orp, Tds, Do, Dan Kadar Garam) Pada Produk Air Minum Dalam Kemasan (Amdk) ,” *Universitas Islam Indonesia* , 2020.

[10] Envilife, “Macam-macam Alat Ukur Kualitas Air dan Fungsinya,” Envilife.
[11] Kementerian Kesehatan, “Peraturan Menteri Kesehatan Nomor 2 Tahun 2023 tentang Peraturan Pelaksanaan Peraturan Pemerintah Nomor 66 Tahun 2014 tentang Kesehatan Lingkungan.”
[12] Souza Dias, (2020, Aug. 22).*Turbidity sensors* [Online]. Coastal Wiki. Available: https://www.coastalwiki.org/wiki/Turbidity_sensors.
[13] Fajri Rachmansyah, Satrio Budi Utomo, and Sumardi, “Perancangan Dan Penerapan Alat Ukur Kekeruhan Air Menggunakan Metode Nefelometrik Pada Instalasi Pengolahan Air Dengan Multi Media Card (Mmc) Sebagai Media Penyimpanan (Studi Kasus Di Pdam Jember),” *Berkala Sainstek*.
[14] Mochamad Denny Surindra, “Unjuk Kerja Clarifier Di Instalasi Pengolahan Air Minum Pdam Dari Turbidity, Ph Dan Kadar Lumpur,” *National Conference Of Industry, Engineering And Technology*, Vol. 3, 2022.
[15] Ridho Yohan Husnira and Rivaldi Rivaldi, “Pendeteksi Kadar Air Pada Tanah Dalam Pot Untuk Mengeluarkan Peringatan Menggunakan Arduino IoT Cloud,” *Journal of Computer Science and Informatics Engineering (CoSIE)*, 2023.

## BIOGRAPHY

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