Indonesian Journal of Electronics, Electromedical Engineering, and Medical Informatics
Multidisciplinary : Rapid Review : Open Access Journal **Vol. 5, No. 3, August 2023, pp.187-192 e-ISSN: 2656-8624**

RESEARCH ARTICLE **OPEN ACCESS**

Manuscript received August 17, 2022; revised August 24, 2023; accepted August 29, 2023; date of publication August 30, 2023
Digital Object Identifier (**DOI**): https://doi.org/10.35882/ijeeemi.v5i3.272

How to cite: Adi Hermansyah, Tri Wanda Septian, Aditya Putra Perdana P, Mgs Muhammad Faris, "Prototype of Automatic Control System for Water Temperature and Acidity in Ornamental Fish Aquarium Based on Internet of Things (IOT)", Indonesian Journal of Electronics, Electromedical Engineering, and Medical Informatics, vol. 5, no. 3, pp.187-192, August. 2023

Prototype of Automatic Control System for Water Temperature and Acidity in Ornamental Fish Aquarium Based on Internet of Things (IOT)

Adi Hermansyah, Tri Wanda Septian, Aditya Putra Perdana P, and Mgs Muhammad Faris
Departement of Computer Engineering, Faculty Of Computer Science, Universtas Sriwijaya

Corresponding author: Adi Hermansyah (e-mail: adihermansyah@unsri.ac.id).

ABSTRACT The Internet of Things (IoT) has brought changes to modern life, such as automatic traffic lights, smart homes, optimizing energy utilization, and monitoring water conditions in ornamental fish. It is necessary to design an integrated system that can monitor and maintain stable water conditions and is suitable for ornamental fishing. This paper describes the design of an automatic control system tool for regulating water temperature and acidity in an IoT-based fish aquarium. The design of the tool consists of a NodeMCU ESP 8266 as the microcontroller, connected to DS18B20 to measure water temperature, and PH-4502C to measure acidity. The application of the control system in the aquarium works well, with an average temperature of 28.99 centigrade and a pH of 5.44.

INDEX TERMS NodeMCU ESP 8266, PH-4502C, DS18B20, Internet Of Things

I. Introduction

The maintenance of water conditions is very important for the survival of ornamental fish. Ornamental fish are tropical fish that require a water temperature of around 24 to 28 degrees Celsius. Ornamental fish also need water conditions with a degree of acidity, or a water pH of around 6 to 7. If these conditions are not met, then ornamental fish usually respond by becoming inactive and losing their appetite; they cannot reproduce; they swim unstable or restless; and their growth becomes stunted, which can even cause ornamental fish to die.[14][15]. Most people do not have enough time or even neglect to maintain this condition. Busy work and feeling lazy due to having to monitor water conditions manually and routinely are problems for some people. For this reason, it is necessary to design an integrated system that can monitor and maintain stable water conditions and is suitable for ornamental fish.[1][2]

The Internet of Things comes as a solution to the problem above. The Internet of Things (IoT) is the use of programming arguments that can produce an interaction between machines that are connected automatically without human intervention and without any distance or time restrictions. [7][20][22][24][25]IoT has brought changes to modern life, such as automatic traffic lights, smart homes, optimizing energy utilization, and monitoring water conditions in ornamental fish.[3][4][5]. Water plays a crucial role in the survival of ornamental fish. Optimum retention of the water environment, especially in terms of temperature and pH,[17,25] is an important factor for the health and life of ornamental fish. However, finding suitable water conditions for decorative fish is not an easy task. Sudden changes in temperature or significant pH fluctuations can cause stress and even death in ornamental fish.[5][6][7]

In this context, the main challenge to overcome is how to consistently maintain water conditions at an optimal level for ornamental fish. Climate change and human activity have had a negative impact on water quality, causing changes in temperature and pH levels that can disrupt the aquatic ecosystems where ornamental fish live. Therefore, innovative solutions are needed that can accurately monitor and control water conditions so that the environment for ornate fish remains stable and supports their lives [8][13]. Maintenance of the Internet of Things (IoT) comes as a promising solution to addressing this challenge[3][10]. By integrating intelligent sensors and connector technology, IoT solutions can provide real-time monitoring of temperature and pH in aquariums or ornamental fish habitats. The information obtained from these sensors will enable owners of decorative fish to

take prompt and appropriate action to address unwanted fluctuations in water conditions.[9][10][11].

With the Internet of Things (IoT),[12] monitoring of water conditions can be done anytime and anywhere via a smartphone that is integrated with the internet. [16][17][18][19]This monitoring also provides automation to the water heater if the water temperature is below a predetermined temperature and to the acid and wet pumps to maintain the stability of the water pH.

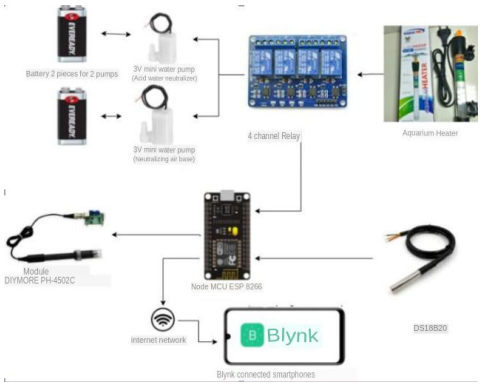


FIGURE 1. Tool design

II. Materials And Methods

The design of this tool consists of a NodeMCU ESP 8266 as the microcontroller, connected to DS18B20 to measure water temperature and PH-4502C (FIGURE 1). To connect the microcontroller to the pH sensor, another DIY MORE module is needed, which functions as a connector because the end of the pH sensor cable is round, and the DIY MORE can also adjust the voltage potentio. To be able to monitor via mobile phone requires an additional application installed on the mobile phone, namely the Blynk application. To be able to connect to the internet, of course, you must have an internet signal from a WiFi or mobile phone hotspot. To connect to Blynk, you only need to write a unique code obtained from your email, SSID, and WiFi pass.

The first one that worked was the NodeMCU ESP8266. After the nodemcu turns on, the PH-4520C sensor and the DS18B20 sensor will turn on and detect the temperature and pH of the aquarium water. If the temperature or pH of the water that is detected is not appropriate, the relay will turn on so that the heater and water pump will turn on. After detecting using a sensor and getting data results from the temperature and pH sensors, Nodemcu will then send the data to Blynk via the internet network. In making an automatic control system tool for regulating water temperature and acidity in an Internet of Things-based fish aquarium, some supporting hardware is needed. The hardware needed is:

TABLE 1
HARDWARE

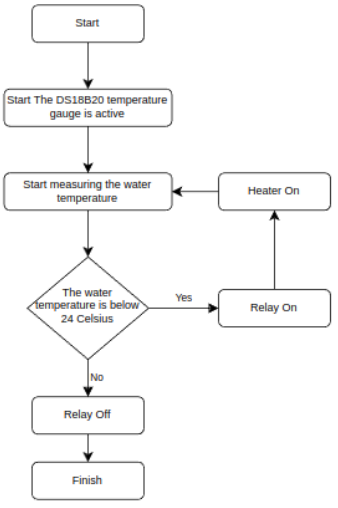
No.	Device	Total	Description
1.	ESP 8266 MCU Node	1	As a microcontroller
2.	DS18B20	1	Temperature sensor
3.	PH-4202C	1	PH Sensor
4.	DIY Module MORE	1	PH sensor module
5	Board	2	To place the tool circuit
6	Jumper cable	10	To connect the tool
7	Laptop	1	Used for tool configuration
8	Mobile phones	1	As an additional device for monitoring
9	Mini water pump 3 v	2	To spray ph liquid
10	Aquarium heater	1	To warm the water
11	Relay	1	As an on off switch for water pump and heater devices
12	Battery	2	To activate the pump

In this application, not only hardware but also software need to be considered. Without software, hardware cannot be operated. The software used in the research, namely:

TABLE 2
Software

No.	Tools	Description
1	Arduino IDE	As software for writing programs, compiling programs, and uploading programs
2	Blynk	As software that resides on mobile phones for monitoring with the concept of Internet Of Things
3	Library ESP8266iWiFi.h	Connecting the ESP8266 board to a WiFi network
4	Library BlynkSimpleShieldESP8266.h	Connecting the WiFi module of the ESP8266 to Blynk
5	Library LiquidCrystal_I2C.h	Controls the 16X2 LCD display output
6	Library DallasTemperature.h and OneWire.h	Activating the DS18B20 temperature sensor

At this stage, after designing the tool on the NodeMCU ESP8266, do the programming using the Arduino IDE software so that the tool that has been designed can function properly. The following flowchart shows the Arduino IDE program:



FiIGURE 2. Flowchart on the DS18B20 temperature device

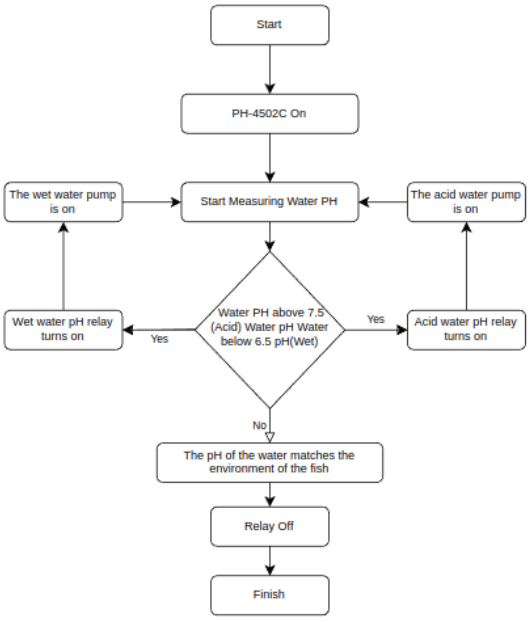


FIGURE 3. Flowchart on PH-4502C

FIGURE 2 is a flowchart of the DS18B20 temperature device. In the DS18B20 temperature program connected to the relay. If the water temperature is cold, then the relay will turn on. The relay is connected to the water heater, which, when the relay turns on, also turns on automatically. If the water temperature is suitable for the ornamental fish environment, the relay will turn off or not turn on, which makes the heater in the aquarium also turn off or not turn on. FIGURE 3 shows the PH-4502C tool. In the PH-4502C program, it is connected to two relays, namely relays that regulate acidic mini water pumps and basic mini water pumps. If the pH captured by the PH-4502C indicates alkaline, then the relay that controls the alkaline mini water pump will turn on, and vice versa, if the water is acidic, then the relay that controls the acidic mini water pump will turn on.

III. Results

In the results of this discussion, several tests and discussions will be carried out relating to measuring the temperature and pH of water that has been made with a DS18B20 temperature sensor and a PH-4502C pH sensor. The DS18B20 temperature sensor and pH-4502C sensor are used as automatic measuring instruments in ornamental fish aquarium water. To calibrate the PH-4502C sensor, two types of water with different pHs are needed: one with pH 4, or acidic, and the other with pH 7, or normal. After having two types of water with different pHs, calibration will be carried out according to the tools used. The test procedure is carried out by putting the DS18B20 temperature sensor and the pH-4502C sensor into the water in the ornamental fish aquarium. This test will show the results on mobile phones using the Blynk application. The purpose of this test is to determine the temperature and pH of the water in the ornamental fish aquarium that we have using the mobile phone we use. The distance that we can see with this tool depends on the range of WiFi signals connected to the WiFi module on the microcontroller used.

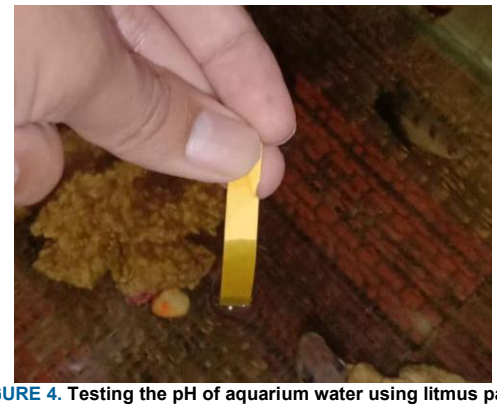


FIGURE 4. Testing the pH of aquarium water using litmus paper

In FIGURE 4, tests have been carried out on aquarium water on litmus paper. The color of the litmus paper is yellow, which indicates that the water in the aquarium is slightly acidic, as in FIGURE 5.

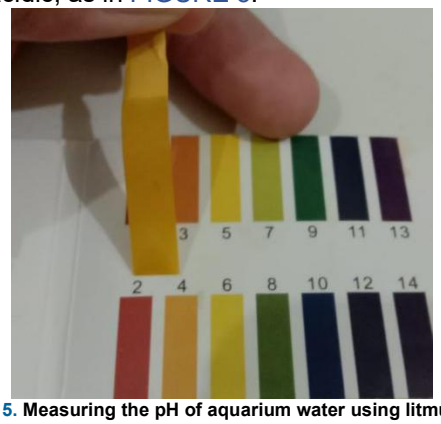


FIGURE 5. Measuring the pH of aquarium water using litmus paper

In FIGURE 5, it can be seen that the pH value in the ornamental fish aquarium is yellow, which indicates that the pH of the water is acidic, which ranges from number 5. After knowing the pH of the aquarium water, test the pH of the aquarium water using a DS18B20 sensor, which will be dipped in aquarium water as shown in FIGURE 6.

FIGURE 6. Testing the PH-4502C sensor in aquarium water

TABLE 3
Data from PH-4502C sensor on aquarium water

Time	ADC value pH	pH Voltage	pH value
01:28:15	915	2.949	5.88
01:28:21	906	2.920	6.10
01:28:27	880	2.836	6.73
01:28:34	1024	3.300	3.25
01:28:40	901	2.904	6.22
01:28:47	913	2.942	5.93
01:28:53	992	3.197	4.02

In TABLE 3, tests have been carried out on the DS18B20 sensor and result in an average pH value of 5.44. After getting the pH value, test the water temperature in the aquarium as shown in FIGURE 7.

FIGURE 8. Relay IN3 switches on to signal the water pump to switch on

In FIGURE 8, testing has been carried out on aquarium water. After the DS18B20 is dipped in the aquarium, the data obtained will be displayed in the Arduino IDE software as TABLE 4.

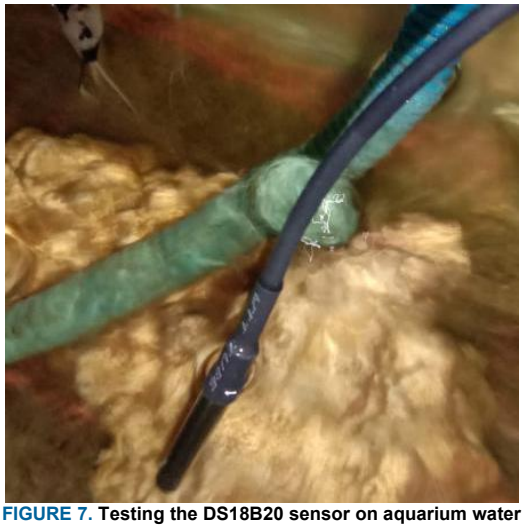


FIGURE 7. Testing the DS18B20 sensor on aquarium water

TABLE 4
Data from DS18B20 sensor on aquarium water

Time	Celsius	Fahrenheit
01:19:51	29.00C	84.20F
01:19:58	29.00C	84.20F
01:20:05	29.00C	84.20F
01:20:12	28.94C	84.09F
01:20:19	29.00C	84.20F
01:20:25	29.00C	84.20F
01:20:25	29.00C	84.20F

TABLE 4 shows the data results obtained by the DS18B20 temperature sensor, with an average value of 28.99 centigrade and 84.18 Fahrenheit. which indicates the water temperature is normal. After getting the centigrade and Fahrenheit values, test the temperature of ordinary water as shown in FIGURE 9.

FIGURE 9. Relay IN1 does not switch on indicating the heater is off

IV. Discussion

After getting all the results from the temperature and pH sensors, the device will send the data to the mobile phone via a WiFi signal connected to the microcontroller. The results will be displayed on the Blynk application as shown in FIGURE 10.

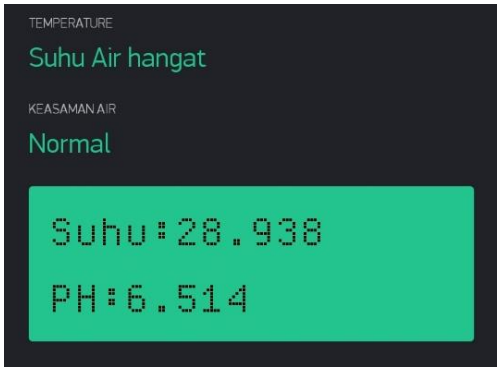


FIGURE 10. Results obtained on blynk

FIGURE 10 shows the results obtained by the DS18B20 and PH-4502C sensors that sent the data to the NodeMCU ESP8266 microcontroller. After that, the data is sent again via a WiFi signal connected to the microcontroller to Blynk, which will display the results obtained by the temperature and pH sensors earlier. After getting all the results, the data obtained will be entered into TABLE 5 in the form of a graph.

TABLE 5
Data graph

Hours	PH	Temperature
1	6	25,3
2	6,1	28,1
3	6,2	28,9
4	6,8	28,9
5	7	28,9
6	7,1	28,9
7	6,8	28,5
8	6,7	28,5
9	6,7	28,7
10	6,5	28,9
11	6,4	29,1
12	6,1	29
13	5,9	28,6
14	6,4	28,8
15	6,9	28,9
16	6,9	28,9

Hours	PH	Temperature
17	6,8	29,1
18	6,4	28,9
19	6,5	28,9
20	6,5	28,8
21	6,3	28,9
22	6,6	28,9
23	6,5	29,1
24	6,5	28,9

V. Conclusion

The design of the tool used functions well for measuring pH and water temperature in small aquariums. The average temperature that is good for ornamental fish is 25 degrees Celsius to 30 degrees Celsius, and a good pH for ornamental fish is in the range of 5 to 7. The application of the control system in the ornamental fish aquarium works well with an average temperature of 28.99 centigrade and a pH of 5.44. The control system used is a pump containing acidic or alkaline liquid, which functions to regulate the pH of the water to remain appropriate, and a heater that functions to regulate the temperature to remain at the ideal temperature for the fish. The application of the Internet of Things sends data to the Blynk application, which can be monitored via a smartphone, with a delay of 7.9 ms and packet loss of 0, which is seen using Wireshark. The results obtained are very normal, which indicates the feasibility of using the Blynk application depending on the connected internet connection. The device used must be continuously connected to an internet connection in order to be monitored through the Blynk application.

References

[1] A. Ali et al., "2014 Index IEEE Communications Letters Vol. 18," IEEE Commun. Lett., vol. 18, no. 12, pp. 2241–2304, 2014.

[2] S. A. Bkheet and J. I. Agbinya, "A Review of Identity Methods of Internet of Things (IOT)," Adv. Internet Things, vol. 11, no. 04, pp. 153–174, 2021.

[3] C.-T. Chang, C.-Y. Chang, K.-P. Shih, R. D. B. Martinez, P.-T. Chen, and Y.-D. Chen, "An IoT Multi-Interface Gateway for Building a Smart Space," Open J. Soc. Sci., vol. 03, no. 07, pp. 56–60, 2015.

[4] A. Hermansyah, R. Hardiyanti, and A. P. P. Prasetyo, "Sistem Perekam Detak Jantung Berbasis Internet Of Things (IoT) dengan Menggunakan Pulse Heart Rate Sensor," JTEV (Jurnal Tek. Elektro dan Vokasional), vol. 8, no. 2, p. 338, 2022.

[5] A. Hu, T. Lv, H. Gao, Z. Zhang, and S. Yang, "An ESPRIT-based approach for 2-D localization of incoherently distributed sources in massive MIMO systems," IEEE J. Sel. Top. Signal Process., vol. 8, no. 5, pp. 996–1011, 2014.

[6] C. Hu, H. Liu, J. Qu, D. Wang, and J. Ru, "Coagulation behavior of aluminum salts in eutrophic water: Significance of Al13 species and pH control," Environ. Sci. Technol., vol. 40, no. 1, pp. 325–331, 2006.

[7] S. F. Islam, M. I. Hasan, M. Akter, and M. S. Uddin, "Implementation and Analysis of an IoT-Based Home Automation Framework," J. Comput. Commun., vol. 09, no. 03, pp. 143–157, 2021.

[8] S. Journal, "International Journal of Cosmetic Science, 2005, 27, 251–252," Int. J., vol. 39, no. 1, pp. 251–252, 2005.

[9] J. KANG, M. WANG, and Z. XIAO, "Modeling and Control of pH in Pulp and Paper Wastewater Treatment Process," J. Water Resour. Prot., vol. 01, no. 02, pp. 122–127, 2009.

[10] V. de P. N. Kwizera, Z. Li, V. E. Lumorvie, F. Nambajemariya, and X. Niu, "IoT Based Greenhouse Real-Time Data Acquisition and Visualization through Message Queuing Telemetry Transfer (MQTT) Protocol," Adv. Internet Things, vol. 11, no. 02, pp. 77–93, 2021.

[11] T. Lv, Z. Lin, P. Huang, and J. Zeng, "Optimization of the energy-efficient relay-based massive IoT network," IEEE Internet Things J., vol. 5, no. 4, pp. 3043–3058, 2018.

[12] S. Madakam, R. Ramaswamy, and S. Tripathi, "Internet of Things (IoT): A Literature Review," J. Comput. Commun., vol. 03, no. 05, pp. 164–173, 2015.

[13] R. E. Moosbrugger, M. C. Wentzel, G. A. Ekama, and G. V Marais, "Weak Acid Bases and Ph Control in Anaerobic Systems - a Review," Water Sa, vol. 19, no. 1, pp. 1–10, 1993.

[14] A. R. Nimodiya and S. S. Ajankar, "A Review on Internet of Things," Int. J. Adv. Res. Sci. Commun. Technol., vol. 113, no. 1, pp. 135–144, 2022.

[15] H. Ning and H. Liu, "Cyber-Physical-Social Based Security Architecture for Future Internet of Things," Adv. Internet Things, vol. 02, no. 01, pp. 1–7, 2012.

[16] J. O. Payero, A. Mirzakhani-Nafchi, A. Khalilian, X. Qiao, and R. Davis, "Development of a Low-Cost Internet-of-Things (IoT) System for Monitoring Soil Water Potential Using Watermark 200SS Sensors," Adv. Internet Things, vol. 07, no. 03, pp. 71–86, 2017.

[17] D. Radev, G. Peeva, and V. Nenov, "pH Control during the Struvite Precipitation Process of Wastewaters," J. Water Resour. Prot., vol. 07, no. 16, pp. 1399–1408, 2015.

[18] J. Ramírez-Faz, L. M. Fernández-Ahumada, E. Fernández-Ahumada, and R. López-Luque, "Monitoring of temperature in retail refrigerated cabinets applying iot over open-source hardware and software," Sensors (Switzerland), vol. 20, no. 3, 2020.

[19] K. S. Aloufi and O. H. Alhazmi, "A Hybrid IoT Security Model of MQTT and UMA," Commun. Netw., vol. 12, no. 04, pp. 155–173, 2020.

[20] K. S., S. T.V., M. S. Kumaraswamy, and V. Nair, "IoT based Water Parameter Monitoring System," no. Icces, pp. 1299–1303, 2020.

[21] A. K. Sikder, G. Petracca, H. Aksu, T. Jaeger, and A. S. Uluagac, "A Survey on Sensor-Based Threats and Attacks to Smart Devices and Applications," IEEE Commun. Surv. Tutorials, vol. 23, no. 2, pp. 1125–1159, 2021.

[22] M. Singh and S. Ahmed, "IoT based smart water management systems: A systematic review," Mater. Today Proc., vol. 46, no. xxxx, pp. 5211–5218, 2020.

[23] A. Tiwari, V. Dhiman, M. A. M. Iesa, H. Alsarhan, A. Mehbodniya, and M. Shabaz, "Patient Behavioral Analysis with Smart Healthcare and IoT," Behav. Neurol., vol. 2021, 2021.

[24] A. Ullah, S. Aktar, N. Sutar, R. Kabir, and A. Hossain, "Cost Effective Smart Hydroponic Monitoring and Controlling System Using IoT," Intell. Control Autom., vol. 10, no. 04, pp. 142–154, 2019.

[25] B. Veerasekharreddy, S. Sarath, J. Philip, U. S. Reddy, L. Naresh, and K. Tejaswini, "Water Quality Monitoring System using IoT and Cloud," Int. Conf. Sustain. Comput. Smart Syst. ICSCSS 2023 - Proc., pp. 1036–1042, 2023.

[26] D. Voumick, P. Deb, and M. M. Khan, "Operation and Control of Microgrids Using IoT (Internet of Things)," J. Softw. Eng. Appl., vol. 14, no. 08, pp. 418–441, 2021.