Development of Water Quality Monitoring Systems in Super Intensive Aquaculture System using ESP32 and Blynk

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Abstract: Best water quality is the most important medium to optimize fish growth in a super-intensive aquaculture system. Any changes in the parameter of water will affect fish growth and even will cause death. For this reason, parameters of water quality should be monitored in real-time and automatically send the data to the owner based on the internet of things (IoT). So that the owner will know all data in real-time and does not need to be located in the pond all day. The owner can simply look at the data on the smartphone. So working time becomes more efficient. In this study, we developed a water quality monitoring integrated, consist of (1) sensors: dissolved oxygen (DO) temperature, pH, and salinity; (2) ESP32 and ADS115 microcontrollers as controllers and ADCs; (3) display of parameter values based on IoT with the Blynk platform. This system can measure water conditions in real-time, display parameter values via a smartphone, and send notifications or alarms if there is a change in value, exceed the specified threshold. The test results show that this system can receive and send data to the Blynk application; alarm gives notification on the smartphone in the event of reading the parameter values exceed the specified threshold.

1 INTRODUCTION

Aquaculture is an up-and-coming food production sector. Business projections in Indonesia indicate that aquaculture will grow to more than 10.1 tons per year, creating 8.9 million jobs equivalent to full-time employment in production and will become a sector with a production value of USD 39.5 billion by 2030 (Phillips et al., 2016). Indonesian aquaculture production includes seaweed, tilapia, catfish, milkfish, shrimp, and tuna. However, to produce high quality of aquaculture production need good water quality. Parameter of water that affects fish growth is dissolved oxygen (DO), temperature, pH, and salinity (Wiranto & Hermida, 2010).

Changes in water quality parameters such as changes in temperature will cause decreased appetite and many calories lost, which can cause death (Fuady & Nitisupardjo, 2013). Avery changes in water quality parameters outside the standard have an impact on the pattern of life, and its development even can cause death. Therefore, it is necessary to measure water quality in real-time and control parameters so that they remain constant within the allowable value.

Water quality management and monitoring systems in aquaculture have been investigated with various method of data reading using Arduino (Anwar, Hermida, & Waslaluddin, 2018; Hongpin, Guanglin, Weifeng, Jie, & Qiuwei, 2015; Multazam & Hasanuddin, 2017; Sambora & Waluyanti, 2016; Wiranto & Hermida, 2010). However, Raspberry Pi is a lot more advanced compared with Arduino because it has an intrinsic Wi-Fi module (Ferdoush & Li, 2014). The continuously detected information is sent directly to the owner through app/Android (Hongpin et al., 2015; Kusrini, Wiranto, Syamsu, & Hasanah, 2016). Recently IoT is reaching the top level to the monitored parameter of water quality (Abinaya, Ishwarya, & Maheswari, 2019; Chavan, Patil, Chavan, Sana, & Shinde, 2018; Encinas, Ruiz, Cortez, & Espinoza, 2017; Niswar et al., 2018; Nocheski & Naumoski, 2018; Zhang, Hua, & Wang, 2013). However, for a case of water quality in super-intensive aquaculture, controlling and monitoring using ESP32 microcontroller connected to ADS115 based on the Blynk platform almost not found.

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Therefore, this research made a system design with the ESP32 controller integrated with ADS115 and data monitoring via the IoT Blynk platform. In this system, there is also an alarm that can provide notification to the owner via a smartphone. If there is a change in the parameter value that exceeds the specified threshold. Also, the data recording for one day will be sent to the owner via email.

2 METHODOLOGY

The research method consists of three parts, namely (1) system architecture design; (2) manufacturing hardware used for implementation; and (3) making software that describes the functions of each component.

2.1 System Architecture

Integrated components in this system are ESP32 module, ADC with ADS115 type, Sensor, database, Blynk platform IoT Service, mobile application, and Desktop application. Figure 1 shows the system architecture: input, process, output, connectivity, and data display.

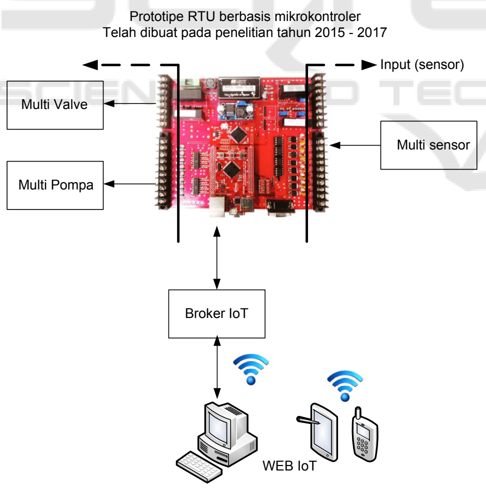

Figure 1: System architecture

In this section, there are four sensors used, namely the LM35DZ temperature sensor, the SEB0161-V2 pH sensor, the salinity sensor, and the Atlas Dissolved Oxygen sensor. Temperature, pH, and salinity sensors are connected with ADS115 to convert analog data to digital then the data is read by ESP32. Whereas the DO Sensor sends data via UART (Universal Asynchronous Transmitter-Receiver) to ESP32. Data measurement is done by immersing all of these sensors into water.

Connectivity data from the sensor transmit via Wi-Fi that is in ESP32. Wi-Fi on ESP32 works in the 2.4 GHz frequency band and transfers data up to 150 Mbit / s.

The ESP32 module is used as a controller for receiving and sending data to the internet. Data from the ESP32 module is displayed on Blynk, which is an internet-based mobile OS application platform.

2.2 Hardware

As equipment storage, we use aluminum luggage with a material thickness of 5 mm, outer size, 27x23x7cm, and inner size 26.5x1.5x6cm. In this suitcase, consist of the component, as in Figure 2.

2.2.1 Power Module

The power module has a DC-DC converter, BMS (batteries management system), and 25 units of Li-Ion 18650 Cylindrical batteries with a capacity of 2700 mAh, 3.7V voltage connected in parallel. The battery is used to supply control in the night as water quality parameters, for the most part, changes at night. A DC-DC converter use for convert voltage to scale controller module, which will work at 5V.

2.2.2 Sensor Module

The sensor module consists of pH, temperature, salinity, and DO sensors. These sensors are connected with ESP32 for detecting the water parameters.

2.2.3 Controller Module

The most important part of this project is ESP32 RTU modules as a controller. ESP32 is a low budget, inbuilt Wi-Fi module, easy write and read data programming with Arduino language, and sends that data to IoT platform.

2.2.4 Output Module

The output module consists of a relay that connected to the water pump and valve. The operation of the relay depends on a signal from the controller.

2.2.5 Display

Smartphone and 7-inch screen size tablets are used to the monitored parameter of water quality. An app of the Blynk platform has been developed in these. If the sensed data exceed the threshold ranges alert message will be shown in the monitor.

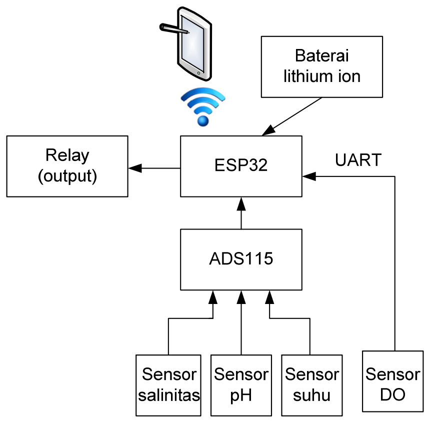

Figure 2: Hardware in the aluminum suitcase

2.3 Software

This system uses ESP32 with the Arduino programming language. We made programming of reading serial sensor data, analog sensor data, conversion of analog to digital data, connection to Blynk, sending data to Blynk, as shown in the flowchart of Figure 3.

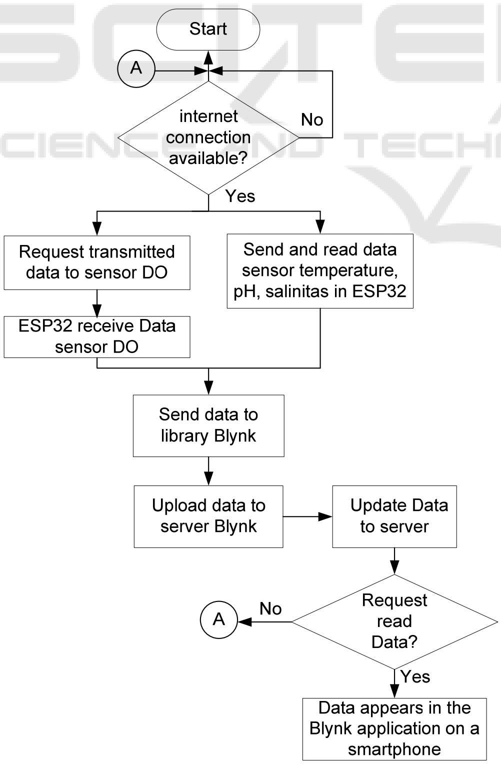

Figure 3: Flowchart system

The flowchart in the software starts with the detection of an internet connection. It must be connected to the Blynk server. If there is an internet connection, the sensor starts sending data, and ESP32 receives the data to be forwarded to the Blynk server. After the server on Blynk is updated, the data will be displayed on the Blynk application on the smartphone.

3 RESULT AND DISCUSSION

A water quality monitoring system has been developed successfully using hardware, software, and architecture that have been designed. The experiment was taken to a fishpond to test the performance of the equipment of a water quality monitoring system. Water quality parameters are set as follows:

1. The range of values for temperature = 27^0C - 33^0C
2. The range of values for PH = 5 - 8.0
3. The range of values for dissolved oxygen (DO) = 4 - 10 mg / l
4. The range of values for salinity = 0 - 1 g / l

Figure 4 shows the system implementation. An aluminum suitcase with four sensors and electronic devices are placed near the pond where the water quality will be measured, and four sensors immersed in the pond. Implementation is started at 07.00 AM until 09.00 PM.

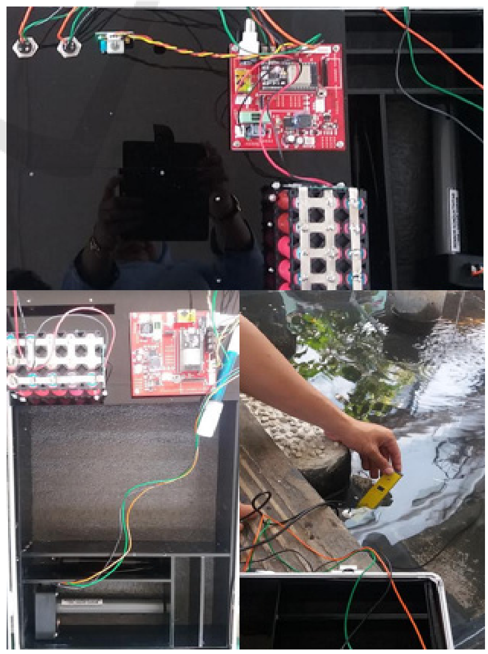

Figure 4: Implementation system

This system has a current of 0.85 a, using a lithium-ion battery of 13,500 mA/hour, the system is capable of working around 114.75 hours. This is more than enough to prove the concept of this prototype. The measurement result can be seen in Figures 5, 6, 7, 8.

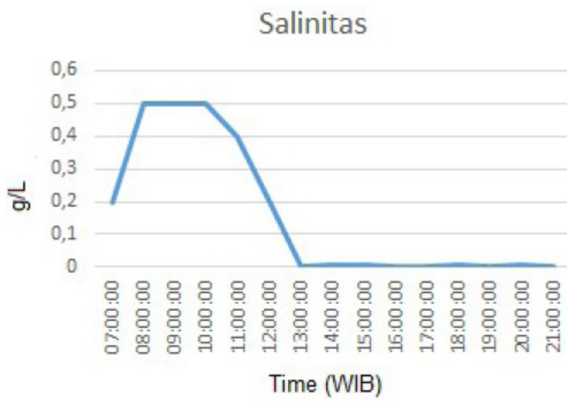

Figure 5: Data measurement from a salinity sensor

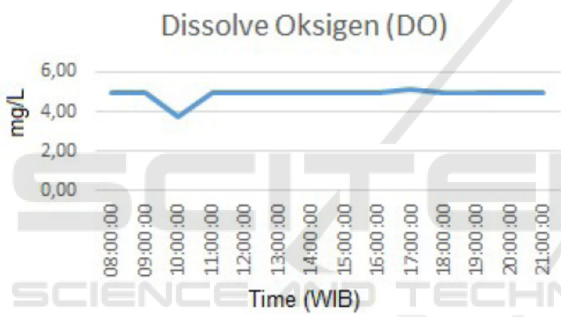

Figure 6: Data measurement from the DO sensor

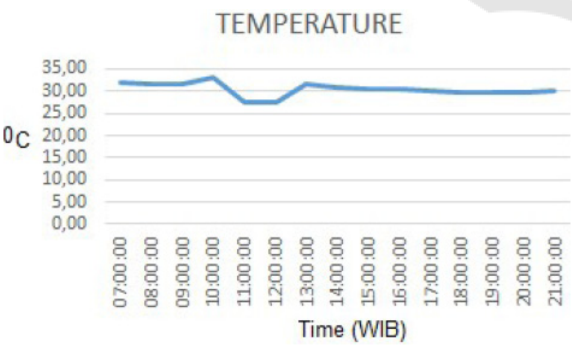

Figure 7: Data measurement from temperature sensor

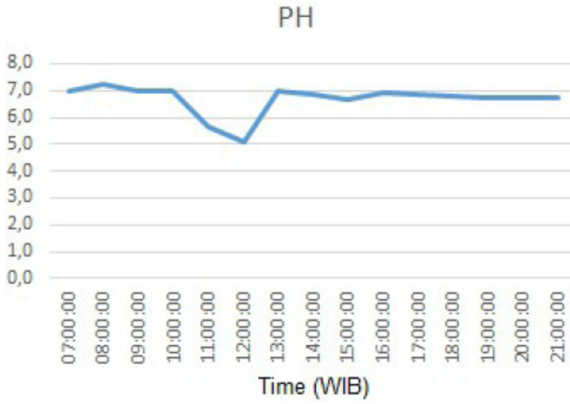

Figure 8: Data measurement from pH sensor

From figure 5-8, we can see that all of the measurement was taken from 07.00 AM until 09.00 PM. All data are within the standard range of values: salinity is 0-0,5 g/L, DO tends to be constant at 5 mg/L, the temperature in range 27^{0}C-33^{0}C, and PH stable at 7.

These data send to IoT with the Blynk platform every second. Display data in a smartphone or tablet can be seen in Figure 9.

Figure 9: Display data in smartphone

From Figure 9, it can be seen that the data of each sensor appears on the smartphone display. Also, history data appears in graphical form. This data history can be sent to the owner if needed via email in the form of data.csv.

If there is a sensor reading condition exceed the standard threshold, a notification will appear on the smartphone, as shown in Figure 10.

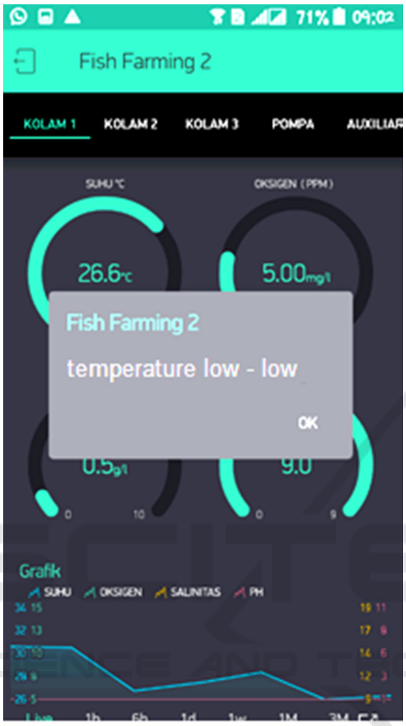

Figure 10: Display of alert in smartphone

Figure 10 shows that the temperature that occurred was 26.6^{0}C. Because this temperature exceeds the standard threshold, the notification "Temperature low-low" appears. Similar to other parameters, if the measurement exceeds the range of standard values, this notification will show.

4 CONCLUSIONS

This study presents a prototype implementation of the concept of a remote monitoring system with IoT technology aimed at monitoring water quality in aquaculture. The test results prove that the system has worked well and able to measure the values of water parameters such as pH, temperature, salinity, and DO.

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REFERENCES

Abinaya, T., Ishwarya, J., & Maheswari, M. 2019. A Novel Methodology for Monitoring and Controlling of Water Quality in Aquaculture using Internet of Things (IoT). Paper presented at the 2019 *International Conference on Computer Communication and Informatics (ICCCI)*.

Anwar, H., Hermida, I. D. P., & Waslaluddin, W. 2018. Rancang Bangun Sistem Telemetri Wireless Realtime Monitoring Kualitas Air Terintregrasi Dengan Automatic Sampling Dan Aplikasi Database Berbasis Mikrokontroler. *Fibusi (Jurnal Online Fisika), 3*(3).

Chavan, M., Patil, M. V. P., Chavan, S., Sana, S., & Shinde, C. 2018. Design and implementation of IOT based real time monitoring system for aquaculture using raspberry pi. *International Journal on Recent and Innovation Trends in Computing and Communication, 6*(3), 159-161.

Encinas, C., Ruiz, E., Cortez, J., & Espinoza, A. 2017. Design and implementation of a distributed IoT system for the monitoring of water quality in aquaculture. *Paper presented at the 2017 Wireless Telecommunications Symposium (WTS).*

Ferdoush, S., & Li, X. 2014. Wireless sensor network system design using Raspberry Pi and Arduino for environmental monitoring applications. *Procedia Computer Science, 34*, 103-110.

Fuady, M. F., & Nitisupardjo, M. 2013. Pengaruh Pengelolaan Kualitas Air Terhadap Tingkat Kelulushidupan Dan Laju Pertumbuhan Udang Vaname (Litopenaeus Vannamei) Di Pt. Indokor Bangun Desa, Yogyakarta. *Management of Aquatic Resources Journal, 2*(4), 155-162.

Hongpin, L., Guanglin, L., Weifeng, P., Jie, S., & Qiuwei, B. 2015. Real-time remote monitoring system for aquaculture water quality. *International Journal of Agricultural and Biological Engineering, 8*(6), 136-143.

Kusrini, P., Wiranto, G., Syamsu, I., & Hasanah, L. 2016. Sistem Monitoring Online Kualitas Air Akuakultur untuk Tambak Udang Menggunakan Aplikasi Berbasis Android. *Jurnal Elektronika dan Telekomunikasi, 16*(2), 25-32.

Multazam, A. E., & Hasanuddin, Z. B. 2017. Sistem monitoring kualitas air tambak udang vaname. *JURNAL IT: Media Infromasi STMIK Handayani Makassar, 8*(2), 118-125.

Niswar, M., Wainalang, S., Ilham, A. A., Zainuddin, Z., Fujaya, Y., Muslimin, Z., . . . Fall, D. 2018. *IoT-based Water Quality Monitoring System for Soft-Shell Crab Farming.* Paper presented at the 2018 *IEEE*

International Conference on Internet of Things and Intelligence System (IOTAIS).

Nocheski, S., & Naumoski, A. 2018. Water Monitoring Iot System For Fish Farming Ponds. *Industry 4.0, 3*(2), 77-79.

Phillips, M., Henriksson, P., Tran, N., Chan, C., Mohan, C., Rodriguez, U., . . . Koeshendrajana, S. 2016. Menjelajahi masa depan perikanan budidaya Indonesia (Exploring Indonesian aquaculture futures).

Sambora, Y. M., & Waluyanti, S. 2016. Monitoring Kualitas Air Pada Budidaya Udang Berbasis ATMEGA328 Yang Terkonfigurasi Bluetooth HC-05. *E-JPTE (Jurnal Elektronik Pendidikan Teknik Elektronika), 5*(6), 72-80.

Wiranto, G., & Hermida, I. D. P. 2010. Pembuatan Sistem Monitoring Kualitas Air Secara Real-Time dan Aplikasinya Dalam Pengelolahan Tambak Udang. *Jurnal Teknologi Indonesia, 33*(2), 107-113.

Zhang, Y., Hua, J., & Wang, Y. B. 2013. *Application effect of aquaculture IOT system.* Paper presented at the Applied Mechanics and Materials.