CEPAT Journal of Computer Engineering: Progress, Application and Technology
Vol. 2, No. 2, September 2023, pp. 11-16
ISSN: 2963-6728, DOI: https://doi.org/10.25124/cepat.v2i03.6286

Application development IoT-based water quality control system for Vannamei post-larvae shrimp

Arief Ilham Novandi[1], Anas Satria[1], Purba Daru Kusuma[1], Reza Rendian Septiawan[1]
[1]Department of Computer Engineering, School of Electrical Engineering, Telkom University, Indonesia

Article Info

Article history:

Received July 6, 2023
Revised July 27, 2023
Accepted July 31, 2023

Keywords:

IoT
Blynk
Vannamei
Aquaculture
Arduino

ABSTRACT

The *vannamei* shrimp is a type of shrimp that has a natural habitat in the Pacific Coast, and Mexico. This shrimp entered Indonesia in 1996 when tiger shrimp experienced a decline in production due to disease attacks caused by the White Spot virus. Demand for this shrimp immediately increased rapidly, requiring innovation to keep shrimp yields in line with market demand. The problem in *vanamei* shrimp farming is water quality, especially water temperature conditions where shrimp live. This shrimp prefer water conditions that have temperatures around 27-29°C. A water quality control system developed to maintain water conditions in accordance with the best conditions for P. *vannamei* shrimp to increase yields due to reduced mortality rates. Based on this problem, an IoT based water quality control system for the shrimp is developed. Meanwhile, this work is aimed at developing the application supporting this system.

Corresponding Author:

Arief Ilham Novandi
Department of Computer Engineering
School of Electrical Engineering, Telkom University
Bandung, Indonesia
Email: ariefilhamnvdi@telkomuniversity.ac.id

1. INTRODUCTION

The Indonesian shrimp industry faced an unpredictable situation caused by the white spot syndrome virus (WSSV) that plagued the black tiger shrimp (Penaesus monodon) industry in 1994. In 1996, many private sectors in Indonesia started introducing white leg shrimp (Penaesus vannamei). Ensuring shrimp market demand. White leg shrimp has specific advantages over black tiger shrimp, such as faster growth rate, higher tolerance to low salinity, and some disease resistance [1].

Shrimp play a vital part in the global market as a product of the fisheries and aquaculture industries. According to the 2019 FAO (Food and Agriculture Organization) fisheries and aquaculture annual statistics report, both the number and value of shrimp trade grow annually. Shrimp trade totaled 5.446.216 tons and USD 32.190.978 in volume and value, respectively, in 2019[2], [3].

The concern that P. vannamei can also be impacted by WSSV has arise as a result of the P. vannamei shrimp cultivation's fast expansion and the switch from the P. monodon pond to the P. vannamei pond, especially the illegally imported shrimp that was not specific pathogen free (SPF) [1]. However, P. vannamei production is preferred by Indonesian shrimp farmers because to its benefits, and as of 2020, shrimp is the top export of the fisheries industry with 39,68% of contribution and an export value of USD 2.064.612.816,04 [4]–[6].

However, viruses and disease still a problem for the P. vannamei shrimp cultivation. The post-larvae (PL) known as pre-juveniles stage, also have high sensitivity in lower temperature which could lead to disease and toxicity [7] The severe mortality of shrimp infected with WSSV [8], [9], and Decapod Iridescent Virus 1 (DIV1) [10] is reduced by warm water temperatures between 28°C and 33°C. A water temperature between 26°C and 28°C produced better results for shrimp farming. As a result, temperature has a significant impact in shrimp development [11]–[13].

Based on prior research, raising the water temperature can reduce P. *vannamei* shrimp mortality rates. This work is aimed to develop an application for an IoT-based system that can monitor water conditions so it can help shrimp farmers to keep the best water conditions for P. *vannamei* shrimp. By using a Wifi-based microcontroller, shrimp farmers can track water condition and control water temperature using an application called *Blynk*. The app itself is available on Ios and Android so farmers can track water conditions remotely. This paper will explain how to connect and configure *Blynk* app into IoT-Based Water Quality Control System for Post-Larvae *Vannamei* Shrimp.

2. METHOD

The objective of this paper is implementing *Blynk* app into IoT-Based Water Quality Control System for Post-Larvae *Vannamei* Shrimp. With functionality is controlling water conditions with 28-29°C range to improve the P. *vannamei* shrimp quality life at post-larvae [7], [8], [10]–[12].

According to the materials specification, which was based on an interview with MMAFI Research and Human Resource Agency, the system uses primarily accessible materials that are inexpensive, simple to maintain, and can operate continuously. The process for creating this system begins with a search for the essential resources, which are generally available online. The sensors, water heater, water pump, and WiFi-based microprocessor are the system's primary components.

After all materials is gathered, A relay module circuit is necessary to prevent damage to the microcontroller and a fire danger from a short circuit since the microcontroller operates on direct current (DC), as opposed to the water heater and water pump, which run on alternating current (AC). A small size 39x24x28cm aquarium for the shrimp to live in is also required.

The system is intended to run continuously for 24 hours while delivering the farmer temperature data and keeping the water between 27°C and 29°C. These figures were obtained from previous research. While the hardware has been installed and configured, a software is needed to keep on check for the sensor for farmers, A complete software package called *Blynk* makes it possible to prototype, deploy, and remotely manage linked IoT devices at any size [14]. This paper uses *Blynk* App to control and monitor all the sensors attached to Wi-Fi-based Microcontroller.

3. RESULTS AND DISCUSSION

Based on the specifications that were previously stated in the method section, the components and tools that were utilized in the Application development for IoT-Based Water Quality Control System for Post-Larvae *Vannamei* Shrimp.

The Arduino Integrated Development Environment (IDE) is the software used to write the appropriate code to the microcontroller. The Arduino IDE is open-source software with sketches written in a language based after the Processing language that runs on a computer to compile and upload program code in C language onto an Arduino-compatible microcontroller board[16]. While the software that has been used for monitoring that is compatible with microcontroller is called *Blynk*. Blynk is a network-based application service for controlling microcontrollers. Blynk is relatively simple to use since the applications itself can be constructed and adjusted based on user preferences.

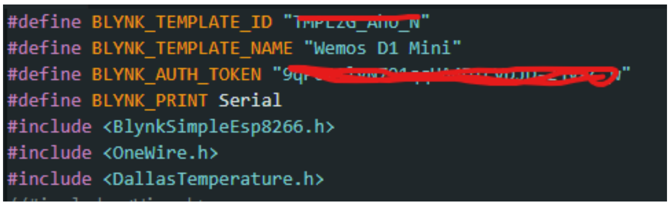

Figure 1. Library that been used in this system.

Based on figure 1, this system uses certain libraries which are explained as follows.

1. BLYNK_TEMPLATE, BLYNK_AUTH, BLYNK_PRINT
   These libraries are for defining a constant and assign in certain values, especially BLYNK_AUTH_TOKEN which is the authentication token for blynk project or application, the token is a unique identifier set to authenticate and authorize the device to communicate with the Blynk server.
2. BlynkSimpleEsp9266.h
   This library is used to make Blynk integration with ESP8266-based microcontrollers easier by allowing them to connect to the Blynk cloud platform and communicate with the Blynk mobile app.

3. OneWire.h
   This library contains methods and utilities for OneWire protocol communication, which allows devices to communicate over a single data cable.
4. DallasTemperature.h
   The DallasTemperature library is used to interface with Dallas Semiconductor (now Maxim Integrated) temperature sensors that use the OneWire protocol for communication, such as the DS18B20.

```
14  OneWire  ds1(D4);
15  int pemanas1 (D6);
16  int pompa (D7);
17  DallasTemperature DS18B20(&ds1);
18  float temp;
19  float Fahrenheit=0;
20  int setpointup=29;
21  int setpointdown=26;
22  DeviceAddress sensPem = { 0x28, 0x15, 0x0D, 0x81, 0xE3, 0x4E, 0x3C, 0x6D };
23  DeviceAddress sensPom = { 0x28, 0x9E, 0x54, 0x49, 0xF6, 0xDB, 0x3C, 0x7F };
24  float sens1;
25  float sens2;
26  float avg;
```

Figure 2. Source code for declaration.

On Figure 2 These lines of code set up the necessary variables and instances for working with the DS18B20 temperature sensors, control pins for heating and pump elements, and define setpoints for temperature control in the system, which the explanation as follow.

1. Line 14-17
   In this line this is where sensors and actuators are assigned, the value after the name is where the pin is assigned for example in here is int pompa where the pin in Wemos is in D7.
2. Line 18-21
   Line 18-21 is the constant for temperature measures, which is setting up a maximum temperature which in value is 29 °C and minimum temperature which in value is 26°C.
3. Line 22 and 23
   This line defines and initializes an array of bytes named sensPem and sensPom with a specified sequence of hexadecimal values.
4. Line 24-26
   This line to stores value from sensPem and sensPom but also to average the values from both sensors in sens1 and sens2.

```
BLYNK_WRITE(V5)
{
  setpointup = param.asInt();
//  Serial.println(setpointup);
}
BLYNK_WRITE(V6)
{
  setpointdown = param.asInt();
}
BLYNK_WRITE(V3)
{
  int pinValue = param.asInt();
  if (pinValue == 1){
    // execute this code if the switch widget is now ON
    digitalWrite(pompa, HIGH);  // Set digital pin 2 HIGH
  }

  else
  {
    // execute this code if the switch widget is now OFF
    digitalWrite(pompa, LOW);  // Set digital pin 2 LOW
  }

}
```

Figure 3. Source code for virtual pins.

```
BLYNK_WRITE(V7)
{
  int pinValue = param.asInt();
  if (pinValue == 1){
    // execute this code if the switch widget is now ON
    digitalWrite(pompa, HIGH);
    digitalWrite(pemanas1, HIGH);
    Blynk.virtualWrite(V8, HIGH);
  }

  else
  {
    // execute this code if the switch widget is now OFF
    digitalWrite(pompa, LOW);
    digitalWrite(pemanas1, LOW);
    Blynk.virtualWrite(V8, LOW);
  }
```

Figure 4. Source code for virtual pins.

Figures 3 and 4 are source code for establishing event handlers for certain virtual pins for Blynk app. When these virtual pins are written to using the Blynk app, the relevant functions are called, and specific actions are taken based on the data received. Updating variables, altering the state of pins (setting them high or low), and sending virtual write commands to other virtual pins among the activities.

```
void setup()
{
  delay(7000);
  Serial.begin(9600);
  Blynk.begin(auth, ssid, pass);
  DS18B20.begin();
  pinMode (pemanas1, OUTPUT);
  pinMode (pompa, OUTPUT);
  timer.setInterval(1000L, getSendData);
}

void loop()
{
  //delay(500);
  temp = DS18B20.getTempCByIndex(0);
  {
  timer.run();
  Blynk.run();
  }
}
```

Figure 5. Source code for the main program.

In Figure 5, The setup function oversees initializing different components, including serial communication, Blynk connections, temperature sensors, and pin modes. The loop function reads the temperature from the sensor periodically, executes the tasks associated with the timer object, and runs the background tasks of the Blynk library.

```
void getSendData()
{
  DS18B20.requestTemperatures();
  delay(2000);
  //temp = DS18B20.getTempCByIndex(0); // Celcius
  sens1 = DS18B20.getTempC(sensPem);
  sens2 = DS18B20.getTempC(sensPom);
  avg = (sens1+sens2)/2;
  Blynk.virtualWrite(V9, sens1);
  Blynk.virtualWrite(V10, sens2);
  Blynk.virtualWrite(V1, avg); //virtual pin V1
if (avg<setpointdown){
    //Blynk.notify("Suhu kurang dari 27 derajat celcius");
    digitalWrite(pemanas1, HIGH);
    digitalWrite(pompa, HIGH);
    Blynk.virtualWrite(V4, HIGH);
  }
  else if (avg>setpointup){
    digitalWrite(pemanas1, LOW);
    digitalWrite(pompa, LOW);
    Blynk.virtualWrite(V4, LOW);
  }

}
```

Figure 6. source code for the sub main program.

In Figure 6 this function is for reading data from the sensors and writing data to control the actuators. There's a situational condition for setting up the temperature, if it's below required conditions then it activates the actuators if its above required conditions are then its deactivated the actuators.

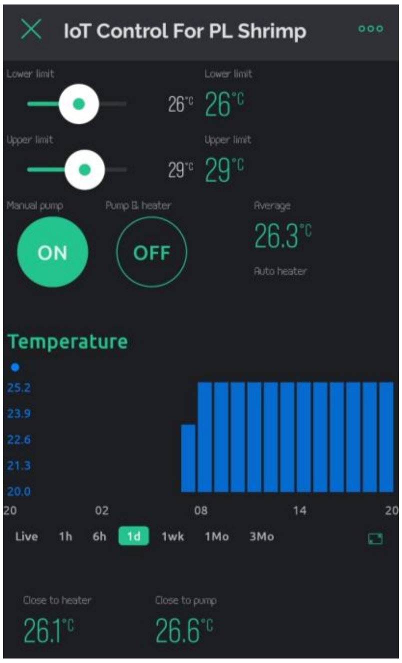

Figure 7. Dashboard of the IoT system.

In Figure 7, this is dashboard of the IoT System, it shows the control and sensors read such as controlling desired temperature, a manual button for pump, display for current value from both sensors and history of temperature by history bar.

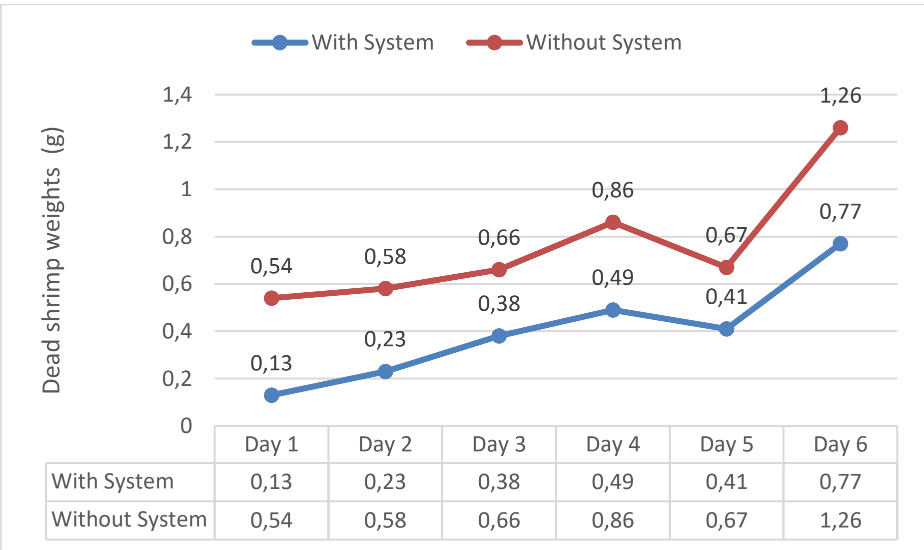

Figure 8. Differences using system and without by dead shrimp weights.

In Figure 8, differences in performance between using the system and without the system are portrayed by curve. Based on the performance, shrimps that lived with the system have more survival chance than without the system within average percentage is 50,10%.

4. CONCLUSION

It can be concluded that using Blynk app in implementing monitoring systems for IoT-based water quality control system for post-larvae *Vannamei* shrimp is needed, as it can improve shrimp's health and performance of the shrimps. Based on results by using the system, shrimps have more survival chance in 6 days experiments by at least 50,10% differences without the system. While also using Blynk app as the controller and monitoring the pond without direct contact increasing safety and comfort for farmers. But also, farmers can change the configuration based on their preference so it can be changed to different shrimps or even fish.

REFERENCES

[1] M. Briggs, S. Funge-Smith, R. Subasinghe, and M. Phillips, “Food and Agriculture Organization of The United Nations Regional Office For Asia And The Pacific: Introductions and movement of Penaeus vannamei and Penaeus stylirostris in Asia and the Pacific,” Bangkok, 2004.

[2] Food and Agriculture Organization of the United Nations, *FAO Yearbook. Fishery and Aquaculture Statistics 2019/FAO annuaire. Statistiques des pêches et de l’aquaculture 2019/FAO anuario. Estadísticas de pesca y acuicultura 2019*. FAO, 2021. doi: 10.4060/cb7874t.

[3] H. Dugassa and D. G. Gaetan, “Biology of white leg shrimp, Penaeus vannamei: Review,” *World Journal of Fish and Marine Sciences*, vol. 10, no. 2, pp. 5–17, 2018, doi: 10.5829/idosi.wjfms.2018.05.17.

[4] F. Amelia, A. Yustiati, and Y. Andriani, “Review of shrimp (Litopenaeus vannamei (Boone, 1931)) Farming in Indonesia: Management Operating and Development”, [Online]. Available: www.worldscientificnews.com

[5] L. A. Wati, “Analyzing the development of Indonesia shrimp industry,” *IOP Conf Ser Earth Environ Sci*, vol. 137, p. 012101, Apr. 2018, doi: 10.1088/1755-1315/137/1/012101.

[6] [MMAFI] Ministry of Marine Affairs and Fisheries of Indonesia, “MMFI Annual Report 2020,” 2020.

[7] A. P. Pawar, S. V. Sanaye, S. Shyama, R. A. Sreepada, and A. S. Dake, “Effects of salinity and temperature on the acute toxicity of the pesticides, dimethoate and chlorpyrifos in post-larvae and juveniles of the white leg shrimp,” *Aquac Rep*, vol. 16, p. 100240, Mar. 2020, doi: 10.1016/j.aqrep.2019.100240.

[8] O. M. Vidal, C. B. Granja, F. Aranguren, J. A. Brock, and M. Salazar, “A profound effect of hyperthermia on survival of Litopenaeus vannamei Juveniles infected with white spot syndrome virus,” *J World Aquac Soc*, vol. 32, no. 4, pp. 364–372, Dec. 2001, doi: 10.1111/j.1749-7345.2001.tb00462.x.

[9] M. M. Rahman *et al.*, “The effect of raising water temperature to 33 °C in Penaeus vannamei juveniles at different stages of infection with white spot syndrome virus (WSSV),” *Aquaculture*, vol. 272, no. 1–4, pp. 240–245, Nov. 2007, doi: 10.1016/j.aquaculture.2007.07.228.

[10] X. Liao *et al.*, “The effect of water temperature on the pathogenicity of decapod iridescent virus 1 (DIV1) in Litopenaeus vannamei,” *Israeli Journal of Aquaculture - Bamidgeh*, vol. 74, 2022, doi: 10.46989/001C.33012.

[11] H. A. Abdelrahman, A. Abebe, and C. E. Boyd, “Influence of variation in water temperature on survival, growth and yield of Pacific white shrimp Litopenaeus vannamei in inland ponds for low-salinity culture,” *Aquac Res*, vol. 50, no. 2, pp. 658–672, Feb. 2019, doi: 10.1111/are.13943.

[12] A. P. Pawar, S. V. Sanaye, S. Shyama, R. A. Sreepada, and A. S. Dake, “Effects of salinity and temperature on the acute toxicity of the pesticides, dimethoate and chlorpyrifos in post-larvae and juveniles of the whiteleg shrimp,” *Aquac Rep*, vol. 16, Mar. 2020, doi: 10.1016/j.aqrep.2019.100240.

[13] V Venkateswarlu, PV Seshaiah, P Arun, and PC Behra, “A study on water quality parameters in shrimp L. vannamei semi-intensive grow out culture farms in coastal districts of Andhra Pradesh, India,” *International Journal of Fisheries and Aquatic Studies* , vol. 7, no. 4, pp. 394–399, 2019, doi: dx.doi.org/10.22271/fish.

[14] Blynk, “Blynk Documentation,” 2023. https://docs.blynk.io/en/#blynk.apps (accessed Jul. 05, 2023).

[15] Wemos, “Wemos LOLIN D1 Mini,” 2021. www.wemos.cc/en/latest/d1/d1_mini.html (accessed Jan. 01, 2023).

[16] M. Banzi and M. Shiloh, *Getting started with Arduino*, Third Edition. Sebastopol: Maker Media, 2014.