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Design of Pond Water Temperature Monitoring Built Using NodeMCU ESP8266

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Abstract: Freshwater fish farming is currently booming in Indonesia, and many use small ponds for efficiency or due to limited location, this can be a problem due to Indonesia's hot climate. Small ponds with not much water volume will cause the water temperature to rise more easily on hot days, of course this is not good for the fish colonies in it. To prevent temperature rise, farmers generally irrigate ponds with fresh water to stabilize the water temperature. Due to the unpredictable weather in Indonesia lately, it will be difficult for farmers to monitor their ponds manually, so a tool is needed that can detect the heat of pond water and turn on the water pump to irrigate ponds. This research is expected to make it easier for farmers to regulate pond temperatures more easily. The use of a microcontroller in Internet of Thing devices is very much needed, considering that the microcontroller is able to carry out the task of controlling the existing sensors. The sensor used in this study uses a temperature sensor that is used to control the pool water. The prototype for detecting pool water temperature and increasing water flow is used to reduce heat in pool water and increase water flow that is reduced due to evaporation of water during the day. The purpose of this research is to make a prototype to detect pond water temperature and increase pond water discharge which is useful for reducing pond water temperature to be cooler and reducing the risk of fish death. The prototype developed is a NodeMCU ESP 8266 micro-controller, a temperature detection sensor in water, a relay as a switch and a mini pump.

Keywords: NodeMCU ESP 8266; Temperature Water Sensor; Freshwater Fish Farming; Relay; Micro-controller.

INTRODUCTION

The presence of self-designed products, especially home-scale fire detectors based on the Internet of Things (IoT) concept, is a highly expected requirement in the era of the Industrial Revolution 4.0 as it is today. The smart home design of a home fire detection system based on the IoT concept has succeeded in detecting a potential fire through a smartphone (Tatik Juwariyah, Sugeng Prayitno, 2018). In the smart home design, the system is connected online with a fire detection circuit. The system is able to detect potential fires and monitor the kitchen in real time. The detector prototype is assembled on a single board consisting of a fire sensor, gas sensor, ESP8266 as a Wifi connectivity module and an internet modem / router (Prayitno, 2020).

Fish cultivation in soil ponds, water conditions really need to be kept at the temperature of the pond water, this is what causes fish to grow well. Water plays an important role in the sustainability of fish life. Extreme temperatures, hot or cold cause health problems for fish. To keep the water stable, a water temperature detection device and a pump are needed to provide maximum water supply. The water recedes and conditions during the day cause the water temperature to increase. One way is to add water so that the pool water temperature can be maintained (Suriana et al., 2021), (Haryanto, 2018), (Indriyanto et al., 2020).

The use of a micro-controller in detecting pool water. The micro-controller used is Arduino, with the model NodeMCU ESP 8266. And a special temperature sensor for water detection using Piece DS18b20. The use of pumps and relays as conductors and circuit breakers, is similar to the use of switches. As soon as the water decreases and the temperature increases, the status relay is ON to drive the pump. When the pump is on, the water increases and the temperature of the water decreases. This method has become a solution to overcome the hot water temperature in the pool. All temperature measurements will be sent via WIFI to the server. The process of recording temperature change information into a database is interpreted by a Data Logger (Idris & Jaya,

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2014), (Ramadhan et al., 2020). Where the Data Logger will be analyzed using data analysis (Data Science). So that it can be known a certain period of time the water in the pool becomes hot. At certain periods the temperature of the pool water becomes colder. Factors that are too extreme temperature changes are the cause of fish health. Fish will be stunted if the water temperature difference is too drastic. Especially if the fish are still too small.

One of the reasons for using the NodeMCU ESP 8266 micro-controller, is because this micro-controller has complete features. The communication feature uses WIFI, it requires a low power consumption of 3.3 volts. There are more Digital pins (D0-D8), but the drawback is that the analog pin is only one pin A0. The purpose of this study is to solve the problem of the pool water temperature being too hot to turn colder, by using a prototype detection of the pool water temperature and turning on the water pump to increase the pool water discharge. This process will reduce the temperature conditions to be more comfortable for the fish. Hopefully the fish will be healthier. This research has limitations, namely devices made using a micro-controller are limited to small prototypes and are still far from feasible for further development.

LITERATURE REVIEW

In previous studies that have discussed the temperature sensor in the pool, printer temperature sensor and monitoring system. This research does not look for the weaknesses of previous research, but is a refinement of previous research.

Table 1. Previous research on pool sensors

Author	Topic	Advantage	Disadvantage
(Su et al., 2020)	Printable, Highly Sensitive Flexible Temperature Sensors for Human Body Temperature Monitoring: A Review.	Monitor human body temperature which is closely related to human health.	The use of sensors is not accompanied by sending data over the network.
(Alimuddin et al., 2021)	Applications of temperature sensor cultivation fish and plant aquaponic with greenhouse for local food innovation.	Efficiency of utilization of nutrients from leftover feed and fish metabolism.	The weakness of this research is that there is no dashboard monitoring system and no user interface that presents history data. So it can not know or monitor the temperature.
(Abana et al., 2021)	Tetra-parameter Fish Feeding Machine.	Pool water temperature is used as one of the parameters in automatic feeding.	The weakness of this research is that there is no dashboard monitoring system and no user interface that presents history data. So it can not know or monitor the temperature.
(Senapati & Sahu, 2020)	Onsite fish quality monitoring using ultra-sensitive patch electrode capacitive sensor at room temperature	Fast and accurate detection of volatile gases produced from raw fish to determine their freshness status	The weakness of this research is that there is no dashboard monitoring system and no user interface that presents history data. So it can not know or monitor the temperature.
(Hsiao & Sung, 2020)	Building a fishfivegetable coexistence system based on a wireless sensor network	Monitor the environment of the fishfivegetable system remotely	Data from sensors is not processed to make other decisions/actions

From the shortcomings obtained from previous studies, in this study these shortcomings will be completed. Where we design a fish pond temperature control system that will detect temperature changes, every 5 seconds the temperature data will be sent to the server, the user interface in the form of a web application will display a

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graph of the water temperature from time to time, so that farmers can monitor and analyze it in the future. Another device will read the data from the server and if the temperature reaches a certain point, the system will turn on the water pump to irrigate the pool and lower the water temperature. State-of-the-art in this study discusses temperature monitoring complete with a dashboard system. This is intended to obtain data from controlling or status of pool water temperature from time to time. The purpose of this research is to create a pool water control system with the help of a micro-controller and create a dashboard monitoring system.

METHOD

In this study, we propose a methodology as shown in figure 1. The system monitors the pool water temperature using a water temperature sensor DS18b20 (Sitanayah et al., 2021). The sensor sends information through the NodeMCU 8266 micro-controller as the control medium. Then the data will be sent to the mongodb database server, via WIFI. After the data is sent to the mongodb database, then the dashboard system will display the temperature per 5 minutes from the temperature sensor.

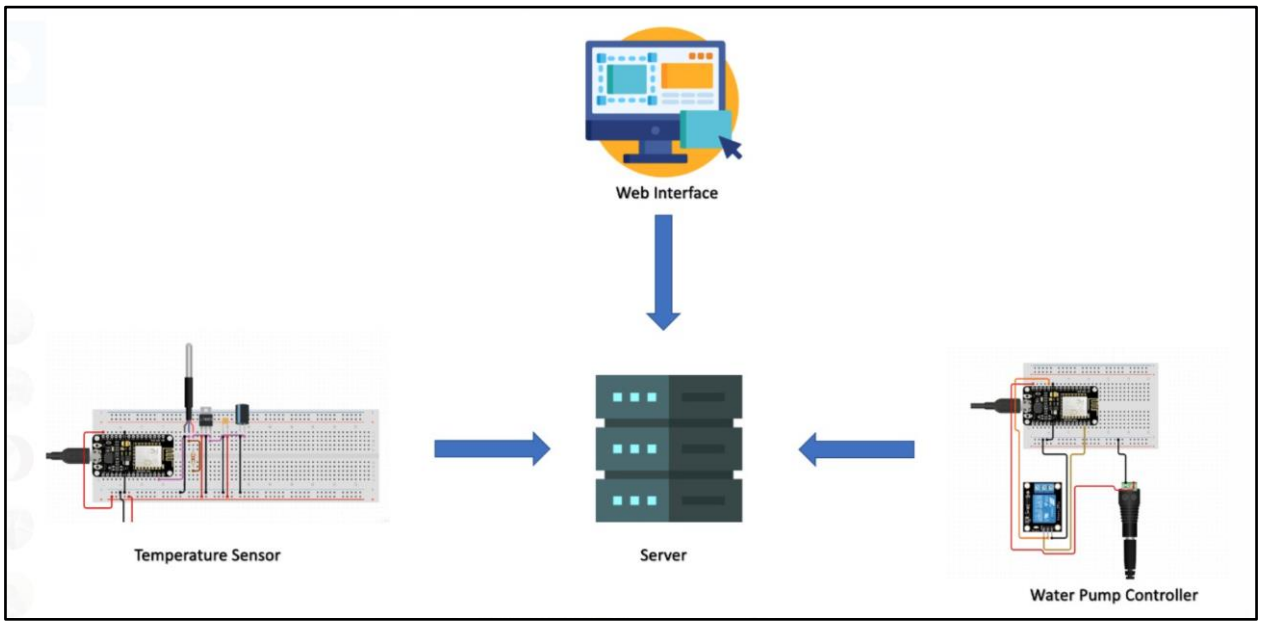

Figure 1. Architecture System Monitoring for detection of pool temperature
Source : researcher property

With this architecture, the following devices are needed:
2 MCU Node with wifi module, DS18b20 temperature sensor, 1 relay module 1 channel, VPS Server, Web Interface. The DS18b20 temperature sensor is connected to the MCU Node so that the temperature detected by the sensor can be sent by the MCU Node to the server.

Micro-controler

NodeMcu is an open source IoT platform and development kit that uses the Lua programming language to help programmers prototype IoT products or can use sketches with the Arduino IDE. This development kit is based on the ESP8266 module, which integrates General Purpose Input Output (GPIO), PWM (Pulse Width Modulation), IIC, 1-Wire and ADC (Analog to Digital Converter) all in one board. The uniqueness of the Nodemcu itself is its very small board, which is 4.83 cm long, 2.54 cm wide, and weighs 7 grams. However, despite its small size, this board is equipped with wifi features and the firmware is open source. Arduino Software The Arduino software (Jauhari et al., 2016) used is a driver and an IDE, although there is still some other software that is very useful when developing Arduino. IDE or Integrated Development Environment is a special program for computers to be able to create a design (Safii & Indrayani, 2020).

Sensor Temperature

A temperature sensor is a tool used to convert heat into electrical quantities that can be used for easy analysis. The temperature sensor uses an LM35 sensor, Op-Amp CA3140, and several other passive components. In its use, LM35 is not allowed to come into direct contact with hot/cold liquids, because a short circuit can occur and cause damage or inaccuracies in temperature measurements. There are many variations of

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the temperature sensor, some control the air temperature sensor, some are used to control the water temperature and others. Of course, for the air temperature sensor using a sensor type DHT11, DHT22.

Because it measures pool water, the DHT11 and DHT22 temperature sensors cannot be used, so use a temperature sensor for water. The DS18B20 sensor is used to detect the temperature in the water. The DS18B20 sensor is a digital sensor that has an internal 12-bit ADC. Very precise, because if the reference voltage is 5Volt, then due to temperature changes, it can feel the smallest change of 5/(212-1) = 0.0012 Volts! In a temperature range of -10 to +85 degrees Celsius, this sensor has an accuracy of +/-0.5 degrees. This sensor works using a 1-wire (one-wire) communication protocol. The DS18B20 IC has three pins, namely GND (ground, pin 1), DQ (Data, pin 2), VDD (power, pin 3). On Arduino, VDD is known as VCC. In this case, we assume VCC equals VDD. Depending on the configuration mode, these three pins of the IC must be configured first. The sensor can work in two modes, namely normal power mode and parasite power mode. In Normal Mode, GND will be connected to ground, VDD will be connected to 5V and DQ will be connected to the Arduino pin, but a 4.7k pull-up resistor is added. This mode is highly recommended in applications that involve multiple sensors and require long distances. In Parasite Mode, GND and VDD are combined and connected to ground. The DQ will be connected to the Arduino pin via a pull-up resistor. In this mode, power is obtained from power data. This mode can be used for applications that involve a small number of sensors in a short distance.

Web Interface

To control the water temperature, tools are needed, such as a temperature monitoring dashboard, which aims to monitor the temperature of the pool water regularly and continuously. Therefore, the need for a system such as a dashboard is very necessary. Development dashboard using a domain and hosting, mysql database and meteor js (Taufiqurrohman & Iwan Nurhidayat, 2016) as programming language.

RESULT

One of the results of this research is making a prototype of the NodeMCU ESP 8266 micro-controller, using a water temperature detection sensor and a mini pump. This prototype is expected to reduce the temperature of the pool water to be colder. Controlling pool water temperature monitoring using a monitoring dashboard as shown in figure 2.

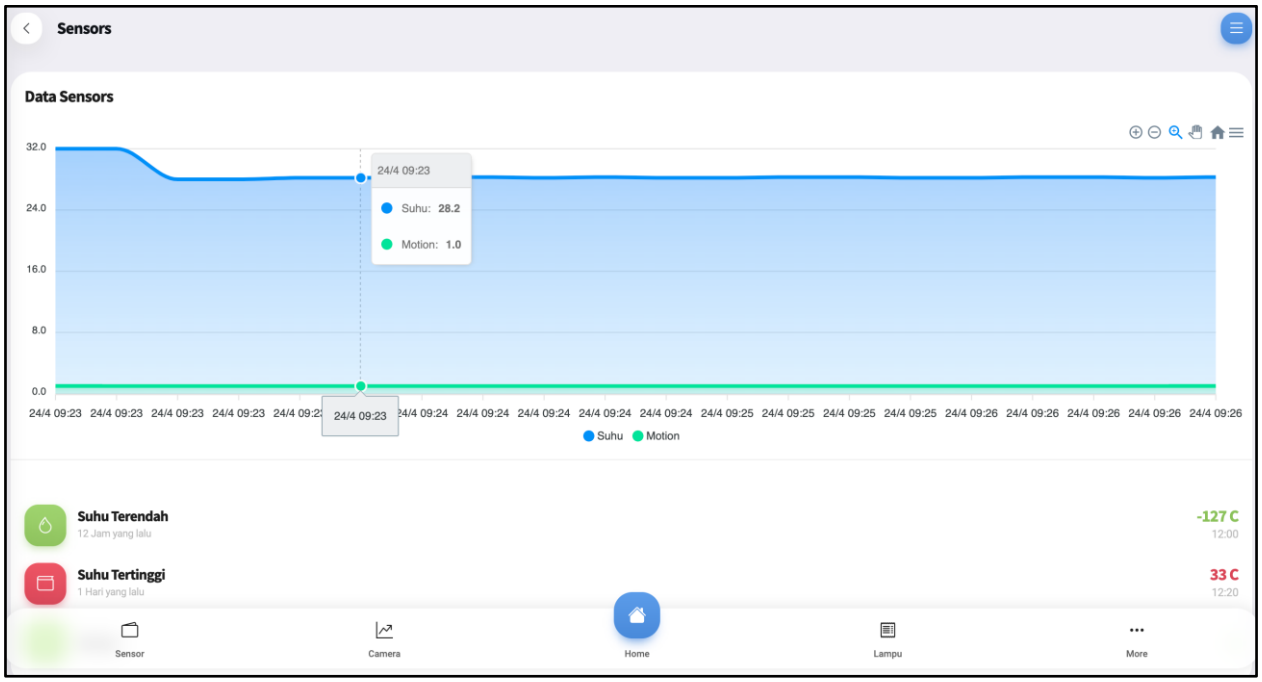

Figure. 2 Dashboard monitoring system
Source : researcher property

In figure 2, it can be seen that the temperature of the pool water has decreased from 32ºC to 28.2ºC. This decrease was due to the increase in pool water discharge. In daytime conditions, the pool temperature becomes hot, due to the hot sun and evaporation of pool water. Due to evaporation of pool water, the pool water discharge becomes less, this causes the pool water to become hotter. After adding water to the pond using a mini pump, the

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pond water becomes colder and causes the fish to be healthier. Judging from the data from the monitoring dashboard, it causes the pond water temperature to become colder and proves that making prototypes for detecting pond water temperature and water pumps makes the temperature more comfortable for fish. Fish can live healthier and reduce the risk of death in fish.

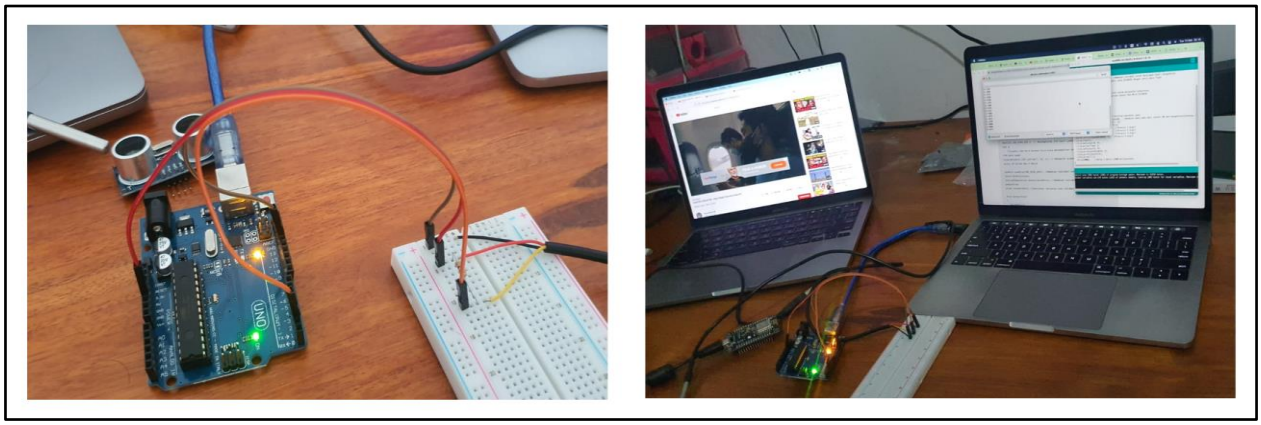

Figure. 3 Penerapan micro-controller pada air kolam.
Source : researcher property

Figures. 3 is a prototype that is used to control the temperature of the water in the pool, it can carry data from the temperature sensor in the water. In addition to checking the pool water, this prototype is useful for turning on the pool water pump, which aims to increase the water flow, so that the pool water becomes colder due to the increase in pool water flow.

DISCUSSIONS

Arduino script with Temperature Sensor, aims to measure the temperature in pool water. Sensor reads and sends data via WIFI to server.

```
void setup() {
      Serial.begin(9600);

      WiFi.begin(ssid, password);
      Serial.println("Connecting");
      while(WiFi.status() != WL_CONNECTED) {
            delay(500);
            Serial.print(".");
      }
      Serial.println("");
      Serial.print("Connected to WiFi network with IP Address: ");
      Serial.println(WiFi.localIP());

      Serial.println("Timer set to 10 seconds");
      sensors.begin();
}

void loop() {

      if ((millis() - lastTime) > timerDelay) {
        //Check WiFi connection status
        if(WiFi.status()== WL_CONNECTED){

            sensors.requestTemperatures();
            Serial.println("Temperature is: ");
            Serial.println(sensors.getTempCByIndex(0));

            sensorReadings = postData(serverNameGetStudent, sensors.getTempCByIndex(0));
            Serial.println(sensorReadings);
            parsingJson(sensorReadings);
        }
        else {
            Serial.println("WiFi Disconnected");
        }
```

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```
            lastTime = millis();
        }
}
```

Script Arduino Pump Controller

```
void setup() {
        Serial.begin(9600);
        pinMode(relay, OUTPUT);
        WiFi.begin(ssid, password);
        Serial.println("Connecting");
        while(WiFi.status() != WL_CONNECTED) {
                delay(500);
                Serial.print(".");
           }
        Serial.println("");
        Serial.print("Connected to WiFi network with IP Address: ");
        Serial.println(WiFi.localIP());

        Serial.println("Timer set to 10 seconds");
}

void loop() {
        if ((millis() - lastTime) > timerDelay) {
          if(WiFi.status()== WL_CONNECTED){
                 sensorReadings = httpGET(gettempdata);
                 Serial.println(sensorReadings);
                 sensorReadingsArr = parsingJson(sensorReadings);
            if(sensorReadingsArr>30){
                digitalWrite(relay, LOW);
            }else{
                digitalWrite(relay, HIGH);
            }
          }
          else {
                 Serial.println("WiFi Disconnected");
          }
                lastTime = millis();
       }
}
String httpGET(const char* serverName) {
        WiFiClient client;
        HTTPClient http;
        http.begin(client, serverName);
        int httpResponseCode = http.GET();
        String payload = "{}";
        if (httpResponseCode>0) {
                Serial.print("HTTP Response code: ");
                Serial.println(httpResponseCode);
                payload = http.getString();
        }
        else {
                Serial.print("Error code: ");
                Serial.println(httpResponseCode);
        }

        http.end();
        return payload;
}
```

CONCLUSION

This research has succeeded in reducing the condition of the pool water temperature to be colder. The hypothesis that the pool water temperature can be lowered by increasing the water discharge has been proven. By adding the pool water discharge, the pool water temperature decreases. This is what makes the proof on the monitoring dashboard in the figure. 2, the temperature of the pool water from 32ºC to 28.2ºC. A decrease in the temperature of the pond water by 4ºC is enough to cool the temperature of the pond water, making the fish healthier and fresher. Using a prototype micro-controller NodeMCU ESP 8266, a water temperature sensor and a mini pump. This prototype still has limitations, namely using a small pump size, not a large electric pump. If you want to apply it to a larger pool, then a bigger mini pump is given.

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SUGGESTION

This research can be continued by conducting research to add sensors to check oxygen in the water, so it is necessary to add sensors to detect and increase air aeration in the pool. The purpose of adding oxygen to pond water is useful for fish, in order to get oxygen in the water. Plankton will grow well because of the oxygen in the water. The use of a microcontroller to control the oxygen detection sensor can be used. Other sensors can be used according to pool conditions. Arduino like Uno, Mega, and other microcontrollers make controlling sensors very easy. Including Raspberry can also be used if there is greater control work.

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