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Dual Web-Based Temperature and Humidity Sensing of The Polyculture Fish Cultivation Pond Surface

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ABSTRACT

Cultivating fish in rural areas is one of the efforts to increase food security and the income of its citizens. Every villager can raise consumption and ornamental fish by making ponds in their large yard. Temperature strongly influences Fish cultivation. The high value of temperature fluctuations in the habitat can reduce feeding activity. It also affects the metabolism of the fish larvae. Temperature changes in fish habitats are affected by changes in environmental temperature. Information regarding weather forecasts is very much needed to anticipate environment temperature and humidity changes. In this study, we want to compare the results of temperature and humidity readings by wunderground.com and IoT monitoring devices toward the habitat of Polyculture Fish cultivation Pond. Both show identical temperature patterns had a deviation value is ($\pm$2 ^{o}C). Meanwhile, both results of humidity measurements appear to be inaccurate, either because they are outside the measurement value or refer to the reference data. Based on monitoring results, both methods can use monitoring the temperature and humidity of the environmental pond.

Keywords: *Fish Cultivation, Food Security for Villagers, Yard Ponds, IoT Monitoring Devices, Temperature, and Air Humidity*.

1. INTRODUCTION

Cultivating fish in rural areas is one of the efforts to increase food security and the income of its citizens. This commodity is promising to develop into an alternative economic resource [1,2]. Every villager can raise fish by making ponds in his yard that are generally still quite large (Figure 1). They can cultivate consumption fish such as tilapia (Figure 2C) and Goldfish. The ideal temperature for growing tilapia ranges from 28°C – 30°C. Meanwhile, the temperature ideal for Goldfish growth is between 20°C – 25° [3,4].

To cultivate consumption fish, villagers can cultivate ornamental fish such as the Koi fish. This fish is much preferred because it has various shapes and colour patterns of scales. Koi fish can live in freshwater ponds with an ideal temperature range of 18 – 28 °C. Moreover, the Ideals temperature for fattening the Koi is between 18°C – 24°C [5].

Figure 1. Fish cultivation in the yard [6].

Koi fish (Cyprinus rubrofuscus) is also in the family of Goldfish (Cyprinus carpio) (Figure 2).

Figure 2. (a) Koi fish (Cyprinus rubrofuscus) are included in the family of (b) Goldfish (Cyprinus carpio). (c) Nile fish (Oreochromis niloticus) is one of the fish that can coexist with Koi fish.

In fish farming, the survival of fish, from eggs, larvae, and fry to adult size, is strongly influenced by temperature. Fish egg mortality is one of the factors causing harvest failure [7–9]. This condition makes the availability of fish seeds for rearing reduced. The death of fish eggs influenced by temperature and humidity is not conducive [10]. The high range of habitat temperature fluctuations can reduce the feeding activity of fish larvae. The temperature mismatch with the needs for growth and development can affect the larvae's metabolism. This condition makes the larvae not want to eat the available food sources in their bodies. Larvae do not grow and lose endurance [11].

Temperature changes in fish habitats are affected by changes in environmental temperature [12]. Differences in air pressure, the duration of solar radiation, the shape of the surface area, and geographical conditions also influence the occurrence of temperature changes in the area [13,14]. For this reason, information regarding weather forecasts is very needed in cultivating fish to anticipate the impact due to changes in environmental temperature and humidity as early as possible [15].

Data on temperature and humidity conditions can find on weather websites. Wunderground.com is one of many websites that affords weather information (Figure 3). This website is linked to a weather station that weather monitoring based on satellite imagery and ground sensors. The data is taken periodically and displayed on their website pages [16–19].

Figure 3. Weather Underground is one of many weathers website.

Another way to get the temperature and humidity data conditions for an area can afford by an IoT monitoring device. This device installation is around the cultivation pond. The device is also web-based in presenting temperature and humidity data obtained from the sensor. Users can access monitoring data from anywhere using an internet-connected device [20].

In this study, we want to compare the results of temperature and humidity readings by wunderground.com and IoT monitoring devices toward the habitat of Polyculture Fish cultivation Pond. Both methods use web-based monitoring methods. This pond is in the countryside house yard and contains Koi fish, Goldfish, and tilapia. Furthermore, the macro physiology of the fish populations uses as a growth indicator of fish in the pond.

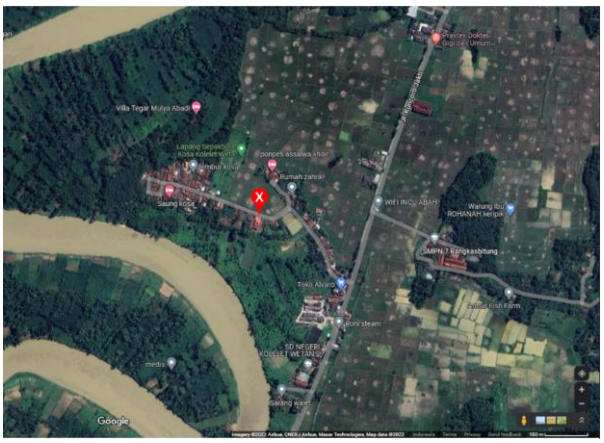

Figure 4. Location map of the cultivated fish pond (red balloon)

2. METHODOLOGY

A simple IoT monitoring device installs on the edge of an open pond in the yard of a house in Kolelet Wetan Village, Rangkasbitung District, Lebak Regency, Banten Province (Figure 4). This pond contains Koi fish, Goldfish, and tilapia. The sample data was taken between 9 to 25 October 2022.

2.1. Topology of simple Weather Monitoring device

The simple weather monitoring tool created is a series of instruments consisting of a microcontroller unit with integrated wifi, a temperature and humidity sensor unit, an AC/DC power supply unit, an internet access point (Cloud), a server unit, and a PC/smartphone to display monitoring data (Figure 5).

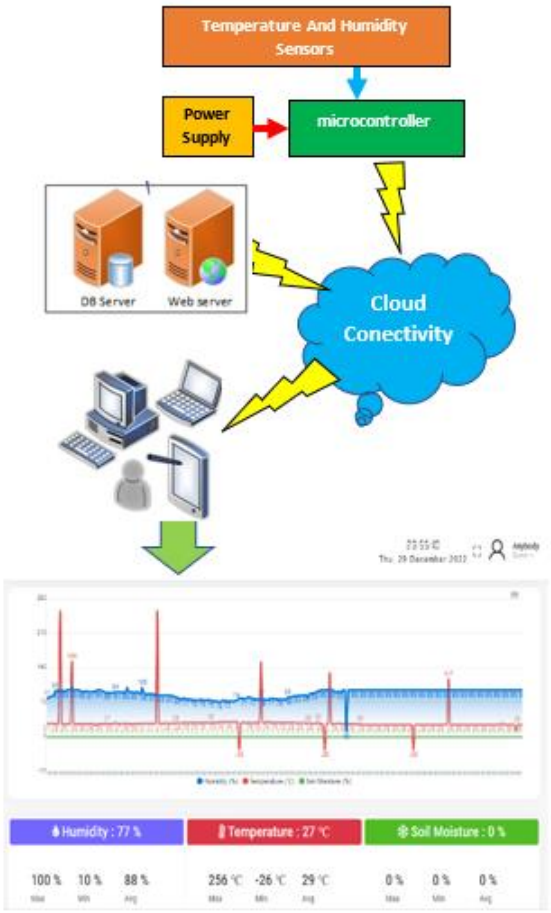

Figure 5. Topology of a simple IoT monitoring device.

This device is a simple weather monitoring tool that will read the temperature and humidity around the pool using sensors. Microcontroller collected data captured. Then it is sent to the server via the internet (cloud) to be processed and stored in the servers. Furthermore, these data show on the website page for the monitoring process.

2.2. Microcontroller

In this study, we use a microcontroller type ESP-8266 32-bit with had size of 58mm x 32mm. A WIFI 802.11 b/g/n module unit is equipped (Figure 6). The microcontroller uses the NodeMCU Clone LoLin model with a Clock Speed of 80 MHz, which has 4 MB of Flash Memory and 64 KB of SRAM memory, with 11 pins of Digital I/O and analogue on pin 1. To operate can use an input voltage of 4,5 V – 10 V over a temperature range of -40 °C – 125 °C. The power supply unit obtains the input voltage.

Figure 6. Microcontroller type ESP-8266 32-bit.

This device retrieves data from the DHT11 and then sends it to a server via the internet. The server will collect and present these data on website pages.

2.3. Sensor Device

The DHT11 sensor reads the temperature (0 ^{o}C – 50 ^{o}C) and humidity (20% - 80%) around it with a duration of 1 Hz with an accuracy of $\pm$ 2 ^{o}C for temperature and 5% for humidities (Figure 7). This sensor has 4's pins with 0,1 inch spacing and operates on an input voltage of 3 V – 5 V with a max current of 2,5 mA. The input voltage source takes from the microcontroller.

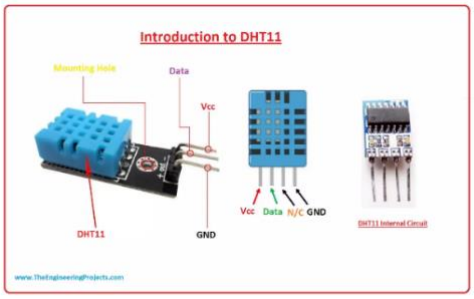

Figure 7. Dashboard of the Monitoring system.

2.4. Software

The operating system in this device uses Linux Plesk – centos software, PHP Version 7.3.33 with Apache 2.0, and MySQL version 5.0.12 to store, manage and organize information - information needed by a website. Monitoring data present using HTML, CSS, and JS.

The internet platform functions as a liaison software between simple weather station devices

and users to present the results of weather monitoring around them.

2.5. Internet Acces Point

The internet network for access points that connects the temperature and humidity monitoring devices on the edge pond with the server is Orbit Star A1 Telkomsel Upto 15 Mbps with 2x2 MIMO LTE Cellular Technology.

3. RESULTS AND DISCUSSION

3.1 Placement of sensors in ponds

The DHT 11 sensor device is placed openly on the edge pond (Figure 8). Data taken from the sensors are the accumulation of the pond condition and the environment around the pond.

Figure 8. DHT11 sensor is placed openly on the edge of the fish pond.

Macro physiology in Figure 9 shows the populations of three species of Koi fish (Cyprinus rubrofuscus), Goldfish (Cyprinus carpio), and Nile fish (Oreochromis niloticus) in various sizes. The size of the fish shows fish's age also varies. The three fish can reproduce continuously in the pond.

This condition indicates that the habitat formed in the pond is very conducive to the reproduction process of the three types of fish in one pond. The air temperature and humidity formed around the pond support the life chain [2–4,9,21].

3.2 Data on temperature and humidity

Figure 10 shows an air temperature comparison around the pool from the IoT monitoring device with temperature data taken from wunderground.com.

Both show identical temperature patterns. The air temperature will rise from 06.00 WIB to 13.00 WIB in the higher temperature between 30 ^{o}C – 36 ^{o}C. Then, the temperature will decrease again from 13.00 WIB until the next day at 01.00 WIB in the lower temperature range between 24 ^{o}C – 26 ^{o}C.

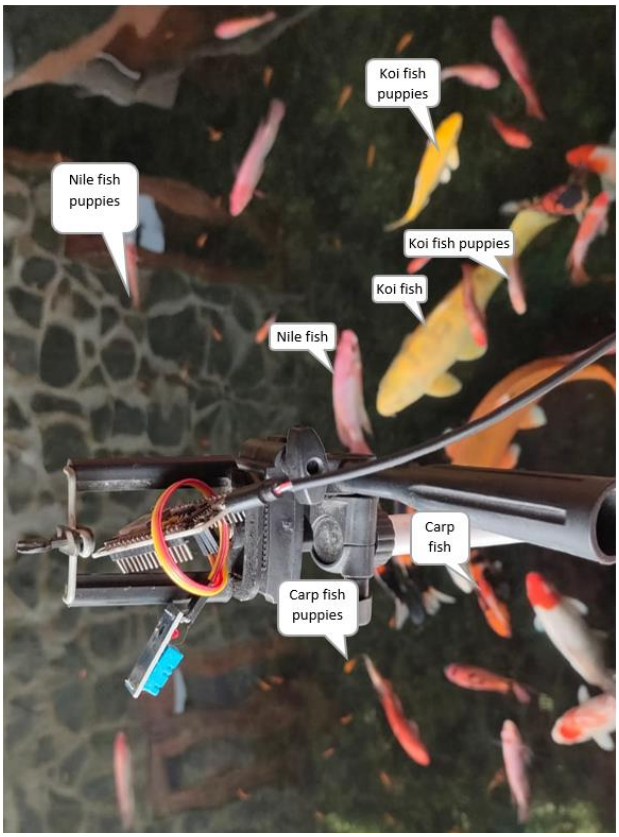

Figure 9. The population of Koi fish (Cyprinus rubrofuscus), Goldfish (Cyprinus carpio), and Nile fish (Oreochromis niloticus) in the fish pond habitat.

Between 01.00 WIB to 06.00 WIB, the temperature generally tends to be stable' unless it rains. The difference between both methods, the IoT monitoring device always shows a higher value than Wunderland.com. Moreover, these differences are still within the range of DHT sensor measurement accuracy (±2 ^{o}C) [22,23].

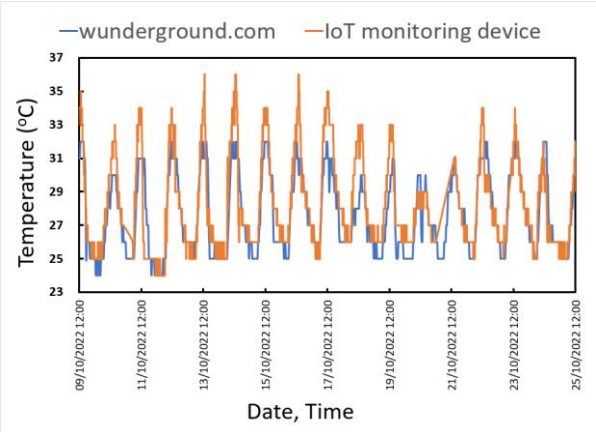

Figure 10. Graphics temperature of simple IoT Monitoring Device versus wunderground.com

A comparison of air humidity around the pool from the IoT monitoring device with humidity data taken from wunderground.com had shown in Figure

11. Humidity data range from wunderground.com is between 10% - 94%. Meanwhile, the humidity data measurement from IoT Device monitoring is between 58%-97%. The humidity will increase at the time between 16.00 WIB to 22.00 WIB and will decrease at the time in between 06.00 WIB to 11.00 WIB. Between 23.00 WIB – 06.00 WIB is the highest humidity value. When the humidity is high, the temperature around the pond is low.

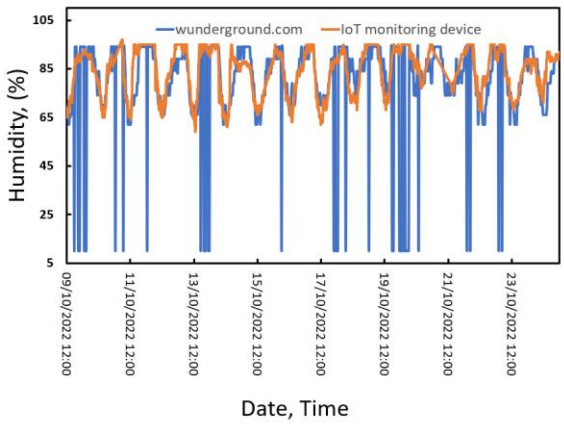

Figure 11. Graphics humidity of IoT Monitoring Device versus *wunderground.com*.

Although the highest humidity value displayed by the IoT monitoring device from the DHT11 sensor looks similar to the value of wunderground.com, this value deviates beyond the sensor's specifications, which is 80% + 5%. Meanwhile, the lowest humidity displayed by wunderground.com is 10% which is far below the average lowest humidity on the island of Java, between 47% - 70% [24]. Meanwhile, the lowest humidity data displayed from the DHT11 sensor shows the lowest logical humidity value, between 59% - 77%. Based on these conditions, we can see the shortcomings of the two web-based temperature and humidity monitors.

Based on the above description shows that both methods, IoT monitoring devices and wundergroud.com, can be used to monitor the temperature and humidity of the environmental pond. However, the two methods have different measurement accuracy. Fish cultivators can choose to use data from an IoT monitoring device that requires equipment with more accurate.

Alternatively, use data from wunderground.com that requires no installation investment but displays an inaccurate range of lowest humidity values. Of course, this will return to adjusting their budget and goals.

4. CONCLUSION

Temperature and humidity monitoring in polyculture fish farming ponds through dual web-based monitoring: wunderground.com and IoT Monitoring device, have been carried out. The temperature monitoring results of both methods obtained an identical pattern. Meanwhile, the results of humidity monitoring from the two monitoring methods show deviations. Among others, out-of-specification measurement results or differences in value compared to reference data. Based on both monitoring methods, IoT monitoring Devices and wundergroud.com can be used to monitor the temperature and humidity of the environmental pond. However, the two methods have different measurement accuracy.

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