Design of Water Temperature Stabilizer Using Element Peltier and Atemga16 for Louhan’s Aquariums

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Abstract. This study aims to design a water temperature stabilizer in the louhan fish aquarium by using a cooling system based on a Thermoelectric Cooler (TEC) or a Peltier element. The system is built using several tools including a DS18B20 temperature sensor, a relay circuit and 3 Peltier elements, and AVR microcontroller. Temperature control is done by comparing the desired temperature set-point with the temperature from the sensor. The test was carried out by stabilizing the water temperature with two conditions, namely running water and not flowing water and observing the behavior of the fish while the stabilizer system was running. The working principle of the stabilizer is that the sensor will read the water temperature, then the data is processed on the microcontroller. The temperature data will be compared with a predetermined set-point value which is around 29°C. If the temperature is more than 290C, then the cooler will turn on. The on-off control signal is generated by the microcontroller to turn on the relay and cooling system. From the test results obtained, the tool is able to stabilize the temperature of 290C and shows the behavior of fish with good conditions.

1. Introduction
Maritime tourism is one of the assets of a country which is also a potential for marine tourism, especially developing countries, one of which is the Republic of Indonesia. Science and technology have developed and have a positive impact on the quality of life of several types of ornamental fish. One of the famous ornamental fish is the LouHan. This type of fish is very sensitive to the temperature of its environment. According to [1], the louhan fish is a type of fish that is resistant to infection by fish diseases, but if the water quality where the LouHan fish is cultivated is not suitable for the fish, the cultured fish will be susceptible to disease. The temperature of the water environment for LouHan fish ranges from 28-30°C, but to live in an aquarium that is always illuminated with lights will make the water temperature increase so that it often interferes with the survival of LouHan fish. Some cultivators have complained about the difficulty of regulating the temperature stability in the aquarium for the cultivation of LouHan fish. One technique that has been used to lower the temperature in the aquarium is to use a cooling system based on a vapor compression system, but this system has several drawbacks, because the price is quite expensive because it uses gas/Freon, besides that it also consumes quite high electricity.

The advancement of modern-day invention and generation is capable to maximizing the efficiency and satisfaction in producing products and is capable of solving all of life's challenges. Therefore, in this study trying to help solve the problem by using the design of water temperature stabilizer by using elemen peltier and atemga16 for LouHan’s aquariums. The cooling system with Peltier elements in this study will be run with an automatic process, so that it is expected to be more efficient and
cheaper than conventional cooling devices. However, the cooling machine that used the Peltier element (TEC) in this study no longer requires Freon fueloline and a compressor, saving production costs, using electricity, and being more environmentally friendly [2]. As a result, the ultimate purpose of this research is to assist LouHan fish keepers in maintaining the stability of the water temperature in the aquarium, so that the growing process of LouHan fish can run smoothly.

2. Literature Review

One of the very profitable business opportunities with bright prospects in recent years is ornamental fish cultivation. This can be seen from the export of ornamental fish which is increasing from year to year. One type of ornamental fish that has high interest is the Louhan fish. LouHan is the result of a cross from another cycloid fish species, namely Cichlasoma synspilum and Cichlasoma cyanoguttatum. Louhan fish is a type of fish that is resistant to infection by fish disease, if the water quality where the louhan fish is cultivated is not suitable for the fish, the cultured fish will be susceptible to disease[3]. The temperature of the water environment for the life of LouHan fish ranges between 28-30°C, so that some cultivations require technically which is quite difficult to maintain a stable temperature in the aquarium.

The method that has been used to maintain the stability of the water temperature is the cooling technique. One of the refrigeration technologies that are currently frequently used is vapor compression based cooling technology because it has a high coefficient of performance[4]. The vapor compression-based cooling system uses a cooling gas that functions to absorb heat in the air in the refrigerator. Several types of refrigerant gases include the type R134a and R600a. However, the use of this cooling gas has drawbacks because this type of cooling gas contains HFCs and HF which can reduce the ozone layer. In addition, the vapor compression based system that uses refrigerant gas has difficulty in setting the temperature of the target. Therefore, along with technological developments, an alternative system for water cooling is needed that is safer and more efficient. Thermoelectric Cooler (TEC) is one of the better cooling technology alternatives because it has the advantages of small size, lower vibration and easier maintenance. In addition, TEC can absorb heat by using the principle of heat difference so that apart from being a cooler, it can also be a heater, and besides that it can be turned on with DC current [5]. One of the TEC applications for cooling is in the drink box carried out by [6], where according to research [6] using 3 TEC elements is able to cool up to a temperature of 14.3°C with a cooling load of 1 liter of water with an initial temperature of 16.4°C.

Another advantage possessed by TEC is that it is not only capable of cooling but also heating at the same time. The nature of this TEC can be regulated by using one of the electronic devices, namely a microcontroller. Microcontroller is a chip that has the ability to digitally process data with a command program in the form of C language [7]. The benefit of using a microcontroller as a control system is that it is able to provide information on the accuracy of a process, one of which is temperature measurement. Temperature settings can be combined using a temperature sensor[8]. One of the temperature sensors this is frequently used is the DS18B20 temperature sensor. The Dallas Semiconductor DS18B20 temperature sensor is a synthetic temperature sensor. This temperature sensor is a temperature sensor whose output is a virtual recording which can be used remotely without compromising its quality of the recording. The DS18B20 temperature sensor is split into 2 sorts according to their nature, specifically water resistant and non water resistant[9]. The display of the results of the combination between the controller and the sensor can be seen on the LCD screen. A liquid crystal display (LCD) is a type of electronic gadget that may display numbers or text. There are two kinds of LCD panels that can display numeric and alphanumeric text and are commonly seen in photocopiers and cell phones. The combination of different technologies is expected to overcome the problems of ornamental fish cultivators, especially LouHan fish.
3. Method
Temperature stabilization implies reducing the temperature of the test material to a specific temperature for several minutes. Temperature control is accomplished by maintaining the temperature at a fixed point of 29°C. A microcontroller is used to control the system digitally. An aquarium water temperature stabilizer based on temperature control was devised in this study using Peltier elements. Temperature is controlled via an integrated system that employs sensors, microcontrollers, and actuators.

A system setting diagram is used to construct the temperature stability system. A microcontroller, a DS18B20 temperature sensor, and Peltier elements are used to create the temperature stability instrument. It serves as a digital control center in a microcontroller system. The temperature sensor data is processed by the microcontroller to determine the derived temperature across the Peltier elements. The coolant on-off pulse mechanism is used to control the process. This technology is critical for preserving the stability of water at a specific temperature. The process temperature is controlled by the instrument to a range of 29 °C to avoid the water temperature from exceeding the limit.

Tests carried out before designing the whole system:
1. Microcontroller testing is the process of generating a program on a circuit created on a microcontroller using a USB ASP tool that links the microcontroller to a PC/Laptop.
2. LCD testing, which involves connecting the LCD to a microcontroller and writing a program to display text on the LCD.
3. Testing the DS18B20 sensor, namely by attaching it to a microcontroller and immersing both the sensor and the standard measuring instrument in a solution at the same time, and comparing the sensor result data with a standard temperature measuring instrument.
4. Actuator (relay) testing, which is accomplished by connecting the actuator to the microcontroller. The data will be output by the microcontroller in the form of a digital ON-OFF signal. The DDR and PORT instructions are used to activate the control. Circuit for driving a relay.
5. All of the gadgets work together to produce a temperature stabilization system. The stabilizer system is controlled by a microprocessor. The Peltier generates cold, which is regulated by disconnecting and reconnecting the relay. Standard relay panel connectors are used to connect the relay unit to the cooling system for safety concerns during instrument setup.

![Figure 1. System Diagram](image1)

![Figure 2. Hardware design](image2)

Figure 5 depicts a system that moves water from the aquarium to the reservoir, then the sensor detects the temperature of the water in the aquarium, the data is sent to the microcontroller, processed, and compared to the set-point, and the data is shown on the LCD. When the temperature rises over the set point, the microcontroller sends a signal to the relay, which links the electric current, causing the peltier to light up and the fan to function as a peltier cooler via the cooling system transmission media.

Figure 2 illustrates the hardware design, which is the design of a temperature control system that employs ATMEGA16 in the development of an aquarium water temperature stability device composed of four primary components: sensors, microcontrollers, cooling devices, and LCDs. The system design is depicted in Figure 3, where the sensor provides input data in the form of temperature measurements. The temperature data value will be utilized as input data for the microcontroller's temperature control
mechanism. The temperature data value will be used as input data for the temperature control mechanism of the microcontroller. The DS18B20 sensor outputs temperature data in 9-bit digital format. When data is sent through a single wire communication method. The data is then shown on the 16x2 LCD. The setpoint temperature is used to regulate the output of the refrigerant on-off control signal coupled to the relay system for 5 to 12-volt TTL DC signal transmission.

Figure 3. The schematic system

4. Results And Discussion

Figure 4 depicts the results of direct testing when integrating an alphanumeric LCD and a microprocessor. The writing of temperature data and the status of the relay condition are displayed on the LCD (cooling). When the chiller is turned off, the LCD displays "OFF," and when it is turned on, it displays "ON." The procedure of assigning algorithms that have been determined on the microcontroller determines cooling control. The sensor output value is compared to a preset set point to ascertain the status.

Figure 4. Display system on the LCD

The integrated stabilizer system is built around a DS18B20 sensor, a microprocessor, a relay controller, and a peltier. All of the gadgets work together to build a temperature stabilization system. The stabilizer system is controlled by a microprocessor. The peltier generates cold, which is controlled by disconnecting and reconnecting the relay. Standard relay panel connectors are used to connect the relay unit to the heat sink for safety concerns during equipment setup. The installation form is depicted in Figure 5, with the LCD and electrical panel at the top.

Figure 5. Whole stabilizer system
5. System Testing Results

Two conditions of water which known as flowing and non-flowing have following result of stabilizer system:

**Table 1.** The results of the measurement of water temperature in non-flowing conditions

| Time (minute) | Temperature (°C) | \((t_{n+1} - t_n)\) |
|--------------|-----------------|---------------------|
| 5            | 35.3            |                     |
| 10           | 34              | -1.3                |
| 15           | 32.7            | -1.3                |
| 20           | 31.75           | -0.95               |
| 25           | 31.1            | -0.65               |
| 30           | 30.25           | -0.85               |
| 35           | 29.6            | -0.65               |
| 40           | 29.2            | -0.4                |
| 45           | 28.7            | -0.5                |

**Table 2.** The results of measuring the temperature of the water in flowing conditions

| Time (minute) | Temperature (°C) | \((t_{n+1} - t_n)\) |
|--------------|-----------------|---------------------|
| 5            | 29.45           |                     |
| 10           | 29.4            | -0.05               |
| 15           | 29.4            | 0                   |
| 20           | 29.35           | -0.05               |
| 25           | 29.3            | -0.05               |
| 30           | 29.3            | 0                   |
| 35           | 29.25           | -0.05               |
| 40           | 29.2            | -0.05               |
| 45           | 29.2            | 0                   |
| 50           | 29.15           | -0.05               |
| 55           | 29.15           | 0                   |
| 60           | 29.1            | -0.05               |
| 65           | 29.05           | -0.05               |
| 70           | 29              | -0.05               |

The results of the measurements in Table 1 average temperature decreased to the target temperature in 45 minutes from the beginning temperature of 35.3°C. When the target is reached, the cooling system is turned off. The water flows from the aquarium into the tank till it returns to the aquarium, and the sensor measures the temperature in the aquarium. The measurement results in Table 2 demonstrate a 70-minute drop-in temperature from 29.45 °C to the desired temperature. When the system tries to lower the water temperature until it reaches the target temperature, the measurement results reveal a substantial difference, indicating that in situations of stagnant water, the system would decline the temperature rapidly.
The table below compares real temperature readings by systems and digital thermometers:

### Table 3. Testing the accuracy of the DS18B20 sensor and standard thermometer

| Data | Sensor DS18B20 | thermometer | differences |
|------|---------------|-------------|-------------|
| 1    | 19.8          | 20          | 0.2         |
| 2    | 25.2          | 25          | -0.2        |
| 3    | 30            | 30          | 0           |
| 4    | 35            | 35          | 0           |
| 5    | 40.1          | 40          | -0.1        |
| 6    | 45.1          | 45          | -0.1        |
| 7    | 49.7          | 50          | 0.3         |
| 8    | 55.3          | 55          | -0.3        |
| 9    | 60.2          | 60          | -0.2        |
|      | Error bar     |             | 0.1         |

Based on these findings, it is possible to conclude that the measurement using this technology has a 0.1°C average discrepancy with the digital thermometer.

### 6. Conclusion

Based on the results of the testing device, it is possible to conclude that the design of the water temperature stabilizer utilizing peltier and ATEMEGA16 for LouHan's aquarium is general with the situation sensing DS18B20 sensor has an analyzing distinction of approximately 0.1 °C in opposition to a well-known thermometer, the stabilizer manage device keeps the water temperature at a cost of 29 °C takes approximately 60-70 minutes.

### 7. References

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