WEB-BASED WATER TEMPERATURE MONITORING BELOW THE RIVER SURFACE USING RS-485 MODULE

Rafwel Maranatha Gultom[1], Jannus Marpaung[2], Leonardus Sandy Ade Putra[3]
rafwelgultom17@gmail.com[1], jannus.marpaung@ee.untan.ac.id[2]. leonardusandy@ee.untan.ac.id[3]
Universitas Tanjungpura

ABSTRACT

This thesis is titled "Web-Based Communication and Water Temperature Monitoring System Under the Surface of the Kapuas River Using RS-485 Module." The research aims to design and implement a system capable of real-time temperature monitoring of water beneath the surface of the Kapuas River, utilizing RS-485 communication technology. The system comprises several components, including the DS18B20 temperature sensor, ESP32 microcontroller, and RS-485 communication module. The research methodology includes hardware and software design, as well as testing to ensure accurate temperature measurements at various depths. Testing results indicate that the system operates effectively, providing accurate temperature data at different depths and displaying this information through a web interface. This system is expected to contribute to water resource management and environmental monitoring, while also raising awareness about the importance of maintaining water quality in rivers. Additionally, this research opens opportunities for further development in the field of environmental monitoring using web-based technology.

Kata Kunci: Water Temperature Monitoring, RS-485 Communication,Web-Based Monitoring, ESP32 Microcontroller, Real-Time Data.

INTRODUCTION

The Kapuas River is the longest river in Indonesia, located in West Kalimantan. The Kapuas River plays a vital role in the lives of the surrounding communities, serving as a source of clean water, transportation, and a habitat for various types of living organisms. However, the water condition of the Kapuas River is often polluted by industrial and domestic waste discharged directly into the river. Therefore, a monitoring system is required to continuously observe the condition of the Kapuas River. The influence of temperature on water quality shows that temperature plays a crucial role in aquatic ecosystems[1].

A monitoring system is essential to maintain the health of the ecosystem. One of the important parameters that needs to be monitored is the water temperature below the river's surface. The RS-485 protocol is a serial communication protocol used to connect electronic devices over long distances. This protocol has advantages in terms of longer range and higher data transmission speed compared to other serial communication protocols. The use of the RS-485 protocol in environmental monitoring systems demonstrates its effectiveness for long-distance data communication, making it highly relevant for such applications. With its capabilities, RS-485 becomes an ideal choice for integrated monitoring systems.Unshielded Twisted Pair (UTP) cables are a common type of cable used in data communication networks. UTP cables consist of several pairs of twisted copper wires, which help reduce electromagnetic interference and external signal disturbances. Additionally, they can transmit signals in opposite directions to improve transmission stability[2].

This research will focus on developing a water temperature monitoring system below the surface of the Kapuas River using the RS-485 protocol and UTP cable as the data transmission medium. The system will utilize water temperature sensors and a microcontroller for data acquisition, transmitting the data to a web application for real-time monitoring[3].

Therefore, a monitoring system is needed to continuously observe the water conditions of the Kapuas River. One important parameter to monitor is the water temperature. With the implementation of a water temperature monitoring system below the surface of the Kapuas River, it can assist in continuously monitoring the river's conditions and temperature.

METHOD

1. Water Temperature In Rivers

The physical characteristics of a river, such as its flow patterns (e.g., dendritic or meandering) which can be seen in the Figure 1, influence the interaction between water and its surrounding environment. Rivers with more winding flow patterns tend to have larger areas exposed to sunlight, which can increase surface water temperatures. Watersheds (Drainage Basin Areas) with radial flow patterns and branching streams can affect heat distribution and water temperature along the river[6].

Factors Affecting River Water Temperature:

1. Weather Conditions: Air temperature, sunlight intensity, and seasonal changes significantly influence water temperature.
2. Depth of Water: Surface water is generally warmer than deeper water due to direct sunlight exposure.
3. Flow Rate: Fast-moving water tends to be cooler than stagnant or slow-moving water.
4. Pollution: Industrial and domestic waste can alter water temperature, often raising it.
5. Geothermal Influence: In certain areas, groundwater mixing or geothermal activity can increase water temperature

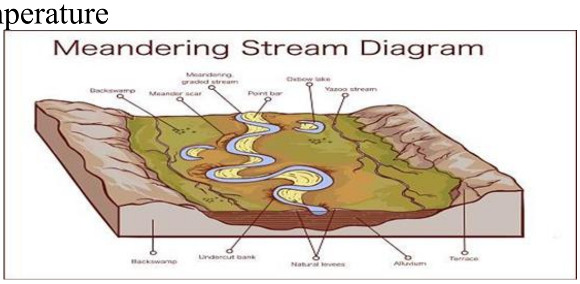

Figure 1. Types of River Water Patterns[7]

River water patterns refer to the flow behavior, movement, and distribution of water within a river system. These patterns are influenced by various natural and anthropogenic factors, shaping the river's physical, chemical, and biological dynamics. Understanding river water patterns is essential for water resource management, ecosystem health, and flood prevention:

- Laminar Flow: Smooth and orderly water movement, where water particles move in parallel layers with minimal disruption. Typically occurs in slow-moving or shallow water with low turbulence.
- Turbulent Flow: Chaotic and irregular water movement with eddies and swirls. Common in rivers with steep gradients, high flow velocities, and rough riverbeds.
- Meandering Pattern: Rivers that flow in curves or loops, forming a winding pattern. Meandering rivers occur in flat areas where water flows slowly, causing erosion on the outer banks and deposition on the inner banks.
- Braided Pattern: Consists of multiple channels that split and rejoin, creating a braided appearance. Occurs in rivers with high sediment loads and variable water discharge.
- Straight Channel: A rare, linear water pattern often found in artificially constructed or controlled river channels.
- Delta Pattern: Found at river mouths where the flow enters slower bodies of water (e.g., lakes, seas, or oceans). Sediments are deposited, forming distributary channels and delta

formations.

- Seasonal Variations: River flow and water levels fluctuate based on seasonal changes, such as wet and dry seasons, snowmelt, or rainfall intensity[7].

The length and shape of river flows with more meandering or branching patterns have a larger surface area exposed to sunlight. This can result in increased water temperature at certain points, particularly at the surface. In contrast, rivers with straighter flows may experience more uniform heating but not as intense as in meandering rivers. Slower water flow allows the water to be exposed to sunlight for longer periods, thereby increasing surface temperature. In slow-flowing areas, such as pools or shallow parts of the river, water temperatures tend to be higher compared to areas with faster flows. At greater depths, variations in water flow that create depth differences along the river also influence temperature distribution. In deeper sections, the temperature tends to be more stable and less affected by fluctuations in air temperature. Conversely, in shallow river areas, particularly in slow-moving sections, temperature fluctuations can be more significant[7].

Interactions with riparian vegetation (plants along the riverbanks) in the surrounding environment can influence water temperature distribution. Areas with dense vegetation tend to have lower water temperatures because they reduce direct sunlight exposure. This can create temperature variations along the river. The flow pattern also affects the interaction between water and the surrounding environment, such as soil and rocks. Certain locations may have different soil or rock characteristics, which can influence the soil's ability to absorb heat, indirectly affecting river water temperature. Therefore, an appropriate communication system is required for measuring river water temperature to analyze these temperature variations effectively[7].

RESULTS AND DISCUSSION

In this chapter, the results of the water temperature monitoring system under the river's surface using Modbus RS-485 communication will be discussed. This testing was carried out to evaluate the performance of the designed and implemented system. The results of this testing will be analyzed to determine how well the devices perform in monitoring water temperature and to identify the factors that may affect the system's performance. The testing process will go through two stages: the sensor performance test and the data verification test received through the Thinger platform.

The first stage involves testing the performance of the sensors used, such as the DS18B20 sensor. This test aims to ensure that the sensor provides accurate data. Following that, the second stage is the data verification test to check the received data through the Thinger application, which allows for real-time monitoring of water temperature conditions and demonstrates the performance of the DS18B20 sensor.

1. DS18B20 Sensor Reading at a Depth of 50 Centimeter

It can be observed that at a depth of 50 cm, the temperature data obtained from the DS18B20 sensor shows that the temperature at this depth is significantly influenced by exposure to sunlight. However, weather conditions can also affect the temperature at this depth. Table 2 and Figure 6 will show the graph of river water temperature at a depth of 50 cm.

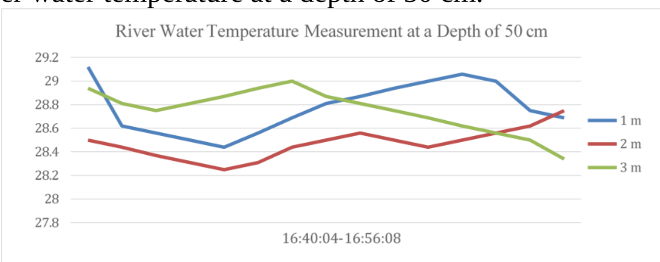

Figure 6. River Water Temperature Graph at a Depth of 50 cm

Table 2. Average River Water Temperature at a Depth of 50 cm

Distance from the Riverbank	Average Water Temperature

1 meter	28,97°C
2 meter	28,45°C
3 meter	28,95°C

Based on Figure 6 and Table 2 from the tests conducted, the table and graph above show the average river water temperature at a depth of 50 cm with distances of 1 m, 2 m, and 3 m from the riverbank. The results indicate that there were no significant changes in temperature during the test. Therefore, the average river water temperature obtained was 28.79°C

2. DS18B20 Sensor Reading at a Depth of 2,5 Meter

At a depth of 2.5 meters, the river water temperature tends to be more stable and less influenced by the intensity of sunlight exposure. This is because, as the depth increases, there is less direct exposure to external factors such as air temperature and sunlight. At this depth, the water temperature is typically slightly cooler compared to the surface temperature due to reduced atmospheric influence. This condition results in a more consistent water temperature at a depth of 2.5 meters throughout the day. Table 3 and Figure 7 will show the graph of river water temperature at a depth of 2.5 meters.

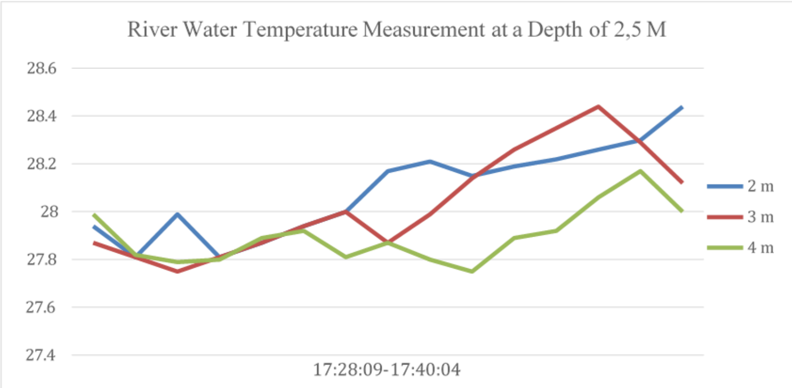

Figure 7. River Water Temperature Graph at a Depth of 2,5 Meters

Table 3. Average River Water Temperature at a Depth of 2,5 Meters

Distance from the Riverbank	Average Water Temperature
2 meter	27,89°C
3 meter	27,92°C
4 meter	27,93°C

Based on Figure 7 and Table 3 from the tests conducted, the table and graph above show the average river water temperature at a depth of 2.5 meters with distances of 2 m, 3 m, and 4 m from the riverbank. The data for this test was taken in the afternoon. Therefore, the average river water temperature obtained was 27.91°C

CONCLUSION

By placing the DS18B20 sensor at depths of 50 cm, 100 cm, 150 cm, 200 cm, and 250 cm below the river's surface, the average temperature at each depth was measured. The test results in the river show that as the river's depth increases, the water temperature tends to be more stable and cooler compared to the temperature near the surface. This is due to the reduced influence of air temperature fluctuations and sunlight exposure in deeper layers. This indicates that the deeper the DS18B20 sensor is placed below the river's surface, the water temperature detected by the sensor tends to be cooler than the temperature near the surface.

It can be concluded that, from a depth of 50 cm to a depth of 2.5 meters, the results show that the water temperature remains relatively constant, with no significant changes observed at the depths tested. This is due to the river's lack of current and the presence of sediment at the riverbed. The stability of water temperature at various depths, from 50 cm to 2.5 meters, indicates that the water flow is not strong enough to create significant heat exchange between the layers. This suggests that the river water conditions are relatively stable, with only slight temperature differences between the surface and deeper layers. Under normal conditions, river flow would result in cooler temperatures at deeper levels due to mixing with colder water layers. However, since the river lacks a current, such mixing does not occur, and the temperature remains nearly uniform.

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