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IMPLEMENTATION OF THE INTERNET OF THINGS (IOT) ON AN AUTOMATIC WEATHER STATION (AWS) WEATHER MONITORING TOOL TO SUPPORT FISHERMAN ACTIVITIES ON THE COAST

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ABSTRACT

Coastal areas play a vital role in fishing activities, with weather conditions, especially wind speed, being a key factor affecting the safety and efficiency of fishermen's operations. High wind speeds can trigger large waves and dangerous sea conditions, so accurate and real-time weather information is essential. This study aims to develop an Internet of Things (IoT)-based Automatic Weather Station (AWS) to monitor weather conditions in coastal areas to support fishermen's activities. This weather monitoring tool combines several sensors, including an Anemometer for wind speed, DHT22 for temperature and humidity, and a rain sensor, which are controlled through an IoT platform. The use of this tool is expected to provide more accurate and real-time weather data, so that this tool can be said to work well to improve the safety of fishermen and efficiency in fishing operations with a level of accuracy of weather monitoring data from manual readings with an average difference in error readings of 1.79%.

INTRODUCTION

Coastal areas are vital for fishing activities, and wind speed plays a crucial role in the safety and efficiency of fishermen's operations. Fishermen often face extreme weather challenges, including strong winds that create high waves and unsafe sea conditions. Therefore, weather monitoring tools in coastal areas are highly relevant and strategic to support safer and more productive fishing activities. One of the main factors affecting the safety of fishermen is access to accurate and real-time weather information. High wind speeds pose a risk of accidents or damage to fishing boats, and reliable weather monitoring can reduce these risks, helping to protect fishermen and their assets at sea.

Several studies have focused on the development of IoT-based weather station monitoring tools. These include: the development of a weather station prototype based on Arduino Yun, which measures light, temperature, and humidity using LDR, DHT11, and BMP180 sensors (Hidayati et al., 2021); a wind speed detector design using an anemometer sensor integrated with the Blynk IoT platform (Diaz Nugraha, Soekarta, & Amri, 2023); an IoT-based temperature and humidity monitoring device for the Aryoko Sorong Hospital drug warehouse (Taufiqur Rahman & Maman Pribadi, 2023); an IoT-based solar-powered rainfall intensity measuring device (Saputri Utami et al., 2023); and a temperature and light intensity monitoring system for a workspace using DHT11, LDR, and HC-SR04 sensors. These innovations demonstrate the potential of IoT technology to enhance weather monitoring in various settings, including coastal areas.

LITERATURE REVIEW

IoT (Internet of Things) refers to any command that is programmed or executed as long as there is an internet connection, allowing the creation and control of objects. With the rapid development of technology, the internet has become a central platform for millions, if not billions, of people worldwide. IoT extends beyond communication devices and computers, enabling various electronic devices to be connected and controlled through the internet.

The Internet of Things (IoT) describes a network of physical objects embedded with sensors, software, and other technologies, allowing these objects to connect and exchange data with other devices and systems via the internet. "Things" refers to anything that can be connected to the internet, encompassing a wide range of devices. In short, IoT means everything that is connected to the internet network and is capable of data exchange.

In IoT architecture, three main elements are involved: physical objects equipped with IoT modules, internet connection devices such as modems, and cloud data centers where applications and databases are stored. When objects are connected to the internet, they store data, which is later collected as "big data." This data can be processed and analyzed by governments, companies, or other institutions for various purposes. IoT offers numerous opportunities, including enhancing national resilience in technology and information systems.

The main purpose of IoT is to simplify users' daily activities, particularly in monitoring and control. It increases the effectiveness of these activities. For example, an IoT-based smart home system can automatically turn off lights, optimizing energy use and saving electricity. IoT can also be applied in environmental monitoring, such as tracking water

Volume 1, **Number** 2, September 2024, pp. 1-9

quality in storage containers using sensors connected to the internet. This real-time monitoring ensures that water cleanliness is maintained, benefiting both the environment and public health.

An anemometer is a device used to measure wind speed and direction, commonly employed by weather stations like the Meteorology, Climatology, and Geophysics Agency (BMKG). The term "anemometer" comes from the Greek word "anemos," meaning wind. The device was first introduced by Leon Battista Alberti in Italy in 1450. The anemometer works by capturing wind in open spaces, and its rotating bowls measure wind speed based on their rate of rotation.

The ESP32 is an advanced microcontroller module with high performance, making it ideal for IoT projects. It includes two computing processors, one dedicated to managing Wi-Fi and Bluetooth networks and another for running applications. The ESP32 supports various useful features such as TCP/IP, HTTP, and FTP, and it can process both analog and digital signals. Its Bluetooth connectivity makes it versatile for IoT applications, enabling easy connection to the internet and other devices.

The DHT22 sensor is a digital temperature and humidity sensor known for its reliability and stability. It features a capacitive humidity sensor and a temperature-measuring element, offering fast response times and strong anti-interference capabilities. The DHT22 is a cost-effective choice for mid-range, high-performance temperature and humidity sensing, especially when paired with Arduino for easy interaction with environmental conditions.

A raindrop sensor detects rain and can also measure rainfall intensity. The sensor operates by detecting electrolytic activity when rainwater falls on its surface. As an electrolyte, rainwater conducts electricity, allowing the sensor to differentiate between dry and wet conditions. This sensor is often used for outdoor rain monitoring, with outputs that can provide both analog and digital signals.

A buzzer is a device that converts electrical signals into sound, often used as an alarm. It emits a sound when it receives an electrical input, typically operating at a frequency between 1-5 kHz.

METHOD

The design carried out includes discussions related to block diagrams of hardware design, software design, android application design using Telegram.

In designing a circuit, the economic value of the use of components must be taken into account. Before a circuit and system are made, a block diagram is first designed which will have one goal so that the circuit created leads to the desired goal.

The hardware design block diagram is depicted in the block diagram with the aim of being a reference for making hardware to make it easier to assemble and create an integrated circuit.

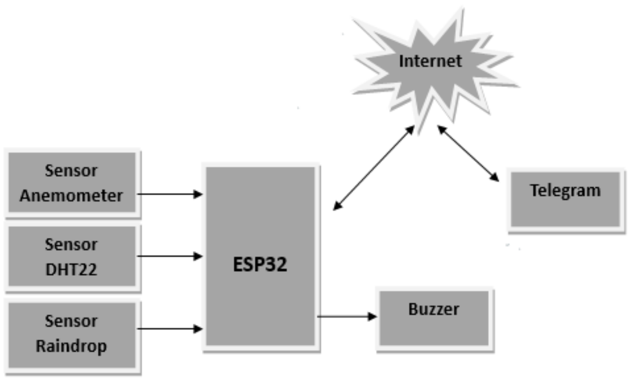

Fig. 1 Block Diagram

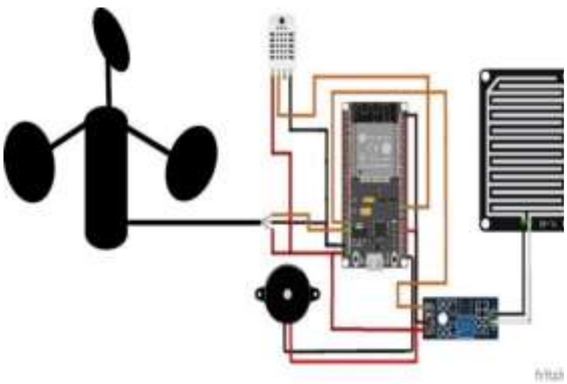

Fig. 2 Whole Series

After starting, the program initializes the port used to define the microcontroller I/O pins. First, connect to the Wi-Fi network so that it can be connected. Next, read the reading values of the anemometer sensor, rain sensor, and temperature sensor. Then process the reading of the values obtained by the sensor in the form of data. The data that has been obtained will be sent to the telegram bot and finished. Can be seen in Figure 3.7 Flowchart Circuit

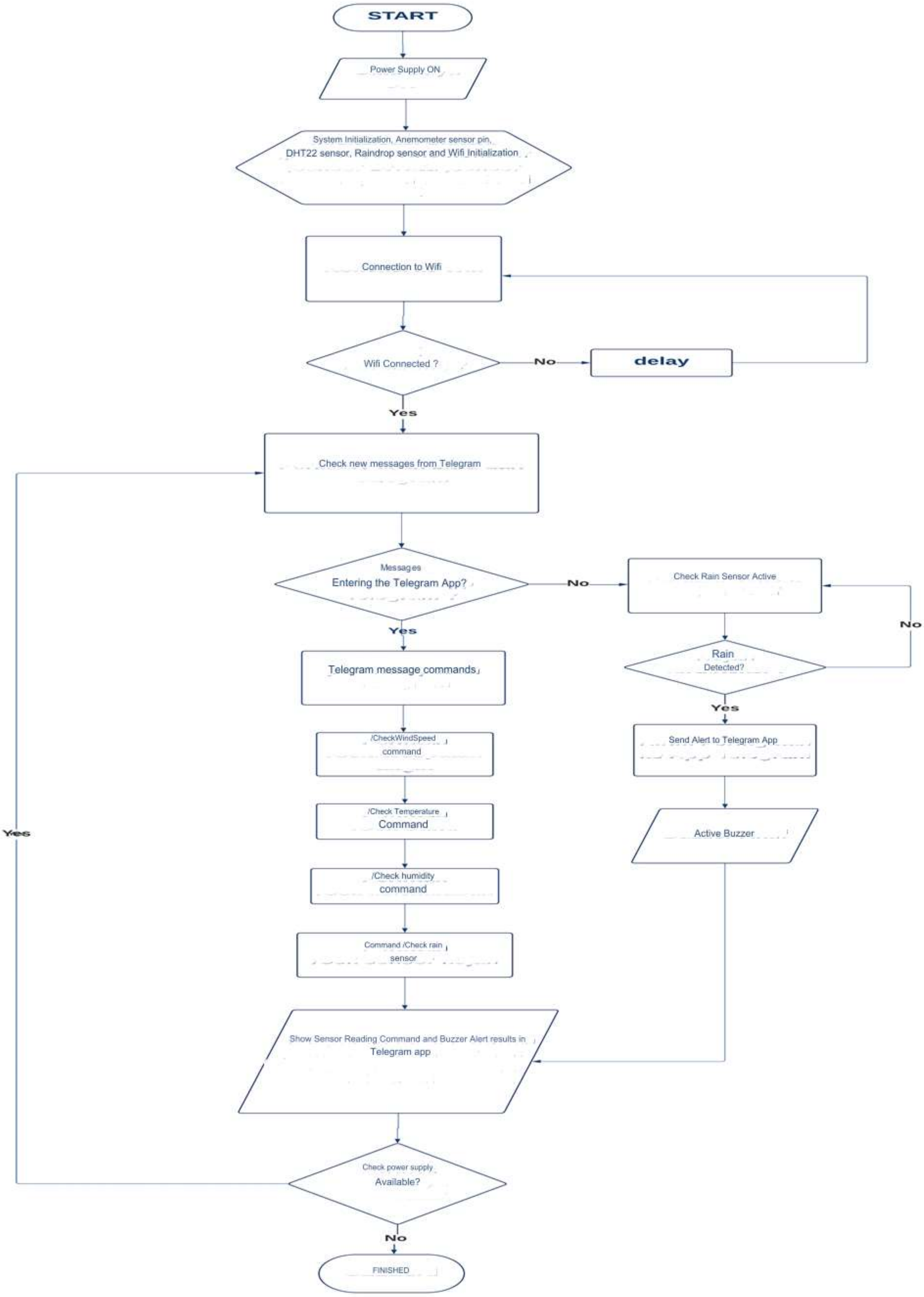

Fig. 2 Flowchart

JIETA
Journal on Internet Engineering Technologies and Applications
Volume 1, **Number** 2, September 2024, pp. 1-9

RESULT

Testing and analysis of the tool is carried out after the tool is finished being made. Testing is carried out to see the tool working and errors caused by software or hardware factors. While the analysis process is a continuation of the testing process. Tool testing is carried out to obtain data from the tool that has been made, then the data obtained is analyzed, both data analysis of damage analysis or error analysis in tool operation.

4.1 Wind Speed Sensor Analysis

Testing of sensors, sending systems, receiving systems and data communication in the implementation of the internet of things (IoT) on the automatic weather station (AWS) weather monitoring tool to support fishermen's activities has an important role in monitoring the weather, and providing early warning of disasters, as well as weather data analysis for decision making. Testing practices before implementation are important for accuracy, while this IoT monitoring system provides great benefits in improving the safety of fishermen.

4.1.1Wind Speed Sensor Testing

In testing the wind speed sensor, it is the same as the wind direction sensor as input. This sensor is connected to pin 13 of the ESP32 nodeMCU, the results of the sensor reading will be processed and sent by the ESP32 NodeMCU to the telegram bot. The results of the wind speed sensor reading test are in table 4.1 below.

Table 1. Wind Speed Sensor Test Data

Day/Date	Time	Anemometer Sensor (meter/second)	*AccuWeather (Meter/Second)*
Friday, August 9, 2024			
	15:45:09	8,69	12,42
	16:19:09	6,77	9,73
	16:31:10	13,11	20,11
	17:32:37	17,59	21.23
	17:34:02	15,87	19,65
	17:40:15	17,47	13,11
Sunday, August 11, 2024	15:52:26	5,27	6,21
	16:03:09	5,87	6,21
	16:15:55	7,33	6,21
	16:43:14	5,69	3,72
	17:01:34	6,89	4,97
	17:06:07	5,3	3,72

4.1.2 Temperature and Humidity Sensor Testing (DHT22)

DHT22 sensor testing is done by measuring the temperature and humidity of the surrounding air using a thermistor and hygrometer in the DHT22 sensor. Temperature reading works by reading the thermistor resistance and converting it to a temperature value. While humidity reading works by the sensor measuring changes in the conductivity or capacitance of hygroscopic materials and converting them to humidity values. DHT22 testing can be seen in Table. 4.2.

Table 4.2 Temperature and Humidity Sensor Test Data

Day/Date	Time	Temperature	Humidity	AccuWeather	
Friday, August 9, 2024					
	15 : 45 : 09	29,90°C	71,30%	30°C	68%
	16 : 19 : 09	29,20°C	75,80%	30°C	72%
	16 : 31 : 10	29,60°C	79,10%	30°C	77%
	17 : 32 : 37	29,40°C	86,20%	30°C	83%
	17 : 34 : 02	29,10°C	86,30%	30°C	82%
	17 : 40 : 15	29,70°C	87,20%	30°C	86%
Wednesday, August 14, 2024					
	15 : 52 : 26	32,70°C	75,10%	30°C	78%
	16 : 03 : 09	32,30°C	76,80%	30°C	77%
	16 : 15 : 55	32.10°C	77,20%	30°C	76%
	16 : 43 : 14	32,20°C	76,60%	29°C	76%
	17 : 01 : 34	32.07°C	76,30%	30°C	78%
	17 : 06 : 07	32,11°C	77,50%	30°C	78%

4.1.3 Rain Sensor Testing (Raindrop)

The rain sensor used is a raindrop sensor. Sensor testing is done by giving water to the sensor surface so that the electrodes on the sensor surface will be covered. The results of the point sensor reading test (raindrop) are in table 4.3 below.

Table 3. Rain Sensor Test Data (raindrop)

Day/Date	Time	Condition	Accuweather.com
Friday, August 9, 2024			
	15:45:09	No Rain	Cloudy
	16:19:09	No Rain	Cloudy
	16:31:10	No Rain	Cloudy

JIETA
Journal on Internet Engineering Technologies and Applications
Volume 1, **Number** 2, September 2024, pp. 1-9

	17:32:37	No Rain	Cloudy
	17:34:02	No Rain	Cloudy
	17:40:15	No Rain	Cloudy
Sunday, August 11, 2024	15:52:26	No Rain	Bright
	16:03:09	No Rain	Bright
	16:15:55	No Rain	Bright
	16:43:14	No Rain	Bright
	17:01:34	No Rain	Bright
	17:06:07	No Rain	Bright

4.1.4 Testing the Sender and Receiver System

In testing the sender system, the inputs are the anemometer sensor, DHT22 sensor and raindrop sensor. The sender system for the three inputs is connected to the pins on the ESP32. Configure the sender system using the Arduino IDE. Figure 4.1 shows a serial monitor indicating the success of the sender system.

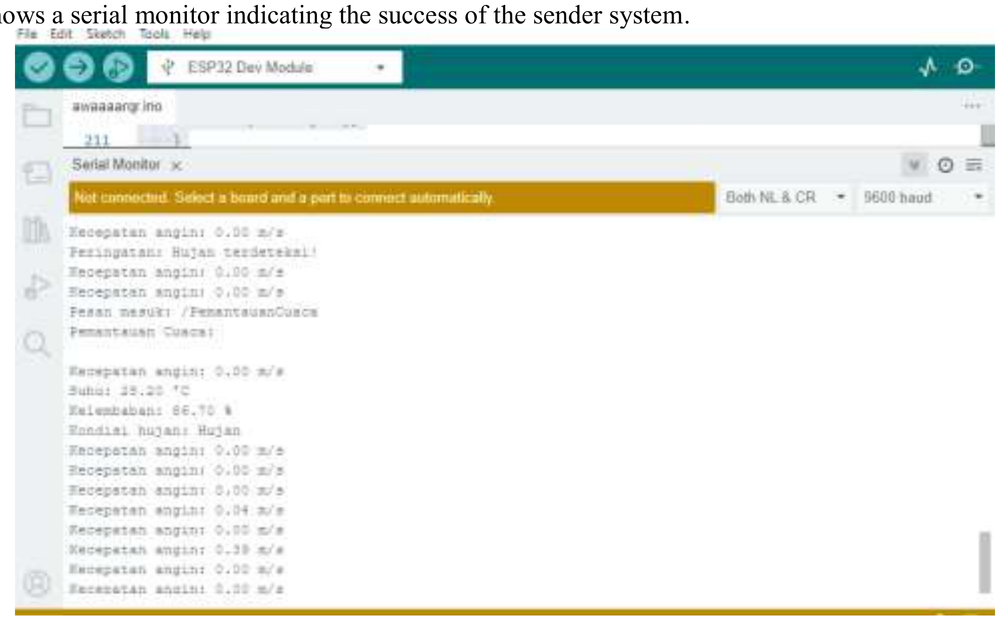

Fig 3. Testing the sender system

Volume 1, **Number** 2, September 2024, pp. 1-9

In the Receiver system, there is a telegram bot connected to the ESP32. Which ESP32 will send the data it receives from the three sensor inputs installed on the ESP32 pins via an internet connection. Figure 4.2 shows the appearance of the telegram bot receiving a message indicating that the test of the receiver system receiving data from the sender system was successful.

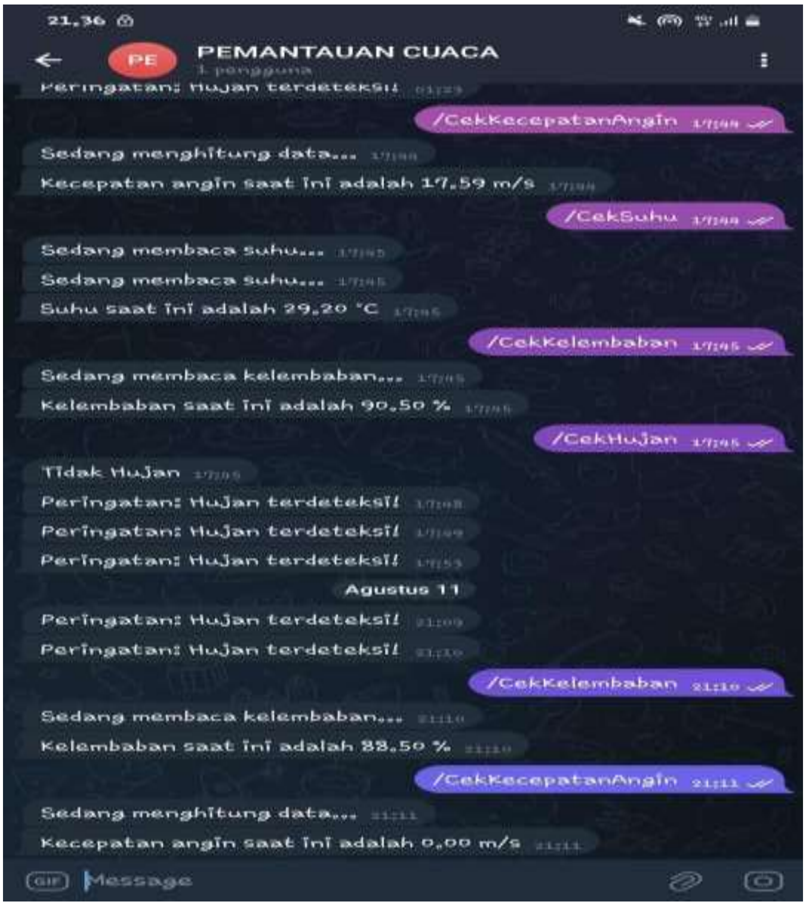

Fig 4.Display of the Receiver System

DISCUSSION

After testing the sensors, transmission system, receiver system, and data communication, the next step is to analyze the results of these tests. The analysis aims to ensure that the sensors produce accurate data, the transmission and receiver systems function properly in sending and managing the data, and that successful integration with the designated platforms is achieved. The results of this analysis will help ensure that the system contributes effectively to supporting the activities of fishermen. The following is the analysis of the tests conducted.

The wind speed sensor on this tool is designed to provide accurate weather information, allowing fishermen to make informed decisions about their fishing activities. The wind speed sensor readings are shown in Table 4.1. Based on the test results on Friday, August 9, 2024, the sensor indicated moderate wind conditions. Similarly, the test results on Friday, August 14, 2024, also showed moderate wind conditions. For the sensor calibration system error test, the relative error of the wind speed sensor (anemometer) was calculated based on data from AccuWeather using the following formula:

$$ER = \frac{|RS - RB| \times 100\%}{RB.}$$

Using this formula, the error rate was calculated as 0.43%. From these results, it is determined that the anemometer's error rate is 0.43% based on 12 data collections over two days. This is the smallest error rate when compared to AccuWeather's data, so the conclusion is that the anemometer wind speed sensor in the weather monitoring system is suitable for providing wind speed information. The discrepancy in wind speed readings is likely due to the use of different sensors, meaning that the accuracy of the readings differs from those used by AccuWeather. Wind speed variations can impact the efficiency of fishermen in their activities. The wind speed sensor readings were taken over one minute, meaning the device measures how fast the wind moves in an area over that time frame.

The DHT22 sensor in this tool is designed to provide accurate information about the surrounding temperature and humidity. The sensor data readings are displayed in Table 4.2. For the temperature sensor calibration error test, the relative error of the DHT22 temperature sensor was determined using the following formula:

$$ER = \frac{|RS - RB|}{RB} \times 100\%$$

Using this formula, the relative error was calculated as 0.31%. From these results, it is concluded that the error rate of the DHT22 temperature sensor is 0.31%, based on 12 data collections over two days. This is the smallest error rate when compared to AccuWeather data, indicating that the DHT22 temperature sensor is suitable for providing temperature information. The discrepancy in temperature readings is due to the use of different sensors, which causes a difference in accuracy compared to AccuWeather data. Similarly, for humidity, the relative error of the DHT22 humidity sensor was calculated using the same formula, resulting in a relative error of 0.15%. Based on this, it is concluded that the DHT22 humidity sensor error rate is 0.15%, making it a suitable reference for providing humidity information. The discrepancy in humidity readings is also due to the use of different sensors, leading to differences in accuracy compared to AccuWeather's data.

The raindrop sensor in this tool is designed to provide early warnings of natural disasters and accurate weather analysis for making informed decisions in agriculture. The raindrop sensor readings are displayed in Table 4.3. Testing was conducted on August 9 and 14, 2024. The data output is represented by values of 1 and 0, where 1 indicates no rain and 0 indicates rain. On August 9, 2024, measurements were taken between 15:00 and 17:00 WIB, and no rain was recorded during that time. On August 14, 2024, similar measurements were taken, and no rain was detected. The sensor successfully provides real-time information on rain conditions during fishermen's activities.

The weather monitoring tool to support the activities of coastal fishermen involves both a transmission and receiver system. The transmission system, which uses a NodeMCU ESP32 with wind speed, temperature, humidity, and raindrop sensors, successfully sends weather data in real time over the internet. The receiver system uses a Telegram bot, which receives the data sent by the NodeMCU ESP32. Once received, users can input a message to check wind speed, temperature, humidity, and rainfall, and the Telegram bot will display the data. The system sends notifications to the Telegram bot user in real-time, ensuring that the bot effectively communicates weather data to its users.

CONCLUSION

Based on the design and manufacture of Telegram-based weather monitoring tools for fishermen in coastal areas and analyzing the test data of the tool, the following conclusions can be drawn.

Through the application of the Internet of Things (IoT) concept, a weather monitoring hardware system has been successfully created to support fishermen's activities in real time. This can help fishermen make decisions about when to go to sea by observing weather conditions, including wind and rain, in order to reduce the risk of accidents and increase fishing efficiency.

Telegram IoT-based software solutions allow weather information such as wind speed, temperature and humidity and rain points to be accessed via smartphone devices. The success of this system has a positive impact on decision making in planning fishermen's activities and dealing with dynamic weather changes. So that the tool is said to be able to work well with a level of accuracy of weather monitoring data from manual readings with an average difference in error readings of 1.79%.

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