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Design of Monitoring Tool for Rainfall Intensity and Wind Direction on Weather Station System

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Abstract

Weather element data is very useful for knowing the climatology of an area, so that humans can take advantage of these weather conditions according to the needs of each party. The most influential weather phenomena are rain and wind. To see how much rain intensity and wind direction a place is, a rainfall and wind direction monitoring system is made in the weather station system. The purpose of designing this monitoring system is to monitor and get information data easily about rain and wind conditions in a place. For the measurement of the rainfall parameters, a tipping bucket type rain gauge is used and for wind direction indicators use the Wind Direction sensor as a wind direction indicator sensor. This system is made using other devices between the hall effect sensor, microcontroller, and NodeMCU Wifi ESP32 and uses blynk to display information from the monitoring tool. This system is expected to help users to find out information about the intensity of rainfall and wind direction indicators in an area.

Keywords: Rainfall; Wind Direction; Rain Gauge; Wind Direction; Hall Effect; Blynk

Abstrak

Data unsur cuaca sangat berguna untuk mengetahui klimatologis suatu daerah, sehingga manusia dapat memanfaatkan kondisi cuaca tersebut sesuai kebutuhan masing-masing pihak. Fenomena cuaca yang sangat berpengaruh adalah hujan dan angin. Untuk melihat seberapa besar intensitas hujan dan arah angin di suatu tempat maka dibuatlah sebuah sistem monitoring curah hujan dan arah angin pada sistem weather station. Tujuan dari perancangan sistem monitoring ini adalah untuk memantau dan mendapatkan data informasi dengan mudah tentang kondisi hujan dan angin di suatu tempat. Untuk pengukuran parameter curah hujan tersebut digunakan rain gauge jenis tipping bucket dan untuk penunjuk arah angin menggunakan sensor Wind Direction sebagai sensor penunjuk arah angin. Sistem ini dibuat menggunakan perangkat lain antara sensor hall effect, mikrokontroler, dan NodeMCU Wifi ESP32 serta menggunakan blynk guna menampilkan informasi dari alat monitoring tersebut. Sistem ini diharapkan dapat membantu pengguna untuk mengetahui informasi mengenai instensitas curah hujan dan penunjuk arah angin pada suatu daerah.

***Kata-kata kunci**: Hujan; Arah Angin; Rain Gauge; Wind Direction; Hall Efek; Blynk*

1. Introduction

Observation of weather elements is very important for the interests of human life [1] [2]. Weather element data helps to know the climatology of an area, so that humans can utilize the weather conditions according to their needs [3] [4]. Weather data can also reduce the risk of adverse weather impacts. In the agricultural sector, wind and rain are important factors to help optimize agricultural output [5] [6] [7]. Weather is a key factor in precision farming techniques. Although the weather cannot be controlled, weather monitoring can be done. Wind direction and high rainfall can cause problems for plants, such as disease and flooding [8] [9]. Therefore, evacuation efforts need to be made before the disease and flooding occur. So a tool is needed that is able to convey news of the height of rainfall and the direction of the wind that occurs.

The development of technology makes it easier for its users with a monitoring system. One example is a weather station tool to monitor the weather, especially rainfall and wind direction. Weather stations consist of various instruments that can measure and record meteorological parameters without human assistance [10]. Weather monitoring is very important, especially for agriculture. Data from the sensors used are processed to obtain information on the characteristics of rainfall and wind direction that often change [11] [12]. Data from the terrserburt sensor will be displayed with the blynk gurna feature to get information from the rainfall intensity monitoring tool and terrserburt wind direction [13] [14]. The purpose of this tool is expected to be able to create a design for an electronic measuring tool that is useful for agriculture. One of them is that farmers must pay attention to the wind direction when spraying pesticides [15]. With the prediction information obtained from this device, farmers can find out the prediction information to start planting and provide instructions for anticipating bad weather that has an impact on agricultural products.

2. Methods

This section explains the research methods in designing and building rainfall and wind direction monitoring tools, including system design, component selection, and data processing techniques for accurate and reliable results.

2.1 Literature Study

The stage of searching for literature related to the design of wind direction monitoring tools to obtain information on the types and characteristics of the tool. Information is obtained from various sources such as books and the internet. This monitoring tool system is designed based on techniques obtained from literature studies, so that it is expected to contribute to quality research and the results can be published in national and international seminars or journals.

2.2 Hardware Development

a) Electronic Design

The creation of this tool includes three main stages, namely a block diagram to understand the general working system of the tool, a flowchart that explains the overall workflow of monitoring rain intensity and wind speed against the design plan, and a circuit schematic to understand the relationship between the components used [16] [17]. These three stages are designed to ensure the tool works according to its function.

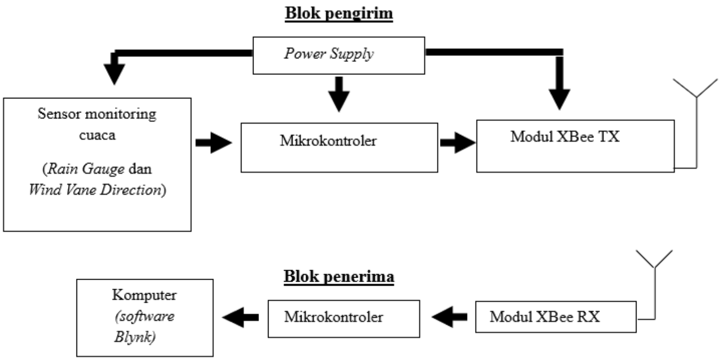


Figure 1. Overall System Architecture of the Tool

b) *Flow Chart*

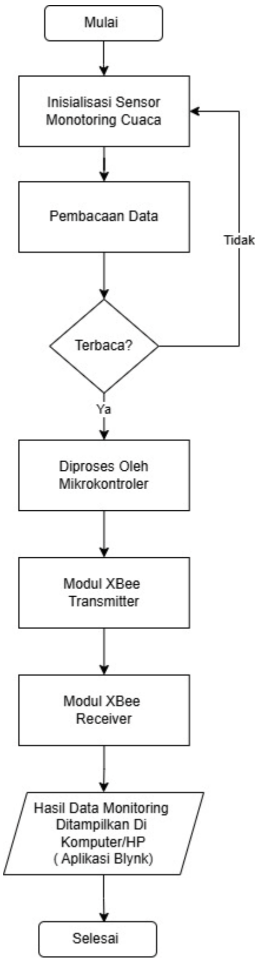


Figure 2. Overall Flow Chart

This tool has an NRF2401L module as a long-distance communication so that data sent remotely can be connected to other parts. On this NRF2401L there are 8 pins in the form of VCC, ground, CSN (Chip Select Zero), CE (Chip Eneble), SCK (Serial Clock), MOSI (Master Output Slave Input), MISO (Master Input Slave Output), and IRQ (Interrupt Pin).

The VCC pin is connected to the VCC or 3.3v pin on the Arduino Nano, the ground pin is connected to the Arduino Nano ground pin. The CSN pin is connected to the Arduino digital pin 9 (PWM), the MOSI pin is connected to the Arduino digital pin 9 (PWM), the MOSI pin is connected to the Arduino pin 10 (PWM-SS), the SCK pin is connected to the Arduino digital pin 13 (SCK) and the MISO pin is connected to the Arduino digital pin 12 (MISO).

c) Arduino Configuration with All Transmitter Components

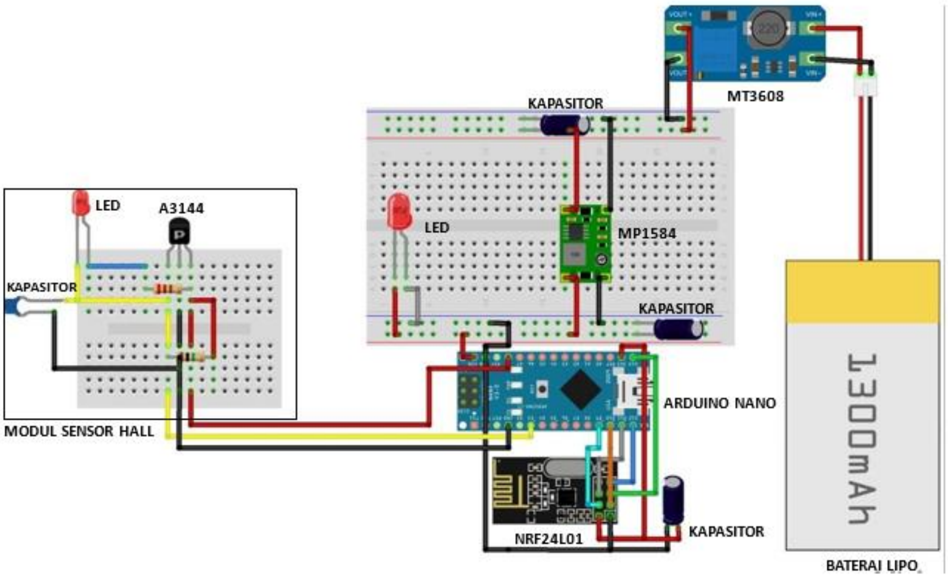


Figure 3. Arduino Nano Configuration with All Transmitter Component Devices

2.3 Mechanical Design

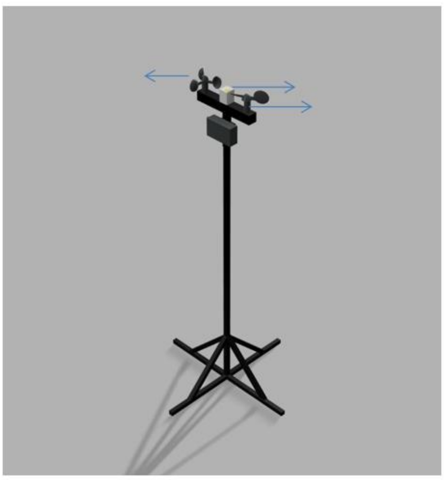


Figure 4. Weather Station System Equipment Design

2.4 Software Design

a) Arduino IDE Microcontroller

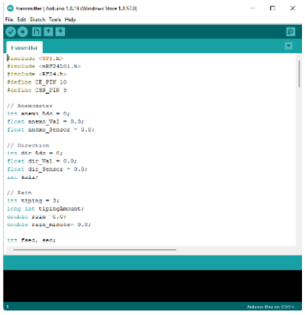


Figure 5. Arduino IDE Software

b) *Blynk*

Blynk is used as a data viewer for rainfall intensity, wind speed, and wind direction to monitor weather conditions in real-time and remotely. With an internet connection, Blynk allows monitoring from anywhere, helping with weather prediction and preventive measures.

3. Results and Discussion

Rain intensity testing on the rainfall monitoring device in the weather station system was carried out directly during the rainy period, from January 7 to 14, 2025. Data was collected every time it rained and displayed in real-time via the Blynk application. The results of the rain intensity test are presented in Table 1.

Table 1. Rain Intensity Test Results with Blynk Display

No	Date	Long Rain	Monitoring (mm/hour)	Condition
1	7th January	15.55 – 16.07	96	Dense
2	13th January	14.34 – 14.41	125	Very Dense
3	14th January	07.00 – 07.22	111	Very Dense

Based on Table 1, the results of the real rain test with the output data values displayed on Blynk show the amount according to the real conditions.

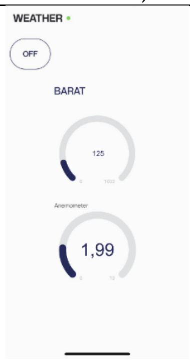
7th January 2025 (12 minutes)	13th January 2025 (7 minutes)	14th January 2025 (22 minutes)
		

Figure 6. Rainfall Monitoring Data on the Blynk Display

Table 2. Results of Tool Testing Based on Artificial Rain on the Blynk Display

No.	Long Rain	Blynk Display (ml/hour)		Difference	error
		Real Rain	Artificial Rain		
1	12 minutes	96	97	1	1,04%
2	7 minutes	125	127	2	1,6%
3	22 minutes	111	115	4	3,6%
		Rata-rata error (%)			2,08%

Based on **Table 2**, after conducting a trial using artificial rain based on data from real rain time displayed on blynk, the average data output error was 2.08%. The difference or error value can be calculated using the following equation.

$$Error = \frac{difference}{direct\ rainfall\ value}\ x\ 100\%$$

Table 3. Data From the Results of Reading the Wind Direction Indicator Monitoring Tool

No.	Date	Wind Velocity	Monitoring Hour											Average
			7	8	9	10	11	12	13	14	15	16	17	
1	7 jan	2,81 km/h	W	W	NW	N	S	W	W	W	NW	NW	NW	W (West)
2	8 jan	3,47 km/h	NW	NW	NW	NW	NW	NW	W	W	W	NW	NW	NW (North-West)
3	9 jan	4,55 km/h	NW	W	W	W	W	W	NW	NW	NW	S	S	W (West)
4	10 jan	5,00 km/h	W	NW	NW	S	S	NW	NW	S	NW	NW	W	NW (North-West)
5	11 jan	5,00 km/h	NW	S	S	S	NW	NW	NW	S	S	NW	NW	NW (North-West)
6	12 jan	4,72 km/h	NW	NW	NW	NW	NW	NW	NW	NW	S	S	S	NW (North-West)
7	13 jan	1,99 km/h	W	W	W	W	W	W	NW	NW	NW	NW	NW	W (West)
8	14 Jan	2,23 km/h	W	NW	NW	NW	NW	NW	NW	NW	NW	S	S	NW (North-West)

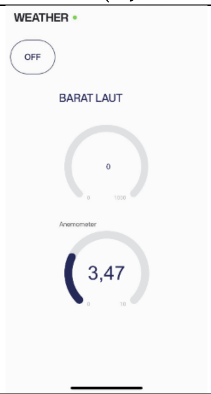
08.00 WIB (8 Jan 2025)	17.00 WIB (10 Jan 2025)
	

Figure 7. Wind Direction Indicator Monitoring Data on the Blynk Display

Table 4. Test Data of Sensor Measurement Results with Compass Measuring Instrument

NO	Wind Direction		ERROR
	Measurement of Wind Direction Monitoring Tools	**Comparative Compass**	
1	West	West	0%
2	North-West	North-West	0%
3	West	West	0%
4	North-West	North-West	0%
5	North-West	North-West	0%
6	North-West	North-West	0%
7	West	West	0%
8	North-West	North-West	0%

The weather monitoring tool testing was conducted for 8 days (January 7-14, 2025) in Sawah Desa Muara Baru, Kayuagung. Rain occurred on January 7, 13, and 14 with an intensity of 96 ml/hour (12 minutes), 125 ml/hour (7 minutes), and 111 ml/hour (22 minutes), respectively. The wind direction is dominated by the West and Northwest with a speed of 5-14 km/h. Data is displayed on the Blynk platform with a 3-second delay due to the internet network and the distance of the NRF24L01 delivery. The artificial rain test showed a higher intensity value than real rain due to differences in the size of the water droplets, resulting in an error of 2.08%. The compass test confirmed the wind direction in accordance with the tool, although this tool is not as accurate as BMKG equipment.

4. Conclusion

This monitoring tool uses two types of sensors. The tipping bucket type rain gauge sensor works with a hall effect sensor that calculates the amount of tipping for each bucket movement, with a water volume per tipping of 0.74 mm. The wind vane direction sensor is used to determine wind direction, consisting of a vertical axis and an arrow-shaped or fin-shaped pointer that moves freely following the wind direction. Rain data is monitored online via the Blynk platform, which can be accessed via the website https://blynk.io or the Blynk application on Android using an internet network. However, there is a delay in monitoring caused by platform provisions, internet network quality, or the NRF24L01 data transceiver. In the artificial rain test, the resulting value is greater than the real value, which indicates a difference in measurement between simulated and actual conditions.

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