The Spirit of Society Journal
International Journal of Society Development and Engagement
LPPM - Universitas Narotama
ISSN : 2594 - 4777 (Online)
2597 - 4742 (Print)
https://jurnal.narotama.ac.id/index.php/scj/index

Design of a Marine Weather Monitoring System Based on an Arduino System

M.Basuki Rahmat[1], Hendro Agus Widodo[2], Agus Khumaidi[3], Ratna Budiawati[4], Eko julianto[5] Sri Wiwoho Mudjanarko[6]

[1,2,3,4]Teknik Kelistrikan Kapal Politeknik Perkapalan Negeri Surabaya
[5]Teknik Permesinan Kapal Politeknik Perkapalan Negeri Surabaya
[6]Universitas Narotama Surabaya

Correspondent author: mbasuki.rahmat@ppns.ac.id

Abstract: The need for information about weather conditions in a particular environment is essential for the community, so that they can plan activities for the future. A forecaster cannot process data to predict weather or climate conditions if it is not supported by historical data within a predetermined time period. Data is a very important savings for future generations, because data will make the nation's generation smart. Without data, all previous information would not be known to be studied. The current condition of the earth is very worrying and not easy to predict. Therefore, it is very important to have integrated observations and services in coastal and marine areas to support resilience to climate change and other marine hazards. Sustainable marine observations and services are very important and relevant to reduce potential problems and threats arising from climate change. In this paper we will discuss the creation of a tool for monitoring weather, where this tool will take data on humidity, temperature and rainfall. so that from this data we can predict weather conditions in the area. By using the fuzzy method, the combination of these three data can be used by fishermen to make decisions whether it is still safe to go to sea. The system is built based on Arduino using mooring buoy media where this tool will be placed in the sea. The power supply system uses solar cells, so that it can independently meet the power needs of the equipment. From the test results the system can work normally and well

Keywords: Arduino; weather, monitoring, data, sustainable

INTRODUCTION

Indonesia is a maritime country that has many islands. The Indonesian archipelago stretches across the waters tropical between the Indian and Pacific Oceans, and from Southeast Asia to Northern Australia. It is not surprising that Indonesia is called the largest archipelagic country in the world. The Indonesian archipelago has an island land area of around 1.92 million km², a 12-mile inland sea and territorial sea area of 3.1 million km², and a 200-mile Exclusive Economic Zone (EEZ) area of 2.7 million km². Indonesia has a coastline of around 81,000 km so it is the country with the longest tropical coastline in the world. The distance between Indonesia and West to East is longer than the distance from London to Moscow or from New York to San Francisco.(Edvin Aldrian, M. K. (2011))(M. S. Akmaluddin, A. S. (2022)

So it is not wrong if fishing is one source of livelihood. In the process of going to sea, fishermen must be observant and sensitive to weather changes. so you can see danger signs so you need to pay attention to extreme weather changes. Weather is one of the factors that supports the smooth and safe sailing of ships at sea. Therefore, information regarding weather forecasts is very important in shipping activities. (Oikonomou dkk, 2023)

The availability of accurate and reliable marine data and information is very beneficial for improving the economy of coastal communities, developing the marine and fisheries sector, shipping security and safety, and can strengthen the early warning system for disasters, especially tsunamis. For Indonesia, coastal and marine areas have strategic and important meaning for Indonesia's future considering that as the largest archipelagic country in the world, these areas dominate Indonesia's total territory. The length of Indonesia's coast is 99,000 km, the second longest after Canada.(bulaka, 2016)

In Indonesia, land-sea interactions are the main driver of weather characteristics. ENSO (El Nino Southern Oscillation) and IOD (Indian Ocean Dipole) are prominent factors because of Indonesia's geographical location which is between two continents and two oceans, namely the Indian Ocean and the Pacific Ocean. Apart from that, Through Flow Indonesia activities also influence weather and climate conditions in Indonesia. Over the last three years, Indonesia experienced a Triple-Dip La Nina, namely in 2020-2022. Meanwhile, in 2023, Indonesia will face quite severe drought due to a strong El Nino. This is what drives marine observations to overcome the challenges of climate change. Therefore, one of the factors in building this system is obtaining data that is used as a reference.(Wele, I. H. (2020)

METHODOLOGY

The research steps are explained in the following figure below:

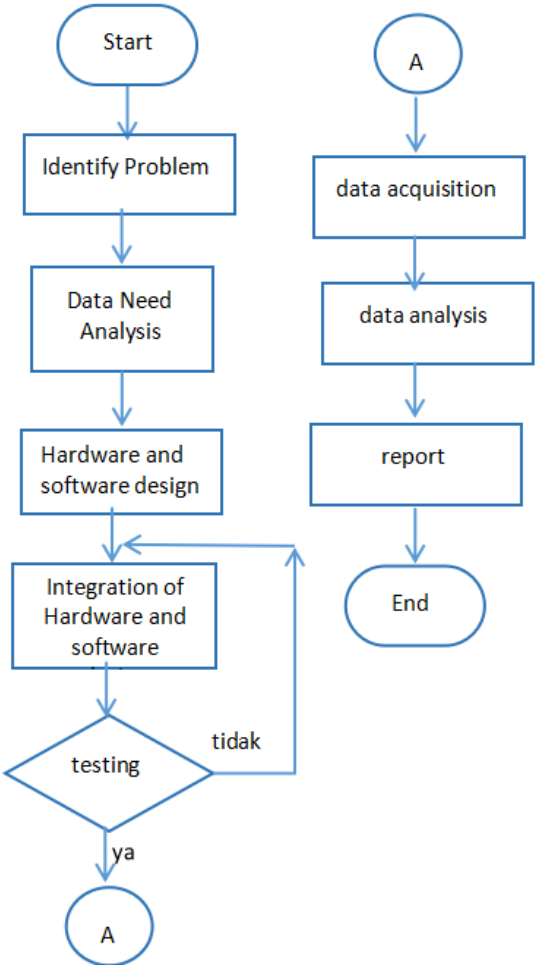

Figure 1. Research steps

In resolving this monitoring problem, the following steps are taken: 1. designing the hardware system; 2. designing a Fuzzy process; 3. designing software systems; 4. Realize the design in floating media. The hardware design is shown in Figure 2.

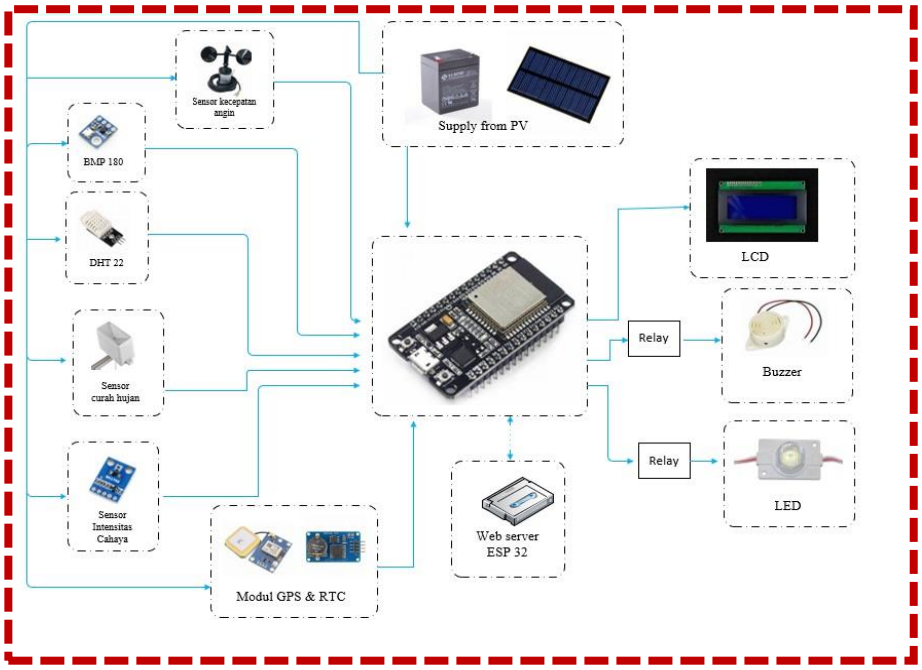

Figure 2. Hardware design

In Figure 2 it can be seen that there are 5 sensors used to determine weather conditions, namely rainfall sensors, light intensity sensors, wind speed sensors, temperature/humidity sensors (DHT 22) and air pressure sensors (BMP 180). The electricity supply for all components comes from solar cells. Apart from that, there is a GPS sensor, whose function is to find out the location of the monitoring tool. all of these components are installed on a floating medium which will be placed in the middle of the ocean. therefore, the GPS component is an important part. There is an RTC module which functions to provide real time when the data is read by the sensor. Next, the data from the sensor is processed via the ESP 32 WiFi microcontroller module which is then sent to the server to be monitored remotely. Next, the system will activate the LCD actuator, LED and also the buzzer will sound if the weather conditions are not good enough.

The fuzzy logic control system consists of several stages as in the following diagram.

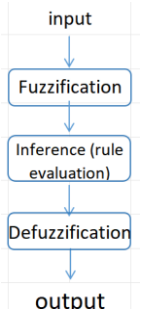

Figure 3. Fuzzy Process

RESULT AND DISCUSSION

All hardware and sensor designs are placed on floating media, making it easier to place monitoring equipment into the sea. Figure 4 shows the process of launching a monitoring system at a field location on the coast.

Figure 4. Monitoring System

The locations of data collection points are distributed at fishermen's locations as shown in the following image.

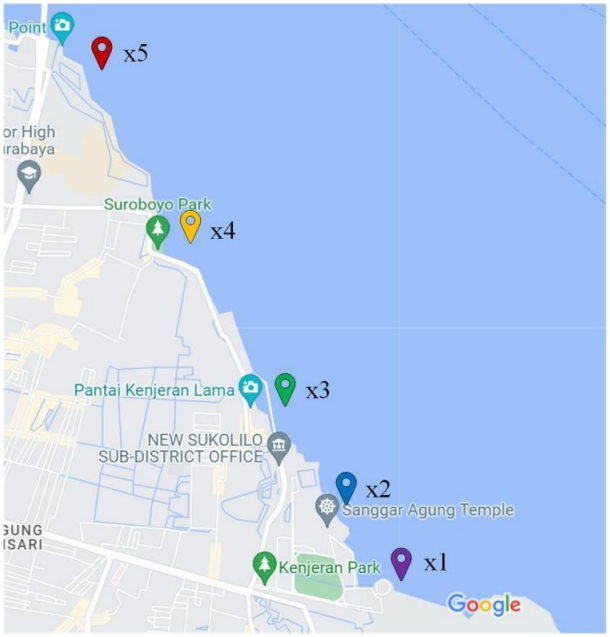

Figure 5. Location data acquisition

The data measurement results can be seen in table 1 below.

Table 1. Data Acquisition

No.	sensor	Information	Location					
			X1	X2	X3	X4	X5	average
1.	Light intensity	BH1750 (lux)	5204,8	5590,5	4323	2946,6	3968	4406, 58
		AS803 (lux)	5280	5556	4370	2995	3926	4425,4
		Error (%)	1,42%	0,62%	1,07%	1,62%	1,07%	1,16%
2.	wind velocity	wind velocity (m/s)	0,0	1	2,0	1,7	1	1,14
		Benetech GM816 (m/s)	0,0	1,6	1,5	2,2	1,6	1,38
		Error (%)	0%	37,5%	33,3%	22,72%	37,5%	26%
3.	DHT 22 humidity	DHT 22 (%)	52	47	48	49,6	50,4	49,4
		HTC – 2 (%)	51	46	49	50	51	49,4
		Error (%)	1,9%	2,17%	2,04%	0,8%	1,17%	1,62%
4.	DHT 22 temperature	DHT 22 (°C)	38,20	39,50	41.20	42,30	42,90	40,5
		Multimeter temperature (°C)	38	39	41	42	43	38,66
		Error	0,52%	1,3%	0,49%	0,71%	0,23%	0,65 %
5.	air pressure	BMP 180 (millibar)	1010,62	1010,18	1010,35	1008,12	1010,16	1009,89
		Altimeter Digital (millibar)	1012,5	1012,0	1011,7	1011,6	1011,4	1011,84
		Error	0,18%	0,18%	0,13%	0,34%	0,12%	0,19%
6.	rainfall	Sensor tipping bucket mm	0,00	0,00	0,00	0,00	0,00	0,00
		real	bright	bright	bright	bright	bright	bright
		Error	0%	0%	0%	0%	0%	0%

The table 1 explains that data has been taken from 5 different locations. on the Light sensor (BH1750) there are changes at locations 3, 4, and 5. This is caused by changes in the environment where during the measurement there is a change in the surrounding environment, namely there are thick clouds covering the area of the measurement location. Then on the wind speed sensor there is a difference that is not too influential. For the DHT22 sensor which monitors humidity there is no significant change and tends to be constant. Meanwhile, for the BMP180 sensor, there were no significant changes, likewise for the temperature parameter data and also the rainfall sensor, the values remained the same and there was no change due to sunny, cloudy weather.

In managing data using fuzzy logic, simulations using MATLAB software are needed to determine the input, output and rules that will be used. This research uses 5 inputs from sensor readings to observe the weather. Meanwhile, the resulting output is in the form of data displayed on the LCD to determine current conditions. Then compare the variables used in the form of input and output in the form of membership functions to obtain their respective membership values. The universe of discussion of each variable is the range of possible values of the average daily data. The universe of discussions can be shown in Table 2.

Table 2. Universes of discussion on fuzzy variables

Fungsi	Variabel	Universe of Discourse
Input	Rain Intensity (mm)	[0, 70]
	Temperature (°C)	[20, 50]
	Humidity (%)	[60, 90]
	Air pressure (mb)	[1000, 1020]
	Wind speed (m/s)	[1, 3,5]
	Light intensity (lux)	[40, 120]
output	Rainfall (mm)	[0, 40]

To get the membership value, the membership function for each variable is determined using a function approach. For this function approach, a sample of the weather is needed each year in the area studied. The membership function used in this final project is the trapezoidal membership function. The membership function of each variable is as figure 6 bellow:

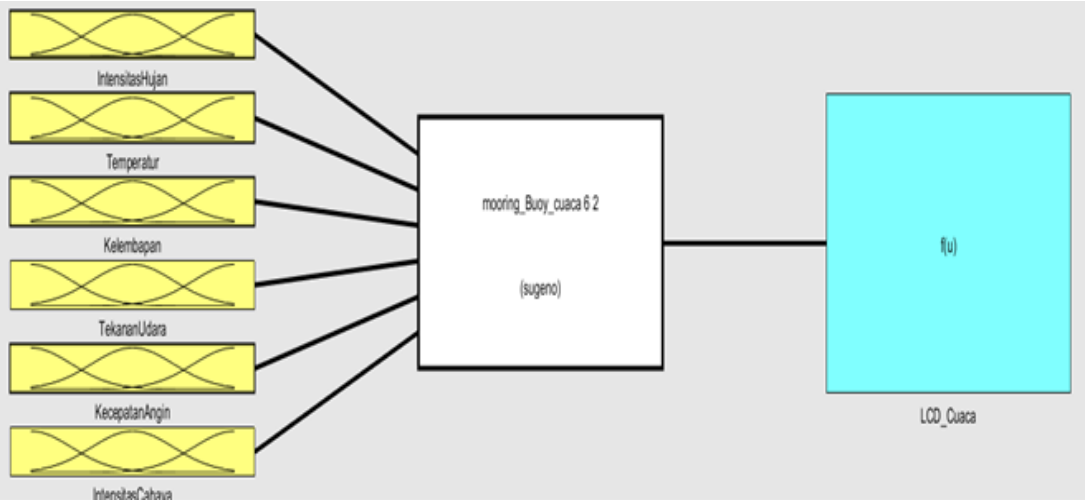

Figure 6. The membership function

The output variable for weather consists of sunny/cloudy (safe), light rain (safe), moderate rain (safe), heavy rain (risky), very heavy rain (dangerous) shown in table.3

Table 3. Composition Rules pada Fuzzy Logic

No.	Rainfall	temperature	humidity	Air pressure	Light intensity	Wind speed
1	sunny	cold	low	strong	dark	slow
2	sunny	cold	low	strong	dark	medium
3	sunny	cold	low	strong	dark	strong
4	sunny	cold	low	strong	dim	slow
5	sunny	cold	low	strong	dim	medium
6	sunny	cold	low	strong	dim	strong
7	sunny	cold	low	strong	bright	slow
8	sunny	cold	low	strong	bright	medium
9	sunny	cold	low	strong	bright	strong
10	sunny	warm	medium	Normal	dark	slow
11	sunny	warm	medium	Normal	dark	medium
12	sunny	warm	medium	Normal	dark	strong

No.	Rainfall	temperature	humidity	Air pressure	Light intensity	Wind speed
13	sunny	warm	medium	Normal	dim	slow
14	sunny	warm	medium	Normal	dim	medium
15	sunny	warm	medium	Normal	bright	strong
16	sunny	warm	medium	Normal	bright	slow
17	sunny	warm	medium	Normal	bright	medium
18	sunny	warm	medium	Normal	dark	strong
19	sunny	hot	normal	weak	dark	slow
20	sunny	hot	normal	weak	dark	medium
21	sunny	hot	normal	weak	dark	strong
22	sunny	hot	normal	weak	dim	slow
23	sunny	hot	normal	weak	dim	medium
24	sunny	hot	normal	weak	dim	strong
25	sunny	hot	normal	weak	bright	slow
26	sunny	hot	normal	weak	bright	medium
27	sunny	hot	normal	strong	bright	strong
28	Medium rain	cold	low	strong	dark	slow
29	Medium rain	cold	low	strong	dark	medium
30	Light Rain	cold	low	strong	dark	strong
31	Light Rain	cold	low	strong	dim	slow
32	Light Rain	cold	low	strong	dim	medium
33	Light Rain	cold	low	strong	dim	strong
34	Light Rain	cold	low	strong	bright	slow
35	Light Rain	cold	low	strong	bright	medium
36	Light Rain	warm	low	strong	dark	strong
37	Light Rain	warm	medium	Normal	dark	slow
38	Light Rain	warm	medium	Normal	dark	medium
39	Light Rain	warm	medium	Normal	dark	strong
40	Light Rain	warm	medium	Normal	strong	slow
41	Light Rain	warm	medium	Normal	strong	medium
42	Light Rain	warm	medium	Normal	strong	strong
43	Light Rain	warm	medium	Normal	strong	slow
44	Light Rain	warm	medium	Normal	strong	medium
45	Light Rain	warm	low	Normal	strong	strong
46	Heavy Rain	cold	low	strong	strong	slow
47	Heavy Rain	cold	low	strong	strong	medium
48	Heavy Rain	cold	low	strong	strong	strong

CONCLUSIONS

The mooring buoy is quite stable and floats well. The equipment for carrying out the weather monitoring process also works well. Where data can be displayed on the web. The data taken by the sensor is relatively not much different from real conditions. where the light intensity sensor has an average error of 1.161%, the wind speed sensor has an error of 26%, the temperature sensor has an average error of 0.65%, the humidity sensor has an average error of 1.62%, the pressure sensor air

which has an average error of 0.19% and rainfall sensors which have an average error of 0.12%. Using fuzzy, three output conditions are taken, such as sunny/cloudy, moderate rain, and heavy rain, with fluctuations that are not far from the weather prediction on the tool compared to the actual weather. From the output results, you can read all weather conditions, with a success rate of 80%.

Acknowledgments (Optional): We would like to thank PPNS for providing support facilities in carrying out this research activity

Conflicts of Interest (Optional): We are a pure team doing this solely because we want to develop knowledge. there are no other conflicts of interest.

REFERENCES

Edvin Aldrian, M. K. (2011). Adaptasi dan mitigasi Perubahan Iklim di Indonesia. Pusat Perubahan Iklim dan Kualitas Udara Kedeputian Bidang Klimatologi Badan Meteorologi, *Adaptasi dan Mitigasi Perubahan Iklim di Indonesia* (p. 22). Jakarta: Pusat Perubahan Iklim dan Kualitas Udara Kedeputian Bidang Klimatologi Badan Meteorologi, Klimatologi, dan Geofisika (BMKG)

Oikonomou, S.; Deli, D.; Kotta, D.; Matsangouras, I.; Myrsilidis, M. HNMS Marine Forecasts in Cases of Weather Warnings: Verification against Satellite Measurements. *Environ. Sci. Proc.* **2023**, *26*, 4. https://doi.org/10.3390/environsciproc2023026004

Bulaka, B., Hendro., 2016. "Rancang Bangun Alat Pemantau Pasang Surut Air Laut Melalui Jaringan Internet Untuk Kawasan Teluk Kendari". Prosiding Seminar Nasional Fisika, vol. 5. doi: 10.21009/0305020106

M. S. Akmaluddin, A. S. (2022). Rancang Bangun Sistem Infomasi Kondisi Cuaca dengan Metode *Fuzzy Logic* Untuk KEselamatan Nelayan Berbasis Arduino. *Seminar nasional 2022* , 167 - 173.

Wele, I. H. (2020). SISTEM PERAMALAN CUACA DENGAN *FUZZY* MAMDANI (Studi Kasus: Badan Meteorologi, Klimatologi, dan Geofisika Lasiana). *J-ICON, Vol. 8 No. 2*, 163~169