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Prototype of Seaweed Dryer Operating in Manual and Automatic Mode Using Wi Fi Based Microcontroller

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ABSTRACT

This study discusses the development of a seaweed dryer prototype that can operate automatically or manually using a IoT (Internet of Things) based Nodemcu ESP826 microcontroller and Telegram application. The operation of the tool can choose automatic mode, where the system regulates the temperature independently, or manual mode via telegram to control the drying parameters directly. The drying process can be carried out by operating an incandescent lamp (50 W) as a heat generator and a fan to generate air flow in the seaweed drying area. The method of testing the tool with automatic mode is by installing a rainwater sensor that will provide a signal for the microcontroller to order the motor to rotate to open or close the roof and turn on the lights and fan, while in manual mode the roof opening and closing operation is carried out by changing the use of automatic mode to manual on the telegram command. The test results are in the form of voltage measurements on several tool components that are in accordance with the working parameters of each part and this tool can operate in automatic or manual mode. When the drying process takes place, the incandescent lamp and fan will be active or ON, and when the water sensor receives rainwater, the drive motor will immediately be active to close the roof. When the water sensor does not receive rainwater, all systems will automatically be OFF. This prototype is worthy to be implemented into a real tool to help seaweed farmers in the seaweed drying process to be more efficient, easier to control, and can improve the quality of the final seaweed product.

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1. INTRODUCTION

Indonesia is recorded as one of the largest seaweed producing countries, with production reaching 10.25 million tons in 2021 according to data from the Ministry of Maritime Affairs and Fisheries (KKP) [1].Seaweed is one of the leading commodities in the fisheries sector which has high economic value, especially in the West Nusa Tenggara region which is the seaweed production center [2] . The characteristic of seaweed lies in the type of pigment it contains, which is the basis for grouping it into several divisions, namely Rhodophyta (red algae), Chlorophyta (green algae), Phaeophyta (brown algae), and Chrysophyta (golden/blond algae) [3]. Processed seaweed products are widely used in the food and non food [4], cosmetics (face mask) [5,6] , pharmaceutical [7] and other sectors [8] . One of the important stages in seaweed processing is the drying process, which has a direct effect on the quality

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and durability of the final product. Conventional (open) drying requires large areas of land and relies on sunlight, often facing various obstacles, such as dependence on weather, long drying times, and the risk of contamination, so this method is not recommended in the seaweed processing industry [9] . Therefore, innovative solutions are needed to improve the efficiency and quality of seaweed drying. As technology develops, Internet of Things (IoT) based systems can be applied to automate remote monitoring processes, evaluate performance and control drying [10]. Nodemcu ESP8266 is NodeMCU is an open source IoT platform that includes hardware a microcontroller [11] that can be used to develop automatic drying systems for remote monitoring and control [12,13]. The ESP8266 is an ultra-low cost module with advanced features, making it an ideal choice for smart home applications with the Internet of Things (IoT) [14]. By integrating temperature and humidity sensors, this system is able to adjust drying conditions in real-time. In addition, using the Telegram application allows users to monitor and control the dryer both automatically and manually remotely. Until now, innovation and research on seaweed drying equipment continues to be carried out. Some previous research includes: G.B. Pradana discusses the process of drying seaweed using a tray dryer equipped with an air dehumidification system to increase energy efficiency and product quality. Seaweed was dried using a tray dryer at temperatures of 40°C, 50°C, 60°C, and 70°C for 2, 3, and 4 hours. Water content was measured every 30 minutes to monitor the drying process. The research results showed that water content in accordance with Indonesian National Standards (SNI) was achieved after drying for 4 hours at 50°C, 4 hours at 60°C, and 2, 3, and 4 hours at 70°C. The increase in drying temperature is directly proportional to the drying rate, but over time, the drying rate decreases. The highest energy efficiency was achieved in drying for 4 hours at 50°C, namely 91.50% [15]. A. Culaba and his colleagues discussed mathematical modeling of the seaweed drying process using sequential statistical criteria analysis to determine the best drying model. Drying modeling is important to understand drying behavior and optimize the process [16]. Sarah Dewi discussed the development of a seaweed dryer that uses an Arduino Uno microcontroller equipped with an OLED LCD screen to monitor and display temperature and humidity during the drying process. This dryer prototype is equipped with a temperature sensor to detect temperature and humidity, a heater to dry seaweed, a fan to distribute heat evenly in the drying chamber, and an OLED LCD screen to display real-time temperature and humidity information. Tests show that this tool is capable of drying 4 kg of seaweed within 4-5 hours until it reaches the desired dryness level [17] . Apart from the many benefits obtained from seaweed processing, there is also waste from processing and it needs to be handled properly before being disposed of into the environment, namely through a neutralization process [18].

2. RESEARCH METHOD

This research aims to develop a prototype seaweed dryer based on the Internet of Things (IoT) using Nodemcu ESP8266 and the Telegram application. This tool is designed to work in manual or automatic mode, so users can control and monitor the drying process remotely. By utilizing temperature and humidity sensors, this system can adjust drying parameters automatically to increase efficiency and quality of drying results. To achieve this goal, this research uses an experimental method with a prototype development approach. The research steps carried out were the first: System Design, several things discussed included, determining the specifications of the seaweed dryer, designing a control system based on the NodeMCU ESP8266, determining the type of temperature and humidity sensor used (DHT22/SHT11) and designing the Telegram application interface for control and monitoring. Prototype Development, assembling hardware components, such as heaters (Bulb Lamp 50W) as a simulator to generate heat and increase room temperature), fans (to generate air flow in the dryer tools) , temperature and humidity sensors, as well as the Nodemcu ESP8266, developing software for control tool via Telegram, implementing manual and automatic control modes. Testing and Evaluation, testing the system in various environmental conditions, evaluating the effectiveness of the automation system in maintaining temperature and humidity according to optimal parameters, testing is carried out by measuring the voltage parameters produced in each important part of the tool being tested. Data analysis, evaluating measurement results and preparing recommendations for further development. The results of

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this research are expected to provide innovative solutions in the seaweed drying process by utilizing IoT technology which can be controlled manually or automatically via the Telegram application.

2.1. Design System

Figure 1. is a depiction of the overall design made on the prototype that was built. Includes input blocks, process blocks and output blocks as well as functions that will be described in each component contained in each block. The input block consists of a rain sensor, LDR sensor and also the Telegram application. These components are the initial trigger for the operation of this seaweed dryer. The triggers created by the input block components will be processed and processed by the process block consisting of the ESP8266 Nodemcu which is connected to the internet, where the data obtained will be processed by the ESP8266 NodeMCU which will then run the other components contained in the output block. Figure 2 is a prototype of the resulting seaweed dryer.

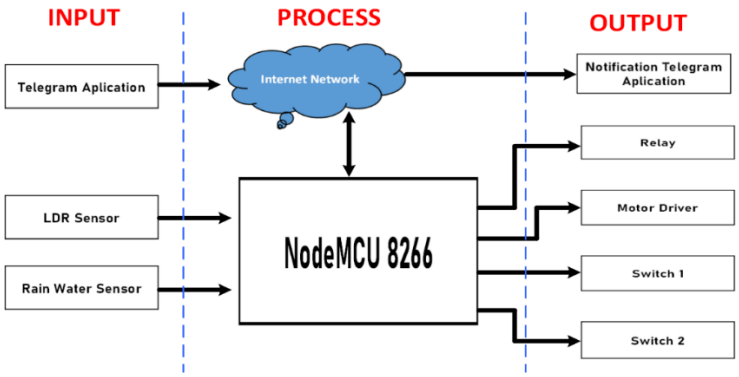

Figure 1. Overall system design diagram

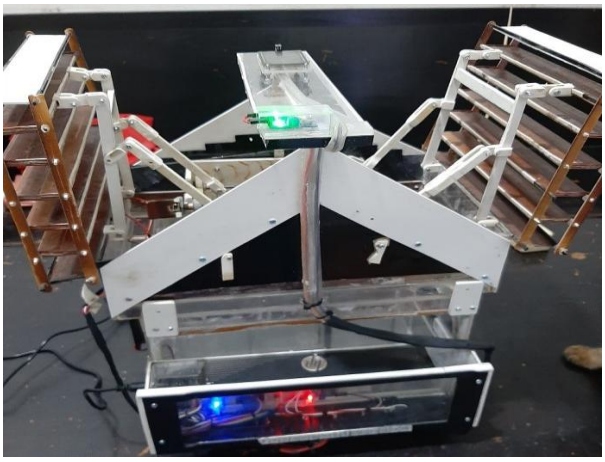

Figure 2. Prototype of Seaweed Dryer

2.2. Input Block

This In this input block there are two components, namely the rain sensor and the LDR sensor as triggers for this tool to run. This sensor works in a way that if the rain sensor is exposed to water, the sensor will detect it. Likewise with the LDR sensor, if the LDR sensor is not exposed to enough light or is dark, the sensor will detect it. Then there is the Telegram application which is used to change manual or automatic methods on tools via bots, which then trigger the triggers which will be processed later in the process block. In the Telegram application you can also find out the current state of the device with the "status" command to find out whether the device is in manual or automatic mode and whether the roof is open or closed. In the automatic method the initial trigger comes from the rain sensor and LDR sensor only and in the manual method the initial trigger comes from Telegram, where the user will give the command to change the tool method in the Telegram application and give the command to open and close the roof from telegram.

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2.3. Process Block

In the process block, the trigger signal given from the input block will be received by the Nodemcu ESP8266 as a microcontroller on the device and process it according to the program that has been designed in the Arduino IDE application. In the automatic method the input block trigger comes from the rain sensor and LDR sensor and in the manual method the trigger comes from the Telegram application which commands the manual method and opens or closes the roof. Then, after the triggers have been processed by the , they are forwarded to the output block and run the components in the output block. Figure 3 is the lead info for the Nodemcu 8266 pin. Table 1 is the relationship between the Nodemcu ESP8266 PIN and the input and output units.

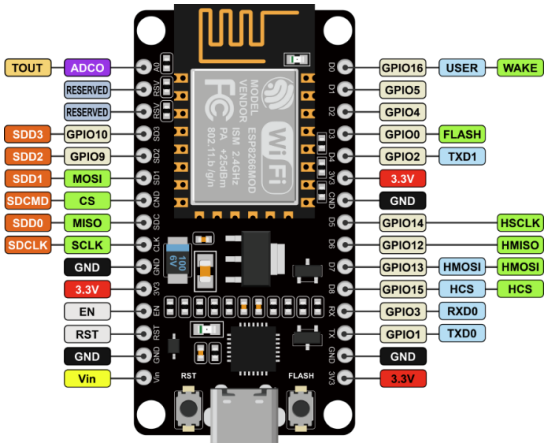

Figure 3. Nodemcu ESP8266 Pin [19]

Table 1. Relationship between Nodemcu Pins and Output Devices

PIN	Terhubung ke
D1	Pin D0 sensor LDR
D2	Pin D0 sensor hujan
D3	Pin IN1 Relay
D4	Pin A-IB motor driver
3V3	Pin VCC motor driver
GND	Pin GND motor driver
D5	Pin tengah limit switch 1
D6	Pin tengah limit switch 2
GND	Pin bawah limit switch 1 dan 2
D7	Pin A-IA motor driver
GND	Pin GND sensor hujan dan sensor LDR
3V3	Pin VCC sensor hujan dan sensor LDR
GND	Pin GND Relay

1. Telegram

Telegram is a cloud-based messaging application that focuses on speed and security and is designed to make it easier for users to send text, audio, video, image and sticker messages to each other safely [20]. By default, all content transferred to Telegram will be encrypted to international standards. Therefore, messages sent are completely safe from third parties, even from Telegram. The Telegram application can not only send text, images or videos, but Telegram can also be a place to send documents, music, zip files, real-time locations and also saved contacts to other people's devices. Because Telegram is a cloud-based application, it makes it easier for users to access one Telegram account from different devices simultaneously. Telegram was pioneered by two brothers from Russia, namely Nikolai Durov and Pavel Durov. The two brothers shared tasks, Nikolah focused on application development by creating the MTPtoro protocol which became the motor for Telegram. Meanwhile, Pavel is responsible for funding and infrastructure through digital fortless funding.

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2. Arduino

Arduino IDE (Integrated Development Environment) is a software that has a very important role in programming, compiling binaries and downloading microcontroller memory. Apart from many supporting modules such as sensors, monitors, readers and others, Arduino itself has become the choice for many professionals. One of the reasons Arduino attracts many people is because of its open source nature, both in hardware and software. Schematics on arduino are also free for everyone, free to download images buy components, make pcb and assemble it yourself without paying arduino maker. Likewise, the Arduino IDE can be downloaded for free and installed on a computer.

2.4. Output Block

In the output block, there are relay components, motor drivers, switches, DC motors, fans, LEDs and telegram applications. After the process block, whether you use manual or automatic methods, the work on the output block components remains the same. After the data is processed by the NodeMCU, when the roof must be closed or opened, the relay and motor driver are active to move the DC motor where the DC motor makes the roof move to open or close. After the roof is opened or closed, the roof will press the switch on each side according to the condition of the roof at that time. then when the roof is closed and pressing the switch it will turn on the fan component and LED, likewise when the roof is open and pressing the switch it will turn the fan component and LED off. Then for the Telegram application in the output block as a notification or notification on Telegram, the notification displays data such as method transfer, equipment status at that time, notification when the roof is closed or notification when the roof is open.

3. RESULTS AND DISCUSSION

The test results are in the form of voltage observations on each part where the working voltage is obtained according to the specifications of each component. Shown in Figure 5 is one of the voltage observations on the LDR sensor, rainwater sensor and relay while table 2 is the result of voltage observations for each component. This prototype is designed to work in two modes, namely automatic and manual, to increase the efficiency of the drying process. Tests were carried out to evaluate the system's reliability in controlling temperature, humidity, and the device's responsiveness to commands sent via the Telegram application. Apart from that, the test results were also compared with conventional drying methods to see the effectiveness of the equipment in speeding up the drying process and maintaining the quality of seaweed. Figure 4 is the workflow of the prototype tool that was built. is a flow diagram that explains the process and how it works from the design and construction of a seaweed dryer using manual and automatic methods using the Nodemcu ESP826 based telegram application. Starting from activating the tool using a 12V – 5A power supply, then initializing the Nodemcu, there are two methods for running this seaweed dryer. The first method is the automatic method, where this automatic method uses readings from the LDR sensor and rain sensor to run this tool. If the LDR sensor detects a lack of light or darkness and the rain sensor detects water hitting the sensor, the Nodemcu will automatically process the data.

The explanation of Figure 4 is as follows, the rain sensor detects water that is hit by the detector board. The rain sensor moves the DC motor to close the roof. When the roof moves, the telegram will send a notification "Roof Closed Automatically" and after the roof is closed and pressing the switch, the fan and LED turn on, then a notification will appear on the telegram, namely, "Weather is Raining - Close the Roof, Turn on the Fan and LED". And if the rain sensor does not detect water that has hit the sensor body or the rain has stopped, the NodeMCU will process the data get this and then move the motor to open the roof, when the roof moves to open the telegram it will send a notification "Roof Opened Automatically" and after the roof opens and presses the switch, the fan and LED will also turn off, then a notification will appear on the telegram "Sunlight Detected - Opening the roof, Turning off the Fan and LED". "Roof Closes Automatically" and after the roof is closed and pressing the switch, the fan and LED turn on, which then a notification will appear on the telegram, namely, "Dark Weather / Night - Closing the Roof, Turning on the Fan and LED". And when the LDR sensor detects light, it works the same as if the rain sensor does not detect water. The second method is the manual method, where this manual method will run if the user uses a command on the Telegram application, to change

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the method that will be used, they will use the "manual method" command on the Telegram application. If the device is in manual mode then you have to use the command "close the roof" or "open the roof", if you use the command "close the roof" the command will then be received by the NodeMCU and the data will be processed and a notification will appear on the Telegram application, namely "The roof is closed manually" and move the motor to close the roof until pressing switch 2. Then a notification will appear on the Telegram application that says "The roof is closed" then the fan and LED turn on. Likewise, if you use the command "open the roof", the command will be received by the NodeMCU and the data will be processed and a notification will appear on the telegram application, namely "Roof opened manually" and moving the motorbike to open the roof after it is open and pressing switch 1, a notification will appear on the telegram "Roof is Open". To find out whether the system design works well, testing is needed at certain points to measure the voltage parameters that occur at that point. Table 2 is the measurement results at each point of the equipment where the measurement results are within the tolerance value of the recommended voltage for each component.

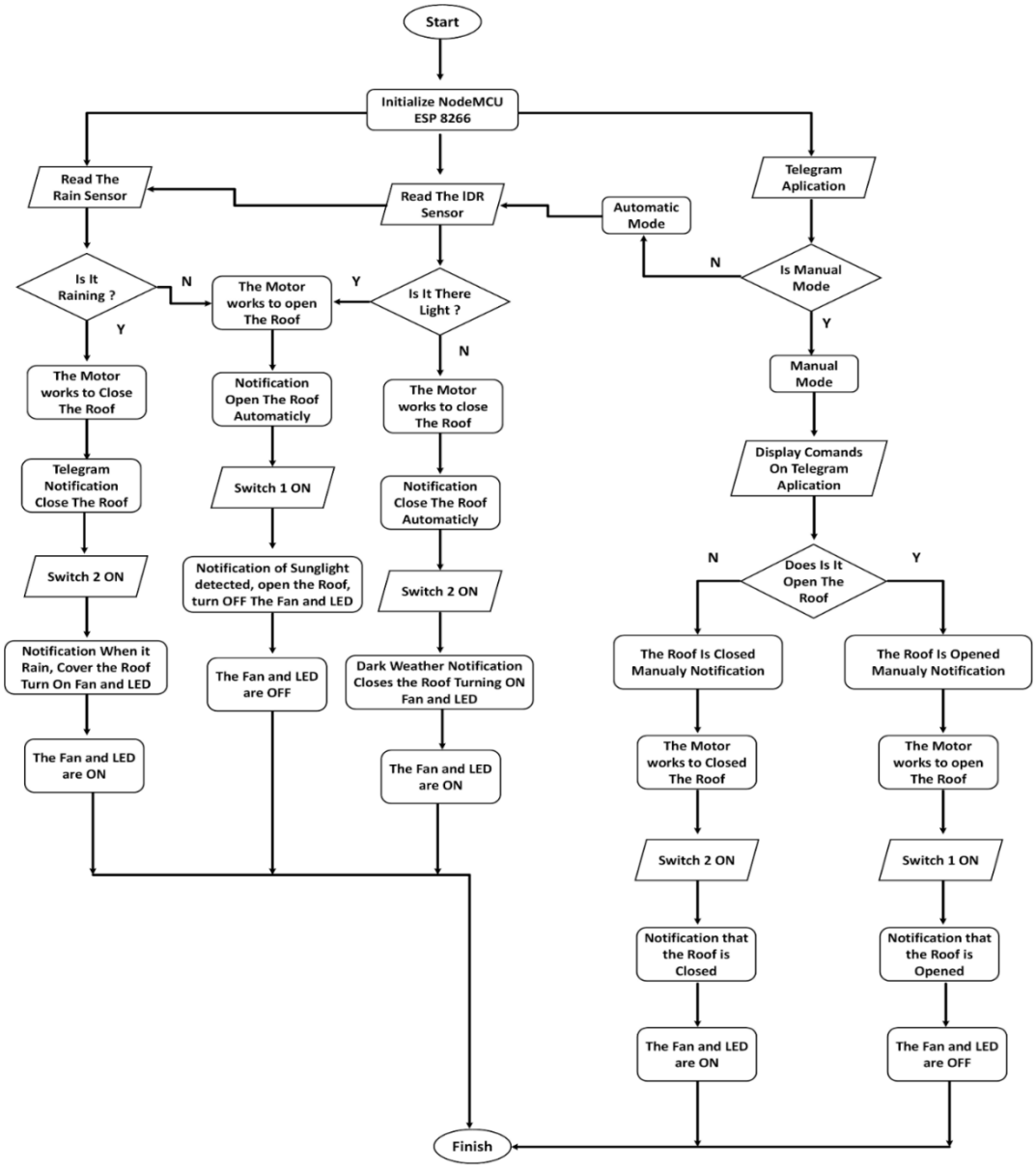

Figure 4. Working step of seaweed dryer research method

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Table 2. Measurement of tool operating voltage on each unit

Unit Test Point	Voltage measurement results	Recommended Operating Voltage Range
LDR Sensor	3.309 V	3.3 – 5 V
Rain water sensor	3.29 V	3.3 – 5 V
Relay	4.992 V	5 – 24 V
NodeMCU ESP8266	4.991 V	3 – 12 V
Motor driver	4.983 V	3.2 – 40 V

(a) (b) (c)

Figure 5. Measurement results (a) LDR sensor (b) Rainwater sensor (c) Relay

Figure 5a Display of measurements on the light sensor using LDR, Figure 5b Measurement results on the rainwater sensor and Figure 5c Is a relay voltage measurement. The development of this system is an innovation in seaweed drying equipment that can work automatically or manually so that it can reduce the workload of seaweed farmers.

3.1. Obeservation Data

In collecting this observational data, it was obtained from the results of testing the seaweed dryer in accordance with the workings of the tool that has been designed and implemented, then the results of this seaweed dryer will be data and described for each component.

1. LDR Sensor Testing

The LDR sensor works by detecting light caught on the sensor. This test was carried out with the aim of determining the sensitivity of the LDR sensor. In this seaweed dryer, the LDR sensor is the input to run the tool automatically, therefore the LDR sensor is tested by providing light which is measured using a lux reader application, the light provided comes from the lamp light and flashlight light. In each experiment you will also see the notification that appears on the Telegram application and also the response from the LDR sensor detecting light until finally the roof runs. In this experiment, the condition of the rain sensor was dry so it only used the LDR sensor as input for this tool. Table 3 is the result of observations on the light sensor unit when it was in several different light conditions.

Table 3. LDR sensor test results

Testing	State of Light	Respon time (s)	Roof State	Telegram Notification
1	Dark	1	Closed	Dark / Night Weather – close the roof, turn on the fan and LEDs
2	A Litle light	1	Opened	Sunlight detected – open the roof, turn off the fan and LEDs
3	Dark	1	Closed	Dark Weather / Night – closingatap, turn ON Fan and LEDs
4	Bright	1	Opened	Sunlight detected – opens roof, turns off fan and LEDs

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Table 3 shows that the LDR sensor is very sensitive to detecting light. If there is a little light, the LDR sensor immediately detects it and the motor immediately moves to open the roof. Likewise, when it is dark, it takes a really dark situation to make the light sensor detect it and make the motor move to close the roof. The responsive time of the LDR sensor has an average time of 1 second, where the LDR sensor detects the motor's light immediately moving without a long delay.In the telegram notification, in the dark and the rain sensor is dry, the notification says "Dark Weather / Night - close the roof, turn on the fan and LED" so the roof is closed due to lack of light or darkness. When it detects light and the rain sensor is dry, the notification says "Sunlight detected - open roof, turn off fan and LED".

2. Rain Water Sensor Testing

In the Rain sensor test, the sensor will only be observed when it is wet and dry. This test was carried out with the aim of determining the sensitivity of the rain sensor. In this seaweed dryer, a rain sensor is used as input to run the tool automatically. Where the rain sensor will detect water that is hit by the detector board on the rain sensor. The experiment was carried out by giving water to the sensor and drying it, then for each experiment you will also see the notification that appears on the Telegram application and also the response from the rain sensor detecting water until finally the roof runs.

Table 4. Rain sensor test results

Testing	Sensor State	Time Respon Sensor (s)	Roof State	Telegram Notification
1	Wet	0.46	Closed	The weather is raining – close the roof, turn off the fan and LED
2	Dry	0,47	Opened	Sunlight detected – open the roof, turn off the fan and LED
3	Wet	0,47	Closed	It was raining – closed the roof, turned off fan and LED
4	Dry	0,47	Opened	Sunlight detected – open the roof, turn off the fan and LED

Table 4 is the result of experiments carried out on the rain sensor. It can be said that the rain sensor has high sensitivity, the sensor can quickly read when the sensor is exposed to water and is also dry. Even though it's only a little water, the rain sensor immediately detects it quickly and the motor moves to close the roof. Likewise, when the sensor is dry, the motor immediately moves to open the roof. The rain sensor has an average detection speed of 1.87 seconds.In the rain sensor notification, when the rain sensor detects water, the text in the notification is "The weather is raining - close the roof, turn off the fan and LED" whereas when the rain sensor is dry, the notification that looks the same as the notification when the light sensor detects it is "Sunlight detected - open the roof, turn off the fan and LED".

3. Roof Door Open and Close Testing

In this roof test, you will observe how long the roof takes to open or close in automatic or manual conditions. You will calculate with a stopwatch how long it takes for the roof to move, with different equipment conditions.

Table 5. Roof door open and close test results

Testing	Operation Mode	Tools State	Roof State	Time (s)
1	Automatic	Dark	Closed	4.15
2	Automatic	A litle Light	Opened	4.18
3	Automatic	Bright	Opened	4.20
4	Automatic	Rain	Closed	4.17
5	Manual	Closed Roof	Closed	4.18
6	Manual	Opened Roof	Opened	4.20

Volume 12, Issue 2, October 2025, pp. 140-150
ISSN 2355-5068 ; e-ISSN 2622-4852
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Table 5 with different conditions and with different methods for the roof to move to open and close, the roof takes about 4 minutes to open and close with the valve. To be precise, the average time to open or close the roof is 4 minutes 18 seconds.

4. Testing Responsiveness in the Bot Menu on Telegram

In testing the bot menu on Telegram, only one of the menus was tried several times to compare the response time of the Telegram bot. This test is carried out in the "/status" menu, which is a menu to see the status of the roof condition, where the test will be carried out for 10 trials by opening and closing the roof as well as changing the methods used. This menu/status is very important to see the condition of the roof at that time, therefore the experiments were carried out alternately by opening and closing the roof. After opening the roof then pressing the /status menu and after closing the roof pressing the /status menu, this experiment was also carried out by changing the method used on this tool.

Table 6. Bot menu test results on Telegram

Testing	Telegram Menu	Respon Time (s)	Telegram Menu Reply
1	/state	3	Open Roof Condition Mode: Automatic
2	/state	3	Closed Roof Condition Mode: Automatic
3	/state	3	Closed Roof Condition Mode: Automatic
4	/state	5	Open Roof Condition Mode: Automatic
5	/state	4	Closed Roof Condition Mode: Manual
6	/state	4	Closed Roof Condition Mode: Manual
7	/state	5	Opened Roof Condition Mode: Manual
8	/state	4	Closed Roof Condition Mode: Otomatic
9	/state	4	Closed Roof Condition Mode: Automatic
10	/state	3	Open Roof Condition Mode: Automatic

Table 6 explains the response time after clicking the /status menu, namely 3.4 seconds. This experiment was carried out by alternating with other menus to see whether the response time in this menu/status was faster or slower. To use the menu on Telegram or notifications usually also depends on the data network or WiFi signal at that time. The response time for the Telegram menu can be long because the data network or WiFi is slow and the response time for the Telegram menu can also be very fast because the data network or WiFi is also fast.

4. CONCLUSION

After designing, testing and data observations were carried out on the seaweed dryer using manual and automatic methods using the Nodemcu ESP826 based telegram application. This tool consists of a rain sensor and LDR sensor, Nodemcu ESP826, limit switch, motor driver, DC motor, relay, DC fan and LED. This tool has a way of working that starts with a rain sensor that detects water or an LDR sensor that detects light. Then the input is processed on the nodeMCU and sends a program to the motor driver then moves the DC motor to open or close the roof until the roof presses the limit switch and the fan and LED turn on or off.This seaweed dryer can dry seaweed in rainy or hot conditions, day or night. The seaweed dryer can operate automatically with an LDR sensor and rain sensor as the main input and this seaweed dryer can also operate manually using the Telegram application as the input. Then when the roof opens and closes it also successfully displays a notification on the Telegram application, then also a notification when the roof has successfully opened and closed.From the results of data observations, it is known that the LDR sensor works with an average time of 1 second to process from the sensor detecting light until the roof moves, as well as the rain sensor which takes an average of 1.87 seconds to detect water until the roof moves. The process of opening and closing the roof takes an average of 4 minutes 18 seconds to open and close completely. Then the Telegram menu also has an average responsiveness of 3.4 seconds. This prototype is very suitable to be realized into a real tool to help seaweed farmers in processing their harvest, where the benefits of grass packaged in dry form include making it last longer, being practical for consumption, maintaining nutritional content, being a

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natural and sustainable product, and being able to be processed into other forms, such as cosmetic products or animal feed.

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