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Automatic Roof Prototype on Aviary with Telegram Based Monitoring

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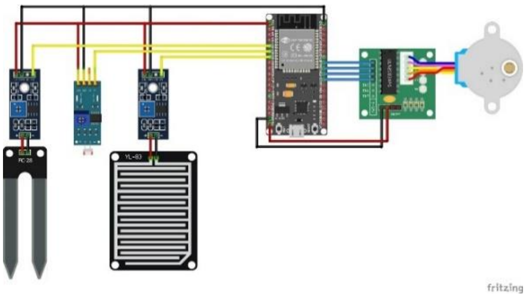
ABSTRACT



Aviary is a large cage that is designed to resemble the natural habitat of the flora and fauna contained therein. The purpose of making an aviary is as a breeding place for several flora and fauna within the scope of the community. Apart from that, some people build an aviary in their yard as a place to channel their hobbies. The success of aviary development has many supporting factors, one of which is weather conditions. Many aviaries out there do not have a protective roof so that the aviary experiences bad conditions when it rains, considering that Indonesia is a country with a tropical climate where rain can fall at any time. Based on these problems, this research was carried out by designing an automatic roof prototype that was placed on the aviary with a working system to detect the conditions that existed in the aviary and to protect the aviary from exposure to heat and excess rain. The prototype will detect the light intensity value and the value from the rain sensor reading, when it exceeds the specified value limit the tool will work and the roof will be closed. Contribution of this research The application of this prototype directly has a success rate of up to 90% as long as the components used can work optimally. The contribution to this research is the use of the Research and Development method as a research method and the use of telegram bots as a monitoring tool in this study.

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1. INTRODUCTION

Some people may not know what an aviary is and even sound foreign to their ears, but for some people who have been involved in the world of flora and fauna for a long time, an aviary is nothing new. Aviary is a large enclosure and contains various types of plants and animals with environmental conditions made similar to the forests out there [1]. This is so that the flora and fauna in the aviary can live and develop perfectly as in their natural ecosystem [2].

Success in developing aviary so that the flora and fauna in it can live and develop perfectly has several supporting factors both internal and external, internal factors such as the quality of the feed and fertilizer provided while external factors such as the weather conditions faced by the aviary considering that Indonesia is a country which has a wet tropical climate that rains more often so this also needs to be watched out for[3][4].

Based on observations in the field there are still many bird cages that do not have a roof as a protection from the heat and rain that hit the cage. When the rainfall is heavy enough, the inside of the cage will become a pool of water which can disturb the animals and plants in the cage. Based on this, it is used as a source of problems in this study.

The automatic roof is one of the innovations resulting from the development of previous research which begins with a roof that can be opened or closed manually using a pulley, then developed using a microcontroller as a control so that the roof can be opened and closed automatically with commands through various sensors [5][6][7]. As technology develops, in the end the automatic roof is developed better, that is, it can be controlled via IoT and can be done remotely wherever we are [8][9][10].

Research on the application of automatic roofing in today's life has begun to be widely carried out considering the enormous benefits it brings. As an example of research on the application of automatic roofing in copra drying houses which explains how to apply automatic roofing which is used to facilitate copra drying [11]. Then research on automatic roofs in clothes drying rooms, in this study the roof was made to open automatically making it easier when drying clothes [12][13]. Seeing the many benefits generated, more and more research is being done to apply automatic roofing with the aim of facilitating our lives, one of which is this research. The contribution to this research is the use of the method used in this study and the use of telegram bots as control and monitoring of a device, in this study telegram bots are used as monitoring so that the tool can be monitored wherever the user is.

2. METHODS

In this study the research and development (R&D) research method was used with the aim of updating and developing previous research by analyzing previous research to make improvements and updates so that new results are obtained that are effective and function in the wider community [14][15]. In this chapter there are 3 processes, namely making block diagrams, compiling flowcharts and the last is designing wiring diagrams that will be used. Each process has a different goal, but in the end these three processes are continuous with the ultimate goal being to make a prototype that can work effectively so that it benefits the wider community.

2.1. Block Diagram System

The research block diagram was made to facilitate the design and manufacture of tools, the block diagram in this study is shown in Figure 1.

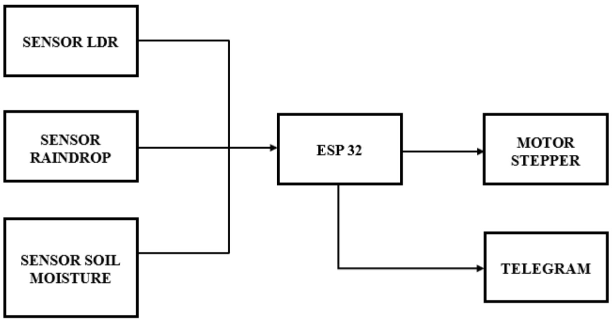

Figure 1. Block diagram

The input section consists of 3 components, namely the LDR sensor which functions to detect the intensity of incoming light with the aim of detecting sunny or cloudy conditions [16]. The rain detection sensor functions as a rainwater detection, when it rains the detection board will be exposed to water and the sensor will respond as rain [17][18]. The soil moisture sensor functions as a moisture detection in the soil which indicates the soil is moist or dry, when the water content in the soil is large, the value of the sensor reading will be very high and when the water content in the soil is small, the value of the sensor reading will be below the limit, defined at the start of programming [19][20].

The microcontroller data processing part used is the ESP 32 which has many advantages compared to the previous ESP series, one of which is the larger number of pins [21]. The function of the ESP 32 microcontroller is as a communication tool for all components and as a data processor received from the input section as well as command messages from connected telegram bots [22][23]. The data that has been processed will be forwarded by the microcontroller to the output stage as the final action of this series. The use of ESP 32 as a data communication medium between tools and users because ESP 32 has a wifi module that can connect to the internet network so that it can provide notification messages to users via the telegram application.

The output part is a stepper motor with type 28BYJ-48 which functions as a gear drive to run the roof so that it can close according to a predetermined program [24]. Apart from that, in the output section there is also a telegram bot that is used for monitoring the entire set of tools [25][26][27].

2.2. System Flowchart

Flowchart is a research flow chart from the beginning of the process to the end which is made to facilitate the research process. In this study there were 2 flowcharts consisting of a flowchart of all tools and a flowchart of the soil moisture monitoring system.

Figure 2 is the first flowchart which is the flowchart of the entire series starting from the initial conditions, then initializing (giving initial values) to input and output. All input components are given a value limit, and the light intensity sensor/LDR is given a value between zero and one hundred to detect light intensity, a reading value above 100 means the detected condition is cloudy when below 100 then the detected weather condition is sunny. Then for the rain sensor a value limit of 150 is given. When the reading value is above 150 then the conditions at that time are sunny, but when it rains the reading value from the rain sensor.

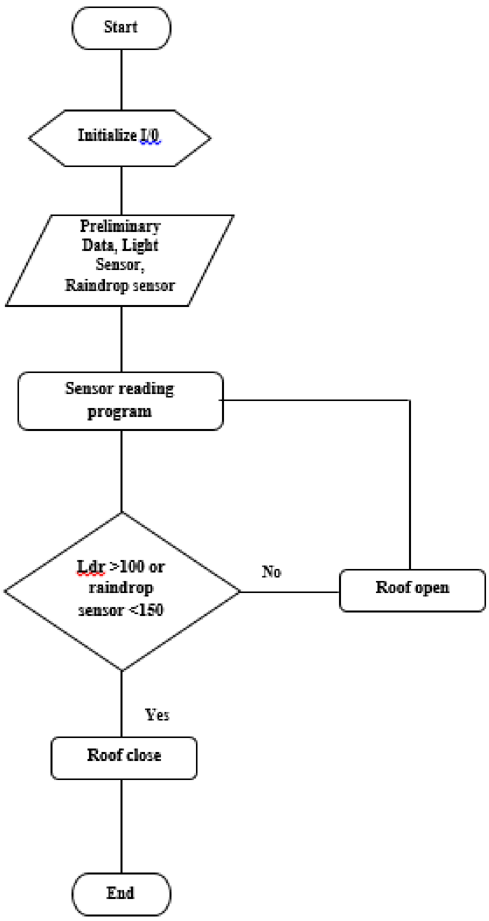

Figure 2. Tool set flowchart

The data from sensor readings will be processed by the microcontroller, then the data from the microcontroller processing will be forwarded to the output when the data detects cloudy or rainy conditions.

Furthermore, the stepper motor will rotate which makes the roof closed, and at that time the microcontroller will provide a notification in the form of a message to the user via the connected telegram bot and the program is complete [28]. When the data received by the microcontroller does not indicate cloudy or rainy conditions, the microcontroller will return feedback to the sensor to be read back by the sensor, and so on.

Figure 3 is the second flowchart which is a flowchart of a series of soil moisture monitoring, starting with start, then initialization, and continues with sensors reading soil moisture conditions in the aviary. The limit value of soil moisture is 250, when the reading value shows a high value above 250 then the soil conditions at that time were damp or the water content in the soil was so high. When the reading results show a value far below 250, the condition detected is the soil is dry or the water condition in the soil is small. The reading results by the sensor will be forwarded to the microcontroller. Furthermore, the microcontroller will provide a notification in the form of a message to the user via a connected telegram bot and the program is complete.

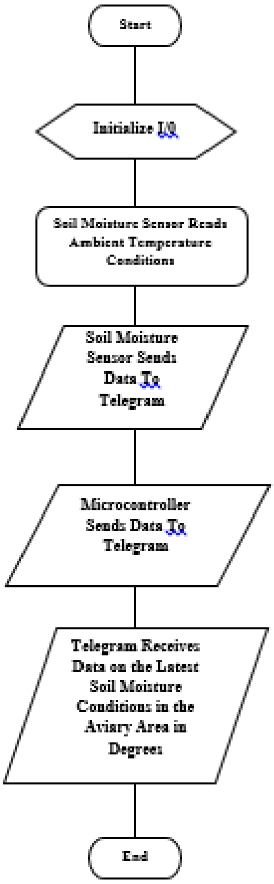

Figure 3. Monitoring series flowchart

2.3. Wiring Diagram

Wiring diagram in Figure 4 is the wiring circuit used in this study, in the figure it appears that all components used as inputs and outputs are connected by the microcontroller used, namely ESP 32. All components used must be properly connected so that the tools used can run optimally.

On Figure 4 There are several components that are used with their uses as follows:

- Soil moisture sensor as a component of measuring soil moisture content in the aviary.
- The LDR sensor is used as a light intensity detector, the less light that is captured, it will be implemented in cloudy conditions and vice versa [29].
- Raindrop sensors are used for rain detection, when the sensor board is exposed to water droplets, the sensor will send data that the current conditions are raining.
- The ESP32 microcontroller is used as the brain of the circuit, its job is to process the data received by the sensor and then pass it on to the output components. This microcontroller will be connected to Wi-Fi so that it can connect to telegram [28].

- The ULN2003 motor driver is used as a module for the stepper motor, the power for the stepper motor will be fed through this module [30].
- The 28BYJ-48 stepper motor is used as an output that will rotate to drive the gearbox so that the roof can be opened and closed.

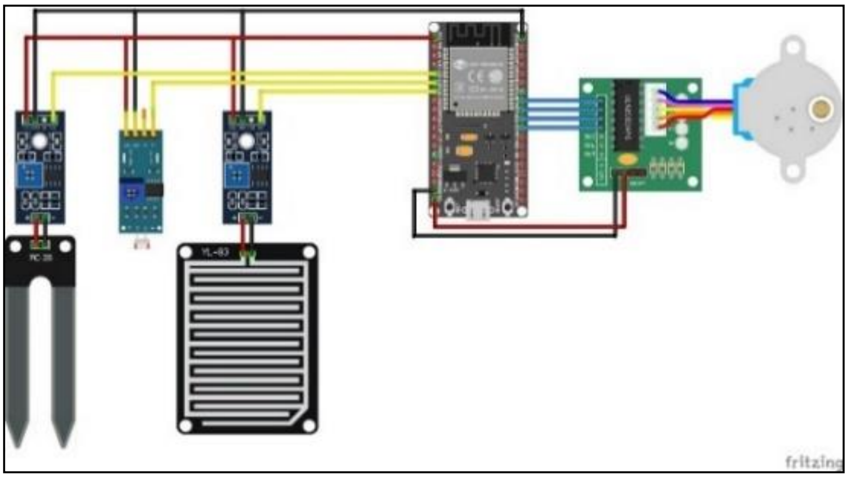

Figure 3. Wiring diagram

The pin address of each connected component can be seen in Table 1:

Table 1. Component pin address

No.	Component	Component Pin Addresses	NodeMCU ESP32 Pin Addresses
1.	Stepper motors	Jump to the ULN2003 module	-
2.	ULN2003 module	IN 1	D19
		IN 2	D18
		IN 3	D5
		IN 4	TX2
		VIN+	VIN
		VIN -	GND
3.	LDR sensors	A0	D35
		VCC	3V3
		GND	GND
4.	Soil moisture sensor	A0	D34
		VCC	3V3
		GND	GND
5.	Rain sensor	A0	D32
		VCC	3V3
		GND	GND

The pin of the stepper motor is connected directly to the module used, namely ULN20003, this pin is in the form of 5 input cables that are put together using a socket (male) then connected to the socket (female) found on the ULN20003 motor driver. In the ULN20003 motor driver there are 6 wiring lines connected to the Esp 32 microcontroller consisting of IN 1 to IN 4 which are used as stepper motor drives, then for the VIN + wiring line as the incoming power supply line and on the VIN wiring line - as grounding.

On the three sensors that are used as wiring lines there are 3, namely the first A0 is used as input that comes from reading the analog value generated by the sensor. Then the second is VCC which is used as a power supply source for the sensor and the third is GND as grounding. The VCC and GND wiring lines on the three sensors are arranged into a parallel circuit because when connected to the ESP, the 32 pins used are the same, namely 3V3 and GND. The required power source comes from the USB port found on ESP 32.

3. RESULTS AND DISCUSSION

The results of the realization of the research on the automatic roof prototype on the aviary with telegram-based monitoring can be seen in Figure 5. All components used will be described with the following numbering: 1. LDR Sensor, 2. Rain Sensor, 3. Soil Moisture Sensor, 4. ESP 32, 5. Servo Motor 28BYJ-48.

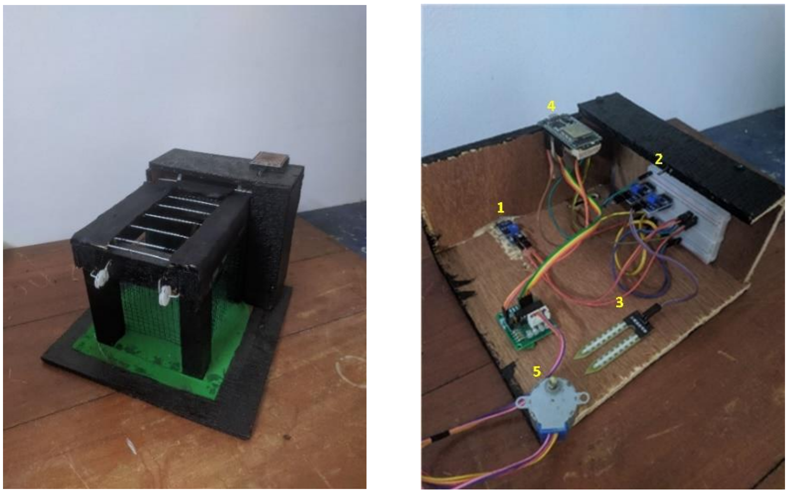

Figure 4. Tool realization

How to operate the prototype as follows:

1. The user turns on the Wi-Fi network that has been connected to the microcontroller
2. Installing the USB cable on the microcontroller as a source of power supply
3. Then the user opens the telegram bot that has been connected to the microcontroller
4. In the telegram chat bot column, type /start to start the program, then the bot will provide a reply message containing a menu of commands that have been programmed as follows:
    - /condition : To find out the overall condition of the aviary
    - / humidity : To determine the humidity value in the aviary
    - /light : To determine the value of light intensity in the aviary
    - /weather : To know the value of the rain sensor
    - /open : The command to open the roof
    - /closed : The command to close the roof
5. Then type the desired menu then send the message
6. The bot will respond and send to the microcontroller
7. In a few seconds the bot will send a message back based on the command sent
8. For example, suppose a user sends a command/condition then the bot will reply. A few seconds later the bot will send a reply message according to the command given in the form of conditions on the aviary in the form of light intensity values, soil moisture values and values on the rain sensor.

This research was carried out based on literacy on several previous studies with the aim of improving, updating and solving the problems that have been studied. In the previous research conducted by Nor Laila and Taufiq explained about the use of an automatic roof that is used as a drying roof with an ATmega 328 microcontroller [5]. This research is considered less when compared to the research being carried out by the author because this research already uses the Internet of Things system so it feels better because with IoT, users can monitor tools that are working wherever the user is.

In addition, research byNovia Setya Putri Yunus, Indah Sulistiyowatiexplained about the use of an automatic roof as a roof in a laundry room with monitoring based on the blynk application [13]. This research is considered less effective in terms of monitoring applications, because to make control via blynk users have to make bots which are quite complicated when compared to making bots on Telegram. In addition, the blynk application is less well known by the public when compared to the telegram application.

3.1. Testing the Wi-Fi Connection on the ESP32 Microcontroller

Tests are carried out to ensure that the ESP 32 microcontroller can be connected to the wifi network that will be used. The test is carried out several times with the aim of getting how long the waiting time is in the process of connecting the ESP 32 microcontroller with the wifi network, the results can be seen in the table Table 2.

Table 2. Testing Wi-Fi connection on ESP 32

Testing -	ESP32 microcontroller		Accuracy
	Condition	Waiting Time(s)	
1stTest	Connect	4	Good
2nd Test	Connect	5	Good
3rd Test	Connect	4	Good
4thTest	Connect	5	Good
5thTest	Connect	5	Good

The results of testing the ESP 32 microcontroller on Table 2 it can be seen that the microcontroller was tested 5 times with the result that it can be connected properly, but the resulting waiting time is different in some tests but can still be said to be normal because the difference is not too far besides the quality of the internet network used also affects the waiting time generated.

3.2. Light sensor testing

Light sensor testing is carried out 2 times, the first test is carried out to ensure the components are in good condition and can be used by providing a light source to the sensor and seeing the resulting value. This value will be used to determine the cloudy or sunny conditions currently occurring in the aviary. The test results can be seen in the table Table 3.

Table 3. Light sensor initial testing

Testing To -	Condition	Giving Light		Value readout (lux)
		yes	No	
1stTest	Connect	I	0	95
		0	I	110
2nd Test	Connect	I	0	92
		0	I	116
3rd Test	Connect	I	0	89
		0	I	123

Based on Table 3 it can be seen that when the sensor is given light, the resulting value is below 100, when the sensor is not given light the resulting value is above 100. Based on these readings, a value of 100 is used as the set point on the light sensor, then for testing the sensor has been assembled on the prototype test results can be seen in the Table 4.

Table 4. Testing both sensors with live weather conditions

Testing -	Testing time (WIB / 24 hours)	Weather conditions	The average value of sensor readings (lux)	Roof condition	Accuracy (%)
1stTest	07.00 – 10.00	Bright	94	Open	90%
2nd Test	10.00 – 13.00	Bright	85	Open	94%
3rd Test	13.00 – 16.00	Bright	92	Open	91%
4thTest	16.00 – 17.00	Evening	100	Closed	89%
5thTest	17.00 – 20.00	Dark	115	Closed	94%
6thTest	20.00 – 24.00	Dark	125	Closed	94%

Test results on Table 4 shows the testing of the tool in direct environmental conditions starting at 7 am to 12 pm. The accuracy generated based on the results of sensor readings is considered quite good, but when testing in the evening from 4 pm to 5 pm the resulting accuracy is quite low when compared to the others. This is caused by the sensitivity of the sensor which is considered to be lacking when reading the situation in these conditions, at that time the sunlight received by the sensor is not too much but the resulting value is right at the set point position that has been set, namely 100 lux so that the sensor takes a little time long enough to detect it.

3.3. Rain sensor testing

Rain sensor testing is carried out in 2 stages, the first test is carried out to ensure the rain sensor can function properly and the second test is carried out when the sensor has been installed on the prototype and tested under direct conditions. The results of component testing can be seen in the Table 5.

Table 5. First test of rain sensor

Testing To -	Component Condition	Number of water droplets (%)	Readout waiting time(s)	The resulting value	Accuracy
1stTest	Connect	-	4	158	Currently
2nd Test	Connect	3%	5	150	Currently
3rd Test	Connect	7%	6	147	Currently
4thTest	Connect	10%	4	140	Currently

The test results Table 5 show that the components can be connected, then given water droplets according to the percentage, namely a little (3%), medium (7%), and a lot (10%). The results of these readings produce different waiting times for each test and produce a reading value and when the value is above 150 then the condition is sunny, when the resulting value is below 150 then the detected condition is rain.

Next, the rain sensor was tested when it was installed on the prototype, the test was carried out directly when the conditions were sunny and rainy, the test results can be seen in Table 6.

Table 6. The results of rain sensor testing on live weather conditions

Testing -	Weather Conditions	Rain intensity (%)	Wait time(s)	The resulting value	Roof condition
1stTest	Bright	-	3	158	Open
2nd Test	Light rain	10%	4	143	Closed
3rd Test	Moderate rain	25%	3	135	Closed
4ndTest	Heavy rain	50%	2	129	Closed

Based on Table 6 the test results can be seen that the resulting waiting times are different, the heavier the rain, the smaller the value of the waiting time. In addition, the value read by the sensor is so low, namely 129, this value is too far from the set point, which is 150.

3.4. Soil moisture sensor testing

Just like the previous component test, the soil moisture sensor test was carried out in 2 stages. The first test is carried out when the component will be used by wrapping the sensor with a wet cloth with different humidity percentages. The second test is carried out when the component has been installed on the prototype by placing the sensor on the ground placed on the prototype. The results of the first test can be seen in the Table 7.

Table 7. Soil moisture sensor testing

Testing To -	Fabric moisture level (%)	Waiting Time(s)	Accuracy
1stTest	0%	5	Currently
2nd Test	5%	3	Currently
3rd Test	15%	6	Currently
4thTest	25%	2	Currently

The second test was carried out after the humidity sensor was installed on the prototype, the test was carried out by placing the sensor into the soil that had been provided on the prototype. The test results can be seen in the Table 8.

Table 8. Test results of soil moisture sensors with soil media

Testing To -	Water in Soil (%)	Waiting Time(s)	Accuracy
1stTest	0%	3	Good
2nd Test	5%	3	Good
3rd Test	15%	4	Good
4thTest	25%	2	Good

In the second test the results obtained were not much different from the first test, the resulting waiting time was not much different between Table 7 and Table 8 this shows that the soil moisture sensor can work well during the component testing process as well as during the testing process directly on the soil media.

3.5. Stepper motor testing

Stepper motor testing is carried out in 2 stages, the first test is used to ensure that the stepper motor can be connected to the microcontroller and can rotate according to the program. The test results can be seen in the Table 9.

Table 9. The first test of a stepper motor

Testing To -	Condition	Wait time(s)	The resulting spin	Accuracy
1stTest	Connect	6	1 x Full Turn	Good
2nd Test	Connect	12	2 x Full Turn	Good
3rd Test	Connect	17	3 x Full Turn	Good
4thTest	Connect	25	4 x Full Turn	Good

In the test results Table 9 to achieve 1x full rotation of the stepper motor requires a waiting time of 6 seconds, but when the stepper motor rotates 4x full rotation the resulting value is 25 seconds. This is because at the start of the stepper motor rotation there is a slight delay of a fraction of a second so that this affects the waiting time when the stepper motor rotates in several tests.

The second test is carried out when the stepper motor has been installed on the gears so that it can move the roof, the test results can be seen in the table Table 10.

Table 10. Stepper motor testing when used

Testing To -	Rounds done	Roof condition	Required time(s)
1stTest	5x Full Spin	Open	32
2nd Test	5x Full Spin	Close	31
3rd Test	5x Full Spin	Open	33
4thTest	5x Full Spin	Close	32

In the test results table Table 10 it can be seen that in this study it took 5 times the stepper motor rotation to cover the roof. The stepper motor is mounted on a gearbox that has been arranged to rotate the roof so that the roof can be closed or opened according to the program or command given. Time values on tablesTable 10is the time required for the stepper motor to close or open the roof, the difference in value is caused by many things such as the time lag during processing besides the shape of the gear used also affects the time required. In this study the gears used used plastic materials and imperfect shapes because they were made using ordinary machines whose accuracy was not optimal so that the products produced were also not quite right, but they could still be used and could still work well.

3.6. Telegram

Telegram testing is carried out after the telegram is successfully connected to the microcontroller. Connecting the ESP32 microcontroller with the telegram bot is done through the Arduino IDE application during the microcontroller programming process, in the programming the token and the telegram bot id are entered which will be used as monitoring media [31]. Then after the telegram bot and the microcontroller can be connected, the bot can already be used. To run it, the user only needs to give the desired command, the microcontroller will respond and carry out according to the command given. The bot will provide information when the roof is open or closed when it rains or is cloudy. The test results can be seen in the Figure 6.

Figure 5. Telegram menu

When the user gives the command/start, the bot will provide the available menus, when given the command/condition, the bot will give an order to the microcontroller to process it and within a few seconds a reply message will appear containing the conditions on the aviary, such as the analog value of the reading of the soil moisture sensor, LDR sensor and rain sensor. When it rains or it's cloudy the roof will close automatically and the bot will provide a notification via a telegram message indicating that it is raining or the conditions are cloudy. When the rain subsides or the sun shines on the LDR sensor, the roof will open and the bot will provide another notification regarding the weather.

4. CONCLUSIONS

Based on the tests that have been carried out, it can be concluded that all components used can function optimally even though there is a time lag in testing several things such as internet connection on the microcontroller, all sensors, and stepper motors used. The time lag on the internet connection affects the response of the microcontroller in sending notifications to users, the better the internet connection used, the lower the time lag generated. In testing the light sensor, the lowest percentage of accuracy was obtained, namely 89%, this was due to the fact that in the evening conditions the sensor detects bright and cloudy conditions that are not too dense so that the sensor takes a little longer to read, but this is still within reasonable limits. Then in testing the soil moisture sensor there is a difference between component testing and direct testing, in the first test with cloth media the waiting time is between 2 to 6 seconds but in direct testing with soil media the waiting time is between 2 to 4 seconds. caused by the difference in the media measured between the cloth and the soil but the value is not much proportional and is still permissible. In the stepper motor test there is a difference in the time lag needed to open and close. When opening it takes about 32 - 33 seconds and when closing it takes 31 - 32 seconds, this is caused by a slight defect in the gear so this affects the rotation process but the difference in time is quite small so it can still be said to be normal . Suggestions for future researchers are to maximize the results of this study, besides that it can improve conditions during the evening conditions in the afternoon so that the sensor can accurately read these conditions so that the time lag caused can be reduced. Then for the application of the prototype directly it is hoped that a review will be carried out on all the materials to be used because materials with poor conditions can affect the effectiveness of the tool in work.

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