Design and Build a Snail Habitat Control and Monitoring System Using Web-Based Fuzzy Logic

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***Abstract*— Snails or with the Latin name Achatina fulica are soft-bodied animals with shells on their bodies. Snails can be found in Indonesia during the rainy season, but are quite difficult to find during the dry season. This is due to high temperature conditions and low air and soil humidity during the dry season, making it difficult for snails to survive. Therefore, a system is made that can see the physical condition of the environment and control it using fuzzy logic because snails can survive in a certain temperature and humidity range. To see the physical condition of the environment, this system uses a DHT22 sensor, a soil moisture sensor and a BH1750 sensor. The results of the sensor readings of air temperature, air humidity and soil moisture will be sent to a website which will later be processed using fuzzy logic and will receive a response in the form of an actuator activation time range in the form.**

Keywords: Snail, Fuzzy Logic, DHT22, Soil moisture, BH1750

I. INTRODUCTION

Snail with the Latin name Achatina Fulica or often called by name snail is no stranger. The existence of the snail itself actually has many benefits such as snail mucus which can heal scratches on part of the body because it contains chemical compounds that function accelerating wound healing [1]. Besides that, snail meat also has the benefits of lowering cholesterol levels, this has been tested on male rats wistar strain [2].

Due to the many benefits that can be obtained from snails, this can cause snails to have many fans. However, snail habitat itself is in a damp place and cold temperatures [3]. Whereas in Indonesia humid places can be found during the rainy season. Will but when the dry season comes, these places are quite difficult to find found during the day. Not only that, in Indonesia the temperature is at each region can also be different so that it can affect the number of populations of snails in one place.

Based on these problems, this research was made research entitled "Design of Habitat Monitoring and Control Systems Snail Using Web-based Fuzzy Logic". In this research will made a snail shelter equipped with air temperature sensors and air humidity using DHT22, soil moisture using capacitive soil moisture and light intensity using BH1750. value that obtained will be sent to a website which will later be saved to a database. The sensor data will be displayed on the website as well as the value of the sensor from air temperature, air humidity and soil moisture will be used as the input value of the fuzzy system and processed which will later be generates a long value of time to run the actuator. The value of the fuzzy result it will be sent back to the microcontroller as a response from the website and will activate the actuator with the duration of the fuzzy result.

II. METHOD

Designing a system or schema in more detail, starting from the creation of each subsystem to the incorporation of the whole system.

A. System design

The block diagram contains the design of the components used in the system. The block diagram is shown in the figure 1.

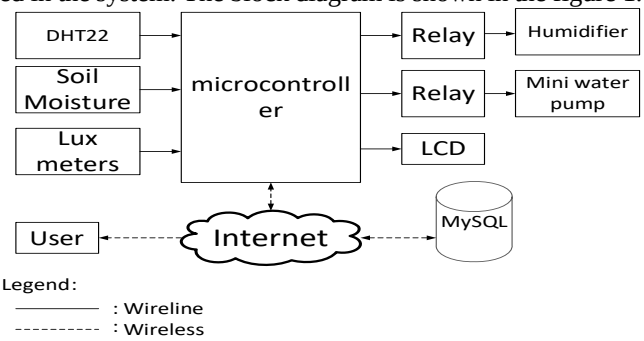

Figure 1 System Block Diagram

Explanations of the components in the block diagram include:

1. DHT22 serves as a sensor to measure the data value of air temperature in the form of units of degrees Celsius and the value of indoor air humidity data percentage form. These values will later influence long time the actuator of the mini water pump is active. The values obtained from sensor readings will be sent to the microcontroller.
2. Soil moisture is used to measure the value of soil moisture by how to plug the sensor into the ground. In this research, using soil moisture with capacitive type. Reading results 15

data from soil moisture readings is sent to the microcontroller and calibrated on the microcontroller
3. Lux meter is a sensor that functions to measure intensity values light. In this study the type of lux meter used was BH1750. The data value obtained from the sensor is then sent to microcontroller for processing.
4. The microcontroller acts as a receiver of data from sensors and sends it to the internet or to a hosting and receives a response from the data. It is used to set the relay.
5. The internet functions as a place to store fuzzy programs function to process the data obtained from the microcontroller. Data obtained from the microcontroller is used as input for fuzzy system so that data is obtained for the active period of the actuator. Data obtained will later be displayed and also stored inside a database and sent back to the microcontroller
6. The relay functions as a controller for the power source or the power supply actuator according to the time span data obtained from the internet
7 The mist maker is used to regulate air humidity with an active period which is regulated by the microcontroller by utilizing the relay as power supply controller
8. The mini water pump is used to regulate the release of water
9. The LCD is enabled to display the value of the sensor reading that has been processed by the microcontroller
10. The user is the person who sees the results of the tool's sensor readings. Users can see online sensor readings and graphical results or the user can also see the results of sensor readings via the LCD.
11. MySQL serves as a place to store data obtained from microcontroller and also the output value of the fuzzy system

B. Flowchart

The flow chart contains the work design flow of the system to be created. The system flowchart is shown in figure 2

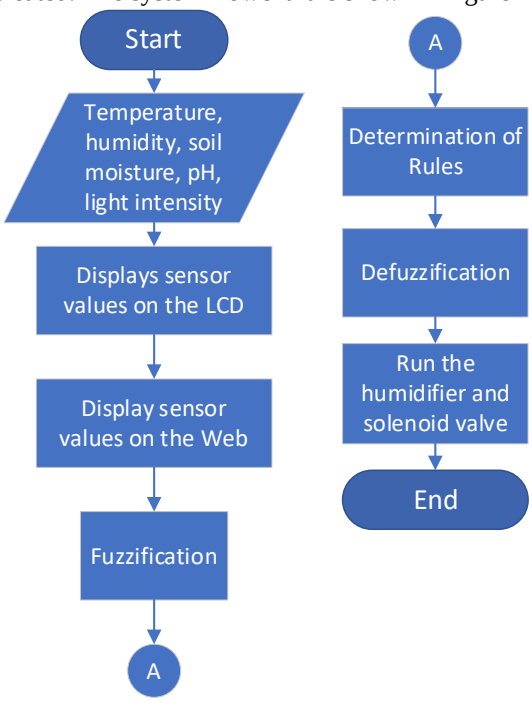

Figure 2 Flowchart System Planning

The microcontroller receives input values from sensor readings in the form of temperature values, air humidity, soil moisture, and light intensity then displays the input values from the sensor to the LCD and sends the sensor readings to the web. On the website, the values of temperature, air humidity and soil moisture that have been sent are carried out by the fuzzification process or determination of the degree of membership using the PHP programming language. Furthermore, the determination of rules will be carried out where this process interference from the fuzzification process will be taken based on the knowledge of the system maker. The defuzzification process is the output of fuzzy logic in the form of a value which will later be used as a determination of the active period of the mist maker and mini water pump, then the value is sent to the microcontroller. The microcontroller receives a response from the website, then runs the mist maker and mini water pump with a time span obtained from the fuzzy results.

C. Implementation of fuzzy temperature and humidity

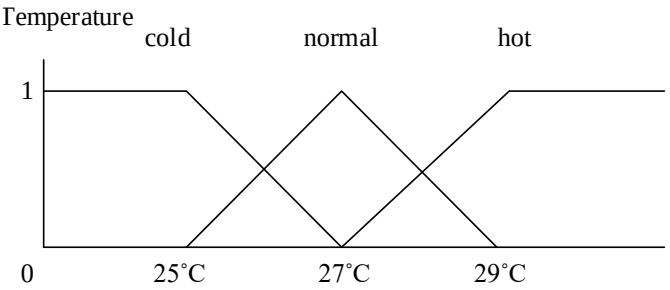

Figure 3 Input Membership Function Temperature

In Figure 3 is the process of fuzzification or determining the degree membership based on related research. Membership grouping temperature and humidity each have three memberships. On the air temperature section has a cold temperature membership with a yang membership the value is below or equal to 270 C, normal temperature has membership whose value is at a temperature above or equal to 250C and less than or equal to 290C, hot temperature has a membership whose value is in temperature above or equal to 270C.

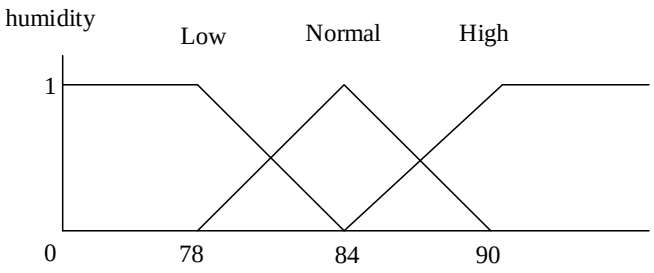

Figure 4 Input Membership Function Humidity

Figure 4 depics the air humidity also has three low humidity memberships, normal humidity and high humidity. Low humidity has membership whose value is below or equal to 84%. Humidity normal has a range of values that are at a value above or equal to 78% and below or equal to 90%. The high

humidity membership is worth it is above or equal to 84%, as shown in Table I.

TABLE I
AIR TEMPERATURE AND HUMIDITY RULES

No	Temperature	Humidity	Mist maker output
1	Cold	Low	Currently
2	Cold	Normal	Fast
3	Cold	High	Fast
4	Normal	Low	Long
5	Normal	Normal	Currently
6	Normal	High	Fast
7	Hot	Low	Long
8	Hot	Normal	Long
9	Hot	High	Currently

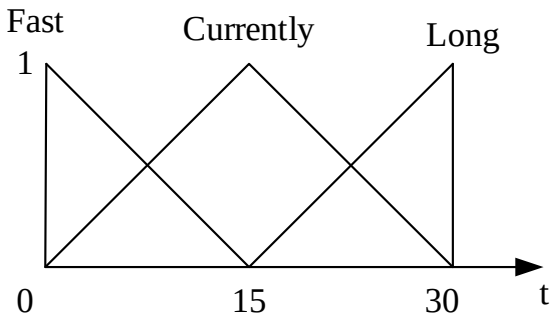

Figure 5 Output Membership Function temperature and humidity

The air fuzzy output image is a specified time range on this research obtained with values in the time range ESP32 received response from the website every 30 seconds. So get the old time value with the active period of miss maker is 15 to 30 seconds. And the degree of membership is moderate within the time range 0 to 30 seconds is the degree of membership of moderate and the time range 0 to 15 seconds is the degree of membership of fast category active period. This membership degree category is a variable freely carried out in this study.

D. Implementation of fuzzy soil moisture

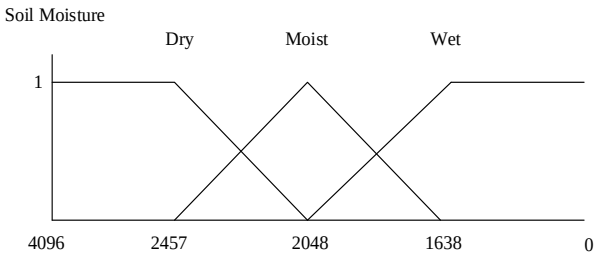

Figure 6 Input Membership Function Humidity

In Figure 6 is the process of fuzzification or membership determination of the soil moisture value. In grouping membership has three membership namely dry soil membership, moist soil membership and 20 Wetlands membership. Dry soil has a soil moisture value of members whose value is above or equal to 2048. Moist soil has a humidity value with a member whose value is at the value below or equal to 2457 and above or equal to 1638. Wet soil has humidity value with members whose value is below or equal to 2048, as shown in Figure

TABLE II
SOIL MOISTURE RULE

No	Soil Moisture	Output
1	Dry soil	Lots
2	Moist soil	Little
3	Wet soil	Off

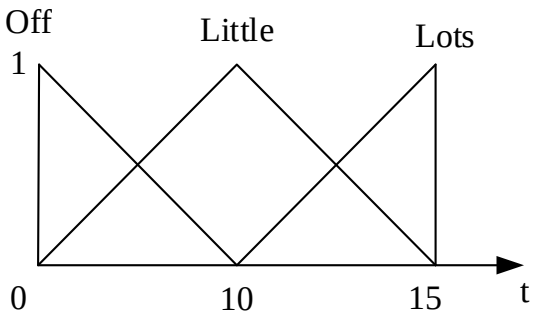

Figure 7 Output Membership Function Humidity

The soil moisture fuzzy output is the time range forturn on the mini water pump with the category like the Picture 7, namely from 0up to 15 seconds.

E. Hardware Design

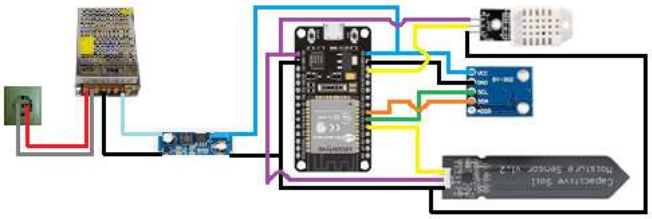

Figure 8 Sensor Design

In the design, the input power supply originating from AC power is changed to DC electricity uses a power supply. On the power supply voltage value lowered and then distributed to the microcontroller and sensor, as shown in Figure 8.

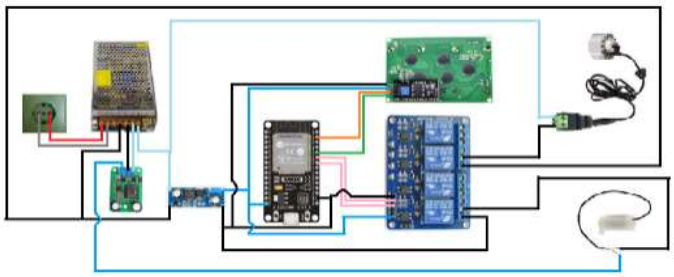

Figure 9 Actuator Design

The output design design has several actuators such as mist makers andmini water pump as well as an LCD to display sensor readings, as shown in Figure 9.

Figure 10 depicts the result of the design that has been made on this research. On the part of the power source that comes

from the house electricity works to provide power supply in the form of AC power with a voltage of 220v, then connected to the power supply to turn the electricity into DC form with a voltage of 24v.

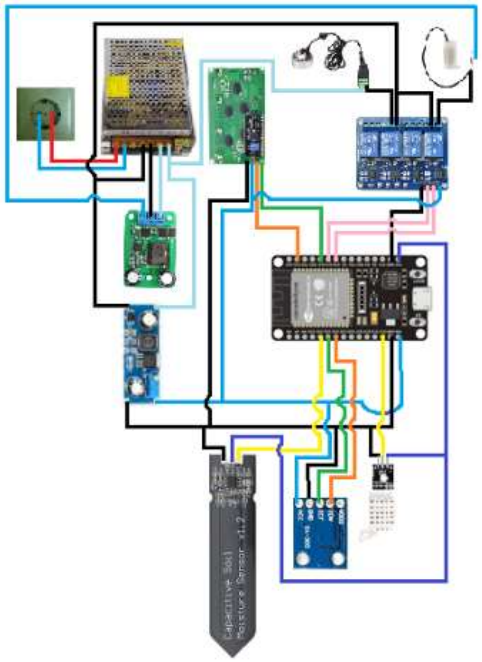

Figure 10 Implementasi Component Design

This 24v voltage is connected to two steps down and one mist maker as a power supply provider. In the mist maker section, a power supply that outputs a negative voltage is not directly connected to in the mist maker, but the power supply with the negative voltage connected to the relay so that it can be controlled when the mist maker turns on or off the. Then the second power supply connected to the step down change from a voltage value of 24v to a voltage value of 5v as a supply power on the mini water pump, but the power supply with a negative voltage connected to the relay so that it can be controlled when it stops or runs. Supply the power from the third power supply is also connected to the step down which converts rated voltage from 24v to 5v. This third power supply is connected to several devices such as liquidcrystal, relay, esp32, light intensity sensors and sensors soil moisture

III. RESULTS AND DISCUSSION

Based on the planning of the system, testing is carried out to determine its performance and analyze the results of the design. So that it can find out the results of several test parameters.

A. Sensor Test

1. DHT22 Air Temperature Sensor Testing

Figure 11 depicts DHT22 sensor testing is done by comparing sensors with the existing tool, UNI-T333s. This case do for find out the accuracy value obtained on the tool. Several tests were carried out times with the location of the place in a certain room and data collection performed every 5 minutes with the following Table 3.

Figure 11 Actuator Design

TABLE 3
AIR TEMPERATURE ACCURACY

No	Time	Temperature		Error(%)
		DHT22(^{0}C)	UNI-T333s^{0}C	
1	21.00	25,9^{0}C	26,1^{0}C	0,77%
2	21.05	25,9^{0}C	25,9^{0}C	0%
3	21.10	26,0^{0}C	26,0^{0}C	0%
4	21.15	25,8^{0}C	25,7^{0}C	0,3%
5	21.20	25,6^{0}C	25,8^{0}C	0,77%
6	21.25	25,6^{0}C	25,8^{0}C	0,77%
7	21.30	25,6^{0}C	25,9^{0}C	1,16%
8	21.35	25,5^{0}C	25,7^{0}C	0,78%
9	21.40	25,5^{0}C	25,7^{0}C	0,78%
10	21.45	25,6^{0}C	25,8^{0}C	0,77%
Average error (%)				0,61%

In testing the comparison between the temperature value on DHT22 and the value the temperature on the UNI T333s was carried out ten times. From the test there is a different error value in the test because it is done calculation of the average error on sensor accuracy of existing measuring instruments.So the results of testing the error value on the temperature sensor using DHT22 compared with the existing measuring instrument, UNI-T333, obtained an error value of 0.61%, so the accuracy value is 99.39%.

2. DHT22 Air Humidity Sensor Testing

TABLE 4
AIR HUMIDITY ACCURACY

No	Time	Humidity		Error(%)
		DHT22%	UNI-T333s%	
1	21.00	76,5%	74,5%	2,68%
2	21.05	76,8%	75,3%	1,99%
3	21.10	76,2%	74,2%	2,69%
4	21.15	76,9%	75,3%	2,12%
5	21.20	77,1%	75,2%	2,53%
6	21.25	77,1%	75,1%	2,66%
7	21.30	77,4%	75,6%	2,38%
8	21.35	77,5%	75,7%	2,38%
9	21.40	77,6%	75,8%	2,37%
10	21.45	77,5%	75,5%	2,65%
Average Error(%)				2,445%

So the results of testing the error value on the humidity sensor using DHT22 are compared with the existing measuring instrument, UNI-T333, the error value is 2.445% so that the accuracy value is 97.55%.

3. BH1750 sensor test

BH1750 sensor testing is done by comparing the sensor with an existing tool, namely AS803. This is done to compare the accuracy values obtained on the snail monitoring system tool compared to existing tools. The test is carried out several times with the location of the place which is in an open place but not exposed to direct sunlight. Data collection is carried out every minute with the following result, as shown in Figure 12.

Figure 12 Actuator Design

TABLE III
LIGHT INTENSITY ACCURACY

No	Time	Light intensity		Error(%)
		BH1750	AS803	
1	07.11	1186.67	1160	2,30%
2	07.12	1188.33	1161	2,35%
3	07.13	1197,5	1197	0,04%
4	07.14	1300	1283	1,32%
5	07.15	1146,67	1127	1,75%
6	07.16	1045	1039	0,58%
7	07.17	1234,17	1232	0,17%
8	07.18	1281,67	1261	1,64%
9	07.19	1393,33	1378	1,11%
10	07.20	1500,83	1474	1,82%
Average error(%)				1,3%

So the results of testing the error value on the light intensity sensor using the BH1750 compared to the existing measuring instrument, namely AS803, the error value is 1.30%, so the accuracy value is 98.7%, as shown in Table III.

B. Software Implementation

Figure 13 Login Software Implementation

Figure 13 shows on the login page there is a display like the image above, in section which reads "Username" and "Password" the user fills in the name and provided password, then press the “Login” button. When "Username" and "Password" are correct, the user will be transferred to dashboard page. When filling in "Username" or "Password" is wrong, it will warning occurs.

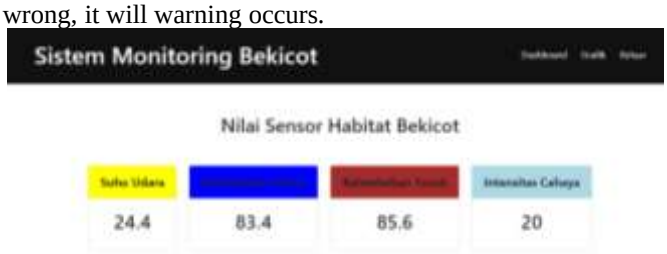

Figure 14 Dashboard Software Implementation

Figure 14, In the header section there are several writings, in the upper left writing labeled "Snail Monitoring System" is a description or information on this system. Then there are three buttons in the header on the side to the right, namely the button that says “dashboard” to move the page inside dashboard view, the button labeled “graph” to move the page to in the graphic display view and the “exit” button works as logs the user out of the system and moves to the login page.

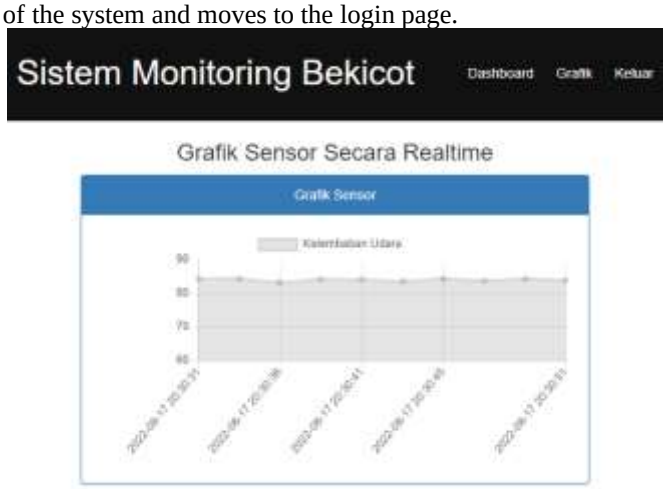

Figure 15 Air Humidity Graph Implementation

In the Figure 15 is the result of a sample implementation of graphic image of air humidity with a range of values between 80% to 90% obtained from the DHT22 sensor with varying data values.

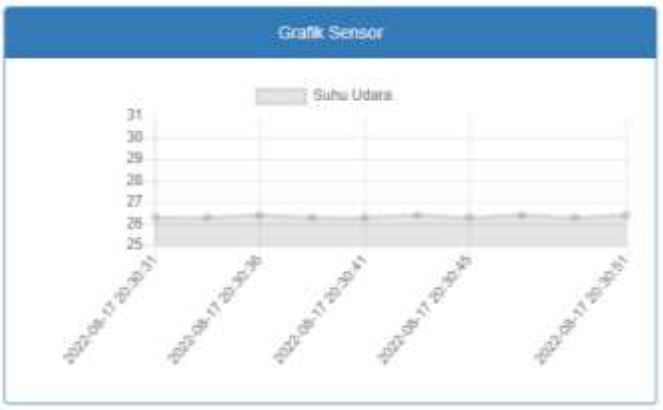

Figure 16 Air Humidity Graph Implementation

In the Figure 16 is the result of a sample implementation of the air temperature graphic image obtained from the DHT22 sensor with data values that vary in the value range of 26ºC to 27ºC.

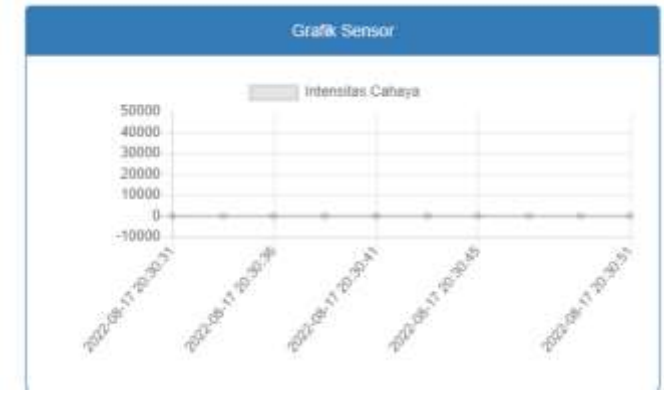

Figure 17 Light Intensity Graph Implementation

In the Figure 17, the light intensity is at a value of 0, the graph is a sample obtained when carrying out tests using the BH1750 sensor. For each of these graphs, the sensor values for money are sent to the website, then the data is stored in a database. The data from the database is then processed in a system and the value is displayed based on the time range obtained.

C. Habitat Monitoring Results

The monitoring results include taking values from the temperature and humidity sensors, soil moisture and light intensity. In the monitoring results, one data or sample is taken every three hours by providing an actuator or motor. The following is the result of monitoring snail habitat

In the sensor monitoring results table there are four samples of data collection for seven days. Sampling of data was carried out from nine in the morning to afternoon with a time span of every three hours and one of the sample data was taken. In these data, the average low temperature values are in the morning, causing fast fuzzy output and high temperatures in the afternoon and evening, causing long fuzzy output. The results of the air humidity value also have a high value in the morning and the average results, causing the fuzzy mist maker output value to be fast, and when the afternoon to evening time has a low value, causing the fuzzy mist maker output value to be long. Meanwhile, the average value of soil moisture is in a high value range which results in the fuzzy output value of the water pump turning off and the light intensity value having a low value at night, as shown in the Figure 19.

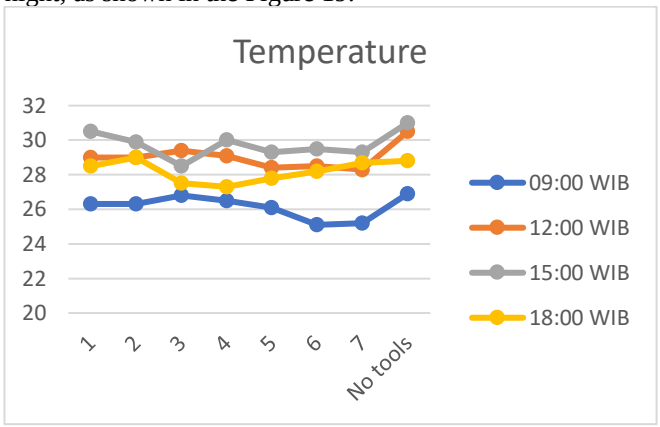

Figure 19 Temperature Change Graph

Based on the graphic image of the comparison of air temperatures, the minimum values obtained on the first day to the seventh day in a row are 26.3ºC , 26.3ºC , 26.8ºC , 26.5ºC , 26.1ºC , 25.1ºC , and 25.2ºC while the lowest value of air temperature without using an actuator is 26.9ºC. For the maximum temperature value on the first day until the seventh day in a row are 30.5ºC, 29.9ºC, 29.4ºC, 30ºC, 29.3ºC, 29.5ºC, and 29.3ºC while the maximum temperature value without using an actuator is 31ºC. The average value of air temperature on the first day until the seventh day in a row is 28.575ºC, 28.55ºC, 28.05ºC, 28.255ºC, 27.9ºC and 27.875ºC while the average temperature value without an actuator is 29 ,3ºC, as shown in the Figure 20.

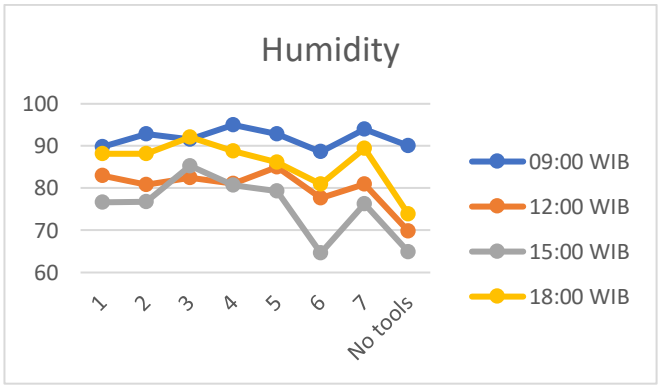

Figure 20 Humidity Change Graph

In the graph of the comparison of air humidity above, the minimum daily humidity values are 76.6%, 76.8%, 82.5%, 80.7%, 79.3%, 64.6% and 76. ,2%, while for the lowest air humidity value without using a tool is 64.9%. The maximum value of air humidity obtained for seven consecutive days is 89.8%, 92.8%, 91.6%, 95%, 92.8%, 88.6% and 94% while the maximum value of temperature without using actuator is 90%. The average value of air humidity on the first day until the

seventh day in a row is 84.4% , 84.65% , 87.875% , 86.4% , 85.8% , 77.95% and 85.15%. the average value of air humidity without using an actuator is 74.625%, as shown in the Figure 21.

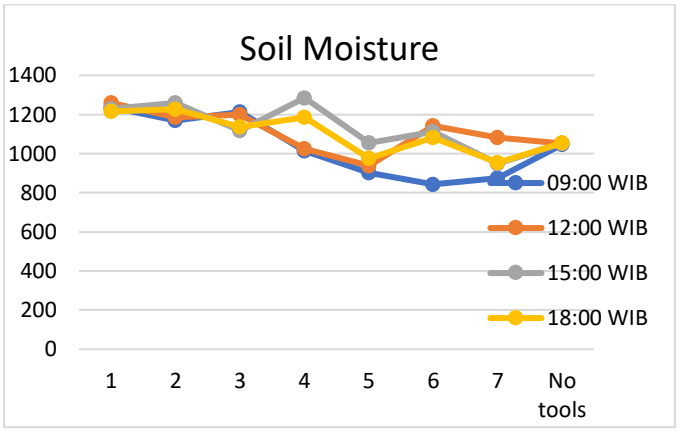

Figure 21 Temperature Change Graph

Based on the comparison graph of soil moisture whose values have been converted, the minimum values obtained on the first day to the seventh day are 1214, 1168, 1117, 1014, 901, 842, and 874 respectively. Meanwhile, the minimum value of soil moisture without using an actuator is 1046 For the maximum value of soil moisture for seven consecutive days is 1259, 1257, 1214, 1284, 1055, 1141 and 1080 while the maximum value without using an actuator is 1055. For the average value of soil moisture for seven consecutive days are 1235, 1209, 1166 1127, 967, 1044 and 964 , while the average value of soil moisture without using an actuator is 1051, as shown in the Figure 21.

IV. CONCLUSION

From the experimental results and the results of data analysis that has been carried out, the following results are obtained:The design of the monitor and control system for snail habitat is carried out using a DHT22 sensor to determine the value of temperature and humidity, a soil moisture sensor to determine soil moisture and a BH1750 sensor to determine the value of light intensity. On the sensor of air temperature, humidity and light intensity, the accuracy of the instrument was carried out and the results obtained were 99.39%, 97.55% and 98.7%, respectively. Meanwhile, the soil moisture sensor is the result of the ADC which is converted to the esp32 bit value. The reading value of each data taken from the sensor reading is stored in a variable with a float data type which is then collected into one and converted into a string to be sent to the website using the GET method. On the website, the response is in the form of a string data type, then the data is converted back to a float data type for the active period of the actuator. The application of mist maker using fuzzy logic has an influence on the temperature and humidity values with the result that the average temperature value using the mist maker is lower and the average humidity using the mist maker gets a higher value when compared to the absence of an actuator. While the use of a mini water pump does not have too much influence on its use

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