Automatic Drip Irrigation System Design for Paprika Plants in A Screen House

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Abstract. One of the technological development in agriculture is watering in screen house using drip irrigation method. This process can be developed to an automatic watering. Automatic watering will ease the farmer work. To make automatic watering, the parameter that we use is a temperature and humidity. Temperature and humidity will be input in fuzzy logic to determine the duration of watering. In this research, we use prototyping method, where the prototype is be adapted from the truth. Sensor in this research using DHT 11 that can read temperature and humidity in a room. The result from temperature and humidity will input to Arduino and will be coded to source fuzzy. Based on fuzzy logic that be determined the relay duration as a switch pump to give a voltage in water pump. This voltage input will be a automatic switch in watering system.

Keywords: Screen House, Drip Irrigation, Automatic Watering

1 Introduction

Drip irrigation is a frequently used watering system in agriculture and has been a subject of interest of many scientists [1]. One of the main advantages of this system is that it saves a substantial amount of water [2], up to 70% compared to the conventional flood irrigation system [3]. The advent of drip-irrigation (DI) is a significant technological improvement in irrigation system which helps in combating water scarcity in agriculture[4].Drip irrigation system is applicable to a variety of plantations, one of which is paprika. With a high sale value [5], paprika will be very profitable provided that farmers can improve its productivity, which is closed link to its irrigation processes [6] [7]. The use of drip irrigation system can serve this purpose.

In Indonesia, paprika plantations that use drip irrigation system can be found in Cikajang area, Garut, West Java. However, their drip irrigation processes in these plantations are still performed conventionally. Automation to these processes will surely help ease the farmers' workload. In an attempt to realize this automatic watering system, this study designs a prototype model of automatic drip irrigation system using a fuzzy logic approach. The purpose is to control the amount of water usage in accordance with the watering quantity required by the plants [8]. Irrigation scheduling is vital for improving the efficiency of drip irrigation system, as excessive or sub-optimum water supply to plants has detrimental effects on yield and fruit quality in banana [9]. The use of fuzzy logic approach in drip irrigation can save the use of water resources

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up to 20-30% [10]. The design of an automatic drip irrigation of this like may use different sensors such as rain sensor, light sensor, temperature sensor and humidity sensor [11]. Our design is somewhat different from those in the previous studies. In the present study, we only use one sensor; i.e., DTH 11. In addition, unlike those in the previous studies where automatic drip irrigation system is used open spaces, ours will be used in a confined space, screen house.

2 Method

This study was conducted using a prototyping. Prototyping is one method of exploring, both individually and collaboratively, a solution space (mathematical entity) for a problem [12] Prototyping method through a procedure consisting of planning, specification, design, and results . The prototype-based model is specially characterized by one idea, the object is the only abstraction provided to the programmer . A prototype is an enactable mock-up or model of a software system that enables evaluation of features or functions through user and developer interaction with operational scenarios.

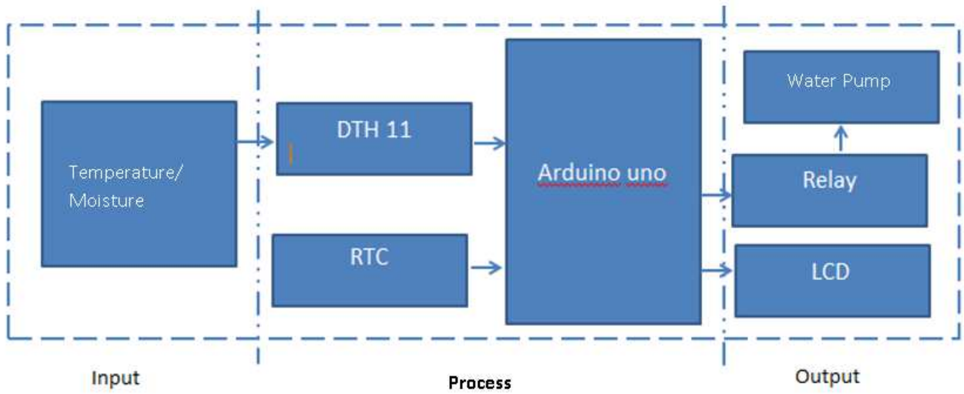

Figure 1. Block Diagram of Input, Process, and Output

Figure 1 shows that temperature and humidity are the input data received by the sensor. The design works as follows: DTH 11 detects the room temperature and humidity, and RTC shows the timing in real time. Data transmitted by DTH 11 and RTC to the Arduino Uno will be displayed on the LCD and turns on the relay, and in its turn, the relay will turn on the water pump.

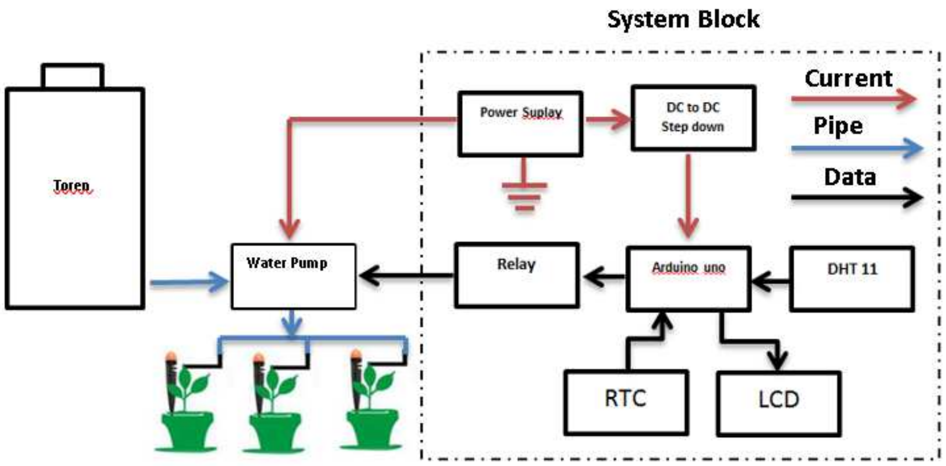

Figure 2. Drip Irrigation

Figure 2 illustrates the whole process; i.e., how the water pump is connected to the system block and the water tank.

3 Result and Analysis

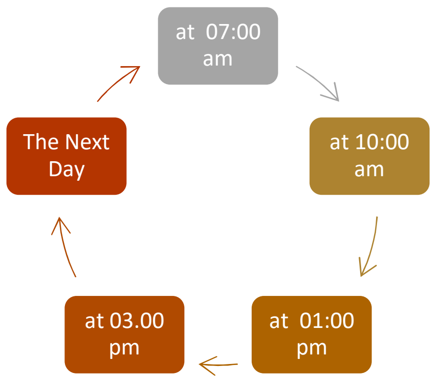

Figure 3. Manual watering daily cycle

Figure 3 shows that the watering is carried out 4 times a day, according to employee working hours. The watering duration is determined by the temperature and humidity.

Table 1. Temperature and Humidity

Time	Temperature	Humidity
05:00-07:00 am	20°C	60%
07:00-09:00 am	21°C	60%
09:00-11:00 am	27°C	70%
11:00 am -01:00 pm	27°C	70%
01:00-03:00 pm	27°C	70%
03:00-05:00 pm	25°C	60%
05:00-07:00 pm	25°C	60%

Table 1 shows the relationship between time and the estimated screen house temperature and humidity.

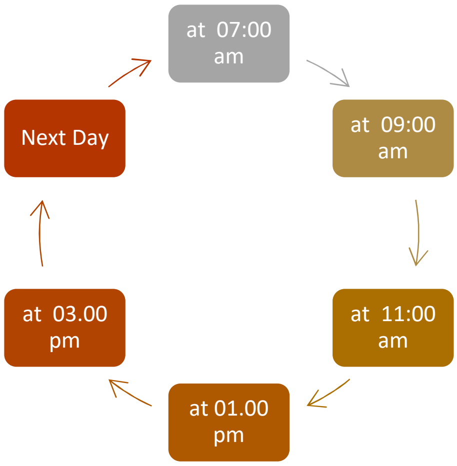

Figure 4. Automatic watering daily cycle

Figure 4 shows that automatic watering is done every other two hours after the first watering at 7 am in the morning. This watering time range is set based on the suggestion of some experts.

In this study, the fuzzy logic includes the classification of temperature, humidity, and watering duration. The temperature is classified into three categories: cold, normal, and hot. Humidity is also divided into three categories: dry, normal, and humid. The watering duration is classified into short, medium, and long. This fuzzy logic is then simulated using Matlab.

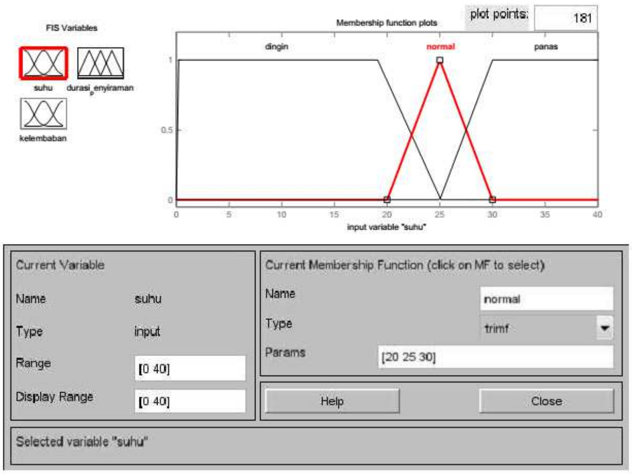

Figure 5. Temperature Curve

Range = [0 40]
Cold [0 0 20 25]
Normal [20 25 30]
Hot [25 30 40 40]

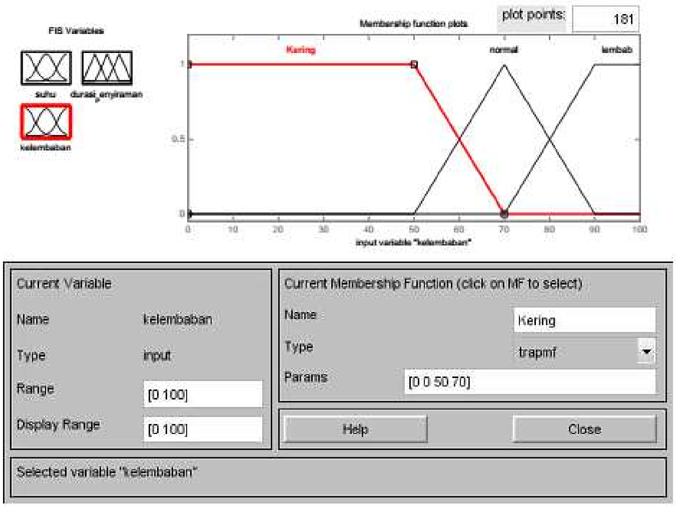

Figure 6. Humidity Curve

Range = [0 100]
Dry [0 0 50 70]
Normal [50 70 90]
Humid [70 90 100 100]

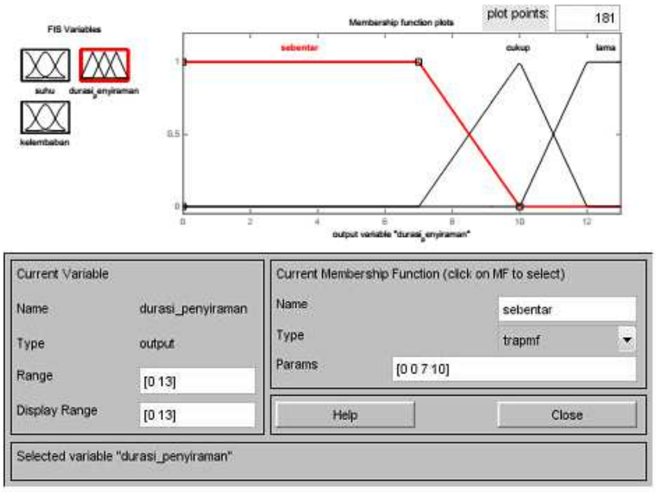

Figure 7. Watering Duration Curve

Range = [0 13]
Short [0 0 7 10]
Medium [7 10 12]
Long [10 12 13 13]

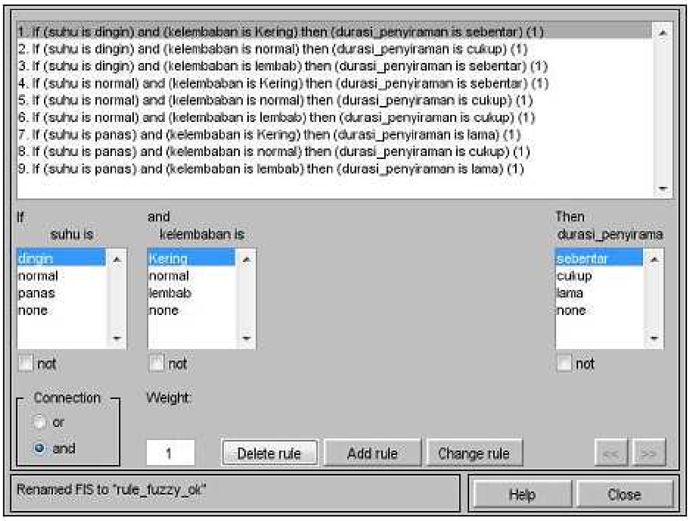

Figure 8. Fuzzy Rules

Figure 8 shows that the fuzzy rules are set by combining temperature, humidity, and watering duration parameters.

Table 2. Equipment Simulation Test

Test No.	Time	Temperature (ºC)	Humidity (%)	Time Range	
				second	minute
1	07.04 am	22.0	56.0	400.4	6.67
2	09.00 am	23.0	64.0	381.9	6.36
3	11.10 am	25.0	62.0	371.1	6.18
4	01.00 pm	25.0	61.0	357.6	5.96
5	03.00 pm	25.0	60.0	332.0	5.54
6	07.20 am	23.0	67.0	453.6	7,58
7	09.10 am	24.0	64.0	402.1	6.70
8	11.00 am	25.0	63.0	385.9	6.43
9	01.10 pm	27.0	58.0	427.2	7.12
10	03.20 pm	26.0	60.0	328.2	6.37

Table 2 shows the results of temperature and humidity measurements.

Table 3. Simulation Test with Matlab

Test No.	Time	Temperature (ºC)	Humidity (%)	Time Range (minute)
1	07.04 am	22.0	56.0	6.68
2	09.00 am	23.0	64.0	6.56
3	11.10 am	25.0	62.0	6.16
4	01.00 pm	25.0	61.0	5.93
5	03.00 pm	25.0	60.0	5.72
6	07.20 am	23.0	67.0	7.56
7	09.10 am	24.0	64.0	6.68
8	11.00 am	25.0	63.0	6.4
9	01.10 pm	27.0	58.0	5.59
10	03.20 pm	26.0	60.0	6

Table 4. Time Difference

Test No.	Time	Time Range Comparison		Time Difference (minute)
		Equipment	Matlab	
1	07.04 am	6.67	6.68	0.01
2	09.00 am	6.36	6.56	0.2
3	11.10 am	6.18	6.16	0.02
4	01.00 pm	5.96	5,93	0.03
5	03.00 pm	5.54	5.72	0,18
6	07.20 am	7,58	7.56	0.02
7	09.10 am	6.70	6.68	0.02
8	11.00 am	6.43	6.4	0.03
9	01.10 pm	7.12	5.59	1.53
10	03.20 pm	6.37	6	0.37
Average time difference				0.24

Table 4 shows the difference between watering duration and Matlab simulation duration. The average difference is 0.24 minutes.

4 Conclusion

This study has managed to design a prototype of automatic drip irrigation for paprika in a screen house. The automation is done based on temperature and humidity measurements. The average difference between watering duration and Matlab simulation is 0.24 minutes.

5 Acknowledgement

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