

# Controlling Smart Green House Using Fuzzy Logic Method

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**Abstract**—To increase agricultural output it is needed a system that can help the environmental conditions for optimum plant growth. Smart greenhouse allows for plants to grow optimally, because the temperature and humidity can be controlled so that no drastic changes. It is necessary for optimal smart greenhouse needed a system to manipulate the environment in accordance with the needs of the plant. In this case the setting temperature and humidity in the greenhouse according to the needs of the plant. So using an automated system for keeping such environmental condition is important. In this study, the authors use fuzzy logic to make the duration of watering the plants more dynamic in accordance with the input temperature and humidity so that the temperature and humidity in the green house plants maintained in accordance to the reference condition. Based on the experimental results using fuzzy logic method is effective to control the duration of watering and to maintain the optimum temperature and humidity inside the greenhouse

**Keywords:** *Temperature, Humidity, Control, Fuzzy Logic method, watering duration*

## I. INTRODUCTION

The development of agriculture industry in Indonesia increased along with increasing knowledge of agricultural techniques. From traditional farming systems evolved into a modern agricultural system where agricultural product is increased, but by using dangerous pesticides in an effort to increase agricultural output. In other hand will destroy the environment. Then developing agricultural technology by manipulating the climate around the plant called micro-climate.

Climate change is happening today has made farmers difficulties for increasing agricultural product. Erratic weather conditions led to the planting and harvesting cannot be determined and estimated. Farmers are difficult to predict the weather in the growing season. Mark and Davel [1] describe an annotated bibliography on issues relating to changes in the concentrations of Earth's greenhouse gases. The areas covered include theory and numerical modelling of climate change; cycles involving carbon dioxide and other radiatively important

trace gases; observations of climate change and the problems associated with those observations; paleoclimatology as it relates to previous changes in the greenhouse gases; the impacts on and interactions with managed and natural ecosystems from climate change; policy issues related to climate change and to the limitation of climate change; history of the study of the greenhouse effect; and some other causes of climate change. Then, in India Sahay and Ghosh[4] explain cities across the globe are considered as major anthropogenic sources of greenhouse gases (GHG), yet very few efforts has been made to monitor ambient concentration of GHG in cities, especially in a developing country like India.

Andrasko [2] mention that measurement and monitoring issues are emerging at the intersections of the project and national scales, referred to here as monitoring-domain edge effects. Andrasko would like to show following actions are necessary to improve existing monitoring capabilities and to help resolve project/national edge effects.

Smart greenhouse technology is an alternative solution to control the micro-climatic conditions in the plant. The use of smart greenhouse in the cultivation of plants is one way to provide an environment that is closer to better conditions for plant growth. The use of smart greenhouse so that plants can obtain air temperature and humidity is optimum.

David and Murat [3] describe an autonomous computer vision-guided plant sensing and monitoring system was designed and constructed to continuously monitor temporal, morphological, and spectral features of lettuce crop growing in a nutrient film technique (NFT) hydroponics system.

In other hand, to control the temperature and humidity inside the smart green house would require an automatic controller that can read existing activities in the smart green house. Park et al [5] show the system collected temperature of leaves and humidity on leaves of crop. As well as greenhouse environmental information such as temperature, humidity, etc. Crop diseases, especially, have deep relationship not only with indoor environmental factors but also with humidity lasting

time on leaves and temperature of leaves. Accordingly, monitoring crop itself is as important as monitoring indoor environments.

In this study the temperature and humidity in the greenhouse can be regulated by watering when the value of high temperatures and low humidity. It is necessary for setting the watering time duration for controlling the temperature and humidity values. The author uses fuzzy logic to produce more crop watering duration dynamic where the temperature and humidity in accordance with the desired plants.

Compared with conventional systems, the system is capable of processing input of real values (exact) into a fuzzy scale and process them using the rule base to make the decision which is the output fuzzy system very quickly and accurately.

## II. CONTROL SYSTEM OF SMART GREENHOUSE

Plants can grow properly if schedule for watering is done every day. In the conventional greenhouse, watering is done manually by the owner to perform continuous scheduling watering during the day.

This being smart greenhouse that plants watering process is performed automatically in accordance with the desired watering schedule. Schedule watering is done at 07.00 in the morning and at 17.00 in the afternoon. In addition to watering schedules, the greenhouse smart also uses temperature and humidity sensors to maintain the condition of the plants in the green house.

Conditioning system for temperature and humidity inside the greenhouse smart refers to climatic factors that affect plant growth. In this case, the parameter is temperature and humidity controlled.

In this study, samples were taken where the tomato plants good growing condition is at a temperature of 24o - 32o C. Under the terms of the growth made control systems using temperature and humidity sensors (DHT11) where the sensor detects changes in temperature and humidity that occur in green house.

## III. CONTROL DURATION OF GREENHOUSE SPRAYING PUMP SYSTEM USING FUZZY LOGIC METHOD

### a. Design Fuzzy Logic System for Smart Greenhouse

Smart greenhouse has a system of spraying plants that use water pumps. Working of water pump is programmed at microcontoller i.e., Arduino-Uno for controlling an electronic device as a link between the power source to the water pump.

Watering duration is controlled by fuzzy logic system. Fuzzy logic method begins by receiving input from a temperature sensor and humidity sensor then their value will be calculated to produce the output as the duration of watering in this smart green house.

In this system the temperature sensors and humidity sensors are inputs, where the sensor will detect temperature and humidity in the smart green house. Then the sensor will give a signal to the microcontroller Arduino-uno which will give the decision of the time duration to electronic devices that connected to a power source of the water pump.

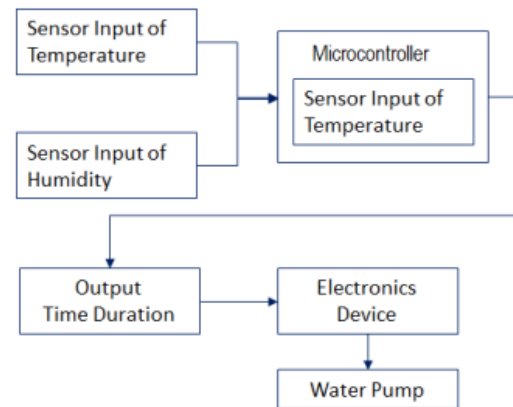


Figure 1. fuzzy logic process for controlling duration of watering

Flow diagram for determining the duration of the water pump settings by using fuzzy logic as shown in Figure 1. In regulating the duration of the water pump using fuzzy These are the reference conditions of temperature and humidity conditions in fact, was to get the output of the temperature and humidity sensors in the form of value for the duration of the water pump used mamdani and defuzzification method used is minimized. The output value of the duration of this water pump will then be sent to the microcontroller types arduino uno.

By using Fuzzy Inference System (FIS) on software matlab, created a program file in matlab toolbox. Engine FIS will be saved by clicking: File - export. There are two options available i.e., Workspace and File. When selected to Workspace then will appear in Matlab active.

At the FIS Editor at setting the two inputs namely Temperature Sensor with conditions of low, medium and high and humidity sensor input with the condition of low, medium and high, as seen in Figure 2.

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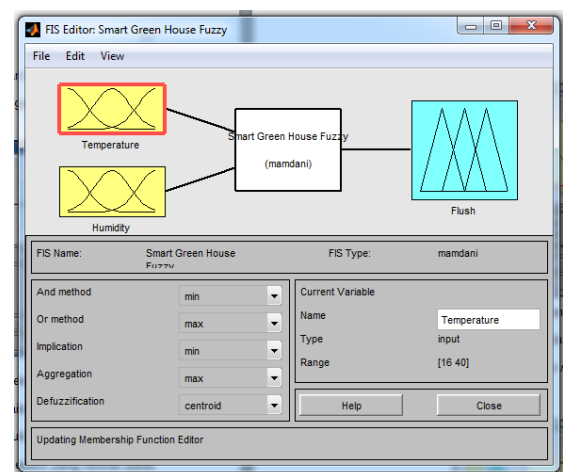


Figure 2. Setting parameter masukan dan keluaran pada editor fuzzy

The first input is a temperature sensor with conditions of low, medium and high use trimf using the membership function types can be seen in Figure 3. The range values from 0 to 40 express the magnitude of the temperature in the green house.

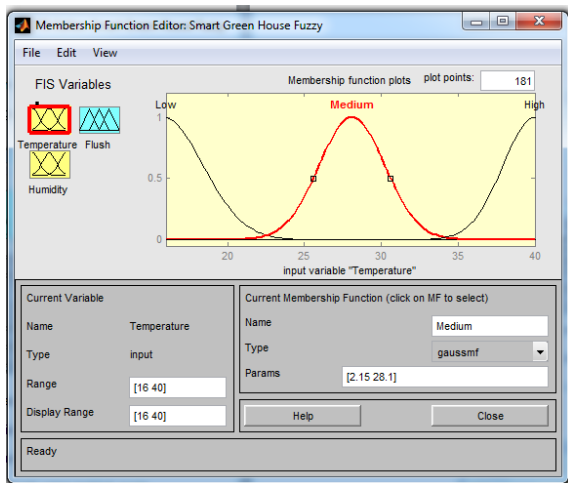


Figure 3. Temperature as an input of Fuzzy system

A second input of humidity with level of membership function low, medium and high, here, it is using the sigmoid function type for representative of membership function, can be seen in Figure 4. Here, it was chosen three membership function using sigmoid formula.

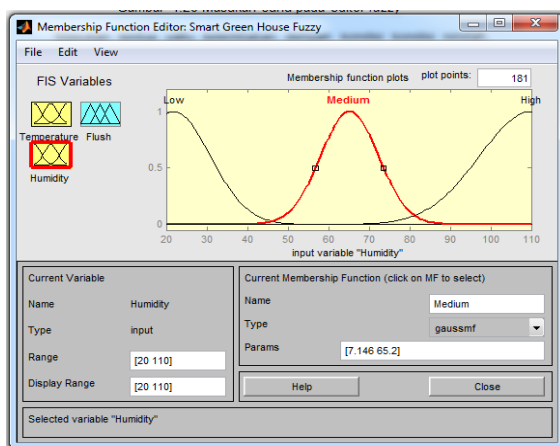


Figure 4. Humidity as an input of fuzzy logic system

For the duration of the output is time, by using the membership function sigmoid type as shown in Figure 5. The duration of the output condition there are short, medium and long conditions.

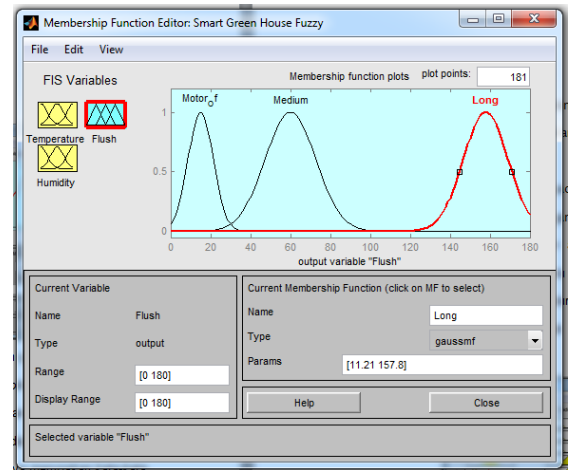


Figure 5. The output of watering duration of fuzzy logic method

Decisions given by the fuzzy controller is derived from the rules which exist in the database. These decisions are stored as a set rule. Rule-the rule is an if-then statement is intuitive and easy to understand, because only a linguistic statement.

There are 9 rules used in setting the duration of the water pump at this Greenhouse. These rules are inserted into the "rule editor" as in Figure 6.

Rule which has been included in the rule editor can be seen in the rule option viewer as shown in Figure 7. Rule viewer is used to set the duration of the likelihood of the water pump, the condition is a short, medium or long, such condition depends on the value of the temperature on the output. To set the trends can be done by shifting the center red line for each membership function.

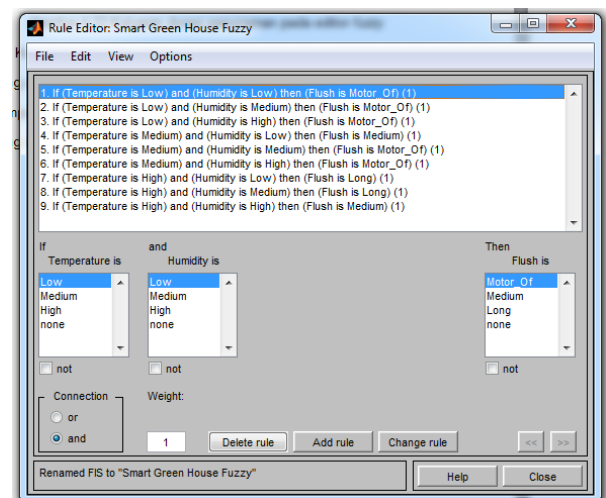


Figure 6. Setting of rules at fuzzy editor

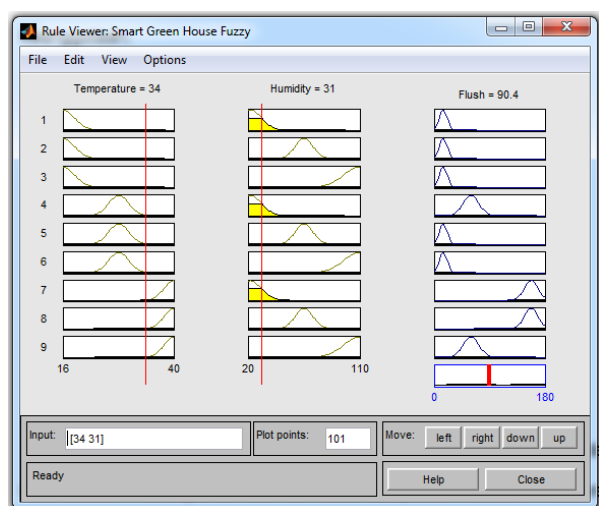


Figure 7. Rule viewer at fuzzy editors

Shown in Figure 7 shows the value when the temperature of 34<sup>0</sup> C and humidity indicate 31%, the output obtained watering for 90.4 seconds. The value of this watering output varies depending on the value of the input temperature and humidity in the greenhouse.

Results of rule viewer can be seen in the form of three-dimensional surface viewer as shown in Figure 8. Surface viewer is plot a graph of the data released in the process of defuzzification.

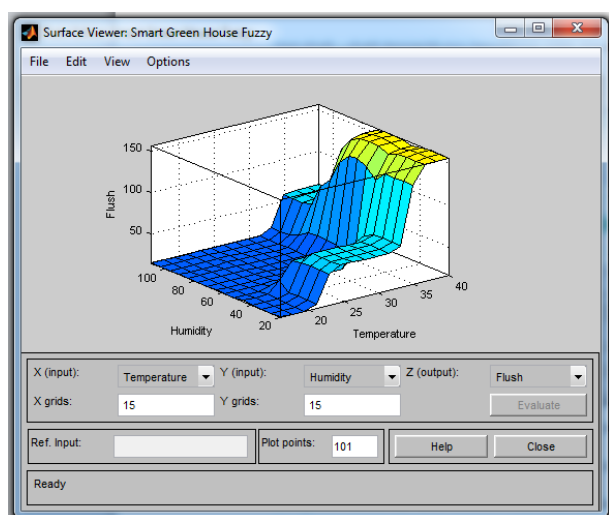


Figure 8. Surface viewer pada editor fuzzy

#### b. Simulasi Fuzzy Logic pada Green house

The temperature and the humidity data has been obtained used as input variables in this system to get the duration of watering plants as the output variable. The data has been obtained and then inserted into the rule to get the duration of

the pump. For the duration of the pump that produced less than 20 seconds otherwise the pump is not running and if the duration of the pump is greater than 20 seconds otherwise the pump running so at 07:00 and 08:00 pump is not running. The duration of the pump obtained at 12.00 where the temperature is 35 °C and humidity of 35% can be seen in Table 1.

Table 1. Result of greenhouse system using Fuzzy Logic

Time (hour)	Temp (°C)	Humidity (%)	Duration (s) Fuzzy Logic	Pump (on/off)	Temp. after watering	Humidity after watering
7	21	61	15,5	Of	21	61
8	28	52	18,2	Of	28	52
9	32	47	43,7	On	28	59
10	32	42	59,9	On	28	59
11	33	39	63,5	On	28	64
12	35	35	140	On	27	66
13	34	36	90,4	On	27	66
14	33	33	63,6	On	27	68
15	31	36	60	On	26	69
16	29	38	60	On	25	70
17	28	43	58,4	On	25	73

Simulation of fuzzy logic control shows the results performed on variable temperature and humidity as input variables obtained hour duration of the pump taken at 7:00 to 17:00 as in the table above and can be seen in Figure 9 below.

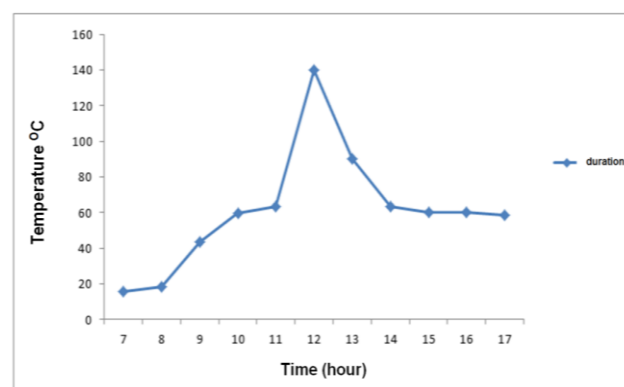


Figure 9. Duration of pump

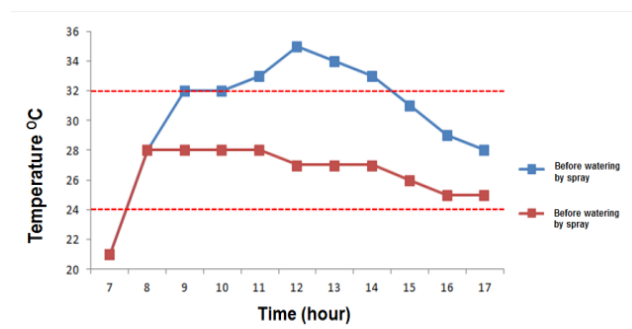


Figure 10. The temperature before and after watering

The results obtained on the duration of the pump tests using fuzzy logic control then carried for watering plants in the

greenhouse temperature and humidity obtained every hour can be seen in Figure 10 and Figure 11.

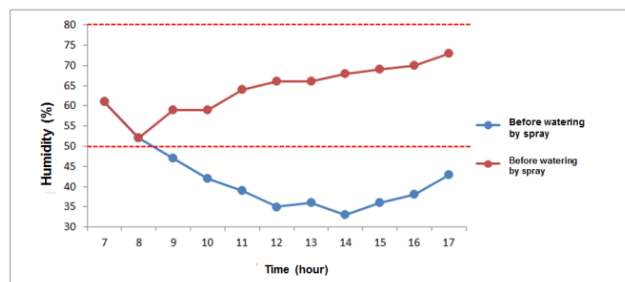


Figure 11. Humidity inside green house before and after watering

From the results of the duration of watering with fuzzy logic is done on tomato plants in the green house can keep the temperature and humidity are optimal temperature of  $24^{\circ}\text{C}$  -  $32^{\circ}\text{C}$  and humidity 40% - 80%. It is effective for the duration of watering with fuzzy logic obtained in accordance with the temperature and humidity in the green house.

#### IV. CONCLUSIONS

1. Simulation of watering duration was success using Matlab. The result was duration of watering which inputs of temperature and humidity in smart green house.
2. Watering duration system using fuzzy logic method was effective to keep the temperature on  $24^{\circ}\text{C}$  -  $32^{\circ}\text{C}$  dan humidity on 40% - 80%.
3. The fuzzy logic method is available to implement at smart greenhouse, which has two or more inputs and single output.

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