APPLICATION OF FUZZY LOGIC TO CONTROL ROOM ILLUMINATION BASED MICROCONTROLLER

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ABSTRAK

Suatu penerangan ruangan diperlukan oleh manusia untuk mengenali objek secara visual. Penerangan mempunyai pengaruh terhadap fungsi sebuah ruangan. Oleh karena itu diperlukan lampu sebagai sumber penerangan utama yang dapat menunjang fungsi ruangan. Umumnya untuk pengaturan penerangan ruangan digunakan prinsip on-off. Pengaturan penerangan dengan prinsip on-off hanya berdasarkan pada kondisi gelap terang ruangan, tanpa menghiraukan kontribusi dari luar seperti cahaya matahari. Hal ini sering mengakibatkan ketidaknyamanan dan ketidakefisienan penggunaan energi listrik. Oleh karena itu diperlukan pengaturan penerangan (iluminasi) yang dihasilkan lampu. Prinsip kendali yang digunakan adalah kendali fuzzy. Sistem inferensi fuzzy yang digunakan pengendali penerangan ruangan ini adalah Metode Sugeno. Komposisi aturan menggunakan operator AND, sedangkan untuk defuzzifikasi digunakan metode COG (Center of Gravity). Sebagai pengendali utama pada sistem menggunakan mikrokontroller dengan input dari sensor cahaya (LDR). Output dari pengendali selanjutnya ditampilkan pada LCD sebagai penampil dan sebagai input rangkaian pengatur tegangan. Sistem ini bekerja di dalam ruangan (in door) menggunakan maket rumah dengan tiga ruangan sebagai model. Dari hasil simulasi dengan kendali fuzzy, jika setpoint ruangan sebesar 200 lux dan keadaan ruangan sudah terang sebesar 80 lux maka lampu akan menghasilkan penerangan sebesar 125 lux, jika setpoint 300 lux dan keadaan ruangan 50 lux, maka penerangan lampu sebesar 250 lux,dan jika setpoint 150 lux dan keadaan ruangan 30 lux, maka penerangan lampu sebesar 125 lux.

Kata kunci: Pengendali Fuzzy, Iluminasi, Mikrokontroler

ABSTRACT

An illumination room is needed by humans to recognize objects visually. Lighting has an influence on the function of a room. Therefore we need the lights as the main lighting source that can support the function room. Generally used for indoor lighting arrangements on-off principle. Lighting settings with on-off principle is based only on the condition of the light dark room, regardless of the contribution from the outside as the sun. This often resulted in inconvenience and inefficiency use of electrical energy. Therefore, adjustment is necessary lighting (illumination) generated light. Control principle used is fuzzy. Fuzzy inference system used in this room is the lighting controllers Sugeno method. The composition rules using the AND operator, while for the COG method is used defuzzyfication (Center of Gravity). As a main controller in the system using a microcontroller with input from the light sensor (LDR). The output of the controller then displayed on the LCD as a viewer and as an input the voltage regulator circuit. This system works in the room (in door) using the model of a house with three rooms as a model. From the simulation results with fuzzy control, if the setpoint of rooms 200 lux and state rooms are light at 80 lux, the light will produce light at 125 lux, if the setpoint 300 lux and 50 lux room condition, then lighting the lamp is 250 lux, and if the setpoint 150 lux and 30 lux room condition, then lighting the lamp is 125 lux.

Keyword: Fuzzy controller, Illumination, Microcontroller

1. PRELIMINARY

The development of control technology are now starting to shift to the automation control system that requires the use of computers, so that human intervention in controlling very small. When compared with manual processing systems, computer-controlled equipment will provide advantage in terms of efficiency, security and accuracy. The ability of computers, both hardware and software, can be used for various control applications, such as temperature control, motor speed, lighting, and others.

An illumination space is needed by humans to recognize objects visually. Lighting has an influence on the function of a room. Therefore we need the lights as the main lighting source that can support the function room. Generally for indoor lighting arrangement used the on-off, at which time a dark room lights on and turns off when the room light. With the on-off, the lighting arrangement is based only on the condition of the light dark room without ignoring the contribution from the outside as the sun. At the time outdoors overcast conditions and light in the off state, meaning the room is rather dark. However, if the lights on it in the room became too bright and even blinding. This often resulted in discomfort. Besides, the use of excessive lighting quality is also associated with efficient use of electrical energy. Therefore we need lighting arrangements, both for the comfort factor and the efficiency of electrical energy. The settings are often called a dimmer. With energy saving settings enabled electric lighting.

Given the importance of lighting arrangements, in this final project designed to control lighting spaces that are functionally different, such as bedrooms, living room and reading room, in a house. As the controlling light intensity used microcontroller with fuzzy logic based control methods.

2. METHODS

A.System Configuration

As a whole system to be designed to form a lighting control system space. Controlling indoor lighting is done by controlling the amount of the quantity of light produced by light. To control the quantity of light, then by controlling the applied voltage to the lamp. Voltage regulation done by the block voltage regulator based on the output of fuzzy controller.

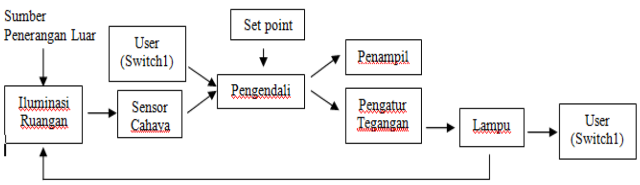


Figure 2.1 Block Diagram System

User interaction with the system can be seen from the input given by pressing a switch 1. After switch 1 is pressed, the input from the light sensor is processed by the controller with fuzzy logic method. The output of the controller then displayed by the viewer and as an input voltage regulator circuit. Lights will illuminate according to the input given by the voltage regulator circuit. The output of the process which produced the lamp light intensity will mingle with the light from outside sources produce illumination space. Further sources of illumination outside illumination space is measured by a light sensor which then generate input signals as feedback for the controller. The controller will continue to process the input signal and generates an output value to form a closed loop control system. The system will stop working when the user presses the switch1.

B.Light Sensor

The series of light sensors that are used in lighting control room as much as 6 units. As a light sensor is LDR (Light Dependent Resistor) which serves to detect the amount of illumination in the room. Room lighting controller uses six LDR as a transducer which convert light energy into electrical energy which would then be processed microcontroller. LDR LDR 1 0 and placed in room 0, LDR 2 and 3 placed in the chamber 1, whereas the LDR LDR 4 and 5 are placed in room 2. Each room using 2 sensors. The first sensor is placed near the lamp, it is aimed so that illumination is measured mostly sourced from the lamp. While the second sensor is placed close to an external source.

C.Solid State Relay

As a voltage regulator, used a series of Solid State Relay (SSR), which in principle is a merger between the optocoupler circuit that uses a Zero Crossing Circuit in 3041 and TRIAC MOC. Figure 3.4 shows an image series of SSR, while the workings of this series is as follows: If there is a logic 1 on input (IN) this circuit, the transistor BD139 will be active and Collector and Emitter connection seems like a closed switch so that current will pass from the power supplied through the MOC legs 1 and 2. This will result in diodes which resides in the MOC is active and transistor 3041 which are also active in MOC3041. This situation will result in the flow of net flow to the legs 220VAC TRIAC Gate and will trigger the TRIAC. These triggers cause the foot MT1 and MT2 will be connected and 220VAC nets will flow through the load. This lead to the load ON.

Capacitor in this circuit serves to reduce the very large currents when the load began to ON. If there is a logic 0 at the input (IN) this circuit, the transistor BD139 will not be active, and the connection collector emitter (CE) seems like an open switch. This results in diodes and transistors inside the MOC3041 not active and there will be no triggers on the triac so that the load is not connected to the nets 220VAC or in other words the load OFF. Giving logic 0 or logic 1 is controlled by the microcontroller.

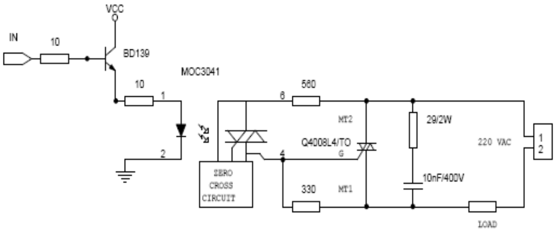


Figure 2.2 Solid State Relay Series

D.Fuzzy Design

1. Membership Function

a) For LDR 0, 2, and 4 have a membership function with 3 input variables (membership functions a3) are as follows: (dark, medium, light)

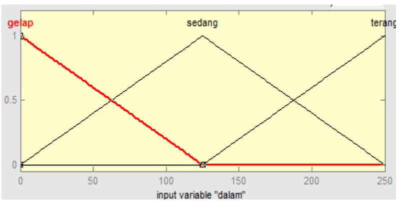


Figure 2.3 Membership Functions a3

b) For LDR 1, 3, and 5 have a membership function with 5 input variables (membership function a5) are as follows: (a dark, quite dark, dim, somewhat bright, bright)

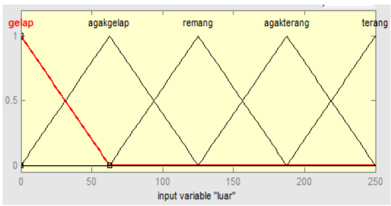


Figure 2.4 Membership Function a5

c) To use the output singleton output membership function as much as 5 (out, very dim, dim, somewhat bright, bright)

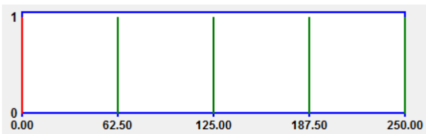


Figure 2.5 Output singleton

Padam =0.00
Sangat redup =62.50
Redup =125.00
Agakterang =187.50
Terang =250.00

2.Rule Base Design

Lighting control system has two inputs namely a3 and a5. Rule base (rule base) to control the room lighting is indicated by table 3.1.

A5 / A3	GPA5	AGA5	RRA5	ATA5	TRA5
GPA3	TROT	ATOT	ATOT	ATOT	RDOT
SDA3	ATOT	RDOT	RDOT	RDOT	SROT
TRA3	RDOT	SROT	SROT	SROT	PDOT

Table 2.1 Rule base

Ket:

1. Input A3: for membership function with three variables
   - GPA3 : Gelap
   - SDA3 : Sedang
   - TRA3 :Terang
2. Input A5: for membership functions with five variables
   - GPA5 : Gelap
   - AGA5 : Agak gelap
   - RRA5 : Remang
   - ATA5 : Agak terang
   - TRA5 : Terang
3. Output:
   - PDOT : Padam out
   - SROT : Sangat redup out
   - RDOT : Redup out
   - ATOT : Agak terang out
   - TROT : Terang out

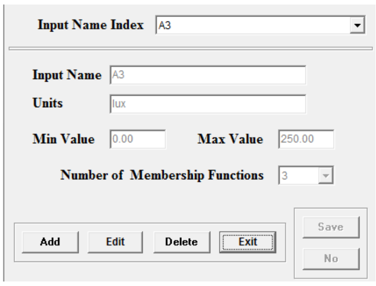
3.Deffuzyfikasi Methods

Defuzzyfikasi methods used method of COG (Center Of Gravity). Defuzzyfikasi COG method is applied to the singleton output membership function. Singleton output membership function is represented by the dots in the output space and also does not have mass. Pemepatan output membership function gives the result in the reduction of height. Using the method defuzzyfikasi COG, singleton output values are combined using a weighted average. COG formula is:

$$\text{Crisp Output (Y)} = \frac{\sum_i \left(\text{fuzzy output}_i\right) \times \left(\text{Singleton position on x axis}_i\right)}{\sum_i \left(\text{fuzzy output}_i\right)}$$

1) With Petrafuz

a. Crisp Design Input A3 and A5, and Crisp output in accordance with the design of membership functions and rule base above.



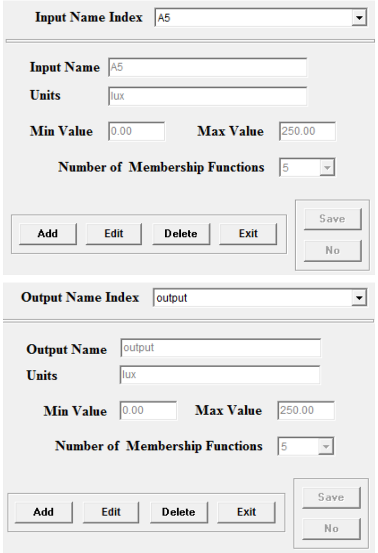


Figure 2.6 Membership Functions

b. Input and output membership function

Membership input function using shapeTriangle, while output in the form of singleon. For him there is Point-point to detemine the point that we want.

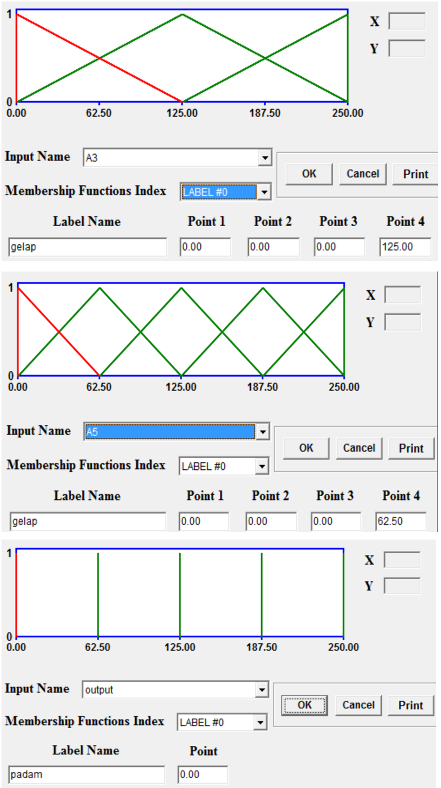


Figure 2.7 Membership function input output

c. *Rule Base*

Rule base is used together with table 2.1

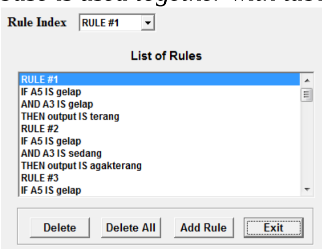


Figure 2.8 Rule Base

d. Fuzzy Evaluation

Fuzzy Evaluation (evaluation rule) is to evaluate the relationship or degree of membership of each rule antecedent.

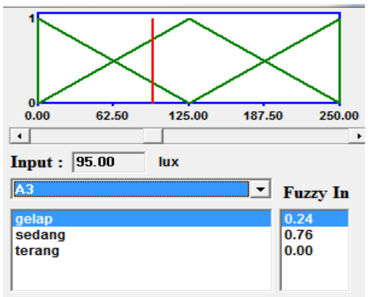


Figure 2.9 Fuzzyfikasi A3 input

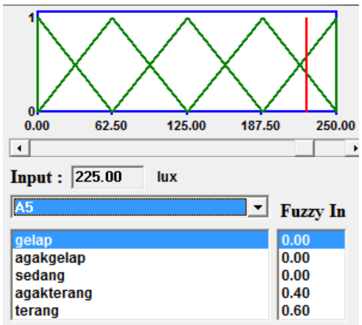


Figure 2.10 Fuzzyfikasi input A5

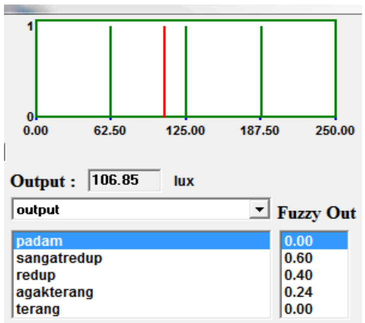


Figure 2.11 Out fuzzy singleton

e. Defuzzyfikasi

Defuzzyfikasi of the above simulation results can be calculated with the formula COA (Center Of Gravity)) is as follows:

$$\begin{aligned} \underset{(Y)}{Crips\,output} &= \frac{\sum_i (fuzzy\,output_i)\,X \begin{pmatrix} \sin gleton\ position \\ on\,x\,axis_i \end{pmatrix}}{\sum_i (fuzzy\,output_i)} \\ &= \frac{(0x0)+(0{,}6\,x\,62.5)+(0{,}4\,x125)+(0.24\,x187.5)+(0x250)}{0{,}6+0{,}4+0{,}24} \\ &= 106.86 \end{aligned}$$

2) With Fudge

The design of fuzzy systems using a design that is used in section fuzzy fuzzy logic design. In Fudge crisp design input, output and the same rule base with Petrafuzz, therefore, directly on the input and output membership function.

a. Input dan output membership function

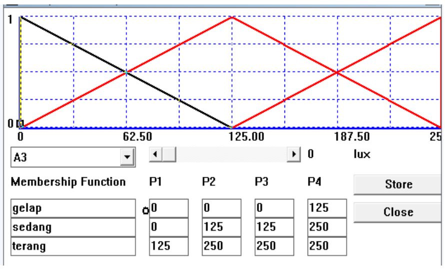


Figure 2.12 Membership function A3

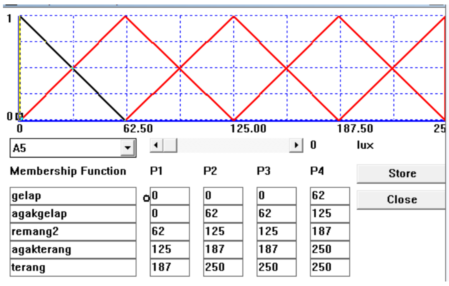


Figure 2.13 Membership function A5

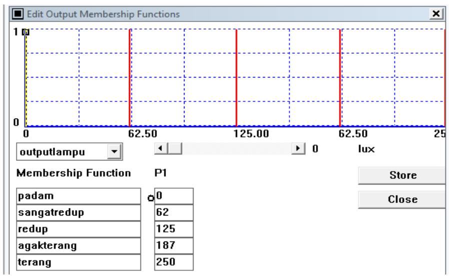


Figure 2.14 Output fuzzy singleton

b. Fuzzy Evaluation

Evaluating the degree of membership between antencedent

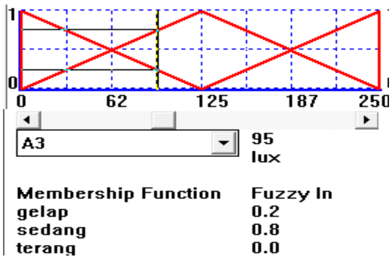


Figure 2.15 Membership function A3

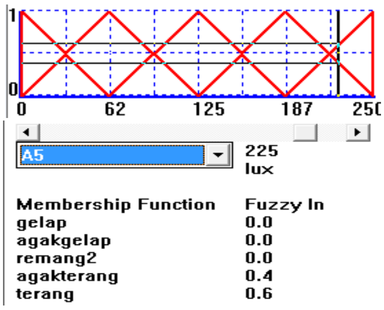


Figure 2.16 Membership function A5

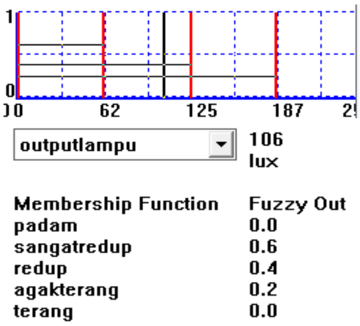


Figure 2.17 Out fuzzy singleton

3. Defuzzyfikasi

The calculation result of the fuzzy output singleton fuzzy evaluation can be calculated as follows (Method COA):

$$\begin{aligned} \textit{Crips output } (Y) &= \frac{\sum_i (\textit{fuzzy output}_i)\, X \begin{pmatrix} \textit{singleton position} \\ \textit{on x axis}_i \end{pmatrix}}{\sum_i (\textit{fuzzy output}_i)} \\ &= \frac{(0x0)+(0,6x62)+(0,4x125)+(0.2x187)+(0x250)}{0,6+0,4+0,2} \\ &= 103.833 \end{aligned}$$

3. SIMULATION RESULT

As a comparative material to test the fuzzy control is carried out three tests of different setpoint of 300 lux, 200 lux and 150 lux. PV (Present Value) is the initial condition of the room light.

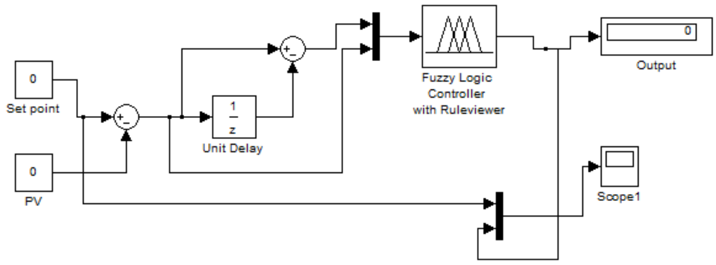
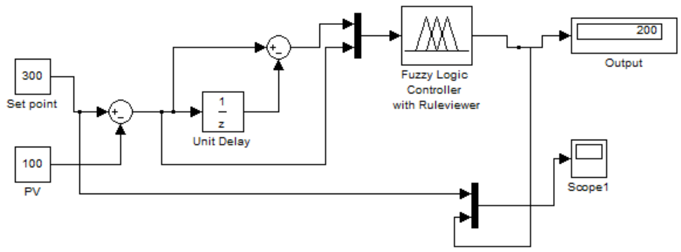


Figure 3.1 Fuzzy Control

Setpoint(SP)	PV	Output
300	50	250
300	60	240
300	70	230
300	80	220
300	90	210
300	100	200



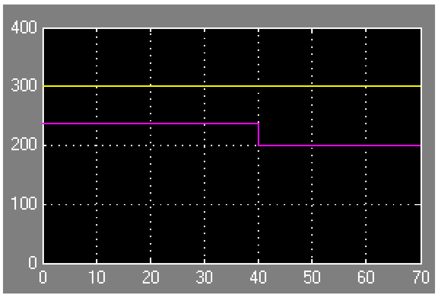


Figure 3.2 SP 300, PV 100, Out 200

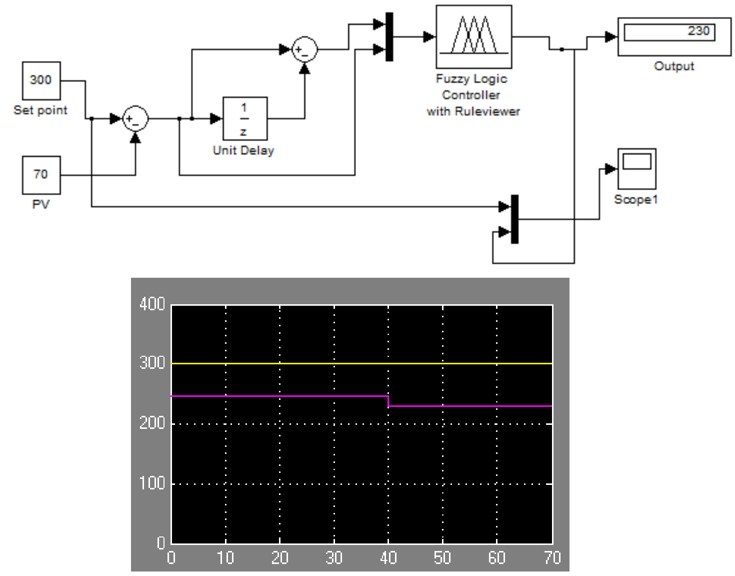


Figure 3.3 SP 300, PV 70, Out 230

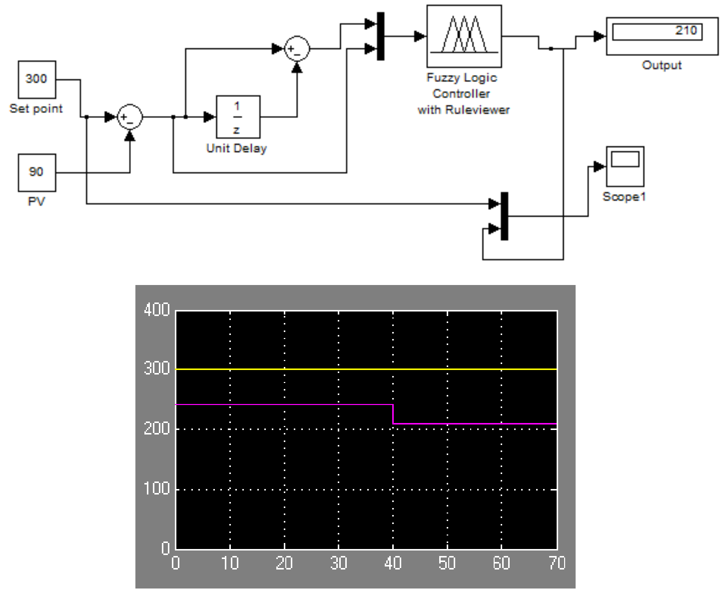
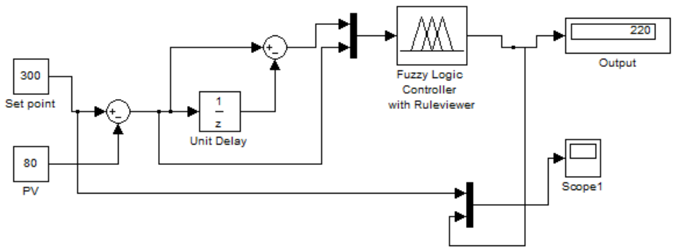


Figure 3.4 SP 300, PV 90, Out 210



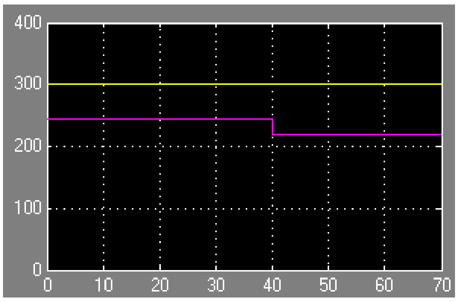


Figure 3.5 SP 300, PV 80, Out 220

Setpoint(SP)	PV	Output
200	20	180
200	40	160
200	60	140
200	80	125
200	90	125

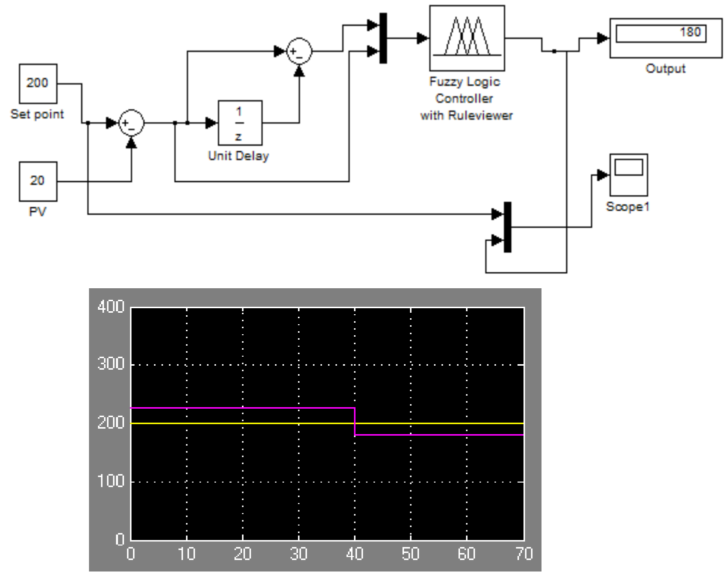


Figure 3.6 SP 200, PV 20, Out 180

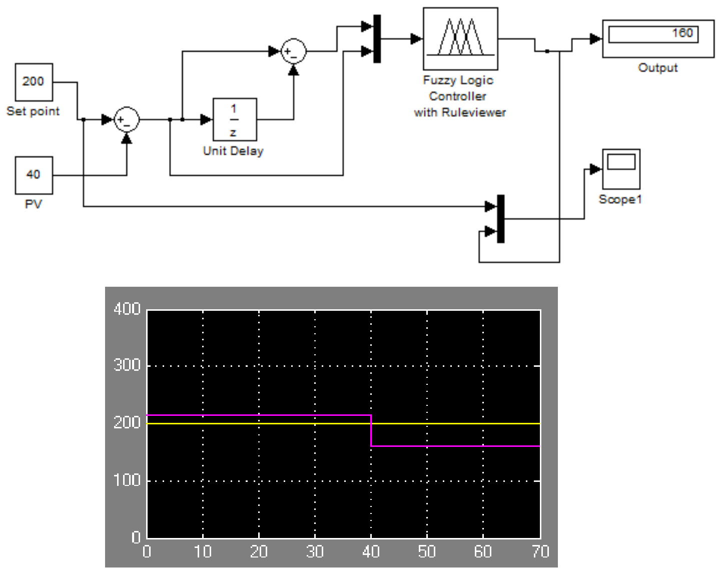


Figure 3.7 SP 200, PV 40, Out 160

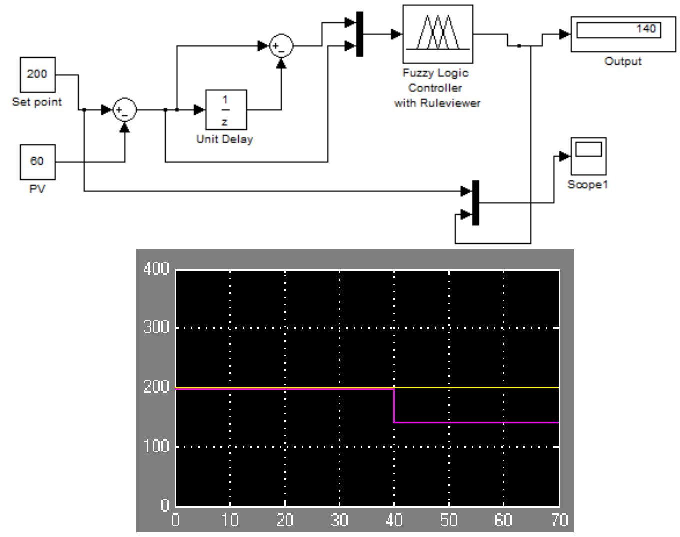


Figure 3.8 SP 200, PV 60, Out 140

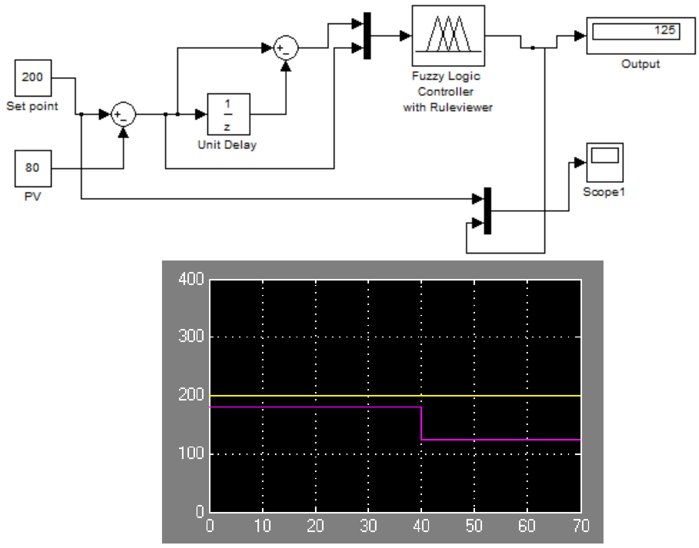


Figure 3.9 SP 200, PV 80, Out 125

Setpoint(SP)	PV	Output
150	10	140
150	20	130
150	30	125
150	40	125

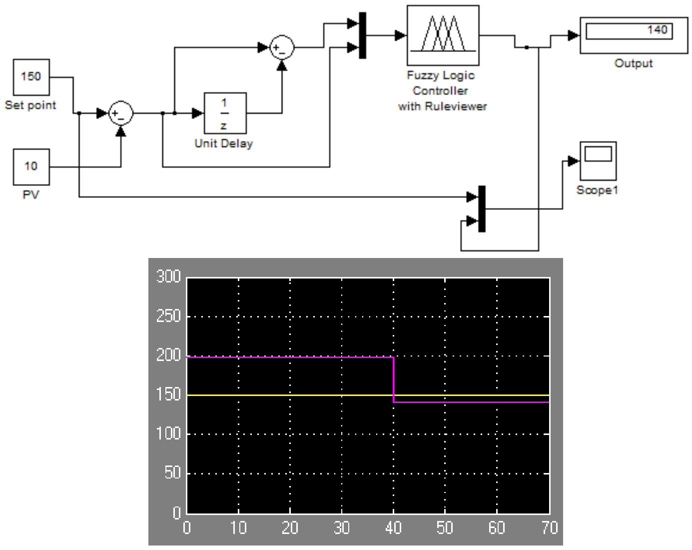


Figure 3.10 SP 150, PV 10, Out 140

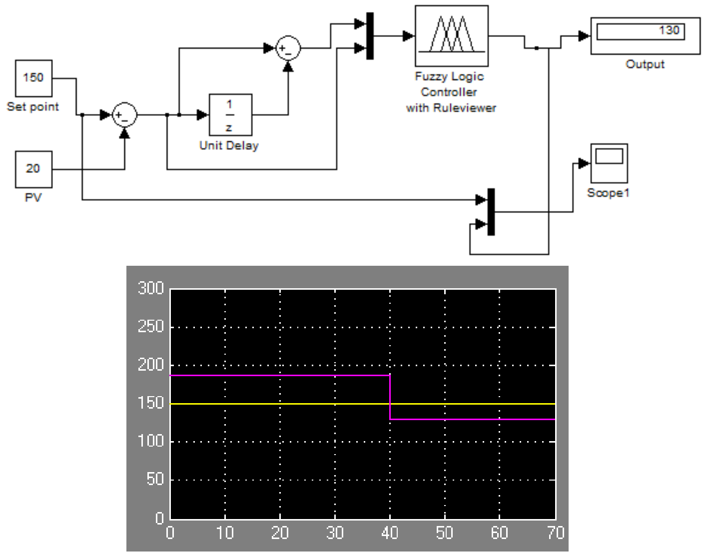


Figure 3.11 SP 150, PV 20, Out 130

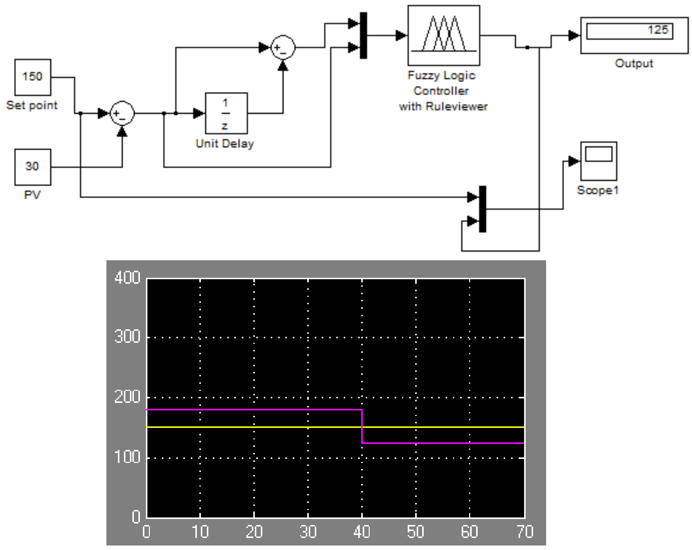


Figure 3.12 SP 150, PV 30, Out 125

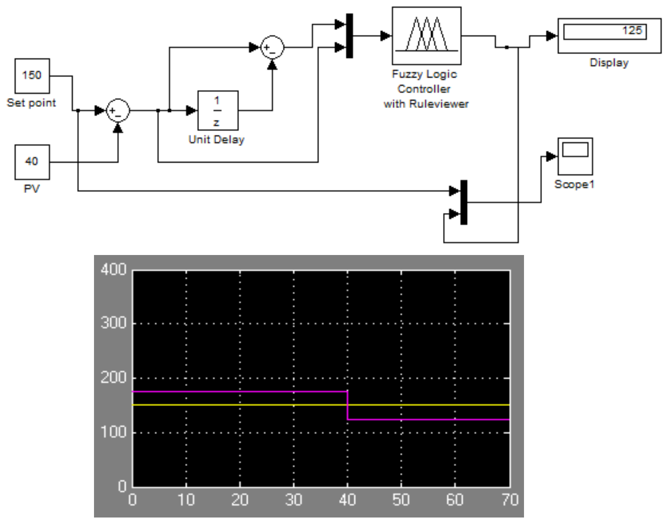


Figure 3.13 SP 150, PV 40, Out 125

From the simulation result shows that fuzzy systems are designed to work well where it can be seen from the output of fuzzy control near the desired setpoint value. From Figure 3.2 with 300 lux room setpoint, and PV (present value) / initial conditions of 100 lux room light the lamp lighting the resulting output is 200 lux, so the total light of the room is 300 lux. So also with pictures 3.3 and 3.4 with 300 lux setpoint and PV 70 and 90 lux light output produced is 230 lux (PV = 70) and 210 lux (PV = 90), the condition of the total light of the room is 300 lux. From the figure 3.6 with the setpoint 200 lux and 20 lux, the PV output is 180 lux, so the total light of the room was 200 lux while for setpoint PV 200 lux and 80 lux (Figure 3.9) then the output is 125 lux, and conditions total light of the room is 205 lux, close to the setpoint value. For setpoint 150 lux and 20 lux PV (figure 3.11), the output is 130 lux, so the total condition of the room light is 150 lux. For setpoint 150 lux and 30 lux PV (figure 3.12), the output is 125 lux, so the total condition of the room light is 155 lux.

4. CONCLUSION

1.Sistem fuzzy designed to work better when the room setpoint is 300 lux than 200 lux and 150 lux.
2. The design of fuzzy control system works well when approaching the desired results, with a setpoint 200 lux, and PV (initial condition bright room) 80 lux output is 125 lux. So the amount of lighting in the room is 205 lux, close to setting point 200 lux. For setpoint 300 lux and 100 lux PV, output is 200 lux, so the amount of room lighting is 300 lux. As for the setpoint 150 lux and 30 lux PV, output is 125 lux, so the amount of room lighting is 155 lux.

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