

Fuzzy Controller for Solar Cell Optimization

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Fuzzy Controller for Solar Cell Optimization

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Abstract. This study describes the Fuzzy Logic Control for the movement of Solar Cells that use fuzzy logic algorithms to achieve intelligent and flexible knowledge-based systems in the design of hardware to achieve efficiency in controlling the movement of solar cells that are better and maximize the function of the solar cell motor works based on time input. Fuzzy Logic allows mapping from the input given based on time to an output. involves components of variables, membership functions, Fuzzy Logic operators and if-then rules. And with an analysis it can produce optimum output of Solar cell rotation.

1. Introduction

The existence of solar energy as an unlimited source of energy around us, can normatively be utilized by using solar cells. However, the absorption of sunlight will not be optimal if the solar panel does not always focus on the projection point of the sun where the position of the sun is always moving from east to west thus reducing the performance of solar panels in the absorption of sunlight. Currently the efficiency of the use of solar cell modules is still relatively low. Acceptance of solar radiation in the solar cell module can affect the output of electrical power. With the development of Fuzzy logic knowledge that provides high capabilities of the final computing related to the coordination of distributed resources ensures the delivery of computational resources as expected. Fuzzy logic allows between 0 and 1 and has the ability in the local language in its design not in accordance with complicated mathematics.

1.1. Solar Cell

Solar cell is a tool to convert solar energy into electrical energy. Solar cells are made of very small pieces of silicon coated with special chemicals to form the basis of solar cells. Solar cells generally have a minimum thickness of 0.3 mm made of semiconductor slices with positive and negative poles. Each solar cell usually produces a voltage of 0.5 volts. Solar cells are active elements or semiconductors that utilize photovoltaic effects to convert solar energy into electrical energy.

1.2. The pseudo motion of the sun

The sun is a fixed star. It is 1,378,000 times the size of Earth. Its diameter is 109.1 times the diameter of the Earth. The distance between the earth and the sun is an average of 150 million km (1 AU) with the closest distance of about 147 million km and the farthest distance of about 152 million km. The sun's rays are 300 thousand km / second, so the time needed for the light to reach the surface of the earth for about 8 minutes. According to mathematical astronomy, the rotation of the earth, which takes 24 hours, causes the earth to become 24 time zones. This means that every 15 degrees longitude has a time difference of 1 hour.



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2. Methodology

2.1. Fuzzy Logic

One of the uncertainty models is Fuzzy Logic that is able to do reasoning because its classification is continuous and isn't crisp like Boolean logic. The results of research by experts showed that the brain's nervous system and the five senses of humans do not work with Boolean logic, but with other logic approached by fuzzy logic. The advantages of fuzzy theory inaccuracy of information can be used to produce decisions that are useful to humans. Algorithm in Fuzzy Logic, namely:

- a. Fuzzyfication
- b. Formation of the Fuzzy knowledge base (rule in the form of IF-Then)
- c. Inference Machine.

Using the MIN implication function to get the value of α -predicate each rule ($\alpha_1, \alpha_2, \alpha_3, \alpha_4 \dots \alpha_5$). Then each value of α -predicate each rule (rule ($\alpha_1, \alpha_2, \alpha_3, \alpha_4 \dots \alpha_5$)). Then each α -predicate value is used to calculate the output of the explicit inference result (crisp) of each rule ($z_1, z_2, z_3, \dots, z_n$) and defuzzification.

3. Results And Discussion

In this study several variables were used. There are two variables used, namely light, and servo motor. Light has a dark, dim, bright set.

3.1. Fuzzification

- a. Degree of LDR membership 1, The curve for degree of membership (μ) in the variable light from the sun consists of three fuzzy sets that are dark, dim, bright.

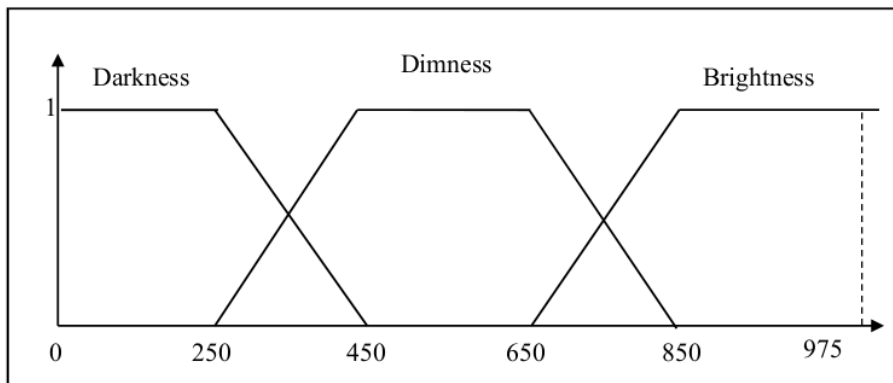


Figure 1. Degree of LDR Sensor Membership 1

Membership value of light intensity:

$$\begin{aligned} \mu_{Darkness}[x] &= \begin{cases} 1 & = x \leq 250 \\ (450 - x) / (450 - 250) & = 250 \leq x \leq 450 \\ 0 & = x \geq 450 \end{cases} & \mu_{Brightnesi}[x] &= \begin{cases} 0 & = x \leq 650 \\ (x - 650) / (850 - 650) & = 650 \leq x \leq 850 \\ 1 & = x \geq 800 \end{cases} \\ \mu_{Dimness}[x] &= \begin{cases} 0 & = x \leq 250 \text{ or } x \geq 850 \\ (x - 250) / (450 - 250); & 250 \leq x \leq 450 \\ (850 - x) / (850 - 650); & 650 \leq x \leq 850 \end{cases} \end{aligned}$$

- b. Degree of LDR membership 2 The curve for degree of membership (μ) in the variable solar light consists of three fuzzy sets that are dark, dim, bright.

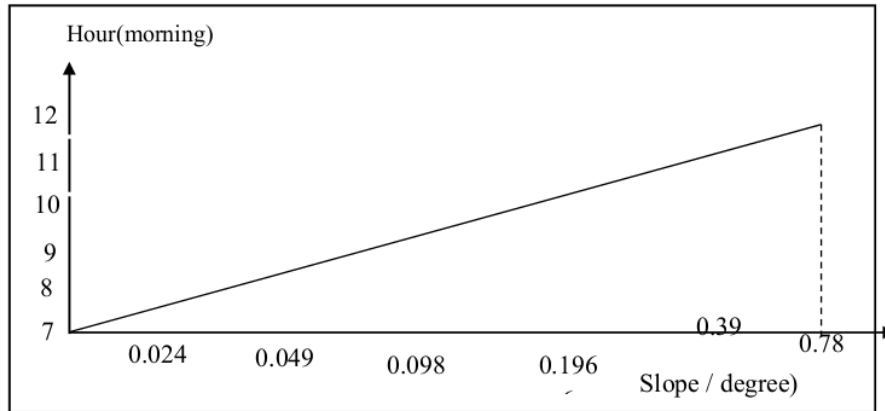


Figure 2. The Sun Tilt Chart Based on Time

c. Degree of membership of solar cell drives of 2 fuzzy sets, namely: East and West

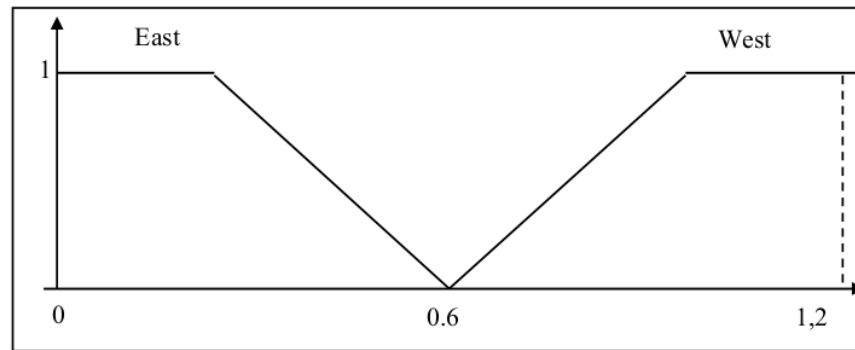


Figure 3. Solar Cell Drive Curve

Membership value for solar cell drives:

$$\mu_{Timur} [x] = \begin{cases} 0 & = x \geq 0.6 \\ 1 & = x < 0.6 \end{cases} \quad \mu_{Barat} [x] = \begin{cases} 0 & = x < 0.6 \\ 1 & = x \geq 0.6 \end{cases}$$

If the solar cell drive state is tested whether it is moving east or west and what degree of slope is when the LDR1 = 760 input, LDR2 input = 260 at 8 am. In LDR1 membership degree (light intensity 760).

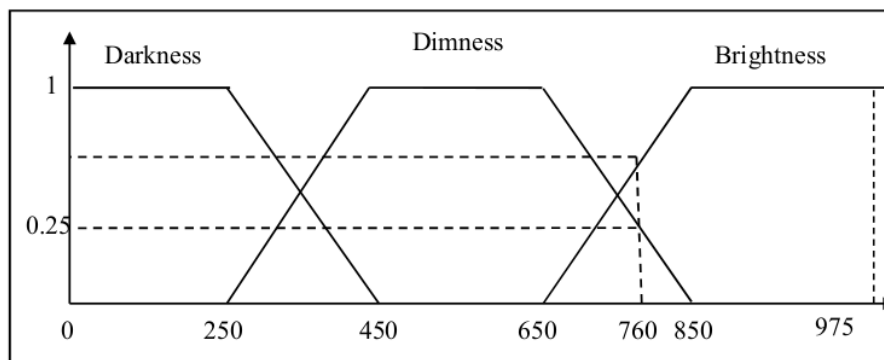


Figure 4. Degree of membership of light intensity 760

Membership value of light intensity (light intensity 760):

$$\begin{aligned} \mu_{Dim} [760] &= (850 - 760) / (850 - 650) & \mu_{Bright} [760] &= (760 - 650) / (850 - 650) \\ &= 90 / 200 & &= 110 / 200 \\ &= 0,4 & &= 0,55 \end{aligned}$$

And the degree of membership of LDR 2 (light intensity 260). $\mu_{Dark} [260]$

$$\begin{aligned} \mu_{Dark} [260] &= (450 - 260) / (450 - 250) & \mu_{Dimness}[260] &= (260 - 250) / (450 - 250) \\ &= 190 / 200 & &= 10 / 200 \\ &= 0,75 & &= 0,05 \end{aligned}$$

And from the degree of membership, there are 9 fuzzy rules as follows Rule:

- IF LDR 1 dark and LDR 2 dark AND Time (o'clock) the solar cell drive will be off.
- IF LDR 1 is dim AND LDR 2 is dark AND THEN time the solar cell drive will move east
- IF bright LDR 1 AND LDR 2 dark AND Time (hours) THEN the solar cell drive will move east.
- IF LDR 1 dark AND LDR 2 dimmer AND Time (hours) THEN the solar cell drive will move west.
- IF LDR 1 dim AND LDR 2 dim AND Time (hours) THEN the solar cell drive will move perpendicularly.
- IF LDR 1 is bright AND LDR 2 is dim AND Time (hours) THEN the solar cell rivewill move east.
- IF LDR 1 dark AND LDR 2 bright AND Time (hours) THEN the solar cell drive will move east.)
- IF LDR 1 is dim AND LDR 2 is bright AND (time) THEN the solar cell drive will move west.
- IF LDR 1 bright AND LDR 2 AND TIME (hours) bright THEN the solar cell drive will move perpendicularly

The application of the AND operator to the membership value to find the weight corresponding to the minimum value.

$$LDR 1 = \{0,4, 0,5\}$$

$$LDR 2 = \{0,05, 0,75\}$$

$$\begin{aligned} LDR 1 \cap LDR 2 &= \{\text{MIN}(0,4,0,75), \text{MIN}(0,5,0,75), \text{MIN}(0,05, 0,75), \text{MIN}(0,05,0,05)\} \\ &= \{0,05, 0,4, 0,5\} \end{aligned}$$

3.2. Defuzzification

After getting the value from the application of AND operator, it is obtained: $f = \{(East), (Perpendicular), (East), (East)\} = \{0,05, 0,4, 0,5\} = 0,4$ (East). Determination of the final results using the Max Method method, namely by taking the highest value of "0.4" with the results of "East". So, if the input LDR 1 = 760 and LDR 2 = 260 then the output is the solar cell drive to the east, with slope angle of 0.049 degrees.

4. Conclusion

The conclusions that can be taken are as follows:

- a. The design of this system uses the LDR sensor and solar cell, where if the LDR sensor detects the presence of sunlight, the solar cell will move following the light detected by the LDR sensor and based on time input.
- b. The fuzzy controller method is applied when the LDR sensor receives light whether it is dark, dim or bright and testing time.
- c. The system will display the motor movement optimally in the direction of sunlight based on the degree of slope and display the time information, rotational speed, direction and degree of motor tilt.

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