Fountains Height Measurement Accuracy With Mamdani Fuzzy Inference System Algorithm

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Abstract. Fountains can be found in gardens or offices. The fountain has several patterns for each activation. The pattern height produced by the fountain greatly affects the beauty of a garden. The purpose of this research is to measure the height of the fountain accurately using the Mamdani Fuzzy Inference System (FIS) method. The input of this research is voltage and volume with the output in the form of the height of the fountain. The output produced in the research is a prototype. The results obtained in this study are in accordance with the tests carried out in the field with three tests with the results of defuzzification or confirmation. The height level of the fountains with a value of 34.6 for a voltage of 10 V and a volume of 20 is included in the MEDIUM category.

1. Introduction

Water fountain is a container produced by humans to beautify a garden with various forms of water jets[1]. In addition, fountains can also be used to filter air so that the air generated around it can avoid air pollution. With many benefits felt by humans, many fountains are found in companies, offices, schools, universities, residences, tourist attractions and others.

Fountains that are widely developed among the public are made manually with simple control. Besides that, the fountain has also been developed using technology. The technology used includes using an Arduino microcontroller as a controller[2][3], and can also be added to control using a smartphone[4].

In this research, the accuracy of the resulting fountain pattern will be determined in creating the desired beauty. The method used is Mamdani's Fuzzy Inference System (FIS)[5]. Mamdani FIS is known as the Min-Max Method which was introduced by Ebrahim Mamdani in 1975. To get the output, 4 stages are required, namely the formation of fuzzy sets (fuzzyfication), application of implication functions, composition of rules, and affirmation (defuzzyfication)[6].

2. Methodology

There are several steps in this research, namely[7]:

...
Based on the picture above, the steps taken are problem identification, literature study, data collection, data analysis, fuzzy mamdani model design and documentation.

Fuzzification of the next process is the process of determining the fuzzy set of predetermined variables, both input and output variables.
Table 2. Fuzzy Set

| Variable      | set  | Domain  | membership function | Parameter      |
|---------------|------|---------|---------------------|----------------|
| Voltage       | Slow | [0.5]   | Left shoulder       | [0;0;2;5]      |
|               |      |         |                     |                |
|               | Normal| [3.7]   | triangl             | [3;5;7]        |
|               |      |         |                     |                |
|               | Fast | [5;10]  | Right shoulder      | [5;8;10;10]    |
| Volume        | Slow | [0;10]  | Left shoulder       | [0;0;4;10]     |
|               |      |         |                     |                |
|               | Normal| [5;15]  | triangl             | [5;10.15]      |
|               |      |         |                     |                |
|               | Fast | [10;20] | Right shoulder      | [10;16;20;20]  |
| Altitude Level| Slow | [0;30]  | Left shoulder       | [0;0;15;30]    |
|               |      |         |                     |                |
|               | Normal| [10;35] | triangl             | [20;30;35]     |
|               |      |         |                     |                |
|               | Fast | [30;37] | Right shoulder      | [30;35;37;37]  |

Rules (Rule) are made to determine the rules that will be used to calculate the suitability of the results with the fuzzy mamdani method where the Min-Max rules apply to this fuzzy method[9].

Table 3. Formed Rules

| No | Langkah |
|----|---------|
| [R1] | If (voltage is slow) and (volume is slow) then (Altitude level is low). |
| [R2] | If (voltage is slow) and (volume is medium) then (Altitude level is low). |
| [R3] | If (voltage is slow) and (volume is medium) then (Altitude level is low). |
| [R4] | If (voltage is normal) and (volume is slow) then (Altitude level is medium). |
| [R5] | If (voltage is normal) and (volume is medium) then (Altitude level is medium). |
| [R6] | If (voltage is normal) and (volume is medium) then (Altitude level is medium). |
| [R7] | If (voltage is fast) and (volume is slow) then (Altitude level is high). |
| [R8] | If (voltage is fast) and (volume is medium) then (Altitude level is high). |
| [R9] | If (voltage is fast) and (volume is hard) then (Altitude level is high). |

Defuzzication with the mamdani method the method used is the centroid method, a method also known as the Center Of Area (CoA) or Center Of Graphity (CoG), taking the center point (z*) of the fuzzy area[10].

3. Result and Discussion

In this study, data will be entered into Matlab with the FIS editor sheet, Membership function, Rule Editor to enter existing rules. From the values obtained, and tested the results of the output tend to match the field results. As an example in the case below: If the voltage in the room is 3v and the speaker volume is 8, the height of the fountains is:

[R1] : If (voltage is slow) and (volume is slow) then (Altitude level is low).
\[\alpha_{-predikat1} = \min (\mu_{slow}(0.7), \mu_{slow}(0.2)) = \min (0.7, 0.2) = 0.2\]

[R2] : If (voltage is slow) and (volume is medium) then (Altitude level is medium).
\[\alpha_{-predikat1} = \min (\mu_{slow}(0.3), \mu_{medium}(0.7)) = \min (0.3, 0.7) = 0.3\]
[R4]: If (voltage is normal) and (volume is slow) then (Altitude level is medium).

\[ \alpha \text{-predikat} = \min (\mu_{\text{normal}}(0.5), \mu_{\text{slow}}(0.3)) \]

\[ = \min(0.3, 0.5) \]

\[ = 0.3 \]

Defuzzification

\[ Z = 34.6 \]

So the result of the strict set above states that the height level of fountains = 34.6 belongs to the MEDIUM category. From the manual calculations obtained, it will be tested with a tool made and proven by Matlab, namely by utilizing the pump voltage[11] and speaker volume.

Testing: If the pump voltage = 10 v and the speaker volume is 20

Figure 3. Testing 3 tool
Figure 4. Defuzzification Results

Based on the test results of the tool system and matlab testing, the status of the altitude level = 34.6 (MEDIUM)

4. Conclusion
After conducting the research, it can be concluded that this research works well, namely that the water discharged through the pump does not come out of the prototype. The fountain height pattern is accompanied by the volume that comes out of the speakers. The resulting height level of the fountain is as expected, namely with a medium level fountain with a value of 34.6.
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