# A Systematic Approach to Compute Wash Time for Washing Machine by using Fuzzy Logic Control System

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*Abstract*— Fuzzy logic controller follows the principle of fuzzy logic, where the truth values of variables maybe 0 or 1. A fuzzy logic controller is used to compute wash time of a washing machine by combining and integrating three independent criteria to calculate a precise wash time. The proposed controller employs the use of membership functions for the fuzzification and defuzzification processes, which converts the fuzzy input values to a crisp output value.

*Key words:* Fuzzy Logic, Membership Function, Crisp Value

## I. INTRODUCTION

Washing machines are one of the most common and essential needs in our livelihood. Which Is used to wash laundry such as clothing and sheets. Laundering by hand involves soaking, beating, scrubbing, and rinsing dirty textiles, which is a tedious and a time consuming process. Hence, washing machine is an automated machine which helps in saving our time. While operating the washing machine it is seen that washing different types of clothes requires different amount of washing time. Therefore, we have implemented fuzzy logic in the working of a washing machine.

Fuzzy logic, in case of a washing machine, employs sensors to judge varying conditions inside the machine and adjusts its operation accordingly. So essentially, there are sensors in the washing machine that will control the entire washing process, performing operations according to varying water intake, washing time, rinse performance, and spin speed. The inputs taken into consideration are amount of clothes, degree of dirt and type of dirt which determines the output (washing time).

## II. PROBLEM DEFINITION

When one uses a washing machine, he or she selects the wash time based upon the type of dirt, degree of dirt the clothes have and the amount of clothes he or she wants to wash. Since there is no possible mathematical relation between type of dirt, degree of dirt, amount of clothes and wash time, this became a trial and error technique by setting the wash time by hand. The washing machine is not asautomatic as it could be. To improve the efficiency of this system, sensors are used to detect these parameters. The sensor provides external input signals through which the washing machine then makes decisions. Fuzzy logic is used in washing machine controllers as it gives the correct washing time even though a precise input/output model is not available.

## III. PROBLEM ANALYSIS

The problem is analyzed based on the factors that affect wash time. In this study we have considered the following inputs-
1) Quantity of clothes
2) Type of dirt
3) Degree of dirt
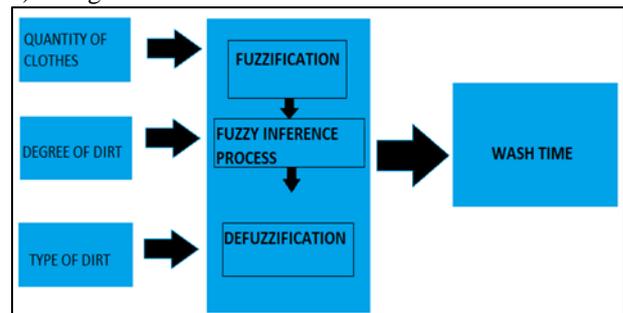


The input parameters were selected based on trials and past experiences. The figure shows the basic approach to the problem. The fuzzy controller takes three inputs, processes the information outputs a wash time. Howthese three inputs are acquired are left to the sensors. We assume that we have the mentioned three inputs with us beforehand.

Quantity of clothes plays a pivotal role in deciding how clean the clothes come out, for a larger quantity of clothes a larger wash time will be required. The degree of dirt is determined by the transparency of the wash water. The dirtier the clothes, less transparent the water being analyzed by the sensors will be. Alternatively, the type of dirt is determined the time it takes to reach saturation. Saturation is a point, at which there is no more appreciable change in the colour of the water. Degree of dirt determines how dirty a cloth is, while, type of dirt determines the quality of dirt. Greasy cloths, for example, take longer for water to reach transparency because grease is less soluble in water than other forms of dirt. Thus a fairly straight forward sensor system can provide us the necessary input for the fuzzy controller.

## IV. DESIGN OF FUZZY CONTROLLER

The proposed fuzzy logic controller for washing machine has 3 linguistic inputs-
− Quantity of clothes
− Type of dirt
− Degree of dirt

These inputs provide one linguistic output- wash time. The first step in the fuzzy controller is-

## A. Fuzzification

In a fuzzy controller unit, the input and output variables are determined beforehand. The membership function creates a relationship between crisp and fuzzy values. Generally, fuzzification involves two processes: derive the membership functions for input and output variables and represent them with linguistic variables. This is equivalent to converting or mapping classical set to fuzzy set to varying degrees. The membership function has a triangular waveform. The following figures explain the relation between the membership functions and each of the input and output variable
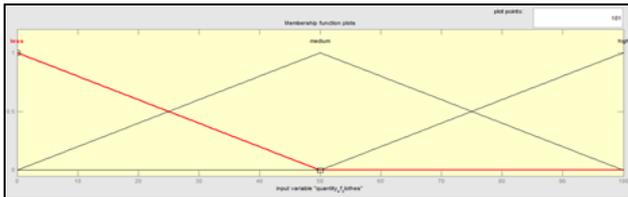


Fig. 1(a): Membership function for input variable quantity of clothes
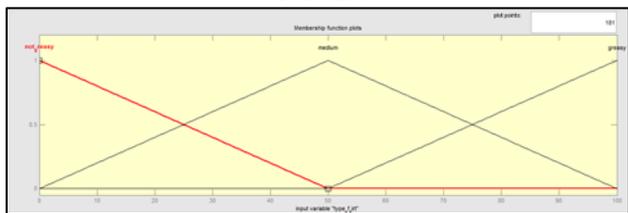


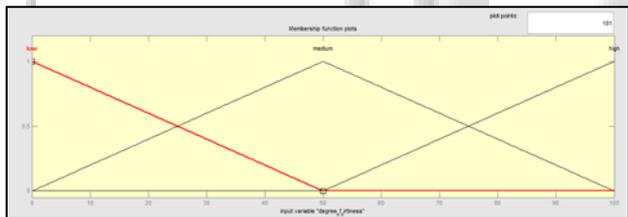Fig. 1(b): Membership function for input variable type of dirt



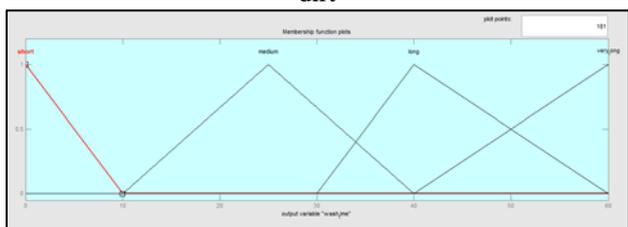Fig. 1(c): Membership function for input variable degree of dirt



Fig.1 (d): Membership function for output variable wash time

So for example, when we consider the quantity of clothes. Lets say 40 clothes are considered, it can be read as: 15% less and 85% medium

## B. Fuzzy Inference Process

The fuzzy inference process uses the fuzzy input and the inference rules created to create a fuzzy output. A table containing all possible input combinations and corresponding output is created. From the table IF-THEN rules are created, it is combined with the fuzzy input to create an output. The output wash times for the combination inputs are based on experience and research.

| Sl No | Quantity Of Clothes | Degree Of Dirt | Type Of Dirt | Wash Time (O/P) |
|---|---|---|---|---|
| 1. | Less | low | Not Greasy | Short |
| 2. | Medium | low | Not Greasy | Medium |
| 3. | High | low | Not Greasy | Medium |
| 4. | Less | Medium | Medium | Medium |
| 5. | Medium | Medium | Medium | Long |
| 6. | High | Medium | Medium | Very Long |
| 7. | Less | High | Greasy | Short |
| 8. | Medium | High | Greasy | Medium |
| 9. | High | High | Greasy | Very Long |
| 10. | Less | low | Medium | Short |
| 11. | Medium | low | Medium | Medium |
| 12. | High | low | Medium | Medium |
| 13. | Less | low | Greasy | Medium |
| 14. | Medium | low | Greasy | Medium |
| 15. | High | low | Greasy | Very Long |
| 16. | Less | Medium | Not Greasy | Short |
| 17. | Medium | Medium | Not Greasy | Medium |
| 18. | High | Medium | Not Greasy | Long |
| 19. | Less | Medium | Greasy | Long |
| 20. | Medium | Medium | Greasy | Medium |
| 21. | High | Medium | Greasy | Long |
| 22. | Less | High | Not Greasy | Less |
| 23. | Medium | High | Not Greasy | Medium |
| 24. | High | High | Not Greasy | Long |
| 25. | Less | High | Medium | Long |
| 26. | Medium | High | Medium | Long |
| 27. | High | High | Medium | Very Long |

The rules are defined as follows:

*1) Rule 1:*

IF(Quantity of clothes is Less) and (Degree of dirt is Low) and (Type of dirt is Not greasy) THEN (Wash time is Very short)

*2) Rule 2:*

IF(Quantity of clothes is Medium) and (Degree of dirt is Low) and (Type of dirt is Not greasy) THEN (Wash time is Short).

*3) Rule 3:*

IF(Quantity of clothes is High) and (Degree of dirt is Low) and (Type of dirt is Not greasy) THEN (Wash time is Medium).

*4) Rule 4:*

IF(Quantity of clothes is Less) and (Degree of dirt is Medium) and (Type of dirt is Not greasy) THEN (Wash time is Medium).

*5) Rule 26:*

IF(Quantity of clothes is Medium) and (Degree of dirt is High) and (Type of dirt is Greasy) THEN (Wash time is Long).

*6) Rule 27:*

IF(Quantity of clothes is High) and (Degree of dirt is High) and (Type of dirt is Greasy) THEN (Wash time is Very long).

*C. Defuzzification*

The result obtained from fuzzy inference technique is then processed to produce a quantifiable result i.e. the wash time. Defuzzification process is used to interpret the membership degrees of the fuzzy sets in some specific real value. Centroid method is used for defuzzification to get a scalar output value for the actual duration of the wash cycle from the output function obtained. The product of defuzzification is the lookup table. Defuzzification needs to be performed for each subset of a membership function, both inputs and outputs. For instance, one needs to perform defuzzification for each subset of quantity of clothes input such as LESS, MEDIUM and HIGH based on the associated fuzzy rules. The defuzzification result for each subset needs to be stored in the associated location in the lookup table.
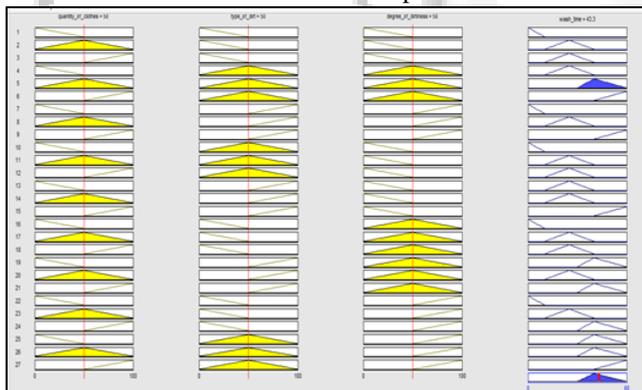

Fig. 2: System Rules

## V. RESULT

The output response surfaces are plotted by the software and a particular wash time can be plotted for any two given inputs at the same time. For example, when the quantity of clothes and degree of dirt is 50, the wash time is 43.3 minutes.

The response surface provide the output wash time of any two inputs at any given time. The inputs are along the X and Y axis and the output wash time along the axis.
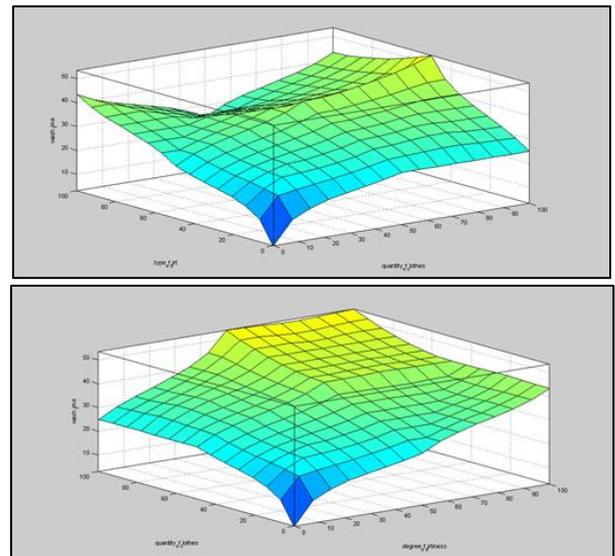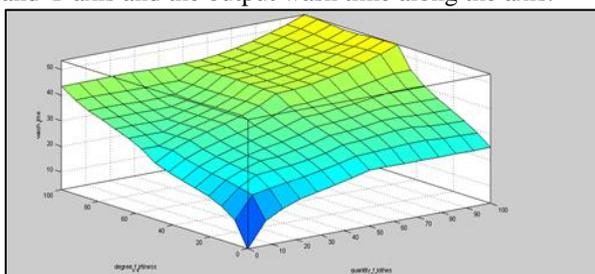



Fig. 3: Response surface of the inputs and output

## VI. CONCLUSION

By the use of fuzzy logic control we have been able to obtain a wash time based on the type of dirt, degree of dirt and quantity of clothes. Conventionally, this would require a human to decide the wash time based in prior knowledge. Here the machine analysis the situation which makes it more automatic and gives it the decision making ability. The sensors sense the input values and fuzzifies it by using if-else statement and other fuzzy set operations.

## VII. SCOPE

In this paper we have emphasized on three inputs which mainly include Quantity of clothes, degree of dirt and type of dirt constituting to one output i.e., the wash time. Which optimizes the life span of the washing machine? Fuzzy logic checks for the extent of dirt and grease, the amount of soap and water to add, direction of spin, and so on. To Optimize the life span of the washing machine further four or more inputs can be taken such as Quantity of clothes, Quality of clothes, Type of clothes, degree of dirt and type of dirt and two respective outputs can be considered such as washing time and washing intensity/speed.

REFERENCES

[1] Ying Bai and Dali Wang, "Fundamentals of Fuzzy Logic Control- Fuzzy Sets, Fuzzy Rules and Defuzzification".

[2] Manish Agarwal,"Fuzzy Logic Control of Washing machines", "Research Gate".

[3] Yousuf Haider and Deepak Kumar, "Fuzzy Logic Based Control System for Washing machines", "International Journal Of Computer Science And Technology", Vol:4, 2013, PP 198-200.

[4] FuzzyLogicin Washing machine (www.samsung.com)

[5] Sudha Hatagar and S.V. Halase, "Three Input- One output Fuzzy logic control of Washing Machine", "International Journal Of Scientific Research Engineering & Technology", Vol:4, 2015,PP 57-62.