A Review on Washing Machine Using Fuzzy Logic Controller

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ABSTRACT

The Paper describes a study of washing machine using fuzzy logic controller as compare to conventional washing machine.Now a days Fuzzy logic washing machines are gaining popularity. Washing machine which don't use fuzzy controller serves most purpose of washing function but wash time is somewhat not dealt properly but machines that employ fuzzy control are able to calculate the effect of a number of variables and decide the right settings for the wash. These machines offer the advantages of performance, productivity, simplicity and less cost.

Key words: Fuzzy Logic Controller, MATLAB, Linguistic Input, Linguistic Output, Membership Function.

1. INTRODUCTION

Washing machines are one of the most common household appliances found today. Conventional, proportional, integral and differential [PID] controllers have proven to be less capable so fuzzy logic enables designers to control complex systems more effectively than traditional approaches.

The essence of such a machine is to reduce the workload and effectively provide cleaner clothes. In terms to prove the cleanliness of clothes the washing machine manufacturers are striving towards a fully automated sensor operated machines which can completely sense the amount of wash load, the amount of dirtiness of the clothes and the type of material in the current wash cycle so as to directly predict the wash time required. The wash sensor can be a simple optical sensor used to measure the physical quantity of light, passed through a glass tube, which can then be converted to electrical signals to predict the amount of dirtiness [10].

The users of washing machines have been facing the problem of selecting the length of wash time based on the type of clothes, type of dirt, dirtiness of clothes and amount of clothes. Most of the people find it very difficult to decide that which cloth needs what amount of washing time. To overcome these problems fully-automatic washing machines based on fuzzy logic offers the advantage of performance, simplicity and less cost.

In this paper, we have discussed the latest growth in washing machine based on Fuzzy technology provide ability of machine even learn from past experience, memorizing programs and adjusting them to minimize running cost.

2. LITERATURE REVIEW

Fuzzy Logic: In 1965 the concept of fuzzy logic was first conceived by Professor Lotfi A. Zadeh University of California, Berkeley [1]. Fuzzy logic is powerful design philosophy for describing and developing control systems which provides simple and intuitive method for design engineers to implement complex systems. [2] Fuzzy logic systems allows for an input to exist with varying degree at more than one state at a time and hence allows the engineers to describe the system in more than natural terms. [3]

Fuzzy Logic Controller and Its Applications: Fuzzy Controllers, [4] as compare to classical controllers are capable of utilizing knowledge elicited from human decisions or human operators. Fuzzy Logic Controller for Gas Heater was designed using behavioral modeling and then these modules are connected via structural VHDL to control "Valve Angle." [5]

The fuzzy logic controller for Liquid Level Control was designed using MATLAB for controlling "Valve" and compared with the PID controller. The comparison results show that fuzzy logic controller significantly reduced overshoots and steady state error. [6]

In 2007, the Fuzzy Inference is used for determining Wash time. In this design MF used was triangular; the inputs of the Fuzzy Controller were Change of Turbidity, the output was Washing Time. [7] In 2009, Pritesh Lohani, proposed "An improved Controller Microchip for Washing Machine" that comprises of three LIs i.e. Types of Dirt, Dirtiness of Clothes and Mass of Clothes and the LO Wash Time with 25 rules. [8] In 2011, Manish Aggarwal, proposed the Fuzzy Logic Control for Washing Machine having two inputs type of Dirt and different Degree of Dirt and the output was Wash Time with the inference engine which provides 9 rules for the FLC. The input-output relation is determined by using Fuzzy Interface Unit. [9]

3. FUZZY CONTROL OF WASHING MACHINES

In the past, a user had to select the type of wash in a washing machine manually; the amount of water and the duration of the wash cycle had to be keyed in before the washing process began. Today, automatic washing machines employ what is known as fuzzy logic to automate this process. Fuzzy logic is a mathematical system that is capable of analysing analog input values and converting them into logical variables.

Fuzzy logic is an important development in washing machines as it helps save water. Machines that employ fuzzy control are able to calculate the effect of a number of variables and decide the right settings for the wash. The variables that fuzzy control evaluates in a washing machine include the weight of the clothes in the machine, the type of dirt, water and electricity required for an optimal wash.

Fuzzy Logic Structure-

The basic elements of fuzzy logic; Fuzzy inputs, outputs, rules and defuzzification; are shown in figure 1.

Fuzzy take the information from a system; which is in normal language; and converts it to values. The values of input quantities, which are associated with of membership functions, are given in form of words such as small, smallest [11].

Input and output variables of fuzzy system are determined and their values i.e. less, much, hot and cold etc. are being selected. Afterwards, rules are being developed and by using those rules input and output relationship is developed.
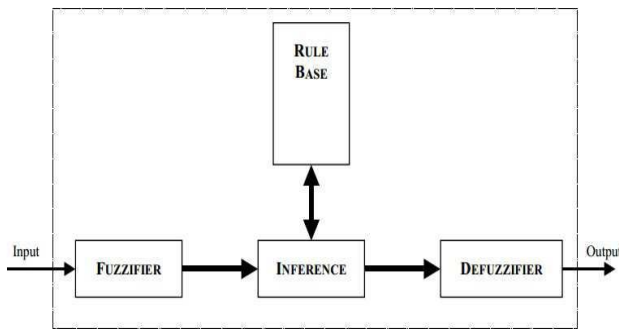
Figure: 1 Structure of a fuzzy logic system

Outputs are being produced by using fuzzified inputs and rules which are being determined. Those fuzzified outputs must be converted to real values so that they can be used in real systems. This whole process is known is defuzzification. [12]

4. DEVELOPMENT OF FUZZY CONTROLLERS FOR WASHING MACHINE

When one uses a washing machine, the person generally select the length of wash time based on the amount of clothes he/she wish to wash and the type and degree of dirt cloths have.

Mohammed Alhanjouri, and Ahmed A. Alhaddad [13] proposed a paper to optimize wash time of washing machine using fuzzy logic. They described the procedure that can be used to get a suitable washing time for different cloths by using only two variables.
The two inputs are:
1. Degree of dirt
2. Type of dirt

Figure (2) shows the basic approach to the problem. The fuzzy controller takes two inputs (as stated for simplification), processes the information and outputs a wash time. How to get these two inputs can be left to the sensors (optical, electrical or any type).We assume that we have these inputs at our hand. The degree of dirt is determined by the transparency of the wash water. The dirtier the clothes, less transparent the water being analysed by the sensors is. On the other hand, type of dirt is determined by the time of saturation, the time it takes to reach saturation. Saturation is a point, at which there is no more appreciable change in the color of the water.

Degree of dirt determines how much dirty a cloth is. Whereas type of dirt determines the quality of dirt. Greasy cloths, for example, take longer for water transparency 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 our fuzzy controller.
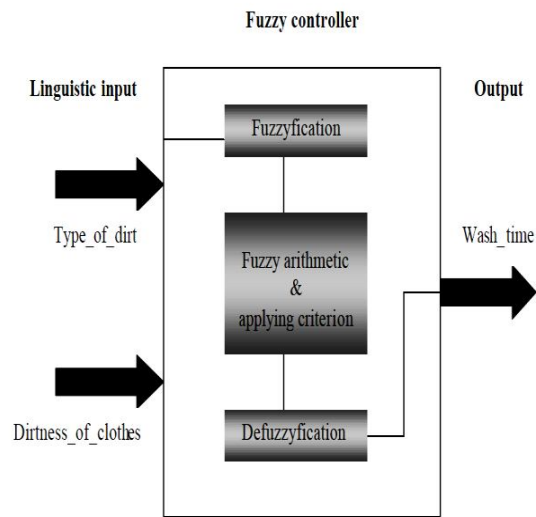
Figure: 2 FLC for Washing Machine

Sudha Hatagar1 and S.V. Halase[14] have proposed the design of fuzzy logic controller having three inputs to give correct wash time of washing machine. The objective is to save lot of time, electricity and water for washing the cloth.

The proposed Fuzzy Logic Controller for washing machine consists of three Linguistic Inputs i.e.
1. Types-of-clothes
2. Type-of-dirt
3. Dirtiness-of-clothes

All the above LIs control the one LO i.e. wash time.
The proposed Fuzzy Logic Controller inference engine is designed using 27 rules for Wash Time.
Every Linguistic inputs and outputs has a set of membership functions. The MF used for all LIs and LOs is triangular MF.

The X-axis of all the MF graphs represents the LI values which are obtained from the sensors and it ranges from 0 to 1 up to first whereas the Y-axis of all MF graph denotes the degree of membership function.

Here the sensors sense the input values and using the above Model the inputs are fuzzyfied and then by using simple if-else rules and other simple fuzzy set operations the output fuzzy function is obtained and using the criteria the output value for wash time is obtained. Figure3. shows the response surface of the input output relations as determined by fuzzy interface unit.
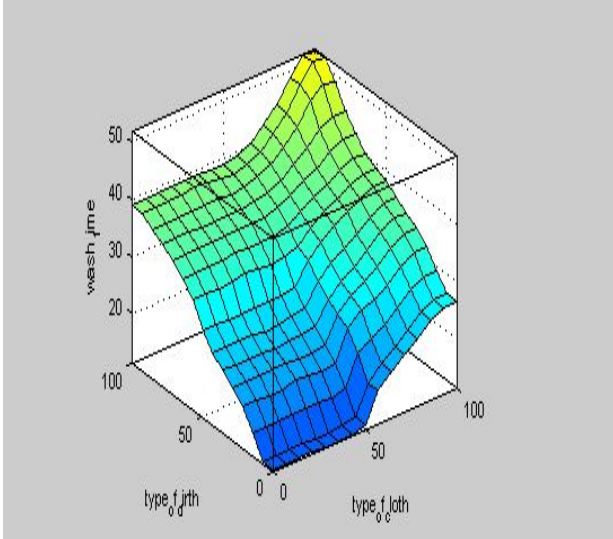

Figure: 3 Response surface of the input output relations

 Suchitra &, Naveen Kumar Malik[15] introduced five input variables and three output fuzzy logic controller to get correct wash time, rinse time and spin time. Fuzzy logic toolbox in MATLAB is used for FLC simulation.

The proposed Fuzzy Logic Controller for washing machine consists of five Linguistic Inputs i.e.

1. Type-of-dirt
2. Dirtiness-of-clothes
3. Types-of-clothes
4. Mass-of clothes
5. Temperature

All the above LIs control the three LO i.e.
1. Wash time
2. Rinse time
3. Spin time

The proposed Fuzzy Logic Controller inference engine is designed using 216 rules for Wash Time, 216 rules for rinse period and 25 rules for Spin Period.
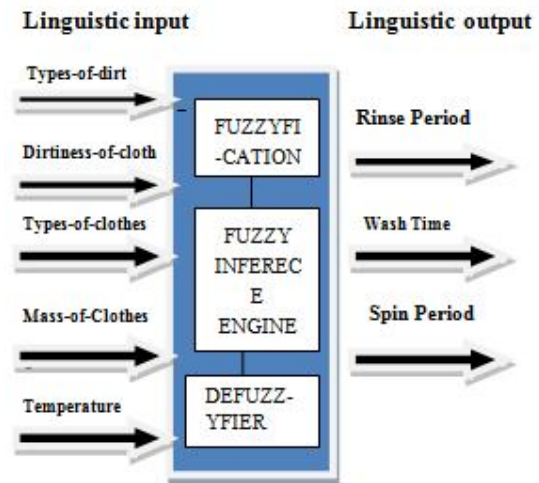

Figure: 4 FLC for Washing Machine

Figure 4 shows the basic approach to the proposed FLC. Fuzzy Logic Controller for Washing Machine consists of mainly three blocks i.e. Fuzzifier, Fuzzy Rule select and defuzzifier.

Fuzzifier: To deal with the details of fuzzy logic controller, the values for the input and output variables are determined in advanced. There is membership function which is used to map the crisp input values to the fuzzy values and after that suitable operation is applied on them. The process which converts crisp value in fuzzy value is known as fuzzification and fuzzifier is used for performing the fuzzification.

Fuzzy Rule Select: The decisions made by fuzzy logic controller are derived from the rules known as fuzzy rules.

Defuzzification: The result obtained from fuzzy inference technique is then processed to produce a quantifiable result i.e. the total time it takes to wash the clothes (Wash Time), it takes to rinse the clothes (Rinse Period) and finally to spin the clothes (Spin Period). Defuzzification process is used to interpret the membership degrees of the fuzzy sets in some specific real value (i.e. in crisp value opposite to that Fuzzification do). Centroid method is used for defuzzification.

By the use of proposed fuzzy logic Controller, we have been able to obtain different Wash Time, Rinse Period, Spin Period (output Variable) for different Type of Dirt, Dirtiness of Clothes, Types of Clothes, Mass of Clothes and Temperature (Input Variable).

This proposed advance and automatic sensor system based Washing Machine depicts the advantage of Fuzzy Logic Controller in the conventional Washing Machine.

To summaries, the benefits of fuzzy controller for washing machine are as follows-

Fuzzy controller are most than other type of controllers because they can cover a wide range of operating condition than PID controllers and can operate with noise and disturbances of different nature (Reznik,1997).

Fuzzy based controllers are cheaper to develop than a model based or other controller to do the same thing.

Fuzzy controllers are customizable, since it is easier to understand and modify their rules, which not only use human operator's strategy but also expressed in linguistic terms.

Operation, application and design of fuzzy controller are easy to learn (Reznik, 1997).

5. CONCLUSION

We discussed the various types of fuzzy controllers having different types of input and output lead to get precise wash time and reduce energy cost and lot of time. The conventional method required the human interruption to decide upon what should be the wash time for different cloths which makes the machine much more automatic and represents the decision taking power of the machine. A more fully automatic washing machine is straightforward to design using fuzzy logic technology in future.

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