



Fuzzy Logic Controller for Home Washing Machine Automation

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Abstract - Home Washing machine automation has achieved great popularity in the last decades in the research field and it has increased the comfort and the quality of life. Washing machine automation system is growing area of interest for industries because they have a measurable impact on quality of life and the value of the product. So in order to prevent more consumption of electricity, reduce time and use less water in washing machine it is obligatory to have command on washing machine system. In this case study the author has used four separate inputs for the determination of washing velocity and three separate inputs for stability of speed of motor using fuzzy controller. The output of this process is washing speed in washing speed controlled system and this output is the input for the motor stability controlled system.

Key Words: Fuzzy logic controller, MATLAB, Fuzzy rules, Washing speed, Smart washing machine.

1. INTRODUCTION

Washing machine is one of the important machines in the day to day usage at home. During early stage of washing machine, it was used manually by operating timer. In the current period fuzzy logic is being used as a controller in washing machine. The fuzzy system updates its parameters on each control cycle that is why we use fuzzy controller system instead of P.I.D controller system. It is very difficult to obtain a constant value of P, I and D for PID controller to get required output. So in this case study the author has developed an advance washing machine which is capable of consuming less energy, reduce time and so on.

2. RELATED WORK

There are many research done by the researchers on the washing machine automation using fuzzy controllers like[1] one research was based on the fuzzy logic controller having five inputs that is types of dirtiness, dirt of cloth, type of clothes, mass of clothes and temperature to give three output which are spin time, rinse and wash. Fuzzy Logic Toolbox of

MATLAB is used in this case study. The purpose was to save the time, energy and water.[2] Other research is done to do the washing work in less time by improving the FLC system.[3] Other research was based on the two input that is saturation time and dirtiness to give one output that is wash time.[4] Another research was based on five inputs which gives five outputs. The concept of the researchers are same that is to save energy, time and water.[5] Other researcher started using microcontroller as predetermined time in washing machine with the evolving technology.[6] Other researchers started using the PID controller for fuzzy control system because it is easy to operate. [7] Other researchers used smart artificial intelligence with FLC system based washing machine which enables us to get desired output.

3. OUR WORK

In this case study, fuzzy logic is used by the author in order to build and to create a washing machine. The main aim of this case study is to design a washing machine which is operated under fuzzy logic controller. Different type of impurities, impurities level, weight of clothing and the clothing sensitivity, different washing rate are main parameters. The main feature of this research that is different from other research is that the output value of the velocity control system is get into the motor stability control system.

Error and derror is another input in proposed method. The main purpose of using the fuzzy controllers is also used to induction motor used in washing machine in order to maintain constant speed. Based on the washing speed level of dirtiness, defilement type and the weight input of the clothing and clothing sensitivity are the important controlled parameters. In this case study the output of the speed-controlled system transfer to the system called motor stability control system. The system also includes two inputs that is error and derror that will not be affected by output from motor stability control system.

If we want a smart working washing machine that can adjust itself automatically then we have to use Fuzzy logic controller system. With the help of fuzzy controller system we can easily access the complex system which is very difficult to access by conventional controllers. The structure is given in figure 1.

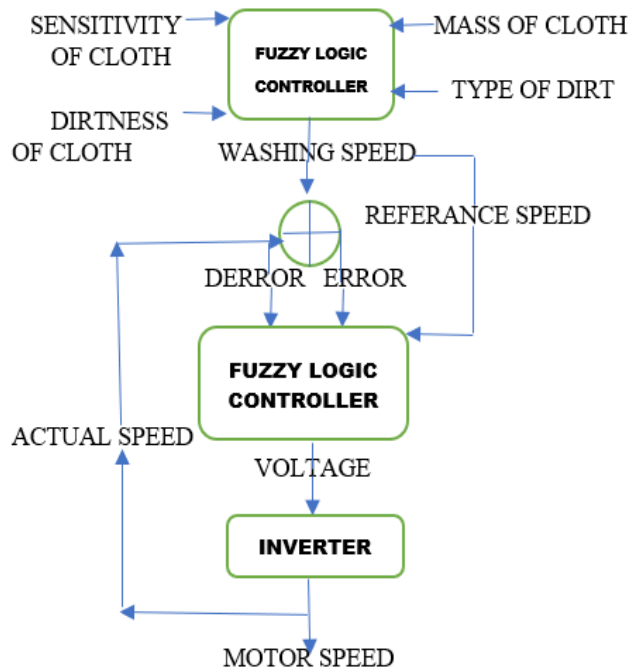


Figure 1- Fuzzy controlled system structure

Mapping technique is used so as to convert the technical value into fuzzy value of input variables into truth values and membership function. Membership function is a kind showing the mapping of data input points into membership value that have intervals between 0 and 1 (15). The membership value is given by the sets of membership function. Triangular, trapezoidal are some of the other membership function. All the fuzzy is linked with one another. Usually IF-Else form is used in general fuzzy rules. The composition of fuzzy rules provide us the fuzzy set by the input of fuzzification process and we get output in the form of number in fuzzy set domain.

In this case study the author has used MATLAB software in fuzzy logic controller Simulink in order to have the control system simulation and to create a model using fuzzy logic system as shown in figure 2.

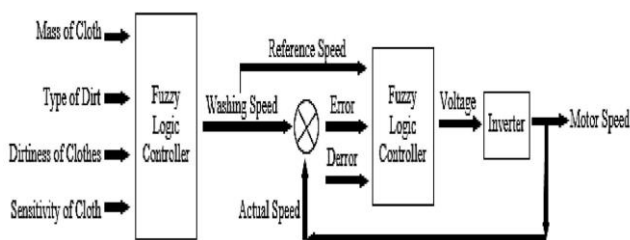


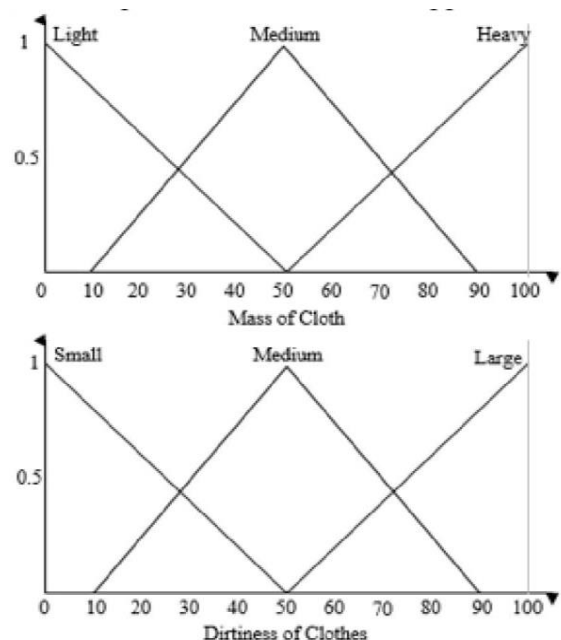
Figure 2- Proposed method

The model proposed by the author has two different system, both of them using fuzzy logic control system. Talking about the first fuzzy logic system which has four inputs which can be added automatically and manually with the help of available sensors. This output from the initial task is considered as the backing velocity for the next second task input. The function of the secondary system is to regulate motor speed stability. The second system uses three inputs that is reference speed from first system and the other are error and error. The second system gives the output as a control voltage so as to run the motor of the inverter.

The first task is to identify output and input using fuzzy logic system. In the first system the needed output is washing speed. Each output and input is positioned into the membership function. After that output function and input function is provided the lower and upper limits. The total 81 rules are required for IF-THEN rule base. In this case study for the defuzzification, center of gravity method is used. The method used in this case study is the Mamdani method.

According to different inputs that is the different type of impurities, impurities level, weight of clothing and the clothing sensitivity, different washing rate can be observed using fuzzy controllers. To stabilize. So according to the reference value of speed, the speed remains constant because of the output voltage given by the speed of induction motor.

Membership functions has both the sets that is output and input. Triangular membership function is used in this case study. It can be clearly seen in figure shown and also upper and lower limit.



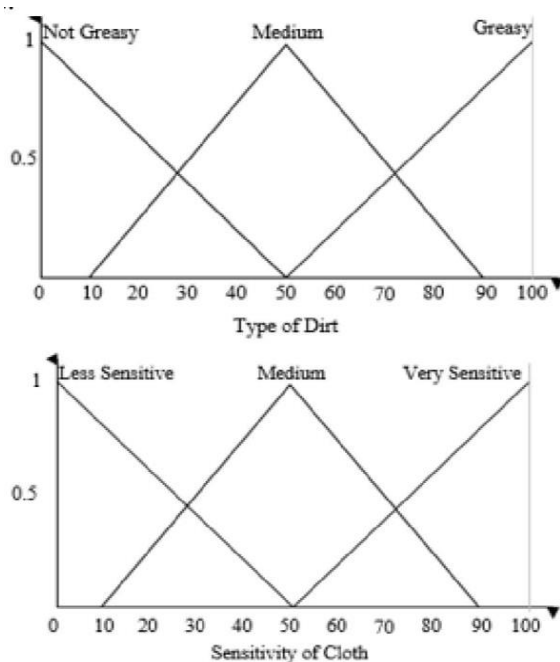


Figure 3- Input Membership Function

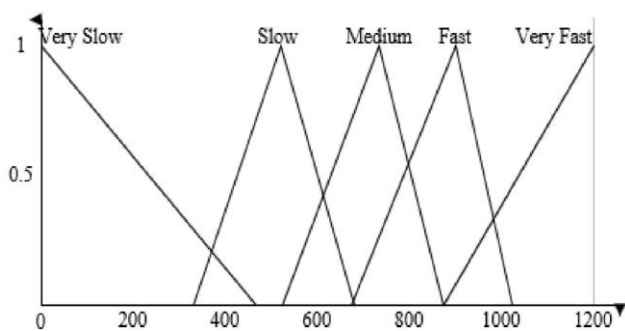


Figure 4- Output Membership Function

After the determination of lower and upper limit and the membership function, the total 81 IF-THEN RULE is used. The result obtained are shown in table below.

Table 1. If-Then Rule base required is 81 rules.

No	MoC	ToD	DoC	SoC	WS
1	Lt	NG	S	VS	VS
2	Lt	NG	S	M	S
3	Lt	NG	S	LS	M
4	Lt	NG	M	VS	S
5	Lt	NG	M	M	M
6	Lt	NG	M	LS	F
7	Lt	NG	Le	VS	M
8	Lt	NG	Le	M	F
9	Lt	NG	Le	LS	VF
10	Lt	M	S	VS	S
...	...	...	...	...	...
81	H	G	Le	LS	VF

In this case study for the defuzzification ,center of gravity method is used . The method used in this case study is the Mamdani method. With the help of center point fuzzy area , the value of crisp output is obtained. It is then forwarded to next system.

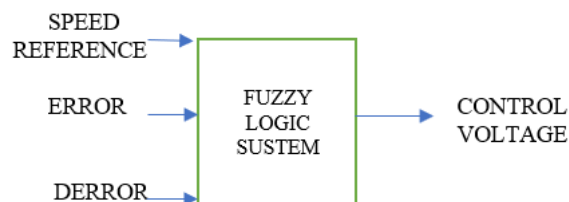


Figure 5- Fuzzy Controller for induction motor speed

So in this system, error, error and reference speed are input parameters. The previous system output gives us the reference speed. The Error is defined as the difference between set point speed and actual speed and the error is defined as the current error with the previous error. So in this triangular and trapezoidal membership function is used.

4. CONCLUSIONS

This case study presents fuzzy logic controller of Mamdani type. The results of the case study reveal the way how a washing machine will respond in different situation. Introduction of fuzzy controllers can help improvement in automation system of washing machine and can help to decrease the consumption the electricity, usage water and also help to decrease the time required. In the conventional washing machine, the fuzzy controller are advanced and automation sensor system based washing machine.

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BIOGRAPHIES



Bhavesh Fulewale is a student of Mechanical Engineering in the department of mechanical engineering YCCE Nagpur and has actively taken part in research fields pertaining to fuzzy logic controller for washing machine home automation.



Dr . Shubhangi Rathkanthiwar has a career in teaching that has spanned over 33 years of teaching experience and she is specialist in the field of Signal Processing in Embedded systems, IoT modules in telemedicine, Artificial neural networks, Wireless Communications, etc. She has published more the hundred papers in many international journals and has six books, five book chapters, three patent applications granted by Government of India, eight. She is currently working as professor in Y.C.C.E Nagpur. Dr. Rathkanthiwar has received many awards and they are', 'Best scientist Award-2017', 'Best research paper award' (2011), 'Best Teacher award' (2010) and and National level. She was nominated for awards in many international universities. For presenting research and academic collaboration she has visited my other countries.



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