An intelligent washing machine using fuzzy logic inference model

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Abstract

Present washing machine cannot foretell the correct spinning speed for washing different type of cloth, type of dirtiness and type of dirt. This work aimed to design and implement intelligent washing machine using fuzzy logic inference model that will checks for the extent of dirt, and dirtiness of cloth and then select the appropriate spinning speed. The four experimental analysis performed for various washing time for different cloth for the improved system are (19.3 min, 19.5min, 30min, and 30mins) while the washing time for the existing system are (30.9min, 35.1min, 42.5 and 51.4) respectively. The result from the four experimental analysis shows that the proposed system reduced washing time for different cloths.

Key words: Fuzzification, Defuzzification, **Control system,Membership function,** Linguistic *variable*

Introduction

Automatic washing machine is a type of machine whose load is wholly handled by the device. In recent time, washing machine allows users to choose the wash interval established on the parameters like quantity of clothes, the nature of cloths or dirtiness of the cloths. The wash period of the machine is then ascertained by the machine. Regrettably, there is no simple way to create a mathematical connection among size of clothes and nature of dirt as well as the required span of wash period. Therefore, this issue has continued to be unsolved till very lately. As a result, users manually set wash times which is typically based on individual trial or from their error experience. Sincerely, washing machineries utilized now were not as programmed as they ought to be. The use of sensors devices was applied to mechanize this device so as to detect the input parameter (i.e. type of clothes, dirtiness of the cloth and type of dirt). The fuzzy controller has the duty of creating the decisions in the device and the decision is signal outside to the user as an output. Since the output/input association has not be strong, designing washing machine regulator has not being a success in the previous using classic means of control design [1]. In this paper is gear toward using fuzzy logic regulator to provide with the exact wash period even when an accurate model of output/input association is not obtainable. The Improved Fuzzy logic washing machine will made functions of washing machines more economical, energy-saving and less time-consuming.

i. Literature review

[2] developed Fuzzy Logic control for Washing Device. Their fuzzy logic regulator was built using dissimilar degree of dirt and type of dirt as input to obtain the system wash time. But they were not able to extend control for other parameter like spinning speed and water level.

Fuzzy controller neural network for washing Machine was projected by[3]. His model was built using fuzzy logic concept, neural network and its learning algorithm to reduce wasting of electricity and water. The parameters used were water level, flow intensity and the system output is wash time.

A fuzzy logic control system was proposed by [1] to optimize washing period for washing device. They address the design problem for washing machine by using fuzzy logic. Their results showed that with Fuzzy logic controller gives accurate wash interval for washing device ever without clear output and input relationship model. They also could not extend control for parameter like water level and spinning speed.

A Fuzzy logic controller for washing Machine was proposed using arduino by [4]They were capable to obtain the system wash time and also recommended that the design can be protracted without much difficulties to other parameters like spinning speed and water level.

[5] proposed Fuzzy logic system for Washing Device. They show the performance Analysis for the system utilizing Five Input and Three Output. Their objectives were to save a lot of electricity, water and time for washing the cloth. Their proposed FLC was simulated using MATLAB simulation language. The result calculated the wash period, rinse time and spin time.

A neruo-fuzzy controller for washing device using four inputs was proposed by [6].The input factors were: type of clothes, degree of dirt, amount of dirt and amount of water. The output parameter was spin time. Their aimed was to minimize energy use in washing process. The engine for the system was built using neuro technique to help the releases of waterand detergent as when the need arise. Their proposed system did not incorporate control for water level and spinning speed.

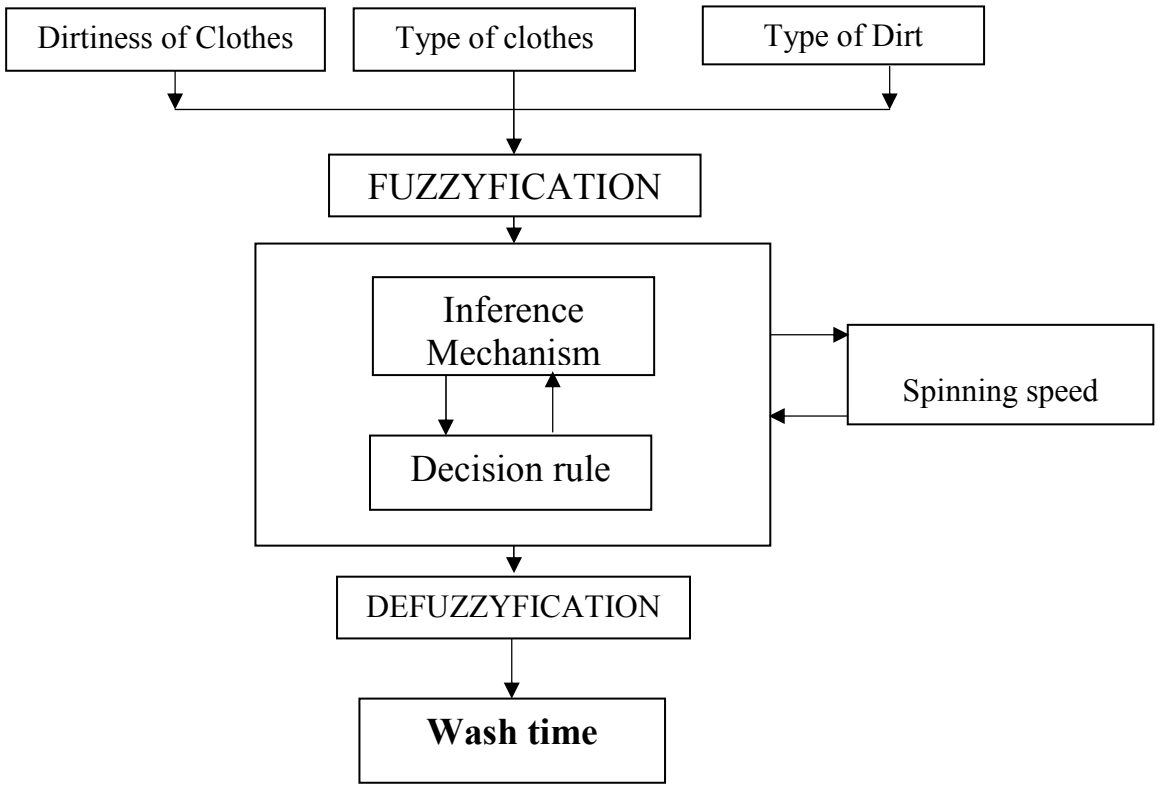
[7] examined a relative study for washing machines efficiency applying fuzzy logic control. They observed that degree of dirt is the very beneficial factor to regulate the washing period and to analysis the effectiveness of the device. Numerical example and Fuzzy solution of the process can defend the cogency of their approach consequently it can likely to ascertain the correctness as stated by some mathematical formulation which can be made because of certain vague or logical circumstances

A Fuzzy logic control for Washing Machine was also proposed by [8] using Three Input (type of cloth, type of dirt, dirtiness of the cloth) and One Output (wash time). The outcome gotten from fuzzy inference method is then treated to yield a finite result.

This work design and simulate an intelligent washing machine using fuzzy logic inference model. The system considered input parameter such as:, type of cloth, types of dirt, dirtiness of the cloth as well as the spinning speed and the output for device is washing time.

Design of the system

The design adopted a pattern of rule that can calculate the spinning speed of washing device for efficient and minimal wash time subject to distinct limits. This will reduce the utilization of water for washing of clothes, electricity and save lots of time. The system will intelligently balance the machine wash load to guarantee correct spinning and as well decreases spinning speed when it notice a disparity.



The architecture of the system as depicted in figure 1 consists of the linguistic inputs which are type of

dirt, the extent of dirt on clothes, type of clothes, and the spinning speed, Fuzzy intelligent logic model and the system output which is wash time. The fuzzy set defined for linguistic variables applied in the system for "types of cloths" are as follow: Not greasy, medium, And Greasy. The set for "types of dirt" are small, large and medium. The set for "dirtiness of cloth" are not greasy, medium, and Greasy. The set for "spinning speed" are low, medium and high. We also has the fuzzy set for the system only output "wash time " as Very short, short, medium and long

Fuzzy rules base.

With four inputs each have three membership function, we formulate a total of 27 rules as presented in table1

Table1 Fuzzy rules base

Rule Number	**Linguistic Inputs**				**Linguistic Outputs**
	Type of Cloths	Type of Dirt's	Dirtiness of Cloth	Spinning Speed	Wash time
1	Silk	Not greasy	Small	LOW	very Short
2	Silk	Not greasy	Medium	Medium	very Short
:	:	:	:	:	:
10	Woolen	Not Greasy	Small	Low	Very Short
11	Woolen	Not Greasy	Medium	Medium	Short
:	:	:	:	:	:
19	Cotton	Not greasy	Small	LOW	very Short
20	Cotton	Not greasy	Medium	Medium	Short
:	:	:	:	:	:
26	Cotton	Greasy	Medium	High	Short
27	Cotton	Greasy	Large	HIGH	LONG

Table1 Shows the adopted rules employed to get the output and input specifications.

Rule1: If type of Cloths is Silk and type of Dirt's is Not greasy and Dirtiness of Cloth is small and Spinning Speed is low then washing time is very short

Rule2: If type of Cloths is Silk and type of Dirt's is Not greasy and Dirtiness of Cloth is medium and Spinning Speed is medium then washing time is very short

. . .

. . .

Rule27: If type of Cloths is cotton and type of Dirt's is greasy and Dirtiness of Cloth is large and Spinning Speed is high then washing time is long.

Figure 2 Fuzzy rules base for washing device

b) Defuzzification

The three most common defuzzification methods in used are Max-criterion, Center-of-gravity and the Mean of maxima (MOM). We applied the Mean of maxima (MOM) in this study because it is frequently used method and its computational complexity is relatively high. MOM is denoted as:

$_T{}^0$= max

μ

$$(min\left(\frac{x-a}{b-a},\frac{c-x}{c-b}\right),0) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 1$$

Where x is the centroid of area,

a = smallest of max, b = mean of max, c = largest of max

Using equation 1 to solve for fuzzy set vshort as

μ_{vshort} = max

$$(min\left(\frac{x-a}{b-a},\frac{c-x}{c-b}\right),0) \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots 2$$

$\mu_{vshort} = 0.4$

$\mu_{short}(5) = 0.5$

$\mu_{medium}(25) = 0.5$

Finally, we calculate for variable long using the min-max formula,

μ_{long} (30)= 0.5

In a discrete form, COG (crisp output) is defined by:

$$COG = \frac{\sum_{i=1}^{N_i} \mu_{T^0}(y_i) y_i}{\sum_{i=1}^{N_i} \mu_{T^0}(y_i)} \quad \ldots\ldots\ldots\ldots\ldots\ldots 2$$

Where N_i is the value of quantization used to discretize membership function μ_{T^0}(y) = fuzzy output T^0.

μ_{T^0} (y) = the degree of membership.

y_i = elements of the set.

Equation 2 can likewise be express as thus:

Crisp Output = {(Sum(Membership Degree*Singleton Position)}/(Membership degree)..3.8

Supposing that the output degree after rule evaluation are:

Vshort=0.4,
Short = 0.5,
Medium = 0.5,
Long = 0.5

Then using the values for each of this linguistic variables

Vshort= 7,
Short = 19,
Medium= 23,
Long =43

The crisp value for wash duration to be:

Wash time = (0.4*7) + (0.5*19) + (0.5*23) + (0.5*42) + (0.5*51)/(0.4+0.5+0.5+0.5) = 33.12 minus.

ii. Results

This paper developed a pattern and rules that can predict the spinning speed of washing machine for minimal wash time depending on different parameters. To increase the eminence washing device, the spinning speed was scales from 0rpm to 1600rpm. The results had shown that proposed system intelligently rebalance the wash contents to make sure that accurate spinning speed and decreases spinning speed whenever an inequity is noticed. Fuzzy logic for washing device in figure 3

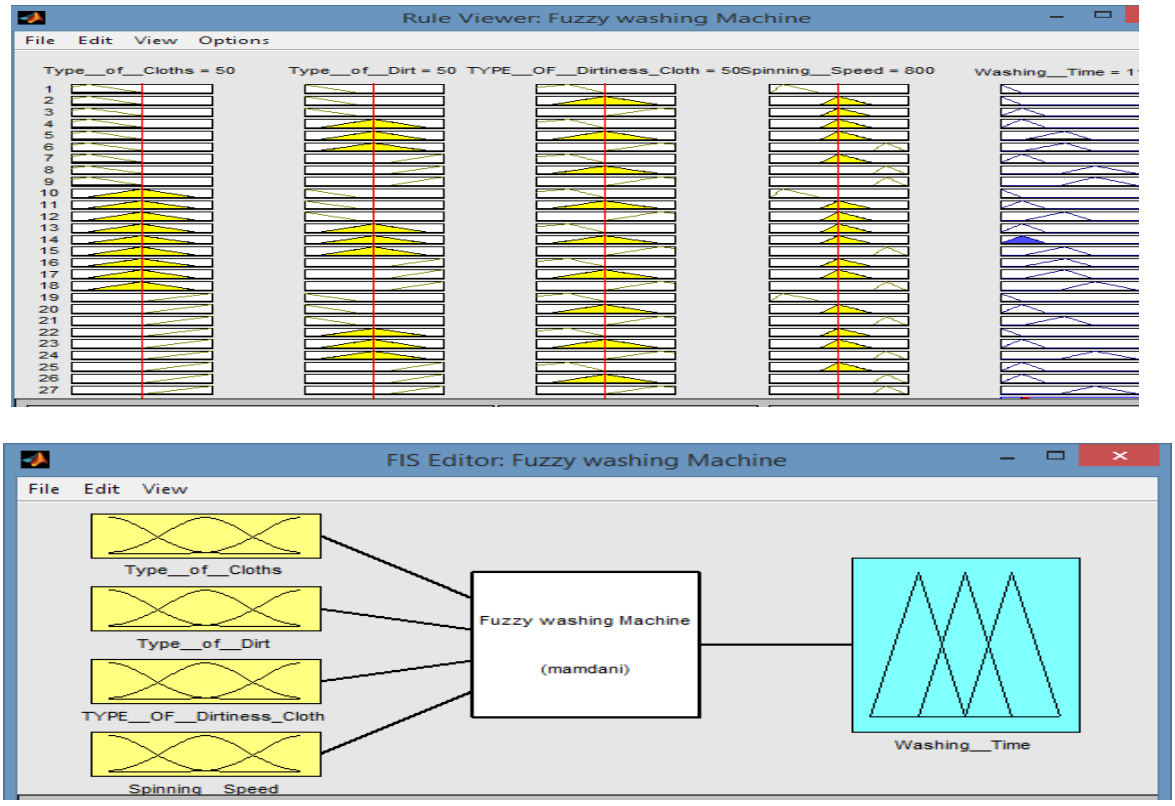


Figure 3Fuzzy logic for washing machine.

a) Discussion of Findings

The paper has found that The introduction of different spinning speed minimized processing time for washing device and saves resources. The proposed system was simulated four times with different values of style of cloths (30 = Silk) nature of dirt (30=not greasy), type of dirtiness o**fii.** cloth (30=small) which gave 19.3mins washing**iv.** time for the planned system and 30.9mins for the present system as revealed in table 4. Figure 4 shows graphical representation of the comparison of the washing duration for both the existing and Improved system are presented.

Userinteractive interface for fuzzy washing machine was developed with java programming language. It has four input box such as type of cloth, type of dirt, type of dirtiness and spinning speed and output box.

. Figure 4 shows graphical representation of the comparison of the washing duration,

Conclusion

This paper successfully designed an intelligent washing device that effectively checks for the kind of dirt, the type of cloth and the dirtiness of cloth, and then used an appropriate spinning speed to diminished wash time. The machine controller was centered on fuzzy logic. This system is an intelligent system that monitors the changing situations in the device and consequently regulates actions of the system for the best wash results.

References

[1] Ramesh.T, Panda AK, Kumar SS (2013) Fuzzy logic and sliding mode based speed control of direct torque and flux control induction motor drives- A comparative study, international journal of emerging electric power system vol 14, issues 5, 385-400,2023

[2] Hatem E.Aydi Ibrahim H. Banat Sameh S. A., (2011). Fuzzy Logic Washing Machine. *Islamic university of Gaza. 2-8.*

[3] Wang Ai-Zhen ,guo-feng R (2012) the design of neural network fuzzy controller in washing machine. control and sensor Network, international conference on sensor network, pg 136 – 139

[4] Alhanjouri, M. and Alhaddad, A.A. (2013). Optimize wash time of washing machine using fuzzy logic. Computer Engineering Department, Islamic University of Gaza E-mail: mhanjouri@iugaza.edu.ps, volume 1,1-4.

[5] Suchitra, N. Kumar, M. (2013). Performance Analysis of Five Inputs – Three Output Fuzzy Based Washing Machine. *IOSR Journal of Electronics and Communication Engineering (IOSR-JECE) e-ISSN: 2278-2834,p- ISSN: 2278-8735. Volume 7, Issue 3, 67-73*

[6] Neha V, JasukarR.W(2014) Neuro-fuzzy Controller Based Washing Machine.International journal of engineering science invention volume 3, 48-51

[7] Yadav, A.K, Reza, A., and Srivastava, S. (2014). A comparative study for ranking the efficiency of washing machines based on fuzzy set theory. International Journal of Innovative Research in Science, Engineering and Technology. Vol. 3, 4-21,

[8] Hatagar, S, and Halas, S.V. (2015) Three Input – One Output Fuzzy logic control of Washing Machine. *International Journal of Scientific Research Engineering & Technology (IJSRET*), ISSN 2278 – 0882. Volume 4 Issue 1. 1-9.