Malaya Journal of Matematik, Vol. S, No. 1, 476-479, 2021

https://doi.org/10.26637/MJMS2101/0109

Fuzzy logic control system of washing machine using Python

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Abstract

Washing clothes is one of our daily routine. Washing is done by hands traditionally. But at present the technology has developed a lot and all the hand done works are replaced by machines. One such invention is a washing machine which helps people to save the water, energy and time. Based on the needs of people, the fuzzy logic control system has been developed. Fuzzy logic system is a type of reasoning logic that reasons out YES or NO based on the given input. Nowadays this system is mainly used in Artificial Intelligence for human like thinking of automated products. Fuzzy logic problems are being used in many of our everyday applications such as washing machines, air conditioners, unmanned aerial vehicles, satellites, traffic control systems, transmission systems, anti-lock braking systems (ABS) etc. Python offers a simple solution to fuzzy logic problem for washing machine environment. Previously, fuzzy logic was used in washing machines designed using MATLAB. But in this we use Python logic, which reduces the disadvantages identified by fuzzy logic MATLAB. In this, the input given are the type of clothes, degree of dirt and load of clothes and the output received is wash time, RPM, dry time, temperature. This objective is to minimize time taken, current consumption and water usage for washing clothes. The result of this simulation shows that this washing machine provides a good wash quality.

Keywords

Python; Fuzzy logic system; Artificial Intelligence; Rule Viewer; MATLAB.

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Article History: Received **01** November **2020**; Accepted **10** January **2021**

Contents

1. Introduction

Python was first designed in 1980 and it was a high-level interpreted programming language. Python was released in the year 1991 by Guido Van Rossum at Centrum Wiskunde and Informatica (CWI) in Netherland. For his continuous efforts in the development and central role in deciding the correct direction, he was given the title, "Benevolent Dictator for Life" (BDFL) by the Python community.

Python is an easy and powerful programming language. It is helpful for the beginners. It can perform complex mathematics and handle large data and files. It increases the reduction of memory usage and time complexity. Python finds its application over several domain such as Artificial Intelligence, Machine Learning, Deep Learning, Web Development, installers, security systems, etc.

In this paper, we use Fuzzy Logic Controller for liquid level maintaining and control. Previous approaches for Fuzzy Logic Control was designed in MATLAB. But here we have programmed Fuzzy Logic Control using Python for easy, precise and compact structure of program.

2. Fuzzy logic system

Fuzzy logic control is a concept which helps the computers to make decision like human. It works on the basis of conditional statement. Most of the people do not know how much time is required for washing clothes in order to overcome these issues, Fuzzy logic controller (FLC) based washing machines are designed in such a way it offers better performance and low cost.

The principle of sensor is that the light is transmitted

through a water sample and the amount of light passed through it is proportional to the amount of soil. The increase in soil levels leads to decrease in amount of light transmitted is measured by the turbidity sensor to find out the turbidity. The decisions on how long to wash in all cycles are given to the dishwasher controller based on turbidity measurements. These decisions are carried out on the basis of the comparison of clean water and wash water turbidity. Using this strategy to make decisions, we can conserve energy on lightly soiled loads by washing as long as necessary.

3. Proposed design

The main work of washing machine is to clean the dirty clothes and other fabrics without any damage. For that, we give a particular input according to the properties of the cloth to produce output such as heavy wash or soft wash, time of washing and so on. In relation to that, 27 principles for washing time and 27 principles for water temperature are proposed and used to design this Fuzzy Logic Control System using Python. To achieve these advantages in an economical way, this washing machine uses fuzzy logic system with some of these three major input parameters:

1. Weight of Fabrics
2. Stains category
3. Type of Fabric

The FLC processes the input information and produces five outputs which are:

1. Wash Duration
2. Temperature
3. RPM
4. Dry Time
5. Wash quality

A. Algorithm for our Fuzzy logic system:
BEGIN < FUZZY LOGIC > (FAB_TYPE, DIRT_TYPE, WEIGHT)
IF FAB_TYPE=SILK AND DIRT_TYPE= LIGHTLY_SOILED AND WEIGHT = BELOW_10KG THEN
PRINT WASH STASTICS
ELSE IF FAB_TYPE = SILK AND DIRT_TYPE =LIGHTLY_SOILED
AND WEIGHT=10_TO_15KG THEN
PRINT WASH STATISTICS
ELSE IF FAB_TYPE = SILK AND DIRT_TYPE =LIGHTLY_SOILED
AND WEIGHT=ABOVE_15 KG THEN
PRINT WASH STATISTICS
ELSE IF FAB_TYPE = SILK AND DIRT_TYPE =NORMALLY_SOILED
AND WEIGHT=BELOW_10KG THEN
PRINT WASH STATISTICS
ELSE IF FAB_TYPE = SILK AND DIRT_TYPE =NORMALLY_SOILED
AND WEIGHT=10_TO_ 15 KG THEN
PRINT WASH STATISTICS
ELSE IF FAB_TYPE = COTTON AND DIRT_TYPE =NORMALLY_SOILED
AND WEIGHT=10_TO_15KG THEN
PRINT WASH STATISTICS
ELSE IF FAB_TYPE = COTTON AND DIRT_TYPE =NORMALLY_SOILED
AND WEIGHT=ABOVE_15KG THEN
PRINT WASH STATISTICS
ELSE IF FAB_TYPE = COTTON AND DIRT_TYPE =HEAVILY_SOILED
AND WEIGHT=BELOW_10KG THEN
PRINT WASH STATISTICS
ELSE IF FAB_TYPE = COTTON AND DIRT_TYPE =HEAVILY_SOILED
AND WEIGHT=10_TO_15KG THEN
PRINT WASH STATISTICS
ELSE IF FAB_TYPE = COTTON AND DIRT_TYPE =HEAVILY_SOILED
AND WEIGHT=ABOVE_ 15KG THEN
PRINT WASH STATISTICS

B. Python code for our Fuzzy logic system:
Fuzzy rules have been involved in the modeling of washing machines. The whole system which we have made is developed by using Python. The code for our FLC system is as follows:

```
list1=[]
def result():
#Silk
print("——")
print("OUTPUT")
print("——")
Rule 1: if((list1[0]=="silk")and(list1[1]=="lightly
soiled")and(list1[2]=="below_10kg")):#1
print("Wash Duration - 0.35 h")
print("Temperature - 30c")
print("RPM - 400")
print("Dry Time - Quick")
print("Quality - Good")
input("Press Enter key to exit...")
Rule 2: elif((list1[0]=="silk")and(list1[1]=="lightly
soiled")and(list1[2]=="10_to_15kg")):#2
print("Wash Duration - 0.47 h")
print("Temperature - 30c")
print("RPM - 600")
print("Dry Time - Intermediate")
print("Quality - Good")
input("Press Enter key to exit...")
Rule 3: elif((list1[0]=="silk")and(list1[1]=="lightly
soiled")and(list1[2]=="above_15kg")):#3
```

```
print("Wash Duration - 0.50 h")
print("Temperature - 40c")
print("RPM - 600")
print("Dry Time - Intermediate")
print("Quality - Best")
input("Press Enter key to exit...")
```

Table 1.

R.No	Linguistic Inputs			Linguistic Outputs				
	Type of Clothes	Degree of Dirtiness	Mass of Cloth Load	Wash Time	Temperature	RPM	Dry Time	Wash Quality
1	Silk	lightly soiled	Below 10kg	0.35h	30$^*c$	400	Quick	Good
2	Silk	lightly soiled	10 to 15kg	0.47h	30$^*c$	600	Intermediate	Good
3	Silk	1ightly soiled	Above 15kg	0.50h	40$^*c$	600	Intermediate	Best
4	Silk	normally soiled	Below 10kg	0.50h	30$^*c$	400	Long	Medium
5	Silk	normally soiled	10 to 15kg	1.18h	30$^*c$	800	Quick	Good
6	Silk	normally soiled	Above 15kg	1.18h	40$^*c$	600	Long	Medium
7	Silk	heavily soiled	Below 10kg	0.50h	30$^*c$	800	Intermediate	Good
8	Silk	heavily soiled	10 to 15kg	1.18h	40$^*c$	800	Quick	Best
9	Silk	heavily soiled	Above 15kg	2.10h	40$^*c$	800	Quick	Best
10	woollen	lightly soiled	Below 10kg	0.47h	40$^*c$	600	Long	Medium
11	Woollen	lightly soiled	10 to 15kg	0.50h	40$^*c$	800	Intermediate	Good
12	Woollen	lightly soiled	Above 15kg	1.18h	40$^*c$	800	Quick	Good
13	Woollen	normally soiled	Below 10kg	0.50h	40$^*c$	600	Intermediate	Medium
14	Woollen	normally soiled	10 to 15kg	1.18h	40$^*c$	600	Intermediate	Medium
15	Woollen	normally soiled	Above 15kg	1.18h	60$^*c$	800	Quick	Best
16	heollen	heavily soiled	Below 10kg	1.18h	60$^*c$	800	Quick	Best
17	Woollen	heavily soiled	10 to 15kg	1.18h	60$^*c$	1000	Quick	Good
18	Woollen	heavily soiled	Above 15kg	2.10h	60$^*c$	1200	Quick	Good
19	Cotton	lightly soiled	Below 10kg	0.47h	40$^*c$	400	Intermediate	Good
20	Cotton	lightly soiled	10 to 15kg	0.50h	40$^*c$	600	Intermediate	Good
21	Cotton	lightly soiled	Above 15kg	1.18h	40$^*c$	800	Quick	Best
22	Cotton	normally soiled	Below 10kg	0.50h	40$^*c$	600	Intermediate	Best
23	Cotton	normally soiled	10 to 15kg	1.18h	40$^*c$	800	Quick	Best
24	Cotton	normally soiled	Above 15kg	2.10h	40$^*c$	1000	Quick	Good
25	Cotton	heavily soiled	Below 10kg	1.18h	60$^*c$	1000	Quick	Good
26	Cotton	heavily soiled	10 to 15kg	1.18h	60$^*c$	1200	Quick	Best
27	Cotton	heavily soiled	Above 15kg	2.10h	60$^*c$	1200	Quick	Good

Here in this table, three types of clothes are taken into consideration. They are silk, woollen and cotton. They have the weight of 10 to 15 kg from lightly soiled to heavily soiled. Using these three parameters, the output such as the temperature ranging from 30 to 60 degree Celsius, RPM ranging from 400 to 1200, washing time differing from quick to long and washing quality ranging from medium to best. These outputs produced from inputs are calculated on the basis of fuzzy logic controller system which is programmed on python for use of a greater number of criteria and also to reduce the power consumption. Thus, the best fit of output is produced by the FLC system for the given input and to reduce the water consumption and power consumption.

4. Resultant and simulation

Consider any type of material or cloth to be used for washing. The mass of the cloth and the degree of dirtiness comes into consideration. When these things are given as an input to the system, that is the washing machine, the fuzzy logic system working in it measures how much temperature it should be maintained while washing, what is the RPM which it has to run, the time of washing and the quality of wash using sensors are calculated and produced as the output.

5. Conclusion

By using Fuzzy Logic, we have designed an automatic washing machine controller to assess the quality of wash based on parameters namely dry/rinse time and drum rotation speed

/ RPM. The wash quality index is a performance measure to accurately determine the working efficiency of a washing machine at given load. The use of Fuzzy Logic Controller using Python automatically detects the necessary RPM for given input load and accordingly presumes the average rinse time of the load, thereby calculating the wash quality index. This system manages the time, saves water consumption and electricity consumption. This automatic control systems depicts the advantages of Fuzzy Logic Controller over traditional washing machine. Thus, Fuzzy logic control systems in Python provides great advantages and provides more solutions for problems that cannot be solved by MATLAB environment by reducing the disadvantages such as time management, processing speed and restricted number of input values and etc. So, Python would be the best solution to solve these problems.

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ISSN(P):2319 – 3786

Malaya Journal of Matematik

ISSN(O):2321 – 5666

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