Image Processing Of Clean And Dirty Dishes To Design And Construct A Fuzzy Logic Dishwasher

Vince Angelo C. Austria, Edwin R. Arboleda, Elbert M. Galas

Abstract: In this paper, an image processing of Clean and Dirty Dishes was done using a MatLab M-file that detects the white color percentage of an image. Samples of Clean and Dirty dishes from the Austria household were used in this research. About 60 samples of Clean Dishes and 60 samples of Dirty Dishes were used. Images were taken using a smartphone with a 5MP camera. Results obtained were implemented in MATLAB by way of fuzzy logic. Using fuzzy logic, rules were implemented based on the white color percentage obtained by using the MATLAB M-file for white color percentage.

Index Terms: Dishwasher, Fuzzy Logic, Grease, Image Processing, Dishes, Clean Dishes, Dirty Dishes

1. INTRODUCTION

A dishwasher, as embodied and broadly described herein, may include a sump configured to contain wash water; a filtering device configured to filter food waste out of wash water contained in the sump; a drain pump configured to discharge the wash water contained in the sump through the filtering device; and a control unit configured to determine whether the filtering device needs to be cleaned based on the time taken for the drain pump to drain the sump[1][2][3][4][5] Every meal generates dirty plates and cups which need to be cleaned quickly and efficiently. Being organized can save you a lot of time and trouble. So there is a need for developing a new method or process for effective manufacturing [6], [7]. Those processor methods should fulfill the requirement about accuracy productivity etc. Ever since the industrial revolution human have been dependent on electricity, now world is entering in the 21st century with new invention and new technology. But also make new types of problems day today. When problem is increased and it becomes more difficult to meet demand for energy and power needs.

In this paper the construction of the dishwasher machine is discussed and how the use of image processing in the detection of grease is used in its fuzzy logic implementation.

2 RESEARCH METHOD

2.1 Dishes

The dishes that will be used in this research were from the Austria household in Buna Lejos, Indang, Cavite. Sample images of the dishes were also acquired. The images were captured using a 5MP smartphone camera.

- *Vince Angelo Austria is is from the Department of Computer and Electronics Engineering, College of Engineering and Information Technology,Cavite State University, Indang, Cavite. mail: vinceaustria69@mail.com*
- *Edwin R. Arboleda is from the Department of Computer and Electronics Engineering, College of Engineering and Information Technology,Cavite State University, Indang, Cavite. E-mail: edwin.r.arboleda@cvsu.edu.ph*
- *Elbert M. Galas is from the Information Technology Department, College of Computing, Pangasinan State University-Urdaneta Campus*

2.2 Fuzzy Logic Implementation

The fuzzy logic of this research will have the input of the Level of Greasiness and Size of the Dish. It will have the output of the level of cleaning.

2.3 Image Analysis

The MatLab (version R2014b) image processing toolbox will be used to develop a computer routine algorithm to preprocess and extract features of dishes sample images. An improvised MATLAB M-file from the internet was used to compute the white color percentage of the images.[8][9][10][11]

The MATLAB M-file:

```
clear all
clc
O=imread('FILENAME.jpg');
imshow(O);
I=rgb2gray(O);
figure;
imshow(I);
A=imcrop;
imshow(A);
[a b]=size(A);
ncount=0;
for l=1:b
   for w=1:a
      if (impixel(A,l,w)>=[150 150 150])
         ncount=ncount+1;
      end
   end
end

if (ncount>1)
   p=(ncount)/(a*b)*100;
   disp('percentage of white color:')
   fprintf('%3.2f%%\n',p)
else
   sprintf('\n no white colour in the image')
end
```

3 RESULTS AND ANALYSIS

In this section, the results of the fuzzy logic implementation and image processing results were explained.

3.1. Image Processing Results

60 sample images of Clean Dishes and 60 sample images of Dirty Dishes were used in Image Processing. There, the

images white color percentages were computed using the improvised M-File.

Figure 1. *An example of images of the clean dishes that were used in Image Processing*

Figure 2. *An example of images of the dirty dishes that were used in Image Processing*

Using the M-file. It returned the following results as shown in Table 1.[12][13][14][1], [2], [11], [12], [15]–[22], [3], [23]–[29], [4]–[10]

Note that the percentages will be used in the Fuzzy Logic Implementation.

White Color Percentage (%)	
CLEAN DISHES	DIRTY DISHES
70.87	24.33
71.72	23.78
69.77	27.01
68.21	30.19
70.11	30.17
75.23	29.88
74.21	25.04
67.11	11.98
55.11	22.13
64.24	20.78
56.12	19.11
50.45	23.09
52.04	27.01
50.39	29.14
48.11	27.11
75.01	25.44
59.31	25.02
60.01	26.10
59.12	13.31
53.21	24.12
67.13	24.08
60.11	25.12
67.12	26.78
55.25	27.00
56.11	28.15
55.25	25.12
55.12	24.50
60.11	27.15
61.00	25.15
56.11	25.10
46.16	20.02
50.11	29.65
71.10	26.03
57.61	26.00
65.11	20.05
55.15	24.01
57.10	25.11
56.19	25.25
60.14	22.18
55.10	19.97
56.42	20.25
55.01	20.98
57.65	16.92
59.01	21.23
59.10	24.42
59.01	21.11
65.00	20.13
60.68	25.11
64.12	26.10
61.11	27.00
70.10	26.11
43.11	20.10
57.10	21.15
50.67	20.81
55.66	21.24
56.77	28.16
59.00	15.19
65.11	25.10
57.17	19.99
46.11	20.03

Table 1*. White Color Percentage using the M-File for 60 Clean Dishes and 60 Dirty Dishes*

3.2 Fuzzy Logic

Using the MATLAB software, the creation of the fuzzy logic using the Mamdani style was made.

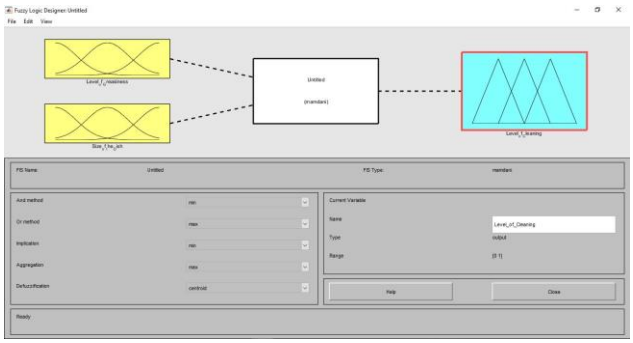

Figure 3*. The fuzzy logic designer in MATLAB*

After changing the names of the inputs and outputs in the fuzzy logic designer, we then change the names of the members of the input and output. For example, as shown below, the name of the members of the input level of greasiness was changed from their default names to what the input will be.

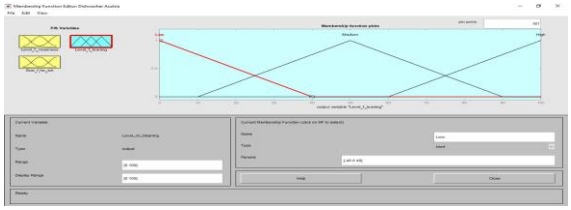

Figure 4. *Membership Function Editor*

AFTER RENAMING THE INPUT AND OUTPUT MEMBERS, WE THEN CREATE THE RULES BASED ON THE ONE FROM

EXCEL.

The Level of Greasiness will be then based on the computed white color percentage from Image Processing. Note that when: White Color Percentage is from 0% to 30%, the level of greasiness is high. White Color Percentage is from 31% to 65%, the level of greasiness is medium. White Color Percentage is from 66% to 99%, the level of greasiness is low.

Input		Output
Level of Greasiness	Size of the Dish	Level of Cleaning
Low	Small	Low
	Medium	Low
	Large	Low
Medium	Small	Low
	Medium	Medium
	Large	Medium
High	Small	Medium
	Medium	High
	Large	High

***Figure 5**. Rules as shown in Excel*

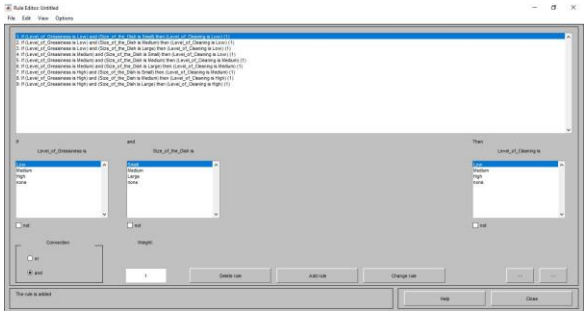

***Figure 6**. MATLAB Rule Editor*

The rules can be viewed in the Rule Viewer and in the Surface Viewer as shown in Figure 7 and 8.

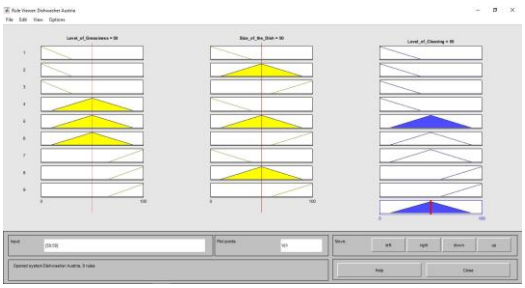

***Figure 7.** MATLAB Rule Viewer*

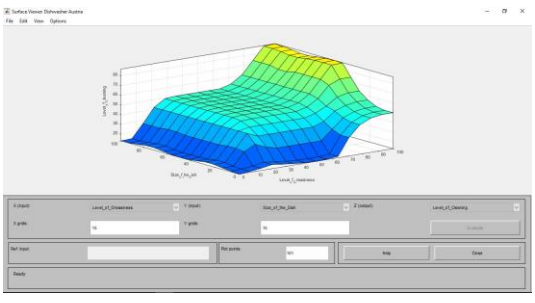

***Figure 8**. MATLAB Surface Viewer*

As seen in figures 5 and 6, only 9 rules were created.

4. CONCLUSION

The use of MATLAB image processing for the detection of grease on clean and dirty dishes can be one of the basis to design and construct a fuzzy logic dishwasher. Using the white color percentage detected using image processing and using the fuzzy logic function in MATLAB with the inputs of Level of Greasiness and size of the dish, the output level of cleaning, the fuzzy logic dishwasher can then be created.

5. ACKNOWLEDGMENT

The author gives a big thank you to the Austria residence for the samples used in this research, my friends in giving some advice during the making of this research and some of the faculties in the University Library for some references that helped a lot in doing this research.

REFERENCES

[1] A. Kho, M. Sales-Pardo, and J. Wilson, “From clean dishes to clean hands,” IEEE Eng. Med. Biol. Mag., vol. 27, no. 6, pp. 26–28, 2008.

[2] X. Sun, “Efficacy of Manual Dishwashing and Sanitizer Wiping in Removing Food Soils From Chel Knives,” Purdue University, 2014. [Online]. Available: https://docs.lib.purdue.edu/open_access_theses/267/.

[3] H. Nomura, N. Wakami, and S. Kondo, “Non-linear technologies in a dishwasher,” IEEE Int. Conf. Fuzzy Syst., vol. 5, pp. 57–58, 1995.

[4] F. Rosa, E. Rovida, S. Graziosi, P. Giudici, C. Guarnaschelli, and D. Bongini, Dishwasher history and its role in modern design. 2012.

[5] J. M. Emmel, K. Parrott, and J. Beamish, “Dishwashing and water conservation: An opportunity for environmental education,” 01-Feb-2003. [Online]. Available: https://www.researchgate.net/publication/296126777_Dishwashing_and_water_conservation_An_opportunity_for_environmental_education.

[6] M. Pipattanasomporn, M. Kuzlu, S. Rahman, and Y. Teklu, “Load Profiles of Selected Major Household Appliances and Their,” Smart Grid, IEEE Trans. Smart Grid, vol. 5, no. 2, pp. 742–750, 2014.

[7] H. Wu, G. Evans, S. Heragu, and K. Rhinehart, “Optimization of production and inventory policies for dishwasher wire rack production through simulation,” Proc. 2013 Winter Simul. Conf. - Simul. Mak. Decis. a Complex World, WSC 2013, pp. 2666–2676, 2013.

[8] J. M. Mendel, “Fuzzy-Logic Systems for Engineering - a Tutorial (Vol 83, Pg 345, 1995),” Proc. Ieee, vol. 83, no. 9, p. 1293, 1995.

[9] E. H. Mamdani and E. H. Mamdani, “Application of fuzzy logic to approximate reasoning using linguistic,” IEEE, Trans. Comput., vol. C–26, no. 12, pp. 1182--1191, 1977.

[10] L. A. Zadeh, “Fuzzy logic = computing with words,” IEEE Trans. Fuzzy Syst., vol. 4, no. 2, pp. 103–111, 1996.

[11] J. Yen and S. Member, “Fuzzy Logic — A Modern Perspective,” IEEE Trans. Knowl. Data Eng., vol. 11, no. 1, pp. 153–165, 1999.

[12] G. Gholap, S. Gaikwad, S. Bhoite, and T. Shaikh, “Design and Fabrication of Dish Washing Machine,”

Int. J. Curr. Eng. Technol., vol. 6, no. 6, pp. 187–189, 2016.
[13] C. . Lee, “Fuzzy Logic in Control Systems: Fuzzy Logic Controller, Part II,” IEEE Trans. Syst. Man Cybern., vol. 20, no. 2, pp. 419–435, 1990.
[14] L. L. Chen, B. , Hoberock, “Robotic Dish Handling System,” Sch. Mech. Aerosp. Eng., pp. 332–337, 1995.
[15] E. R. Arboleda, “Comparing Performances of Data Mining Algorithms for Classification of Green Coffee Beans,” Int. J. Eng. Adv. Technol. ISSN 2249-8958, Vol. Issue-5, June 2019, no. 5, pp. 1563–1567, 2019.
[16] T. H. Duong, M. Emami, and L. L. Hoberock, “Automatic dishware inspection: Applications and comparisons of two new methods,” Proc. - 10th Int. Conf. Mach. Learn. Appl. ICMLA 2011, vol. 1, pp. 25–30, 2011.
[17] H. Chi, G. Zhao, Y. Zhou, and Z. Wang, “Dishwashing system based on loofahs,” Proc. 13th IEEE Conf. Ind. Electron. Appl. ICIEA 2018, pp. 1633–1636, 2018.
[18] Corning, “Suggestions for Cleaning Glassware,” 2007. [Online]. Available: https://www.pelletlab.com/wp-content/uploads/2018/02/Suggestions-for-Cleaning-Glassware-1.pdf.
[19] I. Major and V. Zorta, “Design of a Special Purpose Dish Washing Machine,” Am. Sci. Res. J. Eng. Technol. Sci., pp. 298–318, 2018.
[20] H. D. Kusumaningrum, M. M. Van Putten, F. M. Rombouts, and R. R. Beumer, “Effects of antibacterial dishwashing liquid on foodborne pathogens and competitive microorganisms in kitchen sponges,” J. Food Prot., vol. 65, no. 1, pp. 61–65, 2002.
[21] R. Shanmugasai and P. S. Uma Priyadarsini, “Adaptive food suggestion engine by fuzzy logic,” Res. J. Pharm. Biol. Chem. Sci., vol. 7, pp. 14–25, 2016.
[22] P. Berkholz, “Laboratory Investigation of Manual Dishwashing Habits and its Resource Consumptions : A Study of Consumer Panels in Seven Global Regions,” Inst. für Landtechnik Professur, 2007.
[23] R. A. Rajamani, Haile S., Mcmahon, “Induction Motor Drives for Domestic Appliances,” IEEE Ind. Appl. Mag., vol. 3, no. 3, pp. 21–26, 1997.
[24] E. R. Arboleda, “Secure and Fast Chaotic El Gamal Cryptosystem,” Int. J. Eng. Adv. Technol., no. 5, pp. 1693–1699, 2019.
[25] T. J. MENDENHALL, T. D. NEGUSSE, S. G. SOLOMON, and R. Price, “Design of a vegetable washer for the food service industry,” Foodserv. Res. Int., vol. 5, pp. 43–65, Jun. 2006.
[26] J. Hirtz, R. B. Stone, D. A. McAdams, S. Szykman, and K. L. Wood, “A functional basis for engineering design: Reconciling and evolving previous efforts,” Res. Eng. Des. - Theory, Appl. Concurr. Eng., vol. 13, no. 2, pp. 65–82, 2002.
[27] A. Saha, M. Kuzlu, and M. Pipattanasomporn, “Demonstration of a home energy management system with smart thermostat control,” 2013 IEEE PES Innov. Smart Grid Technol. Conf. ISGT 2013, pp. 1–6, 2013.
[28] T. Kryjak and D. Król, “Shape and colour recognition of dishes for the purpose of customer service process automation in a self-service canteen,” Proc. 2015 Fed. Conf. Comput. Sci. Inf. Syst. FedCSIS 2015, vol. 5, pp. 799–808, 2015.
[29] A. Hauer and F. Fischer, “Open adsorption system for an energy efficient dishwasher,” Chemie-Ingenieur-Technik, vol. 83, no. 1–2, pp. 61–66, 2011.