Conference Paper

Efficient Mixer in Baking "Galamai" Process by Using Camera Sensor

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Abstract

One of Indonesian traditional food, expecially in Minangkabau called galamai was baked with inefficient and complicated manner. At least 4 or 5 person were needed to mix 30 kg galamai batter for 6 hours during baking process. This research solved those problems. The aim of this work was to displace a human labor with an automatic machine to make it more efficient. The basic idea of this reseach is to desain an automatic mixer by using camera sensor for controling the speed of DC machine. This mixer was worked base on the fact galamai batter characteristics that its color and viscosity will change during cooking process. Discoloration in galamai batter will be captured by camera sensor as a data input. Images data of the color of galamai batter will be converted in grayscale images. The intensity of gray scale image became an input for FIS (Fuzzy Inference System) which controled the speed of machine. The speed of motor will increase when the grayscale color of galamai batter is low. The system could controlled turning speed of motor automatically with acuration of speed value is more than 96.4% and synchronized in variation of galamai batter volume.

Keywords: batter galamai, camera sensor, fuzzy-logic, grayscale, DC machine

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1. Introduction

Galamai, one Indonesian traditional food from Minangkabau especially in Payakumbuh is made of glutinous rice flour, sugar and coconut milk. In this current time, people still use a manual process to cook galamai. For instance, to produce 30 kg galamai, all the ingredients were mixed by 4 or 5 person during 6 hours baking process. In case of the batter of galamai was roasted on the fire, it should be continuously mixed without stopping to avoid conglomeration product. However, this manner was inefficient as too much wasted effort and time undertaken during baking process. In case of the plate of batter galamai was not covered during mixing process, it was possible that a lot of dust and sweat affected in the galamai batter. Therefore, the galamai also unhygienic for people.This work tackled such kind of problems. We make a mixer system by using a DC machine as replacing human labor to mix galamai batter. The speed of DC machine was controlled automatically. The plate of mixer was covered and the material was made of aluminum.

There are various methods to control the DC machine such as: cascade control system [1], PID controller [2] and neural network based controlling operation with fuzzy modeling [3]. In this work, the DC machine was controlled based on fuzzy logic rules.

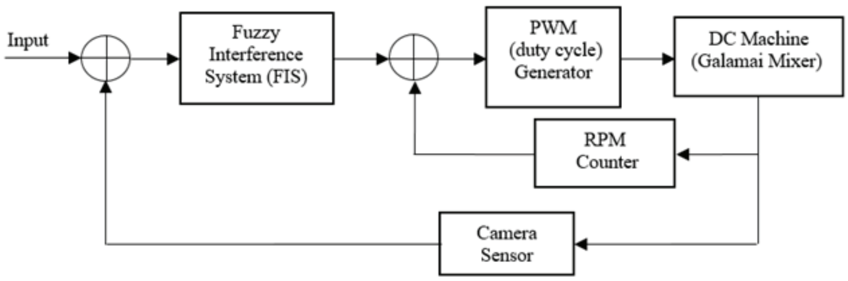


Figure 1: Efficient mixer control block diagram.

The fuzzy membership function determined in accordance with discoloration of galamai In fact, the color of galamai batter was degraded from white to black during this process. This color degradation was observed by camera sensor which put in front of galamai batter during baking process. When the color of galamai batter discolorized to the dark color, its velocity was also becomes more viscous. Therefore, the speed of DC machine was reduced due to the increasingly thickened batter will make the rotation of motor restrained. The system detected this condition by a RPM counter. Then, it generated the microcontroller to magnify the DC motor voltage for stability motor speed.

Previous research has suggested that camera sensor and DC machine can be applied for human daily live. The camera and DC machine are compact and affordable, which makes them attractive for versatile applications including surveillance and computer vision. Some of successful application of these technologies are in automatic door that controlled by smart camera [4], belt conveyor for security checkpoint surveillance by using camera network[5], and smart coffee mixer which can stopped automatically when a suitable of coffee color is reached [6]. In this paper, we designed an efficient mixer in baking galamai which adapted with volume of galamai batter.

2. Methods

At first, the DC machine was set with 55 Pulse Width Modulation (PWM) for minimum starter. PWM Signal is a method for generating an analog signal using a digital source. A PWM signal consists of two main components that define its behavior: a duty cycle and a frequency. In this work, the freqwency was fix because the speed of DC machine should keep consttant. Figure 1 shows the overall view of the mixer system with camera sensor:

When the DC machine switched on and start to mix the galamai batter, there are two feedback loops to control the system. First feedback loop is camera sensor that capture the the color of galamai batter periodically. The second is RPM (rotation per minute) counter for DC machine's speed control.To make the best product of galamai, the batter was mixed without stopping during roasting at temperatures of 100-120 degrees Celsius. Therefore, DC machine *is required to keep rolling at constant speed.*

Camera sensor captured the galamai batter frequently. When the camera sensor captured the batter image, it still in true color format or also known as an RGB frame.

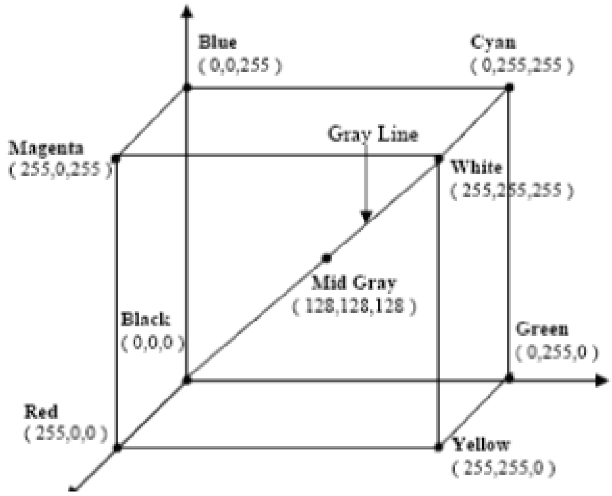


Figure 2: RGB color space [7].

A true color image is an image in which each pixel is specified by three values (0 - 255) one each for the red (R), green (G), and blue (B) components of the pixel scalar. Most often image data are collected from an RGB device. RGB spaces are native to displays, and digital cameras. Each imaging system has its own RGB color space that depends upon the spectral sensitivities of its color sensors and its settings. It is possible to calibrate an imaging device by determining the relationship between its RGB space and a device independent. Figure 2 shows the RGB color space.

In this work, we convert the color of galamai batter ffrom RGB to gray level image. Gray levels represent the interval number of quantization in gray scale image processing. There are 256 gray levels in an 8 bit gray scale image, and the intensity of each pixel can have from 0 to 255, with 0 being black and 255 being white. The gray scale of RGB was obtained by determining the average of each pixel as follows [8]:

$$I = \frac{R + G + B}{3} \tag{1}$$

where I is intensity or gray level of each pixel.

The gray level of each pixel in batter image determined to obtain tthe average of gray level image. This avaerage value was as an input to Mamdani Fuzzy Inference System (FIS). In this step, FIS determined the relationship between average of gray level image and pulse width modulation (PWM) of DC machine as an input. In this paper, the maximum average of gray level image was 200 due the color of batter was not absolutely white. From some experiment results, an appropriate interval of average gray level image and the duct cycle of PWM DC machine as shown in table 1.

Based on tabel 1, the input membership fuction of fuzzy interference system for duty cycle PWM and average gray scale image was described in Fig. 3. While, output variable of fuzzy interference system is RPM. We set the RPM from 0 to 100 rotations per minute. We devided four speed condition of RPM Speed as shown in Figure 4.

As the set speed is varied due to the galamai batter dicoloration, the PWM duty cycle also varies. In Figure 1, there are two ways to get RPM of DC machine in the

Color	Average Gray level	Duty Cycle of PWM
Whitish	97 -255	Very Low
Light Grey	42- 118	Low
Dark Grey	Dec-88	Midle
Black	0 - 32	High

Table 1: Gray Level and PWM Classification.

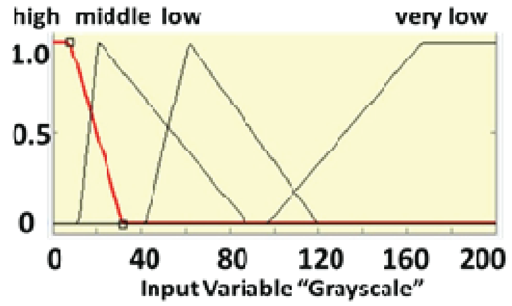


Figure 3: FIS input membership function.

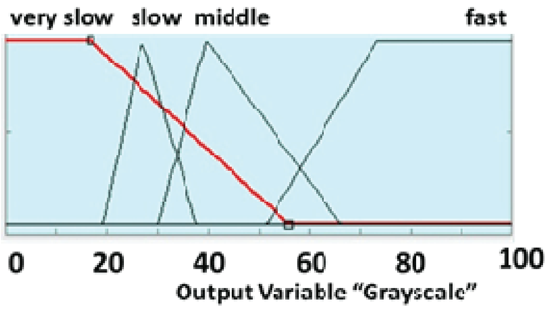


Figure 4: FIS output membership fuction.

system. First, the RPM number of DC machine was counted directly by Adruino when the DC machine was switch on. The second, the RPM number of DC machine was obtained from defuzzification of FIS output which is related with gray level image of batter galamai. These two PWM numbers were compared each other to get the constant speed. Two numbers of these RPM must be equal. If RPM number of Adruino is less than RPM number of FIS output, the PWM generator will increase the duty cycle. Therefore the DC machine rotates faster. If RPM number of Adruino is more than RPM number of FIS output, the PWM generator will decrease duty cycle so that the DC machine become slowly. These step work continuously during baking process

3. Results

In this research, we used two samples batter galamai : the 250 ml and 500 ml. Both were analized separately during baking process. Camera sensor capture the batter 4

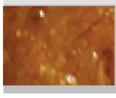
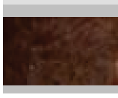
No.	Batter color	Gray Scale Pixel Intensity	No.	Batter color	Gray Scale Pixel Intensity
1		194,2451	3		63,3895
2		96,7731	4		43,8092

Table 2: Batter galamai pixel intensity

Case	Grayscale	Duty cycle PWM [%]	Rpm counter	Rpm fuzzy	RPM Error [%]
1	151.425	21.067	22	21.026	4.427
2	153.449	20.565	25	20.828	16.688
3	98.840	26.996	26	27.511	5.812
4	98.639	28.502	32	28.055	12.328
5	65.727	37.302	40	38.148	4.630
6	65.310	37.804	38	38.237	0.624
7	41.481	28.176	46	45.714	0.622
8	41.319	28.678	45	45.727	1.616

Table 3: RPM and Duty Cycle PWM in 250 ml batter galamai

times as shown in table 2. From the table we observe that the pixel intensity of batter galamai was decrease from light to dark.

We analyze the RPM and duty cycle PWM of each two samples for 8 cases. Table 3 and 4 shows the results:

From table 3, RPM number was increase as the discoloration of gray scale. This condition is caused by the velocity of batter galamai becomes more viscous during baking process. Therefore the duty cycle PMW also increase to reach a constant speed of mixer. From the table 3, we obtained that the average error percentage between RPM counters and RPM Fuzzy is 3.6%. It means that the speed of mixer is commonly

Case	Grayscale	Duty cycle PWM [%]	Rpm counter	Rpm fuzzy	RPM Error [%]
1	146.705	23.075	22	21.580	1.909
2	147.634	22.573	22	21.509	2.232
3	97.772	28.957	28	28.123	0.439
4	96.572	28.455	28	28.187	0.668
5	71.031	39.216	38	37.254	1.963
6	69.584	39.718	38	37.278	1.900
7	41.481	30.180	46	45.714	0.622
8	38.907	29.678	45	45.635	1.411

Table 4: RPM and Duty Cycle PWM in 500 ml batter galamai.

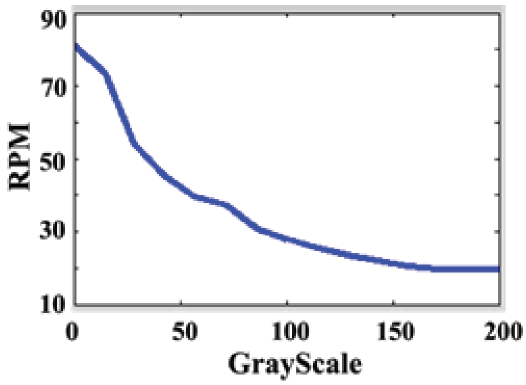


Figure 5: FIS output membership function.

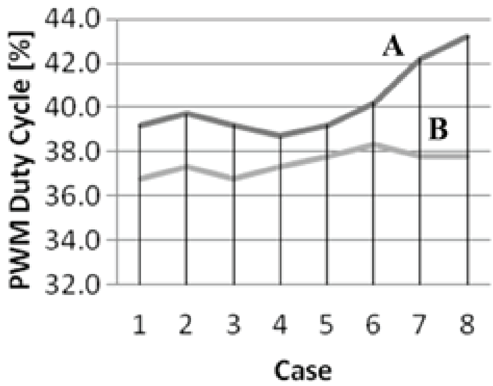


Figure 6: PWM values of various volume.

constant while the gray level and velocity of baked galamai were changed with accuracy of speed value is 96.4 % The complete PWM output of FIS membership function for 500 ml galamai batter was described in Figure 5.

Figure 6 shows the comparison of PWM duty cycle ratio between 250 ml and 500 ml galamai batter for 8 cases observation. From the figure, a big volume of batter galamai requires PWM duty cycle ratio more than the small one.

4. Summary

The proposed a mixer which is designed and implemented using camera sensor to make galamai efficiently is completely succeeded. The system controlled turning speed of motor automatically with accuracy of speed value is 96.4 % and also can be adaptive in variation of galamai batter volume. Simulation results indicate that the proposed efficient mixer can keep its speed constant in various velocities. The system has a good performance in various volume of galamai batter.

5. Acknowledgement

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References

[1] A. S. Abd Elhamid, Cascade Control System od Direct Curent Motor, *World Appl Sci J*, **18**, 1680–1688, (2012).

[2] P. Kumar and R. Mishra, Implementation of FPGA based PID Controller for DC Motor Speed Control System, *International Journal of Engineering Trends and Technology*, **4**, no. 3, (2013).

[3] G. Madhusudhana Rao and B.V.S. Ram, Speed Control of Multi Level Inverter Designed DC Series Motor with Neuro-Fuzzy Controllers, *Journal of Computing*, **1**, no. 1, (2009).

[4] J. -C. Yang, C. -L. Lai, H. -T. Sheu, and J. -J. Chen, An intelligent automated door control system based on a smart camera, *Sensors (Basel)*, **13**, 5923–5936, (2013).

[5] Z. Wu and R. J. Radke, (2011)., Real Time Airport Security Checkpoint Surveillance Using a Camera Network, Workshop CNWASA, IEEE Conf.Computer Vision and Pattern Recognition, 25-32.

[6] I. Intyas, 2012, Implementasi Fuzzy Logic dan Sensor Warna pada Mesin Pengaduk Kopi Otomatis, Padang, Thesis.

[7] A. Noor, et al., Understanding Color Models:A Review ARPN, *Journal of Science and Technolog*, **2**, no. 3, (2012).

[8] M. Rahmadi Kurnia, et al., Object Recognition through Human-Robot Interaction by Speech, Proceedings of the 13th IEEE International Workshop on Robot and Human Interactive Communication (RO-MAN 2004).