ISBN 978-979-95093-9-0

2013 INTERNATIONAL SEMINAR ON SCIENCES FMIPA IPB

PROCEEDINGS

INTERNATIONAL SEMINAR ON SCIENCES 2013

"Perspectives on Innovative Sciences"

FACULTY OF MATHEMATICS AND NATURAL SCIENCES,
BOGOR AGRICULTURAL UNIVERSITY
IPB International Convention Center
15 - 17th November 2013

Published By

Bogor Agricultural University

Faculty of Mathematics and Natural Sciences

ISBN : 978-979-95093-9-0

PROCEEDINGS

ISS 2013

International Seminar on Sciences 2013
"Perspectives on Innovative Sciences"

Bogor 15-17 November 2013

IPB International Convention Center

Published by

Faculty of Mathematics and Natural Sciences
Bogor Agricultural University

Design and Implementation of Roaster Control System Using Image Processing

Mohamad Agung Prawira Negara[1)], Satryo Budi Utomo[2)] & Sumardi[3)]

[1)] Electrical Engineering, Faculty of Technology, Universitas Jember, Jember, Indonesia (mohagungpn@gmail.com)
[2)] Electrical Engineering, Faculty of Technology, Universitas Jember, Jember, Indonesia (satryo.budiutomo@yahoo.com)
[3)] Electrical Engineering, Faculty of Technology, Universitas Jember, Jember, Indonesia (smardi10@gmail.com)

Abstract

Indonesian coffee beans' production significantly rises every year, but the quality of the coffee is poor especially for farmers' home production. That's why we need to increase the technology for it further, so the quality of their coffee product is better. One of the way to do that is to create a simple machine for farmers, yet able to compete with coffee factories. The technology that had been made for this same purpose still have quite some downside, mainly in the aspect of the roaster's heat source. What we have till now is a roaster that use a stove to create the heat that it needs. That's why it needs a lot of time to reach the temperature needed for the roasting process. The other downside is that it still use a conventional method in determining either the beans is already well cooked or not and that makes the effectivity and quality of the production not that good. That's why we will create an automatic control system for the roaster to help increasing the effectivity and quality of the coffee production. The automatic control system we use is to control the heat of the roaster by using image processing to see either the beans already well cooked or not. The use of image processing is intended to assess the colour change of beans as the cooking process in progress.This would enables the system to shut the heat off. This technique would be time efficient and improve the quality.

***Keywords**: Coffee Beans, Roaster, Image Processing*

I. INTRODUCTION

Indonesian coffee beans' production rises every year significantly, but the quality of the coffee is poor especially the homebased industry produced by farmers. One of the way to improve the quality is to create a machine which is simple for farmers to use but still able to compete with coffee factories.

Based on this fact, the farming after process is still not good. With this kind of problem, there will be some reduction in the coffee price. To help in maintaining that kind of problem, there is coffee roaster. Even though there're lack of technology applied in the current roaster, but it still help to maintain the problem in some degree.

The technology that had been made for this same purpose still have quite some downside, mainly in the aspect of the roaster's heat source. What we have till now is a roaster that use a stove to create the heat that it needs. That's why it needs a lot of time to reach the temperature needed for the roasting process. The other downside is that it still use a conventional method in determining either the beans is already well cooked or not and that makes the effectivity and quality of the production not that good. That's why we will create an automatic control system for the roaster to help increasing the effectivity and quality of the coffee production. The automatic control system we use is to control the heat of the roaster by using image processing to see either the beans already well cooked or not. The use of image processing is to see the change of colour on the beans as it cooked and using that information to shut the heat off. By using this method, we hope to increase the effectivity and quality of the

production. This method also help to reduce the workload of the user, so they don't need to check the beans condition all the time.

II. COFFEE ROASTER

Roasting is a process to change physical and chemical condition of coffee beans. The roasting process gives some changes to the flavor characteristic of the coffee by changing the beans such as size, color, taste, smell, and the density of the coffee beans. The coffee beans that still not roasted have the same amount of acidic, protein and cafein with roasted coffee beans, but lack in taste because of the heating process in roasting the beans.

A. Roasting Process

The roasting process is mainly consists of selecting the coffee beans itself, roasting, cooling and also packing. Huge roasting process selecting and collecting the beans manually or using machine then cleaned those beans. After that, the beans are weighed and moved to the storage room. From the storage room those beans then moved to the roaster. The roaster itself processed in temperature between 240–275 °C (464–527 °F), and the beans roasted for 3 to 30 minutes [1].

Normally we can say that the roasting process is an endothermic process (absorbing heat), but at the temperature of 175 °C (347 °F) it changes into exothermic process (blowing heat) [2]. This means that the coffee beans heating itself which needs some changes to the heat source of the roaster. At the final step of the roasting process, the beans which already roasted are cooled outside the roaster using a blowing air. Sometimes the cooling process used water steam.

III. IMAGE PROCESSING

Image processing is a subject that quite developed since people know that computer not only processing text but also processing image. Image processing algorithm is very useful in the early development of visual system, it usually used to sharpening some information in an image, before major processes occur. One of the aspects that can be processed is color. In an image data capturing there are some information included, such as color data, light mirroring data that definite brightness and darkness for the image pixels [3].

A. RGB Colour

RGB format mainly used to define pixel in digital system. This is because it's easy to tell color in primary component such as Red, Green and Blue. There are some RGB specification such as 4 bite RGB (16 colors), 8 bite RGB (256 colors), 16 bit RGB (65535 colors or high color), 24 bit RGB (16 million colors or true color) till 32 bit RGB (4 billion colors or true color). In image processing, color is represented with hexadecimal number from 0x00000000 till 0x00ffffff. Black color is 0x00000000 and white color is 0x00ffffff. It shown that each color have nominal range of 00 (the decimal number is 0) and ff (the decimal number is 255), or having a grey degree of 256 = 28. That means it used a color range of (28)(28)(28) = 224 (commonly known as True Color in Windows).

Color processing using RGB color format is quite easy to be used since it's easy to calculate the color and represent it in RGB color format. One of the ways to do that is to apply normalization to the three color components. Normalization is needed moreover when the image is captured with some different brightness [3].

IV. AUTOMATIC COFFEE ROASTER

In the process of designing automatic control for the roaster there are two steps. First, in the roasting process, controller increases the temperature to 150 °C and also activating ac motor to cycling the cylinder. The second process is when the controller activating the other two ac motors that are used one as a blower and the other one to stir the cooling device. The block diagram system can be seen in figure 1.

A. Working Process

Before the coffee beans enter the roaster, controller is activating one of ac motor to cycle the cylinder. It's also activating the heater so inside the cylinder the temperature reaches 150 °C. When the required temperature is achieved, the beans (weighing 15 Kg) putted into the roaster. While the roasting process is on, the controller must keep the temperature exactly around 150 °C using the temperature sensor. On top of the temperature sensor, there is also another sensor (a camera) used to check either the beans already well cooked or not through its color. When the color is the same as the reference, the roaster is stopping.

When the roasting process is off, controller is activating the other two ac motors to start activating the cooling device. One of the motor is used as blower, while the other one started to stir the device. There's another temperature sensor used to check the temperature around the beans, if the temperature finally reaches 38 °C then the cooling device is

stopping.

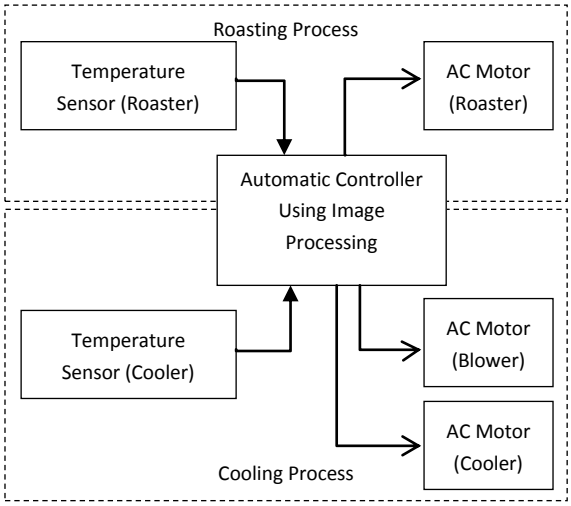

Fig. 1. Block Diagram Coffee Roaster Control System

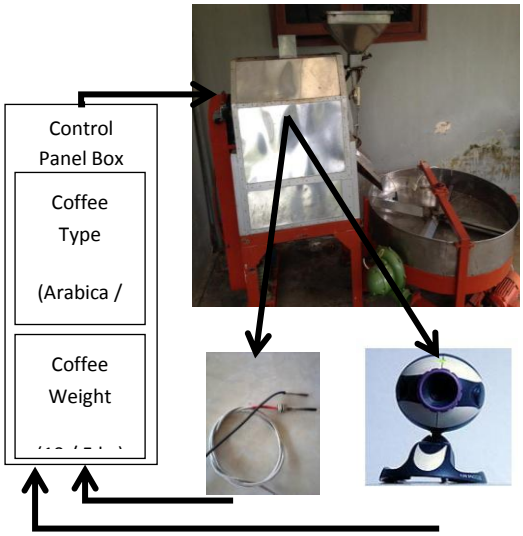

Fig. 2. Automatic Control Design

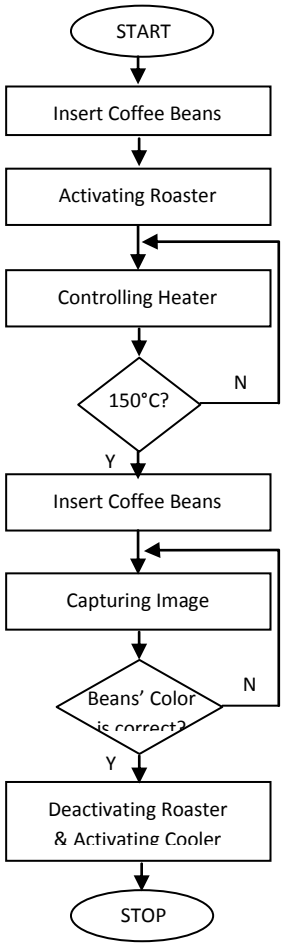

Fig. 3. Roasting Process Flowchart

B. Automatic Control System Design

In the automatic control design for the roaster, we create a main control panel with two choice menus, which are coffee weigh and type. To operate the system, user must define the type and weigh of the coffee first before starting the process so that the controller able to automatically maintain the roaster as needed. This panel is mainly used for controlling the roaster not the cooling device.

The benefit of this system is the temperature control maintaining the heat stability and also using image processing control to check the beans color so the roasted beans quality is maintained well. The controller will maintain the temperature and the time needed depend on the type and weigh of the coffee beans

since for each different kind of beans such as Arabica and Robusta have different moisture.

V. RESULTS AND DISCUSSION

As this research is still in progress, a discussion will be focused on the image processing phase. Using the roasted beans that produced of the normal farmers' roasting method, we get the hexadecimal number for both the Arabica beans and Robusta beans as follows:

Arabica beans: 0x0000196E to 0x00014178

Robusta beans: 0x00001755 to 0x00002E3B

Fig. 4. Roasted Arabica beans

Fig. 5. Roasted Robusta beans

Using those hexadecimal numbers as the set point to check whether the coffee beans already cooked enough or not, we started the automation roasting process. Finally after ten times of doing the automation roasting process, we gained the data bellow. We use rough percentages to easily record the data.

From both tables, we can clearly see that the automatic roasting process using image processing isn't showing a good result since the finely cooked coffee beans percentage only around 40-60%. But we can't say that using image processing in determining the roasted beans cooked level isn't good since there are few factor that makes it shown such a low result.

First factor is that in the farmer's home industries, they didn't differentiate the sizes of coffee beans. It means that they use mixed size coffee beans which is bad since there is a different density for each size and that means there is a different roasting time for each size. The second factor is that there is smoke inside the roaster which resulting the image captured by the camera having low quality. Of course by using low quality images it will giving low results too.

Table 1. Arabica Coffee Beans Roasting Process Results

Roasting Process Attempts	Under Cooked	Properly Cooked	Over Cooked
1.	35%	40%	25%
2.	25%	55%	20%
3.	25%	60%	15%
4.	15%	60%	25%
5.	25%	45%	30%
6.	30%	50%	20%
7.	15%	60%	25%
8.	20%	55%	25%
9.	15%	60%	25%
10.	35%	40%	25%

Table 2. Arabica Coffee Beans Roasting Process Results

Roasting Process Attempts	Under Cooked	Properly Cooked	Over Cooked
1.	30%	50%	20%
2.	15%	60%	25%
3.	30%	45%	25%
4.	30%	40%	30%
5.	10%	60%	30%
6.	20%	55%	25%
7.	15%	60%	25%
8.	20%	40%	40%
9.	15%	55%	30%
10.	20%	60%	20%

VI. CONCLUSION

The effectiveness of using automatic roaster using image processing for roasting coffee beans is around 40-60%. Because of the low score of effectiveness it also means that the quality of the product is also low. That's why we need to do something to increase the effectiveness by solving

the problems which are causing the low score.

VII. FUTURE WORK

The next thing we need to do in this research is of course to completely finishing the whole research till the cooling process. But before that we need to annihilate or at least reduce the smoke inside the roaster for having a better image captured by the camera. And if possible, we need to use one size coffee beans in the roasting process so that we could check whether the usage of this method is good or not.

REFERENCES

[1] Kenneth Davids, "Home Coffee Roasting: Romance and Revival," St. Martin's Griffin, 2003.

[2] Raemy A., Lambelet P., "A calorimetric study of self-heating in coffee and chicory," Int J Food Sci & Tech, 1982.

[3] Usman Ahmad, "Pengolahan Citra Digital," Yogyakarta: Graha Ilmu, 2005.