

Filtering Of Faded Coffee Beans Using Image Processing

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Abstract: Faded defect coffee beans have alterations in the normal color due to iron deficiency in the soil, excessive time in the dryer, or if it is stored for a long time. The research aims to use image processing to differentiate and filter faded coffee beans from the quality coffee beans. A set of a quality coffee bean is used as a reference for color thresholding to identify which coffee bean is faded. It is then removed from the image, leaving only the quality coffee beans. The image processing done had successfully filtered out the faded coffee beans from the quality ones.

Index Terms: Coffee, Image Processing, Thresholding, Faded Defect

1. INTRODUCTION

One of the most valued and significant beverage in this world is coffee [1]. Better quality beverages are associated with more equilibrated sensorial attributes[2]. Coffee bean's cost relies on its quality, which directly correlates with its final product's flavor[3]. There are many factors affecting the quality of the coffee. The quality of coffee beans is traditionally determined by subjective visual inspection, which requires significant effort and time and is susceptible to error [4]. Every coffee bean sample is evaluated by its condition, appearance, and size [5]. The typical way to determine the best coffee bean is by its color. For green coffee beans, color variation is a powerful indication of the occurrence of oxidative processes and natural enzymic biochemical transformations that change the structure of the beans responsible for the flavor and fragrance of the coffee[6], [7]. Visual inspection quickly assesses the kinds of coffee beans and their quality. But human-inspectors' decision-making capacity is subject to external factors such as fatigue, atmosphere, light, emotion, bias, etc[3].

One of the crucial points is the harvesting period, it is essential to have techniques to produce good quality coffee, the degree of coffee fruit ripeness and the prevention of mold contamination during harvesting, drying, and storing of the seeds.[8]. After picking, coffee beans are sun-dried for about 20 days and due to some external factors some of the beans might be damaged [9], [10]. Another important process that affects the bean quality is the roasting, it is the chemical process consisting of heating and evaporation of moisture in the coffee that changes the color and flavor of it [11]. Without proper processes, the quality of a coffee bean could decrease and ultimately be a defect. Uneven drying or re-wetting after drying, storing in bad conditions storage, long time in storage, excessive time in the dryer, or high temperature during drying, all of which can lead to a "Faded" coffee bean, where it loses

its color which is undesirable. By using Matlab the faded coffee bean can be identified and be separated from the good quality coffee beans. MATLAB is the simplest and widely used software in Image processing. In the Image processing algorithm, information can be extracted and also diseases can be determined, etc. It has been used in many areas, including radar systems, medical science, remote sensing, air traffic control systems, and forensic sciences [12]–[16]. Image processing toolbox based on MATLAB offers a broad range of referenced algorithms, techniques and apps for image processing, visualization, and segmentation. MATLAB takes each input as a matrix and performs an image-based algorithm[17]–[19]. MATLAB analyzes the RGB values for every pixel efficiently used for image processing [20]. It could also be used not only to discriminate against a coffee's black bean defects but also to address other color-related quality flaws [21]. RGB is the acronym for colors red, green, and blue. The resulting color is produced by these spectral components [22]. Color Thresholding is another commonly used tool in MATLAB Image processing. The color thresholding function is to separate an image into the region according to the predefined criteria [23], [24],[25]. By finding the RGB of a good quality coffee bean a comparison between the RGB values of the sampled coffee bean and the coffee beans to be tested can be done. The comparison can then determine which coffee bean is faded and which is not, and then filter the faded coffee bean out of the image, leaving only the good quality coffee beans.

2 MATERIALS AND METHODS

2.1 Review Stage

The purpose of this study is to make a series of codes that will determine and filter a faded defect coffee bean to a quality one. The filtering of the faded defect coffee bean was made using color thresholding and a set of codes done in the software Matlab. Figure 1 shows an image of a set of coffee beans to be tested and filtered. The bean on the third row, the fifth column has a faded skin. The researchers aim to remove it from the image after it was analyzed, leaving only the normal ones.

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Figure 1. The original picture ('DSC00522.jpg')

The image was shown on the software by using the command "imread('Name of the image.jpg')". After obtaining the image, a range of values for the colors red, green and blue are needed to be established. This is to determine the base average color of the coffee bean. Values are extracted from the image by the command "impixel(variable)". Its purpose is to obtain the RGB values of a point picked by the user. The researchers picked five points of reference per bean as shown in figure 2. After that, the average value for the colors red, green and blue was obtained. The values were added and subtracted by 40 to set the range needed.

3 RESULTS AND DISCUSSION

The aim of this research is to make a set of codes that differentiate a coffee bean with a faded defect on its skin from the good quality ones and also to filter it out of the image.

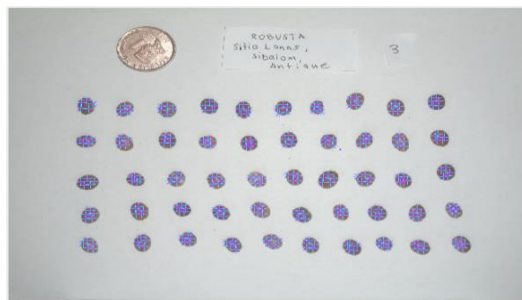


Figure 2. Coffee beans with picked points

Table 1 shows the average values of the colors and their range.

Table 1. RGB average values of the beans

Color	Average Value	Range
Red	136.58	96.58 to 176.58
Green	111.164	71.164 to 151.164
Blue	85.44	45.44 to 125.44

Then the variables for the colors were established, the command below was used in the study.

```
>>red = a(:, :, 1); green = a(:, :, 2); blue = a(:, :, 3);
>> out = red < 176.58 & red > 96.58 & green < 151.164 &
green > 91.164 & blue < 125.44 & blue > 45.44;
```

The command above outputs the image in figure 3 below. It shows the extracted version of the image by using the ranges obtained. As you can see, some of the beans were not perfectly whole and have holes in it, the command

"imfill(variable,' holes')". can be implemented to fill out the holes inside them. The filled-out version is shown in figure 4.

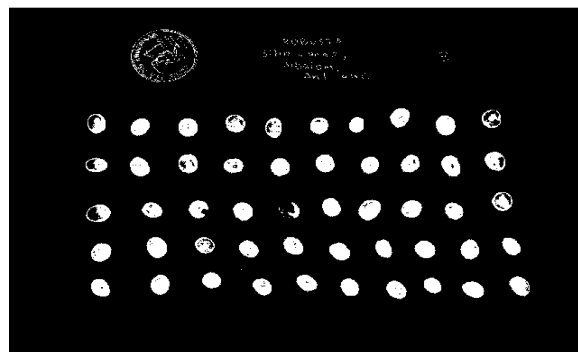


Figure 3. Extracted image from the original

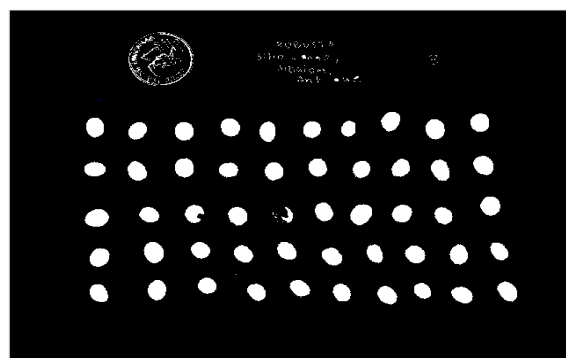


Figure 4. Extracted image with holes filled out

Now that the image was extracted, it is time to remove the ones that are not whole, in this case, the ones with faded defects. It is first needed to obtain the area values of each bean to know which ones will be filtered. Since the bean that has a defect is not whole, its area is only small. For this, the commands, shown in Figure 5 were used.

`L = bwlabel(BW)` returns the label matrix L that contains labels for the 8-connected objects found in BW. The label matrix, L, is the same size as BW.

`stats = regionprops(BW, properties)` returns measurements for the set of properties specified by properties for each connected component (object) in the binary image, BW. stats is struct array containing a struct for each object in the image. You can use `regionprops` on contiguous regions and discontinuous regions (see Algorithms).

Figure 5. bwlabel and regionprops commands

After the values were obtained, the defects or the beans that have an area value lower than the ones from the fine coffee beans will be extracted. It can be done by using the command "find(lowest range value <= area_values)" and "ismember". Figure 6 shows the image with the faded defect coffee bean extracted from the group.

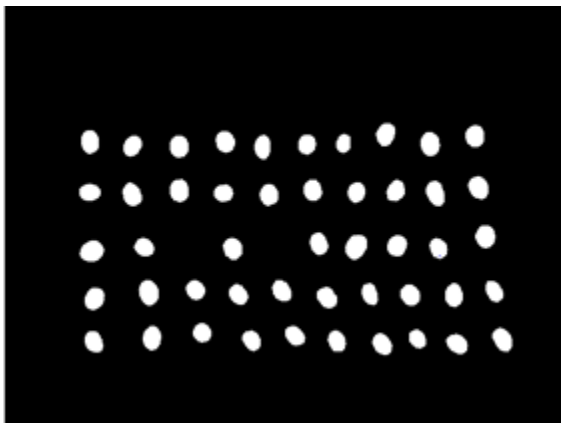


Figure 6. The image without the defective beans

In Figure 6, the defect coffee bean was successfully extracted from the image leaving only the fine ones. The Matlab codes used in the whole process were shown below.

```
>>a = imread('DSC00522.jpg');
>>b = impixel(a);
>>red = a(:, :, 1); green = a(:, :, 2); blue = a(:, :, 3);
>> out = red < 176.58 & red > 96.58 &
green < 151.164 & green > 91.164 & blue < 125.44 & blue >
45.44;
>>c = imfill(out, 'holes');
>>d = bwlabel(c);
>>e = regionprops(d, 'Area');
>>area_values = [e.Area]
>>idx = find(18000 <= area_values);
>>f = ismember(d,idx);
>>imshow(f);
```

The developed set of codes has successfully determined and filtered out the defect coffee bean from the extracted image.

4 CONCLUSION

The researchers successfully determine and filter the coffee beans with a faded defect on its skin from the quality ones. They used an image with a set of coffee beans and picked points on each bean for reference to determine the average color of a quality bean. Then the color thresholding was used to determine which faded coffee beans are and which a quality one is. The filter was done by exterminating the bean with a low area value than a regular one. The coffee bean with a faded defect in its skin has a small area since its shape extracted is incomplete or not whole. The defects were then removed from the image leaving only the good quality ones.

This technique applies not only to detect a coffee bean's faded flaws but also to other color-related quality defects.

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