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Colour Based Image Processing Method for Recognizing Ribbed Smoked Sheet Grade

To cite this article: Ike Fibriani *et al* 2017 *IOP Conf. Ser.: Mater. Sci. Eng.* **185** 012025

Colour Based Image Processing Method for Recognizing Ribbed Smoked Sheet Grade

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Abstract. This research proposes a colour based image processing technique to recognize the Ribbed Smoked Sheet (RSS) grade so that the RSS sorting process can be faster and more accurate than the traditional one. The RSS sheet image captured by the camera is transformed into grayscale image to simplify the recognition of rust and mould on the RSS sheet. Then the grayscale image is transformed into binary image using threshold value which is obtained from the RSS 1 reference colour. The grade recognition is determined by counting the white pixel percentage. The result shows that the system has 88% of accuracy. Most faults exist on RSS 2 recognition. This is due to the illumination distribution which is not equal over the RSS image.

1. Introduction

Rubber is a commodity which is used as a material in many appliances of human life. There are two kinds of rubber, namely natural rubber and synthetic rubber. Natural rubber is made from latex of para rubber tree, while synthetic rubber is made from crude oil. These two kinds of rubber have different utilizations, although they actually able to replace each other. The natural rubber is often used when the crude oil supply is in a few amount and vice versa. Indonesia is the second largest natural rubber producing country in the world. In 2011, Indonesia contributed 27.3 % of rubber production. The manufactured natural rubber in Indonesia generally is formed into rubber crepe or rubber sheet. The natural rubber which is formed into sheet is called Ribbed Smoked Sheet (RSS).

There are some processes in forming natural rubber into RSS, namely harvesting rubber from the tree (the rubber is in the form of latex), latex dilution, latex coagulation which forms the latex into rubber, rubber milling, rubber smoking process, and rubber sorting process. Sorting process is necessary because previous process produces different qualities/ grades of rubber sheet which also have different economy aspect in the market, they are RSS 1, RSS 2, RSS 3, RSS 4 and RSS 5 [?]. In traditional sorting process, RSS is sorted manually by the worker based on the colour of the RSS. This sorting process has some weaknesses because it depends on human perception which is not consistent. Due to this problem, an automatic system which can recognize the RSS grade is needed. The system must consist of a programmed camera which will capture the RSS surface and use it to automatically recognize the grade of the RSS with the use of an image processing method on its algorithm.

A previous work [?] has designed RSS grading system which has a good result with nearly 81% precision, but the system proposed is quite complex which needs 10 seconds of access time and still has error in recognizing the RSS quality. RSS grade can be recognized based on its colour, therefore a system based on image processing is suitable for RSS automatic sorting system process. Image processing has been used widely in many aspect including agriculture industry. Paper [?] used colour based image processing for fruit sorting system, another paper [?] used it to check the rice grade. Moreover, colour based image processing has been used in estimating air quality and fire detection [?, ?, ?]. This article proposes a based image processing method for recognizing the RSS so that the sorting process becomes more accurate and faster than the traditional one.

2. Ribbed Smoke Sheet

RSS is divided into six categories based on The Green Book-International Standard for Quality and Packing for Natural Rubber Grades, although many manufacturers do not always produce all the six categories. In this article, only three categories (RSS 1, RSS 2 and RSS 3) will be discussed and observed. These three RSS can be distinguished by its physical properties. RSS 1 must be dry, clean, strong, sound, and free from blemishes, resinous matter (rust), blisters, sand, dirty packing and any other foreign matter. RSS 2 must have at most 5% of rust and dry mould, while RSS must have at most 10% of rust and dry mould [?]. The samples of these three RSS rubbers are shown on Figure ??.

Figure 1. Comparison of different grades of RSS surface from left to right RSS 1, RSS 2, and RSS 3 (http://www.psc-rubber.com/)

3. Method and Model

The complete RSS recognizing algorithm is shown in Figure ??. RSS 1 surface has no rust and mould so it is considered having a smooth surface and a brighter colour than other RSS. So, the idea of the algorithm is making the pixel colour of RSS 1 as a reference point to detect the percentage of how much rust and mould on an unknown grade RSS which will be sorted. The percentage of the rust and mould of the RSS will determine its grade. When the RSS is captured by the camera, its image is on the RGB model. This model of image causes some difficulties when we try to compare between the RSS 1 reference pixel with an unknown grade RSS since a pixel in the image consist of three values namely red, green and blue. For simplifying the comparison, both RSS 1 reference pixel and unknown grade RSS are transformed into grayscale image. Grayscale image is chosen because its pixel only has one value and it represents the darkness level or the luminance of the RSS which can distinguish a smooth surface and a surface with rust and mould. RGB image is transformed into grayscale image using Equation ??.

$$I_{GS}(x,y) = \frac{I_R(x,y) + I_G(x,y) + I_B(x,y)}{3} \tag{1}$$

where $I_{GS}(x,y)$ is a grayscale value of an image pixel, $I_R(x,y)$ is red value of a RGB image pixel, $I_G(x,y)$ is green value of a RGB image pixel, $I_B(x,y)$ is blue value of a RGB image pixel and (x,y) is the pixel coordinate in an image.

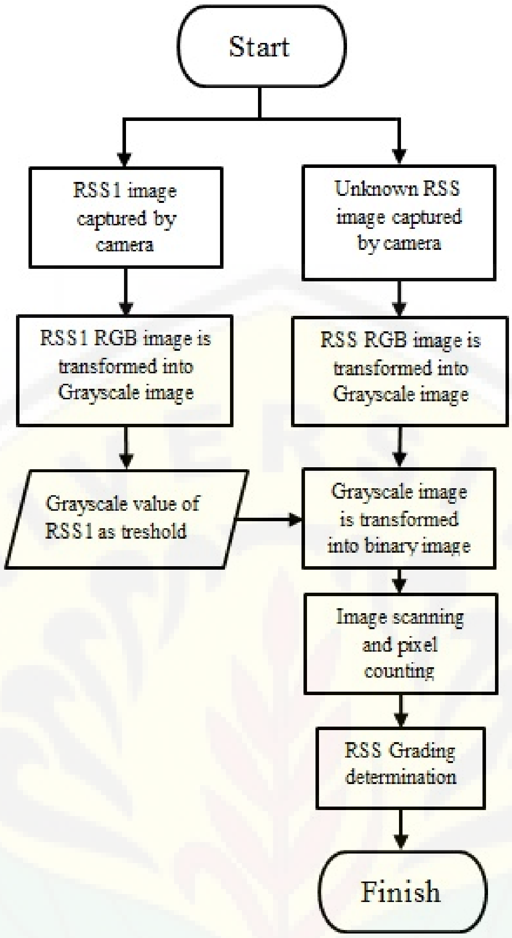


Figure 2. Flowchart of colour based image processing algorithm for recognizing RSS grade

After grayscale transformation, the unknown grade RSS is transformed into binary image using Equation **??** with the grayscale reference pixel as the threshold. This process produces a binary image with white pixel represents the smooth surface and black pixel represents the rust and mould. Next step, the binary image is scanned to count the percentage of the black pixel (rust and mould) compare to all pixels in the image. Having the percentage of black pixel, the unknown grade RSS can not be directly graded using the The Green Book rule (RSS 1 has 0%, RSS 2 has 5%, and RSS 3 has 10% of black pixels/rust and mould) because the RSS image captured by the camera is always affected by the environment illumination which often produces noise or black pixel on the binary transformation. In order to find the right percentage of white pixel for grading rule, the statistical data must be obtained. Twenty sheets of each RSS 1, RSS 2, and RSS 3 are tested to find the white pixel percentage. The process ends when the RSS grade has been recognized. Each of the colour model transformation is shown on Figure **??**.The system which has been designed is tested to recognized the grade of a hundred sheets of known grade RSS.

$$I_{bin}(x,y) = \begin{cases} 0 & if \quad I_{GS}(x,y) < T \\ 255 & if \quad I_{GS}(x,y) \geq T \end{cases} \tag{2}$$

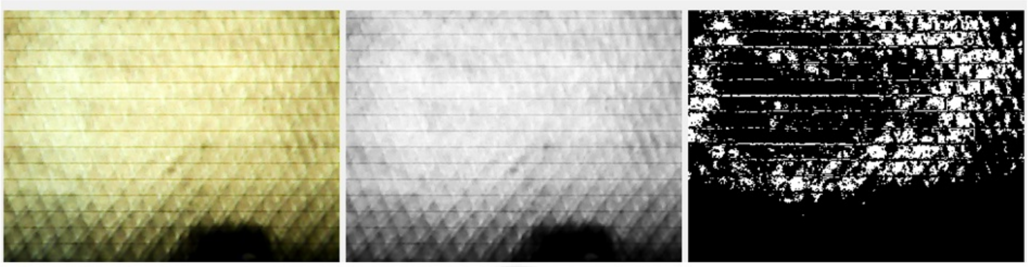

(a) (b) (c)

Figure 3. A sample of RSS image in (a) RGB model captured by camera, (b) Grayscale model after transformation, (c) Binary model after threshold process

where $I_{bin}(x, y)$ is a binary value of an image pixel, $I_{GS}(x, y)$ is a grayscale value of an image pixel, (x, y) is the pixel coordinate in an image and T is the threshold value.

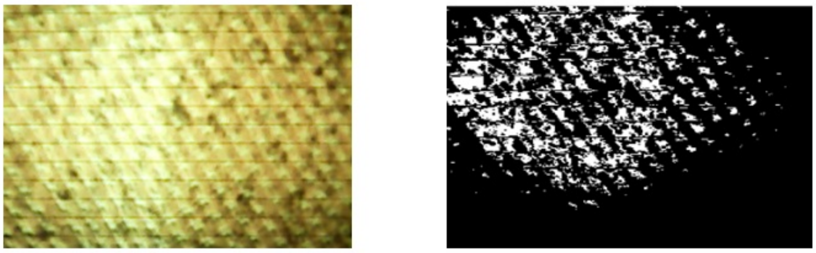
4. Result and Discussion

Statistical result of pixel percentage in each grade of RSS is shown in Table **??**. It has been discussed on previous chapter that the white pixel percentage which represents smooth surface on RSS 1 can not reach 100% (0% rust and mould) due to illumination effect. It makes the RSS 1 has about 73% of white pixel. The RSS 2 statistical result shows that RSS 2 has a range of 34-72% white pixel. Comparison of RSS 1 and RSS 2 result shows that the system works properly that the RSS 2 has less white pixel or has more black pixel which represents more rust and mould.

Table 1. Black and white pixel percentage statistical result compared to actual rust and mould percentage

RSS grade	rust & mould	black pixel	white pixel
RSS 1	0%	$0 - 27\%$	$73 - 100\%$
RSS 2	5%	$28 - 66\%$	$34 - 72\%$
RSS 3	10%	$> 67\%$	$< 34\%$

The system is then tested to recognize a hundred random known sheets. The result shows that from a hundred sheets there are twelve false recognitions. Among twelve false recognitions, there is only one fault on RSS 1 recognition, none of them is on RSS 3 and eleven faults are on RSS 2 . This means that the system is 100% accurate in recognizing the RSS 3. The system is also almost perfect in recognizing RSS 1. The real problem is on RSS 2 recognition which produces eleven faults out of forty one sheets (randomly forty one sheets of RSS 2 is selected to be tested). Most faults happened are the RSS 2 sheet is graded as RSS 1 sheet. One sample of the fault is shown in Figure **??**. From the image, it can be seen that the illumination affects the system. There are some area with darker colour in the edge of the image and there are some are with brighter image on the center of the image straight to the camera. This illumination unequal illumination distribution produces difference noise which can not be tackled by statistical threshold. This weakness can be solved by conditioning the environment area and adjusting illumination distribution. Even with the faults, in RSS 2 recognition, the system still obtain a good result with 73% of accuracy.



(a) **(b)**

Figure 4. A sample of RSS 2 image with fault recognition in (a) RGB model captured by camera, (b) Binary model after system process

5. Conclusion
The statistical result produces two threshold value to distinguish the RSS grade namely 34% and 73% white pixel on the image. The system can work properly in overall RSS grade recognition with 88% of accuracy. Most faults are found on RSS 2 recognition. This fault is exist due to illumination effect to the image which produce noise or black pixel which can not be tackled by the system statistical threshold. On the next research there must be a designed system which can assure the equal distribution of illumination over the RSS image so that the noise can be decreased significantly.

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