Swietenia Mahagoni Wood Defects Segmentation Using YIQ Color Space and Thresholding

Sri Rahayu¹, Nurul Qhomariyah², Jajang Jaya Purnama³, Dwiza Riana⁴, Yuni Eka Achyani⁵, Fattya Ariani⁶
Program Studi Ilmu Komputer STMIK Nusa Mandiri¹-⁴
Program Studi Sistem Informasi STMIK Nusa Mandiri⁵-⁶
E-mail: dwiza@nusamandiri.ac.id

Abstract. The biggest income from Southeast Asian countries came from timber production export activities. The potential for timber exports in Indonesia continued to increase every year. This skyrocketing potential needed to be improved by maintaining quality so that trust and good cooperation continued to be established. The quality of wood has closely related to wood defects, the faster detection of wood defects would be the faster also determines the quality of wood. Current technology has been developing rapidly to help productive human activities, image processing has been a breakthrough to be able to detect wood defects. This study aims to detect wood defects by segmenting Swietenia Mahagoni wood images by using the YIQ color space and Thresholding has resulted in a fairly good segmentation that is successful in segmenting the types of bark grown wood defects on bontos and defects in healthy knot on the body of wood with each percentage of 83.3%.

1. Introduction
The tropical rain forests in Southeast Asia had more than 15,000 different plant species, which comprise around 3000 categories of wood species. The biggest income from Southeast Asian countries came from timber production export activities [1]. Based on WITS (World Integrated Trade Solution) data in 2018, Indonesia’s wood exports were spread in 191 partner countries. Among Indonesia’s top wood export partner countries including China with a selling value of $ 3,170,496.63 (26.83%), Japan with a selling value of $ 1,375,878.33 (11.64%), the United States with a selling value of $ 838 865, 3 (7.10%), the Republic of Korea with a selling value of $ 753,413.46 (6.38%), and India with a selling value of $ 524,449.63 (4.44%). While the other 43.61% is about 186 other partner countries with a selling value of $ 5,152,764.85[2].
Swietenia Mahagoni (King Swietenia macrophylla) is a species that was known throughout the world and most important is economical because of the inherent characteristics of wood, such as easily formed, while mechanical resistance, high dimensional stability and interesting aesthetic aspects[3][4].

So there is no doubt that Swietenia Mahagoni wood or which is called with mahogany is included in wood that has exported by Indonesia with increasing value. This potential needs to be continuously improved while maintaining quality so that trust and cooperation continue to be well established. The quality of wood products is very dependent on the strength of wood. Defects in wood, especially knots might reduce the strength of wood[5]. Currently the determination of wood quality based on existing defects has still done manually by wood testers.
without any tools. This research aims to convey a technology-based solution by creating an image processing system to segment the defects of swietenia mahagoni wood which often occurs as an initial step to detect wood defects to determine the quality of the wood.

Image processing research on wood defects is not the first, before researchers have written various studies, An improved binarization algorithm of wood image defect segmentation based on non-uniform background by [7] has segmenting wood defects using the proposed method namely image binarization optimization algorithm based on local threshold shows that it can improve segmentation for wood defect images on complex backgrounds. An improved Otsu method using the weighted object variance for defect detection by [8] proposed an increase in the otsu method, called Weighted Object Variance (WOV) to segment surface defects, was developed from the otsu threshold, previously mentioned segmentation with thresholding separating the background from the object [9]. From these various sources, the authors feel compelled to conduct research on wood defects using datasets taken from Indonesia’s Forests by segmenting defects in mahogany wood that often occur and have a major influence on quality with segmentation techniques using thresholding which were previously converted to the YIQ color space (Luminance, Inphase, Quadrature).

2. Method
The research method carried out by the author to realize the technological solutions discussed earlier is as illustrated in the following figure:

![Research Method](image)

**Figure 1. Research Method**

2.1. Observation
The data that will be processed was taken from observations to a TPK (Wood Storage Area) in West Java by digging information directly from a team of wood testers who have proven competent by Ministry of Environment and Forestry.

2.2. Image Acquisition
Data collection is done by taking your own image using an Handphone Realme 3 whose camera size is 13 MP with a distance of the object and the camera is about 30 centimeters in solar lighting around 12 noon West Indonesia Time.
2.3. Resize
Image taken manually, generally cannot be directly processed because the image size is too large, then change the image size from 4160 x 1968 pixels to 416 x 197 pixels and change the image format .jpg to .Bmp so that the image becomes easier to use.

2.4. Color Conversion
Before segmentation, the initial image with RGB (Red Green Blue) color space is converted to YIQ color space. The YIQ color space is defined by the NTSC (National Television System Committee), Y represents lighting or image intensity, while I and Q (in-phase and quadrature) represent chroma or color information, Q also shows the color depth in the image[10][11].

2.5. Color Extraction
Images that are already in the YIQ color space are extracted every component of Y, I and Q to find out the lighting chroma, color patterns and intensity or color depth in the image. Each color composition of the histogram was raised, so that the color tendency can be seen. A histogram in image processing is a graphical representation for the color distribution of a digital image or illustrates the spread of pixel intensity values of an image or certain parts of the image. From a histogram relative frequency of occurrence of intensity in the image, brightness, and contrast of an image can be seen [12][13].

2.6. Segmentation
The result of extraction from the YIQ color, the Q value representing the intensity or depth of the color is then carried out Thresholding with a value of 0.5. The threshold value also important when image will be classified[14]. Binary images are digital images that have only two possible pixel values, namely black and white. Binary images are also referred to as B&W (Black and White) or monochrome images[15][16]. With so visible disability area, then clarified again by doing a conversion to the RGB color space and added yellow coloring to the defects area.

3. Result and Discussion
From the various stages of the research method conducted using matlab2015, it produces a good segmentation of mahogany wood defects, in this study the authors focus on 3 types of defects, namely bark grown on bontos, healthy knot and rotten defects on the body. If in previous studies [7] optimizing binary images from the local threshold can be segmented on 2 types of defects, black spherical vertex defects and creeping cracks, then this study segmented 3 different types of wood defects that have almost the same texture color not as prominent as the knot defects in the previous case, then the last stage carried out in the previous study produced a binary image that shows the position of the defect area while in this study the image is returned to the RGB color space as the original image with a yellow mark on the disability area so that users know in real terms from the original image. Almost the same as [7], research [8] proposes an increase in the otsu method of the otsu threshold also segmenting surface defects with the final result in the form of binary images, as well as [9] using thresholding to separate the background from the object.

3.1. Original Image
The original image obtained from the image acquisition and then collected it, pre-processed so that it is ready for image processing. The following is an example of the original image of wood defects based on their class:
Table 1. Image of Wood Defects

| Types of Wood Defects | Example Image |
|----------------------|--------------|
| Bark Grown defects   | ![Example Image](image1.png) |
| Healthy knot defects | ![Example Image](image2.png) |
| Rotten knot defects  | ![Example Image](image3.png) |

3.2. Color Conversion
The image processing technique that was first performed was by converting an RGB image into a YIQ color space by pouring it on each composition Y, I and Q.

Table 2. Image Conversion RGB to YIQ

| Original Image | Y Image | I Image | Q Image |
|----------------|---------|---------|---------|
| ![Original Image](image4.png) | ![Y Image](image5.png) | ![I Image](image6.png) | ![Q Image](image7.png) |
| ![Original Image](image8.png) | ![Y Image](image9.png) | ![I Image](image10.png) | ![Q Image](image11.png) |
| ![Original Image](image12.png) | ![Y Image](image13.png) | ![I Image](image14.png) | ![Q Image](image15.png) |

3.3. Defect Segmentation
Wood defect segmentation is done by using Thresholding from Q layer of image that has been converted to YIQ space, after segmenting, image segmentation is clarified in yellow by returning the color space to RGB again.

3.4. Success Rate of Segmentation
This segmentation experiment conducted on self-captured images results in the following success rates:
Table 3. Wood Defects Segmentation

| Original Image | Segmentation | Result |
|----------------|--------------|--------|
| ![Original Image](image1) | ![Segmentation](image2) | ![Result](image3) |
| ![Original Image](image4) | ![Segmentation](image5) | ![Result](image6) |
| ![Original Image](image7) | ![Segmentation](image8) | ![Result](image9) |

Table 4. Success of Segmentation

| Type of Wood Defects | Samples | Segmented Image | Percentage |
|----------------------|---------|-----------------|------------|
| Type 1               | 18      | 15              | 83.3%      |
| Type 2               | 18      | 15              | 83.3%      |
| Type 3               | 18      | 11              | 61.1%      |

In Table 4, we can see that the segmentation was successfully done on the Bark Grown Defects there were 15, in Healthy Knot Defects there were 15 and in the Rotten Knot Defects there were 11, one of the factors that caused the less successful segmentation of the Rotten Knot Defects on the body Mahogany wood is because the disability is not merely circular as in Healthy Knot Defects so it is rather difficult to segment.

4. Conclusion

Given Indonesia’s potential for its abundant timber output, the quality of wood must be maintained. Based on the problems that occur in the field that the sorting of wood quality can be seen from how many defects that occur and in which part of the occurrence that is done manually, it’s so long time and a high level of accuracy, it is indeed necessary to have technological assistance that can detect defects wood so that it is faster, accurate and efficient. Image processing carried out using the YIQ color space and Thresholding turned out to be able to segment well, that is, successfully detecting wood defects that often occur in Swietenia mahagoni wood including bark grown on bontos that were detected as many as 15 images from 18 images of wood defects (83.3% ), healthy knot defect on bodies that were successfully detected as many as 15 images from 18 defective wood images (83.3%) and rotten knot defect on the body that was detected as many as 11 images out of 18 defective wood images (61.1%). Judging from the level of success, which is segmented very well is the type of bark grown defects and healthy
knot defect, while other defects still need to be improved for further research.

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