

# Correlation of Wood Coconut Quality to the Bundle Density in its Digital Image

Ottopianus Mellolo  
Manado State Polytechnic  
Jl.Raya Politeknik Ds.Buha  
Manado, North Sulawesi

Toban T. Pairunan  
Manado State Polytechnic  
Jl.Raya Politeknik. Ds.Buha  
Manado, North Sulawesi

Eliezer M. Rongre  
Manado State Polytechnic  
Jl.Raya Politeknik Ds.Buha  
Manado, North Sulawesi

## ABSTRACT

Coconut wood has a variety of benefits, namely as a fuel, also used as building material for wooden houses, with a unique texture of coconut wood which is widely used as furniture such as table chairs and cabinets, besides that, with the beauty of the texture of coconut wood, many are made as souvenirs. One of coconut wood quality parameters is the strength of wood in this case the strength of coconut wood holds the loads. This study was directed to determine the correlation between bundle density in digital image of coconut wood and its quality especially the quality of compressive strength. The research phase starts from the preparation stage where coconut wood samples are taken from local coconut species in North Sulawesi with various ages, after going through various preparatory treatments. The sample is then taken the digital image and the sample is also through a compressive strength test. Bundle density values in images obtained through image processing operations to extract the desired features. Coconut wood image sample through a series of image manipulation processes, such as Gray Scale, Histogram Equalization, Threshold, Opening, Invert, and mathematical calculations, on the other hand as comparative values, the same sample was tested by giving the maximum load so that the compressive test value of each sample was obtained, using a simple statistical test obtained a correlation value between bundle density and compressive test strength of 0.64325 and forming a regression equation  $y = 0.13734x + 12.9874$  so it can be concluded that bundle density has a strong correlation to the quality of coconut wood

## Keywords

Image processing, Coconut Wood,

## 1. INTRODUCTION

Generally coconut wood is obtained from coconut trees that are not productive fruiting, for local coconuts in North Sulawesi such as Kelapa Dalam Mapanget has a production period approximately 50 years and after that it will decrease, at this time usually coconut farmers will rejuvenate their coconut plants, unproductive coconut trees are then cut and harvested, old coconut wood generally has better quality compared to the young both in terms of texture and color. Coconut wood has a variety of benefits namely as a fuel, also used as building material for wooden houses, with a unique texture of coconut wood which is widely used as furniture such as table chairs, cabinets and souvenir.

soft parts of wood generally on the outside or near the skin but different from coconut wood instead the hardest part is the closest to the skin because this coconut stem has vascular bundles that spread more tightly on the edges near the skin and the base part of the center of the stem and end of the stem, this results in coconut sawn timber having different strengths

even though taken from the same coconut trunk, Consumers who want to choose coconut wood so far, usually only using manual methods such as observing the appearance of wood fibers, wood is compared to one another and what is chosen is one that has a rough surface and denser density of bundles, this method is an selection method that only chooses the best among those available without a certain standard about the strength of wood to be selected, this study tries to prove how the relationship between bundle density and coconut wood quality, especially compressive strength. By utilizing digital image processing methods, bundle density can be identified. The results of image processing from coconut wood samples were then compared with the compressed test results on the same sample.

## 2. LITERATURE REVIEW

### 2.1 Digital Image

Digital image processing refers to processing two-dimensional images using a computer. In the broader context digital image processing refers to the processing of each two-dimensional data. Digital image is an array of real and complex values that are represented by a certain row of bits.

Digital image can be expressed as a two-dimensional function  $f(x, y)$ ,  $x$  and  $y$  is the position of spatial coordinates and amplitude  $f$  at the coordinate point  $(x, y)$  is called the intensity of the image on that point. If the value of  $x, y$  and the amplitude value of  $f$  is finite and discrete. Grayscale image is a digital image that has only one channel value in each pixel, the value is used to show the gray intensity level from black to white with an eight-bit color depth. Binary image is a digital image that has only two possible pixel values, black and white. It only takes one bit to represent the value of each pixel. [1]

Image quality improvement is an important pre-process step before analyzing and extracting feature from images. Histogram equalization is a method to improve the image by changing the distribution gray level of the image. This is intended so that the gray level distribution is more evenly distributed than the original image [2]

To extract the desired feature from an image, the object in the image must be separated from the background, the object's pixel and the background pixel are grouped into two domain modes. the threshold value ( $T$ ) that divides that modes then any point  $(x, y)$  for where  $f(x, y) \geq T$  is called the object point while the other is called the back ground point as defined in equation(1).

$$g(x, y) = \begin{cases} 1 & \text{if } f(x, y) \geq T \\ 0 & \text{if } f(x, y) < T \end{cases} \quad (1)$$

Pixels with a value of 1 are related to the object, while pixels that are 0 are related to the background,  $g(x,y)$  is a threshold pixel. This approach is called global threshold. [3]

## 2.2 Wood Compressive Strength

The main indicator of the quality of coconut wood can be seen from the large capacity of the wood to withstand the pressure that can be proven through the coconut wood press test. Some notions relating to this test method are:

- The compressive strength of structural building wood is the compressive force per unit area of the press field
- The compressive strength parallel to the direction of the fiber is the strength of the wood bearing the load acting on it which is parallel to the direction of wood grain
- Defective test specimens are wood test objects that are free of wood, sapwood, cracks, holes, molds, brittle and do not twist
- Newton is a unit according to the International System (SI) for the equivalent force of 0.1  $kg f$  and is written with N notation
- Mega Pascal is  $10^6$  Pascal equivalent to  $kg f / cm^2$  and is written with  $MPa$  notation
- Air dry wood is wood with a maximum moisture content of 20%

The parallel compressive strength of the fiber ( $f_{c//}$ ) is calculated as define in (2) by comparing the maximum test load ( $P$ ) per unit area of the press field ( $b \times h$ ).

$$f_{c//} = \frac{P}{b \times h} (MPa) \quad (2)$$

Scope of the testing method includes the requirements and method of testing wood with small defect free test items for air dry wood types. [4]

The characteristics of coconut wood are no homogeny both in longitudinal direction (stem height) or in radial or tangential direction transverse (stem diameter) and Conventional wood mechanical properties also apply on coconut wood. [5]

## 2.3 Correlation and Regression

Correlation coefficient ( $r$ ) is a value that is used to measure the level of closeness of the relationship between two variables ( $x$ ) and ( $y$ ) with number of data ( $n$ ). Correlation coefficients have values ranging from -1 to +1. Positive value (+) shows the relationship of two variables that are proportional or directly proportional. The correlation coefficient is 0 means that two variables are not related to each other. And the correlation coefficient is negative (-) meaning that two variables have inversely related relationships. The correlation coefficient can be calculated using (3)

$$r = \frac{n(\sum xy) - (\sum x)(\sum y)}{\sqrt{[n\sum x^2 - (\sum x)^2][n\sum y^2 - (\sum y)^2]}} \quad (3)$$

Curve matching is looking for smooth curves that are closest to the data but do not have to go through each data point. a minimum of two points is needed to define the line, the straight line connecting the dots represents linear

interpolation. The best straight-line approach that will be produced is better known as linear regression [6]

## 3. METHODOLOGY

### 3.1 Preparation Stage

Coconut wood sample preparation is carried out through the following stages :

#### 3.1.1 Sampling Process

The samples were taken from local coconut wood type namely *Kelapa Dalam Mapanget*, which were approximately 20, 40, 60, 80 and 100 years old, Each coconut tree trunk was taken in 10 middle / inner samples and 10 marginal / outer sample samples with a distance of 1/10 part of the tree length.



Fig. 2 Coconut wood samples

#### 3.1.2 Dimension and Water Content

Sample Test Preparation, wood samples which are the result of cutting using a chain saw machine have a very rough surface so that the sample needs to go through the stages of surface smoothing and adjustment to the measurement dimensions 50mm x 50mm x 200mm. Air Drying Preparation, the drying process is carried out by placing the sample in an open space (air drying) until a dry sample is obtained dry wood with a water content of less than 20%.

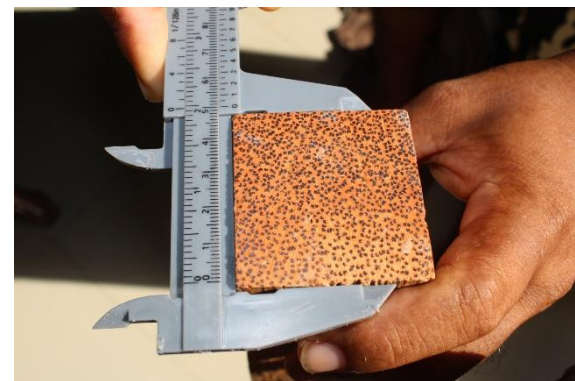


Fig.3 Dimension of wood coconut sample

#### 3.1.3 Image Acquisition

Image Acquisition Preparation, the coconut wood sample was then acquired by digital image on the cross-sectional side using a digital camera. Shooting using close up mode at a distance of 13 cm and lighting using camera flash, all digital image used has the same pixel size 1920 x 1280, the position of the sample image is tight on the right as in figure 4. The coordinates of the sample in the image lie in pixels (640, 1) to (1920,1280) in the form of a square with a size of 1280 x

1280 pixels, while the label of the sample information is in the coordinates of pixels (1.1) to (639.1280) rectangular.

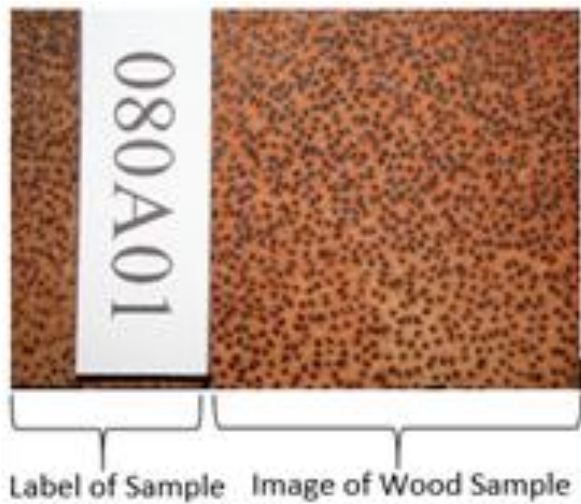


Fig.4 Digital image of wood coconut sample

### 3.2 Measurements

Measurement of coconut wood samples that have been prepared will be divided into two main processes:

#### 3.2.1 Compressive Strength Test

Compressive Strength Test Measurement, this test is carried out on the physical sample of coconut wood as shown in figure 5. by giving a load to get the maximum limit of the ability of the sample to withstand the given load



Fig.5 Compressive strength test of wood coconut sample

#### 3.2.2 Bundle Density measurements

Digital Image Sample Measurement, this measurement is done by extracting feature data contained in the digital image of coconut wood samples through a series of operations and image manipulation. Which can be described in the following flowchart shown in figure 6. The extraction process begins with the reading of digital images, while the sample image used physically is 1920 x 1280 pixels which still contains the sample label image and the image of the coconut wood sample as the main concern area, the image needs to be resized to get the image that becomes the region of interest to extract.

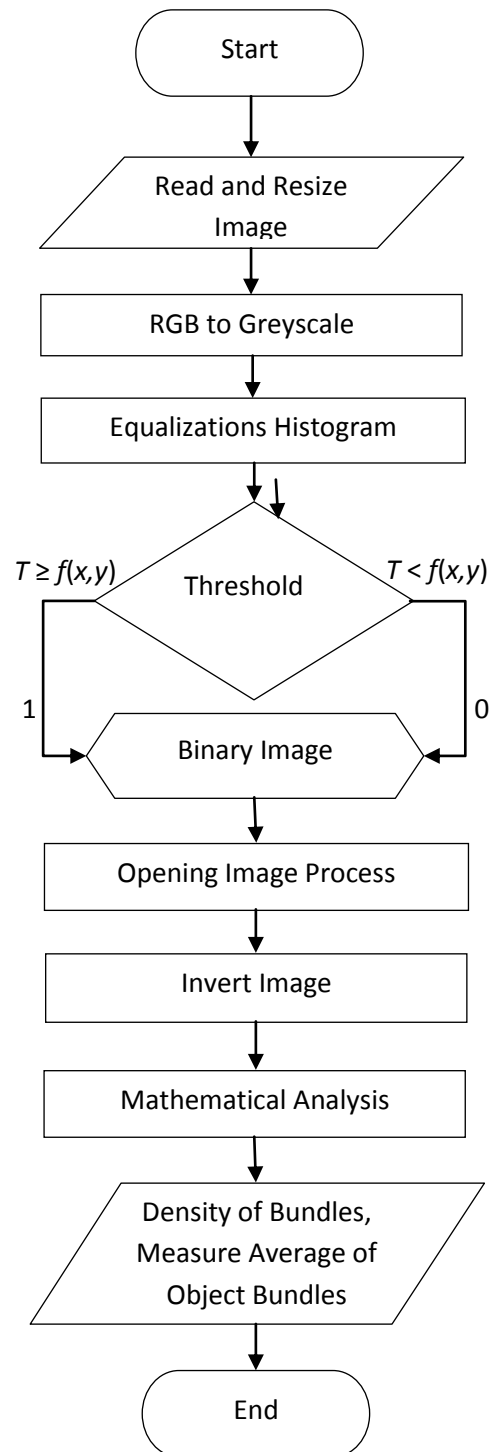


Fig.6 Flowchart extraction of feature

Starting from the fact that the bundle distribution pattern on the pieces of coconut wood which is increasingly towards the edge on the stem the bundle density is greater and vice versa, so that for each image of coconut wood pieces can be taken in the middle as a sample image that can describe the state of the entire image section. This resize method is also intended to optimize the computing process. The digital image samples used in this study are RGB-colored digital images, each pixel in this image format still has three values, namely *Red*, *Green* and *Blue* so that a process is needed to unite these three values. This process will change the color image to Greyscale

image. Greyscale image condition with an uneven gray level in an image allows features in the image that cannot be extracted properly so that a smoothing process is required by equalizing the histogram method until an almost uniform gray distribution is obtained, this process also helps separate objects from the background image behind him. The area of concern for extraction is the region that contains bundles in the image so that needed to separate the pixels that represent the bundle from the environment, the Threshold process helps us make a separation, Determination threshold value of each image using the Otsu's method implemented with the *gray thresh* function in MATLAB. And the pixel with a value less than the threshold becomes 0 while the opposite is worth 1 threshold image.

Binary image. The obstacle that often arises in feature extraction from binary imagery is the appearance of noise in the image as part of the process of forming errors. Noise can be reduced by the image opening method in order to reduce the appearance of noise in the form of pixels of a certain size. The last image manipulation process is invert, this process is done to make it easier to calculate the bundle object's pixel value which is the main focus of this feature extraction process. Data Bundle density in the image is obtained by comparing the number of pixels with the pixel area of the image sample. Data on many objects is obtained by calculating the number of white pixel objects contained in the image while the Average Data of objects is obtained by comparing the number of pixels with the number of objects in the image. Expected image measurement in accordance with physical appearance.

## 4. RESULT AND DISCUSSION

### 4.1 Extraction Feature Software

by using the MATLAB program obtained software for extracting features from digital images as shown below :

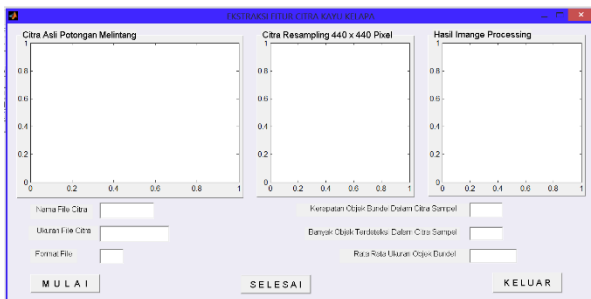


Fig.7 Display when the program starts

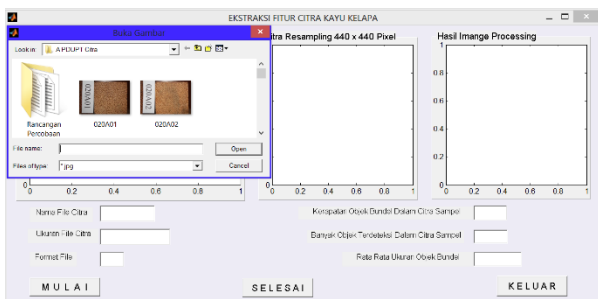


Fig.8 Image file selection process



Fig. 9 Image measurement



Fig.10 The program is complete.

### 4.2 Measurements Result

Table 1. Measurements results according pieces

No.	Pieces	Average Measurements Results	
		Compressive strength test ( $M Pa$ )	Density of boundless (%)
1	Outer pieces	46,10	19,77
2	Inner pieces	18,06	14,92

Table 2. Measurements results according ages

No.	Ages (Years)	Average Measurements Results	
		Compressive strength test ( $M Pa$ )	Density of boundless (%)
1	20	39,43	19,85
2	40	45,76	20,16
3	60	45,18	18,39
4	80	51,85	20,64
5	100	45,87	19,16

### 4.3 Correlation and Regression

By using as many as 75 pieces of image samples that meet the measurement criteria and by using MATLAB, results are obtained as shown in Figure 11

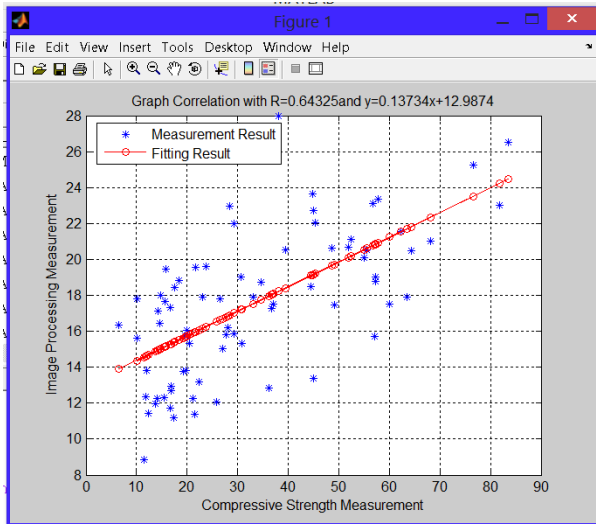


Fig. 11. Regression Graph

## 5. CONCLUSION

The regression model between the average density variable of the bundle object on the sample image with the compressive test results showed a strong correlation. High density is obtained from the outside of the piece of coconut wood as well as the portion of the base of the second or third piece is the highest density in coconut wood.

Age affects the density of bundles, coconut wood with an age of 80 years and above average has a bundle density on the image higher than the age below it. The quality of coconut wood, especially compressive strength, can be identified through bundle density checks on digital images

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