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Detection System of Illegal Logging Image Using Matching Process With Discrete Cosine Transform

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ABSTRACT

To support the government monitoring system, Logging Detection Tool is used as an implementation of remote sensing technology. It prevents the forest from any damage due to illegal logging activity. Illegal Logging is an actifity of deforestation without any authority and causes many problems in some sectors such as economic, ecology and enviromental inbalance as a result of disruption of the forests. The research is aim to create a system to detect the illegal logging, using Discrete Cosine Transform (DCT). The Image Processing Stage is using index selection. The value of index is taken from RGB Image that has been proceed with DCT and applied as the data to determine the forest location based on its damage. In this system, to reveal the site or forest location, it is derived from its damage level through the selection of total of avarage index value and characterized as low, moderate and severe level. Image sample is taken from reserved forests in Gowa, South Sulawesi, Indonesia. It has 750 m x 560 m size and using a sample image pairs in year 2007 as the initial data and year 2009 for the final data. The test results give the accuracy of the illegal logging detection system with DCT and it reaches 83.33%.

KEYWORDS: *Illegal Logging, Illegal Logging Detection, Discrete Cosine Transform, Image Processing Stage, Index selection.*

I. INTRODUCTION

Forest has many advantages to human life and the earth as the lungs of the world. In the economic field, the forestry sector contributes significantly to the national income accounts. The high price of timber in international market leds to timber exploitation in the early 90's [S. Syarif, et.al, 2012]. It encourages illegal logging actifity, which causes adverse effects especially on the economy and ecology fields. In the economic field, the state revenues declined due to the loss of timber tax and the chance to produce the high quality products of timber also decreased. In addition, the nature inbalance causes climate change, declining soil productivity, soil erosion and flooding, habitat destruction, and loss of biodiversity. To solve the problems, the illegal logging detection system is urgently needed.

In this research, image processing and Discrete Cosine Transform (DCT) are applied for the detection. Nowadays, image processing has a very wide application in various fields of life, i.e astronomy, archeology, industrial, and remote sensing. The image data in this research obtained from Google Earth that is composed of high-resolution images (Quick bird, Iconos, Geo-eye) and medium resolution imagery (Landsat, Aster, Spot).DCT is a mathematical transformation that takes and converts the signal from spatial domain into the frequency domain. Many digital image and video compression scheme are using block-based DCT, because the algorithm minimizes the amount of data needed to create digital images. In particular, JPEG and MPEG use DCT to concentrate image information by removing the spatial redundancy in the two-dimensional image. The DCT transformation is also known as low-frequency term, medium frequency and high frequency. This relates to the frequency of the wave of DCT basis functions. If the function of a small base, then the corresponding coefficients are called low-frequency coefficients.

The aims of this research are to help the government and other parties to monitor the human activity in the forest to reduce the illegal logging. However, identification of illegal logging in protected forest areas in Gowa, one of regions of South Sulawesi in Indonesia, was difficult because the forest functions like a water buffer. In this research, The used of image sample size is 530 x 400 pixels where one pixel in the image presents the actual size of 2 m^2. The structure of this paper as follows: Section II defines the pre image processing, Section III describes the proposed design system, Section IV discusses the results of design system and Section V concludes the paper.

II. Image Processing Theory

Each picture element (pixel), in indexed color image, has an assigned intensity that ranges from 0 to 255, called color palette, as shown in Figure 1. Color palette facilitates the manipulation of the color image without changing any information at any point in the image. In addition, the image size becomes smaller.

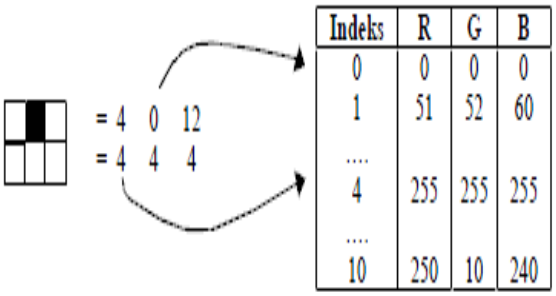


Figure 1 The Division of RGB Index [Iqbal, Muhammad, 2009]

To simplify image processing analysis, the color images are converted to the grayscale images. A color image composed of three matrix layers, namely the ***R***-layer, the ***G***-layer, and ***B***-layer. The value of ***RGB*** in the color image is converted to the ***S*** value in the grayscale image as shown in equation 1. The example of the image conversion is shown in Figure 2.

$$S = (R + G + B) / 3 \qquad (1)$$

Figure 2 The Example of Grayscale Image [Rahmanti and Farah Zakiyah, 2010]

2.1 DCT (Discrete Cosine Transform)

The Discrete Cosine Transform (DCT) transforms a signal into its fundamental components. It is widely used in image compression. DCT has two main properties for image and video compression, namely:

1) Concentrate image energy into a small number of coefficients (energy compaction).
2) Minimize the mutual dependence between the coefficients (correlated).

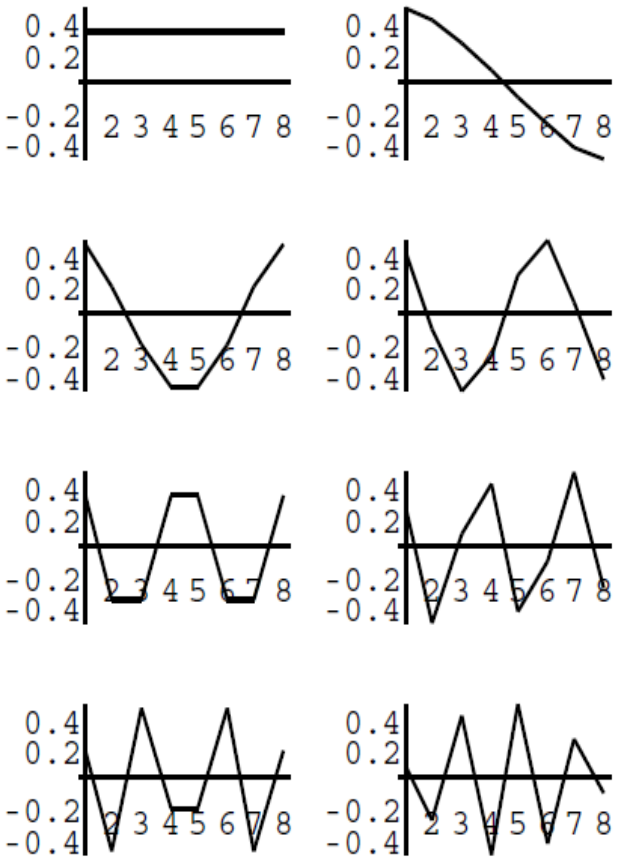


Figure 3 The eight basis vectors for the discrete cosine transform of length eight []

Each element of the transformed list *S(u)* is the inner (dot) product of the input list *s(x)* and a *basis vector*. The constant factors are chosen, thus the basis vectors are orthogonal and normalized. The eight basis vectors for n = 8 are shown in Figure 3. The DCT can be written as the product of a vector (the input list) and the n x n orthogonal matrix whose rows are the basis vectors. The list $s(x)$ can be recovered from its transform $S(u)$ by applying the inverse cosine transform (IDCT): [Khayam and Syed Ali, 2003]

$$S(x) = \sqrt{2/n}/n \sum_{n=0}^{n-1} S(u)\, C(u)\, \cos\frac{(2x+1)\,\mu\,\pi}{2n} \qquad (2)$$

where $x = 0, 1, 2, \ldots, n\text{-}1$ and $c(u)$ defined as

$$C(u) = \begin{cases} 2^{-1/2}, for\ u = 0 \\ 1, \quad otherwise \end{cases} \qquad (3)$$

This equation expresses s as a linear combination of the basis vectors. The coefficients are the elements of the transform S, which may be regarded as reflecting the amount of each frequency presents in the input s.

III. PROPOSED SYSTEM

The research is purposed to create the detection system of illegal logging using Discrete Cosine Transform (DCT). The color image data from Google Earth is converted to the grayscale image data before the matching process using Discrete Cosine Transform (DCT) is completed. The concept of the system is illustrated in Figure 4.

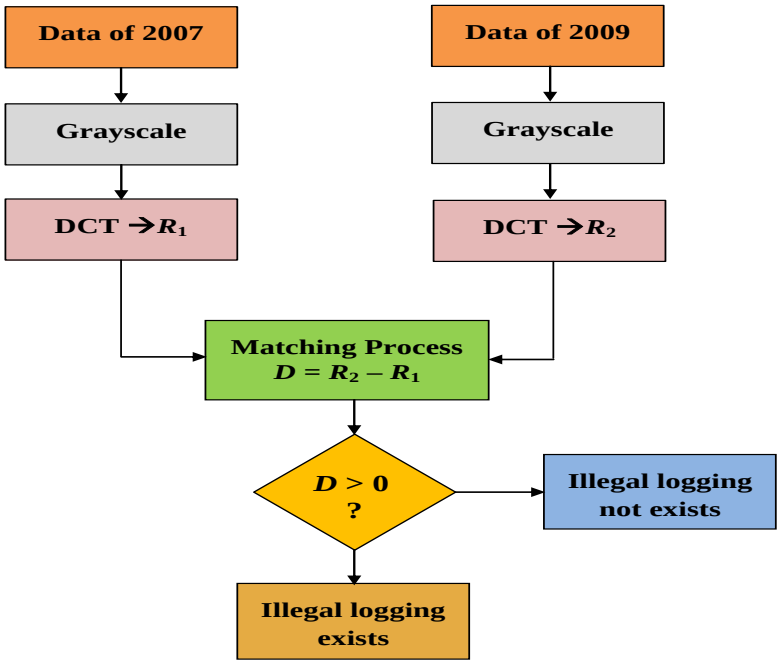


Figure 4 The concept of the system

The Image from Google Earth is cropped and normalized to 530 × 400 pixels. Each pixel is classified by the index value. Damage levels due to illegal logging based on the index value are categorized into :
(1) Low illegal logging : Index value ≤ 150.
(2) Medium illegal logging : index value between 150–200.
(3) High illegal logging : index value ≥ 200

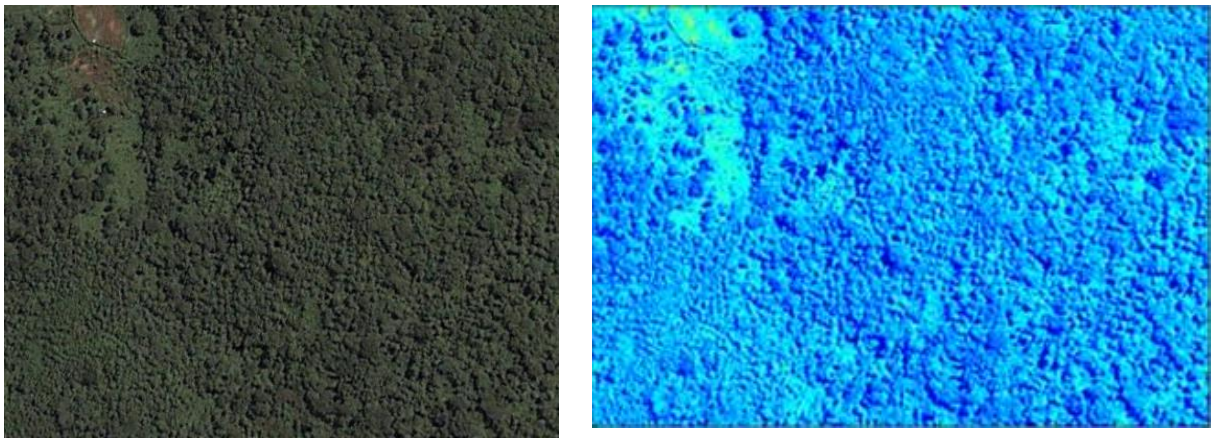
The example of the illegal logging areas based on the ***RGB*** value of each pixel is shown in Figure 5. The dark blue color represents trees area and the light blue to the dark brown represent illegal logging area.

Figure 5 The example of the color index

In this research, the detection system is designed by Matlab and using the DCT function of MATLAB. Data from clustering index has been created and put into the function of DCT as a parameter to determine the level of illegal logging.

IV. RESULTS AND DISCUSSIONS

Figure 6 shows the results example of image before and after DCT process. Data input is the image of reserved forest in Gowa, South Sulawesi, Indonesia. The accuracy of illegal logging detection system using DCT is 83.33%. Therefore, the research is very useful for the forestry department to reduce the level of illegal logging. The detection results based on the illegal logging levels are shown in Table 1. The minimum area detection is $2m^2$.



(a) Before matching process by DCT (b) After matching process DCT

Figure 6 The example of the results

Table 1 The detection results

Data		Non Illegal Logging (%)	Illegal Logging low (%)	Illegal Logging medium (%)	Illegal Logging high (%)	Total Illegal Logging (%)	Areas of Illegal Logging (m^2)	Results of Detection	Validation
1	**Start**	79.4151	20.5434	0.0415	0	20.5849	-	-	-
	End	24.1637	49.5052	25.8415	0.4896	75.8363	234266	Detection Illegal Logging	Illegal Logging
2	**Start**	99.6874	0.3126	0	0	0.3126	-	-	-
	End	32.0278	55.0579	12.7552	0.1591	67.9722	287418	Detection Illegal Logging	Illegal Logging
3	**Start**	99.7227	0.2731	0.0028	0.0014	0.2773	-	-	-
	End	30.3847	51.4694	17.7674	0.3785	69.6153	294548	Detection Illegal Logging	Illegal Logging
4	**Start**	99.7853	0.2147	0	0	0.2147	-	-	-
	End	41.4586	48.5767	9.5932	0.1568	58.5414	247772	Detection Illegal Logging	Illegal Logging
5	**Start**	99.7335	0.2637	0.0028	0	0.2665	-	-	-
	End	32.0734	48.9315	18.9482	0.4468	67.9266	287420	Detection Illegal Logging	Illegal Logging
6	**Start**	99.6088	0.3912	0	0	0.3912	-	-	-
	End	37.5391	56.4383	6.0141	0.0085	62.4609	263672	Detection Illegal Logging	No Illegal Logging

V. CONCLUSION

The results of illegal logging detection system using Discrete Cosine Transform is showing the accuracy of the detection approaches 83.33% with the minimum area detection is $2m^2$. The accuracy of detection results is influenced by the quality of the input image and brightness level.

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