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INDUSTRY 4.0; RETROSPECT PROSPECT AND CHALLENGES

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Comparison of Skewness Normalization Methods on Javanese Script Documents Input

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***Abstract*— The scan of a text document that is visually quite perpendicular to its axis is very important. Correction operations on image slope will make the image visually perpendicular. This paper will compare the method of tilt detection both moment-based, center of gravity, and hough transformation on a printed image of a modern Javanese text document. The results of this study will be very useful in the line segmentation of document images which are part of the transliteration of Javanese script text documents. The data used in this study is the result of scanning Javanese literary books entitled "Hamong Tani". On each page of the scan, the slope angle of the coordinate axes is tested using the three selected slope detection methods. The next step is the line segmentation process using the vertical projection method to see the success of each method in making slope corrections. Based on the result of comparation shown that the Hough Transform methode work better more than two methods else.**

Keywords*— *document image; slope detection; moment orientation; center of gravity; Hough transform

I. INTRODUCTION

The development of the science of document image analysis, namely the analysis of visual representations of paper documents such as journals, facsimile results, office documents, form sheets, etc. (Srihari, et al., 1986), opens a great opportunity to be utilized for the preservation of manuscripts. many ancient manuscripts found in Yogyakarta. O'Gorman and Kasturi (O'Gorman and Kasturi, 1997) provide stages of the process of document image analysis that can be modified for Javanese literary text image recognition.

It starts with the digitization phase of the data, followed by the pixel level processing stage which aims to prepare image documents, as well as creating intermediary features to help recognize images, and the final step of character recognition in order to translate a series of characters that have various shapes and sizes.

One of the stages that must be passed in the pixel level processing stage is the segmentation stage, where in the introduction of the text document image that stage means the stage to reduce the text document image into text components, namely finding columns, paragraphs, words , until finally it is found that the character of segmentation works well, the process for the introduction of the acquired characters will run easily.

Problems arising when in the digitalis process cannot always be guaranteed that documents are always placed or taken in a position perpendicular to the coordinate line. Scanned results if not corrected will produce incorrect results when analyzing and recognizing images, especially text document images (AL-Shatnawi and Omar, 2009).

The results of this study will be very useful in the line segmentation of document images which are part of the transliteration of Javanese script text documents (Himamunanto, 2015).

II. RELATED WORKS

There have been several studies related to tilt detection, where relatively good results have been obtained. Al-Shatnawi and Omar (2009) conducted a study to detect the slope of documents written in Arabic script, Widiarti (2010) examined how much the slope angle was produced by scanning the Hamong Tani book written using Javanese characters using the moment method, and Kurdianata (Kurdianata, 2011) does the same thing with Widiarti but uses the center of gravity method. The disadvantage of the Widiarti and Kurdianata research is that the direct finding of the angle obtained for the process of line segmentation in the printed text documents of modern Javanese literature can be a measure of the success of the slope detection process.

Widiarti, et al. (2010), by calculating the magnitude of the position of the pixel compiler image, and Niko (Kurdianata, 2011) using the input method, each page of the book "Hamong Farmer". On the other hand there is the Hough transformation method which has been investigated for its use for tilt detection in the scanning images by Rezaei et al. (2013), which raises the reason that research is needed to compare which methods are relatively good in finding large slope angles automatically, in the successful use of corrections to the angles found for the process of segmenting document image lines.

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III. SKEWNESS OF DOCUMENT IMAGE

The slope of the document as an input to further processes can be caused by many factors. As explained above, the effect of sloping document images is the result of further unsatisfactory processes. The document images that experience a visual slope are like Fig. 1.

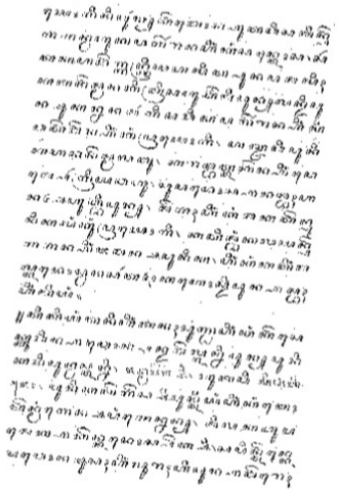


Fig. 1. Skewness of Javanese image document

If the input data for image document image recognition is shaped like Fig. 1, it is necessary to process the slope image correction of the input document in order to obtain the image of the input document which is located near the perpendicular to the coordinate axes.

IV. SKEWNEES NORMALIZATION ALGORITHMS

There are at least 3 methods of slope normalization of document images, namely: center of gravity, moment orientation, Hough transformation.

A. *Center of Gravity(Centroid)*

Center of Gravity or better known as centroid is a focus of an area (Al-Shatnawi and Omar, 2009). When implementing the slope detection process, the centroid will be searched from the area represented by the object in the image to be searched for the slope angle.

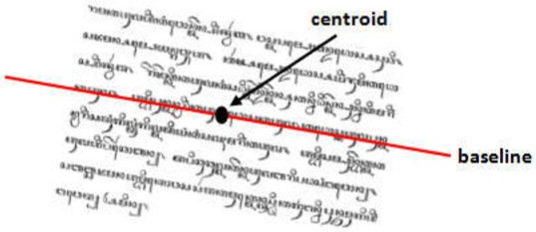


Fig. 2. Centroid and baseline an input image (Kurdianata, 2011)

Centroid can be searched using formulas:

$$Cen(X,Y)=\left(\frac{\sum OrigX_i}{N},\frac{\sum OrigY_i}{N},\right) \quad (4)$$

where OrigXi and OrigYi are the coordinate points of objects, while N is the total number of pixels of the object. From the centroid obtained the baseline can be obtained, which is a line that intersects with the centroid and is perpendicular to the object in the image.

The formula for finding the baseline can be seen in the formula:

$$\mu_{xx}=\left(\frac{\sum X_i^2}{N}\right), \qquad \mu_{yy}=\left(\frac{\sum Y_i^2}{N}\right), \qquad \mu_{xy}=\left(\frac{\sum (X_i * Y_i)}{N}\right) \quad (5)$$

where,

$$X_i=OrigX_i-X \text{ , dan } Y_i=OrigY_i-Y \quad (6)$$

Then do a comparison,

$$Skew(\mu_{xx}>\mu_{yy})=\frac{\mu_{yy}-\mu_{xx}+\sqrt{(\mu_{yy}-\mu_{xx})^2+4*\mu_{xy}{}^2}}{2*\mu_{xy}} \quad (7)$$

$$Skew(\mu_{yy}>\mu_{xx})=\frac{2*\mu_{xy}}{\mu_{yy}-\mu_{xx}+\sqrt{(\mu_{yy}-\mu_{xx})^2+4*\mu_{xy}{}^2}} \quad (8)$$

After the baseline value is found, the next step is to find the slope angle by looking at the object as an ellipse polygon, where the angle created by the intersection between the baseline and the x axis is the slope angle of the object.

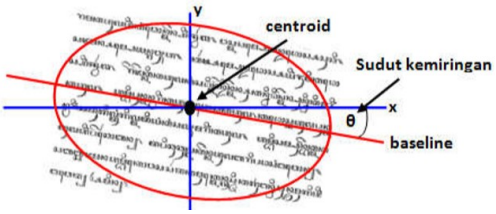


Fig. 3. Slope angle description (Kurdianata, 2011)

The value of object orientation as an ellipse polygon can be searched using formula 9.

$$Orientation=\frac{180}{\pi}\tan^{-1}(skew) \quad (9)$$

After the Orientation is obtained, a comparison is made where if (Orientation> 0), then:

$$Angle(\theta)=90^0-Orientation \quad (10)$$

But if (Orientation <0), then:

$$Angle(\theta)=-90^0-Orientation \quad (11)$$

B. *Moment Orientation*

If there is a binary image text document, the value of Θ as the value of the document slope is determined by formula (1) (Gonzales, and Woods, 2002).

$$\theta=\frac{1}{2}\tan^{-1}\left[\frac{2\mu_{1,1}}{\mu_{2,0}-\mu_{0,2}}\right] \quad (1)$$

with,

$$\mu_{p,q}=\sum_m\sum_n(m-\bar{m})^p(n-\bar{n})^q \quad (2)$$

is the central moment of the order (p, q), where m, n is the center point of the moment defined as follows:

$$\bar{m} = \frac{1}{N}\sum_{m}\sum_{n} m, \qquad \bar{n} = \frac{1}{N}\sum_{m}\sum_{n} n, \tag{3}$$

N states the number of pixels in the image, while m, n states the coordinates of the object from the image. This formula only applies to binary images.

C. Hough Transform

The Hough transformation was invented by Paul Hough in 1962. The initial use of the Hough transformation was first used to detect straight lines in an image.

The basic idea developed by Hough is, if given a point (x, y) in an image (assumed to be a binary image), the equation of the line can be written:

$$y = ax + b \tag{12}$$

The accumulator is the pairs of points (a, b) that fulfill the equation. This accumulator array is then called a transformation array.

V. PROCES STAGES

There are two main steps that must be done when tilt correction, namely:

1. Detect the slope of the document image which aims to find out how big the slope angle of the document image is to the lines of the coordinates of the main axes
2. Rotating the input document image as big as the angle found at tilt detection.

VI. RESULTS AND DISCUSSION

Tests carried out on image input that has experienced a slope manually. A total of 10 input images with various slopes become the third test input method.

A. Test Results of Comparation Methods

The following are the 10 test inputs used in the normalization experiment of the tilt image of Javanese script documents..

TABLE I. VARIOUS INPUT OF DCUMENT IMAGE

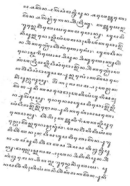
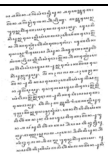
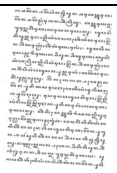
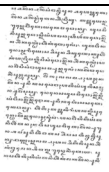
Visual	Name
	image_1.jpg
	image_2.jpg
	image_3.jpg
	image_4.jpg
	image_5.jpg
	image_6.jpg
	image_7.jpg
	image_8.jpg
	image_9.jpg

	image_10.jpg

One example of document input that is in a slope is shown as in Fig. 4. Input image is taken from a Javanese script document titled "Hamong Tani".

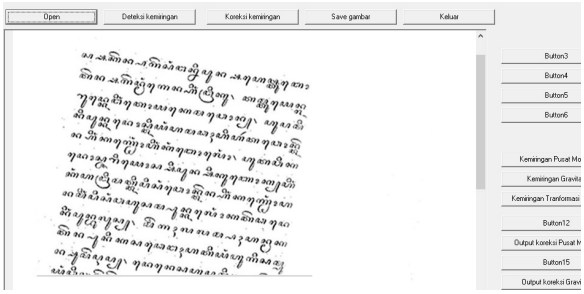


Fig. 4. A document input that is in slope

Furthermore, the tilt angle is calculated by considering the resulting angle based on horizontal straight lines and oblique lines of the document image. In Fig. 5 is shown how a slope angle is found.

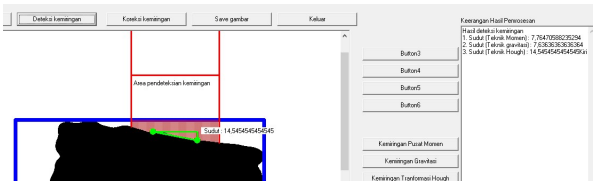


Fig. 5. The results of the slope detection testing process

The slope normalization process is carried out several times to get the angle of normalization results closest to the 0 degree angle.

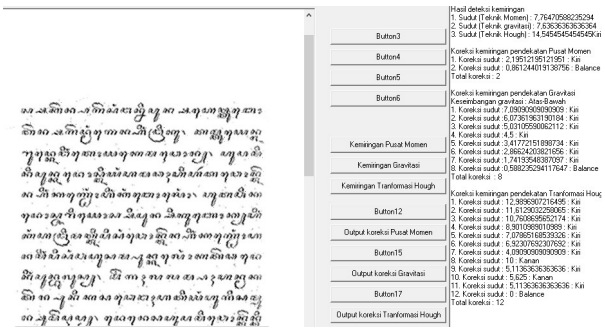


Fig. 6. The results of the slope normalization testing process

The maximum angle is the best angle produced by each method. The results of this maximum angle are then used to see the results of the comparison and get information on which method is the best.

B. Test Results of Comparation Methods

The following are tables of test results based on the 10 input images to the 3 slope normalization methods.

TABLE II. TEST RESULT OF ANGLE SKEWNESS

No	File	angle of skewness		
		Momen	Gravitation	Hough
1	image 1	7,81	10,05	10,69
2	image 2	7,52	7,13	12,9
3	image 3	2,21	0,58	4,09
4	image 4	4,32	5,03	3,87
5	image 5	6,73	8,62	9,09
6	image 6	7,76	7,63	14,54
7	image 7	5,94	3,41	8
8	image 8	7,06	15,58	18,16
9	image 9	5,24	2,86	7,91
10	image 10	6,56	3,96	8,9

TABLE III. TEST RESULT OF CORRECTION

No	File	correction		
		Momen	Gravitation	Hough
1	image 1	1	22	7
2	image 2	2	14	8
3	image 3	1	1	3
4	image 4	2	5	4
5	image 5	1	9	18
6	image 6	2	8	12
7	image 7	4	3	7
8	image 8	2	19	15
9	image 9	2	2	13
10	image 10	2	4	8

TABLE IV. TES RESULT OF MAX ANGLE

No	File	max angle		
		Momen	Gravitation	Hough
1	image 1	0,43	0,58	0,97
2	image 2	0,43	0,58	0
3	image 3	0,86	0.58	0
4	image 4	0,86	0,58	0
5	image 5	0,87	0,58	0
6	image 6	0,86	0,58	0
7	image 7	0,88	0	0

8	image 8	0,85	0,58	0
9	image 9	0,88	0,58	0
10	image 10	0,88	0	0

C. *Discussion of Results*

Based on table 4, it is known that the normalization results with degrees approaching 0 appear 9 times in the Hough Transform column.

This shows that the Hough Transform method is sufficiently recommended as a slope normalization method in preprocessing with document image input.

VII. CONCLUSION

Based on the test results it is known that the Hough Transform method shows better success compared to the Moment method and the Gravitation method.

The input image has been successfully recovered with a near-perfect tilt. Considering the test results, the Hough Transform method can be suggested to be used as a preprocessing operation in the process of recognizing the pattern of letters in a document.

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