

GLCM Based Locally Feature Extraction On Natural Image

Edi Faisal ^{*1}, Agung Nugroho²

Universitas Dian Nuswantoro, Jl. Imam Bonjol No. 207, Indonesia (+6224) 3517261

E-mail : faisal@dsn.dinus.ac.id^{*1}, joyondaru@gmail.com²

*Corresponding author

Ruri Suko Basuki³, Suharnawi⁴

Universitas Dian Nuswantoro, Jl. Imam Bonjol No. 207, Indonesia (+6224) 3517261

E-mail : ruri.basuki@dsn.dinus.ac.id³, suharnawi@dsn.dinus.ac.id⁴

Abstract - GLCM is a feature extraction method that uses statistical analysis using a gray scale. Contrast, correlation, energy and entropy are feature features whose value will be sought as the basis for finding the threshold which can then be used to find the threshold value in image segmentation. In this study, a local-based GLCM method is used where the image that has been made into grayscale will be divided into 16 parts of the same size. Each section will look for the value of its GLCM features, namely Contrast, correlation, energy and entropy. The calculation of these four features will be applied to 16 parts of the grayscale image, which can then be used to find the threshold value. The results of the four features in the calculation with an angle of 0° are the contrast value = 0.0080, correlation = 0.619, energy : 0.00160 and entropy : 0.05591.

Keywords - GLCM, contrast, correlation, energy, entropy

1. INTRODUCTION

Image *segmentation* is one of the processes in digital image processing to divide an image into homogeneous pixel groups. One of the tasks of segmentation is to divide an image into groups called *foreground* and *background*. The *foreground* and *background* extraction process is the first step before starting the *matting process* on an image [1]. This process has been studied for years using various methods [2], [3], [4], [5], [6]. By doing the right extraction process, it will be easy to separate the *foreground* from the *background*.

The right image segmentation method will have a big influence on the *alpha matting process* because it is in the *alpha section* that the value of a separator threshold will play its role in separating the *foreground* from the *background*. This limit value is called the *threshold*. Many studies have been carried out on the image segmentation method in *alpha matting*. J. Wang and MF Cohen conducted a study using the *trimap model* [5]. Their research refers to the research that has been done by Anat Levin [2], where the researcher gives different colors (*scribble*) manually as *sampling sets* and separates them into three parts, namely *foreground* (*F*), *background* (*B*), and *unknown* or also known as with *alpha* (α). The alpha value obtained from the *trimap* results in a distance from 0 to 1. Then from the resulting information it will be used to predict the known area (*F*, *B*) with the help of the *alpha value*. The results obtained from using *trimap* to separate the *foreground* and *background areas* show close to perfect results visually [1]. However, this has a weakness, namely from the level of thickness of the

scratches manually in the *scribble process* requiring a high level of experience from the user and also this will apply more complexly to images with more complicated areas such as falling snow images [7].

Ruri Suko Basuki, Moch. Hariadi, and Ricardus Anggi P. conducted research on segmentation at the threshold value as a substitute for *alpha values* in *image matting* using the *Fuzzy C-Means algorithm*. *Threshold* is obtained from the average maximum value in the class which has the smallest and lowest middle value among other classes, where the pixel cluster value uses three class concepts in *Fuzzy C-Means* [8]. *Thresholding* in method this calculated with method collect clusters in areas that have level same *similarity* and mutual distance close by with develop level resemblance *gray-level* from grayish based on *inter class* and *intra class* so that separation Among *background*, foreground and *alpha* can more perfect.

Success best in method *threshold* a image picture determined by technique extraction feature from picture the [9]. Wrong one technique extraction feature to image picture is *GLCM (Gray Level Co- occurrence Matrix)*. *GLCM* is method extraction feature with use analysis statistics with use scala gray. *GLCM* is method checking statistics texture with consider connection spatial from pixels on a image. As for threshold method on discussion this will used method *local adaptive threshold* with hope method this capable produce optimal value in segmentation a image.

2. RESEARCH METHOD

In discussion this, stages method used are :

2.1. Convert the input image to grayscale

Change RGB image to level gray (*grayscale*) this working for make composition scale color from original image _ have three fruit value (RGB) to worth two (grey). Next image scale gray this will processed Becomes image with score scale binary for make it easy search score *threshold* (value 1 and value 0). Process change image from image of type RGB to Grayscale shape can use matlab order **rgb2gray** which when write in equality is as following :

$$0.2989 * R + 0.5870 * G + 0.1140 * B$$

Following is results conversion to grayscale image



Filename (Size)	Original image	Grayscale image
Teddy.BMP (486 x 416 pixels)		



Figure 1 : TeddyGR_01.bmp conversion to grayscale image

2.2. Region of Interest (ROI) Process

Process *Region of Interest (ROI)* used here use method *block processing* where image original that has been converted to form *grayscale* divided into 16 *block images* that have size same.

Following is results ROI process on grayscale image above :

Table 1. process on grayscale image

No.	Name image	Size	Image
1.	TeddyGr1.BMP	121 x 104 pixels	
...			
...			
16.	TeddyGr16.BMP	121 x 104 pixels	

2.3. Process Extraction GLCM Features

Process extraction feature use method *Gray Level Co-Occurance Matrix (GLCM)* use calculation texture on order two. On order second, relationship between couple two pixels image original taken into account [9].

Reading extraction GLCM features taken of the input sub image. In discussion this using 4 features extraction GLCM features are : *Contrast, Correlation, Energy* and *Entropy*.

3. RESULT AND DISCUSSION

For To do process extraction GLCM features, done to all block image of ROI process. Each block have window size 121 x 104 pixels like on figure 2.

	1	2	3	4	5	.....	121
1	133	144	139	133	140	.....	83
2	132	133	149	143	145	.....	96
3	139	161	171	162	160	.....	112
4	146	166	177	174	162	.....	121
5	160	164	164	158	149	.....	120
.....
104	163	161	160	161	164	.....	168

Figure 2 : TeddyGR_01.bmp dataset matrix with window area 121 x 104 pixels

Wrong one method for represent connection this that is in the form of (1 0, 0), which states connection two pixels aligned horizontally with pixels value 1 followed with pixels value 0. Based on composition that, the amount group pixels that meet connection the calculated.

	0	1	2	3	4
0	0,0	0,1	0,2	0,3	0,4
1	1,0	1,1	1,2	1,3	1,4
2	2,0	2,1	2,2	2,3	2,4
3	3,0	3,1	3,2	3,3	3,4
4	4,0	4,1	4,2	4,3	4,4

133,133	133,144	133,139	133,144	133,144
132,133	132,144	132,139	132,133	132,144
139,133	139,144	139,139	139,133	139,144
146,133	146,144	146,139	146,133	146,144
160,133	160,144	160,139	160,133	160,144

(a)
(b)

Figure 3 : Figure (a) is composition pixels 5 x 5 rotation 0°, Figure (b) is composition pixels 5 x 5 rotation 0° on example sub-dataset teddyGR_01.bmp.

After composition formed then determine intensity pixels based on composition so that generated data as following :

0	1	0	0	1
1	0	0	1	0
1	0	0	0	0
0	0	0	0	0
0	0	0	0	0

Figure 4 : Amount intensity 5 x 5 pixels based on composition direction angle 0° on TeddyGR_01.bmp image sub-dataset example

For get symmetrical GLCM matrix then, matrix new results from amount intensity pixels need add up with matrix the transpose.

<table border="1" style="text-align: center; border-collapse: collapse;"> <tbody> <tr> <td style="background-color: #f4a460;">0</td> <td style="background-color: #4682b4;">1</td> <td style="background-color: #f4a460;">0</td> <td style="background-color: #f4a460;">0</td> <td style="background-color: #4682b4;">1</td> </tr> <tr> <td style="background-color: #4682b4;">1</td> <td style="background-color: #f4a460;">0</td> <td style="background-color: #f4a460;">0</td> <td style="background-color: #4682b4;">1</td> <td style="background-color: #f4a460;">0</td> </tr> <tr> <td style="background-color: #4682b4;">1</td> <td style="background-color: #f4a460;">0</td> <td style="background-color: #f4a460;">0</td> <td style="background-color: #f4a460;">0</td> <td style="background-color: #f4a460;">0</td> </tr> <tr> <td style="background-color: #f4a460;">0</td> <td style="background-color: #f4a460;">0</td> <td style="background-color: #f4a460;">0</td> <td style="background-color: #f4a460;">0</td> <td style="background-color: #f4a460;">0</td> </tr> <tr> <td style="background-color: #f4a460;">0</td> <td style="background-color: #f4a460;">0</td> <td style="background-color: #f4a460;">0</td> <td style="background-color: #f4a460;">0</td> <td style="background-color: #f4a460;">0</td> </tr> </tbody> </table>	0	1	0	0	1	1	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	+	<table border="1" style="text-align: center; border-collapse: collapse;"> <tbody> <tr> <td style="background-color: #f4a460;">0</td> <td style="background-color: #4682b4;">1</td> <td style="background-color: #4682b4;">1</td> <td style="background-color: #f4a460;">0</td> <td style="background-color: #f4a460;">0</td> </tr> <tr> <td style="background-color: #4682b4;">1</td> <td style="background-color: #f4a460;">0</td> <td style="background-color: #f4a460;">0</td> <td style="background-color: #f4a460;">0</td> <td style="background-color: #f4a460;">0</td> </tr> <tr> <td style="background-color: #f4a460;">0</td> <td style="background-color: #f4a460;">0</td> <td style="background-color: #f4a460;">0</td> <td style="background-color: #f4a460;">0</td> <td style="background-color: #f4a460;">0</td> </tr> <tr> <td style="background-color: #f4a460;">0</td> <td style="background-color: #4682b4;">1</td> <td style="background-color: #f4a460;">0</td> <td style="background-color: #f4a460;">0</td> <td style="background-color: #f4a460;">0</td> </tr> <tr> <td style="background-color: #4682b4;">1</td> <td style="background-color: #f4a460;">0</td> <td style="background-color: #f4a460;">0</td> <td style="background-color: #f4a460;">0</td> <td style="background-color: #f4a460;">0</td> </tr> </tbody> </table>	0	1	1	0	0	1	0	0	0	0	0	0	0	0	0	0	1	0	0	0	1	0	0	0	0	=	<table border="1" style="text-align: center; border-collapse: collapse;"> <tbody> <tr> <td style="background-color: #f4a460;">0</td> <td style="background-color: #ff0000;">2</td> <td style="background-color: #4682b4;">1</td> <td style="background-color: #f4a460;">0</td> <td style="background-color: #4682b4;">1</td> </tr> <tr> <td style="background-color: #ff0000;">2</td> <td style="background-color: #f4a460;">0</td> <td style="background-color: #f4a460;">0</td> <td style="background-color: #4682b4;">1</td> <td style="background-color: #f4a460;">0</td> </tr> <tr> <td style="background-color: #4682b4;">1</td> <td style="background-color: #f4a460;">0</td> <td style="background-color: #f4a460;">0</td> <td style="background-color: #f4a460;">0</td> <td style="background-color: #f4a460;">0</td> </tr> <tr> <td style="background-color: #f4a460;">0</td> <td style="background-color: #4682b4;">1</td> <td style="background-color: #f4a460;">0</td> <td style="background-color: #f4a460;">0</td> <td style="background-color: #f4a460;">0</td> </tr> <tr> <td style="background-color: #4682b4;">1</td> <td style="background-color: #f4a460;">0</td> <td style="background-color: #f4a460;">0</td> <td style="background-color: #f4a460;">0</td> <td style="background-color: #f4a460;">0</td> </tr> </tbody> </table>	0	2	1	0	1	2	0	0	1	0	1	0	0	0	0	0	1	0	0	0	1	0	0	0	0
0	1	0	0	1																																																																											
1	0	0	1	0																																																																											
1	0	0	0	0																																																																											
0	0	0	0	0																																																																											
0	0	0	0	0																																																																											
0	1	1	0	0																																																																											
1	0	0	0	0																																																																											
0	0	0	0	0																																																																											
0	1	0	0	0																																																																											
1	0	0	0	0																																																																											
0	2	1	0	1																																																																											
2	0	0	1	0																																																																											
1	0	0	0	0																																																																											
0	1	0	0	0																																																																											
1	0	0	0	0																																																																											
a		b		c																																																																											

Figure 5 : Image (a) results intensity pixels, Image (b) transpose matrix of matrix a, Image (c) result summation matrix intensity with transpose

After obtained matrix results summation, step next is normalize values the so that amount worth 1, step normalize this used for remove dependency on ukran image. With method share every score pixels results addition (matrix c) with total value all pixels i.e. 10 then will obtained score new.

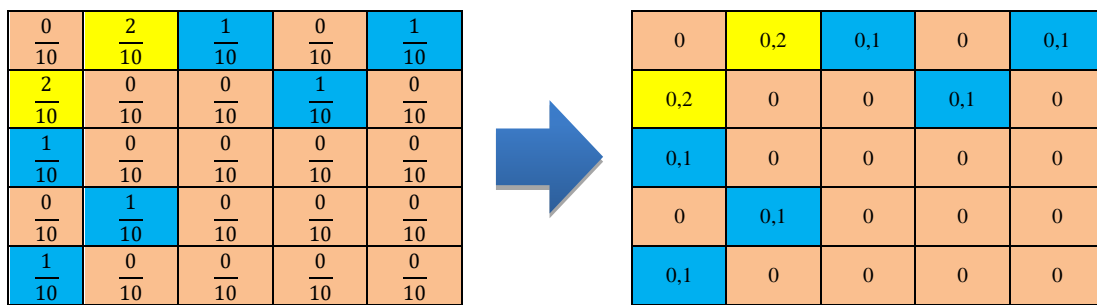


Figure 6 : GLCM matrix sub-dataset TeddyGR_01.bmp size 5 x 5 pixels on direction angle 0°

From calculation GLCM matrix in on step next is start count required GLCM features. On discussion this use four GLCM features, namely : *contrast*, *correlation*, *energy*, and *entropy*. Four feature the already can produce good GLCM features as data extraction for used in various study about GLCM.

From calculation GLCM matrix above and calculation features used next entered to in dataset calculation and produce values as following :

1. Contrast

Contrast is size existence variation level gray pixels image could calculated use equality in lower this :

$$Contrast = \sum_{n=1}^L n^2 \left\{ \sum_{|i-j|=n} GLCM(i,j) \right\},$$

Where L is number of levels used in computing, n is amount pixels, i is intensity pixels smallest, and j is intensity pixels biggest.

From matrix direction angle 0° like on Figure 6 obtained from results counting in above, then known :

$$L = 1;$$

$$n = 5;$$

$$i = 0;$$

$$j = 0.2$$

$$Total\ GLCM = 1$$

$$Average\ GLCM = 0.0400$$

So that could calculated score contrast on direction angle 0° with use equality

$$Contrast = \sum_{n=1}^L n^2 \left\{ \sum_{|i-j|=n} GLCM(i,j) \right\} \text{ is :}$$

$$= 1^2 \times (| 0 - 0.2 |) \times \text{average GLCM (i , j)}$$

$$= 1 \times 0.2 \times 0.04$$

$$= 0.0080$$

2. Correlation

Correlation which is size linear dependence between values level gray in image calculated with use equation 10 like in lower this :

$$\text{Correlation} = \frac{\sum_{i=1}^L \sum_{j=1}^L (ij)(GLCM(i,j) - \mu_i' \mu_j')}{\sigma_i' \sigma_j'}$$

where L is number of levels used in computing. n is amount pixels, i is intensity pixels smallest, and j is intensity pixels biggest. Then $\sigma_i' \sigma_j'$ is the *standard deviation* for all intensity pixels on GLCM matrix.

So that score *correlation* on direction angle 0° in on could determined with calculation as following :

$$\begin{aligned} &= 1 - 0.040 / \text{standard GLCM deviation} \\ &= 1 - 0.04 / 0.064 \\ &= 0.619 \end{aligned}$$

3. Energy

Energy is size intensity from variation a region area is calculated with equation 11 like in lower this :

$$\text{Energy} = \sum_{i=0}^{G-1} [GLCM(i)]^2,$$

where i is the average intensity pixels in GLCM matrix. So that take example GLCM matrix on Figure 6 can be calculated *energy* as following :

$$\begin{aligned} &= 0.04 \times 0.04 \\ &= 0.00160 \end{aligned}$$

4. Entropy

Entropy state size irregularity level gray in in image could calculated use equation 12 like in lower this :

$$\text{Entropy} = - \sum_{i=1}^L \sum_{j=1}^L (GLCM(i,j) \log(GLCM(i,j)))$$

the zero value this because example illustration on writing this take example matrix sized small 5×5 pixels course. Score *entropy* very influenced by score other GLCM elements (features). So that from matrix example on picture the could calculated score *entropy* as following :

$$\begin{aligned} &= - (GLCM \text{ installment-installment}) \times \text{LOG} (GLCM \text{ installment-installment}) \\ &= - (0.040) \times \text{LOG} (0.040) \\ &= 0, 05591 \end{aligned}$$

For next on GLCM matrix with direction angles 45° , 90° , and 135° , then the steps same. What makes the difference is on making composition with change direction corner in accordance with degrees calculated angle.

4. CONCLUSION

Image segmentation is one of the processes in digital image processing to divide an image into homogeneous pixel groups. The function of segmentation is to divide an image into groups called foreground and background.

GLCM (*Gray Level Co-Occurance Matrix*) is a feature extraction method that uses statistical analysis using a gray scale. The four features used in this GLCM calculation include contrast, correlation, energy and entropy. The results of the four features in the calculation with an angle of 0° are the contrast value = 0.0080, correlation = 0.619, energy : 0.00160 and entropy : 0.05591.

Furthermore, the results of the four features can be used as a threshold value. By getting the threshold value, it can be used for calculating the threshold value in image segmentation.

REFERENCES

- [1] J. Wang and M. F. Cohen, "Image and Video Matting: A Survey," *Found. Trends[®] Comput. Graph. Vis.*, vol. 3, no. xx, pp. 97–175, 2007.
- [2] A. Levin, A. Rav-Acha, and D. Lischinski, "Spectral matting," *IEEE Trans. Pattern Anal. Mach. Intell.*, vol. 30, no. 10, pp. 1699–1712, 2008.
- [3] A. Levin, D. Lischinski, and Y. Weiss, "A closed-form solution to natural image matting," *IEEE Trans. Pattern Anal. Mach. Intell.*, vol. 30, no. 2, pp. 228–242, 2008.
- [4] E. Shahrian, D. Rajan, B. Price, and S. Cohen, "Improving image matting using comprehensive sampling sets," *Proc. IEEE Comput. Soc. Conf. Comput. Vis. Pattern Recognit.*, pp. 636–643, 2013.
- [5] J. Wang and M. F. Cohen, "Optimized color sampling for robust matting," *Proc. IEEE Comput. Soc. Conf. Comput. Vis. Pattern Recognit.*, 2007.
- [6] X. Bai and G. Sapiro, "Geodesic matting: A framework for fast interactive image and video segmentation and matting," *Int. J. Comput. Vis.*, vol. 82, no. 2, pp. 113–132, 2009.
- [7] H. Liu, L. Ma, X. Cai, Z. Chen, and Y. Shen, "A closed-form solution to video matting of natural snow," *Inf. Process. Lett.*, vol. 109, no. 18, pp. 1097–1104, 2009.
- [8] R. S. Basuki, "Fuzzy C-Means Algorithm for Adaptive Threshold on Alpha Matting," no. July, pp. 177–180, 2012.
- [9] N. Zayed and H. A. Elnemr, "Statistical Analysis of Haralick Texture Features to Discriminate Lung Abnormalities," *Int. J. Biomed. Imaging*, vol. 2015, 2015.