Scientific Journal of Informatics
Vol. 4, No. 2, November 2017
p-ISSN 2407-7658 http://journal.unnes.ac.id/nju/index.php/sji e-ISSN 2460-0040

Algorithm for Identifying Objects in The Relief Image Using Watershed Segmentation

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Abstract

This study aims to automate the process of understanding temple relief, despite the difficulties to analyze the contents of natural images. Three preprocessing stages are develop in this research namely edge detection based on convolution (EC), edge detection based on gaussian (EG) and Hybrid which is a combination between edge detection based on convolution and gaussian. These algorithm is to support the operation of Watershed transform to segment relief images. A set of relief images obtained from several temples near Malang City are used in this experiment. Two experimental parameter are develop in order to measure the performance of these algorithm, namely number of object and quality of retrieval from segmentation result. The result of experiment show that hybrid approach deliver the best performances compare the other approaches.

Keywords: Relief, Temple, Segmentation, Watershed

1. INTRODUCTION

Indonesia have a unique culture buildings like a temple, this temple has a variety of artwork that carved into the wall of the temple. This artwork is called by relief. Relief is a method that working by hands to carve a symbols or figures on every area of the temple. The relief it self have a meaning that tells about the story of any kingdom, or any legend. A symbols or figures in relief contains about human, animal, plants, building, boat that use to arrange a story. To learn about the meaning of the relief, archeologist has intrepret one by one of a symbols or figures to built a concept story about the meaning of the relief. Not all figures in a reliefs have a complete shape, the relief stone has suffer from deterioration due to the condition of the temple. This condition show the complexity to deal with actual relief image obtained dirrectly from the temple spot. From that problem this research develop an algorithm to enhanced and segmentation relief images. The algorithm is design to support the operation of Watershed transform to segment relief images.

A number of research papers related to the use of watershed methods in the segmentation process were studied. A report of the literature review is presented here. Tochon et al. use the watershed segmentation method to classify the individual crown (ITC) area into four groups based on the results of the segmented area. The

classification of the segmentation area is based on four parameters: segmentation state, correctly detected, over-segmented, under-segmented and missed. Each segmentation quality of individual crown (ITC) segmentation areas is assessed in percentages [1]. The use a combination of three methods to test the results of image segmentation is done by [2]. Three methods used include image morphology method, watershed segmentation and machine learning. In testing the results of Isgum segmentation using false false positive or a false negative areas parameter to classify the variety of the segmentation result area. In this study, Isgum also showed that machine learning improved overall segmentation performance. Assessment is done by weighted averaging in order to find the best method [2]. Hybrid gradient and self-adaptive marker extraction to solved over-segmentation problem is done by [3]. Hybrid gradient method in this research is improved by gradient function. In this case the entropy theory information improves the gradient function by calculating the gradient color space. The self-adaptive marker extraction is used to extract the local minima from the low frequency regions of the image gradients. From experiment, the result that this appoarch effectively improves the weak edges, extract the external contour and reduce the noise. However, the result also show that segmenting image object accurately is still a difficult task to achieve, it is shown by the result of segmentation that still produce meaningless object [3]. Campbell et al. develop a algorithm to segmenting microsctructural images. The watershed algorithm is used to improve segmentation accuracy. However, the watershed algorithm is prone to over-segmentation as flooding from small local minima, caused by noise in the image, result in that region being incorrectly detected as a grain. Therefore, to improve the realibility of phase separation, Campbell et al. assess each region from Watershed segmentation based on the percentage of its constituent pixels that are classified as each phase. Next each region were label as alpha or beta phase to obtain a robust phase separation [4]. Galibourg et al. compared the effect of automatic segmentation using a Watershed-based method with semi-automatic segmentation on 52 teeth micro computed tomograph image for accuracy and reproducibility of 3D reconstruction. From experiment result show that automatic segmentation have similar tooth volumes when compared with semi-automatic segmentation, the difference value found at the cervical margins and incisal edges but general form was preserved [5]. Kavzoglu and Tonbul compared region-based and edge-based segmentation methods using Area fit index (AFI) and Quality rate (Qr) metrics to assessed segmentation quality metrics of satellite images. The experiment result show that multi-resolution segmentation method more accurate than watershed method in the creation of segments. For the segmentation quality metrics, show that multi-resolution segmentation outperformed the watershed method in terms of all quality metrics. Number of image objects produced by the two segmentation methods was close to eaach other, this is observed that segmentation quality increased significantly [6]. However, result of [5] and [6] still carry oversegmentation due to difficulties to obtained correct edges from it is object. The complexity to retrieve edges from natural image object is high and indeed become an open research issue [7]. This study aims to automate the process of understanding temple relief, despite the difficulties to analyze the contents of natural images.

2. METHODS

This section presents a methodology to develop segmentation for relief image. The methodology consist of three processing stages that consists of pre-, main- and post-processing. The pre-processing is to enhanced the presentation of image by using contrast enhancement by using grayscaling, contrast enhancement and thresholding in order to detect edges. Here the presentation of image in term of edges is vital for the input of segmentation process, seen this type of process always require gradient image. Main segmentation employs watershed transform to do image segmentation. The last stage is post-processing that aims to identify meaningfull object. It is settle by using a sorting process on the site of its segmented object. Here the descending approach is employ with the assumption that the bigger size of object represent more meaningfull content of image rather tahn the samller one [7]. The process flow of three stages is shown in Figure 1.

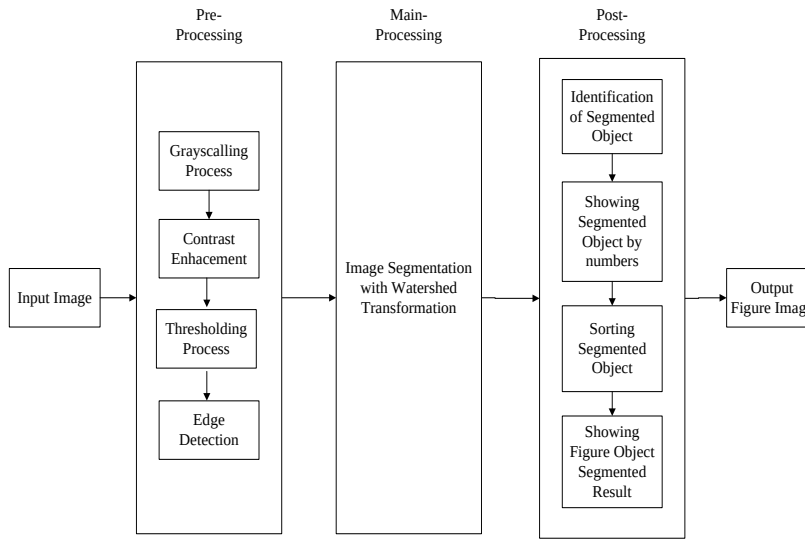


Figure 1. Three steps of relief image segmentation

The relief image obtained from several temple located near Malang City. The database includes one whole figure of each relief fragment. Not all figures in a fragment of reliefs have a complete shape. It has to be notice that some content of the relief image suffer from deterioration due to the condition of the temple. This condition show the complexity to deal with actual relief image obtained dirrectly from the temple spot. Relief image prepared as input image has a dimensions of 340 x 648 pixels.

The beginning of all processes is to do image enhancement of the input image. Prior to the image repair process, the input image is converted into grayscale first. From the input image that has high contrast, the contrast enhancement is applied., the results are shown in the Figure 2. A contrast enhancement to redistribute the brightnesses in an image. Some fragment relief image are very low or very high in a contrast, in a case like this perhaps only a few gray values separate the background from the figure object

of relief. Preprocessing will result a clear edge figure of the relief. After doing a contrast enhancement the next step is to do thresholding and edge detection operations. This procedure can enhance horizontal or vertical edge of the figure. The contrast enhancement operation is very useful in removing illumination nonuniformities. Basically, any enhancement operation can be used as long as the requirements to analyze relief image is fulfilled.

Figure 2. Image enhancement on the input image

In Figure 2 shape of the relief more clearly, which is from that result threshold operation applied to the image. This is basically the area with the intensity values higher than the defined threshold. A high intensity area, mostly comprises of figure relief. After doing threshold operation the next step is to do edge detection operations. This procedure can enhance horizontal or vertical edge of the figure. So through the edge detection operation, we can recognize more clearly the shape of the relief, this result as shown in the Figure 3.

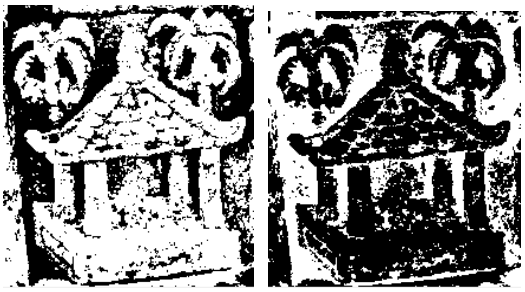


Figure 3. Threshold and edge detection operation

The watershed method is used by referring to the three-dimensional image, first the image must be complemented, so the bright objects appear as a pixel depressions in the image rather than pixel mounds. The image if we flooding with water, the depressions initially fill with water, and then a water level rises, neighboring objects collect water independently. The water fills the lowest portions of the image, then as the water level rises, the operation begins to mark pixels where a single object pixel separates two water bodies. The marked pixels are the in-between points separating objects. The resulting image displays the marked points in the image that separated any two water bodies by a single-pixel-wide strip of dividing pixels.

An image illustrating the whole process using watershed is shown in Figure 4.

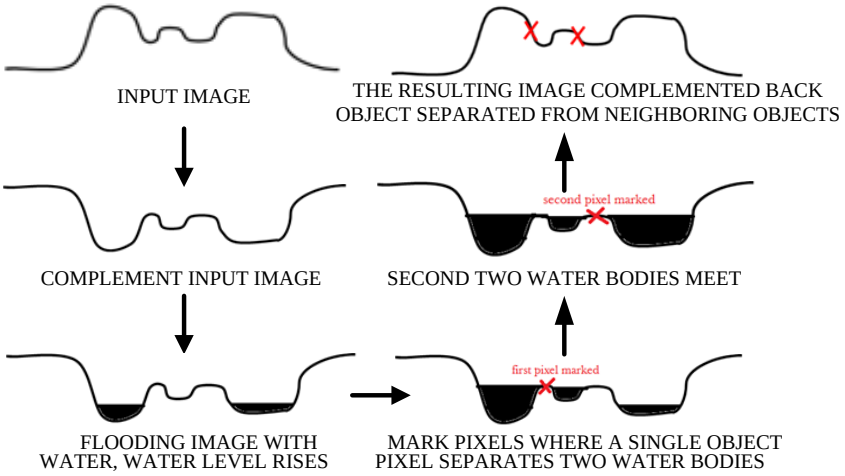


Figure 4. Watershed process

Watershed segmentation as seen on the resulted image obtained after morphological gradient image operation. Every single segmented object of the relief which contains figure is highlighted here. These segmented objects are marked and get number object through watershed segmentation methods. In addition to sorted by object number each segmented object on the image can be sorted by size from large to small. This two result of sorting process is shown in Figure 5 and Figure 6.

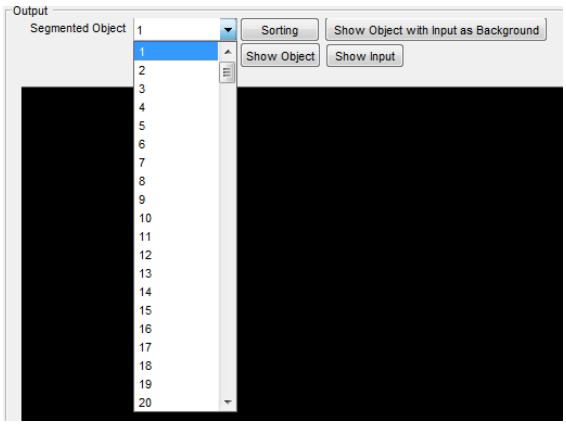


Figure 5. Sorting process based on number of the object

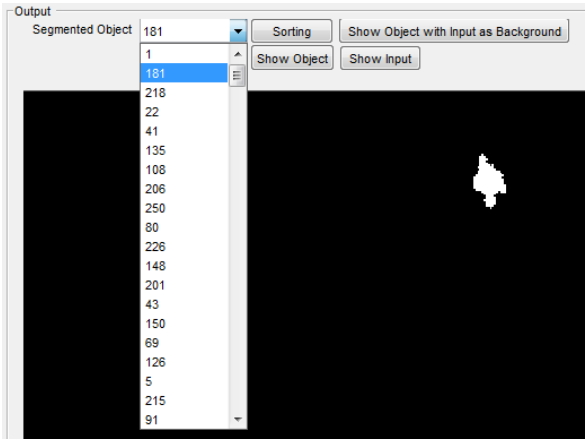


Figure 6. Sorting process based on size of the object

To facilitate the appearance of objects obtained in post-processing done sorting process against the objects that have been generated. The sorting process is performed on the relief object object that has been generated where the size of each object becomes the reference of this process.

3. RESULTS AND DISCUSSION

In this research the experiment is done through the following steps:

a. Data collection

The data used in this experiment is primary data that is obtained directly from three temple sites near Malang City, as follows:

- Candi Jago that is located in Jl. Wisnuwardhana Kecamatan Tumpang Kabupaten Malang (latitude -8.005833 dan longitude 112.764097)
- Candi Kidal that is located in Jl. Raya Kidal Kecamatan Tumpang Kabupaten Malang (latitude -8.025626 dan longitude 112.709035)
- Candi Singosari that is located in Jl. Kertanegara No.148 Kecamatan Singosari Kabupaten Malang (latitude -7.8877797 dan longitude 112.6616923)

The acquition of data is conducted by using Canon Power Shot SX1000ES camera. The collected data are shown in Figure 7.

b. The definition of experimental parameters

Two parameters are develop in order to meassure the result of segmentation, namely the number of segmented objects and the quality of segmentation. The number of objects produce by segmentation process. This parameter represent the problem of over-segmentation problem that causes the production of small and meaningless object. The second parameters is quality of segmentation result that is obtained from the evaluation of human observer. In this case the quality of segmentation result is compared againts the actuall appearance of the object by human observer. The result of comparison is presented in arrange of 0 to 1. Where 0 and 1 represent lowest and highest quality of segmentation process respectively.

Figure 7. Image acquisition

Experiment step is done by developing three different approaches as shown in Figure 8. The result of experiment is shown in Table 1. The detail explanation of these approaches are:

- Edge detection based on convolution (EC) that consist of Sobel, Prewitt and Robert edge detector operator.
- Edge detection based on gaussian (EG) that contains a combination of Canny, Laplace of Gaussian (LoG) dan zerocross.
- Hybrid is a combination between edge detection based on convolution and gaussian. This approach is contains a combination of six edge detector operator (Sobel, Prewitt, Robert, Canny, Laplace of Gaussian and Zerocross) in one function.

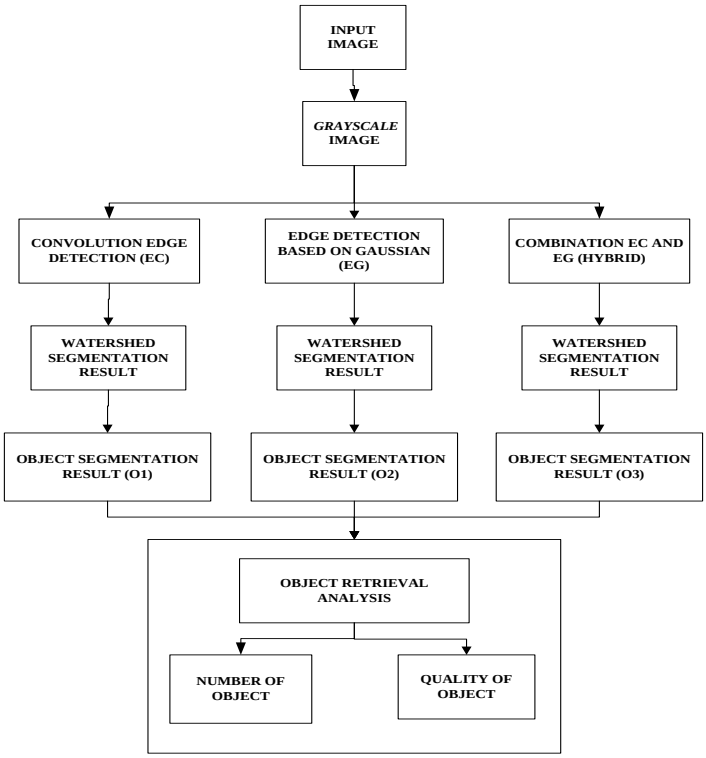
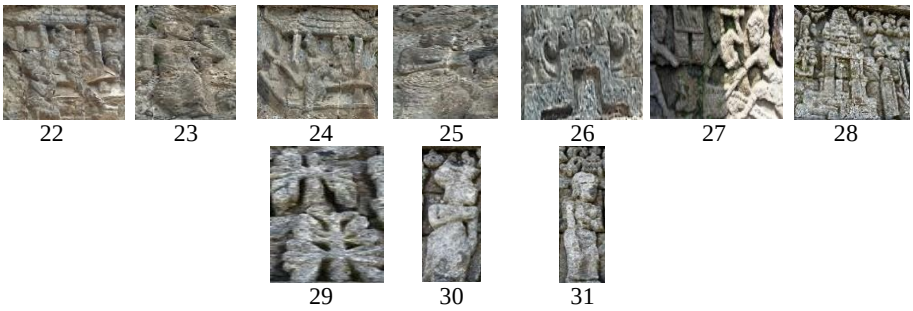


Figure 8. Three different approaches of experiment

The picture experiment is shown in Figure 9.



22 23 24 25 26 27 28

29 30 31

Figure 9. Picture Experiment

Table 1. Experiment result data

Data	Picture	Number of Object			Quality of Retrievel (0-1)		
		EC	EG	HYBRID	EC	EG	HYBRID
1	Figure 9.1	21	536	600	0	0.25	0.5
2	Figure 9.2	18	607	623	0	0.25	0.25
3	Figure 9.3	60	807	978	0.1	0.25	0.5
4	Figure 9.4	40	785	944	0	0.25	0.5
5	Figure 9.5	14	694	717	0	0.25	0.5
6	Figure 9.6	37	692	775	0.1	0.25	0.5
7	Figure 9.7	48	1024	1136	0	0.25	0.25
8	Figure 9.8	16	588	554	0	0.25	0.25
9	Figure 9.9	24	959	1096	0	0.25	0.25
10	Figure 9.10	19	829	825	0.1	0.25	0.5
11	Figure 9.11	27	740	935	0.1	0.25	0.5
12	Figure 9.12	0	107	107	0	0.1	0.1
13	Figure 9.13	0	66	84	0	0.25	0.5
14	Figure 9.14	63	577	816	0.1	0.25	0.25
15	Figure 9.15	8	527	578	0	0.25	0.25
16	Figure 9.16	11	439	500	0	0.25	0.25
17	Figure 9.17	19	972	1119	0	0.25	0.5
18	Figure 9.18	71	1339	1663	0	0.25	0.25
19	Figure 9.19	64	1082	1292	0	0.25	0.5
20	Figure 9.20	39	859	1118	0	0.25	0.5
21	Figure 9.21	41	1054	1387	0	0.25	0.5
22	Figure 9.22	37	857	987	0	0.25	0.25
23	Figure 9.23	30	662	766	0	0.25	0.5
24	Figure 9.24	41	1073	1273	0	0.25	0.5
25	Figure 9.25	22	721	796	0	0.25	0.25
26	Figure 9.26	10	270	270	0	0.25	0.25
27	Figure 9.27	109	445	753	0	0.25	0.5
28	Figure 9.28	13	535	574	0	0.25	0.25
29	Figure 9.29	0	59	54	0	0.25	0.5
30	Figure 9.30	4	127	122	0	0.25	0.25
31	Figure 9.31	5	108	94	0	0.25	0.25
AVERAGE		29,387	649,677	759,225	0,016	0,245	0,374

Experimental result shown that EC approach has a potention to eliminate over-segmentation problem. This is shown from the low number of objects obtained from the segmentation process. An average of 29 objects is produce by this approach. Compared to the number of objects produce by EG method and the Hybrid method, that has average of 649 and 749 objects, the strength EC method to reduce over-segmentation is obvious. However, the quality of segmentation results of EC is much lower compare to EG and hybrid, in the average the EC methods hold only 0.016 from the range 0-1. In contrast, EG and hybrid hold on 0.245 and 0.374 respectively this experiment also show that hybrid methods produce better quality of segmentation result compare to other approaches.

4. CONCLUSION

Three preprocessing stages are develop in this research namely edge detection based on convolution (EC), edge detection based on gaussian (EG) and Hybrid which is a combination between edge detection based on convolution and gaussian. These algorithm is to support the operation of Watershed transform to segment relief images. A set of relief images obtained from several temples near Malang City are used in this experiment. Two experimental parameter are develop in order to measure the performance of these algorithm, namely number of object and quality of retrieval from segmentation result. The result of experiment show that hybrid approach deliver the best performances compare the other approaches.

5. REFERENCES

[1] G Tochon, G., Feret, J. B., Valero, S., Martin, R. E., Knapp, D. E., Salembier, P., & Asner, G. P. (2015). On the use of binary partition trees for the tree crown segmentation of tropical rainforest hyperspectral images. *Remote sensing of environment*, Vol. 159, 318-331.

[2] I. Isgum, M.J.N.L Benders, B. Avants, M.J. Cardoso, S.J. Counsell, E.F. Gomez, L. Gui, P.S. Huppi, K.J. Kersbergen, A. Markpoulos, A. Melbourne, P. Moeskops, C.P. Mol, M. Kuklisova-Murgasova, D. Rueckert, J.A. Schnabel, V. Srhoj-Egekher, J. Wu, S. Wang, L.S de Vries and M.A. Viergever. 2015. Evaluation of automatic neonatal brain segmentation algorithms : The NeoBrainS12 challenge. *Medical Image Analysis*, Vol. 20: 135-151.

[3] L. Yuan, Q. Yu, C. Shen, W. Hu, and Z. Yang. 2016. New Watershed segmentation algorithm based on hybrid gradient and self-adaptive marker extraction. *Proceedings of IEEE 2nd International Conference on Computer and Communications*, 978-1-4673-9026-2: 624-628.

[4] A. Campbell, P. Murray, E. Yakushina, S. Marshall, and W. Ion. 2017. Automated microstructural analysis of titanium alloys using digital image processing. *Proceedings of 4th International Conference recent Trends in Structural Materials* (IOP Conference Series : Materials Science and Engineering 179 (2017) 012011, doi: 10.1088/1757-899X/179/012011).

[5] A. Galibourg, J. Dumoncel, N. Telmon, A. Calvet, J. Michetti and D. Maret. 2017.

Assessment of automatic segmentation of teeth using a watershed-based method. *The British Institute of Radiology* (available at https://doi.org/10.1259/dmfr.20170220).

[6] T. Kavzoglu and H. Tonbul. 2017. A Comparative study of segmentation quality for multi-resolution segmentation and watershed transform. *Proceedings of IEEE 8th International Conference on Recent Advances in Space Technologies* (RAST 2017).

[7] C. Crysdian. 2017. Performance measurement without ground truth to achieve optimal edge. *International Journal of Image and Data Fusion, Taylor and Francis Group* (available at https://doi.org/10.1080/19479832.2017.1384764).

[8] J.B.T.M. Roerdink and A. Meijster. 2001. The watershed transform : definitions, algorithms and parallelization strategies. *Fundamenta Informaticae*, Vol. 41: 187-228.

[9] N. Amoda and R.K. Kulkarni. 2013. Image segmentation and detection using watershed transform and region based image retrival. *International Journal of Emerging Trends & Technology in Computer Science*, Vol. 2.

[10] A. Chadha and N. Satam. 2013. A robust rapid approach to image segmentation with optimal thresholding and watershed transform. *International Journal of Computer Applications*, Vol. 65(9).