Level Set Interactive Segmentation on Perforated Road Image using Region Based Active Countours Method with im'4

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Abstract. The main key why IT is growing rapidly lies in the level of human consumption which is increasing time after time. This level of consumption is measured by the progress made in the industrial revolution which has fundamentally changed one's working conditions and lifestyle. One of the AI fields that is currently trending is digital image processing (PCD). In PCD there is an image manipulation technique without touching other objects and that method is image segmentation. Image segmentation is used to separate certain objects or partition the image into several main target areas to change the appearance of the entered image to a new one in the sense that it is easy to access and analyze. One technique is active contour. In this research, we will use region based active contour segmentation with 37kb perforated image objects after being modified. Using Matlab R2016a, the initial mask value (3:80, 1:91) = 4 was determined with 800 iterations, the image was successfully segmented as expected.

Keywords: Digital Image Processing, Segmentation, Level Set, Artificial Intelligence

INTRODUCTION

If our view is pushed back to a few years ago, all the technologies that already exist today are certainly a discourse or some are even under research projects. Many things in the past became the forerunner of an innovation today, that everything that was created to achieve one goal, namely to help sustain the processes of human life, both daily activities and work, has a significant impact on work efficiency and effectiveness [1], [2] as well as tools to support various activities [3] all of which are the role of information technology.

Today's information technology (IT) functions vary depending on the specifications of the benefits to be achieved, for example to design a private asset system [4], security audit systems [5], evaluate university databases [6] and so on. IT continues to grow and develop, at an AdAsia 2017 session entitled "Merge: Closing the Gap Between Humans and Technology" there are 5 technology phases, namely: Phase 1 Surfacing (1950-1995), Phase II Organizing (1990-2015), Phase III Extracting (2010-2025), Phase IV Anticipating (2020-2035) and Phase V Elevating (2030-2050). The main key why IT is growing rapidly lies in the level of human consumption which is increasing from time to time. This level of consumption is measured by the progress made in the industrial revolution which fundamentally changes the working conditions and lifestyle of a person. The industrial revolution started from 1.0 where in the 18th century steam power and mechanization of production were used. The industrial revolution 2.0 began in the 19th century with the invention of electricity and the assembly line. Industrial revolution 3.0 in the 1970s through partial automation using memory-programmable controls and computers.

The industrial revolution 4.0 was marked by the application of information and communication technology. Currently, we are faced with the era of the industrial revolution 4.0 which is attracting individuals into intelligent systems. According to [7], [8] intelligent system or artificial intelligence (AI) is a process/model of human thinking, designing, reasoning, taking action transformed into a machine. So that machines become intelligent systems because they are able to analyze (human thinking/reasoning processes), machines can design and even make decisions (human ways of acting). The artificial intelligence process includes the process of learning, reasoning and self-correction [9]. One area of AI that is currently trending is digital image processing (PCD). PCD itself has penetrated into various fields, including biomedical, sports, fisheries, broadcast, automotive, industry and so on. Image processing depends on image quality, which is an important parameter to maintain the quality of the image itself in converting the information

contained in it [10]. An image will have a lot of interpretation meaning when compared to a text. However, there is nothing wrong with the original image being manipulated to achieve a certain goal. In PCD there are image manipulation techniques without touching other objects, this is due to the difficulty of separating one object from another.

The method is image segmentation. Image segmentation is used to separate certain objects based on initial boundaries that can expand or collapse or partition the image into several regions [11][12]. One of the digital image segmentation techniques that is widely used for PCD and computer vision is level set. The advantage of this technique is that it can perform good segmentation of geometric shapes, namely convex and concave. This research will use a level set completion technique with the active contour method, a method that is popular in the last few years [13][14] and is widely used in visual tracking applications. While the object of research is the image of potholes, small, medium and large potholes is one of the factors to indicate a damaged road. According to data compiled from PUPR open data, the 2019 updated data on the area of Indonesia's national roads is 47017.27 km, of which total roads are in good condition 21107.78 km (44.89%), moderate condition 22528.95 km (47.92%), lightly damaged condition 2405.307 km (5.12). %), and 975.3555 (2.07%). From the data, it means that the road is in a slightly damaged condition and is around 3,380km. Damaged road conditions often trigger traffic accidents, that's why this research was made so that it can be the rationale for making a tool that can detect/segment potholes that can be implemented by the automotive sector.

METHODS

Each method will have limitations in a certain scope, as well as the image segmentation method, because of these limitations it is necessary to improve, in recent years the active contour model is able to provide closed contours of the target object and has been applied to image segmentation. The active contour model is a level set method proposed by Osher and Sethian to describe low-dimensional curves and high-dimensional surfaces [14][15]. The basic idea of active contour lies in the contour that can be changed in order to minimize the functional energy to produce the desired segmentation. Two main concepts in active contour are edge-based and area-based [16]. contour is edge-based using image gradients to determine object boundaries, this model will locally display high image information but in certain situations with constraints it is very sensitive to noise and depends on the initial distribution curve. The foreground and background are heterogeneous so that they will create optimal segmentation/position so as to produce the best image and match the original. Region-based active contour assumes a wide range of image areas for constant intensity, a weakness of this model is not ideal when using statistics for segmentation of heterogeneous objects. Figure 1 below shows how the heterogeneous foreground and background share in almost the same statistical situation.
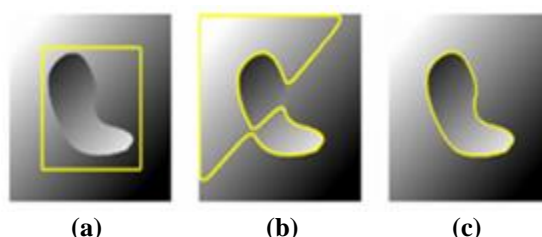

(a)   **(b)**   **(c)**

Figure 1. Example of Synthetic Blob Image with Heterogeneous Intensity on the same background and heterogeneous intensity. For example figure 1(a) Contour initials model, 1(b) Failed region-based segmentation results, 1(c) Successful edge-based segmentation results

The image in Figure 1 is segmented by a standard algorithm using a region-based model, but is then corrected by an edge-based algorithm to obtain segment accuracy on the object. It is said to have a high difference with neighboring points if the point (x, y) is the edge of an image. Figure 2 below is a path to get the edge of an image. While Figure 3 describes how the principle of filtering in the image is to find the edges of the image using a high pass filter [17] with the applicable formula, $\sum_y\sum_x H(x,y)=0$
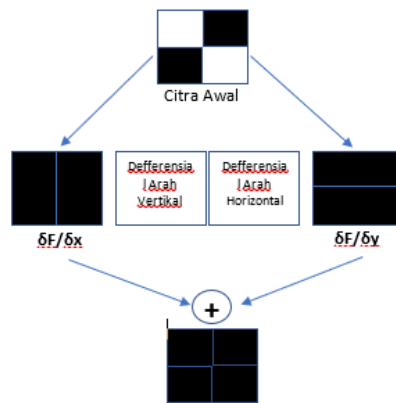
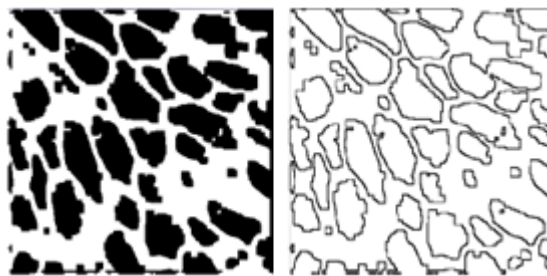Figure 2. Edge Detecting Process Flow

Figure 3. Example of Digital Image Edge Detection

The framework that will be used serves to form an active contour, in this case the segmentation process is not based on a global region but allows the foreground and background to describe a small local area, removing the assumption that the foreground and background regions can be represented in general. For local area analysis, it will be seen the development of capabilities at each point along the curve, to optimize local capabilities, each point will be considered separate and move to minimize or maximize computing power in the region itself. To calculate the ability of the local environment, it is divided into two parts, namely the closed area or the open area. The mathematical translation is described as follows that, I is an image in the domain, and C is a closed contour which is represented as a zero-level arrangement of the function. ϕ, i.e., C={x| ϕ (x) = 0} while C is refined by using a function like this.

$$\mathcal{H}\phi(x) = \begin{cases} 1, & \phi(x) < -\epsilon \\ 0, & \phi(x) > \epsilon \\ \frac{1}{2}\left\{1 + \frac{\phi}{\epsilon} + \frac{1}{\pi}\sin\left(\frac{\pi\phi(x)}{\epsilon}\right)\right\}, & \text{otherwise.} \end{cases}$$
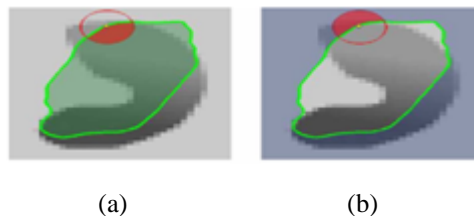
(1)

(a)   (b)

Figure 4. Assuming the contours of the outer and inner regions. Figures a and b have points represented by small dots, the neighbors of the function (x,y) are represented by small red circles. (a) is a closed region marked by shading on the circle while, (b) The open area is marked in shading on the circle

To determine the area around the curve, the derivative of equation (1) is used to smooth the image, then the derivative is equation (2) below.

$$\delta\phi(x) = \begin{cases} 1, & \\ 0, & \phi(x) = 0 \\ \frac{1}{2\epsilon}\left\{1 + \cos\left(\frac{\pi\phi(x)}{\epsilon}\right)\right\}, & |\phi(x)| < \epsilon \end{cases} \tag{2}$$

From the second equation, the second spatial, namely y, serves to represent the spatial variable at each point by using the characteristic function notation (x,y) and the measured parameters, pay attention to equation (3).

$$\mathcal{B}(x,y) = \begin{cases} 1, & \|x - y\| < r \\ 0, & \end{cases} \tag{3}$$

Function notation (x,y) serves to disguise the local area, the function will be worth 1 when point y is on a circle of radius r centered on point x and vice versa will be worth 0 if the circle is at point y. The interaction of the function (x,y) with closed and open regions is shown in Figure 4, and the equation can be seen in equation (4) below.

$$E(\phi) = \int_{\Omega_x} \delta\phi(x) \int_{\Omega_y} \mathcal{B}(x,y) \cdot F(I(y), \phi(y))\, dy\, dx. \tag{4}$$

At this stage, the author designs a flowchart to describe the steps needed to produce the desired output. As a first step determine the specific image that will be tested with potholes. Randomized images with potholes and their respective sizes after processing with the region based active contours (RBAC) technique obtained failed results. Then determine a more specific image with an original size of 117kb processed using the RBAC technique, the output failed, and the previous image with the original size modified with a size of 37kb was processed using the RBAC technique and produced a successful output. The flowchart can be seen in Figure 5.
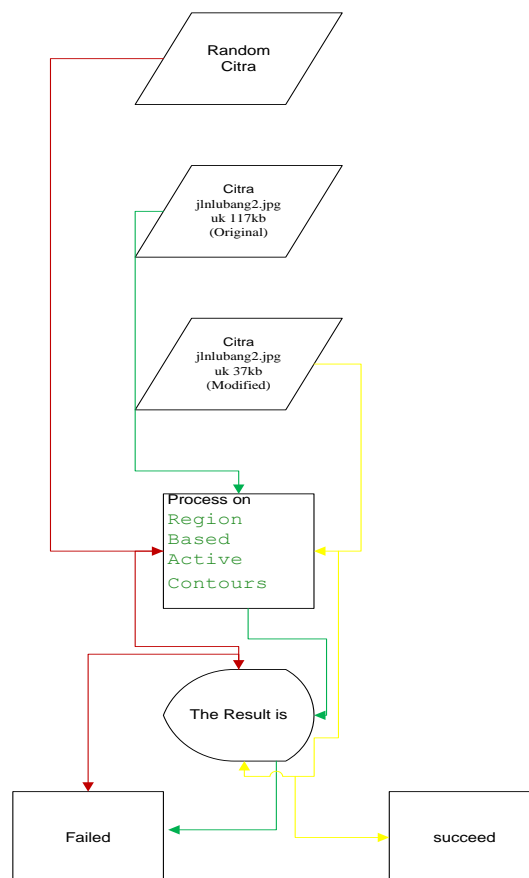
Figure 5. Flowchart of Region Based Active Countors Potholes Road Image

Referring to the explanation of the previous flowchart, that in this research looking for, determining the right image according to expectations so that the following in Table 1 will describe the eight trial data using the RBAC technique.

Table 1. Data Ujicoba

No	Random Citra	Im	x	y	Iteration	Result	Dimensions
1		1	2:45	2:15	475	Failed	299x168
2		2	3:38	2:20	400	Failed	259x194
3		2	4:52	4:07	500	Failed	300x168
4		3	2:90	1:05	750	Failed	275x183
5		4	8:03	7:00	693	Failed	275x183
6		2	4:92	4:90	595	Failed	277x182

No	Random Citra	Im	x	y	Iteration	Result	Dimensions
7		3	3:71	2:98	681	Failed	300x168
8		3	3:99	2:71	600	Failed	224x225

The conclusion from Table 1 is that randomizing more than one image by combining the value of im(x,y) and determining the iteration value will produce an output that fails and takes a lot of time. Therefore, the researcher focuses on one image, namely the eighth order image.

RESULT AND DISCUSSION

In this research, the strength of active contour will be tested which will segment area-based objects with the image of potholes using Matlab R2016a. After testing, it was found that the image size/quality has a significant impact on the speed or duration of the computational process. The image used was obtained by browsing the internet and obtained a gray image with the original size of 117kb and compressed to 37kb. The results of the analysis obtained consider Table 1.

Table 2. Image Testing "jlnlubang2.jpg"

Im	x	y	Result	Iteration
2	4:25	2:15	Failed	475
2	2:78	1:90	Failed	150
2	3:12	1:87	Failed	250
3	1:10	2:27	Failed	275
3	5:05	1:05	Failed	795
3	2:92	3:61	Failed	910
4	4:37	2:19	Failed	812
4	1:98	1:31	Failed	716
4	3:80	1:91	Succeed	800

Referring to Table 2 with successful outcomes, the researcher describes the steps for implementing the RBAC segmentation technique. Here are the steps.

1) Repeated trials are carried out so that the segmentation is right on target. Figure 6 below is a jlnhole2.jpg image that has been resized first.

Figure 6. Image jlnlubang2.jpg with size 195x195pixels

2) The image to be segmented is focused, so you will see the difference between the foreground and background. This serves to provide convenience in the segmentation process, after the segmentation area is known, an initialization process or initial mask (im) = zeros (size(x), size(y))

will be carried out, to distinguish which region is the focal point of segmentation. Figure 7 shows the results of a successful initialization.
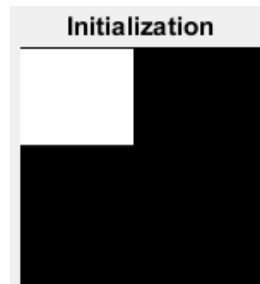

Figure 7. Initialize the image area to be segmented

3) After the initialization process is successfully carried out, Figure 8 shows that with 800 iterations and combined with the imresize command (mask, 8) the maximum results are obtained for segmentation, while Figure 8 is the result to be achieved that region based segmentation has been successfully carried out.
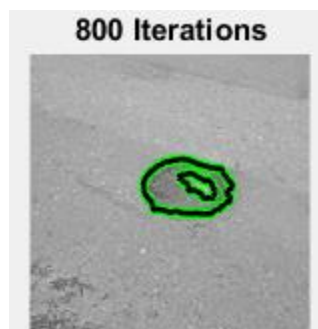

Figure 8. Iteration Result is 800

4) In Figure 9 it can be seen that there are 2 inner and outer segmentation lines, because they read the original image form. The result of region based segmentation is the white one.
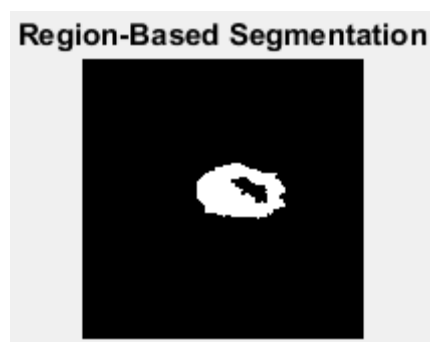

Figure 9. Result of *Region Based Segmentation*

From the decomposed steps, the image with the name jlnlubang2.jpg original size 117kb (224x225) with modified to 37kb (195x195) segmented using the region based active contours with initial mask (3:80, 1:91) = 4 and iterations of 800 to produce the output as expected.

CONCLUSION

Based on the discussion and the results obtained refer to Figure 9, it can be concluded that the level set technique has been successfully applied for segmentation of gray images with a size of 37kb, the segmentation pattern can distinguish the outer and inner regions by calculating im = 4 with imresize (mask, 8) 800 iterations. Level set with area basis manipulation on active contour provides a significant improvement in heterogeneous image segmentation accuracy and decomposes it into globally focused steps for segmented regions.

REFERENCES

[1] Sawitri, "Pengaruh teknologi informasi, pemanfaatan teknologi informasi, efektivitas penggunaan dan kepercayaan teknologi informasi terhadap kinerja individual," vol. 85, no. 1, pp. 2071–2079, 2016.

[2] A. Hanif, M. Giatman, and A. Hadi, "Komunikasi Dan Informatika Menggunakan Framework Cobit 5," vol. 9, no. 1, pp. 94–101, 2020.

[3] R. Putri and R. E. Putri, "Penilaian Kapabilitas Proses Tata Kelola TI Berdasarkan Proses DSS01 Pada Framework COBIT 5," *J. CoreIT J. Has. Penelit. Ilmu Komput. dan Teknol. Inf.*, vol. 2, no. 1, pp. 41–54, 2016, [Online]. Available: http://ejournal.uin-suska.ac.id/index.php/coreit/article/view/2181.

[4] M. Ridwan, M. Muhammad, and S. Ramadhani, "Rancangan Sistem Informasi Manajemen Aset di PT. Sentral Tukang Indonesia," *J. CoreIT J. Has. Penelit. Ilmu Komput. dan Teknol. Inf.*, vol. 3, no. 2, p. 47, 2018, doi: 10.24014/coreit.v3i2.4415.

[5] P. Februari and F. Fitria, "Audit Sistem Keamanan Informasi Menggunakan ISO 27001 pada SMKN 1 Pugung, Lampung," *POSITIF J. Sist. dan Teknol. Inf.*, vol. 5, no. 2, p. 97, 2019, doi: 10.31961/positif.v5i2.833.

[6] T. Thoyyibah, "Evaluasi Manajemen Keamanan Informasi Menggunakan Indeks Keamanan Informasi (KAMI) berdasarkan ISO 27001:2013 Pada Pusat Informasi dan Pangkalan Data Perguruan Tinggi X," *J. CoreIT J. Has. Penelit. Ilmu Komput. dan Teknol. Inf.*, vol. 4, no. 2, p. 72, 2018, doi: 10.24014/coreit.v4i2.6292.

[7] D. I. Putra, R. Aisuwarya, S. Ardopa, and I. Purnama, "Sistem Cerdas Reservasi dan Pemantauan Parkir pada Lokasi Kampus Berbasis Konsep Internet of Things," *J. Teknol. dan Sist. Komput.*, vol. 6, no. 2, pp. 57–63, 2018, doi: 10.14710/jtsiskom.6.2.2018.57-63.

[8] A. Rahmat, K. Haba, and K. C. Pelangi, "Ruk Berdasarkan Fitur Ekstraksiglcm Dengan Metode," *J. Teknol. Dan Manaj. Inform.*, vol. 6, no. 1, 2020.

[9] M. Sobron and Lubis, "Implementasi Artificial Intelligence Pada System Manufaktur Terpadu," *Semin. Nas. Tek. UISU*, vol. 4, no. 1, pp. 1–7, 2021, [Online]. Available: https://jurnal.uisu.ac.id/index.php/semnastek/article/view/4134.

[10] T. Handayani and D. -, "Pemampatan Citra Satelit Terra Modis Menggunakan Alihragam Gelombang-singkat," *SATIN - Sains dan Teknol. Inf.*, vol. 5, no. 2, pp. 1–8, 2019, doi: 10.33372/stn.v5i2.548.

[11] L. Angriani, "Segmentasi Citra dengan Metode Threshold pada Citra Digital Tanaman Penyelenggara : Program Studi Teknik Informatika Fakultas Ilmu Komputer Universitas Muslim Indonesia Makassar , Indonesia Editor : Tim Editor SNRIK 2015 Penerbit : Fakultas Ilmu Komputer," *Semin. Nas. Ris. Ilmu Komput.*, vol. 1, no. 2, 2015.

[12] M. Orisa and T. Hidayat, "Analisis Teknik Segmentasi Pada Pengolahan Citra," *J. Mnemon.*, vol. 2, no. 2, pp. 9–13, 2019, doi: 10.36040/mnemonic.v2i2.84.

[13] N. Badshah, A. Ahmad, and F. Rehman, "Variational level set image segmentation model coupled with kernel distance function," *J. Algorithm. Comput. Technol.*, vol. 14, pp. 1–10, 2020, doi: 10.1177/1748302620931421.

[14] H. Y. Id, P. Sun, F. He, and Z. Hu, "A weighted region-based level set method for image segmentation with intensity inhomogeneity," 2021, doi: 10.1371/journal.pone.0255948.

[15] Z. H. E. Zhang, "An Adaptive Fuzzy Level Set Model With Local Spatial Information for Medical Image Segmentation and Bias Correction," *IEEE Access*, vol. 7, pp. 27322–27338, 2019, doi: 10.1109/ACCESS.2019.2900089.

[16] A. Manuscript and L. R. A. Contours, "NIH Public Access," vol. 17, no. 11, pp. 2029–2039, 2009, doi: 10.1109/TIP.2008.2004611.Localizing.

[17] M. Yunus, "Perbandingan Metode-Metode Edge Detection Untuk Proses Segementasi Citra Digital," *J. Teknol. Inf.*, vol. Vol. 3, no. 02, pp. 146–160, 2012.