Image Segmentation Using Minimum Spanning Tree

M P Dewi*, A Armiati, S Alvini
Mathematics Department, Faculty of Mathematics and Natural Science, Universitas Negeri Padang, Jl. Prof. Hamka, Padang, Sumatera Barat, Indonesia 25131

*meiradaud@gmail.com

Abstract. This research aim to segmented the digital image. The process of segmentation is to separate the object from the background. So the main object can be processed for the other purposes. Along with the development of technology in digital image processing application, the segmentation process becomes increasingly necessary. The segmented image which is the result of the segmentation process should accurate due to the next process need the interpretation of the information on the image. This article discussed the application of minimum spanning tree on graph in segmentation process of digital image. This method is able to separate an object from the background and the image will change to be the binary images. In this case, the object that being the focus is set in white, while the background is black or otherwise.

1. Introduction
One of the necessity in human living is the information that can people get from everithing arround them. In this era of information technology the information can be obtained from digital device or multimedia component included digital image. Digital image is one of the multimedia components that play an important role as a form of visual information [3]. Image processing is needed for getting the information from the digital image. One of digital image processing is image segmentation.

Image segmentation is a process that separates the main picture in image from the background [6]. The aim of image segmentation are to obtain the information of the image and to find the meaning of the image which can be used to next image processing, for example to identification of finger print, barcode reader, detection of cancer cell and so on.

Nowadays, there is variety of image segmentation methods. One of them is watershed method. This method produces some objects as main image as the result of segmentation process that call as over segmentations [5]. Another method in image segmentation is global thresholding. This method is suitable for an image which uneven lighting [4]. Those weaknesses of the methods can give the non accuracy of segmentation product.

This research uses the minimum spanning tree method for image segmentation. This method is based graph and in the selection side adds the criteria of similarity. That is, the selected side is not only the minimum weighted but also meets the criteria of similarity. The neighboring pixels and having a relatively small gray level difference will be on the same object. Thus, images with a very tight gray level can be overcome if the selection of criteria is appropriate. Then, this method is not done repeatedly to get the results of segmentation, so there is no possibility of the result of segmentation of image overload (over segmentation).
2. Method and Design
This research is a basic or theoretical research. Method was conducted in this study is literature study and in the solution of the problem, the steps taken are as follows:

a. Make the stages in segmenting the image by using the concept of minimum range trees.
b. Create a process design for each stage.
c. Applying process design in the form of computer program assisted matlab application program.
d. Conducting a trial of the application program that has been created.
e. Make the conclusions from the results and discussions that have been done.

Image segmentation by using the concept of minimum spanning tree is divided into three processes, which are:

a. to convert the image to graph form
b. to process the minimum range of graph formed
c. to form the result of image segmentation.

The minimum range of tree processes performed not only takes into account the minimum weight but also considers the similarity criteria in side selection, resulting in more than one minimum range tree.

3. Findings and Discussion

3.1. Image Segmentation Using Minimum Range Tree Concepts.
Image segmentation using the minimum spanning tree concept is divided into three stages:

3.1.1 Convert Image to Graph Shape. The gray level of each pixel in the image is represented in matrix form, where the value of the matrix elements expresses the level of image, while the position of the matrix element represents the pixel coordinates of the image. Each pixel in the image is identified as the neighboring dots and pixels with the right, left, up, down, right top right, lower right corner, upper left corner of the lower left corner connected by a side. The weight of each side is obtained by using the formula:

\[ w(v_i, v_j) = |I(v_i) - (v_j)| + 1 \]  \hspace{1cm} (1)

where \( I(v) \) is the gray level at the point (pixels) \( v \).

So we will get the weighted graph represented in the form of adjacency matrix.

3.1.2 Minimum Range Tree Process. In this process, the algorithm used is the Prim algorithm by adding the criteria of similarity. That is, the selection of sides is not only based on the minimum weight but also considering the criteria of similarity. A side is said to meet the criteria of similarity if the weights are less than the value of the likeness criterion in which this value is any value. As a result, there will be some minimum range trees.

3.1.3 Shaping Image Segmentation Results. Each point (pixel) in a minimum range tree has the same color. The color of each pixel on a minimum range tree is determined by looking for the average pixel gray level in the minimum range tree. Then, the average obtained will determine the color of pixels on condition,

\[
\begin{align*}
\text{black,} & \quad \text{if average } I > T \\
\text{white,} & \quad \text{if average } I \leq T
\end{align*}
\]  \hspace{1cm} (2)

where
\[ T = \frac{\text{maxv} + \text{minv}}{2} \] 

(3)

Change the gray level of the input image with 0 (white) and 1 (black) based on the above provision, to obtain the result of image segmentation in the form of binary image. For example if we have the image:

![Image Segmentation Process](image.png)

**Figure 1. Image Segmentation Process**

Figure 1 is a process of image segmentation where the first image is a gray scale image. This image has a lot of information, where the information locate in the structure of the letter i. It appears that in the letter i there is a bright part and there is a dark part. In order to gray scale image is only focused on the object only and do not consider the structure of the letter i, it is necessary to do image segmentation. This needs to be done so that the information from the image only focuses on the shape of the object only. The result of image segmentation can be seen in second image which is binary image.

3.2. **Process Design of Image Segmentation Application Program with Minimum Range Tree Concept**

In this process the modification of Prim algorithm will be translate application programming which is Matlab.

3.2.1 **Algorithm Design of Matrix Establishment of Image.** The color image needs to be converted to a gray scale image. Gray scale image will provide information in the form of image size and gray image level. The image size determines the many points of the graph and the gray level determines the side weights of the graph. This information will form the adjacency matrix of the image. The flow chart is shown in Figure 2.

3.2.2 **Design of Minimum Range Tree Search Algorithm.** In the design of this algorithm, the initial values given by intree \{1\} and notintree \{2,3, ..., many points\} where the in tree is a minimum range tree and notintree is not a minimum range tree. Then, from this initial value will be investigated the weights of the sides connecting the point on the intree with the point on notintree. The selected side weights are side weights that meet the criteria for similarity and have minimum weight. Side weights are said to meet the similarity criteria if the side weights are less than the value of the likeness criterion, whereby the value is chosen in any way. The selected side will be stored on the intree so that the point on the intree will increase by one and the point on notintree will be reduced by one. If there is no side that meets the criteria of similarity and has a minimum weight then we select the point on notintree and save in next intree, so that will form the second minimum range tree. If there is still a side that does not meet, then obtained the third minimum range tree, and so on. If each point has been investigated, then the work is completed and obtained some minimum range trees. The flow chart is shown in Figure 3.
3.2.3 Design of Image Segmentation Result Generation Algorithm. In the design of this algorithm, some of the minimum range trees obtained will be searched for the average pixel gray level (dots) in
each of the minimum range trees. Then find the threshold value by searching the midpoint of the highest gray level and the lowest gray level of the image. This threshold value will determine the color of the segmentation result. If the minimum range tree that has an average gray level is less or equal than the threshold then each point (pixel) in the minimum range tree will be white. Conversely, if the minimum range tree has an average gray level over threshold then each point (pixel) in the minimum range tree will be black. The flow chart is shown in Figure 4.

3.3. Determining Results of Image Segmentation in Simulation Data

Suppose we have a UNP symbol image. In order for the object in the image can be read, it is necessary to do image segmentation with the concept of the minimum range of trees, with the following segmentation results:

![Flowchart of Establishment Image Segmentation Results](image)

**Figure 4.** Flowchart of Establishment Image Segmentation Results

![Result of Segmentation in Application Program](image)

**Figure 5.** Result of Segmentation in Application Program
Based on the results of segmentation in Figure 5, the left image is the image entered and the right image is the result of image segmentation. If observed from the simulation results, it is seen that the object on the UNP symbol image can be read where the circle, letters and other objects can be seen in the image segmentation results. The selection of the criterion value of similarity should be appropriate, so that the results of segmentation in accordance with the expected.

4. Conclusion
Each pixel in the image is identified as a dot. The neighboring pixels to the right, left, up, down, upper right corner, lower right corner, upper left corner of the lower left corner are connected by a side. The weight of each side of the graph grid is determined based on the gray level of each point (pixels) using the formula (1). Image segmentation using the minimum spanning tree concept is divided into several processes. The first process is to form the image into a graph form that is represented in the form of an adjacency matrix, the process of finding the minimum range of trees, and forming the result of image segmentation. The minimum range search process uses a modified algorithm of the Prim algorithm, where the algorithm produces some minimum range trees. Application program to determine the result of image segmentation with the concept of minimum assisted range of Matlab R2013a. Use of this application program on some simulation data, resulting in image segmentation in accordance with expectations. Based on the evaluation, the program can run well on the image is not too large, the object on the image is not too much, no noise (noise) on the image and the selection of appropriate criteria of similarity.

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