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Digital Image Segmentation with Wavelet Transformation Using Matlab Version R2010b

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Abstract One of the image processing is the segmentation process, which is a stage in the image analysis process that aims to obtain information contained in an image by dividing the image into separate areas where each area is homogeneous and refers to a clear uniformity criterion. In the wavelet signal decomposition process, two coefficients are produced, namely the *approximation* coefficient and the details coefficient. In this paper, the application of Wavelet Transformation in image segmentation by designing an application using MATLAB Version R2010B will be raised. Wavelets are mathematical functions that cut data into different sets of frequencies so that each component can be studied using different resolution scales.

Keywords: Segmentation, Wavelet Transformation, MATLAB

Introduction

Technological advances in terms of data recording have now made it possible to provide data in the form of digital images (Djiwo, 2008). An image is an image on a two-dimensional plane. In a mathematical review, imagery is a continuous function of light intensity in a two-dimensional plane (Murinto, 2009). When a light source illuminates an object, the object reflects back some of that light. These reflections are captured by optical sensing devices, such as the human eye, cameras, scanners and so on. The shadow of the object will be recorded according to the intensity of the light reflection. When the optical device that records the reflection of light is a digital machine, such as a digital camera, then the resulting image is a digital image. In digital imagery, the continuity of light intensity is quantized according to the resolution of the recording device (Wu et al., 2017).

Digital image processing is a process that aims to manipulate and analyze images with the help of computers with input data and output data in the form of images.

Image *segmentation* is a stage in the image analysis process that aims to obtain information contained in an image by dividing the image into separate areas where each area is homogeneous and refers to a clear uniformity criterion.

Wavelets are mathematical functions that cut data into sets of different frequencies, so that each of these components can be studied using different resolution scales (Akansu et al., 2010). Some of the applications of wavelet transformation in digital image processing include fingerprint recognition preprocessing, noise reduction in images, steganography, biometrics and so on. Therefore, it is important to raise how to apply wavelet transformation in digital image processing using Matlab version R2010b (Irawan, 2012).

Methods

The research materials needed to carry out the entire process of segmentation of digital images in this application use two digital images with a grayscale image type that has a color depth of 8 bits, namely from 0 to 255 and an RGB image type which is a combination of three color components R *(Red*), G *(Green)*, B (*Blue*) with a depth of 24 bits or commonly called *truecolor image*,. Each component consists of 8 bits, so for 3 color components it uses 24 bits or equal to 3 *bytes* per pixel. In this experiment, before the experimental image is segmented, a short wave (wavelet) decomposition is first carried out to emphasize the information on the image objects. Both images are shown in Figure III-1.

Results and Discussion

Wavelet *Decomposition Testing Process*

The first experiment uses the "lena.bmp" image with the initial format is *truecolor*, then the resulting image of the grayscale wavelet decomposition is as follows:

Figure IV-1. Grayscale image of Wavelet Decomposition "Lena.bmp"

After conducting experiments with grayscale wavelet decomposition, the next experiment uses the same image file name and RGB wavelet decomposition method. So the resulting wavelet decomposition RGB image can be seen as follows:

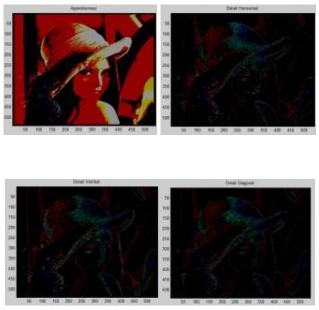

Figure IV-2. RGB image of Wavelet Decomposition "Lena.bmp"

The second experiment uses the "pelabuhan_ratu.jpeg" image with the initial format being *grayscale* , so the resulting image of the grayscale decomposition *wavelet* is as follows:

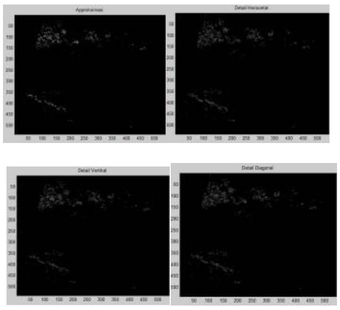

Figure IV-3. Grayscale image of Wavelet Decomposition "pelabuhan_ratu.jpeg"

After conducting experiments with grayscale wavelet decomposition, the next experiment uses the same image file name and RGB wavelet decomposition method. So the resulting wavelet decomposition RGB image can be seen as follows:

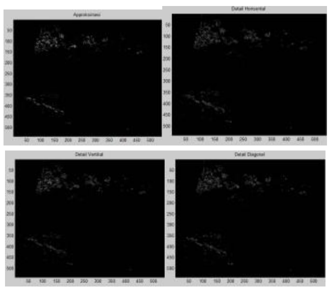

Figure IV-4. RGB image of Wavelet Decomposition "pelabuhan_ratu.jpeg"

In the above two experiments, the analysis process with the visual vision method can only be carried out in the first experiment, which clearly shows the intensity and contrast values of the image resulting from the wavelet decomposition process. While in the second experiment, the resulting *wavelet* decomposition image is quite complicated to be analyzed visually, so the two experiments above can be analyzed specifically using *the wavelet toolbox*. Where the following values are obtained:

Table IV-1. Statistical calculation of wavelet decomposition images

Name of Citra	Method	Mean	St. Deviathe
Lena.bmp	Grayscale Decompost Wavelet contents	192,5	90,01
	RGB Decompose the contents of Wavelet	192,4	110
Pelabuhan_ratu.jpeg	Grayscale Decompost Wavelet contents	64,78	70,59
	RGB Decompose the contents of Wavelet	64,77	70,54

Where:

Mean is the average intensity of an image. Standard deviation is the distribution of values from the average intensity (describing the contrast of the image). Contrast is a difference in the high intensity of the image.

Save the approximated wavelet image; since the contrast of the detailed wavelet image is the same, it is enough to save one of the detailed wavelet images.

Image Segmentation Testing Process

The segmentation process in this application is an image segmentation process with an edge detection method which includes five operators, namely Sobel, Prewitt, Robert, Canny and Laplacian of Gaussian as well as with the segmentation of the threshold method.

Edge Detection Segmentation Testing

In this first discussion, we will first discuss image segmentation based on the edge detection method using grayscale decomposition wavelet *approxismotic* "lena.bmp" images.

In this first experiment, the image of the segmentation results is as follows:

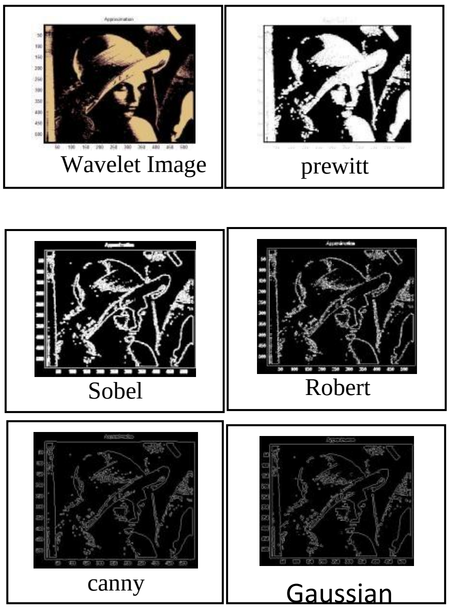

Figure IV-5. Segmentation Image of Wavelet Image "lena.bmp"

From the results of the experiments that have been carried out above, it can be concluded that:

- The best *edge detector* in detecting the edges of objects in wavelet images is the Canny operator. From Figure IV-5, it can be seen that of all the edge detection images produced, only the Canny operator's edge detection image has a shape and information content that resembles the input image. Although the boundaries of the edges of the object in the image are not so clear in intensity compared to the other four operators. However, the Canny image can provide a better picture of the boundaries of the object's edges.
- As for Gaussian operators, there are several objects whose edges are not so clear, thus reducing the content of the information they carry.
- For Roberts operators, the resulting edge detection is quite good. Although this operator is one of the operators that uses masking with a size of 2 x 2 pixels as well as a simple operator. The Roberts operator only checks for an additional pixel in one direction of the gradient, but since it is a pixel in the diagonal direction, the difference located on the beveled sides of the object will be detected.

As for the sobel and prewitt operators, the visually generated edge imagery has a strong intensity, as a result of which the detail of the edge image is reduced.

Threshold Segmentation Testing

In the second discussion, image segmentation based on the thresholding method will be discussed.

Single thresholding and double thresholding operations require an image whose histogram contains two or more dominant modes, where one or more modes are the accumulation of object pixels and the other mode is the accumulation of background pixels, then in this experiment will use a grayscale "pelabuhan_ratu.jpeg" image that has 2 dominant colors.

In this second experiment, thresholding segmentation will first be tested based on the double thresholding method. The double thresholding method determines the threshold that is carried out automatically without the need to specify the input of the threshold value itself. The results of this threshold method can be seen as follows:

(r1 = T, r2 = 255)

Figure IV-6. Double Thresholding Image

The next experiment will be tested thresholding segmentation based on the single threshold method, and will be tested in comparison with two different threshold input values with the following threshold values:

T = 0.1 T = 0.5

Figure IV-7. Single Thresholding Image

From the results of the experiments that have been carried out above, it can be concluded that:

- From Figure IV-6, it can be seen that the double thresholding operation is relatively faster than the single thresholding operation because in this operation the determination of the thresholding value has been carried out automatically (*user* without looking for a thresholding value that is considered good).
- From Figure IV-7, it can be seen visually that the selection of the threshold value is very decisive in the success of thresholding operations. This operation will give poor results if the threshold selection is not optimal.

In the two experiments above, it can be seen that the technique of determining the threshold value (*thresholding)* can be carried out in two ways, namely by automatic method and technique carried out by trial *and error*

Conclusion

After testing the segmentation of digital images with wavelet transformation based on the predetermined objectives, it is concluded as follows:

1. In the process of signal decomposition using *wavelets*, two coefficients are produced, namely the *approximation* coefficient and the details coefficient. The approximation coefficient is the most important coefficient because it contains the low-frequency components that are the identity of a signal, while the coefficient of detail (horizontal components, vertical components and diagonal components) is the coefficient that contains the high-frequency components that are the "spice" or nuances of the signal. In this case, the variant image used is *wavelet bior 3.7.*
2. From the experiments that have been carried out on the digital image segmentation application, it can be seen that of all the edge detection images produced, only the Canny operator's edge detection method has *the best edge detector* in detecting the edges of objects in the image because only the Canny operator has the shape and information content that resembles the input image.
3. In the test results of the edge detection segmentation method, it can be seen that the implementation of conversion from raster data model to vector data model is one of the advantages of vector data is that it requires less space or space in computer memory.
4. In the threshold method (*thresholding*) in the technique of determining the threshold value (*thresholding)* can be done in two ways, namely by automatic and technique that It is done by trial and error (*Trial and error*)

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