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Detection of Vessel on UAV based on Segmentation Using Edge Based Dilation

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ABSTRACT

UAV usually is used in military field for reconnaissance, surveillance, and assault. To detect a moving object in real-time like vessel, there are complex processes than to detect the object that does not moving. There are some issues that faced in detection process of moving object in UAV, called constraint uncertainty factor (UCF) such as environment, type of object, illumination, camera of UAV, and motion. One of the practical problems that become concern of researchers in the past few years is motion analysis. Motion of an object in each frame carries a lot of information about the pixels of moving objects which has an important role as the image descriptor. In this paper, we use SUED (Segmentation using edge-based dilation) algorithm to detect vessel. The concept of the SUED algorithm is combining the frame difference and segmentation process to obtain optimal results. This research showed that the SUED method having problem to detect the vessel even though we combine it with sobel operator. using the combination of wavelet and Sobel operator on the detection of edges obtained increasing in the number of DR about 3%, but then FAR also increased from 41.23% to 52.09%.

Keywords: UAV, SUED (Segmentation using edge-based dilation), Vessel, UCF.

INTRODUCTION

The UAV is an acronym for Unmanned Aerial Vehicle, which is an aircraft with no pilot on board. UAV can be remote controlled aircraft (e.g. flown by a pilot at a ground control station) or can fly autonomously based on pre-programmed flight plans or more complex dynamic automation systems. The greatest utilization of the UAV is in military field [1]. To detect moving objects like vessel, involved complex signal processing than if the object does not move cause not only the object moves but also the background of object keep moving. There are some issues that faced in detection process of moving object in UAV, called constraint uncertainty factor (UCF) such as environment, type of object, illumination, camera of UAV, and motion [2]. One of the practical problems that become concern of researcher in the past few years is motion analysis. Motion of an object in each frame carries a lot of information about the pixels of moving objects which has an important role as the image descriptor. One of the methods for detecting moving objects is the SUED (Segmentation using Edge based Dilation) [3]. This method combined frame difference and segmentation process to obtain optimum detection results. At the process of analyzing motion, frame difference is utilized to capture the information of moving object by utilizing the difference of two frames. Then, segmentation process will yield object form that almost similar with its original form but this segmentation process does not have the ability to distinguish moving region from static background region and the effect will result in noisy region [3]. In this paper, segmentation process using the combination of wavelet transformation and Sobel operator to detect the edges of moving objects to minimize the occurrence of noisy region as a result of moving background [4,5]. This method will be explained in the following section.

This paper is divided into the following sections: part 2 describes the Related works of this method, part 3 describes the methodology of this research, section 4 show the results and analysis, and the last part is the conclusion of the paper.

LITERATURE REVIEW

In order to obtain accurate detection, motion must be accurately detected using suitable methods which are affected by a number of practical problems such as motion change over time and unfixed direction of moving object. Motion pattern analysis before detecting each moving object has started to get attention in recent years, especially for multiple object scenarios when detecting each individual is very difficult. Through the modelling of object motion, the detection task becomes easy and thus also can handle noise. Detection of motion and detection of object are coupled. If proper motion detection is done, detection of moving object from UAV's image becomes easier. Very few researches concentrate on adaptive robust handling of noise and unfixed motion change as well as unfixed moving object direction. For that reason, an adaptive and dynamic motion analysis framework is needed for better detection of moving object from UAV aerial images where overall motion analysis reduces dependency on detection of motion pixels from frames which can be described as some function of the image pixel intensity. Pixel intensity is nothing but the pixel color value. Moments are described with respect to their power as in raised-to-the-power in mathematics. Very few previous researches used image moments to present motion analysis. Thus, this paper proposes to use image moments before segmenting individual objects and to use motion pattern in turn to facilitate the detection in each frame parameter. In other words, detection of motion indicates detection of motion pixels from frames which can be described as some function of the image pixel intensity. Pixel intensity is nothing but the pixel color value. Moments are described with respect to their power as in raised-to-the-power in mathematics. Very few previous researches used image moments to present motion analysis. Thus, this paper proposes to use image moments before segmenting individual objects and to use motion pattern in turn to facilitate the detection in each frame.

Moving object detection from UAV aerial images involves dealing with proper motion analysis. Previously very few researchers used methods which involve effective motion analysis. Several studies using a method that involves the analysis of motion as in [6], the researchers propose Bayesian methods that depend on the constraint that an object must have a fixed shape and do not exceed the aspect ratio that has been set, then the [7, 8] where the use of image registration methods are not suitable because of the increased number of motion detection block will result in rate decreases, so that the study was not suitable to be used for moving objects. In [9] Researchers using SIFT (Scalar invariant Feature Transform) that utilizes the characteristics of an object, but these methods are not suited to the noisy environment. Then on [10, 11] using Cascade Classifier method that require

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grayscale image as the input, this method certainly not unrealistic to be used in real time. This paper states that as frame difference cannot obtain motion for the complete object alone and segmentation does not have the ability to differentiate moving regions from the basic static region background, so applying frame difference and segmentation together is expected to give optimum detection result with high detection speed for moving object detection from UAV aerial images instead of applying frame difference or segmentation separately. In addition, to improve the detection rate, Wavelet and Sobel operator will be combine in the edge detection process.

METHODOLOGY

3.1 SIMULATION FLOWCHART

The flowchart of the simulation is shown in Figure 1. According to the flowchart, the process starts by using a dataset video obtained from the CV online: Image Databases. Then perform preprocessing stage to extract frames from video. The number of frames used are 300 frames, or 1 frames/sec. The next stage will obtain IB (m, n, t), the decomposition of the original image frame. I(x, y, t) is the original in frame-t, in a video sequence, wherein (x, y) indicates the position of a pixel in the original frame. The next process is the process which has been called by the algorithm SUED consisting of process motion estimation using the frame difference and the segmentation process by using edge detection from combination of wavelet and Sobel operator. The next stage is the process of dilation and the last is the process of evaluating the performance of the algorithm that employ two metrics, detection rate and false alarm rate. The next section explains every process of the simulation flowchart.

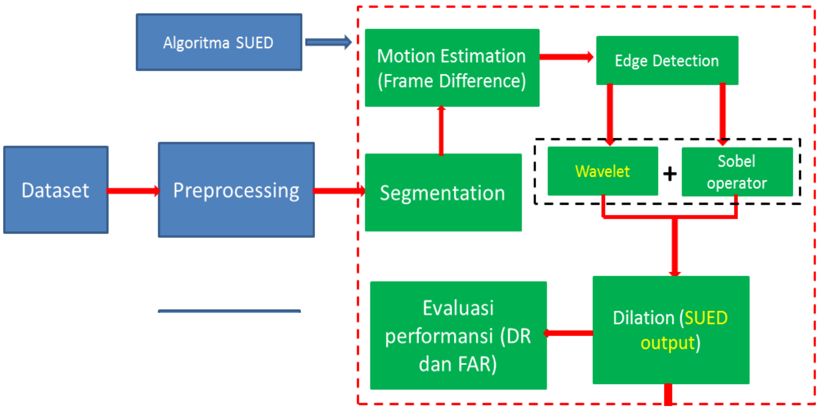

FIGURE 1. Block Diagram of simulation

3.2 SEGMENTATION USING WAVELET AND EDGE DETECTION

The following steps for implementing this algorithm are:

(1) Start

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(2) $FD_r(m,n,t) \leftarrow$ *Decomposed image between 2 frames,* $I_B(m,n,t) - I_B(m,n,t-1)$ *at t and t-1 time.*

(3) Wavelet

(4) $FD_e(m,n,t) \leftarrow FD_f(m,n,t) \leftarrow$ *Wavelet*

(5) $FD_d(m,n,t) \leftarrow FD_e(m,n,t)$

(6) End

It starts by assuming I (x, y, t) is the original frames at t in a video sequence, where (x, y) denotes a position of a pixel in the original frame and assumed I_B(m, n, t) is the image decomposition of the original frame, where (m, n) indicates the position of the block area with a pixel density that is higher as shown in Figure 2, this area has a robust against noise but sensitive to the movement of the object. I_B (m, n, t) is defined in the equation (1).

$$I_B(m,n,t) = mean\ (m,n,t) + \frac{\alpha}{\beta^2}\left(N_1(m,n,t) - N_{-1}(m,n,t)\right) \quad (1)$$

where $(m$,n) is feature densed block; α is the random constant smaller than 1; mean $(m,\ n,\ t)$ is mean gray level of all pixels within the block $(m,\ n)$ at frame t, $N_1(m,n,t)$ is the number of pixels with levels of gray that is greater than the mean (m, n, t), $N_{-1}(m,n,t)$is the number of pixels with levels of gray that are smaller than the mean (m, n, t). the result of the representation of the equation (1) can be seen in Figure 2. From (1), difference image $FD(m,n,t)$ of two consecutive block images is obtained by (2):

$$FD_r(m,n,t) = \left(\frac{|I_B(m,n,t) - I_B(m,n,t-1)|}{\frac{FD_{max}\ (t)}{256}}\right) \quad (2)$$

where $FD(m,n,t)$ is the result of the quantization image after rounding operation, FD_{max} is the maximum value of the $FD(m,n,t)$. The result of the representation of the equation (2) can be seen Figure 3.

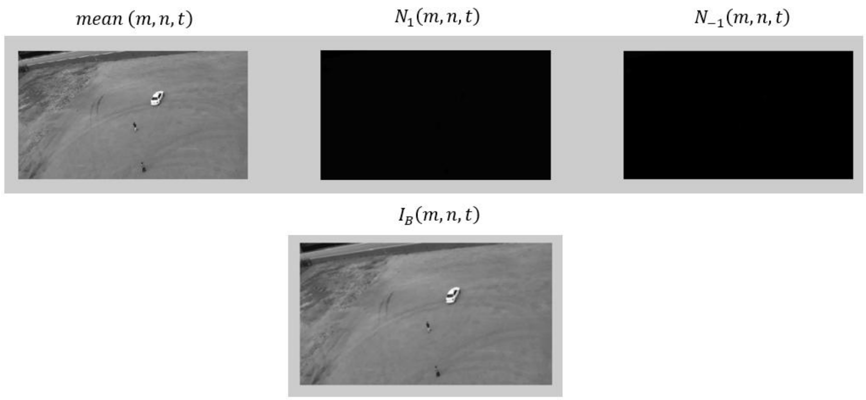

FIGURE 2. Representation pictures of equation (1)

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FIGURE 3. Representation pictures of equation (2)

Detection using wavelet edge process begins with the decomposition process (Wavelet Transform) of an image. An image can be assumed of as a two-dimensional matrix and in doing transformation of lines in the image, and continued with the transformation of the columns in the image, for example, Figure 4. is the result of the decomposition of a pictorial image using the wavelet Haar.

Decomposition only done two levels (a ^{0} to a $^{2)}$. Decomposition is done using the Matlab Wavelet Toolbox. In Matlab, wavelet decomposition is shown with the following caption: In Matlab notation, LL parts called approximation (A), LH section called vertical part (V), HL section called horizontal detail (H), and a section called HH detail diagonal (D). Approximation (A) is modified by downloading the zero-level of intensity so that this section will be a black image. Image results *approximation* section *(A)* that are zero-level can be seen in Figure 4.

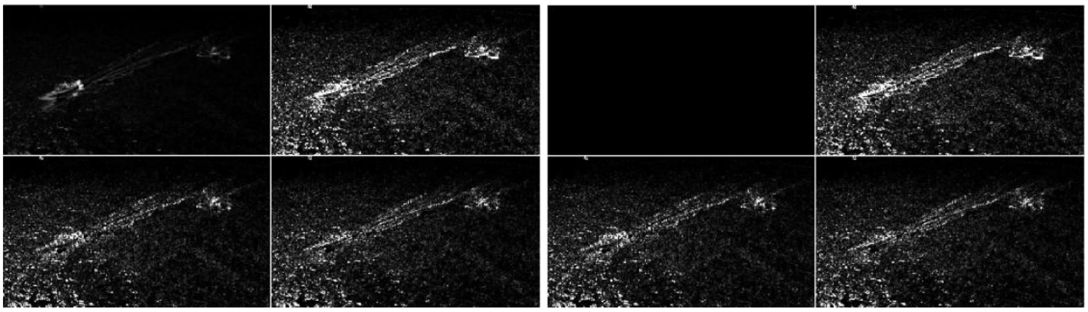

FIGURE 4. Representation pictures of wavelet transformation

After the decomposition process is the process of modifying one of the four sections mentioned above. Next step, $FD_r(m,n,t)$ filtered by 3 x 3 median filter. $F_f(m,n,t)$ is obtained by following formula:

$$FD_f(m,n,t) = \begin{cases} 1, & FD(m,n,t) \geq T(t) \\ 0, & otherwise \end{cases} \tag{3}$$

where $T(t)$ = (Mean of all blocks in $FD_r(m,n,t)$ at time t + Positive weighting parameter $*$ (Largest peak of histogram of $FD_f(m,n,t)$-Largest peak of histogram of $FD_r(m,n,t)$. Binary image $FD_b(m,n,t)$ is obtained by the following condition showed in Figure 5:

$$if\ FD_f(m,n,t) = 1$$
$$Then\ FD_b(m,n,t) \leftarrow FD_f(m,n,t) \quad (4)$$
$$\text{Otherwise, } FD_f(m,n,t) = 0$$

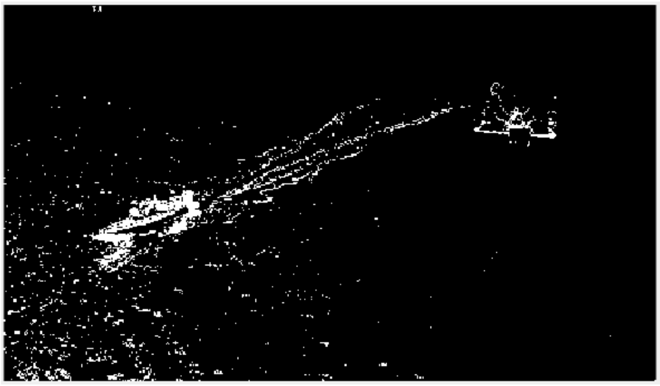

FIGURE 5. Implementation of equation (3)

The edge-based morphological dilation is carried out to ensure there are moving objects. Edge of this image could be obtained by combining gradient operators such as Sobel operator and Wavelet Transform. Having obtained modified decomposition process, then performed the synthesis process *(Inverse Wavelet Transform)* of the four parts of the image and then take the absolute value, the result is showed in Figure 6.

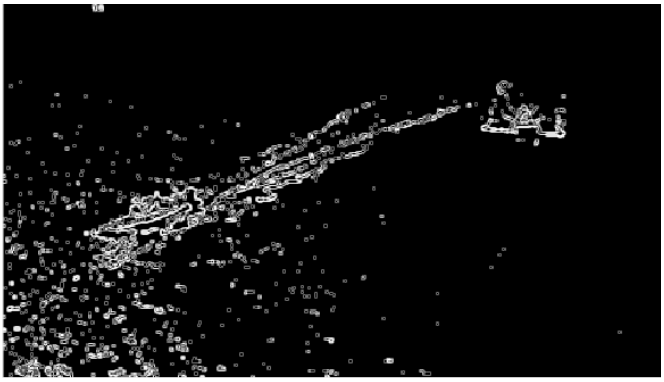

FIGURE 6. Output of sobel operator and wavelet combination

Based on the Figure 6, the image contains smaller blobs indicated by white dots as a result of the movement of the background object which are small waves. The further effect of those blobs can decrease the performance of detection.

SIMULATION RESULT AND ANALYSIS

The algorithm utilizes the datasets video UAV from the CV online: Image Databases. Each region in the figure indicates the coherence between the intensity of the pixels and the motion of moving objects. By using algorithms that combine

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SUED frame difference and the segmentation process in the form of edge detection, moving objects can be distinguished from the background. The evaluation process SUED algorithm uses two parameters: detection rate (DR) and false alarm rate (FAR) Metrics-this metric is obtained based on the parameters below:

1. True Positive (TP): region detected that there is a moving object
2. False Positive (FP): region detected that there are no moving objects
3. False Negative (FN): a moving object is not detected.
4. Detection rate or Precision rate (DR) = (TP/(TP+FN)) x 100%
5. False alarm rate (FAR) = (FP/(TP+FP)) x 100%

The results of the evaluation of the overall frame of the two methods used are shown in Table 1.

TABLE 1.
Result of Evaluation SUED Algoirthm

Method	FP	TP	FN	DR	FAR
SUED	80	114	106	51.81%	41.23%
SUED + Wavelet	112	103	85	54.78%	52.09%

In comparison results shown in Table 1, the combination of wavelet method and the Sobel operator on algorithms SUED can minimize the noise region (the area that contains white spot). This area is caused due to movement of the camera UAV resulting background that should be silent will appear to move. The combination of wavelet methods and Sobel operator showed performance increasing as shown in Table 1. The evaluation results of SUED algorithm obtained the number of frames for the TP about 114 frames, then 80 frames for FP and FN are 106 frames. The percentage of DR is 51.81% and FAR is 41.23%. Then the results of the evaluation algorithm with a combination SUED wavelet method and Sobel operator yield the number of frames to TP are 103 frames, 112 frames for FP and 85 frames for FN. So, we get DR about 54.78% and FAR about 52.09%. Thus, using the combination of wavelet and Sobel operator on the detection of edges obtained increasing in the number of DR about 3%, but then FAR also increased from 41.23% to 52.09%. This research showed that the SUED method having problem to detect the vessel even though we combine it with sobel operator. The dynamic move of the background make the detection rate not acceptable and increasing the false alarm rate. Furthermore, the condition of environment such sunlight that reflect in ocean make detection worsen and this part will become our focus for the next research.

CONCLUSION

As a conclusion, SUED algorithm simulation results show that vessel hardly be detected by the motion which carries the information of pixels of the moving object.

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