International Journal of Engineering and Technical Research (IJETR)
ISSN: 2321-0869 (O) 2454-4698 (P) Volume-8, Issue-4, April 2018

Performance of Discrete Wavelet Transform on CCTV Images Data Decomposition

Luqman Hakim, Muhammad Ihsan Zul, Memen Akbar

***Abstract*— In this paper presented the performance of discrete wavelet transforms (DWT) on movement image data in Closed Circuit Television (CCTV). Movement image on CCTV recordings is taken using background subtraction technique. Implementation of DWT on data is aimed to obtain a smaller amount of image data but not eliminating the characters of the original image characters. The application of discrete wavelet transforms is performed by filtering technique using impulse wavelet Daubechies order 4 (Db4). From the test conducted, on the first level decomposition, the data size reduction is 49.99% with the change in parameters average value of pixel is 1.19% and pixel pattern change 1.93%. In second level, the data size reduction is 24.99% with the change in parameters average value of pixel is 1.62% and pixel pattern change 2.46%. In Third level, the data size reduction is 12.48% with the change in parameters average value of pixel is 2.32% and pixel pattern change 3.84%. In fourth level, the data size reduction is 6.22% with the change in parameters average value of pixel is 2.31% and pixel pattern change 4.57% from the pattern of original image. From these results it can be concluded that wavelet transformation can be used to minimize the amount of image data without loss the characteristics of its original.**

***Index Terms*— Discrete wavelet, image, decomposition, data**

I. INTRODUCTION

The use of CCTV cameras as a monitoring tool has been widely used. However, the installed cameras only serve as a monitoring and recording device. Therefore, the enhancement of the function of CCTV cameras equipped with motion detection capabilities become an interesting topic studied. To be able to build a motion detection system on CCTV recordings it is necessary to do various steps to process data in the form of weight value contained in each pixel image.

The wavelet transform has been widely used by researchers to study time-frequency characteristics of complex and non-static natural signals. Many researchers have published various variants of wavelet transformations and their use to analyze complex and non-stationary nature signals and compare them with other transformations such as Fourier transforms. Implementation of a discrete wavelet transform on an image will result in a reduction in the amount of data without losing the characteristics or shape of original image [1][2][3].

II. THE PROPOSED METHOD

Fig.1 shows the block diagram of the general proposed method in which human activity recognition is based on Closed Camera Television (CCTV) analogue surveillance. Digital Video Recorder (DVR) with USB interface is used to convert analogue signals (images) from CCTV camera to digital signals, so the image can be processed in laptop or personal computer.

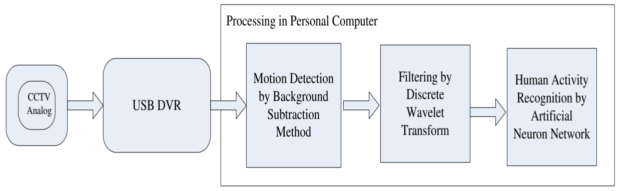


Fig. 1: Block diagram of the general proposed method

A. *CCTV and USB DVR*

Close Circuit Television (CCTV) is a set of video cameras used to send a signal to monitor or specific place. The CCTV system consists of camera components, storage, monitors and other equipment for data transmission purposes. Digital Video Recorder (DVR) is a medium to change the analog signal from CCTV cameras to digital and then stored in storage media and displays it to the monitor screen. The size of the data storage capacity depends on the capacity of the hard drive installed. USB DVR type is used to acquiring image data from analogue CCTV to computer [4][5].

B. *Motion Detection by Background Subtraction*

Background subtraction method is used to review an object's motion. The technique used is to calculate the absolute difference of background image with new image during camera monitoring. The background image is taken immediately after command to detect is executed. Comparison is done every 100 milliseconds. At the same image size, with the data in each pixel background image $bg(x, y)$ and the new image $ni(x, y)$, the motion image data $mi(x, y)$ can be calculated by [6][7][8]:

$$mi(x,y) = 255, if\ |bg(x,y) - ni(x,y)| \geq Th, else\ mi(x,y) = 0 \quad (1)$$

Where, Th is threshold value that chosen.

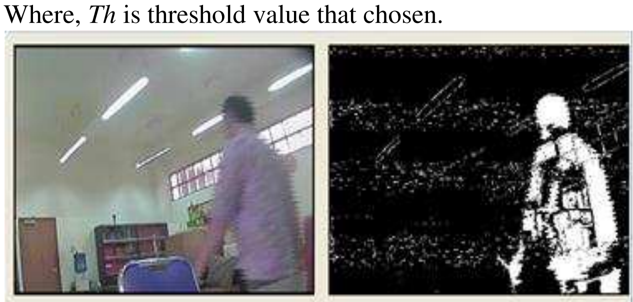


Fig. 2. Color image and background subtracted result image before filtering

Luqman Hakim Lecturer in Industrial Technology Department, Politeknik Caltex Riau, Pekanbaru, Indonesia.
Muhammad Ihsan Zul Lecturer in Informatic Technology Department, Politeknik Caltex Riau, Pekanbaru, Indonesia
Memen Akbar Lecturer in Informatic Technology Department, Politeknik Caltex Riau, Pekanbaru, Indonesia.

Fig.2 shows the example of background subtraction results. There are many noises in the image of the result background subtraction. To reduce the noises, then filter function is implemented.

The filter function that used is smooth bilateral filter function. Image of the result background subtraction after filtering is shown in Fig.3. There is a rectangle marker that created after the location of motion pixel is obtained.

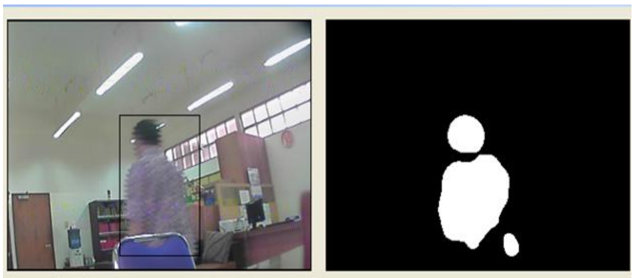


Fig. 3. Color image and background subtracted result image before filtering

In this paper, the propose method will be implemented to recognize the human suspicious activities. As sample of case study, the method is implemented in surveillance of residential environments. So that, obtained some images of human activities. The images are divided into two categories, normal and suspicious image, and shown in Fig.4 and Fig.5 as examples.

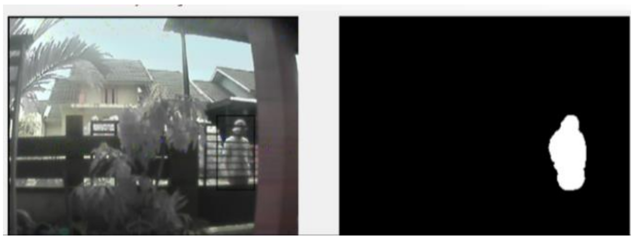


Fig. 4. Color image and background subtracted for example of normal activity

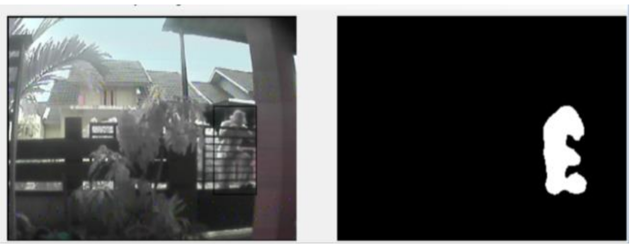


Fig.5. Color image and background subtracted for example of suspicius activity

C. Discrete Wavelet Transform

The widely used wavelet transformation currently consists of two types, namely continuous wavelet transform (CWT) and discrete wavelet transform (DWT)[1]. CWT has an advantage in the spectral analysis results that can localize the signal frequency components of the time plane correctly and is easy to see and analyze from a non-stationary signal. The wavelet transforms from a continuous non-stationary signal in the time domain defined as:

$$CWT_{(a,b)} = \frac{1}{\sqrt{a}} \int_{-\infty}^{\infty} x(t)\,\psi'\left(\frac{t-b}{a}\right) dt \qquad (2)$$

Where ψ' is a complex conjugate of the wavelet function, “a” is a scale or wavelet dilation parameter and “b” is the location or time translation parameter. Each wavelet scale value is inverse correlated to the specified value of decomposed signal. With variation of “a” value and wavelet operation is done each “b” translation during the time of the signal, it will get information of the presence of frequencies on the signal at the time location indicated by the signal translation value. There are many continuous wavelet functions, but the most famous wavelet functions are Mexican hat and Morlet functions. To analyze complex signals, the wavelet Morlet function, this is defined:

$$\psi(t) = \frac{1}{\sqrt[4]{\pi}} e^{j\omega_0 t} e^{\frac{-t^2}{2}} \qquad (3)$$

Where is the central frequency of the Morlet function. Usage of = 5.33 rad / s or 0.849 Hz has been widely used by researchers to solve various problems of complex non-stationary signal analysis [1]. The coefficients of the CWT result are the sum of the multiplication of the signal value x with the wavelet function on scale “a” and translation “b” of wavelet function divided by the root of the scale “a”.

$$CWT_{(a,b)} = \frac{1}{\sqrt{a}} \sum x[n]\,\psi'_{(a,b)} \qquad (4)$$

In the field of image processing, the frequently used wavelet transformation is discrete wavelet transform (DWT)[1]. From the separation of data at each frequency range it can be analyzed and detected the value of signal power at each frequency range and time in question simultaneously. In DWT, to obtain representation of data information at time and scale (frequency) is using filtering technique. The DWT application procedure for a signal begins with passing the original data signal array x [n] to a digital low pass filter (LPF) with impulse responds h [n] and high pass filter (HPF) g[n]. This filtering yields a decomposition of a signal by subtracting half the data at each writeable decomposition level:

$$a[n] = \sum_{k=0}^{N-1} h[k].x[2n+k] \qquad (5)$$

$$d[n] = \sum_{k=0}^{N-1} g[k].x[2n+k] \qquad (6)$$

Using the low pass filter introduced by Ingrid Daubechies, known as wavelet daubechies order 4 (D4 wavelet), the LPF coefficients used are shown in Table 1 and the HPF used is denoted by equation 7 [2].

Table 1. LPF coefficients D4 wavelet

n	**h(n)**
0	$(1+\sqrt{3})/8$
1	$(3+\sqrt{3})/8$
2	$(3-\sqrt{3})/8$
3	$(1-\sqrt{3})/8$

$$g[n] = (-1)^n h[3-n] \qquad (7)$$

III. Experimental Evaluation

Implementation of a discrete wavelet transform on an image will result in a reduction in the amount of pixel data without losing the characteristic of original image or shape. In this research we have analyzed the transformed images with Daubechies 4 DWT function. The following are examples of identification of monitoring movements at residential locations, shown in Fig.5.

From Fig. 5 we can see that the output of DWT db4 produces four levels of decomposition output. At each level yields half the data from the previous level. At higher levels it produces less image data, but the patterns are not much different. By calculating the average value of data source and data in each level, it can be seen the similarity of data weight. For the distribution of data variations in each level can be seen with standard deviation parameters. The degree of difference of data at each level of decomposition with the source data can be seen from the difference in mean value Δ and the difference in standard deviation α. For example, the decomposition of four different images shown in Table 2.

Fig.6 shows clearly the performance of the DWT output when implemented in a series of data. That Significant decrease in the amount of data but the pattern of distribution and the value of data on average changes relatively small. At 4thlevel, where the amount of data decreased to 6.22% of the initial amount of data, changes in the average value of amplitude is only 2.31% and changes in pattern or pixel frequency by 4.57%.

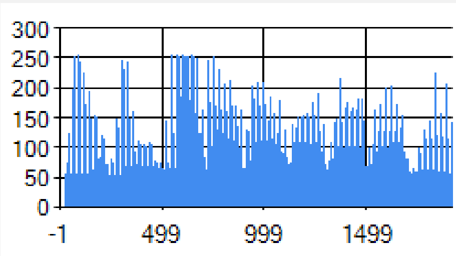
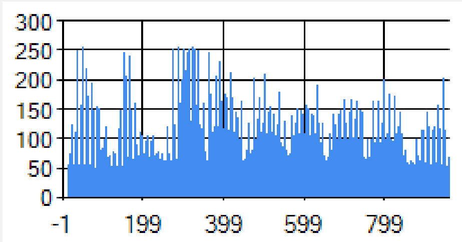
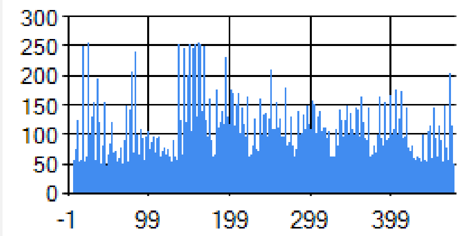


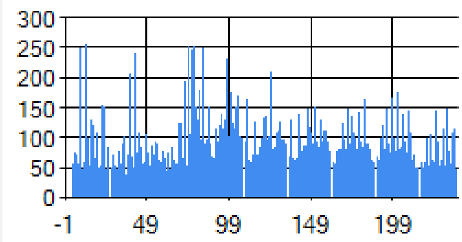
Image data is displayed in 1-dimensional graphics mode, showing the pixel point and its weight as the source image



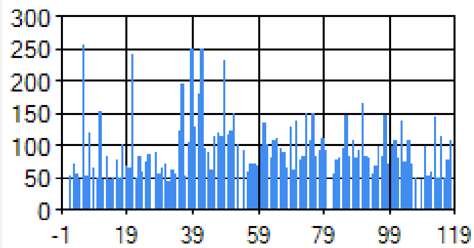
Level 1 decomposition image data



Level 2 decomposition image data



Level 3 decomposition image data



Level 4 decomposition image data

Fig.5. Graph of DWT transformation results in image data

Table 2. Samples DWT output decomposition

No	Parameters	Original	Decompositions			
			1st Level	2nd Level	3th Level	4th level
1	amount of data	1917	958	479	239	119
	average	88.8482	88.74635	89.275574	90.76569	91.03361
	SD	45.64042	45.73703	46.293644	47.87278	48.42597
	Δ		0.11%	0.48%	2.16%	2.46%
	α		0.21%	1.43%	4.89%	6.10%
2	amount of data	3256	1628	814	407	203
	average	84.558354	84.53808	84.834152	84.93612	84.96552
	SD	39.476756	39.50583	39.80281	40.0339	40.48321
	Δ		0.02%	0.33%	0.45%	0.48%
	α		0.07%	0.83%	1.41%	2.55%
3	amount of data	2088	1044	522	261	130
	average	87.780172	87.74234	88.363985	88.70498	87.83077
	SD	44.500862	44.63719	45.142704	45.89227	43.94124
	Δ		0.04%	0.67%	1.05%	0.06%
	α		0.31%	1.44%	3.13%	1.26%
4	amount of data	1254	627	313	156	78
	average	140.98884	134.5167	133.93291	133.0705	132.1923

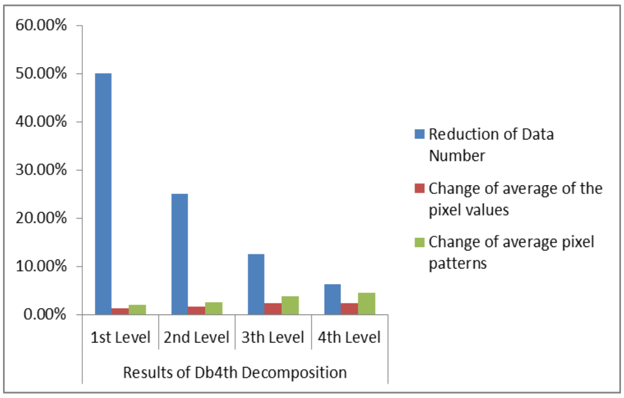


Fig.6. Graph of image data parameter change after decomposition with DWT Db4.

IV. Conclusion

In this paper, can be concluded that DWT can be used to reduce the amount of data of an image without losing much characteristic of an image. At 4thlevel where the amount of data dropped to 6.22% from the initial amount of data, the change in the average value of amplitude is only 2.31% and the pattern change or pixel frequency is 4.57%. With these results it is expected that this wavelet transformation can be developed for use in image data processing so that it is more effective and efficient. The next project from this stage is implementation of DWT results to recognize human activity based on CCTV surveillance.

Acknowledgment

We would like to thank Ministry of Research, Technology and Higher Education of the Republic of Indonesia and Unit of Research and Community Services Politeknik Caltex Riau, Pekanbaru, Indonesia.

References

[1] Paul S. Addison, James Walker, and Rodrigo C. Guido (2009), “Time–Frequency Analysis of Bio signals “, IEEE Engineering in Medicine and Biology magazine edition September / October 2009, pp. 14 – 29.

[2] Raguveer M.Rao & Ajit S. Bopardikar (1998), Wavelet Transforms: Introduction to Theory and Its Application,. Massachusetts: Addison wasley Longman, Inc.

[3] Polikar, R., “The Wavelet Tutorial”, Second Edition, http://users.rowan.edu/~polikar/wavelets/ wttutorial.html, 4th August 2017 10:50

[4] Space and Naval Warfare Systems Centre Atlantic (2013), CCTV Technology Handbook, New York: National Urban Security Technology Laboratory

[5] Planning, design, installation and operation of CCTV surveillance systems code of practice and associated guidance (2017), (https://www.bsia.co.uk/Portals/4/Publications/109-installation-cctv-systems.pdf), accessed 27th august 2017

[6] Rastivlac Lukac & Konstantios N. Plataniotis. (2007), Color Image Processing Methods and Applications, Boca Raton: Taylor & Francis Group

[7] Rupali S.Rakibe & Bharati D. Patil,(2013), Background Subtraction Algorithm Based Human Motion Detection, International Journal of Scientific and Research Publications, Volume 3, Issue 5

[8] D. Parks and S. Fels, (2008) “Evaluation of background subtraction algorithms with post-processing,” in Advanced Video and Signal Based Surveillance, AVSS ’08. IEEE Fifth International Conference on, pp.192–199

Luqman Hakim Lecturer in Industrial Technology Department, Politeknik Caltex Riau, Pekanbaru, Indonesia.

Muhammad Ihsan Zul Lecturer in Informatic Technology Department, Politeknik Caltex Riau, Pekanbaru, Indonesia

Memen Akbar Lecturer in Informatic Technology Department, Politeknik Caltex Riau, Pekanbaru, Indonesia.