International Research Journal of Computer Science (IRJCS)
Issue 02, Volume 3 (February 2016)
ISSN: 2393-9842
www.irjcs.com

Comparison of Texture's Features of SAR Images Based on Grey Level Co-occurrence Matrix : Case on Multi Polarization P Band and L Band

Harwikarya
Department of Informatics, Mercu Buana University

Abstract— ***Texture of SAR Image could be extracted by using Grey Level Co-occurence Matrix method. This research was an extended research on texture's feature which had aim to calibrate the sea wave height. The research object was the Sinthetyc Apperture Radar (SAR) image L band of Kalimantan's coastal. This L Band SAR image had full polarization such as horizontal horizontal, horizontal vertical, vertical horizontal and vertical vertical. The result showed Horizontal Vertical polarization and Vertical Vertical polarization both in P and L band had good accuracy in homogeneity, it means that this feature could be considered as the proposed calibrator for the sea wave height in 0° observation angle of Grey Level Co-occurrence Matrix.***

Keywords— GLCM, sea wave, SAR, texture

I. INTRODUCTION

This paper was an extended research on new proposed method to calibrate the height of sea wave in Kalimantan Island or Borneo in Indonesia based on grey level co-occurrence matrix (GLCM) method. In the previous research the feature texture of P band Synthetic Aperture Radar (SAR) image of coastal of East Kalimantan had been be extracted. The results described that Homogeneity was a robust feature, and this research used observation angle 0º [1],[2],[3]. These features extracted were contrast, correlation, energy and homogeneity. In this research we worked on L band multi polarisation SAR image and we focus on same sea area of East Kalimantan island. The results of this research was very important for us to complete previous research. It had been stated that Indonesia is an archipelago country where the sea transportation was a highest priority . The objective of this research was to have the four feature texture of the East Kalimantan sea area and to compare these features between different polarization and different band such as of L band and P band SAR image.

The government of Indonesia had to ensure the safety system on ferries, fishery and tourism due to its geographical condition. Indonesia consists of 70% of sea areas and 30% of the land area and had five big islands and thousands of small islands. Geographycal atlas of Indonesia stated that area of the sea was 3,257,483 km^2 and lands was 1,369,65 km^2 . Regarding this geographical condition, mode of transportation between two islands in Indonesia must used ferry or speedboats. Here are example inter-island crossing Banyuwangi – Gilimanuk to connect Java and Bali island , Merak – Bakauheuni to connect Java and Sumatra island. Despite there were still ferries and fisher accident, this research would avoid these accident, it was reported in previous research that terrible accident was occurred in the middle of December 2015 in Bone bay, Sulawesi east Indonesia, ferry hit by 3 to 5 meters sea wave height and the dead victim were more than 60 died and more than 100 were wounded.

It was stated in previous research that to monitor the height of wave, in principe there were two two methods such as directly measure from the beach and measure on the surface of the sea by using certain type of gage. We could use inferential method by using wind velocity, this method was known as Gumbel method [4]. Here in this extended research we proposed the new method by using the feature texture on SAR image. Theorytically SAR image consists of amounts return signal that is mostly influenced by the roughness of the surface of the sea. The roughness of the sea was proportional to sea wave height and it caused the texture on the SAR image. In this extended research we extracted the features texture of L band multipolarization SAR image to provide and to compare to previous research on P band.

II. TEXTURE ANALYSIS

To analyse textured SAR image we could use two approach, structural approach and statistical approaches. Texture in SAR image was a descriptor that contains information about the regularity, roughness and smoothness. Structural approach could be applied on images which certain structural components. Examples for the image tile floor, it had rectangular structural component. Unfortunately SAR images did not have a structural component. Statistical approach was the only one to analse it. Tomita described a statistical approach is divided into three levels such as [5]:

a. The first level: by calculating the average, maximum and minimum.
b. The second level: by counting Grey Level Co-occurrence Matrix (GLCM), Semi-variogram, or Autoregresi.
c. The third level: by counting the cover or run length interval.

Three levels statistic also proposed by Naddler:
a. Imaged-based: characteristic obtained directly from the image.
b. Model-based: characteristics obtained by creating a model of texture.
c. Transform based: transform image to another domain which included based transform is a Fourier transform, Wavelet, and CLCM

Harallick proposed the well known mehod, Grey Level Co-occurrence Matrix (GLCM), to extract the texture's features and the features were energy, entropy, correlation, dissimilarity, inverse different moment, inertia, cluster shade, cluster prominence, homogeneity, but not all features must be applied [6]. For the efficiency in computation of texture's feature extraction using only four features was reported had good results [7],[8]. GLCM is really good method that is widely used for texture analysis in the SAR image.

Here the cooccrence matrix was computed based on two parameters; the distance between two pixels and orientation angle of pixels. Suppose we have a small cropped picture which 5 x 5 pixels image depicted on Figure 1. There are four degrees of grey level from 10,17, 25, and 30.

10	25	10	30	10
10	25	10	30	25
25	30	10	10	25
10	30	17	25	10
25	25	17	17	30

Figure 1. 5 x 5 pixels image .

Supposed distance pixels are selected one from left to right, and the direction angle co-occurrence 0 had been chosen, it means if we choosed 10 in first column and first row as first pixel, the next pixel was 25, if we chose 25 in second column and fifth row , the next pixel was 17. Then matrix can be formed as follows:

1. Determine the degrees of grey, sorted from minimum to maximum in the example was from 10,17, 25 and 30.
2. Form m x n framework matrix where m = n was the number of degrees of greylevel, elements of the frame matrix F is $f_{i,i}$, where $f_{i,I}$ was the number of occurrences with a degree of grey level. In the first row $f_{i,I}$ or $a_{1,j}$ were the number of pixels 10 followed by 10, 10 followed by 17 , 10 followed by 25 and 10 followed by 30. In the second row $f_{2,j}$ were the number of pixels 17 followed by 10, 17 followed by 17 , 17 followed by 25 and 17 followed by 3.

Frameworks matrix form depicted on Figure 2 below.

	10	17	25	30
10	1	0	2	3
17	0	1	1	1
25	3	1	1	0
30	2	1	1	0

Figure 2. Framework matrix

1. Create a co-occurrence matrix C, divide each element of the matrix F with n where n is the number of all elements of the matrix F, it was 18. The matrix C depicted in Figure 3 below.

1/18	0	2/18	3/18
0	1/18	1/18	1/18
3/18	1/18	1/18	0
2/18	1/18	1/18	0

Figure 3. Co-occurrence Matrix.

Here are the four texture's feature :

1. Contrast.

$$\sum_{i=1}^{n}\sum_{i=1}^{n}(i-j)c_{i,j}$$

2. Correlation.
   m is a meant of matrix element C

$$\sum_{i=1}^{n}\sum_{i=1}^{n}(i-m)(j-m)c_{i,j}$$

3. Energy.

$$\sum_{i=1}^{n}\sum_{j=1}^{n}c_{i,j}$$

4. Homogeneity

$$\sum_{i=1}^{n}\sum_{j=1}^{n}c_{i,j}/1+(i-j)^2$$

III. METHODOLOGY

A small part of cropped image which has dimension 10 x 10 pixels would be processed. We had 5 cropped image from different coordinates in each polarization, therefore we had 20 cropped images to be extracted, these all images were references images. Features extracted were contrast, correlation, energy and homogeneity like previous research. Simultaneously we cropped a small part of image 10 x 10 pixels in each polarization but on the different coordinates with the 8 images cropped before, these image were test images; and continue to extract the GLCM features such as contrast, correlation, energy and homogeneity. The features as a results from test images than would be compared to the results of references images. If these test results still in the range of reference image, it has been accepted otherwise it has been rejected.

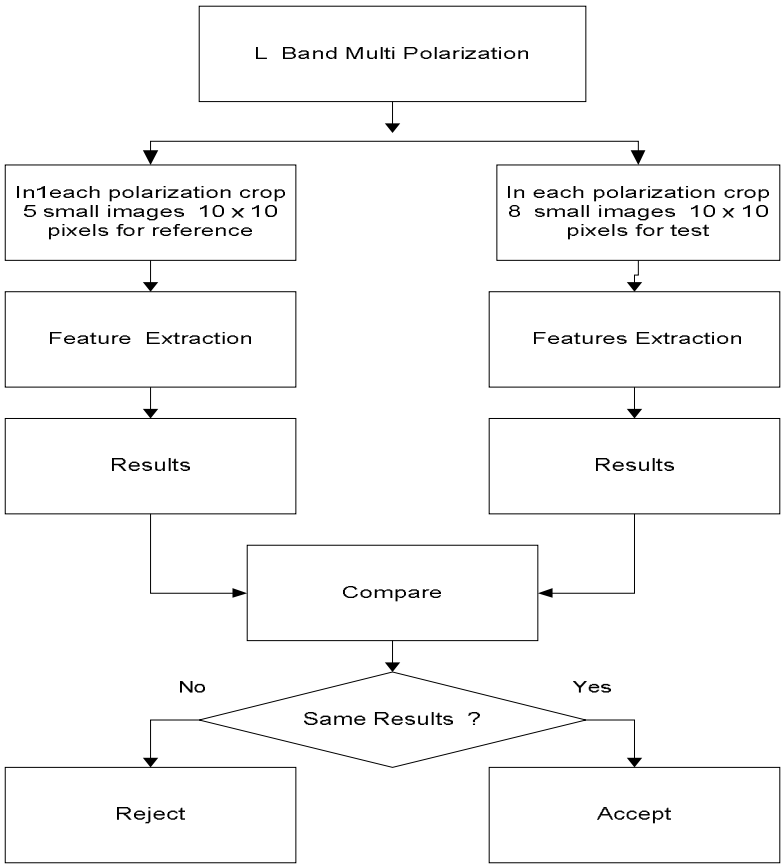

Figure 4. Diagram of experiments.

IV. DISCUSSION

In this research the object was the L Band multi polarization SAR images acquired from East Kalimantan. The polarization were horizontal-horizontal (HH), horizontal-vertical (HV), vertical-horizontal (VH) and vertical -vertical (VV). The size of this images 512 x 128 pixels, these images depicted on Figure 5, Figure 6, Figure 7 and Figure 8.

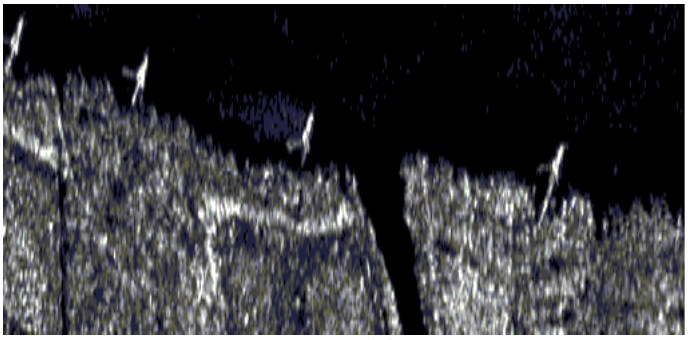

Figure 5. L-HH SAR image.

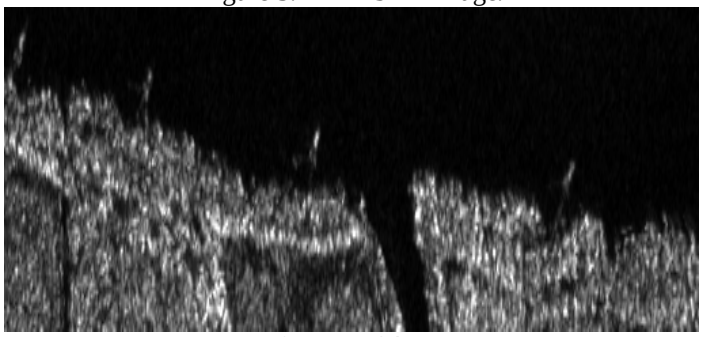

Figure 6. L-HV SAR image.

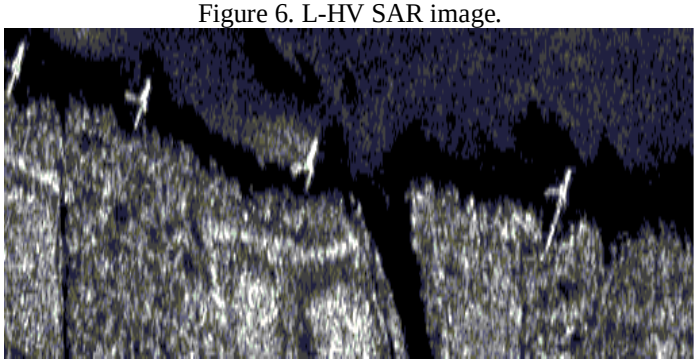

Figure 7. L-VV SAR image.

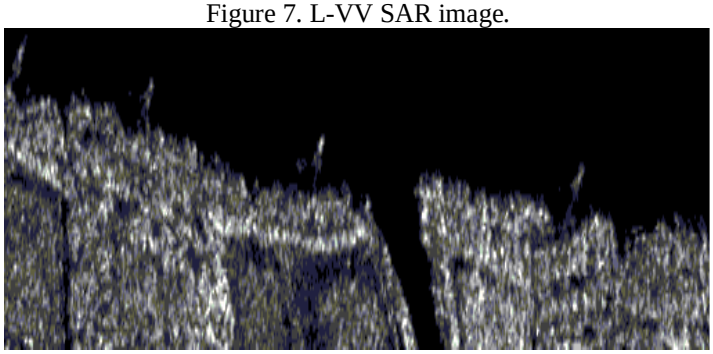

Figure 8 . L-VH SAR image.

Table 1 described the results of L-HH extracted features, followed by Table 2 described the mean in each feature and comparison to P-HH extracted feature. On Table 2 it was showed that there were the difference between P-HH mean and L-HH mean at Energy. The other 3 features were similar. For a while we still don't know the cause of this, it could be possible from the observation angle or the possible other thing.

TABLE 1- TEXTURES'S FEATURE OF L-HH

	CON	COR	EN	HOM
L-HH1	2.4444	0.3656	0.0548	0.5669
L-HH2	0.5669	0.3141	0.0627	0.0627
L-HH3	2.2778	0.3873	0.0573	0.5609
L-HH4	1.2667	0.6184	0.0617	0.6481
L-HH5	2.1778	0.0227	0.0141	0.9611

TABLE 2- MEAN OF FEATURES OF P-HH AND L-HH

NO	FEATURES	P-HH MEAN	L-HH MEAN
1	CONTRAST	1.7467 ± 0.6640	1.7467 ± 0.6640
2	CORRELATION	0.5199 ± 0.1380	0.5199 ± 0.1380
3	ENERGY	0.2301 ± 0.0144	0.0512 ± 0.0144
4	HOMOGENEITY	0.5599± 0.1998	0.5599 ± 0.1998

Table 3 described the results of L-HV extracted features, followed by Table 2 described the mean in each feature and comparison to P-HV extracted feature. Table 4 showed that the feature of L-HV were totally different compare to P-HV. This phenomena really challenge us to explore to another observation angle. In this experiments we worked on 0° observation angle. This results could not use be chosen to represent the feature of the sea due to diversity of these 2 band images in the same polarization. For a while we thought to vary or to change the observation angle or to recrop the 5 test iamges in precise coordinate compare to reference images. It could be happened that the L-HV image has been cropped at different coordinate with the reference images..

TABLE 3- TEXTURES'S FEATURE OF L-HV

	CON	COR	EN	HOM
L-HV1	0.9778	0.3120	0.2415	0.7356
L-HV2	1.1222	0.6328	0.2244	0.7546
L-HV3	0.7546	0.7546	0.0763	0.6054
L-HV4	1.6667	0.5766	0.0711	0.6120
L-HV5	2.6111	0.3091	0.0528	0.5313

TABLE 4- MEAN OF FEATURE OF P-HV AND L-HV

NO	FEATURES	P-HV	L-HV
1	CONTRAST	1.4265 ± 0.5669	3.4936 ± 3.3937
2	CORRELATION	0.5170 ± 0.1651	UNDEFINED
3	ENERGY	0.1322± 0.0797	0.7325 ± 0.2026
4	HOMOGENEITY	0.6647± 0.0778	0.8269 ± 0.1743

Table 5 described the results of L-VV extracted features, followed by Table 6 described the mean in each feature and comparison to P-VV extracted feature. Table 6 showed that the feature of L-VV were totally different compare to P-VV. We found another diversity in the results of experiments. In Table 6 correlation was undefined in both polarization and 3 others features were totally different. If we compare to Table 4 or results of P-HV and L-HV only on L-HV correlation was undefined. This second phenomena was a signal to explore to another observation angle. In this xperiments we worked on 0° observation angle, and again this results could not use be chosen to represent the feature of the sea due to diversity of these 2 band images in the same polarization as described in previous HV polarization research.

TABLE 5- TEXTURES'S FEATURE TEXTURES OF L-VV

	CON	COR	EN	HOM
L-VV1	0.9903	0.6289	0.8121	0.9460
L-VV2	1.0889	0.6990	0.9141	0.9806
L-VV3	0.5444	NA	0.9780	0.9903
L-VV4	11.9778	0.1834	0.5269	0.7861
L-VV5	2.8667	0.3657	0.4314	0.4314

TABLE 6 - FEATURE TEXTURES OF P-VV AND L-VV

NO	FEATURE	P-VV	L-VV
1	CONTRAST	0.2551 ± 0.2181	3.4936 ± 3.3937
2	CORRELATION	UNDEFINED	UNDEFINED
3	ENERGY	0.9358 ± 0.0939	0.7325 ± 0.2026
4	HOMOGENEITY	0.9382± 0.0949	0.8269 ± 0.1743

Table 7 described the results of L-VH extracted features, followed by Table 8 described the mean in each feature and comparison to P-VH extracted feature. Table 8 showed that the feature of L-VH were totally different compare to P-VH. We found another diversity in the results of experiments. In Table 8 correlation was undefined in both polarization and 3 others features were totally different. If we compare to Table 4 or results of P-HV and L-HV only on L-HV correlation was undefined. This second phenomena was a signal to explore to another observation angle. In this xperiments we worked on 0° observation angle, and again this results could not use be chosen to represent the feature of the sea due to diversity of these 2 band images in the same polarization as described in previous VV polarization research

TABLE 7 - TEXTURES'S FEATURE TEXTURES OF L-VH

	CON	COR	EN	HOM
L-VH1	0.5313	0.6472	0.7010	0.7010
L-VH2	0	NA	1	1
L-VH3	0.5444	NA	0.9780	0.9903
L-VH4	0	NA	1	1
L-VH5	0	NA	1	1

TABLE 8 - FEATURE TEXTURES OF P-VH AND L-VH

NO	FEATURE	P-VH	L-VH
1	CONTRAST	3.4936 ± 3.3937	0.2151 ± 0.2581
2	CORRELATION	UNDEFINED	UNDEFINED
3	ENERGY	0.7325 ± 0.2026	0.9358 ± 0.0939
4	HOMOGENEITY	0.8269 ± 0.1743	0.9382 ± 0.0949

TABLE 9- ACCURACY OF TEST IMAGES

NO	POLARIZATION	CONTRAST		CORRELATION		ENERGY		HOMOGENEITY	
		P BAND	L BAND	P BAND	L BAND	P BAND	L BAND	P BAND	L BAND
1	HH	12.5	15	0	0	0	0	0	0
2	HV	0	0	50	0	62.5	62.5	100	100
3	VH	0	0	0	0	0	0	0	0
4	VV	0	0	0	0	0		100	100

Table 9 was a results of accuracy from P band and L band in HH, HV, VV and VH polarization. In HH polarization both P and L band only had 1extracted feature, it was contrast, accuracy was 12.5% and 15%. In HV polarization P band had 50% accuracy in correlation, both L band P had 62.5% accuracy in energy and both P and L band had 100% accuracy in homogeneity. In VH polarization both P and L band did not have accuracy or none for all features, and the last in VV polarization both P and L band only had one feature, homogeneity, which accuracy was 100%. These results presented in Table 9 had been done for observation angle 0°. As mentioned before the observation angle could be have another value such as 45°, 90° and 135°. In the pursuit research we have to vary observation angle and we crop the reference image exactly on the same coordinate by using the function in certain programming language to ensure this coordinate both for P and L band.

V. CONCLUSIONS

The results in Table 9 described for a while from P band and L band we concluded that Horizontal Vertical polarization and Vertical Vertical polarization both in P and Lband had good accuracy in homogeneity, it means that this feature could be considered as the proposed calibrator for the sea wave height in 0° observation angle of Grey Level Co-occurrence Matrix .

ACKNOWLEDGMENT

We want to thank to Mercu Buana University Research Centre Jakarta for funding this research. We want to thank to all team in this research for kindly supporting this research.

REFERENCES

[1] Harwikarya, Desi Ramayanti, Study on Calibration of Sea Wave Height Using Synthetic Aperture Radar Image Based on Grey Level Co-occurrence Matrix : Case on Multipolarization P Band, International Research Journal of Computer Science (IRJCS), Issue 01, Volume 3, January 2016.

[2] Harwikarya, Perbandingan ciri tekstur GLCM citra radar pita L multipolarisasi dari Wilayah Laut : Kasus Pengamatan sudut 0°, SINAPTIKA Universitas Mercu Buana, 2014.

[3] Harwikarya, Classification of SAR Images Based on Pulse Coupled Neural Networks :Case on L-VH Band and C-VH Band, FIFO, Vol IV/No.4/November/2013.

[4] Maxi Lolong, Jendri Masinambow, Penentuan Karakteristik dan Kinerja Hidro Oseanografi Pantai, Jurnal Ilmiah Media Engineering, vol 1 No 2, Juli 2011.

[5] Harwikarya, Metodologi Segmentasi Citra Synthetic Aperture Radar Berdasarkan Pulse Coupled Neural Networks Dikombinasikan dengan Ciri Tekstur, Disertasi, Fakultas Ilmu Komputer, Universitas Indonesia, 2009.

[6] Haralick,R.M.,Shanmugan, Dinstein, I., Textural Features for Image Classification, IEEE Transaction on System, Man and Cybernetics, vol. SMC 3, no 6, 1973.

[7] Kandaswamy,U., Adjeroh, D.,A., Lee, M.,C., Efficient Texture Analysis of SAR Imagery, IEEE Transaction on Geoscience and Remote Sensing,vol 43, no 9, September 2005.

[8] Dipankar Hazra, Texture Recognition with Combined GLCM, Wavelet and Rotated Wavelet features, International Journal of Computer and Electrical Engineering, vol 3 No 1, Februari 2011.