USE OF STATISTICAL DISTRIBUTION FOR SEGMENTATION OF SAR IMAGES OF OCEANIC AREAS

R.F.Rocha

Remote Sensing Division, Hydrographic Navy Center, Av. Barão de Jaceguay s/n, 24048-900,
Niterói, RJ, Brasil - renatofrocha@hotmail.com

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ABSTRACT:

In this work the use of statistical techniques will be approached for segmentation of SAR images, with the purpose of ship detection, being used RADARSAT images of the Brazilian coast. As described in Rocha et al (2001) and Rocha and Stech (2003), a specific software for ship detection was developed where, based on Eldhuset (1996), Vachon et al (1997), Oliver and Quegan (1998), Zaart et al (1999), Ferreira et al (2000) and Macedo et al (2001), some routines were implemented for the use of several statistical distributions for the segmentation of the images, as, for example, the Weibull, Gama, and K distributions. Initially, the shape and scale factors were dear in function of the statistical characteristics of each image, as average, variance and standard deviation. However due to the variability of these characteristics in agreement with each image, they were established values patterns for these factors, that allowed a desirable adaptation of the curve of the distribution to the curve of the histogram of the image. These routines were, then, tested for this group of images and its results were analyzed. The results were analyzed individually, through a comparison among them and, also, using a RGB composition among them.

1. INTRODUCTION

Brazil have a large territorial sea and the necessity of a naval traffic control is very important. Many reasons motivate us to develop technologies directed toward the ships detection, as cited for Fingas and Brown (2000), such as the combat to the illegal fishing, the combat to the drug traffic and the control of our territorial sea.

Initially created for military use, diverse targets detection and monitoring systems had been developed, being called Automatic Targets Recognition systems (ATR). In the last years satellites images have been used for the monitoring and the detection of oceanic targets and boats. McDonnel & Lewis (1978) had demonstrated that the ship detection of great load is theoretically possible in the visible bands with LANDSAT images. However, due to problems of clouds covering and low temporary repetitivity, this methodology was not made possible operationally.

With the development of the technology of the synthetic aperture radar (SAR) and the appearance of satellites using this technology, an growing number of works has been developed in the most several areas of performance in the last years. Such fact made with that innumerable techniques for the SAR images processing were developed, in order to allow a convenient extration of information, according to the area of interest. Due to the inherent characteristics its formation, SAR images have a factor that make difficult its interpretation, that is speckle, whose reduction, either total or partial, beyond difficult, it can cause the loss of some information. Staples et al. (1997) demonstrated the viability of the use of RADARSAT SAR images for ships detection. The results of this study had indicated that the ships detection with SAR images depends on a series of factors, such as: direction and intensity of the wind, size of the ship, route of the ship in relation to the direction of aimed of the radar and the direction of aimed of the radar in relation to the direction of the wind.

2. METHODOLOGY

The area of study described in this work is situated in the Southeast of Brazil, specifically the area of Santos (SP), one of most important and busy harbor of Brazil.

It was used in this work a RADARSAT SAR image, Standard mode, acquired on December 17, 2003.

Amongst the several referring existing works to this theme, we base our work on the methodologies described by Eldhuset (1996), Vachon et al (1997), Oliver and Quegan (1998), Zaart et al (1999), Ferreira et al (2000), Fernandes (1998) and Macedo et al (2001). All these works are base on the use of statistical distributions for segmentation of SAR images. Amongst these diverse statistical distributions, K distribution has been used as a flexible tool for modelling of data deriving of a SAR image, as described by Yanasse et al (1994). In the case of SAR images of oceanic areas especially, Vachon et al (1997) corroborates the statement of Yanasse et al (1994) and uses K distribution for ship detection. However, as described in Oliver and Quegan (1998), other statistical distributions can also be used in the SAR image processing. According to this author, the Rayleigh, Weibull and Gama distributions can also be used for the SAR image processing, depending on the area of study. Some other authors had also demonstrated the adaptation of these distributions for the SAR image processing. The distribution Gamma is also used for the segmentation of SAR images for Zaart et al (1999). Ferreira et al (2000), Fernandes (1998) and Macedo et al (2001) demonstrated the use of the Weibull distribution in the segmentation of SAR images. Already in the method demonstrated by Eldhuset (1996) a new image is generated after the use of some statistical parameters, as mean and variance.

The detection of possible targets in SAR images is accomplished by means of the great difference of values of grey level presented by ships in contrast with the water. In general way, in a SAR image the ships are present as points with high values of grey level, while the water is presented as points with low values of grey level, except for the pixels of water strongly contaminated by speckle. However these basic characteristics can be modified, therefore they depend on a series of factors, such as: state of the sea, oil presence in the water, position of the ship in relation to the aimed of the satellite, incidence angle of the image, amongst others. Beyond these characteristics, in the case of ships in movement, the probable targets can also be identified for the existence of ships wake, that is, the superficial waves caused by ships movement.

In this work we will show the result of the use of the techniques above metioned maids with the purpose of ships detection. We will use the software described by Rocha et al (2001) and Rocha and Stech (2003). In this software routines based on the methodologies above cited had been implemented, being accomplished studies regarding the values of the statistical parameters of each distribution. After the observation of the results obtained in diverse tests using diverse values for such parameters, it was decided to use fixed values for each statistical parameter in accordance with each distribution. Thus each distribution had its statistical parameters established in order to provide the best adaptation of the curve of its histogram. In the case of the methodology described by Eldhuset (1996) it was made only a change in the value used as factor of comparison by this author.

After the act of receiving of the image, your digital processing was initiated using Geomatica software. The image was, initially, analyzed visually. After this visual analysis the image was converted of 16 bits for 8 bits. Soon after the image was registered using the ephemrides data that follow the image. Made this, the image was exported to the "raw" format so that it could be processed in software in question. Then, we made a subset of the image of 2500 for 2500 pixels with the purpose to reduce the computational effort.

In this software, the image was processed in order, in a first stage, to discover which the value of grey level corresponds to a probability of 99,5% of pixel to be a target. Discovered this value of threshold, the value of the grey level of each pixel of the image is compared with it and, in case that it is superior, it will be associated in the resultant image to one pixel with value 255, that is to say, white. Otherwise it will be associated with one pixel with value 0, generating black pixels in the exit image. This way, the generated image will show pixels with a minimum probability of 99,5% to be a target with the white color and pixels with probability lower than 99,5% to be a target with the black color. Only in the case of the use of the methodology described by Eldhuset (1996) this procedure is not obeyed, therefore in this case we worked with a 2x2 mask covering the original image and generating an intermediary image, that is compared with a factor of comparison described by the author.

3. RESULTS AND DISCUSSIONS

Remote Sensing is a tool wide used at the present time for diverse activities. In the case of ship detection, amongst other areas, the use of SAR images has been highly used with great efficiency. The fact of it could be acquired independent of the clouds covering or the conditions of illumination, that is, as much of day as the night, is a great big shot of these images. The existence of speckle can make it difficult, but it does not make impracticable the use of these images for this application. The noise speckle is inherent to the process of formation of SAR images, not being able therefore to be discarded. However, the use of statistical distributions comes being used with the purpose to allowing the digital processing of SAR images in order to minimize the influence of speckle, without with this causing the loss of information. In this work we can verify the mentioned statement. In Figure 1 we can see the original image. This image was processed in the software described by Rocha et al (2001) and Rocha and Stech (2003) and, as we can see in Figures 2 to 7, the diverse tested methodologies had presented excellent results, only occurring small variations inherent to the characteristics of the used statistical distributions, showed in Figures 8 and 9.

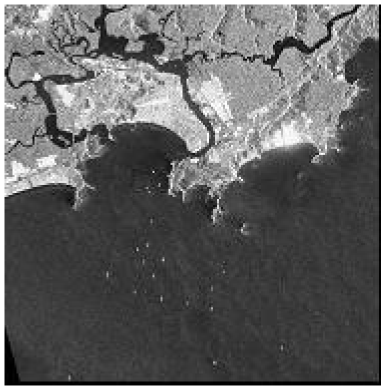

Figure 1. Original image

The image generated by K distribution, shown in Figure 2, was the one that presented a bigger amount of noise in the oceanic area and a bigger answer in the land area.

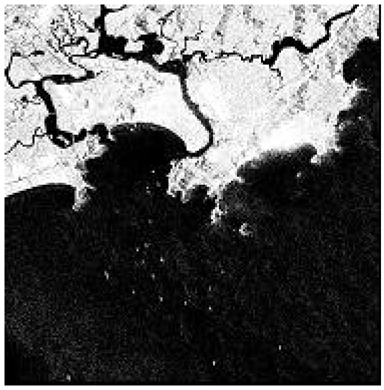

Figure 2. K distribution processed image

These noises are represented in the image as diverse white points in the oceanic area, could cause conflict in the interpretation, because they could be interpreted as false targets. Such fact happens by virtue of threshold established by software for this distribution, as cited previously, to have been established in a value not very high.

As we can see in Figures 3 and 4, the images generated by the processing based on the use of the distributions Rayleigh and Weibull, respectively, had presented very good results, without the presence of noises in the oceanic area, as it occurred with distribution K. The image generated for the Weibull distribution still presented a good reply in the land area.

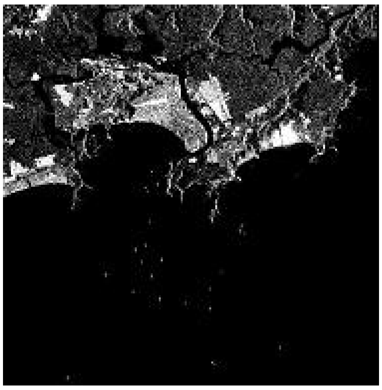

Figure 3. Rayleigh distribution processed image

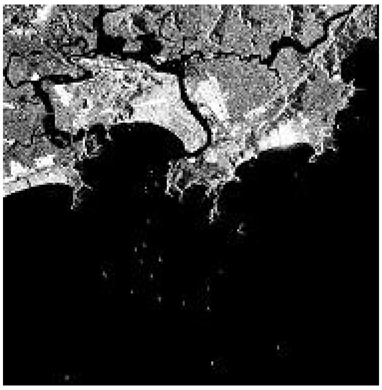

Figure 4. Weibull distribution processed image

Already in the Figures 5 and 6 we can see the results obtained by the processing based, respectively, in the use of the distributions Gamma and Root of Gamma. We can observe that these distributions had been the ones that presented a smaller answer so much for the oceanic area as for land area, mainly the distribution Root of Gamma, without, however, leaving to detect the existing targets.

The Figure 7 shows the result obtained by the processing based on the use of the methodology described by Eldhuset (1996). This methodology presented also resulted very good, getting to detect the existing targets, without a high answer of the land area, presenting, however, some noises next to the detected targets.

In Figure 8 we see the composition among the images generated by the use of distributions K, Gama and Weibull. We can observe in that Figure the existence of some red points, corresponding to the existing noises in the image generated by K distribution. In the Figure 9 we see the composition among the images generated by the use of the distributions Rayleigh, Gama and Weibull and we can observe that there is not the noise presence. In both images we can observe the difference of ratio of the size that the targets had been detected in accordance with each used distribution.

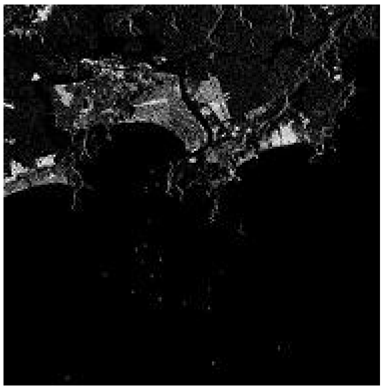

Figure 5. Gama distribution processed image

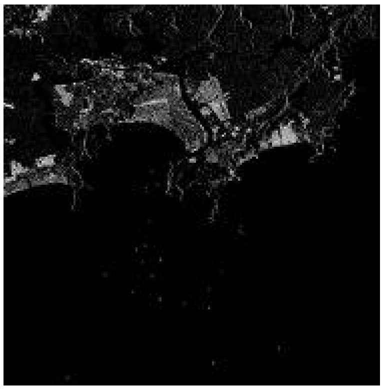

Figure 6. Root of Gama distribution processed image

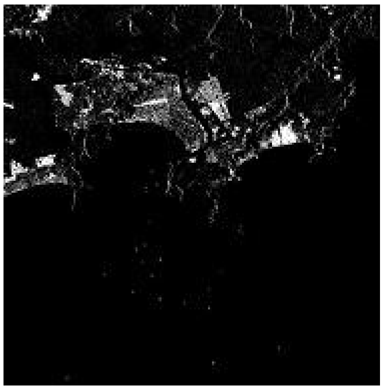

Figure 7. Eldhuset´s methodology processed image

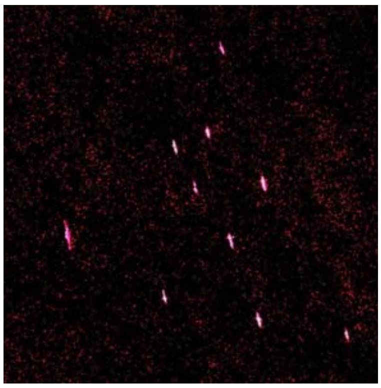

Figure 8: Zoom of RGB composition using K-Gama-Weiull distributions

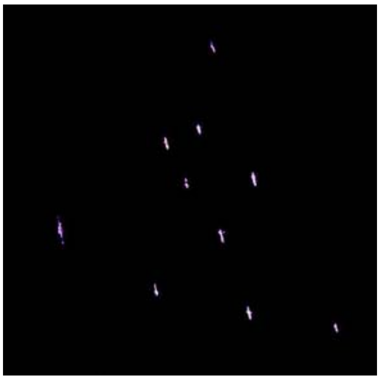

Figure 9: Zoom of RGB composition using Rayleigh-Gama-Weibull distributions

4. CONCLUSION

We can conclude with this work that the use of statistical distributions for segmentation of SAR images that enclose oceanic areas with the intention of ships detect is very efficient. It was looked in this work to use the more cited statistical distributions in existing literature, being only accomplished the necessary adaptations for the obtaining of the best possible resulted. We can conclude that the use of the distributions Weibull, Rayleigh and Gama were the ones that had presented the best results in relation the others used distributions. As already says previously, distribution K and the methodology described by Eldhuset (1996) presented a result with some noises next to the targets detected, what could make difficult the image interpretation because it can be interpreted as false targets. The distribution Root of Gamma presented a result whose value of threshold established by software for this distribution made with that the targets were detected with a smaller size in relation the others distributions, fact this that can cause a loss of information and, consequently, the omission of some target or a wrong evaluation of the targets. We can also conclude that the targets were detected with different sizes in accordance with each methodology, which possible to observe in RGB compositions shown in the Figures 8 and 9. Such fact, however, does not harm the interpretation of the results and the consequent detection of the targets. This occurs by virtue of the value of threshold established by the software to be different for each distribution.

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