Methodology For Merging Multispectral And Radar Satellite Images

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Abstract: The satellite images present us with information of the terrestrial coverage, making a record of large extensions of land between 15 to 60 kilometers wide up to 300 kilometers long, the resolutions are also between 0.50 centimeters up to 30 meters equivalent to each pixel in The image, for this characteristic, is of the utmost importance for the analysis of large land extensions, for different applications. In the development of studies on satellite images, we find two types that present very different information from the same registered area, first we have the optical images, one of its advantages is that they provide multispectral images, consisting of the color bands R, G, B, panchromatic, near infrared, among others, and as a disadvantage it presents that it can only be acquired in the day and when the weather conditions allow it, so if there is a cloud cover, the acquired images only resgit the clouds instead of land cover; A technological alternative to this problem of cloud cover is the registration of the land cover using radar satellite images, this type of acquisition allows the registration of the land cover even at night and when there is a presence of cloud cover. In the present work a methodology is described to be able to merge optical satellite images and radar satellite images in order to be able to improve the information that is had in each one of them, the methodology tests were carried out by means of a climatological event produced by the excess rainfall, which causes the flooding of the river affecting urban and crop areas, the result shows that radar images provide information on the presence of water, even when there is a cloud cover, therefore the merged image (RGB) presents information of the Red and Green spectral bands of the optical image and the Blue band corresponds to the radar image, the resulting image can help in mitigating the effects of possible natural disasters.

Index Terms: Satellite image, radar, segmentation, color bands, image processing.

1 INTRODUCTION

Radar images are becoming increasingly important in the study of terrestrial coverage, due to the advantages they have before optical images, which is why with the use of radar images they can be used to discriminate the different areas that correspond to the terrestrial coverage [1], the processing of radar images requires high computational capabilities, so the processing is done through GPGPU programming using graphic processors, the use of these graphic processors allows to improve the performance in the processing of the images [2], to be able to discriminate the different areas of the land cover you can use the chromatic characteristics characterized by the texture analysis, which can be identified by the characteristics of homogeneity, energy and entropy, which allow to discriminate between the different uses of land cover [3]. In the analysis of satellite images, color processing is important in order to discriminate the use of terrestrial coverage with the color of the image, which depends on the combination of bands and their order, so if the infrared band is used and it is located in the first band of the RGB color model, the plant cover corresponds to the red color [4], satellite images are used for monitoring bodies of water such as lakes, where their dynamism can be recorded with respect to time [5].

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Currently there are many types of images produced by the different satellite missions, so being able to merge them allows to increase the amount of information, the fusion process will depend on the use and the desired application [6], merging images implies using different techniques such as the known ones transformed Wavelet, main components, transformed from Brovey among others [6] [7], in this work the fusion of optical and radar images will be carried out using the satellite images provided by the SENTINEL satellite mission. In order to present the methodology, the emergency caused by the overflow of the Piura river in northern Peru is analyzed, the overflow was carried out on March 25, 2017, so the methodology regarding this natural emergency will be analyzed.

2 METHODS Y MATERIALS

The proposed methodology is characterized by the fusion of two very different imaging modalities, both in the physics of the acquisition and in the information provided by the image itself, in Figure 1 the block diagram of the methodology is presented. It is proposed, from the choice of the area of interest, through the download, analysis and evaluation of the image and finally with the generation of the merged image that corresponds to the RGB color model where the radar image is the third Blue component of the Color model, the methodology is described below.

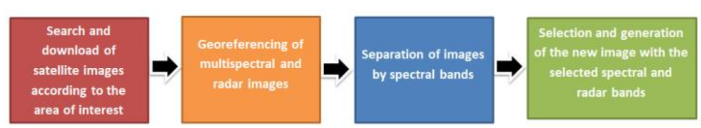

***Figure 1**. Block diagram of the proposal*

Figure 1 shows the block diagram of the methodology proposed to merge optical satellite images and radar satellite images, the block diagram is a generic representation of the methodology, where it can be applied to any use and application of the satellite images, one of the characteristics in the fusion of images is the RGB color model, this color model represents the color that you want to represent in the image, for example if you have information on the radar image that corresponds to the vegetation and we would like to represent Green, the radar image must be in the second component of the color model that corresponds to the Green color, the location of the radar image in the RGB model will depend on the use and application of the merged image. In the first block, it corresponds to the search of the area of interest that needs to be analyzed, the search of the area of interest will depend on the application, as well as the temporality of the image, in the image portal of the SENTINEL mission you can locate the area of interest and with it the download of the optical image such as radar, for this both images must coincide with the area of interest. In the second block, it corresponds to the geo-referencing process of images, optics and radar, this process is important because it allows both images to be superimposed in the area of interest, so that the same point can be located in both images, as well This process also allows to normalize the images in a single special resolution. The third block corresponds to the separation of the spectral bands from the optical image, this separation allows each spectral band to be analyzed separately and to be able to analyze according to the application that is desired to study, each spectral band is stored in an individual matrix. The fourth block corresponds to the selection of the spectral bands to form the fused image according to the RGB color model, depending on the information that is required to be represented by the radar image, this will be located in the band of Red, Green or Blue according to the application being studied.

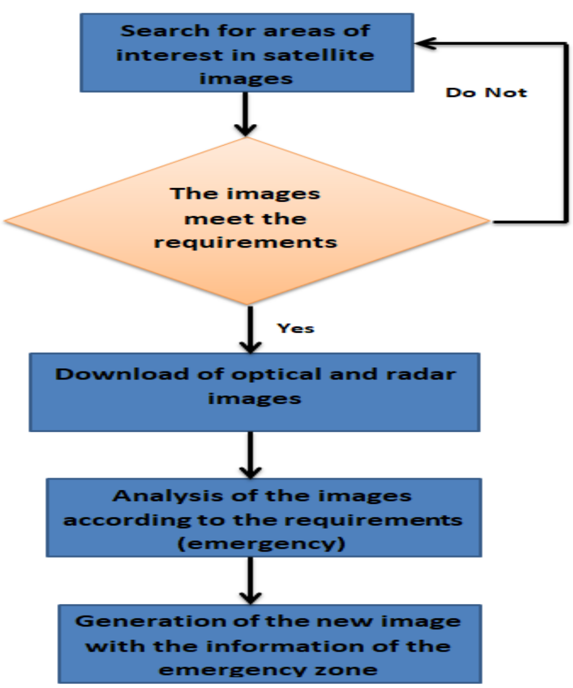

***Figure 2**. Flow chart of the proposal*

Figure 2 shows the flow chart of the proposal, for which it begins with the search of the area of interest, the search is carried out in the image portal of the SENTINEL mission, the sequence is continued if the image of the portal meets the requirements of the application, the process continues downloading the optical image and the radar image, the process continues with the analysis of the images of the area of interest that in practice would be the emergency zone according to the application, Finally, the process continues with the generation of the image merged with the RGB color model in the order according to the study application.

2.1 Application of the methodology

The application of the methodology is referenced to an event that occurred in March 2017 in the department of Piura, where the overflow of the Piura river occurred, affecting the city and the fields. Below is the development of the methodology. The first process, is to perform is to look for the image indicating the area affected by the emergency, the search can be out on the portal of the SENTINEL satellite mission.

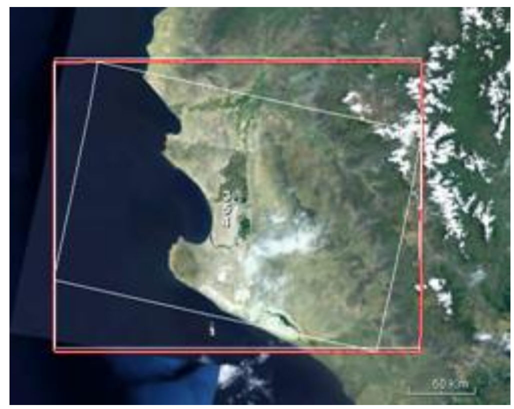

***Figure 3.** Search of the affected area in the geoeportal of the SENTINEL satellite mission.*

In figure 3. The process of search of the area of interest is described, this process is important, because by locating the area of interest we can obtain the images of the affected area with different acquisition dates, in image 4 it is presented an acquisition made on October 27, 2015, this image is used as a reference in order to analyze it later.

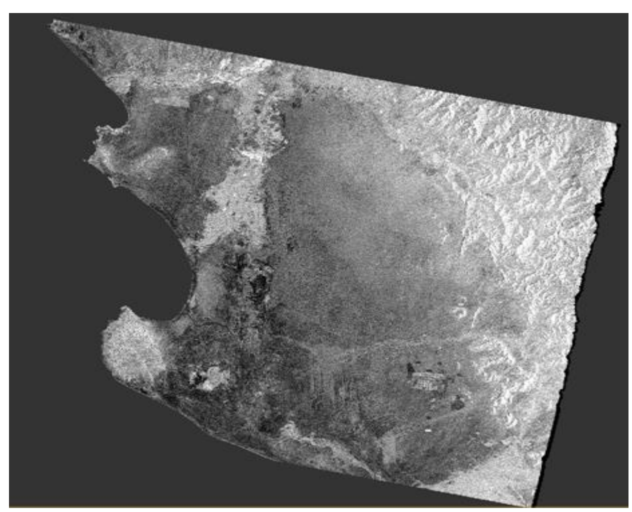

***Figure 4.** Radar image of the SENTINEL-1A Mission of October 27, 2015.*

The next process is to look for the image that corresponds to the most recent image after the emergency, the image to look for must be the radar image, because due to the rains there is a high probability that the sky is covered with cloud cover, the Radar image will allow us to obtain the greatest amount of information that corresponds to the bodies of water, which is one of the characteristics of the radar image.

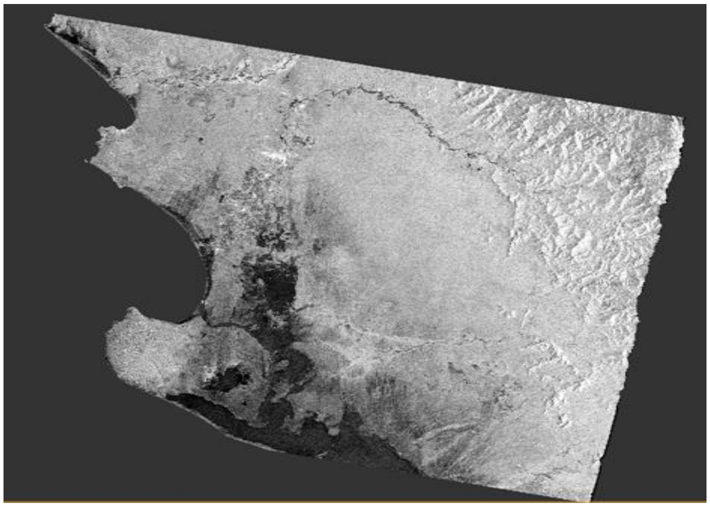

Figure 5*. Radar image of the SENTINEL-1A Mission of March 26, 2017.*

Figure 5, a radar satellite image is presented, with acquisition date after the emergency occurred, in the methodology proposed this image is very useful because it is a day after the emergency occurred. Up to this point in the methodology, there are two radar images, one before the emergency and the other after the emergency, making a visual comparison can identify an increase in areas with the presence of black pixels, these pixels are characteristic because it indicates the presence of bodies of water.

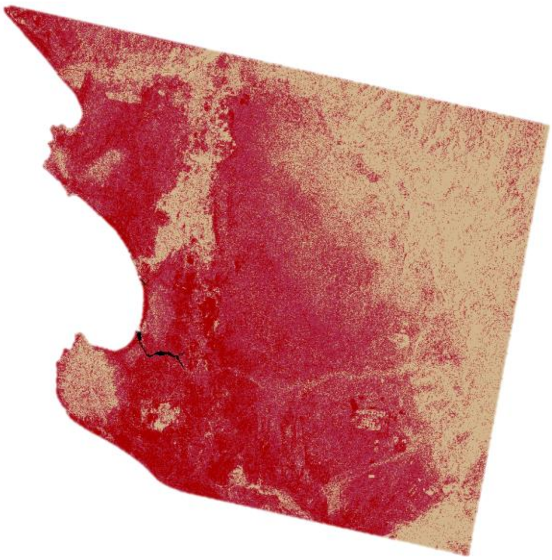

Figure 6*. Multispectral image of the SENTINEL-1A Mission of October 27, 2015.*

After downloading the radar images, the following procedure is to download the optical image, Figure 6 shows the image of the SENTINEL mission dated before the emergency.

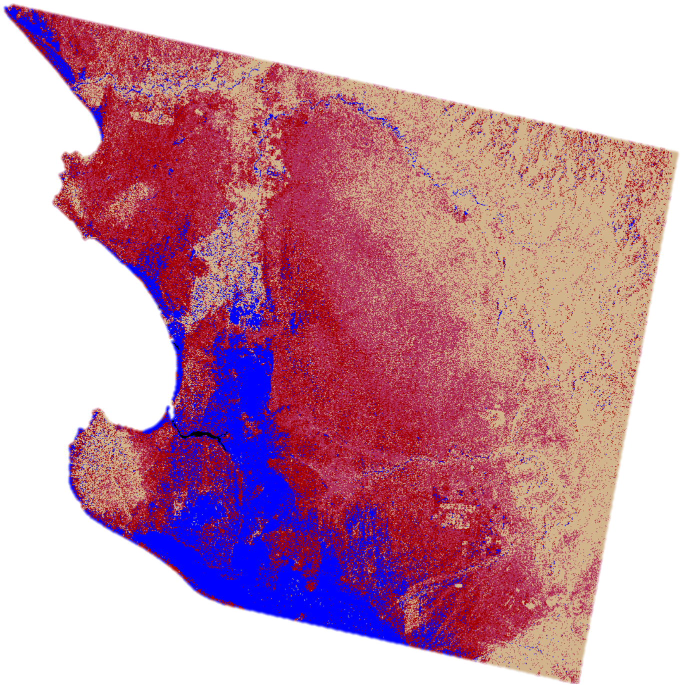

Figure 7*. Multispectral image of the SENTINEL-1A Mission of March 26, 2017.*

Figure 7 shows a multi-spectral image with acquisition date after the emergency has occurred, with figure 6 and figure 7 a variation in the land cover caused by the overflow of the river can be determined which has caused the presence of bodies of water.

3 RESULTS

After analyzing the images after the emergency and making a visual comparison with the reference images acquired before the event, both images are merged, in order to find the maximum size, what is sought is to obtain the image with the bodies of water caused by the emergency. After making as many combinations as possible between the multi-spectral and radar bands, we find that the best combination that corresponds to assign to the red channel, the image dated after the emergency that corresponds to the multi spectral image, to the green channel the multi-spectral image is assigned that also corresponds to the image after the emergency, for the blue component the radar image that has been acquired after the emergency is assigned. Below we present the resulting image, which corresponds to the area affected by the overflow of the Piura river, which corresponds to March 2017, in the image you can see the presence of water bodies, in places where it was not previously presented that are the reference image of 2015, with this image it can be demonstrated that the methodology can be useful to mitigate the effects of these natural emergencies.

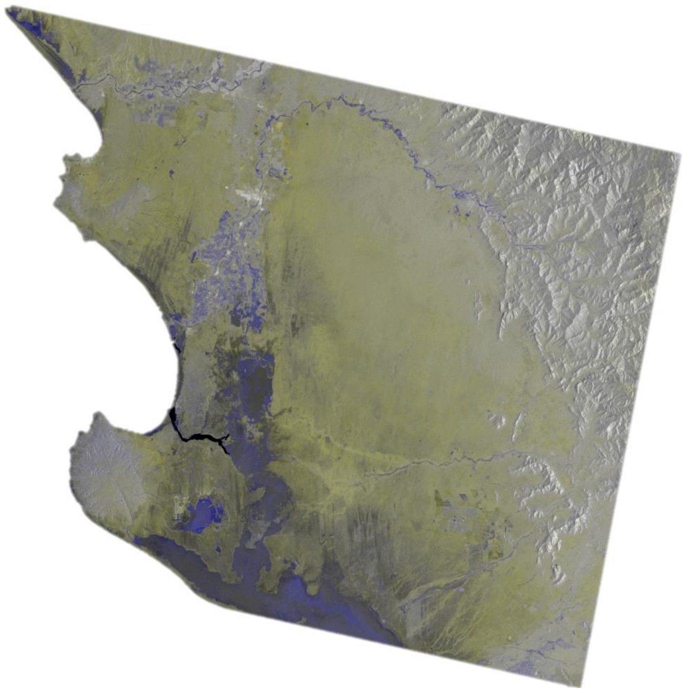

Figure 8*. Image resulting in the fusion of optical and radar satellite images.*

4 CONCLUSIONS

It is concluded that the proposed methodology presents benefits in being able to analyze satellite images of different modalities, for this it is vital to be able to understand that the use and applications of each of them, radar images provide us with some important information that corresponds to the presence of water and humidity, for this reason we use this characteristic to be able to merge them with the multi-spectral images, to be able to obtain an image with greater level of detail with information of the presence of bodies of water. The merged images will help to mitigate the effects of natural phenomena, through the evaluation of the affected areas, being able to have the largest amount of information produced by satellite missions allows us to develop a greater amount of methodologies for image management satellite, the ability to merge several types of images generates great opportunity in the management of information from observation and radar satellites, which can be improved through advanced processing of these images, in this work we developed a methodology to merge different types of satellite images, obtaining encouraging results in the exploitation of its use in different applications, the development for the detection of water bodies is presented, obtaining Good results, the methodology can be supported with the use of other techniques of image processing.

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