Investigation and Monitoring change Detection in Synthetic Aperture Radar Satellite Images for Disaster Analysis in agriculture and mining.

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Abstract- This research investigates on change detection in synthetic aperture radar images for disaster analysis. A satellite image is one of the important sources of the research-oriented platform which helps to monitor earth regularly. It provides information through multi-temporal images. It also ensures accurate data over a large geographical area in the world. The satellite image is independent of sunlight and atmospheric conditions so it is countered as the best source of an image detection device in remote sensing. The main objective of this research is to implement image change detection and analysis for two same geographical satellite images of different days. This research four stages preprocessing, image enhancement, segmentation through thresholding, detection of changes. The result ensures with 91.87% accuracy with change detection for disaster analysis.

Keywords- Satellite images, change detection, Image processing, segmentation

1. Introduction

Remote sensing platforms in digital technology run faster with advanced features throughout the world for land monitoring, weather forecasting, military surveillance, disaster analysis, ocean technologies, and many more important areas [1]-[3]. The satellite image represents the behavioral condition of atmospheric nature as well. All geographical changes made by the earth can be monitored continuously through satellite images [4]-[6]. There are following different kinds of satellites used to cover images like ENVISAT-ASAR, SCATSAT-1and INSAT-3DR. The images can be captured based on half-hourly, hourly, and depends on atmospheric changes [7]. Based on satellite image it is very easy to monitor changes detection happened due to geographical or man-made disasters. Many researchers have been conducted based on satellite images for data observation and examination [8]. In satellite image processing it is very important to extract features using image processing techniques which help to identify each region of the satellite images. With the help of the latest technology, it becomes one of the best sources of development and prediction using the remote sensing process [9]-[12]. For satellite imaginary LandSat works well for the acquisition of images. Landsat works in the detection and monitoring of agriculture, geology, cartography, forestry, and surveillance, regional planning, and education of geological survey [13]-[14]. The main goal of the satellite image is to achieve continuous, global, autonomous, high-quality data for investigation and research. By providing timely, accurate, and easily accessible data will improve the management of the environment. It helps to mitigate and understand the facts and effects of climate changes, weather forecasting, and civil surveillance security [15]. The images captured from the satellite are microwave and infrared images. In a microwave, the image can easily detect capture hidden embedded objects and artifacts using EM waves which follow the range of ~300MHz to 300 GHz with a wavelength of 1meter-to-1millimeter and the infrared images are mostly not used by researchers and meteorologist due to the disadvantages of not capturing a hidden or embedded image, which is overcome by using microwave images. Infrared images have EM wavelengths between 3-to-20 micrometers. Satellite images help in tracing objects more clearly which provides more accurate results [16]. The ISRO built INSAT-3DR, an Indian weather satellite is used to capture weather images and helps to provide Indian meteorological services. This satellite was launched in 2016.

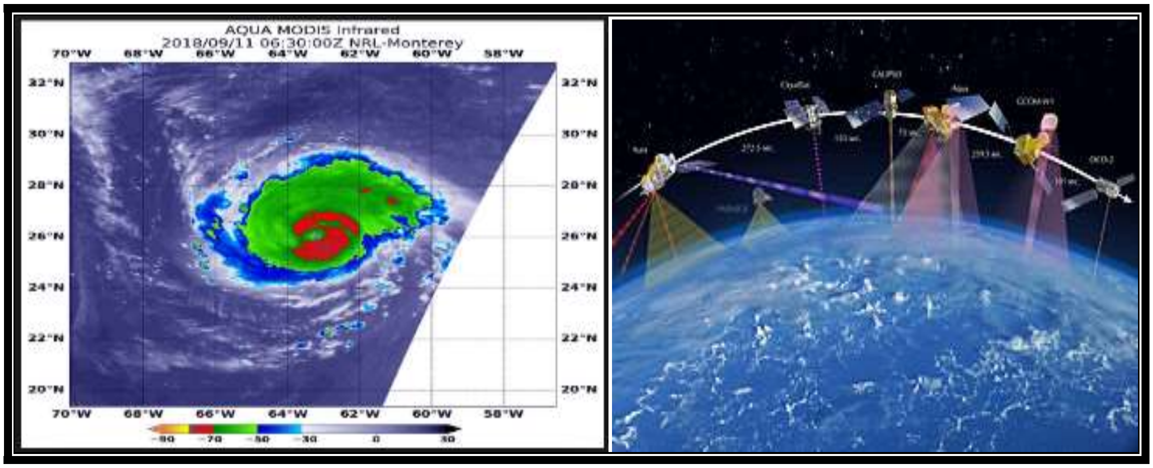


Figure 1- Satellite Monitoring

2. Methodology

These studies investigate stages, image preprocessing, and image enhancement, segmentation of the image, and change detection using image processing techniques. Initially, data collected and then applied the preprocessing technique using a median filter helps in removing noise then applied image enhancement technique with histogram equalization then applied the segmentation process to achieve change detection of the given input images. The input image was taken as the Ottawa dataset from the satellite monitoring system for two different years.

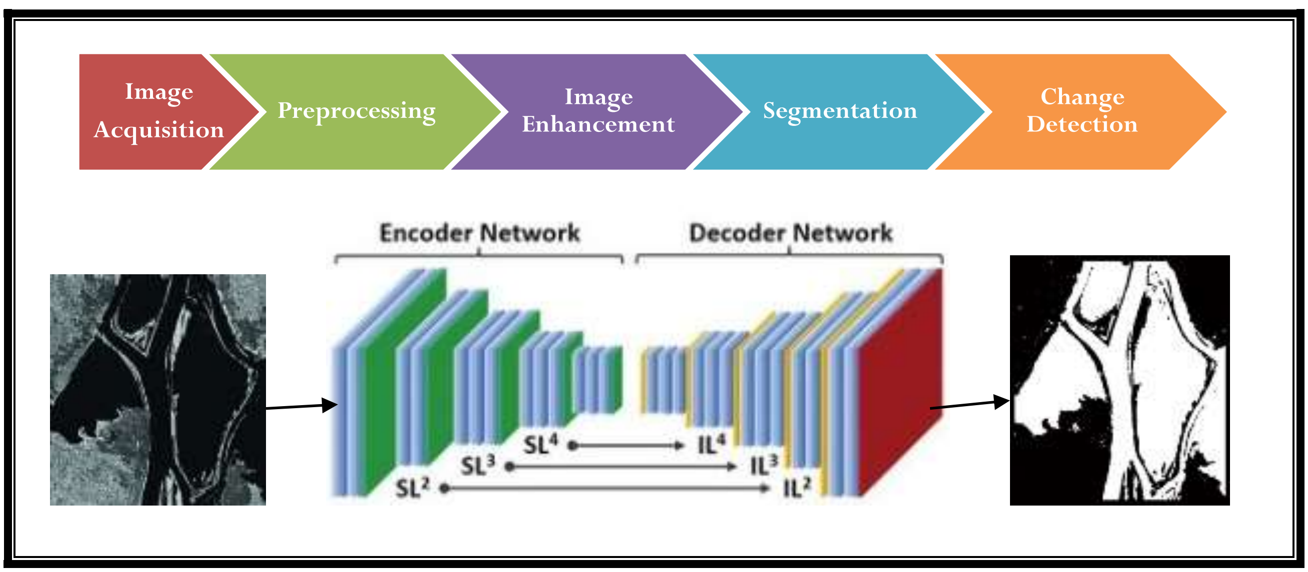


Figure 2- Methodology

3. Preprocessing

Preprocessing is a method for removing background noise from images. To remove noise from images median filter is used. Preprocessing helps in improving data quality with change detection using satellite images. In preprocessing involves grayscale representation, it holds information relevant to intensity. It represents in the form of black and white form which denotes as value counting in black with weakest range count and white in the largest range count. It helps to resize the input image taken from satellite and form into grayscale images.

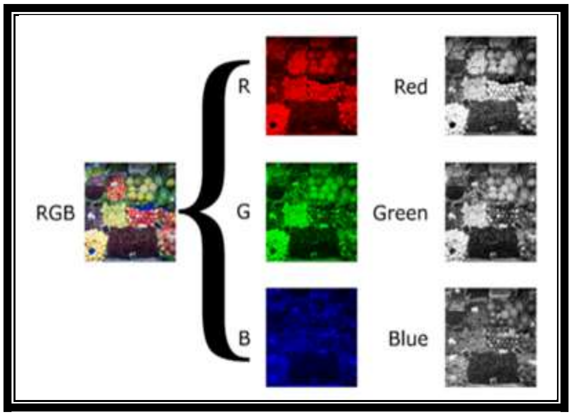


Figure 2- Gray Scale Image

4. Ground truth image

It helps to find a region of interest that needs to be examined based on the given satellite images. It also enables calibration of satellite data and provides interpretation and observation of what it senses to monitor for detection oil spills affected area over the time of practical observation.

5. Median filter

Median filters play an important role in removing noise from images. The median filter is a non-linear statistical filter, which describes in spatial domain form. It smoothing images be utilizing the median value of the neighborhood pixels over the image. In the processed image median filter perform two tasks. Firstly all pixels in the neighborhood and the original image are sorted in ascending value orders. Secondly, the sorted median value computed and chosen as the pixel value for the processed image. Preprocessing helps in removing all unrequired noise or background from the image.

Median value using 3x3 masks the given matrix shows the marked computed pixel calculation

$$\text{Matrix form with 3x3 Masks} \quad \begin{bmatrix} 8 & 12 & 14 \\ 9 & 11 & 13 \\ 10 & 9 & 8 \end{bmatrix}$$

Step1: Firstly pixel value arrange in ascending order

8	8	9	9	10	11	12	13	14

Step2: Secondly the median value computed based on pixel order

8	8	9	9	**10**	11	12	13	14

In this matrix calculate the median value is 10 which is computed after steps 1 and 2. Then the original pixel values will be replaced and change to processed values.

$$\begin{bmatrix}8 & 12 & 14\\ 9 & 11 & 13\\ 10 & 9 & 8\end{bmatrix} \longrightarrow \begin{bmatrix}8 & 12 & 14\\ 9 & \mathbf{10} & 13\\ 10 & 9 & 8\end{bmatrix}$$

Original Image Median filter Image

6. Image enhancement using histogram equalization

Equalization is the process of evenly distributing gray levels across their range in the image. It helps in reassigns the pixel brightness value. In this research, the histogram equalization method used to achieve more visual results of images that are in a wide range. It contains the following four stages-

4	4	4	4	4
3	4	5	4	3
3	5	5	5	3
3	4	5	4	3
4	4	4	4	4

Based on the input image initially calculate the maximum and minimum value among the given pixel. Maximum _Value is 5 and Minimum _Value is 3. Based on the max and min value there are possible gray value is eight counting from 0 – 7. The given tables show the histogram of input images.

Gray _Level	0	1	2	3	4	5	6	7
Total no. of Pixel counted	0	0	0	6	14	5	0	0

Step 1- Initially computes histogram values with running sum which is also known as cumulative frequency distribution. *(1)*

Gray _Level	0	1	2	3	4	5	6	7
Total no. of Pixel counted	0	0	0	6	14	5	0	0
Running sum	0	0	0	6	20	25	25	25

Step2 – Divide the running sum value with the total number of pixels counted. In this input image, the total number of pixels is 25. *(2)*

Gray _Level	0	1	2	3	4	5	6	7
Total no. of Pixel counted	0	0	0	6	14	5	0	0
Running sum	0	0	0	6	20	25	25	25
Running _Sum/Total No. of Pixel	0	0	0	0.24	0.8	1	1	1

\Step 3- Now multiply the max_ gray level value with obtaining the result in step 2 *(3)*

Gray _Level	0	1	2	3	4	5	6	7
Total no. of Pixel counted	0	0	0	6	14	5	0	0
Running sum	0	0	0	6	20	25	25	25
Running _Sum/Total No. of Pixel	0	0	0	0.24	0.8	1	1	1
Multiplied result	0	0	0	2	6	7	7	7

Step 4- Now maps gray level value with one –to- one correspondence. *(4)*

Gray level original value	***Histogram based calculated value***
0	***0***
1	***0***
2	***0***
3	***2***
4	***6***
5	***7***
6	***7***
7	***7***

The below table shows resulted in the original image and histogram equalization image-

4	**4**	**4**	**4**	**4**
3	4	5	4	3
3	5	5	5	3
3	4	5	4	3
4	4	4	4	4

Original image

6	**6**	**6**	**6**	**6**
2	6	7	6	2
2	7	7	7	2
2	6	5	6	2
6	6	6	6	6

Histogram equalization image

7. Segmentation

In the segmentation method, it helps to detect the region of interest area for the particular image which needs to be examined. The main objective of image segmentation is to find out region-based interest over the image. Segmentation steps involve split methods which help the image to split into the equal region or called as a unit. For iteration, it involves a split and merges process. Firstly, iteration split the region into different parts of the region then it followed by the merging process. In segmentation, the threshold value is set to 0.1. It is also called an unsupervised classification method. It does not consist of any training data.

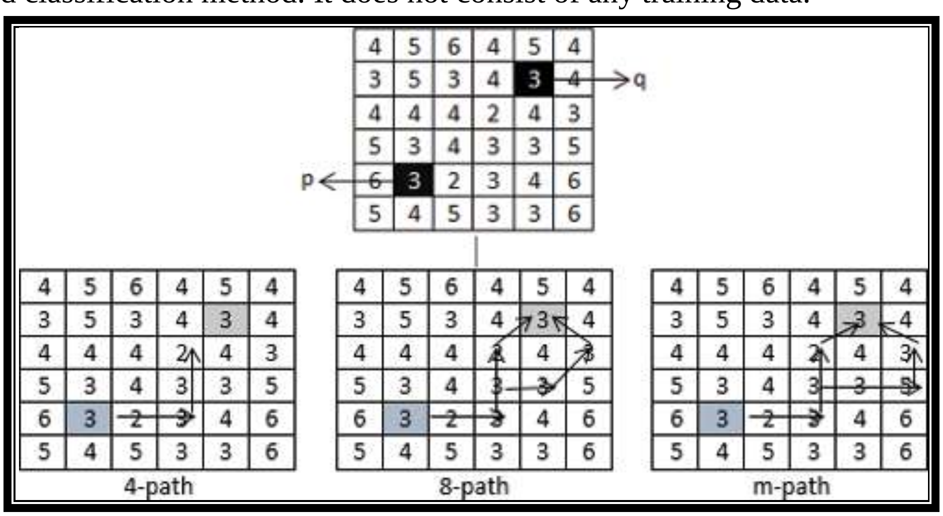


Figure 3- Segmentation based on pixel

The clustering algorithm is an iterative method in which algorithm clusters pixels value iteratively by computing intensity of mean value for the given classes and segment the pixel by classifying its closest mean from each pixel values. It finds out the nearest neighbors' values. To analysis satellite images with change detection then Initially calculate overall pixel values which represented as 'N' after overall pixel calculation count actual numbers of unchanged nearest pixel and region which is changed according to for binary map calculation, pixels are classified according to change and unchanged classes, which is denoted as L_i & L_j respectively.

$$N_c - L_i = True_{Positive}$$

$$N_u - L_j = True_{Negative}$$

Now calculate PCC _percentage correct classification based on pixels. This is denoted as

$$P_{\text{Percentage Correct Classification}} = \frac{True_{Positive} + True_{Negative}}{\text{N}}$$

Due to a larger value, it is difficult to calculate similarity. For this reason, it introduces an overall error calculation method to overcome this issue.

$$True_{Positive} + True_{Negative} \quad = \text{OE \_Overall Error}$$

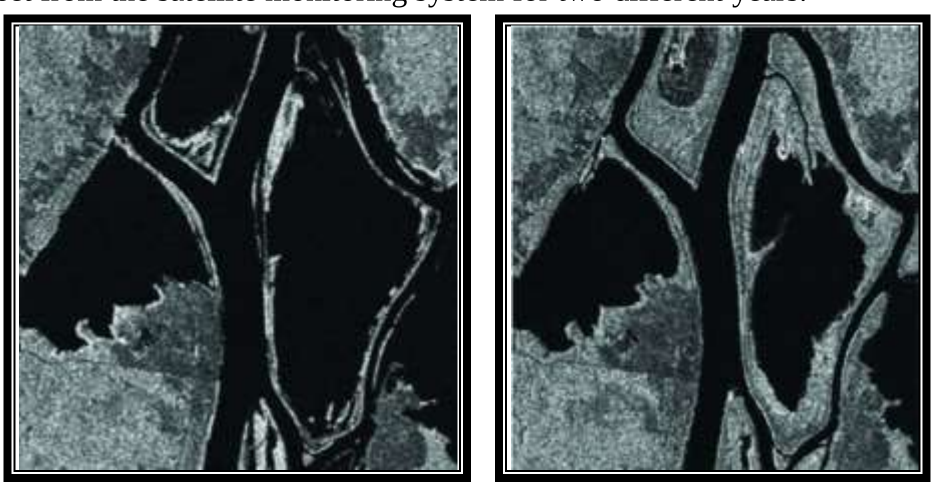
Then KC _kappacoefficient is applied to have good segmentation results.

$$K_{Coefficient} = \frac{P_{\text{Percentage Correct Classification}} - \text{Pre}}{1 - \text{Pre}}$$

$$\text{Whereas,} \quad \text{Pre} = \frac{(\text{Tp}+\text{Fp}).\text{Nc} + (\text{Fn}+\text{Tn}).\text{Nu}}{\text{N}}$$

8. Result and Discussion

These studies investigate stages, image preprocessing, and image enhancement, segmentation of the image, and change detection using image processing techniques. Initially, data collected and then applied the preprocessing technique using a median filter helps in removing noise then applied image enhancement technique with histogram equalization then applied the segmentation process to achieve change detection of the given input images. The input image was taken as the Ottawa dataset from the satellite monitoring system for two different years.



(a)Input image 1 (b) Input Image 2

Figure 4- Input image for Ottawa satellite dataset from different years

Initially takes two input images then it calculates grayscale image with mean and logarithmic values using image enhancement and segmentation methods and finally detects changes between two images using Hue saturation image (HSV) output images, which helps to monitor the changes between two images. During segmentation methods, it uses fuzzy clustering methods which help to cluster similar features among two images during the fusion process.

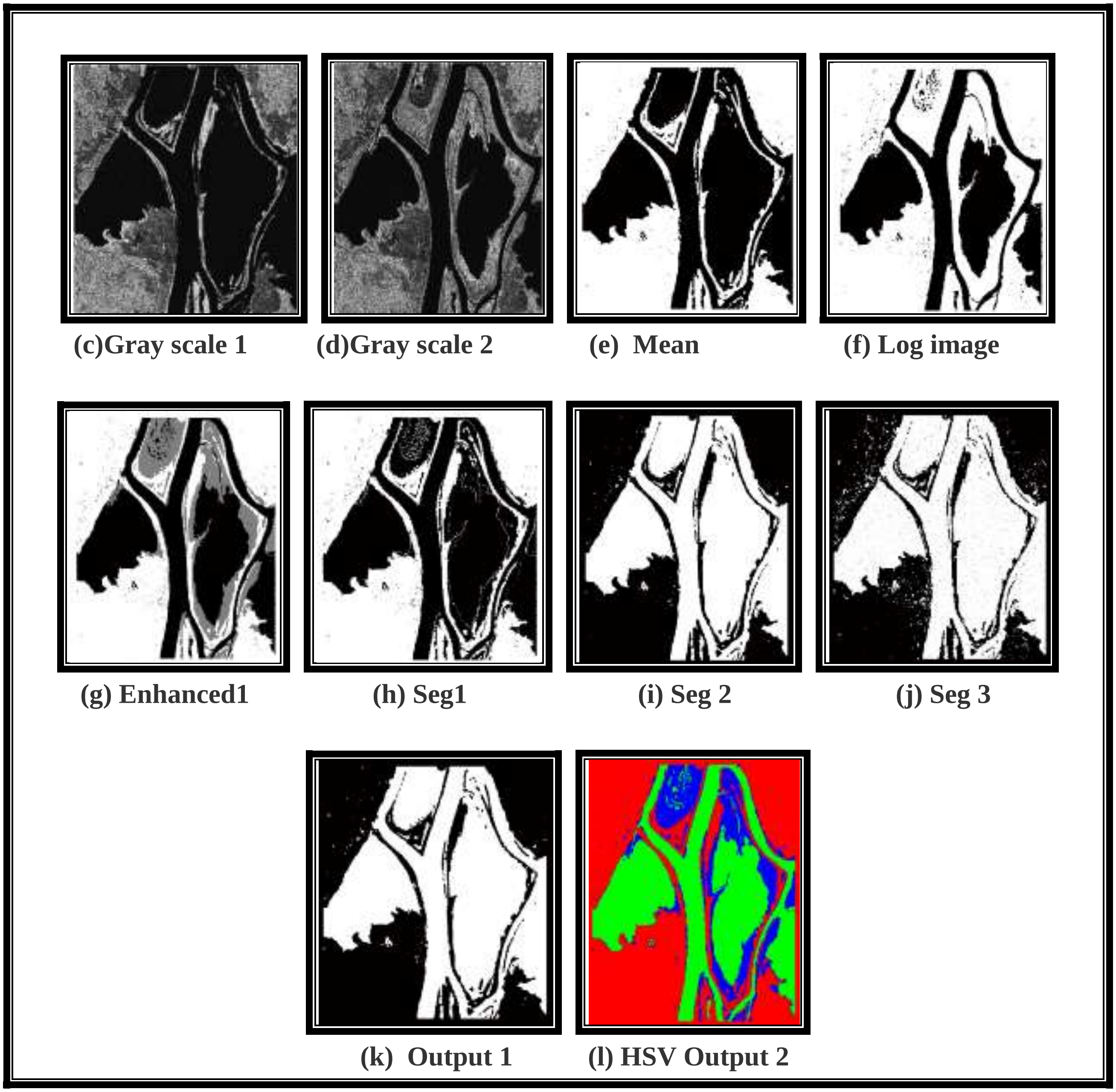


Figure 5- Resultant Images of given Satellite dataset

Figure 5 represents (a) & (b) Gray scale value, (e) mean, (f) log ratio value, (g) enhanced image for the input model, (h)-(j) represents segmented value Ottawa dataset, (k) output result, (I) HSV Output result.

Table 1- Evaluation criteria Ottawa Dataset

ANALYSIS OF REAL-TIME IMAGES						
Fuzzy Clustering Algorithm	**FP**	**FN**	**OE**	**PCC**	**KC**	**T/s**
	1653	**713**	**2435**	**0.9187**	**0.9123**	**83.4**

Table 1 represents the evaluation criteria of the Ottawa dataset with false positive, false negative, overall error, percentage correct classification, kappa coefficient, and time per second for calculating the change detection of satellite images.

Table 2- Evaluation of Ottawa Dataset Mapping

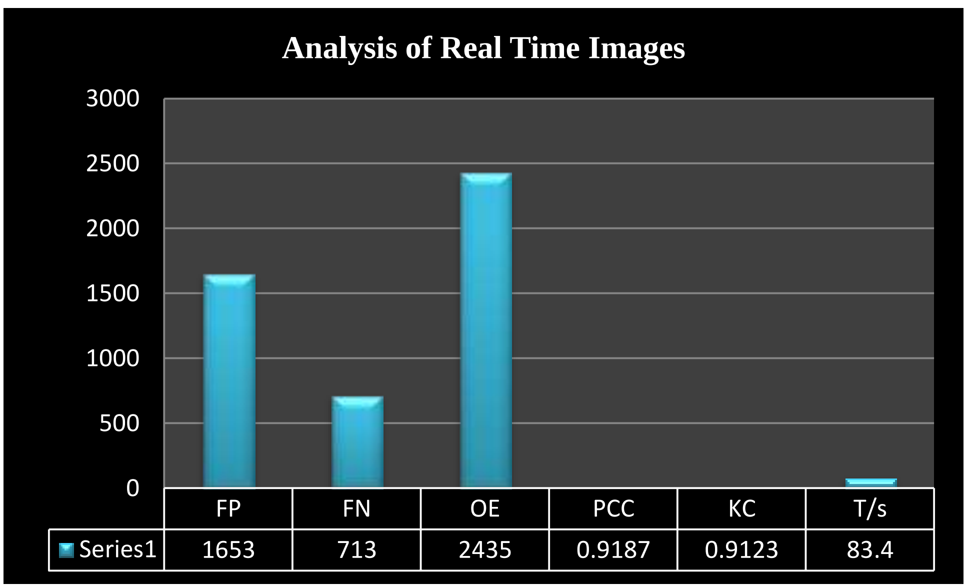


Table 2 – Represents the accuracy of change detection with overall outcomes by using a graphical mapping technique.

Conclusion

This research investigates on change detection in synthetic aperture radar images for disaster analysis. A satellite image is one of the important sources of the research-oriented platform which helps to monitor earth regularly. It provides information through multi-temporal images. It also ensures accurate data over a large geographical area in the world. The satellite image is independent of sunlight and atmospheric conditions so it is countered as the best source of an image detection device in remote sensing. The main objective of this research is to implement image change detection and analysis for two same geographical satellite images of different days. This research four stages preprocessing, image enhancement, segmentation through thresholding, detection of changes. The result ensures with 91.87% accuracy with change detection for disaster analysis.

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