ISSN 2278-3091
Volume 8, No.6, November – December 2019
International Journal of Advanced Trends in Computer Science and Engineering
Available Online at http://www.warse.org/IJATCSE/static/pdf/file/ijatcse24862019.pdf
https://doi.org/10.30534/ijatcse/2019/24862019

MLC based Classification of Satellite Images for Damage Assessment Index in Disaster Management

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ABSTRACT

Maximum likelihood Classifiers (MLCs) are very closely reliable to classify the Satellite images for the land cover mapping community. By the nature MLCs are predominantly binary classifiers and statistical supervised learning technique. However, these MLCs are chosen to determine damage assessment index for satellite images. Mostly these MLCs are useful to specifying and classifying as the optical images for land, build up land, sand, water body, fallow land, degraded scrub and land with scrub. The main emphasis in this paper is to improve the average classification accuracy and at the same time reduce the variance in the classification performance by machine learning approach like MLCs for damage assessment index in disaster management. To aid in this quantification, the classifications of images by MLCs are formulated a Damage Assessment Index (DAI). The proposed approach results of DAI are carried out by using python software and the justifications of DAI will be very useful for the disaster management.

Key words : Satellite images, Damage Assessment Index (DAI), Disaster management, MLCs and python.

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1. INTRODUCTION

MLC is a supervised ML algorithm that is used in classification challenges. Now a days research has been entered into new methods of classification where MLCs have recently enthralled the attention of the remote sensing fraternity. More recently MLCs are applied to machine vision fields like satellite image classification. MLCs like ANN and other non-parametric classifier have a repetition for being robust. Satellite remote sensing is useful tool to monitor earth surface. Particularly in producing land cover and land use classifications. Generally land cover and land use classification builds upon two imaging methods viz..optical and microwave remote sensing. These are having both merits and demerits.

The primary requirement for image analysis is to have effective classification of an image by MLC technique. Image classification needs a very important and basic operation for significant analysis and interpretation of images. For the purpose of disaster management , it must be necessary to complete damage detection as fast as possible after the occurrence of disasters in order to make use of the detection result in emergency management. For proper and timely implementation of image detection result in emergency management, it is important that the damage detection procedures be complete as fast as possible. This has led to the need of automated damage assessment system with proper accuracy and required information that would aid in decision making in practical scenarios.

A supervised classification of connected component analysis is employed for assessing the damage. Connected component labeling or connected component analysis or blob extraction region labeling or blob discovery or region extraction, by whatever the name it is known, refers to the algorithmic application of graph theory that uses subsets of connected components which are labeled depending on a given heuristic. Here, if a pixel p is at coordinate (x,y) and has 4 direct neighbors say N4 (p) and 4 diagonal neighbors say ND(p), This preprocessed image is usually binary and consists of numerous regions against a background. In this work the images classify by different MLC approaches implemented as a part of this work is considered as input images. Now, as the components are connected, each region is assigned a unique label, so that the distinct objects can be distinguished. In the next stage, these regions based on their labels are processed to extract a number of features that is represented by the region like, for example area, center of gravity, bounding box etc. In the final stage, all these features help in classifying each region into one or more than two classes. There are typically two stages in connected component analysis and labeling.

1.1 Objectives of the Research Work

The MLCs are chosen to determine damage assessment index for satellite images. Mostly these MLCs to specifying and classifying as the optical images for land, build up land, sand, water body, fallow land, degraded scrub and land with scrub. As an improvement in the average classification accuracy and at the same time for reducing the variance for MLC performance in the classification.

. **1.2 Research Methodology**

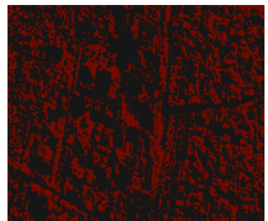
By Selecting the Image which is desired area to find Damage Assessment Index (DAI) calling as study area. This can be done by acquisition of LISS-IV Image of that particular area .Then the Image undergoes through various filters for Geometric correction and for the selection of precise band of frequencies as a preparation of the Classification. The methodology to assess damage can be broadly categorized as qualitative and quantitative damage assessment. Qualitative assessment refers to the visual interpretation of mono temporal or multi temporal images of the disaster affected areas. This methodology is costly and takes time and requires high resolution image since the low resolution images will be difficult to interoperate. Quantitative damage assessment on the other hand uses digital image processing and has three different methodologies that include detection of change, classification of image and texture analysis. In this research work image classification philosophy is employed in order to quantify and formulate the damage. A supervised classification of connected component analysis is employed for assessing the damage. Connected component labeling or connected component analysis or blob extraction region labeling or blob discovery or region extraction.

"Maximum likelihood Classifier" (MLC) is a supervised ML algorithm that can be useful in both classification and regression challenges. However, it is predominantly using a solution for the classification problems. In this algorithm, we plot each data item as a point in n-dimensional space (where n is number of features you have) with the value of each feature being the value of a particular coordinate. Then, we perform classification by finding the hyper-plane that differentiate the two classes very well. Two major categories of image classification techniques include **unsupervised** (done by software) and **supervised** (done manual) classification. Unsupervised classification is that in which the outcomes (collecting of pixels with same properties) are based on the software analysis of an image without human providing sample classes. The techniques used by the computer to determine which pixels are related and groups them into classes. Where as in the Supervised classification the user can select the sample pixel in an image that which pixel relate to their respective class. Maximum likelihood Classifiers (MLC) have proved recently their ability in pattern recognition and classification [Vapnik, 1995]. The aim of this paper is to evaluate the potentiality of MLC on image recognition and image classification tasks.

2 . VALIDATION AND DISCUSSION

The images are sourced from the open repository of Digital Globe. Some of the images are also sourced from web site which credits the images to Digital Globe. A pre April 2015 Nepal earthquake image of the densely populated area of Katmandu, Nepal is shown in Figure (1). This earthquake which is also known as the Gorkha earthquake had claimed lives of 8800 people while injuring more than 23000. It occurred at 11:56 NST on 25 April, with a magnitude of 7.8. Similarly the figure (2) illustrates the image captured post the occurrence of earth quake.

prior the earth



classified image .

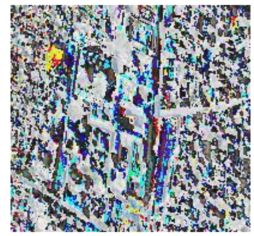


Figure 4: Binary classified image .

Figure 5: MLC simplified results

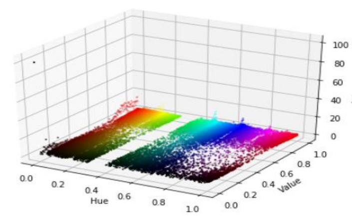


Figure 6: MLC based DAI

The index size of the resulted image is (200, 200)
The total index values damaged(White) are 126
The total index values undamaged(black) are 156

The qualitative damage analysis through visual interpretation reveals that even though there is damage, the damage is relatively less and there are lots of standing structures. A connected component analysis for the segmented image through the proposed method reveals the presence of number of labeled components in each image. The histogram analysis of the image reveals the distribution of pixels in images pre and post the event. It can clearly observe from the histogram figures there is narrowing of distribution of the pixel intensities in regard for the post event image. It can also be observed that there is difference in the peaks between the images. It can also be observed in the case of pre event image it is close to normal distribution and in the case of post event image; it is skewed towards its right.

In order to differentiate the damage and to illustrate the suitability and the validity of the DAI another set of **images before and after the** April 2015 Nepal earthquake are considered. These images have relatively high damage when compared to the damage represented by figure (2) for corresponding prevent image illustrated by figure (1).

Figure 7: Katmandu prior to earth quake.

Figure 8: Katmandu post the earth quake.

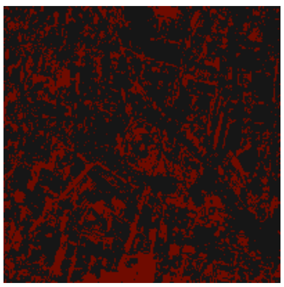


Figure 9: Binary classified image

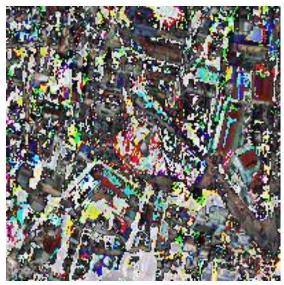


Figure 10: : Binary classified image .

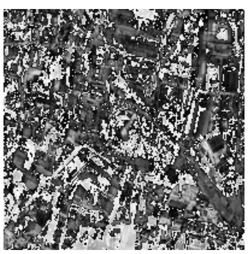


Figure 11: MLC simplified results

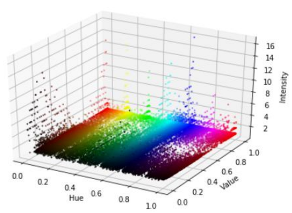


Figure 12: MLC based DAI

The index size of the resulted image is (200, 200)
The total index values damaged(White) are 186
The total index values undamaged(black) are 155

A visual interpretation reveals clear and significant damages to standing structures and relatively the damage is higher in comparison to the region represented by figure (1) and figure (2). Similarly we can observe from the figures that there is lot of people moving around and even we can see vehicles and other small objects. In order to remove the influence of these small objects only those regions having a specific number of pixel counts are considered. This helps in identifying the damage to major structures and helps in reducing false interpretations. *The DAI calculated for the above damage represented through image (4) and image (5) is 5.6* indicating damage for majority of region. The comparison between DAI of the two different regions provides an inference towards the relative damage across the two regions. This provides a very crucial indicator that will aid in the rescue phase. The images from the 2004 Indian Ocean earthquake that occurred at 00:58:53 UTC on 26 December along the west coast of Sumatra Indonesia have been considered to illustrate the suitability of the DAI by the authors here. Sumatra-Andaman earthquake is the name given to the event by the scientific community. Figure (7) and Figure (8) represent the pre event and post event image after the Tsunami in Band Aceh region of Indonesia.

Figure 13: region in Banda Aceh Indonesia

Figure 14: region in Banda Aceh Indonesia

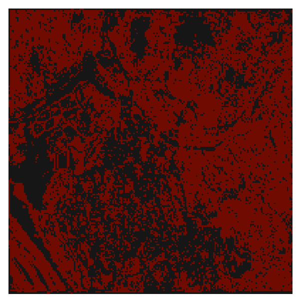


Figure 15: Binary classified image

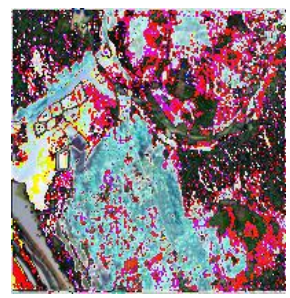


Figure 16: Binary classified image

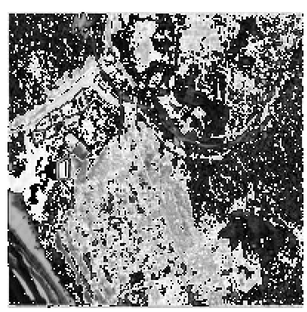


Figure 17: MLC simplified results

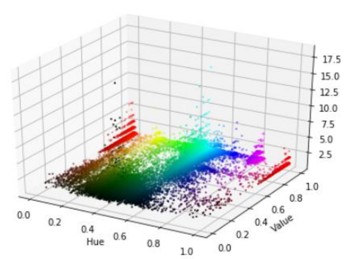


Figure 18: MLC based DAI

The index size of the resulted image is (200, 200)
The total index values damaged(White) are 162
The total index values undamaged(black) are 170

Visual interpretation and analysis of the images (5) and image (6) reveal extensive damage post tsunami. It can be concluded with utmost confidence that there is collateral damage with both the loss of settlement and the tree / forest cover. The damage can be categorized as very high. To further show the validity of the proposed index, specific cases of damage assessment through field surveys and other methods of calculation available in the literature have been compared. In order to develop an automatic damage detection methodology, the authors observed the characteristics of he buildings that were damaged in area using the high-resolution satellite images that shows pre and post affect of the Haiti earthquake in 2010[23].Based on the results and interpretation of the authors about the accuracy of the prediction it can be inferred that out of a total of 1378 building close to 877 images have suffered different degrees of damage. It comes to around 63 % damage. The before and after event images of the capital city of the republic of Haiti, Port-au-Prince is given in the figure (19) and figure (20).

Figure 19: Port-au-Prince, Haiti prior to earthquake

Figure 20: Port-au-Prince, Haiti post the earthquake

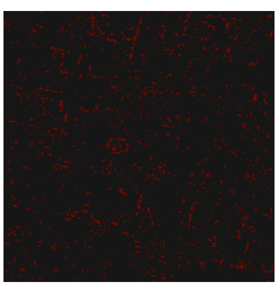


Figure 21: Binary classified image

Figure 22: Binary classified image

Figure 23: MLC simplified results

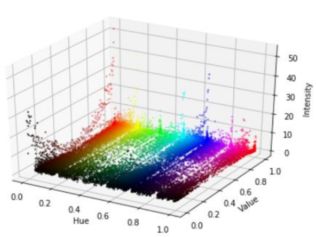


Figure 24: MLC based DAI

The index size of the resulted image is (200, 200) The total index values damaged(White) are 169 The total index values undamaged(black) are 168

In [24] authors have performed a study to evaluate the damage before and after December 26th 2003 Bam, Iran earth quake. The pre event and post event images are illustrated using figure (25) and figure (26).

Figure 25: Pre event image of the Bam, Iran

Figure26: Post event image of the Bam, Iran

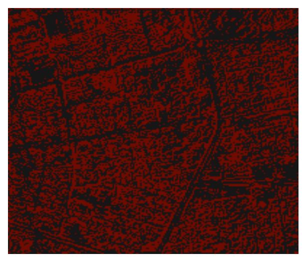


Figure 27: Binary classified image

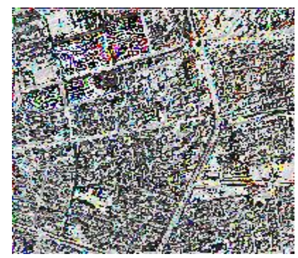


Figure 28: Binary classified image

Figure 29: MLC simplified results

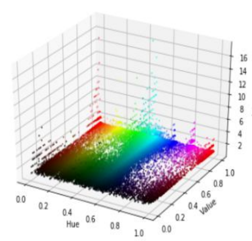


Figure 30: MLC based DAI

The index size of the resulted image is (200, 200) The total index values damaged(White) are 196 The total index values undamaged(black) are 168

The authors in [24] through their analysis observed that there is damage to 88.7 % of the buildings in the region and attribute an accuracy of 74.4 % to their proposed method. This assessment puts the damage in high damage category and the DAI arrived in this research work suggests the same *with a DAI of 7.7 indicating a high damage factor.* In [25] Authors have attempted to access damage due to earthquake and subsequent tsunami cause impart of BandraAceh, Indonesia prior owing to 2004 tsunami. The pre and post event images are represented using figure (31) and figure (32).

Figure 31: Banda Aceh - Indonesia (Pre Tsunami Image)

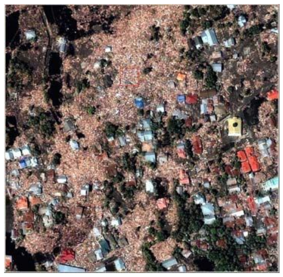


Figure 32: Banda Aceh - Indonesia (Post Tsunami Image)

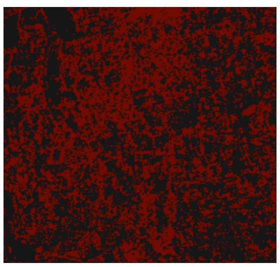


Figure 33: Binary classified image

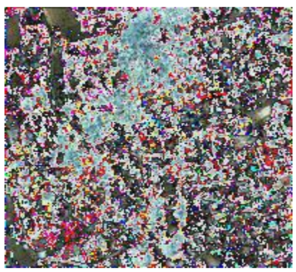


Figure 34: Binary classified image

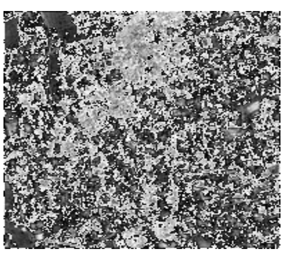


Figure 35: MLC simplified results

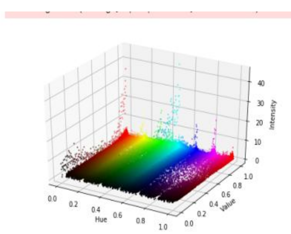


Figure 36: MLC based DAI

The index size of the resulted image is (200, 200)
The total index values damaged(White) are 154
The total index values undamaged(black) are 158

5. CONCLUSION

In regard to the implementation of the damage assessment index, the simplicity of the algorithm makes it computationally less complex. This reduced computationally complexity enhances the suitability of the proposed index for real time and contiguous analysis. The damage assessment index clearly indicates the degree of damage and can provide the planners with valuable information in directing the rescue and research operations. This kind of quantification on a scale, helps in easy interpretation of the level of damage and can aid in the decision making process. The damage assessment index has been validated through visual interpretation and comparing the results with interpretation available in the existing literature. It can be inferred from the results discussed the assessment of damage is in close agreement with that of the visual interpretation and other documented analysis. The significance of index can be observed form the fact that it gives a holistic view about the damage by comparing images captured pre and post event.

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