Classification of Land Cover in Optical Satellite Images, Using CNN after Noise Removal

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***Abstract*— Due to their ability to record large areas of land, satellite images are increasingly being used in the analysis of land coverage, allowing researchers to determine whether or not a given area is covered by vegetation and, if so, what kind of vegetation is present. In this work, images of Amazonian-area satellites are analyzed in an effort to determine, with the help of Neural Networks, whether or not a given area is covered by vegetation. A MATLAB-based tool is supplied for the aim of analyzing the analysis approach, allowing for the management of pictures, the execution of operations involving the usage of neural networks, and the display of characteristics and the final result of the classification to be performed. The suggested approach is flexible and extensible, allowing for a greater variety of applications and uses, as well as an increased number of evaluable features (by, for example, the usage of different kinds of picture groups). In addition, we provide a model for an image database that can distinguish between regions with and without plant cover based on a set of images. The built-in software allows for rigorous testing of the suggested procedure. CNN model has been used for classification of satellite images after noise removal.**

Keywords - Satellite image, classification, artificial intelligence, land cover, deforested area, CNN.

I. INTRODUCTION

There has been an uptick in research into land cover as a result of satellite imagery; this research makes use of a wide variety of sensors, including optical and radar [1] [2]. Some examples of this research include investigations into the extent to which land is covered by vegetation, the effects of water stress on vegetation, and the strength of individual plants. Algae cultivation in the future may be studied by using satellite imagery for water temperature monitoring [3] [4]. It is possible to distinguish distinct UOSs of land cover via the examination of pictures by using a number of features, including the usage of different colors. Studies are being presented on the ability to identify the various land covers using predictive processes, employing neural networks and their derivatives [5] [6]. This is all thanks to the rise in popularity of AI approaches. The value function for the stock-selection policy was derived using this model's calculations. However, when the number of action-state combinations is enormous, reinforcement learning approaches become computationally demanding. So, techniques based on supervised learning developed. The method utilizes supervised learning for autonomous adaptability [7] [12]. In the variety of image analysis methods, those associated with texture characteristics are provided; thus, they use a wide variety of forms to separate applications and coverage based on texture. One unique aspect of satellite photos is their size, which necessitates the use of computer power to analyses. Options for employing GPU graphics processors to reduce processing times are discussed [8] [9]. Optical pictures have the greatest resolution in the panchromatic band, therefore this is the band with the most importance in GB, and analyses of this image band are also provided using GPU[10][11]. Since privacy is also a concern, when optical photographs of the affected region are unavailable owing to the difficulties of registering the images to display the cloudiness, the imaging radar may aid to understand the results of the investigation by providing radar images[12]. The radar picture is an interpretation of texture of the registered region, thus it has to be examined in accordance with the requirements of the application to be carried out [13] [14] [16]. Finally, with the use of image processing methods, we can attest that the high-resolution satellite photos show a degree of detail, differentiating the items contained in the image. Security concerns have also been addressed [15][17] [18].

II. MATERIALS AND METHODS

It is beginning with finding and downloading the satellite picture, the suggested approach progresses through four phases, each of which is distinguished by unique tasks[19], in order to modify the satellite image, towards a mechanism that may use Artificial Intelligence methods. We provide the process in its entirety, from the initial study of the features to be categorized through the development of CNN model to enable the use of Artificial Intelligence methods to the final categorization of land cover regions.

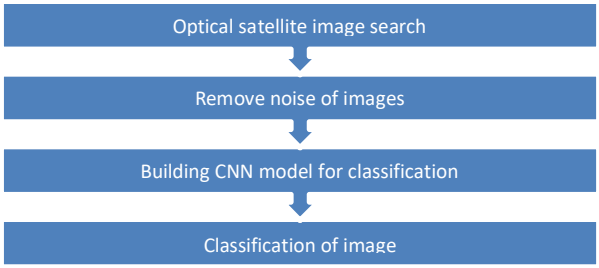

Fig.1. Block diagram of the proposal

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1. Optical Satellite Image Search

The optical pictures provided by satellite systems come in a wide variety of formats and coverage sizes. These include the more common RGB and IR spectrums, as well as the less common panchromatic and infrared spectra.

Fig.2. Satellite image of area with vegetation cover, greyscale

Pictures with metric resolutions were employed [20] because of the need to analyses vegetation cover over a wide region; for example, in Figures 2 and 3, you can see images of Satellites with registration of plant areas and areas with the effect of predatory agents that are producing deforestation. Figure 2 shows a satellite picture of a forested region with a river running through it; the image spans an area around 60 kilometers in length and width.

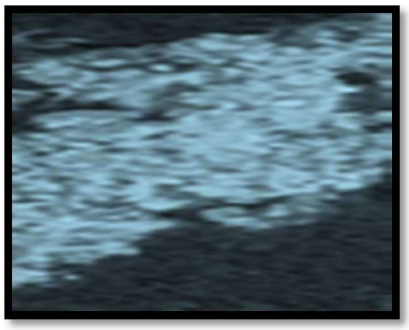

Fig.3. Satellite image of deforested vegetation zone, greyscale

Figure 3 shows a satellite picture showing a huge portion of a registered area that has been cleared of trees; the image was created using the RGB color model, which allows for a wider range of colors to be shown.

2. Characterization of Optical Satellite Images

We need to categories two groups here: the first is a set of photos that corresponds to the vegetation cover, and the second is a set of images that relates to the places where the vegetation cover has been removed, also known as deforested areas. Images are grouped together, their reflectance computed, and the NDVI vegetation index generated in order to provide data that can be fed into a neural network and used for classification in the program that was written.

3. Application Design

It is proposed that an application be developed in which this methodology can be demonstrated; this was done using the MATLAB development environment.

4. Classification of Images

The final step in the methodology is the classification of the images; this is done through the design of a Neural Network, with Reflectance and NDVI values as inputs, and the type of coverage, for what has two possible answers: if the image being analyzed corresponds to a vegetal zone, or if it does not. The results provide a comprehensive presentation of these findings.

III. RESULTS

During simulation over MATLAB, Median noise removal filter has been applied over images in order to get the better picture quality [19][21]. So that CNN model could make the classification of Deforested vegetation zone and area with vegetation cover.

A. CNN model confusion matrix for vegetation cover

TABLE 1: CNN MODEL CONFUSION MATRIX FOR UNFILTERED IMAGES

	Area with vegetation cover	**Deforested vegetation zone**
Area with vegetation cover	822	178
Deforested vegetation zone	153	847

Considering table 1 confusion matrix has been calculated and presented in table 2

Results

TP: 1669

Overall Accuracy: 83.45%

TABLE 2: ACCURACY CHART OF UNFILTERED IMAGES

Class	**n (truth)**	**n (classified)**	**Accuracy**	**Precision**	**Recall**	**F1 Score**
1	975	1000	83.45%	0.82	0.84	0.83
2	1025	1000	83.45%	0.85	0.83	0.84

B. CNN model confusion matrix for vegetation cover

TABLE 3: CNN MODEL CONFUSION MATRIX FOR FILTERED IMAGES

Class	Area with vegetation cover	Deforested vegetation zone
Area with vegetation cover	891	109
Deforested vegetation zone	106	894

Considering table 3 confusion matrix has been calculated and presented in table 4

Results

TP: 1785

Overall Accuracy: 89.25%

TABLE 4: ACCURACY CHART OF UNFILTERED IMAGES

Class	n (truth)	n (classified)	Accuracy	Precision	Recall	F1 Score
1	997	1000	89.25%	0.89	0.89	0.89
2	1003	1000	89.25%	0.89	0.89	0.89

C. *Comparison Analysis*

This section is comparing the accuracy, precision, recall and f-score for filtered and unfiltered images.

1) Accuracy

Table V is presenting accuracy from table II and table IV for filtered and unfiltered images.

TABLE 5: COMPARISON ANALYSIS OF ACCURACY

Class	CNN model without noise removal	CNN model with noise removal
1	83.45%	89.25%
2	83.45%	89.25%

Considering table V the comparative analysis of accuracy has been presented in figure 4. In this figure CNN model without noise removal has been compared to CNN model with noise removal.

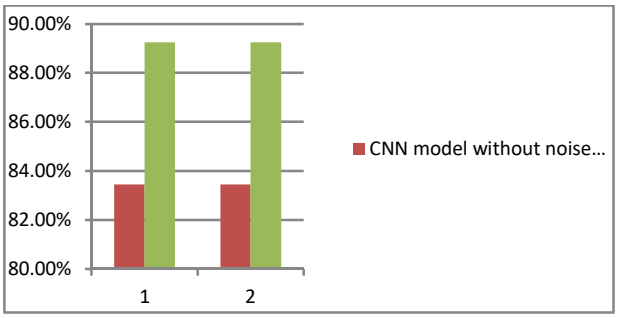

Fig.4. Comparison analysis of accuracy

2) Precision

Table VI is presenting precision from table II and table IV for filtered and unfiltered images.

TABLE 6: COMPARISON ANALYSIS OF PRECISION

Class	CNN model without noise removal	CNN model with noise removal
1	0.82	0.89
2	0.85	0.89

Considering table VI the comparative analysis of precision has been presented in figure 5. In this figure CNN model without noise removal has been compared to CNN model with noise removal.

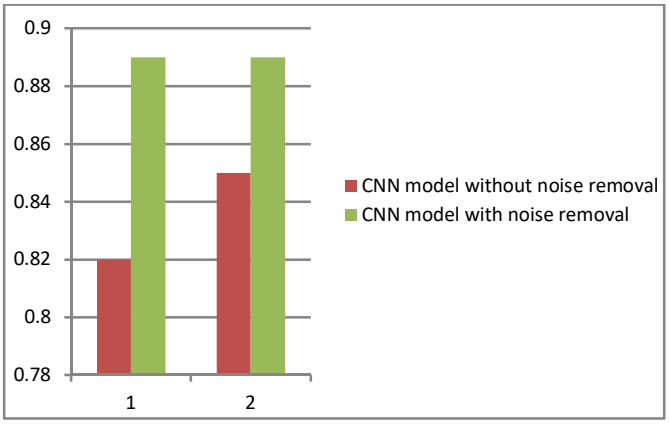

Fig.5. Comparison analysis of precision

3) Recall Value

Table VII is presenting precision from table II and table IV for filtered and unfiltered images.

TABLE 7: COMPARISON ANALYSIS OF RECALL VALUE

Class	CNN model without noise removal	CNN model with noise removal
1	0.84	0.89
2	0.83	0.89

Considering table VII the comparative analysis of precision has been presented in figure 6. In this figure CNN model without noise removal has been compared to CNN model with noise removal.

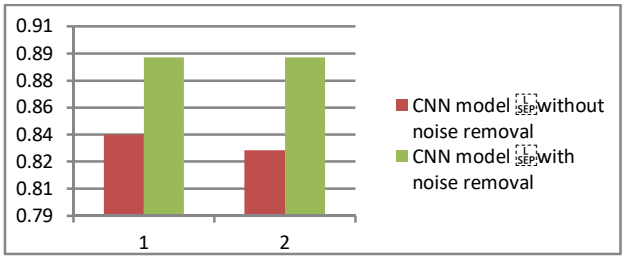

Fig.6. Comparison analysis of recall value

4) F1-score

Table VIII is presenting precision from table II and table IV for filtered and unfiltered images.

TABLE 8: COMPARISON ANALYSIS OF F1-SCORE

Class	CNN model without noise removal	CNN model with noise removal
1	0.83	0.89
2	0.84	0.89

Considering table VIII the comparative analysis of precision has been presented in figure 7. In this figure CNN model without noise removal has been compared to CNN model with noise removal.

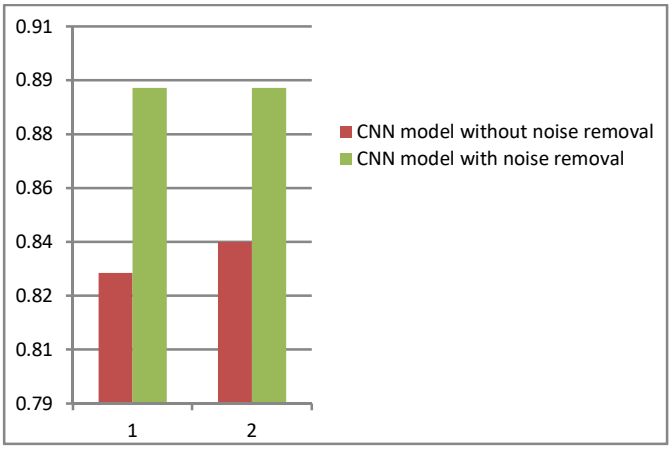

Fig.7. Comparison analysis of F1-score

IV. CONCLUSIONS

After presenting the approach and demonstrating its efficacy, the researchers came to the conclusion that using AI methods for land cover categorization allowed them to determine whether or not a given region included vegetation. Two widely-used features, reflectance and the vegetation index normalized difference vegetation index (NDVI), are employed in the classification; consequently, a MATLAB application was built to demonstrate the methodology's utility. From this, it was deduced that the approach is both practical and scalable, as the number of image features and the number of inputs to the neural network can be increased.

Since the original satellite images are in GEOTIFF format and the database images are in PNG format, converting the images to a format compatible with MATLAB was an important part of the project's final deliverables.

It should be noted that the NDVI, it is necessary to work with the band of the near infrared, so for visualization purposes we worked with the RGB model, and in the analysis model for the neural network. Ultimately, we can indicate that the RGB color model was used; being able to perform other combinations using the algebra of bands, working with the near infrared band and others, in this way other chromatic characteristics can be obtained that can help in the classification. The findings will have broad implications for the use of spectral characteristics, texture characteristics, and other features in satellite image analysis. CNN Model has contributed significant role in classification process. But it is observed that the filter images that have no noise are classified with high accuracy as compared to images that are having noises.

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