



e-ISSN: 2319-8753 | p-ISSN: 2347-6710

IJIRSET

International Journal of Innovative Research in
SCIENCE | ENGINEERING | TECHNOLOGY



INTERNATIONAL JOURNAL OF INNOVATIVE RESEARCH

IN SCIENCE | ENGINEERING | TECHNOLOGY

Volume 10, Issue 7, July 2021

ISSN INTERNATIONAL
STANDARD
SERIAL
NUMBER
INDIA

Impact Factor: 7.569



9940 572 462



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Hyperspectral Image Classification

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ABSTRACT:Hyper-spectral image classification is a popular topic in the field of remote sensing. Hyper- spectral images capture light information from across the electromagnetic spectrum. This gives significantly large amount of information to perform classification tasks. With the advent of Deep Learning many neural networks have been proposed for Hyper-spectral Image Classification. Recently, many Convolutional Neural Network based models have been proposed. However, many of these frameworks use only 3D-CNN or only 2D CNN or the use of alternate 3D-2D CNN. They do not fully capture the spectral, spatial and the spectral-spatial features. To solve this issue a Novel 3DCNN with spectral-spatial feature extraction, spatial feature extraction and a spectral feature extraction method is proposed. Specifically, we use Principal Component Analysis to reduce the dimensions along the spectral dimension, later for each pixel, the surrounding neighborhood pixels are formed into a data cube and fed into the 3D convolutions to hierarchically extract high level spectral- spatial features. We then introduce a spectral feature extraction sub-network and a spatial feature extraction sub-network to extract useful features from the input. We then combine the outputs of these two sub-networks into a feature fusion layer.

KEYWORDS: Building detection, Classification, Convolution neural network, Connected component labelling.

I. INTRODUCTION

Hyperspectral images unlike regular images can be visualized as a 3-Dimensional hyper cube that contains a 2-Dimensional pixel image called spatial image and 1-Dimensional array for each pixel called the spectral range that collects information from across the electromagnetic spectrum. The 1-Dimensional array is further divided into narrow channels or bands that have a width of 4 - 10nm over the range of 400nm – 2500nm. Unlike ordinary images Hyperspectral images are rich in spectral information, and this spectral information can reflect the physical structure and chemical composition of the objects of interest, and hence provide high discrimination ability. And with the development of remote sensing technology, research study on the use of hyperspectral images has become popular over the years. Although, it is not possible for a person to afford this technology, government organizations however can afford it. It has been found to have a wide range of applications in environment, medicine, military and mining fields. Remote sensing is the process of detecting and monitoring the physical characteristics of an area, by measuring the radiation reflected from a distance, usually from an aerial vehicle like a drone or from a satellite. Hyperspectral remote sensing, also known as imaging spectroscopy, is a relatively new technology that is currently being investigated by researchers and scientists with regard to the detection and identification of minerals, terrestrial vegetation, and man-made materials based on their spatial and spectral characteristics.

II. RELATED WORK

The concept of image classification was first introduced by Zilong Zol [1]. The method was inspired by the analysing the image from a satellite view. The image smoothness information by running algorithm. Gradient decent technique is [2] used a best at masking and cutting the edges of the images. This technique uses an approach which combine structure propagation with texture synthesis and space filtering. In [3], the authors decompose the image into sum of two functions and then reconstruct each function separately with structure and pixel matrices algorithms. The technique is insensitive to noise, skew and text orientation. The authors in [4] have applied the CCL (connected component labelling) to detect the building and classify.

The work in this paper is divided in two stages. 1) Building- Detection 2) Classification. Building detection is done by applying algorithms, filters and combines the images. Thereafter, gradient is applied to detect the edges defined by

threshold. Then, connected component labelling is performed to mark each object separately. Finally, the set of selection criteria is applied to filter out non marked regions. After building detection, classification is accomplished by using convolution neural network algorithm.

III. METHODOLOGY

The Convolutional Neural Network that we designed consists of 3 3D-Convolutional Layers with kernel values $64@3 \times 3 \times 3$. The activation function used is mish as described previously. The output of this 3 convolution layers is then passed to two sub-networks one focuses on extracting spatial characteristics with kernel values $128@3 \times 3 \times 1$ and the other focuses on extracting the spectral characteristics with kernel values $128@1 \times 1 \times 3$. The outputs of these two networks are then flattened to a linear array and then concatenated. This array is then passes to 4 fully connected layer as described. Dropout is placed here so that the model does not overfit. Finally it is passed to the final layer whose activation function is SoftMax which outputs the probability distribution for each class in the datasets.

There are 4 modules:

- ▶ Data preprocessing
- ▶ Training the data
- ▶ Testing and Validation
- ▶ Prediction

IV. EXPERIMENTAL RESULTS

To further improve upon our model an unsupervised approach in which the model tries to learn the data needs to be further explored.

The current implementation support only Matlab files as an input, this framework needs to expand to support other file extensions like .lan. .tif etc

For better visualization of the output, a User Interface shall be added to invoke the implemented modules.

Using Hyperspectral Image Classification, system will enable the government officials to monitor the growth of urban area by finding the distribution of manmade materials (e.g. buildings, roads etc) and analyzing the distribution of vegetation.

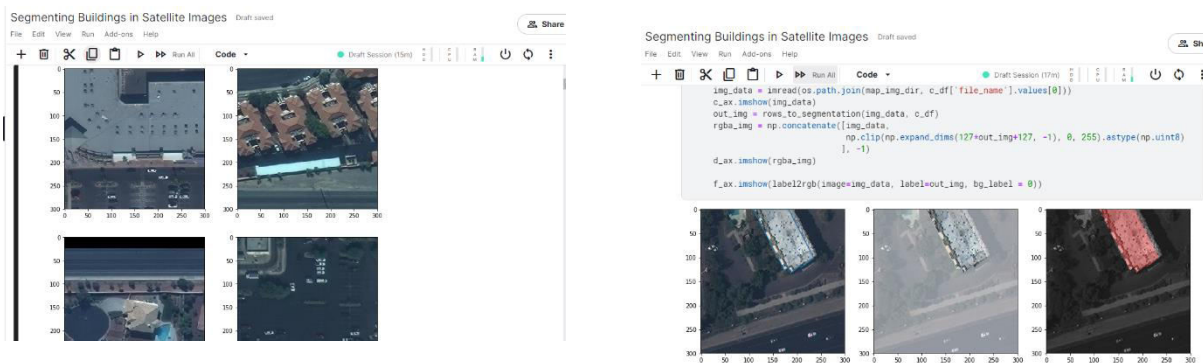


Figure1: satellite imagefigure 2: Marking

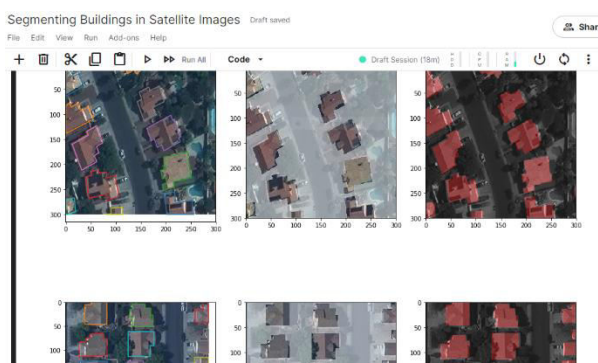


figure3: satellite view.

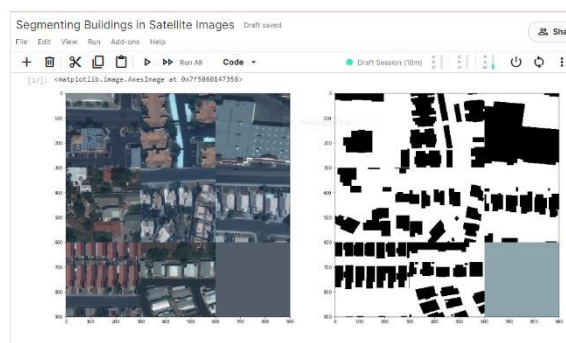


Figure 4: classified

V. CONCLUSION

We have implemented an building detection technique from an image for classifying damaged and undamaged using algorithm successfully detects the needed region from the image which consists of mixed graphic regions. We have applied our algorithm on many images and found that it successfully detects the buildings region. Hyperspectral Image Classification is an emerging topic in the field of remote sensing. It has wide application ranges from agriculture, urban area analysis, mining and even in the forest area analysis. Due to the complex nature of Hyperspectral images and spectral-spatial correlation, high dimensionality and low sample size it is a challenging task for classification. In this work, a framework for Hyperspectral Image Classification using 3D Convolutional Neural Network is proposed which extracts the spectral-spatial, spatial and the spectral characteristics.

To further improve upon our model an unsupervised approach in which the model tries to learn the data needs to be further explored.

- The current implementation support only Matlab files as an input, this framework needs to expand to support other file extensions like .lan, .tif etc
- For better visualization of the output, a User Interface shall be added to invoke the implemented modules.

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