A REVIEW ON CONVOLUTION NEURAL NETWORKS ON LAND COVER CLASSIFICATION

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Abstract : Image classification and prediction is a task with quite a lot of challenges.. The efficient and the simplest deep learning algorithm is Convolutional Neural Network (CNN). One of the important applications of image classification is in remote sensing, where it is used for land cover classification. In this paper we review a different methods of CNN architecture for the classification of multi-spectral images from different datasets. Two sets of experiments are conducted using the model by feeding it with different features. First level of experiment is providing the model with Near-Infrared (NIR) band information which sense vegetation health. The domain knowledge of Normalized Difference Vegetation Index (NDVI) motivated us to utilize Red and NIR spectral bands together. Second level of experiment that the two band information gave better results for land cover classification.

***IndexTerms* – Deep Learning, Convolutional Neural Network, Normalized Difference Vegetation Index, Near-Infrared**

I. INTRODUCTION

Deep learning is specific subset of Machine Learning, which is a specific subset of Artificial Intelligence. Artificial Intelligence is a technique that enables computers and machines to mimic human intelligence while machine learning enables machines to improve at tasks with experience and Deep learning is a toplevel abstraction in data through the use of model's architecture which are composed of multiple nonlinear transformations. Normalized Difference Vegetation Index is one application for satellite imagery which can be calculated in any satellite image that contains a near infrared- color channel. It compares reflected visible red light. This has implications for object or land type identification and use it to track changes to an ecosystem over time.

Image classification is a simple task for the human brain but understanding the pixel relation, extracting the relevant features and classifying the images to different categories is NDVI difficult for the computers. The major task in image classification is optimal feature extraction. Deep learning is capable of extracting the right features to the particular classification tasks.

Deep learning is capable of extracting the right features to the particular classification tasks. The deep learning architecture in the context of image classification is Convolutions Neural Networks (CNN). It is a reticular formation that have a series of convolution, maxpooling and activation layers. They exploit the structure of images leading to sparse connections and helps parameter sharing between input and output neurons. They generate feature maps between image pixels and class scores. The most renowned CNN architectures like Alexnet, VGG net etc., gave ground breaking results in terms of classification accuracies but these deep CNN architectures are involved with very high computations in terms of learning parameter and require high technical aid like GPU. The implementation of these architectures are time consuming.

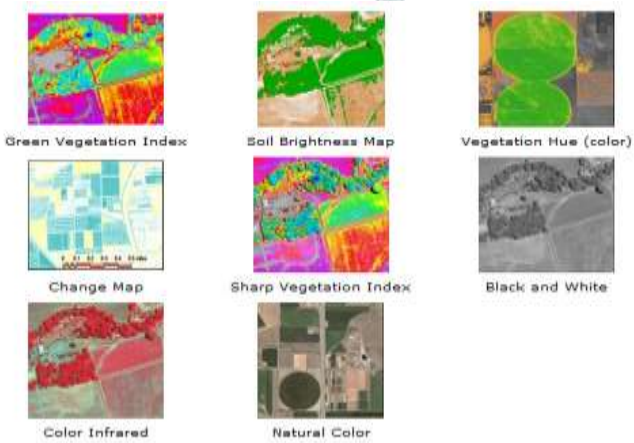

FIG 1: VEGETATION INDEX MAPS

Satellite images with moderate to high resolution have facilitated scientific research activities at landscape and regional scales.Input is a tensor with shape (number of images) x (image width) x (image height) x (image depth). Convolutional kernels whose width and height are hyper-parameters, and whose depth must be equal to that of the image. Convolutional layers convolve the input and pass its result to the next layer. This is similar to the response of a neuron in the visualcortex to

a specific stimulus. Each convolutional neuron processes data only for its receptive field. Although fully connected feed forward neural networks can be used to learn features as well as classify data, it is not practical to apply this architecture to images. Pooling Layer: Convolutional networks may include local or global pooling layers to streamline the underlying computation. Pooling layers reduce the dimensions of the data by combining the outputs of neuron clusters at one layer into a single neuron in the next layer. Local pooling combines small clusters, typically 2 x 2. The input area of a neuron is called its receptive field. So, in a fully connected layer, the receptive field is the entire previous layer. In a convolutional layer, the receptive area is smaller than the entire previous layer.

II DATASET

In CNN Based architecture classifies land cover using satellite images. The major difference between the satellite images for land cover classification and normal images is the number of bands. The satellite image consists of 4 bands (Red, Green, Blue, and Near-Infrared). Normalized Difference Vegetation Index (NDVI) is the most common parameter used for land cover classification. Among the 4 bands which reside in a satellite image Red and Near-Infrared contains the relevant information to identify vegetation.

The experiment is conducted on the NAIP(National Agriculture Imagery Program) extracted "SAT-4 and SAT-6 airborne datasets" which are publicly available. The average size of each satellite extracted image is 6000x7000 pixels and from these labeled uniform image patches, 28x28 disjoint sliding blocks were extracted inorder to avoid inter-class overlapping. Basically they used two datasets namely SAT-4 and SAT-6.

Both datasets are comprised of 4-band (Red, Green, Blue and Near-Infrared(NIR)) 28x28 dimension images. SAT4 data consists of four classes namely Trees, Grassland, Barren land and Other where as SAT-6 has six classes namely Trees, Grassland, Barren land, Roads, Buildings and Water bodies.

III RELATED WORK

Prediction and Image classification is a task of challenges. Introduction of deep learning gave a rapid rise in this area of research. The efficient and the simplest deep learning algorithm that has helped researchers to make immense contributions in the field of image classification is Convolutional Neural Network (CNN). One of the important applications of image classification is in remote sensing, where it is used for land cover classification.T Tulasi Sasidhar et al., [1] developed a SimpleCNN architecture for the classification of multi-spectral images from SAT-4 and SAT-6 airborne datasets. Two sets of experiments are conducted using the model by feeding it with different features. First level of experiment is done by providing the model with Near-Infrared (NIR) band information as it can sense vegetation health. The domain knowledge of Normalized Difference Vegetation Index (NDVI) motivated us to utilize Red and NIR spectral bands together in the second level of experimentation for the classification. It is observed from the experiment that the two band information gave better results for land cover classification.

Zhice Fang et al.,[2] research on Landslides are regarded as one of the most common geological hazards in a wide range of geo-environment. The aim of this study is to assess landslide susceptibility by integrating convolutional neural network (CNN) with three conventional machine learning classifiers of support vector machine (SVM), random forest (RF) and logistic regression (LR) in the case of Yongxin Country, China. To this end, 16 predisposing factors were first selected for landslide modelling. Then, a total of 364 landslide historical locations were randomly divided into training (70%; 255) and verification (30%; 109) sets for modelling process and assessment. Next, the training set was used for building three hybrid methods of CNN-SVM, CNN-RF and CNN-LR. In the following, the trained models were used for landslide susceptibility mapping. Finally, several objective measures were employed to compare and validate the performance of these methods.

Baoxuan Jin et al.,[3] suggest Land-use information provides a direct representation of the effect of human activities on the environment, and an accurate and efficient land-use classification of remote sensing images is an important element of land-use and land-cover change research. To solve the problems associated with traditional land-use classification methods (e.g., rapid increase in dimensionality of data, inadequate feature extraction, and low running efficiency), a method that combines object-oriented approach with deep convolutional neural network (COCNN) is presented. First, a multi-scale segmentation algorithm is used to segment images to generate image segmentation regions with high homogeneity. Second, a typical rule set of feature objects is constructed on the basis of the object-oriented segmentation results, and the segmentation objects are classified and extracted to form a training sample set. Third, a convolutional neural network (CNN) model structure is modified to improve classification performance, and the training algorithm is optimized to avoid the overfitting phenomenon that occurs during training using small datasets. Ten land-use types are classified by using the remote sensing images covering the area around Fuxian Lake as an example.

S. Rajesh et al.,[4] proposes a new method for classifying the LISS IV satellite images using deep learning method. Deep learning method is to automatically extract many features without any human intervention. The classification accuracy through deep learning is still improved by including object-based segmentation. The object-based deep feature learning method using CNN is used to accurately classify the remotely sensed images. The method is designed with the technique of extracting the deep features and using it for object-based classification. The proposed system extracts deep features using pre-defined filter values, thus increasing the overall performance of the process compared to randomly initialized filter values. The object-based classification method can preserve edge information in complex satellite images

Agriculture plays a strategic role in the economic development of a country. Appropriate classification of land cover images is vital for planning the right agricultural practices and maintaining sustainable environment. Anushree Ramanath et al.,[5] provides methods and analysis for land cover classification of remote sensing images. Satellite images form the input while mapping of every image to a distinct class is obtained as output. The objective is to compare the hand-crafted features based on Normalized Difference Vegetation Index (NDVI) and feature learning from Convolutional Neural Networks (CNN). The rationale of this work is to take advantage of techniques that are illumination invariant. NDVI versus CNN features have been compared on a linear Support Vector Machine (SVM).

Giuseppe Scarpa et al.,[6] research on Sensitivity to weather conditions, and specially to clouds, is a severe limiting factor to the use of optical remote sensing for Earth monitoring applications. A possible alternative is to benefit from weather-insensitive synthetic aperture radar (SAR) images. In many real-world applications, critical decisions are made based on some informative optical or radar features related to items such as water, vegetation or soil. Based on these data and a tiny cloud-free fraction of the target image, a compact convolutional neural network (CNN) is trained to perform the desired estimation. To validate the proposed approach, we focus on the estimation of the normalized difference vegetation index (NDVI), using coupled Sentinel-1 and Sentinel-2 time-series acquired over an agricultural region of Burkina Faso from May–November 2016.

With the increasing availability of high-resolution satellite imagery it is important to improve the efficiency and accuracy of satellite image indexing, retrieval and classification. Furthermore, there is a need for utilizing all available satellite imagery in identifying general land cover types and monitoring their changes through time irrespective of their spatial, spectral, temporal and radiometric resolutions. Therefore, Yuri Shendryk et al.,[7] studies, developing deep learning models able to efficiently and accurately classify cloud, shadow and land cover scenes in different high-resolution (< 10 m) satellite imagery. Specifically, we trained deep convolutional neural network (CNN) models to perform multi-label classification of multi-modal, high-resolution satellite imagery at the scene level.

Landslides are a type of frequent and widespread natural disaster. It is of great significance to extract location information from the landslide in time. At present, most articles still select single band or RGB bands as the feature for landslide recognition. To improve the efficiency of landslide recognition, this study proposed a remote sensing recognition method based on the convolutional neural network of the mixed spectral characteristics. Firstly, Yu Wang, Xiaofei Wang et al.,[8] tried to add NDVI (normalized difference vegetation index) and NIRS (near-infrared spectroscopy) to enhance the features. .en, remote sensing images (predisaster and postdisaster images) with same spatial information but different time series information regarding landslide are taken directly from GF-1 satellite as input images. By combining the 4 bands (red + green + blue + near-infrared) of the prelandslide remote sensing images with the 4 bands of the postlandslide images and NDVI images, images with 9 bands were obtained, and the band values reflecting the changing characteristics of the landslide were determined. Finally, a deep learning convolutional neural network (CNN) was introduced to solve the problem.

IV CONCLUTION

By analysis of different papers we conclude that a convolutional neural network (CNN or ConvNet) is a class of deep neural networks, most commonly applied to analyzing visual imagery. CNNs are regularized versions of multilayer perceptrons. Multilayer perceptrons usually mean fully connected networks, that is, each neuron in one layer is connected to all neurons in the next layer. At present, most articles still select single band or RGB bands as the feature for landslide recognition. We can use hyperspectral images which have hundred of bands and augmented dataset for future work.

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