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Remote Sensing Image Category Classification Using Deep Learning

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ABSTRACT: The remote sensing Images Classification plays a vital role of real time applications and Deep Learning massive growth in different fields such as Natural language Processing, Computer Vision and medical fields. Compared to the machine Learning algorithms, deep networks provide higher accuracy and also strong ability to learn for data extraction. Geographical satellite pictures that are utilized for the investigation of environmental and geological fields are acquired through remote sensing techniques. The crude pictures gathered from the satellites are not appropriate for factual examination and precise report arrangement so raw images undergo the traditional image classification techniques such as data preprocessing, segmentation, data feature extraction and classification. The old image classification methods have spatial and spectral resolution problems. The latest image classification method ,namely deep CNN techniques

KEYWORDS: Machine Learning, Convolution Neural Network, Recurrent Neural Network, Transfer Learning.

I.INTRODUCTION

Satellite images are rich and play a vital role in providing geographical information. Satellite and remote sensing images provides quantitative and qualitative information that reduces complexity of field work and study time. Satellite remote sensing technologies collects data/images at regular intervals. The volumes of data receive at datacenters is huge and it is growing exponentially as the technology is growing at rapid speed as timely and data volumes have been growing at an exponential rate. There is a strong need of effective and efficient mechanisms to extract and interpret valuable information from massive satellite images.

Satellite image classification is a powerful technique to extract information from huge number of satellite images. Satellite image classification is a process of grouping pixels into meaningful classes. It is a multistep workflow. Satellite image classification can also be referred as extracting information from satellite images. Satellite image classification is not complex, but the analyst has to take many decisions and choices in satellite image classification process. Satellite image classification involves in interpretation of remote sensing images, spatial data mining, studying various vegetation types such as agriculture and foresters etc. and studying urban and to determine various land uses in an area.

Image classification is an important part of the remote sensing, image analysis and pattern recognition. In some instances, the classification itself may be the object of the analysis. For example, classification of land use from remotely sensed data produces a map like image as the final product of the analysis. The image classification therefore forms an important tool for examination of the digital images. The term classifier refers loosely to a computer program that implements a specific procedure for image classification (Campbell 2002). The analyst must select a classification method that will best accomplish a specific task. At present, it is not possible to state which classifier is best for all situation as the characteristic of each image and the circumstances for each study vary so greatly. Therefore, it is essential that each analyst understand the alternative strategies for image classification so that he or she may be prepared to select the most appropriate classifier for the task in hand.At present, there are different image classification procedures used for different purposes by various researchers. These techniques are distinguished in two main ways as supervised and unsupervised classifications. Additionally, supervised classification has different sub.Classification methods which are named as parallel piped, maximum likelihood, minimum distances and Fisher classifier methods. These methods are named as Hard
Classifier.

In recent years, there has been an increasing demand for applications to monitor the targets related to land-use, using remote sensing images. Classified satellite image maps have been used for studying, monitoring and analyzing the earth's surface over time. Popular real world applications of Image Classification include identifying, monitoring and analyzing disaster affected regions for effective disaster management; studying and understanding urban encroachment and its consequences and monitoring for changes in hostile territories. The different classification approaches like per pixel, sub pixel, object based and knowledge based classification has been studied and categorized based on their usage. The parameters used to determine the comparisons for these classifications are namely kappa coefficient, producers, users and overall accuracy. The various classification strategies have been compared based on their kappa coefficient performance. However, they have still problems such as low accuracy on detection of targets, specific algorithms for a specific area etc., so Proposed the automatic approach to classify and detect building footprints, road networks and vegetation areas. The automatic interpretation of visual data is a comprehensive task in computer vision field. The Deep learning approaches improve the capability of classification in an intelligent way. The Proposed method, which has high accuracy on detection and classification. The multi class classification is developed for detecting multiple objects.

II.LITERATURE SURVEY

1.Convolution Structure Sparse Coding for Fusion of Panchromatic and Multispectral Images

Recently, sparse coding-based image fusion methods have been developed extensively. Although most of them can produce competitive fusion results, three issues need to be addressed: 1) these methods divide the image into overlapped patches and process them independently, which ignore the consistency of pixels in overlapped patches; 2) the partition strategy results in the loss of spatial structures for the entire image; and 3) the correlation in the bands of multispectral (MS) image is ignored. In this paper, we propose a novel image fusion method based on convolution structure sparse coding (CSSC) to deal with these issues. First, the proposed method combines convolution sparse coding with the degradation relationship of MS and panchromatic (PAN) images to establish a restoration model. Then, CSSC is elaborated to depict the correlation in the MS bands by introducing structural sparsity. Finally, feature maps over the constructed highspatial-resolution (HR) and lowspatial-resolution (LR) filters are computed by alternative optimization to reconstruct the fused images. Besides, a joint HR/LR filter learning framework is also described in detail to ensure consistency and compatibility of HR/LR filters. Owing to the direct convolution on the entire image, the proposed CSSC fusion method avoids the partition of the image, which can efficiently exploit the global correlation and preserve the spatial structures in the image. The experimental results on QuickBird and Geoeye-1 satellite images show that the proposed method can produce better results by visual and numerical evaluation when compared with several well-known fusion methods.

2. Automatically Locate Tropical Cyclone Centers Using Top Cloud Motion Data Derived From Geostationary Satellite Images

This article presents a novel technique for automatically locating tropical cyclone (TC) centers based on top cloud motions in consecutive geostationary satellite images. The high imaging rate and spatial resolution images of the Gaofen-4 geostationary satellite enable us to derive pixelwise top cloud motion data of TCs, and from the data, TC spiral centers can be accurately determined based on an entirely different principle from those based on static image features. First, a physical motion field decomposition is proposed to eliminate scene shift and TC migration in the motion data without requiring any auxiliary geolocation data. This decomposition does not generate the artifacts that appear in the results of the previously published motion field decomposition. Then, an algorithm of a motion direction-based index embedded in a pyramid searching structure is fully designed to automatically and effectively locate the TC centers. The test shows that the TC concentric motions are more clearly revealed after the proposed motion field decomposition and the located centers are in good agreement with the cloud pattern centers in a visual sense and also with the best track data sets of four meteorological agencies.

3.Learning and Adapting Robust Features for Satellite Image Segmentation on Heterogeneous Data Sets

This paper addresses the problem of training a deep neural network for satellite image segmentation so that it can be deployed over images whose statistics differ from those used for training. For example, in post-disaster damage assessment, the tight time constraints make it impractical to train a network from scratch for each image to be segmented. We propose a convolutional encoder-decoder network able to learn visual representations of increasing semantic level as its depth increases, allowing it to generalize over a wider range of satellite images. Then, we propose two additional methods to improve the network performance over each specific image to be segmented. First, we observe that updating the batch normalization layers' statistics over the target image improves the network performance without human intervention. Second, we show that refining a trained network over a few samples of the image boosts the network performance with minimal human intervention. We evaluate our architecture over three data sets of satellite images, showing the state-of-the-art performance in binary segmentation of previously unseen images and competitive performance with respect to more complex techniques in a multiclass segmentation task.

4.Phased Array Shaped-Beam Satellite Antenna With Boosted-Beam Control

As smart vehicles have become more ubiquitous, the capability now exists to detect environmental road features (e.g., potholes, road incline angle, etc.) from their embedded sensor data. By aggregating data from multiple vehicles, crowdsourcing can be leveraged to detect environmental information with improved accuracy. We focus on using such data to detect and localize potholes on multi-lane roads. Extracting information from aggregated vehicle data is challenging due to undersampling sensors, sensor mobility, asynchronous sensor operation, sensor noise, vehicle and road heterogeneity, and GPS position error. GPS position error is particularly problematic in multi-lane environments since the position error is generally larger than standard lane widths. In this paper, we investigate these issues and develop a crowdsourced system to detect and localize potholes in multi-lane environments using accelerometer data from embedded vehicle sensors. Our crowdsourced system reduces the required network bandwidth by determining road incline and bank angle information in each vehicle to filter acceleration components that do not correspond to pothole conditions.

5. Extraction of road networks from the VHSR satellite images by the Algorithm

The present work 1 addresses the problem of extracting road networks from very high Spatial resolution satellite images in order to supply and / or update road databases in a Global Positioning System (GPS). This extraction is performed using a multi-resolution approach working in two steps: 1) extracting the road axis from a re-sampled image and then 2) using it to define the edges of the road. The results of the experiments are encouraging and demonstrate effectiveness of the method adopted.

III.METHODOLOGY

TYPES OF CLASSIFICATION
Classification is of two types:
Binary Classification : When we have to categorize
given data into 2 distinct classes. Example – On the basis of given health conditions of a person, we have to determine whether the person has a certain disease or not.
Multiclass Classification : The number of classes is more than 2. For Example
– On the basis of data about different species of flowers, we have to determine which specie does our observation belong to Fig 2 : Binary and Multiclass Classification. Here x1 and x2 are our variables upon which the class is predicted.Suppose we have to predict whether a given patient has a certain disease or not, on the basis of 3 variables, called features. Which means there are two possible outcomes:
The patient has the said disease. Basically a result labelled “Yes” or “True”.
The patient is disease free. A result labelled “No” or “False”.
This is a binary classification problem.We have a set of observations called training data set, which comprises of sample data with actual classification results. We train a model, called Classifier on this data set, and use that model to predict whether a certain patient will have the

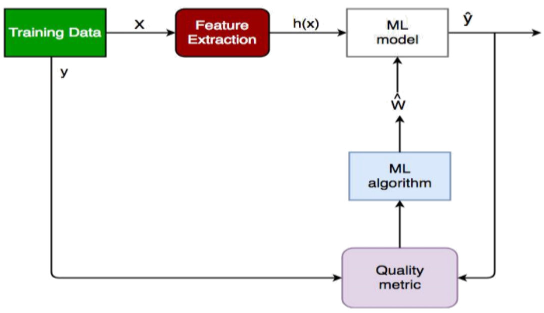


Fig 1: Generalized Classification Block Diagram.

1. X : pre-classified data, in the form of a N*M matrix. N is the no. of observations and M is the number of features
2. y : An N-d vector corresponding to predicted classes for each of the N observations.
3. Feature Extraction : Extracting valuable information from input X using a series of transforms.

4. ML Model : The "Classifier" we'll train.
5. y' : Labels predicted by the Classifier.
6. Quality Metric : Metric used for measuring the performance of the model.
7. ML Algorithm : The algorithm that is used to update weights w', which update the model and "learns" iteratively.

Types of Classifiers (Algorithms)
There are various types of classifiers. Some of them are :

- Linear Classifiers : Logistic Regression
- Tree Based Classifiers: Decision Tree Classifier
- Support Vector Machines
- Artificial Neural Networks
- Bayesian Regression
- Gaussian Naive Bayes Classifiers
- Stochastic Gradient Descent (SGD) Classifier
- Ensemble Methods : Random Forests, AdaBoost, Bagging
- Classifier, Voting Classifier, ExtraTrees Classifier Practical Applications of Classification
- Google's self driving car uses deep learning enabled
classification techniques which enables it to detect and classify obstacles.
- Spam E-mail filtering is one of the most widespread and well recognized uses of Classification techniques.
- Detecting Health Problems, Facial Recognition, Speech Recognition, Object Detection, Sentiment Analysis all use Classification at their core.

3.6.4 REGRESSION

A regression problem is when the output variable is a real or continuous value, such as "salary" or "weight". Many different models can be used, the simplest is the linear regression. It tries to fit data with the best hyper-plane which goes through the points.

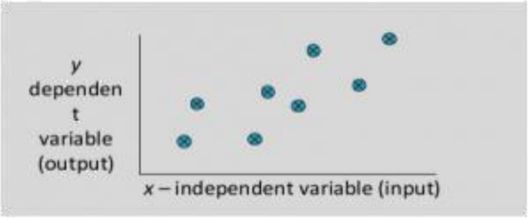


FIG 2: LINEAR REGRESSION MODEL

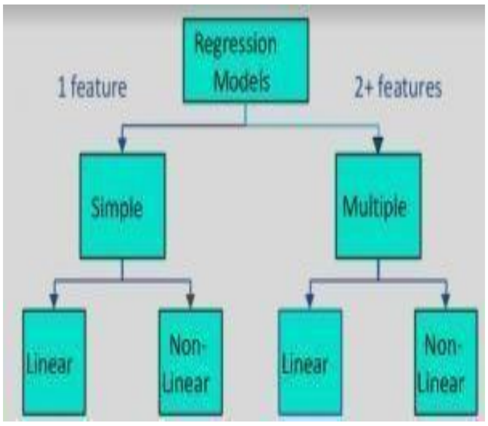


FIG 3 : TYPES OF REGRESSION MODELS

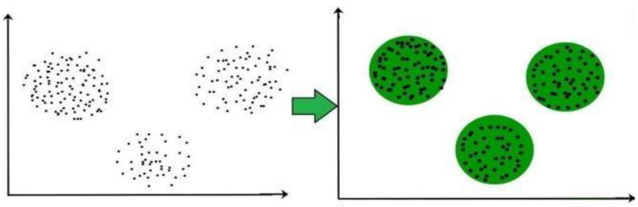
3.6.5 UNSUPERVISED LEARNING

Unsupervised learning is where we only have input data (X) and no corresponding output variables. The goal for unsupervised learning is to model the underlying structure or distribution in the data in order to learn more about the data. These are called unsupervised learning because unlike supervised learning above there is no correct answers and there is no teacher. Algorithms are left to their own devises to discover and present the interesting structure in the data.
Unsupervised learning problems can be further grouped into clustering and association problems.

3.6.5.1 CLUSTERING

It is basically a type of unsupervised learning method. An unsupervised learning method is a method in which we draw references from datasets consisting of input data without labelled responses. Generally, it is used as a process to find meaningful structure, explanatory underlying processes, generative features, and groupings inherent in a set of examples. Clustering is the task of dividing the population or data points into a number of groups such that data points in the same groups are more similar to other data points in the same group and dissimilar to the data points in other groups. It is basically a collection of objects on the basis of similarity and dissimilarity between them.For example, the data points in the graph below clustered together can be classified into one single group. We can distinguish the clusters, and we can identify that

II.there are 3 clusters in the below picture.



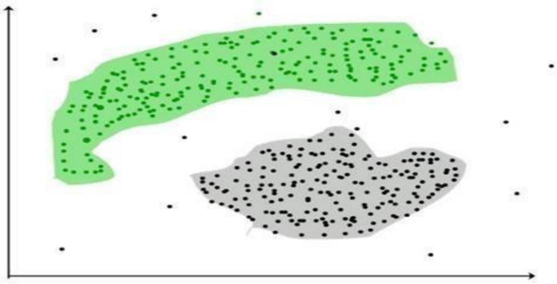
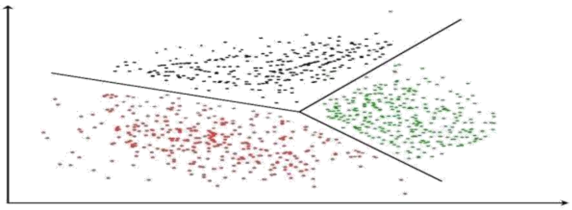


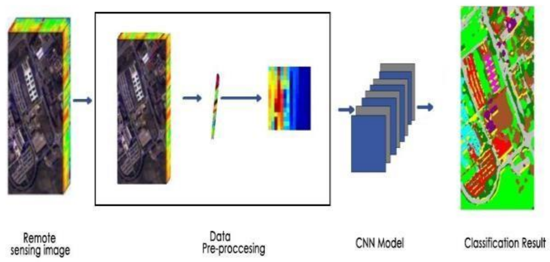
FIG 4: CLUSTERING EXAMPLE:



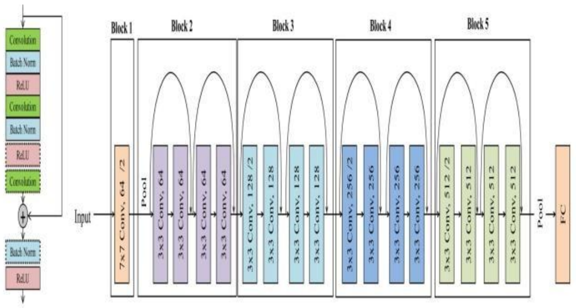
IV.ARCHITECTURE

4.1 SYSTEM ARCHITECTURE

A system architecture is the conceptual model that defines the structure,behavior, and more views of a system. An architecture description is a formal escription and representation of a system, organized in a way that supports reasoning about the structures and behaviors of the system.



VI.SYSTEM DESIGN



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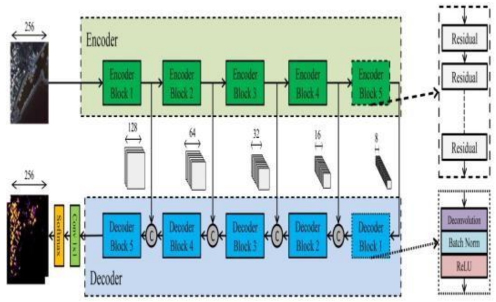


FIG:5 SYSTEM DESIGN

VII.CODING AND TESTING

7.1 CODING

Once the design aspect of the system is finalizes the system enters into the coding and testing phase. The coding phase brings the actual system into action by converting the design of the system into the code in a given programming language. Therefore, a good coding style has to be taken whenever changes are required it easily screwed into the system.

7.2 CODING STANDARDS

Coding standards are guidelines to programming that focuses on the physical structure and appearance of the program. They make the code easier to read, understand and maintain.

This phase of the system actually implements the blueprint developed during the design phase. The coding specification should be in such a way that any programmer must be able to understand the code and can bring about changes whenever felt necessary.

TEST PROCEDURE

SYSTEM TESTING

Testing is performed to identify errors. It is used for quality assurance. Testing is an integral part of the entire development and maintenance process. The goal of the testing during phase is to verify that the specification has been accurately and completely incorporated into the design, as well as to ensure the correctness of the design itself. For example the design must not have any logic faults in the design is detected before coding commences, otherwise the cost of fixing the faults will be considerably higher as reflected.

Detection of design faults can be achieved by means of inspection as well as walkthrough.

Testing is one of the important steps in the software development phase. Testing checks for the errors, as a whole of the project testing involves the following test cases:

➢Static analysis is used to investigate the structural properties of the Source code.

➢Dynamic testing is used to investigate the behavior of the source code by executing the program on the test data.

7.4 TEST DATA AND OUTPUT

7.4.1 UNIT TESTING

Unit testing is conducted to verify the functional performance of each modular component of the software. Unit testing focuses on the smallest unit of the software design (i.e.), the module. The white-box testing techniques were heavily employed a.for unit testing.

b.The most 'micro' scale of testing to test particular functions or code modules. Typically, it is done by the programmer and not by tester, as it c.requires detailed knowledge of the internal program design and code. Unit testing is a method by which d.individual units of source codeare tested to determine if they are fit for use. A unit is the smallest testable part of an application. In proceduralprogrammingaunit could be an entire module but is more commonly an individual function or procedure. In objectoriented programmingaunit is often an entire interface, such as a class, but could be an individual method. Unit tests are created by programmers or occasionally by e.white box testersduring the development process.

f.Ideally, each test caseis independent from the others: substitutes like method stubs,mock Examples of how to use all the functionality of each module

A means to build regression tests to validate any future changes to the code

In Java, you can use the main routine to run each unit tests.

A test harness can handle common operations such a Logging status, Analyzing output for expected results, Selecting and running the tests. Harnesses can be GUI driven, Written in the same language as the rest of the project, May be implemented as a combination of make files and scripts. A test harness should include the following capabilities:

A standard way to specify setup and cleanup.

A method for selecting individual tests or all available tests.objects,fakesand test harnessescan be used to assist

VIII.SCREENSHOTS AND OUTPUTS

Testing a module in isolation. Unit tests are typically written and run by softwaredevelopersto ensure that code meets its design and behaves as intended. Its implementation can vary from being very manual (pencil and paper) to being formalized as part of build automation.Depending upon established development practices and unit test coverage, up-tothesecond accuracy can be maintained. Ideally, each test case is independent from the others: substitutes like method stubs, mock objects, fakes, and test harnesses can be used to assist testing a module in isolation.

The goal of unit testing is to isolate each part of the program and show that the individual parts are correct. A unit test provides a strict, written contractthat the piece of code must satisfy. As a result, it affords several benefits. Unit tests find problems early in the development cycle.

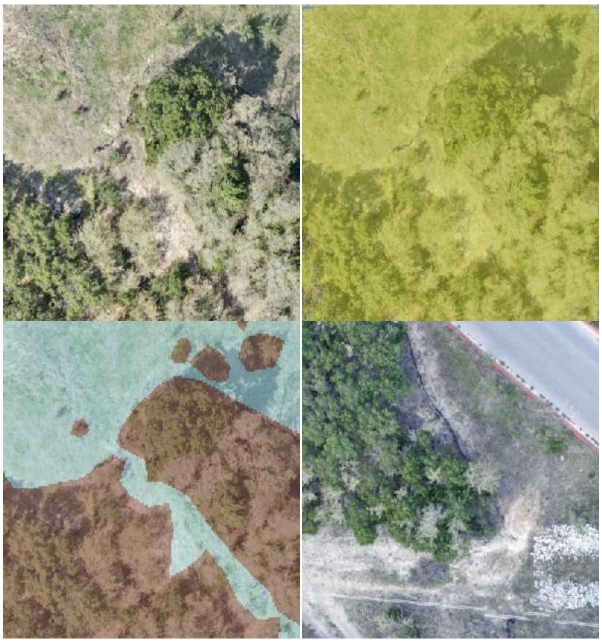


FIG 6: Sample Image classification

Writing unit tests

i. Unit test should be conveniently located
   a. For small projects you can imbed the unit test for a module in the module itself.
   b. For larger projects you should keep the tests in the package directory or a /test subdirectory of the package.

ii. By making the code accessible to developers you provide them with:

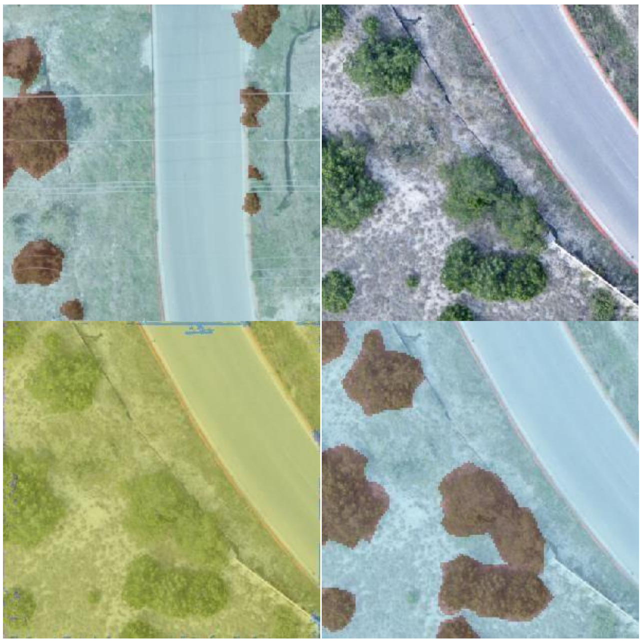


FIG:7 Sample Image classification

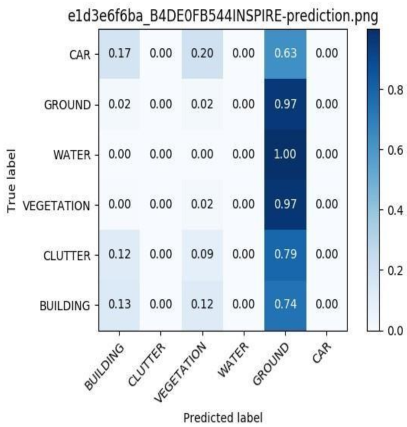


FIG:8 Prediction Labelling

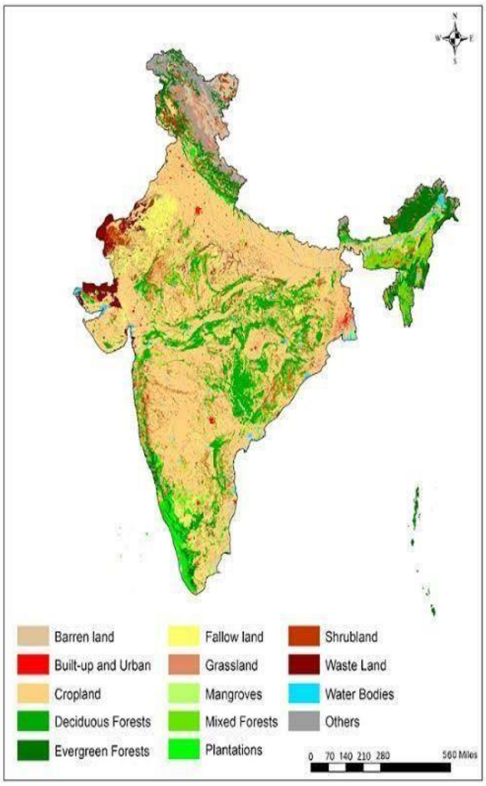
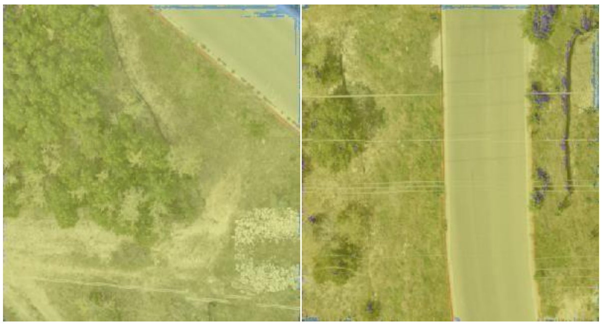


FIG 9: Satelite Image Category classification of India



IX.CONCLUSION

A wide comparative survey given on various methodologies available in deep learning techniques and models. Also in this paper analyzing the difference literature gap for deep learning techniques and models. In this paper provides quantitative metrics like accuracy, precision, recall for evaluate the satellite images. All the supplementary information will be extremely much useful for image classification and identification of images .Its help the users to learn significant feature representations. i

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