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Horticulture Crop Inventory: A Survey on Identification and Classification of Crops using Satellite Image Processing

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Abstract

Identification of horticulture crop type is as important and classification of crops, it shall be used for crop yield measurement and planning of plantation. It is also important to obtain an accurate classification of crops to help ARO's report outcomes to the authorized representatives in the respective department. It mainly focuses on crop identification in certain areas and hence it is important not only to classify the crop but also to detect the type and grade based on the satellite imagery and ground data. The dataset used is composed of the local region and appropriate channel images from the satellite. The analysis identifies the techniques of Machine Learning methods that will classify the type of horticulture crop, Deep Learning methods are used to diagnose grades for the crop in a particular region/area that helps the farmers and agriculturists. Neural Network algorithms have been successfully used to identify the crop and grade the crop with very little variation. In this paper, it is proposed to provide a detailed survey on information technologies and methodologies used in horticulture crop inventory to improve the accuracy of crop identification and classification.

Keywords: *Machine Learning, Deep Learning, Crop Inventory, Satellite Imagery, k-Nearest Neighbour (KNN), OpenCV2*

1. Introduction

Horticulture is the study of science and adapted methods to progress, dependable production, trading, and avail exquisite, vigorously cultivated food and decorative plants. Horticulture crops are assorted, including:

- Yearly and eternal species,
- Organic Fruits and green vegetables,
- Beautifying indoor plants and Herbs
- Terrain plants.

It is a method of cultivating plants as part of produce and medicinal research to improve our quality of life. It is focused on producing sustainable growing and habitual nature food produce in our environment. Horticulture is the science which engages notable methodologies, dexterity, and strategy to mulch vegetation, it also includes conditioning of soil, atmosphere, and irrigation methods to plant the seed that produces good and rich yields. The skills required to study horticulture study are farming, vegetation dexterity by root cuttings, multiplying of plants, crops production, check on

functions of plant, and chemical processing with congenital engineering. The vegetation considered are green herbs, trees fruits, colorful flowers, bush, organic fruits, and dried seeds. Horticulturalist's job is to identify the best techniques to grow crops to get best in quality organic vegetation yields, improve its quality of essential nutrients to consumers, ensure produced crops are less prone to pests and disease; and adjust to environmental changes.

Vegetation, herbage, and green environment improve and boost up our livelihood by adding healthier diet, improve ambiance of our environment and fellowship groups, and lessen carbon spoor.

A. Crops Inventory

It is often an important activity that helps a resource manager or agriculturist to identify, document, and survey the collection of distinct types of crops within an explicitly defined study area, considering an example, a taluka, a district, or natural resources region.

B. Classification

It is categorizing crops or their attributes into a certain group or system based on certain characteristics. The following are a few categories that can be considered while classification:

1. Season
2. Taxonomy
3. Botany
4. Special Purpose
5. Cultural Method/Water
6. Root System
7. No. of Cotyledon.

C. Satellite Images

The images of Earth are collected by imaging satellites sponsored by governments and businesses around the world. Satellite imaging companies such as ISRO, Apple Maps, Esri, Google...etc. sell multiple categories of satellite images by licensing them to governments and businesses.

D. Digital Image Enhancement

Digital Images are enhanced by performing certain actions on images, to get a further improved quality image, or to withdraw useful information. The input images are analyzed and processed using Digital Signal Processing

System, and output can be an enhanced image or change of characteristics/ attributes associated with the image. There are many licensed or open-source tools available in the market such as OpenCV, TensorFlow, Matlab, CUDA, Keras, BoofCV.

LITERATURE SURVEY

A summarized view of methods, technologies, and applications used in the identification and classification of horticulture crops inventory is presented in the following:

Rachel BARRETT *et al.,* [1] describes a method for processing the graphically digitized satellite information from SPOT-XS, SPOT-XI, and Landsat TM that were obtained from Coastal part of Tasmania (North West), Australia during the spring/summer in the growing seasons of 1997/98 and 1998/99. The goal was to find a simple and cost-effective method of identifying crops in horticulture areas or locations. these satellite data were processed, classified, and compared to ground-truth data of crop cover location. The data was collected in two methods: 1. Digital Satellite images 2. Ground-based data of the crops collected at different intervals. The collected digital images were analyzed using the Principal Component Analysis technique to remove any noise. Then machine learning technique of the Maximum likelihood classification process was applied to the data to categorize each crop. About 1/3 of the data of each crop area was used as training data. Finally with iterative classification using a trained dataset and ground dataset was tabled and accuracy assessment of classification is determined by using Russell Congalton(1991) method. The prediction on the accuracy of overall crops obtained of this technique/ method is 70%.

Nataliia Kussul et al., [2] describes a method of crop mapping with Arieal image data from satellites or airborne devices. The techniques classify multitemporal optical and SAR (Segmentation and Reassembly) satellite Arieal image data of crops into harvesting-season and end-of-harvesting season crop. The objective was to identify crop for multiple seasons at a territorial scale in Ukraine using multitemporal Arieal satellite images. The maps, both in harvesting-season and end-of-harvesting season, are captured using moderate spatial Arieal resolution satellite images of 30 m Landsat-8 Operational Land Imager (OLI) (2013–2015), The dataset of 10 m Sentinel-1A, C-band SAR (2015–2016), and 10 m Sentinel-2 Multi-Spectral Instrument (MSI) (2016). The Machine Learning method assembled of ANNs (multi-layer perceptron – MLPs) is used to identify Arieal satellite images into several types of crops for each season. As the first step, self-organizing Kohonen maps (SOMs) is empirical to reinstate missing pixel values in a time series of optical satellite imagery. but, with

tenacious cloud noise, satellite imagery is not good to obtain the required accuracy. Hence, SAR imagery is merged with optical satellite imagery to improve the classification of crops.

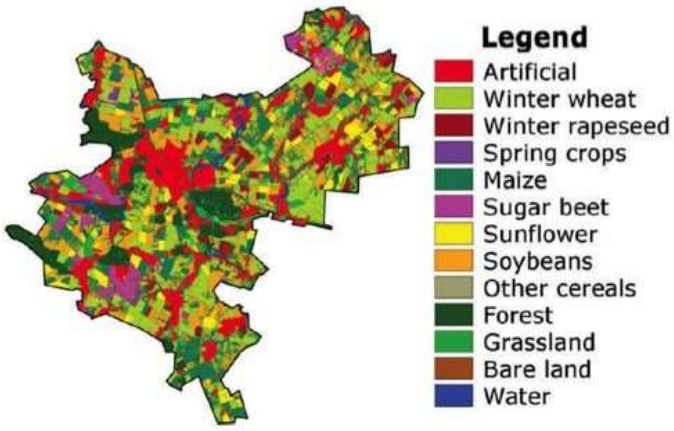

Fig. 1. classification results

The usage of four trained multi-layer perceptron's with the discrete number of hidden neurons (10, 20, 30, and 40) averaged class probability was determined. as output. After the results of a pixel-based crop classification map, a parcel-based method is applied to enhance accuracy along with image quality in the maps. This method provided rich reliable results with an overall accuracy of 85.3%, 90.1%, and 92.4%, respectively, for 13 classes of crops. The merging of SAR and optical data improved classification accuracy by +0.8%.

N.S. Vorobiova *et al.,* [3] describe a method to recognize crops based on an algorithm for calculating estimates. The data from satellite Terra/MODIS are used to construct time series and ground data of fields is obtained from farmers and is used as a training dataset to classify and evaluate the quality. This data is pre-processed to plot NDVI values sorted by date, and it is selected to provide the time series. The classification of crops is determined by using the (ACE) Algorithm for Calculating Estimates proposed by Zhuravlev YI. It is a model of recognition algorithm. The final probability of accurate classification is 0.72.

Bhavana Sahay *et al.,* [4] describes an Object-oriented approach that is adopted that includes a hybrid classification technique. This applies visual and digital interpretation techniques to improve spatial extent accuracy of mango and oil palm crops. The process includes the following steps

1. Pre-processing of spatial data using Brovey Transformation (RGB) method. The technique integrates the images of spatial data using a ratio algorithm. It increases the visual contrast in the low and high ends of transformed spatial images.

2. Ground Data collection using the CHAMAN app (developed at NRSC). helps in faster and most efficient collection of ground crops information along with field photographs.

3. Classification of crops, at first based on NDVI to accurately segregate plantation area and non-plantation area with other classes. As the next step, the potential crop areas are classified based on the texture, shape, and geometry information. Finally, post-classification is conducted by smoothening of vector files by validating a tolerance. The object-oriented method with spatial imagery can be potentially used for the classification of long-term crops such as mango and oil palm plantations.

Karim Ennouri and Abdelaziz Kallel *et al., [*7] describe the need for remote sensing and classifying the crops using different machine learning techniques on spatial data imagery. The crops identification procedure has a dependency on environmental conditions like air, temperature, soil moisture, humidity, and rainfall. There are a diverse set of remote sensing indices like NDVI, LSWI, TVDI, SAVI, and WDI

With the help of these indices, it is an easy and straightforward way to identify the growth structure of crops and their connection of concerned variables. Based on this information and tests, the remote sensing method helps estimate the crop development, yields, and estimation at the land level. Amplification of land range by recognizing and grouping satellite image data, it is possible to classify different crops using scientific procedures like the k-nearest neighbor, artificial neural nets, decision tree analytical technique, and finally clustering division and segmentation methods [8-13].

Challenges

Some of the challenges faced by horticulture crop inventory techniques are as follows:

- Determinating cost-effective and best accurate predictive classifier type for individual crops will help to aggregate crop yields, timing, and cultivation methods to support farmers or horticulturists.
- The most important challenge is to classify the multi-temporal satellite images of unaccounted data that exists due to clouds, atmospheric disturbances, and Arieal shadows.
- Some of the data collection methods are unreliable; incorrect crops for few fields, the division of crops into multiple classes is carried out not most desirable or satisfactory.
- Low accuracy for a few horticultural crops because of mixed or inter-cropping with other field crops will make it difficult to classify the crops.

Study Analysis

Article Name	AGRICULTURAL CROP IDENTIFICATION USING SPOT AND LANDSAT IMAGES IN TASMANIA
Crop Identification	Principal Component Analysis technique
Crop Classification	Maximum likelihood classification process
Results	Accuracy of 70%.

Article Name	CROP INVENTORY AT REGIONAL SCALE IN UKRAINE
Crop Identification	Artificial Neural Networks (Segmentation and Reassembly)
Crop Classification	Pixel-based method
Results	Accuracy of 85.3%

Article Name	CROPS IDENTIFICATION BY USING SATELLITE IMAGES AND ALGORITHM FOR CALCULATING ESTIMATES.
Crop Identification	NDVI values
Crop Classification	Algorithm for Calculating Estimate
Results	Accuracy of 72%.

Article Name	MAPPING MULTIPLE HORTICULTURE CROPS USING OBJECT ORIENTED CLASSIFICATION TECHNIQUES
Crop Identification	NDVI values
Crop Classification	Object-oriented method
Results	Accuracy of 89%.

Applications

A few of the applications of crop inventory using satellite images are listed:

- A wide range of horticultural applications, including estimation of crop area, total yield forecasting of a specific crop, assessment crop state at different intervals, crop maps used to determine the land use for cultivation.
- The horticultural applications are also used for crop rotation violation detection.
- Using the satellite data history, crop changes can be analyzed and planned. With the extended support of Mobile technology, field data collection is made easy for horticulture surveillance and monitoring of valuable crops.

4. Conclusion

The methodologies and technologies involved in classification of horticulture crops using satellite images obtained by remote sensing provides frequent information at an economical value, at the pertinent time, in the classification of crop plight and its recovery. These methods are promising but still the satellite's spatial information which is the primary data used to monitor high value crop inventory, crop estimation, crop planning, and crop yields for horticulturists does not provide precise results. The best approach as per the survey is using the NDVI values for identification of crops and Object-oriented approach for classification providing highest efficiency. However, there is need for improvement in both Image processing techniques and classification methods or algorithms that need to be developed specifically to meet accuracy at its best.

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