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Coconut Inventory and Mapping Using Object Oriented Classification

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A B S T R A C T

Object Based classification involves grouping of pixels based on spatial relationships like similar colour, tone, Shape with surrounding pixels. Object-based information extraction depends on spectrum character and geometry and structure information. Object based classification interprets an image that is represented not only by a single pixels, but also in meaningful image objects and their mutual relationships. In this study has been attempted mapping of coconut growing areas for Kozhikode taluk, Kerala.Cartosat-2 and LISS-IV data was used in this study for classification of coconut using Object-oriented classification techniques. Main objective of this study is Comparison of different classifiers for better accuracy. Cartosat data gave the spatial information of object and LISS-IV data gave the spectral information of the object. Multi resolution Segmentation process was performed for classification. Multi resolution Segmentation is nothing but images subdivide into separate regions based on the spatial and spectral heterogeneity. Using eCognition software as the platform, this study carries two kinds of supervised classification and Rule based classification. Methodology used in this study was SVM Classifier (Support Vector Machine), KNN classifier (K-Nearest Neighbour) and Rule based classification. Parameters used in the rule set was NDVI, Maximum Difference, Brightness, Mean, standard deviation, Asymmetry, shape index. Kozhikode had a scattered settlement so there was a chance to settlements can be classified under the coconut classification. Young plantations were difficult to classify and Inter crops or mixed crops like arecanut also been a big challenge.

Introduction

Agriculture is major important in Indian economy and also for ensuring food security. Agriculture sector employs more than 50% of the total workforce in India and contributes around 17-18% of countries GDP. India is one of the country which uses space technology and land based observations for generating updates on crop production statistics. It also provide inputs to achieve sustainable agriculture. Indian agriculture has been the source of supply of raw material to leading industries in India. Indian agriculture has been the source of supply of raw materials leading to industries in India. Coconut (*Coccus nucifera*) is the one of the plantation crop. Coconut palm thrives on Light sandy soils to heavy soils with a pH - 5.2 to 8.0. Coconut prefers 200cm rainfall per year. The ideal

temperature for coconut growth and yield is 27 ± 5° C and humidity greater than 60 per cent. In the month of June-July and December-January will be coconut planting. The Coconut planting can also be taken up in other seasons wherever irrigation and drainage facilities are available.

Coconut varieties are classified into two that is tall and dwarf. Maximum grown Tall varieties are West Coast Tall and East Coast Tall. The dwarf variety is shorter in nature and its life span is shorter than tall. Important hybrids are Tall x Dwarf (TxD), Dwarf x Tall (DxT). 10 different combinations of hybrids are developed by Kerala Agricultural University and Tamil Nadu Agricultural University. Coconut planting systems are Triangular - 7.6m, Square-7.6x7.6m, 8x8m, 9x9m, Single-6.5m in rows-9m between rows, Double hedge-6.5 to 6.5m in rows- 9m between pairs of rows. Coconut is grown in more than 80 countries in the world. In India, coconut is cultivated mainly in the coastal tracts of Kerala, Tamil Nadu, Karnataka, Andhra Pradesh, Orissa, West Bengal, Pondicherry and Maharashtra and in the islands of Lakshadweep, Andaman and Nicobar. Total Coconut Production area in India is 2,082,000 hectares and Production of 23,904 nuts. Total Coconut Production in Tamil Nadu is 4, 35, 673 hectares and production of 47,064 lakh nuts. Kerala is the main coconut growing state with an area of 7, 81,916 hectares and production of 53,840 lakh nuts.

Kozhikode Taluk in Kerala has been selected as the study area. The area comprises of land cover features like built-up, vegetation, water bodies, and river. Latitude, longitude of Kozhikode taluk is 11.2829° N, 75.7903° E. In this area major cultivated crop is coconut. Kozhikode taluk contains scattered settlements this is the one of the big challenges to classify the coconut cultivated area. Mixed crop or Intercrop like arecanut, banana and the young plantations also may be misclassified as coconut. Kozhikode districts have a humid climate with a very hot season extending from March to May. The rainy season is during the South west Monsoon, which sets in the first week of June and extends up to December. The North East monsoon of Kozhikode district extends from the second half of October through November. Kozhikode is north side extent up to Kannur, south side extent up to Malappuram, East side extent up to Wayanad and West side extent up to Arabian sea.

The soils of Kozhikode district are alluvial soil, lateritic and forest loam. The pH range of lateritic soil is 5.5-6.5 and the forest loam soil is 5.5-6.3 Object based classification involves identification of image objects, or segments that are spatially contiguous pixels of similar texture, color, tone (Green and Congalton, 2012). This classification method allows for consideration of shape, size and context as well as spectral content. Object-based information extraction depends on spectrum character and geometry and structure information. Object based classification interprets an image that is represented not only by a single pixels, but also in meaningful image objects and their mutual relationships. Then it creates objects with same attributes. It provides a whole bundle of innovative features and techniques for automated image analysis. So we classify the image not through pixels but rather through extracted objects.

In this study we used object based classification for coconut mapping. Based on the discussions above, this study was taken up with the following objectives in mind:

To classify the coconut cultivated areas in Kozhikode taluk using Object oriented classification.

To compare the Rule based classification and different classifiers for better accuracy.

RS and GIS integration in coconut mapping

The delineation of coconut and spatial analysis using geospatial technology can provide additional information for management of decision making, such as the prediction of coconut cultivation area, Coconut Production, soil fertility, the quantification and scheduling of precise and proper fertilizer, irrigation needs, and the application of pesticides for pest and disease management. Geospatial technology is a combination of four essential tools: remote sensing, geographic information systems (GIS), global positioning system (GPS) and information technology and data management. Remote sensing is importance for the general detection of the growth and health of coconut, calculation of nuts. It is also very important to compare the previous year data with present year data to determine if there is any change in crop acreage of coconut cultivation. It also determines the ecological suitability of an area for coconut cultivation and their influence to a large extent to both directions of coconut production and quality of the coconut. GIS is most widely used for coconut mapping.

Materials and Methods

Study area

Kozhikode Taluk in Kerala has been selected as the study area. The area comprises of land cover features like built-up, vegetation, water bodies, and river. Latitude, longitude of Kozhikode taluk is 11.2829° N, 75.7903° E. Kozhikode district is drained by 6 rivers namely chaliyar, Kuttiyadi, kadalundi, Kallayi and Korapuzha. Kozhikode districts have a humid climate with a very hot season extending from March to May. The rainy season is during the South west Monsoon, which sets in the first week of June and extends up to December. The North East monsoon of Kozhikode district is extends from the second half of October through November. The average rainfall is 3266mm. The highest temperature recorded was 39.4 degree Celsius in March 1975.The lowest was 14 degree Celsius on December 26, 1975. Kozhikode district is drained by 6 rivers namely Chaliyar, Kuttiyadi, Kadalundi, Kallayi and Korapuzha. The soils of Kozhikode district are alluvial soil, lateritic and forest loam. The pH range of lateritic soil is 5.5-6.5 and the forest loam soil is 5.5-6.3.Kozhikode is north side extent up to Kannur, south side extent up to Malappuram, East side extent up to Wayanad and West side extent up to Arabian sea (Fig. 1).

Segmentation

The first step in the object based classification is segmentation, which is the process of partitioning the image into a set of discrete, non-overlapping regions on the basis of internal homogeneity criteria(Devereux *et al.*,2004).In the segmentation procedure, the whole image is segmented and meaningful image objects are generated based upon several adjustable criteria of homogeneity or heterogeneity in color and shape.it segmentation is very important procedure in classification to experiment until obtaining the best parameters to influence the classification accuracy.

Further these segments are classified into respective objects type using different methods of classification. To overcome the under segmentation and over segmentation problems, the multi resolution segmentation embedded in eCognition Developer software, was employed in this research.

Multi-resolution segmentation

Three parameters should be defined for each level of segmentation in multiresolution segmentation that are scale, shape, compactness (Table 1 and 2). The selection of optimal parameters is a trial and error process,

which depends on the analyst's experience. Scale Parameter: It is indirectly influences the average object size. If the scale parameter is high the object size will be large. If it is less the object size also small. Color/Shape Parameter: This parameter influence the color versus shape homogeneity on the object generation Smoothness / Compactness: The smoothness parameter is used to optimize the image object with regards to smooth borders. The compactness criterion is used to optimize the image object regards to compactness. The parameters that was used for this classification is as follows

Rule based classification

In this classification method coconut cultivated areas were segmented and similar pixels were grouped into clusters based on the rulesets (Fig. 3). The feature combination used in this study involves spectral, textural and hierarchical context features. Objects classified based on the mean spectral value. i) Maximum difference (Difference between the maximum value and the minimum value, ii) Brightness (average mean value of Blue, Green, Red, NIR bands).

Brightness =B+R+G+NIR/4

Shape parameters also were input variable for the classification. Shape parameters used were Shape index (The border length of the object divided by four times the square roots of its area), Compactness (product of the length and width of the object divided by the number of inner pixels), Asymmetry (lack of equality).

NDVI was the one parameter to classify the image. Normalized difference Vegetation index was computed as customized features in eCognition software. NDVI was used to highlight the presence of vegetation, formula

NDVI=NIR-R / NIR+R

These parameters were selected because of their relation to the shape of the segmented objects. Tests were conducted for combination of parameters of different values to evaluate the classification accuracy. Finally two parameters were finalized to rule based classification (Table 3).

i) NDVI: In this study NDVI Value of the objects between 0.09 and 0.27 were classified as coconut ii) Brightness: In this study brightness value of the objects between 75 and 90 were classified as coconut

SVM (Support Vector Machine)

A Support Vector Machine (SVM) is a supervised Machine learning methods that performs classification based on the statistical learning theory. The standard SVM takes a set of input data and predicts, for each given input, which of two possible classes the input is a member of given a set of training samples, each marked as belonging to one of two categories, an SVM training algorithm builds a model that assigns new examples into one category or the other. An SVM model is a representation of the examples as points in space, mapped so that the examples of the separate categories are divided by a clear gap that is as wide as possible. New examples are then mapped into the same space and predicted to belong to a category based on which side of the gap they fall on. Support Vector Machines are based on the concept on the concept of decision planes defining decision boundaries. A decisions plane separates between a set of objects having different class memberships (Fig. 2).

There are different kernels that can be used in Support Vector Machines models. Included in eCognition is linear and radial basis function (RBF).The RBF is the most popular choice of kernel types used in Support Vector Machines. Training of the SVM classifier involves the

minimization of an error function with C as the capacity constant.

KNN (K-Nearest Neighbor)

The K-nearest neighbor algorithm (K-NN) is a method for classifying objects based on closest training examples in the feature space. K-NN is a type of instance based learning functions is only approximated locally and all computation is deferred until classification.

The K-nearest neighbor algorithm is amongst the simplest of all machine learning algorithms: an object is classified by a majority.

Vote of its neighbor, with the object being assigned to the class most common amongst k nearest neighbors (K is a positive integer, typically small. if k=1, then the object is simply assigned to the class of its nearest neighbor. This means k is the number of samples to be considered in the neighborhood of an unclassified object/pixel. The best choice of k depends on the data. Larger values reduce the effect of noise in the classification, but the class boundaries are less distinct. The eCognition software has the Nearest Neighbor implemented as a classifier that can be applied using the algorithm classifier (KNN with k=1) or using the concept of classification based on the Nearest Neighbor Classification.

Results and Discussion

SVM classifier

A Support Vector Machine (SVM) is a supervised Machine learning methods that performs classification based on the statistical learning theory. The segmented image was further classified into three different classification that are SVM. For SVM classification to operation given as train, configuration classes, the features that given are Brightness and NDVI value and again operation was set as apply (Fig. 4).

KNN classifier

The K-nearest neighbor algorithm (K-NN) is a method for classifying objects based on closest training examples in the feature space. The segmented image was further classified into KNN classification. For KNN classification to operation given as train, configuration classes, the features that given are Brightness and NDVI value and again operation was set as apply. All Classifications were rectified using visual interpretation techniques (Fig. 5).

Table.1 Sensor parameters

Sensor	Resolution
LISS-IV	5.8m
Cartosat-2	2.5m

Table.2 Parameters for segmentation

Area	Image	Scale	Shape	Compactness
Kozhikode	Cartosat_Liss IV Fused	15	0.4	0.5

Table.3 Accuracy assessment

S. NO	Classification Method	Accuracy
1	SVM classification	93%
2	KNN classification	93%
3	Rule based Classification	94%

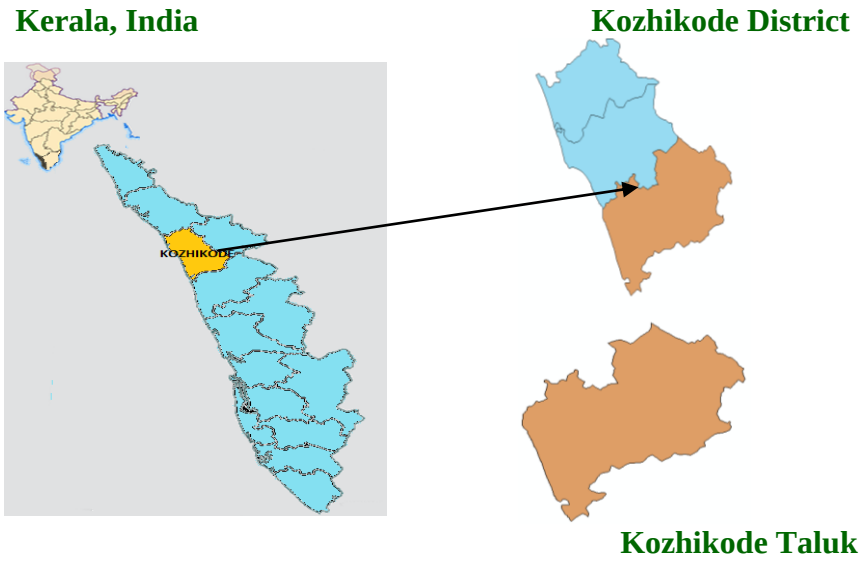


Fig.1 Location map of Kozhikode taluk, Kerala

Fig.2 Flow chart of image classification

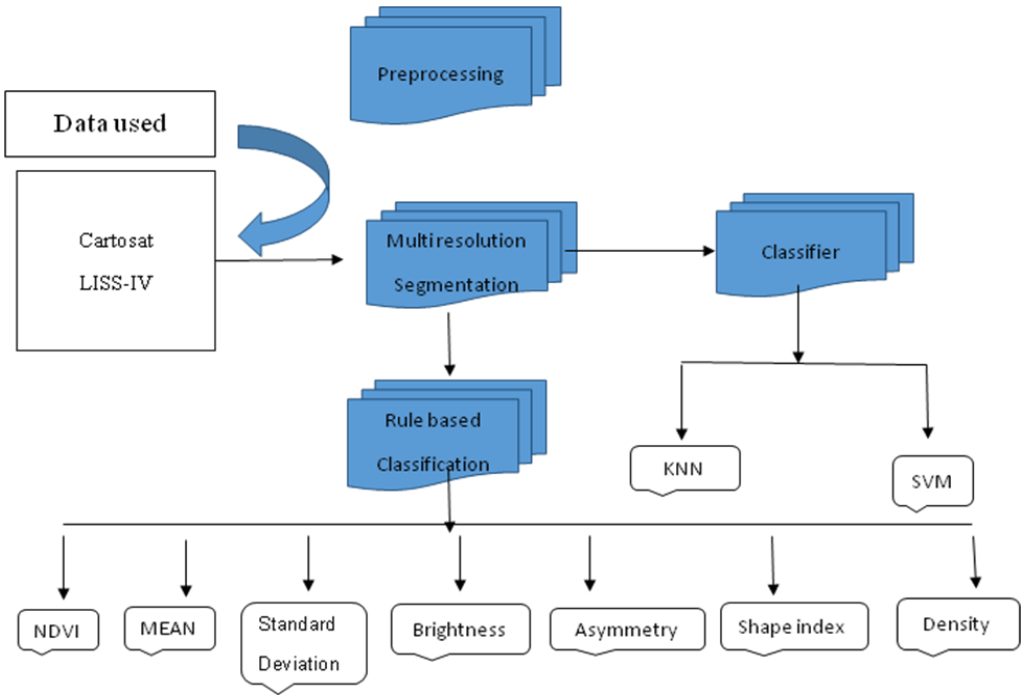


Fig.3 Rule based classification

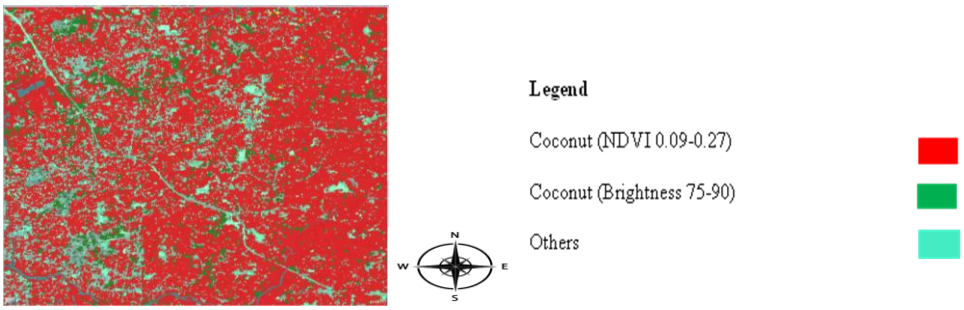


Fig.4 SVM Classification

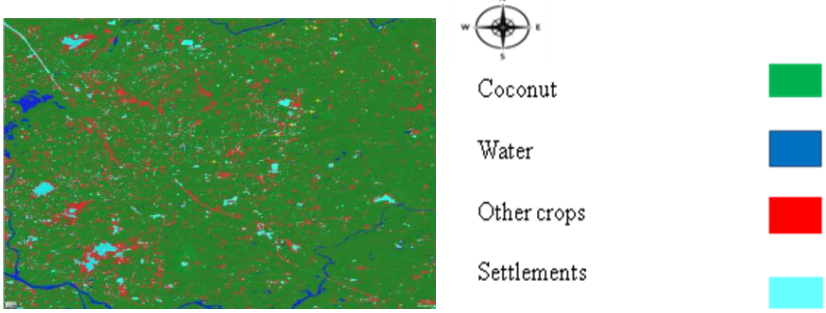
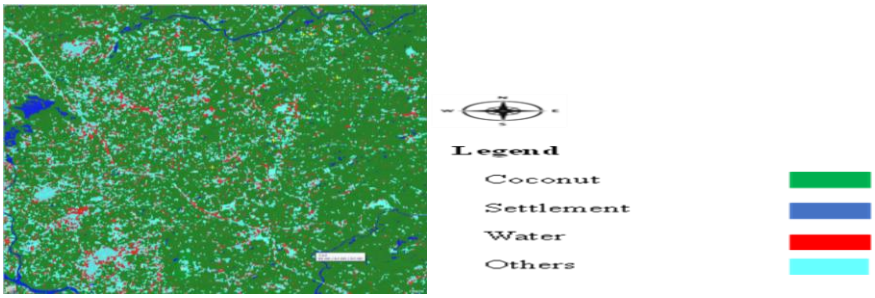


Fig.5 KNN classification



The study was discussed about the object oriented classification for Cartosat_LISS-IV data using eCognition software, the objects were clearly segmented in the scale parameter of 15, size 0.4, compactness 0.5, and the images were properly segmented. The classes are assigned by selected samples through the class hierarchy. After sample selection classes were assigned with different names. The parameters such as NDVI, Brightness value were given as the parameter for (KNN, SVM classification and rule based classification). Rule based classification was identified as the most suitable classification. The classifies obtain different level of accuracy were SVM 93% and The KNN also 93% and the rule based classification up to 94% accuracy with the ground truth values obtained from the Google earth.

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