ABSTRACT

Remote sensing is the science and art of obtaining information about an object through the analysis of data acquired by a device that is not in contact with the object. One of the primary applications of remote sensing is to identify patterns of vegetation distribution on the ground and to assess changes in vegetation over time.

Remote sensing plays an important role in analyzing the conditions of vegetation area cultivated in large acres. Different types of crops are grown in different seasons. Monitoring the growth conditions of crops are mandatory. Information about the health of crop conditions helps in providing solutions continuously.

Indices are used in processing satellite images. Vegetation indices are mathematical combinations of different color bands used for satellite imaging. About 19 different vegetation indices are used to assess the presence of the quantity of vegetation.

This thesis presents the segmentation analysis of vegetation image. The image has innumerable textures taken by using remote sensing. The image contains multispectral bands. The segmentation of the vegetation images helps in quantifying the amount of vegetation growth in a given cultivable land.
This research work implements segmentation algorithms for the satellite images using a) contextual clustering b) empirical mode decomposition (Hilbert) with Huang transform (HHT) and c) fuzzy logic.

The implemented algorithms segmentation performance are compared with patented algorithm (CA2491794A1 - Method for generating natural color satellite images).

During segmentation of vegetation image 3x3, 5x5, 7x7, 9x9 overlapping windows (BS-block size) have been used. Different segmentation methods have been implemented in this thesis. They are as follows:

1. Contextual clustering (CC) statistical method has been used for segmentation of the vegetation image. Three features are extracted from the CC to use as inputs for the Fuzzy logic algorithm. The three features are i) summation of 9 pixels, ii) mean of 9 pixels and iii) contextual value from the CC algorithm. The controlling parameters in CC are simulated with different values. The optimal values for $\beta$ is 0.1, the segmentation threshold is 140 for most of the texture images.

2. Fuzzy logic is a concept that assumes inexactness in practical situations. In reality, data obtained is not perfect to the expectation during experimentation. The data can fit to its defined category or possibly to an adjacent category. This looseness of association of data to more than one
category leads to the development of fuzzy logic (FL). This concept is very much used in control related applications in Engineering. FL can be combined with ANN / Genetic Algorithm or other types of mathematical algorithms to achieve an Input-Output data mapping concept. Many researchers have used fuzzy related concepts in segmenting images. In this research work, three features obtained from CC are input to fuzzy logic. Hence, this new combination is called fuzzy logic with CC (FLCC). FLCC performance is controlled by the radius of centers. Different radii (0.1, 0.6) have been simulated and the optimal radius is 0.1 for producing best segmentation of vegetation image.

3. Huang developed an empirical method of extracting various signal components present in a single signal. He combined the concept developed by Hilbert to extract instantaneous frequency and instantaneous amplitudes. The combined method of Huang and Hilbert is called Hilbert Huang transform. The features obtained from HHT are as follows.

1. Mean of Instantaneous Amplitude and Instantaneous frequency.

2. Maximum of Instantaneous Amplitude and Instantaneous frequency.
3. Minimum of Instantaneous Amplitude and Instantaneous frequency.
4. Norm of Instantaneous Amplitude and Instantaneous frequency.
5. Standard deviation of Instantaneous Amplitude and Instantaneous frequency.
6. Coarse to fine and
7. Fine to coarse energy value.

Two types of features are used for vegetation segmentation.

a) Features based on the statistics (Mean, Summation) in contextual clustering algorithm. These features are used as inputs to Fuzzy logic training algorithm.

b) Features based on the (Mean, Std, Norm, Maxima and Minima) extracted from Hilbert-Hang Transform (HHT). Features based on HHT

Justification of methods implemented in this thesis with respect to segmentation of vegetation image is based on the following:

1. Statistical features are good representation of information of an image. Hence, statistical parameters have been extracted from the image and used as features for segmentation of the vegetation pixels.
2. HHT uses signal processing concepts empirically to obtain various frequencies and amplitudes present in the vegetation image. Using these information, the segmentation of the vegetation image has been achieved.

The thesis mainly contributes the following methods for improved vegetation segmentation:

1. Applying HHT for extracting features from the vegetation image for segmenting it.

2. Applying contextual clustering method to extract statistical features which are representative of the vegetation and using these statistical features to train the Fuzzy logic algorithm.

The segmentation performances of the implemented algorithms are analyzed by segmenting the vegetation images with standard segmentation algorithms. The number of pixels segmented by the patented algorithm and number of pixels segmented by the implemented algorithms are used for obtaining true positive (TP), true negative (TN), false positive (FP) and false negative (FN) values. Based on the 4 values obtained, receiver operating characteristics (ROC) curve has been plotted and sensitivity, specificity and accuracy are obtained for all the 4 algorithms.
The term TP refers to the boundary pixel correctly segmented, TN refers to pixels inside the objects not segmented, FN refers to boundary pixel not segmented, FP refers to pixels segmented adjacent to the boundary.

As part of future direction of research work, grey scale co-occurrence matrix (GLCM) features can be extracted from the moving window and combined with contextual clustering method / Fuzzy logic algorithms / HHT to find out improvement in vegetation segmentation accuracy.