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Segmentation Of Satellite Images Using Fuzzy Logic And Hilbert Huang Transform

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Abstract—
This paper presents the segmentation of Satellite images using the Fuzzy Logic and Hilbert Huang Transform. Fuzzy logic is used to extract the features from the satellite images. Hilbert-Huang Transform is used to segment the vegetation area based on the features which is extracted from fuzzy logic. The results of segmentation is good

Keywords—Satellite image, Vegetation, Fuzzy Logic Hilbert-Huang Transform.

1. Introduction

Satellite images are used to understand the land information. It helps the private and government people to know the status of vegetation in different places. Satellite images with high resolution are used to vegetation area identification. This paper is used to identify the vegetation area which is existing in satellite images. It helps to monitor the vegetation area products and supports the government to balance the planted crops are damaged by failures like floods. In this paper fuzzy logic and Hilbert-Huang transform is used to identify the vegetation area in satellite images.

2. SCHEMATIC DIAGRAM

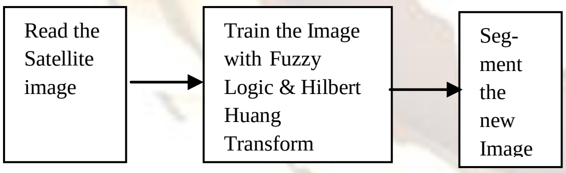

Fig. 1 Flow of Implementation

3. Segmentation Algorithm

3.1. Fuzzy Logic

Fuzzy Logic (FL) is a multi valued logic that allows intermediate values to be defined between conventional evaluations like true/false, yes/no, high/low. Fuzzy systems are an alternative to traditional notions of set membership and logic.

The training and testing fuzzy logic is to map the input pattern with target output data. For this, the inbuilt function has to prepare membership table and finally a set of number is stored. During testing, the membership function is used to test the pattern.

Training Fuzzy logic
Step 1: Read the pattern (NIR image) and its labeled values.
Step 2: Create Fuzzy membership function.
Step 3: Create clustering using K-Means algorithm.
Step 4: Process with target values.
Step 5: Obtain final weights.

Testing Fuzzy logic for NIR image segmentation
Step 1: Input a pattern (NIR image feature).
Step 2: Process with Fuzzy membership function.
Step 5: Find the cluster to which the pattern belongs.
Step 4: Obtain estimated target values.
Step 5: Classify the texture

3.2. .Emperical Mode Decomposition

3.2.1. Processing intensity values row wise

A signal can be analyzed in details for its frequency, amplitude and phase contents by using EMD followed by Hilbert Transform (HT). The EMD produces the mono components called intrinsic mode functions (IMFs) from the original signal. In a given frame of signal, there can be many IMFs. Each IMF will contain a wave form of different amplitude. Hilbert Transform is applied on an IMF to obtain, instantaneous frequency (IF) and instantaneous amplitude (IA). It is mandatory that a signal be symmetric regarding the local zero mean, and should contain same number of extreme and zero crossings.

The steps involved in EMD of a signal X(t) with harmonics into a set of IMFs are as follows.

- **Step 1:** Identify all local maxima of X(t). Connect the points using a cubic spline. The interpolated curve is obtained. The upper line is called the upper envelope (Maximum_envelope).
- **Step 2**: Identify all local minima of X(t) connect the point using a cubic spline.. The lower line is called the lower envelope (Minimum_envelope) obtained by cubic spline.
- **Step 3**: Compute the average by:

$$M = \frac{(a+b)}{2} \qquad (1)$$

Where a = Maximum_envelope and b = Minimum_envelope.

- **Step 4**: Obtain a new signal using the following equation:

$$h_{11}(t) = X(t) - M_{11}(t) \quad (2)$$

Where $h_{11}(t)$ is called first IMF. Subsequent IMF's had to be found if there are some overshoots and undershoots in the IMF. Hence, the envelope mean differs from the true local mean and $h_{11}(t)$ becomes asymmetric.

In order to find the additional IMF's, $h_{11}(t)$ is taken as the new signal. After n^{th} iteration, we have:

$$h_{1n}(t) = h_{1(n-1)}(t) - M_{1n}(t) \quad (3)$$

Where $M_{1n}(t)$ is the mean envelope after the n^{th} iteration and $h_{1(n-1)}(t)$ is the difference between the signal and the mean envelope at the $(k-1)^{th}$ iteration.

- **Step 5:** Calculate coarse to fine (C2F) as follows:

$$C2F_1 = IMF_n \quad (4)$$

Where IMF_n = final IMF obtained

$$C2F_2 = IMF_n + IMF_{(n-1)} \quad (5)$$

Similarly,

$$C2F_n = IMF_n + IMF_{(n-1)} + \ldots\ldots + IMF_1 \quad (6)$$

Where $C2F_n$ is the original signal.

- **Step 6:** Calculate fine to coarse (F2C) as follows:

$$F2C_1 = IMF_1 \quad (7)$$

$$F2C_2 = IMF_1 + IMF_2 \quad (8)$$

$$F2C_n = IMF_1 + IMF_2 + \ldots\ldots + IMF_n \quad (9)$$

Where $F2C_n$ is the original signal.

- **Step 7:** Hilbert transform is applied for each IMF and analytical signal is obtained. A complex signal is obtained from each IMF:

$$Analytic(IMF) = real(IMF) + imag(IMF) \quad (10)$$

- **Step 8:** Instantaneous frequencies are obtained from analytical signal using

$$IF = \frac{0.5 \times (angle(-X(t+1) \times conj(X(t-1))) + \pi)}{2 \times \pi} \quad (11)$$

- **Step 9:** Instantaneous amplitudes are obtained from the analytical signal using the following

$$IA = \sqrt{real(IMF)^2 + imag(IMF)^2} \quad (12)$$

3.2.2.Feature extraction from HHT

Twelve features are extracted from each IF and IA. The features are mean, standard deviation, norm, maximum and minimum of IF. Similarly mean, standard deviation, norm, maximum and minimum of IA and energy of F2C and C2F waveforms of an IMF.

$$V1 = 1/d \sum(IF) \quad (13)$$

Where d = Samples in a frame and V1 = Mean value of Instantaneous Frequency.

$$V2 = 1/d \sum(IF - V1) \quad (14)$$

Where V2=Standard Deviation of Instantaneous Frequency.

$$V3 = maximum\ (IF) \quad (15)$$

$$V4 = minimum(IF) \quad (16)$$

$$V5 = norm(IF)^2 \quad (17)$$

Where V5 = Energy value of frequency.

$$V6 = 1/d \sum (IA) \quad (18)$$

$$V7 = 1/d \sum(IA - V6) \quad (19)$$

Where V7 = Standard Deviation of Instantaneous amplitude

$$V8 = maximum\ (IA) \quad (20)$$

$$V9 = minimum\ (IA) \quad (21)$$

$$V10 = norm(IA)^2 \quad (22)$$

Where V10 = Energy value of Amplitude.

$$V11 = \sum \log_2 (abs(F2C))^2 \quad (23)$$

Where V11 = Log 2 value of F2C

$$V12 = \sum \log_2 (abs(C2F))^2 \quad (24)$$

Where V12 = Log 2 value of C2F.

4. Sample Input And Output

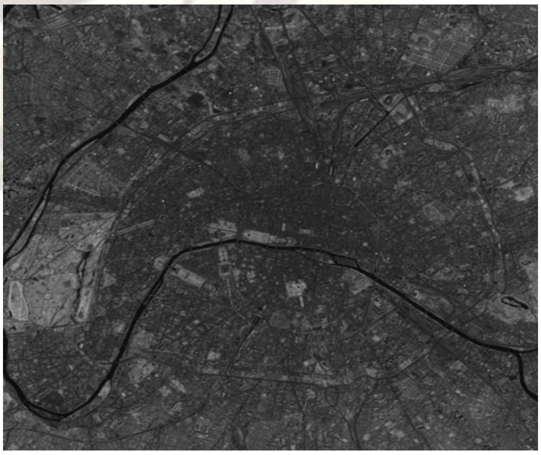

Fig. 2 Satellite image

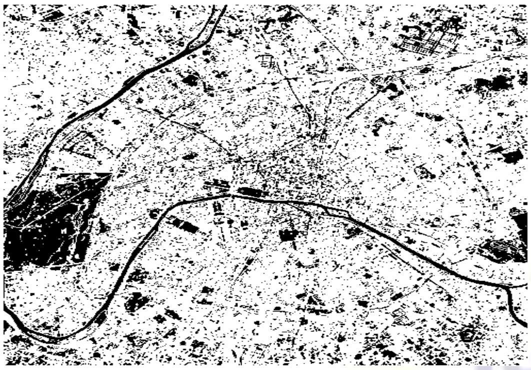

Fig. 3 Fuzzy Segmented NIR image

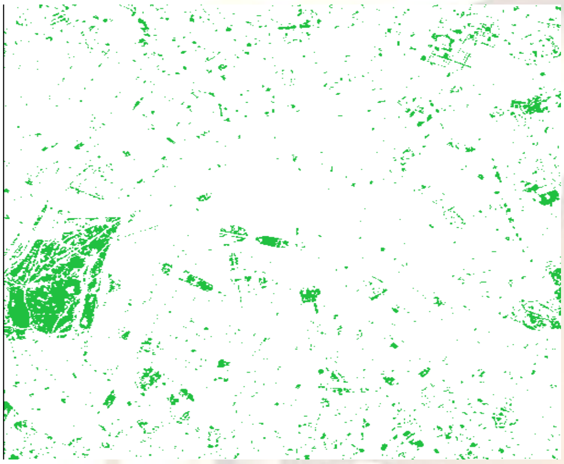

Fig. 4 Color segmented output of vegetation

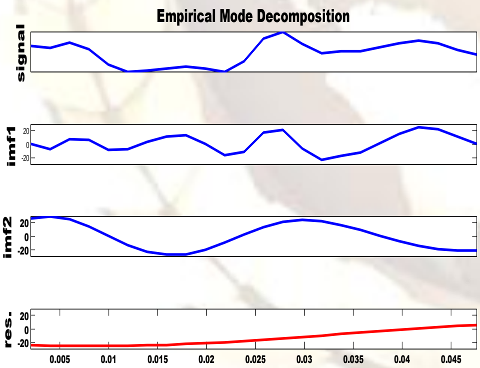

Fig. 5 Empirical mode decomposition

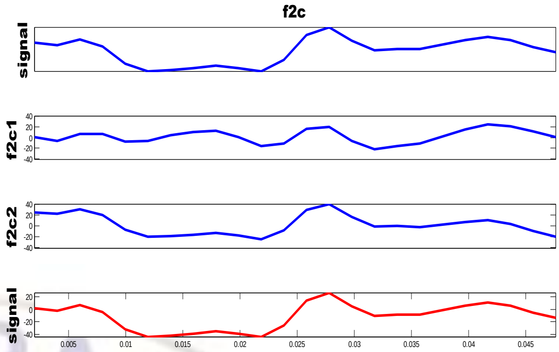

Fig. 6 Fine to coarse signals

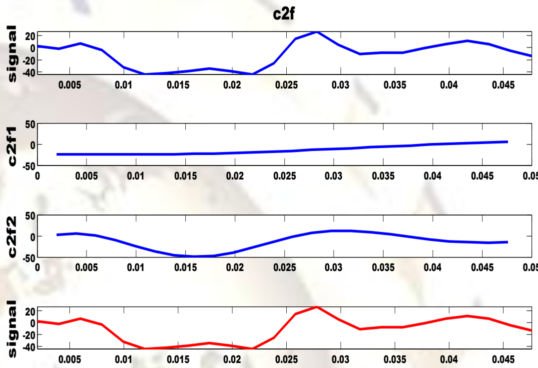

Fig.7 Coarse to fine signals

5. Conclusions

This paper uses Fuzzy Logic & Hilbert Huang transform method to segment the satellite images. The fuzzy logic extracts the features which presents in a given satellite image. Hilbert-Huang transform is used to segment the satellite image. This method involves less time to segment the satellite image. However, it is very much suitable to process multispectral image

References

Journal Papers:

[1] Alba Castro,JoseL.; Rey,SusanaM.; Docio,Laura, Adaptive image segmentation neural network: application to Landsat images, *Proc. SPIE* Vol. 3812, p. 233-240.

[2] Awad M., Chehdi K., and Nasri A., “MultiComponent Image Segmentation Using Genetic Algorithm and Artificial Neural Network,” *Computer Journal of Geosciences and Remote Sensing Letters*, vol. 4, no. 4, pp. 571-575, 2007.

[3] Benediktsson J., Swain P., Ersoy O., and Hong D., “Neural Network Approaches Versus Statistical Methods in Classification of Multisource Remote Sensing Data,” *Computer Journal of Institute of Electrical and*

Electronics Engineers, vol. 28, no. 4, pp. 540-551, 1990.

[4] Chen Z.; Zhao Z.; Gong P.; Zeng B.,A new process for the segmentation of high resolution remote sensing imagery, *International Journal of Remote Sensing*, Vol. 27, No. 22, 20 November 2006, 4991–5001

[5] Hardin, Perry J., Neural networks vs. nonparametric neighbor- based classifiers for semi supervised classification of Landsat imagery, *Proc. SPIE* Vol. 3812, p. 252-263.

[6] Kurnaz M., Dokur Z., and Olmez T., “Segmentation of Remote Sensing Images by Incremental Neural Network,” *Computer Journal of Pattern Recognition Letters*, vol. 26, no. 8, pp.1096-1104, 2005.

[7] Mohamad Awad, An Unsupervised Artificial Neural Network Method for Satellite Image Segmentation, *The International Arab Journal of Information Technology*, Vol. 7, No. 2, April 2010

[8] Sowmya B and Sheelarani B, Land cover classification using reformed fuzzy C-means ,Sadhana, Vol. 36, Part 2, April 2011, pp. 153–165._c *Indian Academy of Sciences.*

[9] Thompson, Bruce T, Application of fuzzy logic to feature extraction from images of agricultural material, *Proc. SPIE* Vol. 3812, p. 241-250.

[10] Wanga S., Wanga A., Segmentation Of High-Resolution Satellite Imagery Based On Feature Combination , *The International Archives of the Photogrammetry, Remote Sensing and Spatial Information Sciences.* Vol. XXXVII. Part B4. Beijing 2008

[11] Xiangyun Hu, C. Vincent Tao, and Björn Prenzel , Automatic Segmentation of High-resolution Satellite Imagery by *Integrating Texture, Intensity, and Color Features ,Photogrammetric Engineering & Remote Sensing*, Vol. 71, No. 12, December 2005, pp. 1399–1406.

[12] Hilbert huang transform and its applications world scientific publishing company private limited

Books:

[1] W.B. Vasantha Kandasamy, Florentin Smarandache, K. Ilanthenral, *Elementary fuzzy matrix theory and fuzzy models for social scientists*

[2] Robert Fullér, *Neural Fuzzy Systems*

[3] A. Ramachandra Rao, En-Ching Hsu, *Hilbert-Huang transform analysis of hydrological and environmental time series*