<<Taikichiro Mori Memorial Research Fund>>

Graduate Student Researcher Development Grant
Application Form for the Academic Year 2017

Research Project: An Integrated Causality Computational System by Semantic Functions of Heterogeneous Spectral Images for Interpreting Degree of Deforestation Effect.

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Result of this project Research in Published Journals and conferences:

[1] Rachmawan, I.E.W. Tadono, T., Hayashi, M. and Kiyoki, Y., "Temporal Difference and Density-Based Learning Method Applied for Deforestation Detection Using Alos-2 Palsar-2," IEEE Geoscience and Remote Sensing Society 2018. [Under review]

[2] Rachmawan, I.E.W. Tadono, T. and Kiyoki, Y., " Development of Hybrid Automatic-Clustering and Neural Network for Automatic Deforestation Detection of ALOS-2 PALSAR-2 Data," Proceeding on 63rd Remote Sensing Society of Japan. **[student award]**

[3] Rachmawan, I.E.W. and Kiyoki, Y., "Semantic Spatial Weighted Regression for Realizing Spatial Correlation of Deforestation Effect on Soil Degradation," In Proc. of the 2017 International Electronics Symposium (IES), Surabaya, Indonesia, 26th-27th September 2017, [Online]. Available: IEEE Xplore, http://www.ieee.org

[4] Rachmawan, I.E.W., Kiyoki, Y., "A Semantic Multispectral Images Analysis Retrieval Method for Interpreting Deforestation Effects in Soil Degradation," Information Modelling and Knowledge Bases, Vol. XXIX, IOS Press, May 2018 (In press)

Future Challenges:

- Semantic retrieval based on location and effect in global view for the analysis of deforestation in soil degradation
- The wide-area differential computing for deforestation effect on soil degradation

Taikichiro Mori Memorial Research Grant Report 2017

An Integrated Causality Computational System by Semantic Functions of Heterogeneous Spectral Images for Interpreting Degree of Deforestation Effect.

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Abstract. Deforestation is still a major nature phenomenon in our society. In this research, I realize a new semantic function for heterogeneous spectral images to create Integrated Deforestation Computational System. The Features of this system is to detect deforestation automatically and integrating causality computation to represent the deforestation effect and condition of its substances in human knowledge domain. The objective of this research is to create a new way to create and bring deep deforestation knowledge to common user even to people who are not familiar with environmental science. The key technology of this research is an integrated system with semantic functions for heterogeneous spectral images to produce high-precise Object-based detection method for representing the nature object of forest substances in human language. The system aims to presenting new knowledge to the users in human interpretation of nature and representing the area of deforestation in temporal space. The system implements multiple semantic functions and applied to object-based detection for calculate the degree of deforestation by observing the nature object of forest substances features on heterogeneous spectral images. It is done by analyzing the wavelength reflected by natural object in different bands. The system combine two types of spectral; Landsat and SAR data. Each dataset contains of numerical value extracted from Landsat and SAR data. The experimental study done in three different tropical places with high percentage of deforestation activity.

Keywords. Semantic, Computing, Retrieval, Multispectral image, SAR, Deforestation

1. Introduction

Deforestation activity has been around for decades, efforts for detecting and analyzing deforestation activity has been proposed in order to serve the information related to forest change. Research on detecting deforestation activity using optical satellite imageries has been very popular for identify and map the forest change. However, there are some limitations of the usage of this technology, the greatest challenge being the inability to penetrate clouds. When observing deforestation area in tropical country the use of Synthetic Aperture Radar (SAR) imagery should also be considered. Moreover, the extensive analysis of temporal changing is necessary to not only map the deforestation area but provide more information in regards to the condition and deforestation phases.

In this research, we realize an Integrated Deforestation Causality Computational System by realizing a new Semantic Functions, which measure and interpret the deforestation degree automatically by identifying the of forest substances features of heterogeneous spectral images from Landsat Satellite and combined with SAR. The different stages of deforestation are necessary to be observed to determine decision making of forest treatment. Thus, temporal changes happen in recognized deforested area are should be studied. Therefore, this study aims to construct hybrid algorithm to construct automatic deforestation detection for PALSAR-2 data in order to identify deforestation area precisely. To achieve the desired analytical result, this study performs fully automatic methods to detect deforestation using ALOS-2 data.

2. Objective

In this research, we realize an Integrated Deforestation Causality Computational System by realizing a new Semantic Functions, which measure and interpret the deforestation degree automatically by identifying the of forest substances features of heterogeneous spectral images from Landsat Satellite and combined with PALSAR-2. We extend our previous research in and improve the ability of system to arise the linkage between causality of deforestation with its impact and give automatic human labelling by using semantic computing. We develop a new semantic calculation based on semantic space and a high-precise Object-based detection method for representing the nature object and forest substances to determine the degree of deforestation. The system enables users to ascertain the condition of deforestation by human interpretation of nature and representing the area of deforestation in spatiotemporal space. The data collected on three different tropical forests in past 10 years, from 2005 to 2015 for identifying and measuring the deforestation area in recent days. The dataset; which consist of multispectral images and PALSAR-2, later processed by using function and multispectral analysis techniques based on object detection in the finite area. The research about remote sensing analysis based on object detection are increasing in today's research. This is still a new topic to identify nature change by the object contains in some specifics area and represent in human language using semantic computing. The future experiment of our proposed system should prove our hypothesis, that semantic function for object based and causality computation analysis methods could bring the high precision to detect the degree of deforestation area.

3. System Design

To achieve automatic detection of deforestation area, we proposed new system consists of four processes: the proposed system essentially composed of three main blocks after intended for temporal difference as the following: (1) Find structure of temporal density; (2) calculate the speed of change; and (3) find expansion patterns.

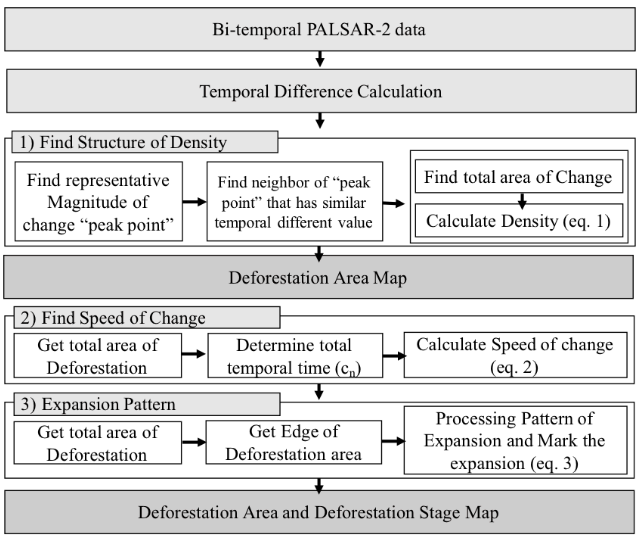

Fig 1. Top-level block diagram view of the proposed a temporal difference & density-based learning method

4. Experimental Study

The progress of this research is we apply the semantic computing to interpret effect of soil condition in deforestation activity in language interpretation by using semantic analysis by using soil moisture and texture, soil temperature, and soil salinity. After converting multispectral images from DN to Reflectance, and process the language interpretation and semantic analysis, the semantic matrices for deforestation is produced.

To realize our deforestation detection using our proposed idea, Peru was selected as a study area. Peru is located in the continent of south America and half of its territory is covered by dense forest.

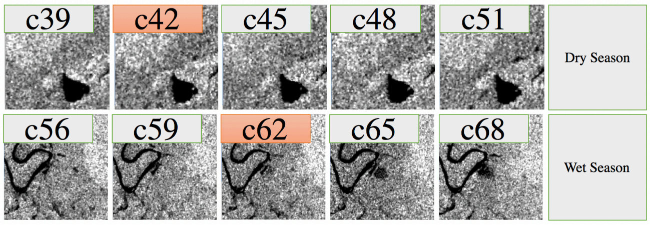

Fig 2. Five cycles of PALSAR-2 data. This method detects the Orange blocks indicating the captured deforestation activity.

The dataset used in this study is ALOS-2 PALSAR-2 data which consists of one year observation. Dataset were acquired from January 7th 2016 to January 24th 2017 with 46-day interval of each data. Implementation of our proposed procedure is done from scratch using python. Each image was filtered using Improved Lee Filter using 7x7 window size.

Step 1. Deforestation detection.
Following application results are given to demonstrate our model performance for detecting deforestation. First initial step is to determine peak point to represent the significant change between c_1 and c_2. By using the rule 1 in Section 3.A, the result of peak point (white dots) as shown in Fig. 4 (c).

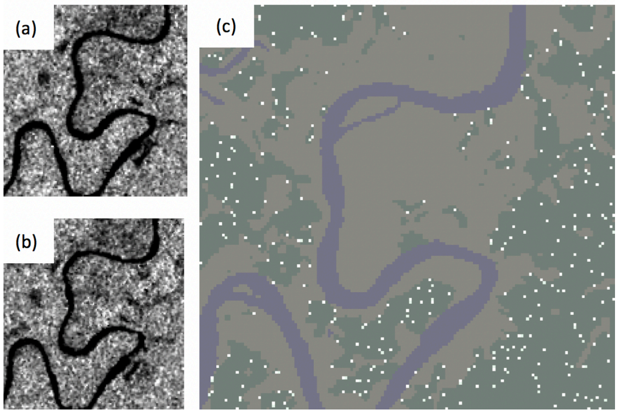

Fig 2. Application of Temporal Density-Based on Peru whereas (a) cycle 59 (c_1); before deforestation (b) cycle 63 (c_2); after deforestation (c) temporal difference with peak point between c_1 and c_2,

After the stopping rule in Section 3.A chained member will be considered as one deforestation area as shown in Fig. 5 (a) red polygons indicates the remaining highest density which considered as deforestation area, and white points are peak points that were indicated as noise. Fig 5(b) shows the speed of change, where highest speed is referred to forest fire. Purple polygons have the speed of change in about 2.9 km/day. Figure (c) indicates the road has been expanded through forest region as indicated in orange circle.

Step 2. Determining stage of deforestation based on combination of three essential parameters.

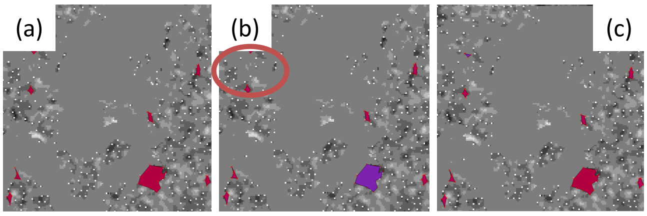

Fig 3. Shapefile result derived from our proposed idea (a) structure of density (b) speed of change; purple indicate fast speed change (c) expansion pattern indicate new road is establish

Table 1. Pixel grouping

Total Area		150 x 150 pixels =22500			
Density Label		Speed of change		Expansion Pattern	
Deforestation	Noise	High	Low	Line	Unstructured
61	145	34	27	7	54

Number of pixel identified by within deforestation density indicated in table 1. From total pixel in observed area, it could be indicated that deforestation activity between c_1 and c_2 shows in 61 pixels. It its correspondent to 244 km^2 in real natural scale. With 145 peak points is indicated as noise, hereinafter noise points will not be included in deforestation shapefile. To evaluate and compare the performance of our proposed idea, we use GLAD data as ground reference of step 1 and we compare our proposed algorithm performance with common PALSAR-2 bi-temporal classification using k-means.

Table 2. Performance comparison between our temporal difference & density-based and well-known kmeans

Algorithmn	Cohen Kappa
Temporal difference & density based learning method	0.86
Kmeans	0.71

PUBLICATIONS

Regarding this research on A Semantic Multispectral Images Analysis Retrieval Method for Interpreting Deforestation Effects in Soil Degradation system during April 2016-February 2017, we already published several papers. Here are results of our research:

[1] Rachmawan, I.E.W. Tadono, T., Hayashi, M. and Kiyoki, Y., "Temporal Difference and Density-Based Learning Method Applied for Deforestation Detection Using Alos-2 Palsar-2," IEEE Geoscience and Remote Sensing Society 2018. [Under review]

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