LAND CHANGE DETECTION STUDIES WITH INFORMATION OBTAINED FROM SATELLITE IMAGES

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Abstract

Satellite images and remote sensing techniques and algorithms makes it possible for us to obtain information about natural and artificial resources on Earth.

Mapping the source distributions and observing the change with the images obtained can be done efficiently and makes it possible to evaluate landcover changes. In this context, a study is presented in which the preliminary studies, editing, classifications and transformations that need to be done, and the operations performed by verifying the images numerically and visually are explained.

In the scope of this study you can find literature of obtaining and processing satellite images.

Keywords: remote sensing, satellite images, change detection, deep learning

INTRODUCTION

Nowadays, thanks to satellite images, every distant object has become close and every invisible and mysterious information has become visible. Today, every certain distance area from the Earth can be reached via satellites. Satellites have a wide coverage area and can access objects and provide data at periodic intervals without make any physical contact with any object. Digital data obtained from satellites are transformed into processable satellite images and have been preferred to other alternative sources in recent years and are widely used. The process of obtaining and processing satellite images is Remote sensing (RS). The process collects and records the electromagnetic energy reflected, emitted or scattered from the earth and/or objects on it, through a sensor. It is then transferred to the ground station at regular intervals. The data is prepared for processing. Today, there are many satellite data providers with different features.

The main topic reviewed in this study are;

- Pre-processing technics to classify satellite images.
- Change detection technics to analyze

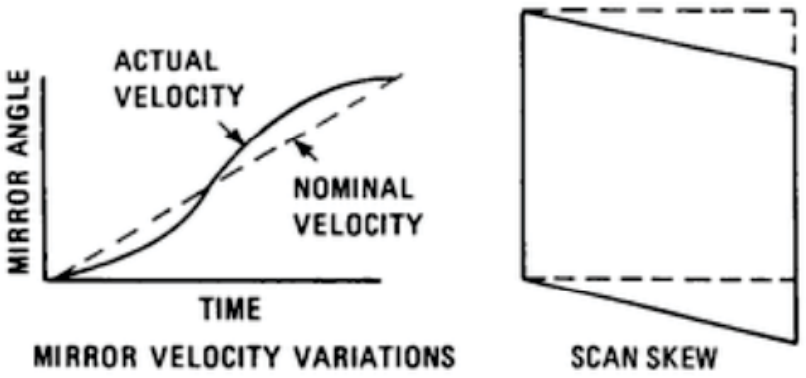
land use and land cover.

- Algorithms for land cover change, based on Machine Learning

IMAGE PRE-PROCESSING TECHNICS

Environmental factors and weather conditions in the time and region where the satellite image data are obtained affect the image quality depending on the type of sensor. For this reason, the pre-processing stage is strongly recommended for applications when using satellite images. Image "errors", image distortions or may arise due to the location of the sensor, and the effects of weather conditions may be permanent and make the image difficult to understand or completely unusable. At this stage, image defects are eliminated (to a certain extent) and a better image data are ready for interpretation is obtained. In addition, satellite images are digital data that is subjected to processing, so the process itself is called "digital image preprocessing". In the digital image preprocessing stage, image correction, image enhancement and even image conversion are also performed.

Image preprocessing include geometric and radiometric corrections. A corrupted image indicates lost data and image noise. Data loss due to environmental factors and sensors can mostly be missing line (loss occurring during the scanning of the sensor's surface), de-striping (detection differences between the sensor bands) and lost bit errors (apparent high or low brightness value). The process of correcting errors caused by the sensor is known as radiometric correction. There are certain methods used during correction. Mostly, correction is achieved by averaging the surrounding value (row/column) information [1,2].



Scan Skew, Mirror-Scan Velocity Variance, Panoramic distortion, Perspective and Platform speed are geometric corrections [1]. It aims to eliminate systematic and non-systematic distortions, such as atmospheric refraction and earth curvature. In the end, it involves accurate re-modeling of sensor and platform movements and the relationship between the platform and the world, such as earth-sun distance, sun elevation, viewing geometry and etc. By the way, all corrections increase data quality and make images more useable.

CHANGE DETECTION METHODS IN REMOTE SENSING

Changes on the Earth's surface have always been a one of main subjects of fundamental research. Especially, after

disasters, surface changes have become noticeable and important. Since disasters are changes that cannot be fully predicted in advance, the damages they cause are revealed by comparing them. For example, when comparing the previous situation of the region covered by forest fires, earthquakes, landslides and natural water level changes and after the disaster, differences can be easily detected. Changes on the Earth's surface are examined in two basic groups; land use and land cover. Land use is expressed as the use of a certain land. Land cover is expressed by the characteristics of that land and the cover on it; such as buildings, plants, flora.

Both issues form two integral parts of surface change. In addition, change detection involves various classification analysis methods and the examination of time-dependent clusters. Today, surface change detection can be easily done using traditional methods and remote sensing technologies.

The term "Remote Sensing", first used in the United States in the 1950s by Ms. Evelyn Pruitt of the U.S. Office of naval research. The word "Remote" are indicated like a "away from or at a distance", "Sensing" is "detecting a property or characteristic". Remote sensing is defined: "Remote sensing is the science (and to some extent, art) of acquiring information about the Earth's surface without actually being in contact with it". The definition of Dr. Nicholas Short; "Remote sensing is a technology for sampling electromagnetic radiation to acquire and read non-immediate geospatial data from which to pull info more or less features and objects on the earths land surface, seas, and air."[3].

In summary, remote sensing is defined as the science and/or art of obtaining information about the object or area being examined through the analysis of data obtained by a device that is not in contact with the area. Remote sensing is divided into active and passive remote sensing. Passive remote sensing use radiation from the sun during observation. In active remote sensing, the device interacting with the object emits its own electromagnetic radiation. The energy radiated back from the surface is recorded by sensors and the relevant data is used to examine the earth's surface with different detection technics.

Change detection requires two or more state information. It should clearly indicate the change that occurred in the region of interest between two or more image dates, so that the purpose of change detection can be achieved. The success of this process is also important due to the quality of the images, image reliability and matching ability. Environmental factors mostly affect optical images. The change detection techniques used can be divided in seven categories, listed as follows;

First category is Algebra, include topics Image differencing, Image regression, Image ratioing, Vegetation index differencing, Change vector analysis(CVA), Background subtraction. Second category is Transformation; Principal component analysis (PCA), Tasselled cap, Gramm–Schmidt Method, Chi-square. The thirth categori is Classifications, include Post-classification comparison, Spectral–temporal combined analysis, Expectation–maximization detection, Unsupervised change detection, Hybrid change detection, Artificial neural networks; and Advanced models categories, include Li–Strahler reflectance model, Spectral mixture model, Biophysical parameter method. GIS application categories are Integrated GIS and remote sensing method and GIS approach. The six category is Visual analysis - Visual interpretation and category Other change detection techniques as foloow;

- Measures of spatial dependence (Henebry 1993)

- Knowledge-based vision system (Wang 1993)

- Area production method (Hussinet al. 1994)

- Combination of three indicators: vegetation indices, land surface temperature, and spatial structure (Lambin and Strahler 1994b)

- Change curves (Lawrence and Ripple 1999)

- Generalized linear models (Morisetteet al. 1999)

- Curve-theorem-based approach (Yueet al. 2002)

- Structure-based approach (Zhanget al. 2002)

- Spatial statistics-based method (Read and Lam 2002). [4]

However, before starting any change detection study, it is important to know the change detection procedure and comply with it. It is necessary to comply that in the process of detecting changes on the Earth's surface, the six main steps identified by Jensen should be followed:

1. The nature of change detection problems. 2. Selection of remotely sensed data.

3. Image preprocessing.

4. Image processing or classification.

5. Selection of change detection algorithm.

6. Evaluation of change detection results.[5]

DEEP LEARNING ALGORITHMS AND PYTHON

The base knowledge are, that the algorithm is a set of instructions for performing a computation for solving one or more problems with similar way. Using solving instraction we write the pseudo code and algorithm that will be solve similar problems using remote sensing images.

It is change detection based on deep learning, which has been added to the methods listed in the previous section in recent years and is very popular. Deep learning is a specialized subbranch of machine learning. It uses neural networks consisting of many layers to use data. With the development of deep learning methods at the forefront of computerized or machine learning techniques, its use in remote sensing has increased at a parallel pace and its application has become widespread. Deep learning models are successful in transferring the complexity and hierarchical structure between data, thus gaining importance in gaining clarity in solutions.

Change detection is the presence of visible changes in the other image of the first image taken among the images and focuses on the subject of detection. Every pixel in the previously captured image can be changed in the later captured image without making any changes to the objects depicted in it. While this poses a challenge for more stable and change-proof algebraic algorithms, deep learning and the work of resilience of prediction support overcome these challenges. Due to their scalability and hierarchical structure, deep learning models have the potential to represent and learn data that is too complex to be described with simpler models. Since high-level features are used in decision making, each pixel can be evaluated within the context of the pixels surrounding it and therefore very powerful decision models can be formed. Classical approaches rely on spectral indices that combine various bands to highlight desired features. Choosing the right index or combination of bands is a

task that requires expert knowledge, and as a result only part of the available information (information contained in the selected bands) is used. Thanks to its learning ability, deep learning techniques allow all available bands in images to be used simultaneously without the need for pre-selection. During the training process, the importance and contribution of each band is easily learned and adopted by the model.

Deep learning change detection models are generally divided into two categories: supervised models and unsupervised models, that is have semi-supervised also. While fully supervised methods almost always require large amounts of labeled data to train the network, semi-supervised and unsupervised methods reduce or eliminate the need for precisely labeled data.

These models are developing day by day, and the software that can use them and enable their development is also improving itself to the same extent. Here, Python is one of the most powerful supporting software with its large number of libraries [6].

Python is a high-level programming language that is easy to learn and has a clear and concise syntax. Python is an open source interpreted language that can be used for a wide range of applications such as web development, data analysis, machine and deep learning, artificial intelligence, and more. Python supports basic programming paradigms such as object-oriented programming. It contains a sufficiently comprehensive standard library and frameworks with many modules and functions for various purposes.

Python is also used to efficiently develop complex applications ready for remote sensing. Some of the libraries used in the field are NumPy, Pandas, Matplotlib, Django, Flask, PyTorch, etc.

CONCLUSION

In conclusion, with today's disaster agenda, land change detection studies stay at the center of remote sensing researches. Machine and deep learning techniques are regularly used to increase the accuracy and speed of results of research. Within the scope of this study, a brief summary of the subject has been made. An overview of deep learning methods is presented along with the techniques and methods applied in the field of change detection of remote sensing images. The use of open source data, which is very suitable for change detection, and the widely available satellite imagery portfolio also contribute to the selection and development of current deep learning models.

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