Algorithm and System Development for Automation-based Geospatial Feature Extraction using High Resolution Satellite Imagery

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ABSTRACT: Object-based classification methods are generally used for geospatial feature extraction of submeters-grade high resolution satellite images such as Quickbird, WorldView-3, KOMPSAT-3 and 3A. The object-based classification method is a technology for extracting geospatial feature through the process of image segmentation and classification. Geospatial feature extraction techniques are often used to produce subject maps, such as land cover and land use, so users who only require specific spatial objects should invest a long time. It is also inefficient because it requires users to extract not only desired geospatial feature but also unneeded geospatial feature together. Therefore, this study developed a geospatial feature extraction algorithm that introduced a parallel process that extracts only specific geospatial feature. The algorithms developed were oriented toward automation and software development was carried out based on open source. Software development used open source software SAGA GIS engine, GDAL and CXSparse libraries. In this study, PostgreSQL was used to implement the function of merging the same class not supported by SAGA GIS. In addition, parallel processing techniques were applied by applying Intel's AVX2 to speed up image processing. Although image division using SAGA GIS took more than 3 hours, AVX2 was applied to reduce time from about 20 minutes to 1 hour. Using the developed geospatial feature extraction software and commercial software, the geospatial feature was extracted with the same parameters and thresholds, and the accuracy analysis was performed, showing that the two software had similar results. Through continuous research, we are going to upgrade our software and to upgrade our algorithms so that we can automatically extract geospatial feature.

1. INTRODUCTION

The Ministry of Land, Infrastructure, and Transport of the Republic of Korea has been developing two satellites, KAS500-1 and KAS500-2, that are capable of acquiring images with a ground sample distance (GSD) of 0.5 m. The KAS500 satellites are intended to be used solely for land observation purposes. By gaining competence in technologies for land surface monitoring, such as land use classification and spatial feature extraction, change detection and time-series monitoring, and digital surface model/digital terrain model (DSM/DTM) extraction, the Ministry has been developing software that enables the utilization of the information provided by satellites.
Land use classification and spatial feature extraction technologies are excellent tools for evaluating the environment and its changes (Pekel et al., 2016). Land use and land cover (LU/LC) changes over the period are essential to understand the development of human activities within a region to define the impact of anthropogenic and natural activities (David et al., 2017). Object-based classification typically uses spatial information, of the pixel's group, which is recognized along with the object. It has been demonstrated that this method is effective primarily for high-resolution satellite images, such as ASTER (Whiteside and Ahmad, 2005), KOMPSAT-2 (Lee et al., 2010) and WorldView-3 imagery (Li et al., 2015). Object-based analysis has been gaining importance in the fields of remote sensing, especially for high-spatial-resolution image processing (Do et al., 2019).
In the study, geospatial feature extraction SW is being developed to utilize high-resolution satellite images of the KAS500. Development of SW is using open source. The satellite images used for

the experiment in this study are KOMPSAT-3A satellite images. Because the KAS500 satellite is under development, it can not capture image.

2. MATERIALS AND METHOD

2.1 KOMPSAT-3A Satellite Specification

Since the KAS500 satellite is under development, no satellite images are available. Therefore, this study was conducted using KOMPSAT-3A satellite image, which is expected to have similar specifications with KAS500 satellite image. Table 1 shows specification of KOMPSAT-3A satellite images used in this study.

Table 1 Specification of satellite images used in this study

Satellite		**Ground sample distance**			
KOMPSAT-3A		Approx. 0.55 m			
KOMPSAT-3A satellite specification					
Spectral bands		Optics		Data quantization	Swath width
PAN Blue Green Red NIR	450-900 μm 450-520 μm 520-600 μm 630-690 μm 760-900 μm	Focal length F number	8.6 m f/11.5	14 bit	12 km (at nadir)

2.2 Establishing a Parallel Process for Extraction of Geospatial Feature

The serial process is sequentially extracted from the largest feature to the smallest feature. It takes a long time to extract all feature, and this method also has the disadvantage that the user needs to extract feature that are not necessary to extract the small feature. On the other hand, the parallel process is utilizes specific features as geospatial information. Parallel processes, unlike serial processes, extract only specific feature. The parallel process is faster than the serial process because it selects the features to extract and removes the features that are not needed, and it is expected that this process can be automated (Lee et al., 2015). Figure 1 shows a comparison between serial and parallel processes.

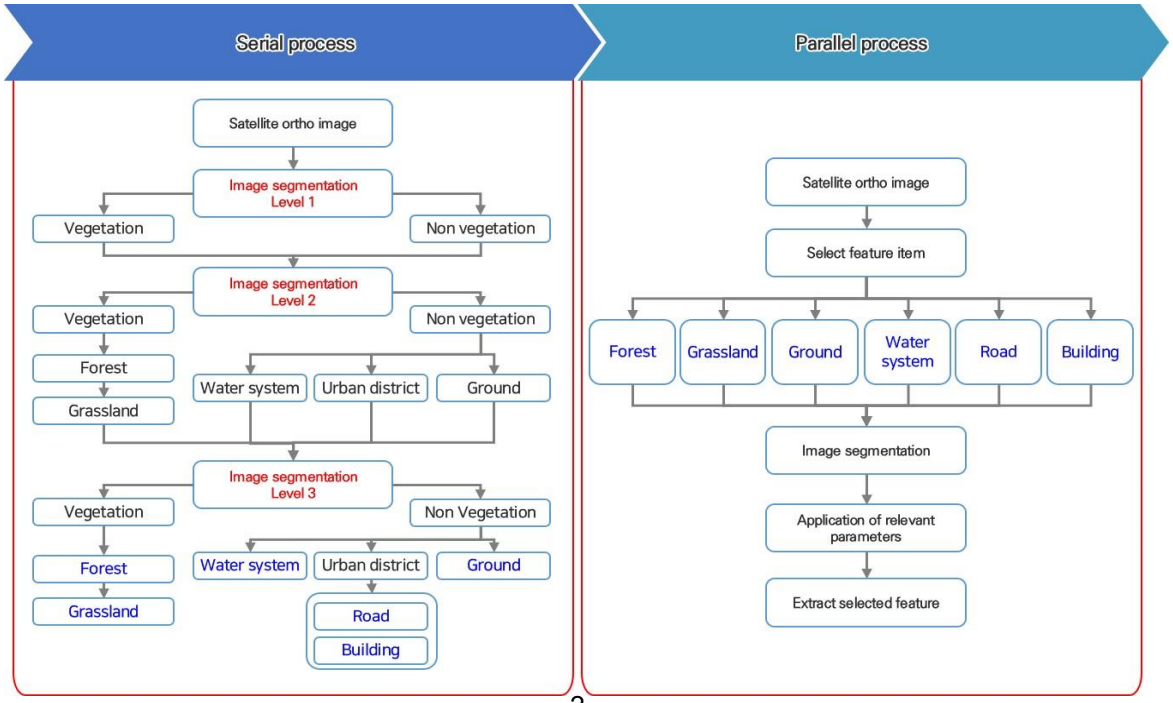

Figure 1. Comparison of serial and parallel process

2.3 Development of Object-based Geospatial Feature Extraction SW on Open Source
A version 6.4.0 of the Automated Geoscientific Analysis (SAGA) GIS was selected as the primary platform for use in the development of open source software-based object-based geospatial feature extraction software. SAGA GIS is open-source software that supports object-based classification techniques and is less difficult to develop. They also determined that functions already implemented in the platform could be used in this study. Developing software required libraries such as GDAL, OpenCV, CXSparse and SAGA GIS engines. The software is designed in two stages: data generation and visualization, and data postprocessing.

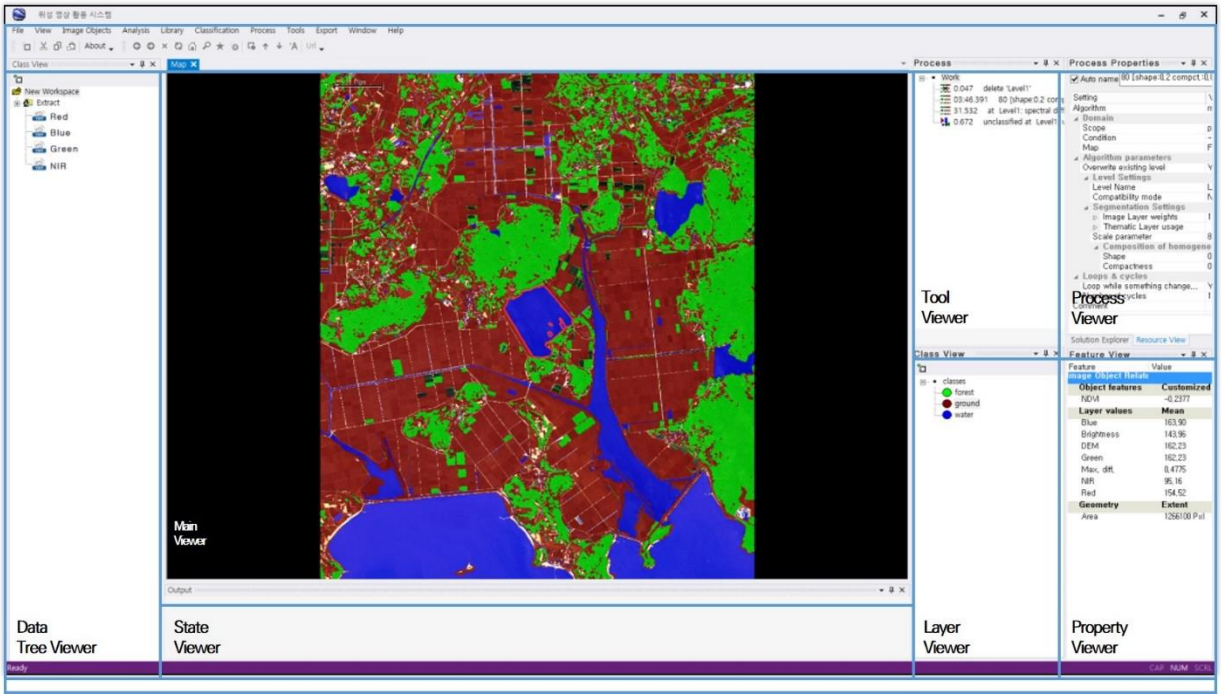

Figure 2. UI of developed SW in this study

SAGA GIS is very slow in image processing. Therefore, parallel processing technology using Intel's Advanced Vector Extension 2 (AVX2) was used to accelerate data processing during geospatial feature extraction. Intel's AVX2 serializes two-dimensional image data into one-dimensional data.

3. RESULT AND DISCUSSION

This study developed geospatial feature extraction SW based on SAGA GIS. SAGA GIS has disadvantage of being very slow in image processing. And there's not all the functions we want. Therefore, SW was developed in this study using GDAL, OpenCV, CXSparse and SAGA GIS engines. And improved speed of image processing by using Intel's CVX2. Although image division using SAGA GIS took more than 3 hours, AVX2 was applied to reduce time from about 20 minutes to 1 hour.
In this study, geospatial feature were extracted and compared and analyzed using developed SW and commercial SW. Using the two software, geospatial features were extracted with the same parameters and thresholds, and accuracy analysis was performed to show that the two software achieved similar results. Through continuous research, we are going to upgrade our software and to upgrade our algorithms so that we can automatically extract geospatial feature.

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