Development of a Cloud Detection Method For PlanetScope Imagery

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1. Introduction

Recently, the importance of preprocessing techniques to improve the usability of satellite imagery has been highlighted due to the rising demand for satellite imagery across various fields. However, the nature of optical images, which are often affected by weather conditions, poses challenges for clear image analysis due to the presence of clouds. Obtaining cloud-free images is essential for more accurate satellite image analysis. This makes it necessary to develop technology that can remove the effects of weather from the imagery. In this study, we developed a cloud detection method suitable for PlanetScope satellite imagery and analyzed its detection performance. Additionally, since the cloud detection method developed in this study utilized spectral resolution, it is expected to be applicable to both satellite and drone hyperspectral imagery.

2. MATERIALS AND METHODS

PlanetScope satellite imagery consists of four bands: Blue, Green, Red, and NIR (Near-Infrared). Due to the limitations of this band composition for precise cloud detection, we developed a cloud detection method based on the Object-Oriented Cloud and Cloud Shadow Matching (OCM) algorithm, which detects clouds using only visible and near-infrared bands. The OCM technique applies the Modified Automatic Cloud Cover Assessment (ACCA) algorithm to detect high-confidence cloud maps (CMH), low-confidence cloud maps (CML), and cloud shadows based on thresholds, and refines the detected clouds through cloud-shadow object matching to extract the final cloud areas.

The original OCM algorithm was developed for Landsat-7 imagery, which causes performance degradation when applied to PlanetScope imagery due to differences in key thresholds. To optimize the thresholds for PlanetScope imagery, we analyzed Regions of

Interest (ROIs) for thick clouds, thin clouds, cloud shadows, and water bodies, as well as the spectral reflectance characteristics of each layer's band. Additionally, to eliminate artificial structures with similar reflectance to clouds, we analyzed the spectral reflectance characteristics of artificial structures. By graphing the spectral reflectance characteristics of all the analyzed ROIs, we determined the usable threshold ranges for each band in the OCM algorithm. Simultaneously, we compared the standard deviations between clouds and surface objects to confirm the results. Through this process, we derived the optimal thresholds for cloud detection and used them to detect clouds in the images.

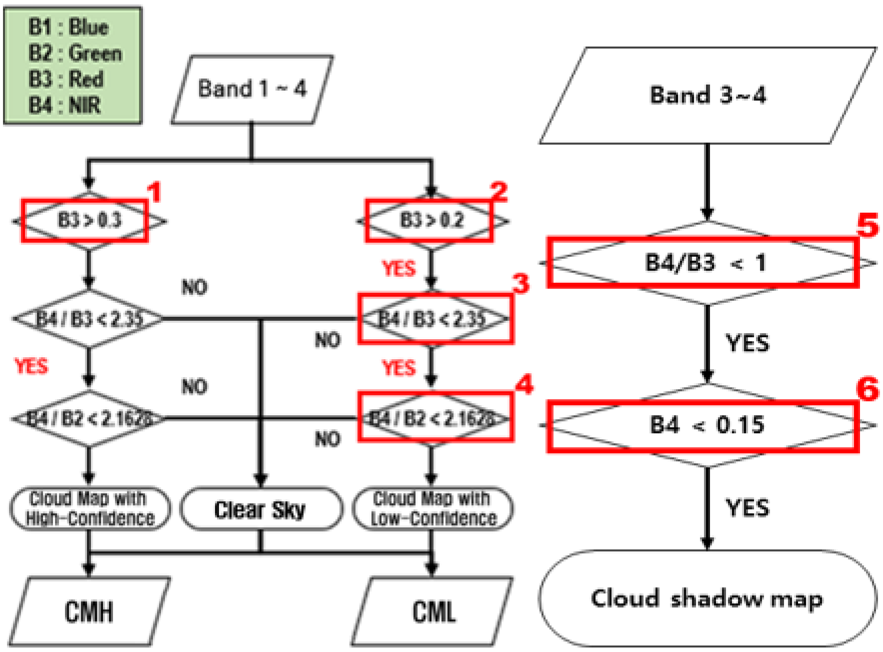

Figure 1: Flowchart of OCM algorithm and thresholds

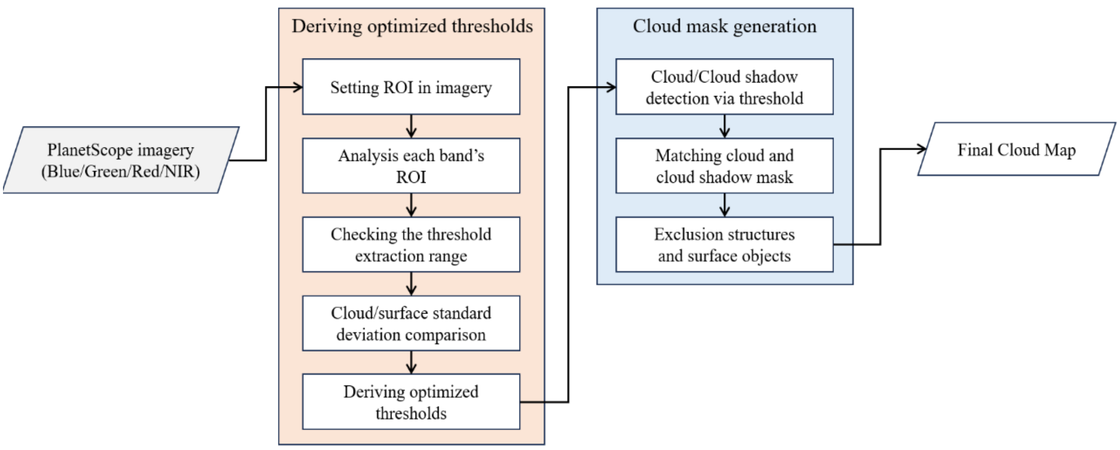

Figure 2: Flowchart of the proposed method

3. Results and Discussion

To evaluate the performance of the improved OCM algorithm, we used PlanetScope imagery of the Sanpo area in Naju, Jeollanam-do, South Korea. When applying the original OCM algorithm, over-detection issues arose with artificial structures (e.g., white buildings, greenhouses) and surface areas near clouds. Results showed unclear distinctions between cloud and non-cloud areas. In some cases, clouds were not detected at all. However, after adjusting the thresholds, over-detection of artificial structures and surface areas significantly decreased in all the tested images, and the cloud shapes closely matched the actual images. These results demonstrate improved cloud detection performance.

Table 1: Result of optimal thresholds

Threshold	Original threshold	Proposed method threshold
#1. B3	> 0.3	> 0.45
#2. B3	> 0.2	> 0.15
#3. B4/B3	< 2.35	< 2.35
#4. B4/B2	< 2.1628	< 2.16
#5. B4/B3	< 1	< 1.2
#6. B4	< 0.15	< 0.07

Figure 3: (a) PlanetScope imagery (b) Before applying threshold (c) After applying threshold

4. Conclusion and Recommendation

In the future, we expect that the developed algorithm will enhance the usability of PlanetScope imagery. Additionally, the usability of satellite imagery in various fields, such as disaster analysis, is expected to increase. Furthermore, we plan to obtain hyperspectral surface reflectance satellite images and apply this technology to them.

Acknowledgments

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