terrain shadow detection from seasonal sentinel-2 images using hillshade algorithm

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**ABSTRACT:** Terrain relief causes terrain shadow in satellite images over mountainous areas. Terrain shadow attenuates the Sun’s irradiance on the corresponding region. Therefore, it should be identified. To identify terrain shadow, we used a hillshade algorithm. A hillshade value shows the intensity of illumination on a terrain through the geometric relationship between the Sun and the terrain. This value changes depending on the position of the Sun. In this paper, we analyzed the accuracy of terrain shadow detection based on hillshade algorithm using two Sentinel-2 images of the same region but acquired at different seasons. We used two L1C Sentinel-2 images. One was acquired in August 2019 with the Sun’s elevation of 60.2° and the Sun’s azimuth angle of 148.1°. The other satellite image was acquired in November 2022 with the Sun’s elevation of 35.4° and the Sun’s azimuth angle of 167.1°. Firstly, we applied hill-shade algorithm to each dataset and manually selected best threshold for terrain shadow. Secondly, we run our terrain shadow detection model to calculate estimated optimal thresholds. We used a Digital Elevation Model (DEM) generated by the National Geographic Information Institute of Korea with a spatial resolution of 10 m. From the DEM, we calculated a height gradient along each of the X-axis and Y-axis. Using a height gradient, slope and aspect angles of the terrain surface were estimated. The hillshade value was computed using the terrain surface’s slope and aspect angles, and the Sun’s elevation and azimuth angles. This value was converted into an incidence angle and optimal incidence angles were determined. The accuracy analysis was performed by comparing our results with the Ground Truth data. As a result of the first step, manually extracted threshold for an incidence angle was 34° for the August image and 59° for the November image. From the second step, the value for incidence angle threshold was 38.5° with the f1-score of 0.87 for the August image. For the November image, the value for incidence angle threshold was 63.3° with the f1-score of 0.81. The manual and estimated thresholds for terrain shadow detection varied on the elevation of the Sun and the two values were very close. This indicates that for automated terrain shadow detection, our terrain shadow detection method can be applied.

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