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Abstract

A topographical correction application was applied on calculating NVDI from mountain area remote sensing data. This algrithm is based on the illumination correction on topographically distorted satellite images. In order to evaluate the performance of this method, a test site study was done on Landsat TM data. The result demonstrates the effectiveness of this method.

1. Introduction

Satellite imagery provide a unique perspective to observe the earth's surface. One of the most successful application lies in its ability to monitor vegetation on a large scale. Because NDVI is sensitive to changes in vegetation cover, we can use it to monitor vegetation[1] and assess the production at quantitative levels. NDVI plays an important role in vegetation studies in large plains, but in rugged mountainous areas, things are different. Because of complex topographic conditions, the solar illumination varies remarkably, thus, the topography causes image distortions [2]. We can not extract correct vegetation information from distorted images. In this study, we present a method to calculate the NDVI in mountainous areas. This method is based on the theory that the amount of irradiance reaching a surface is directly proportional to the cosine of the incidence angle[3][4]. The study results show the effectiveness of our approach.

2. Method

The satellite image brightness values depend on how much radiant flux is reflected or emitted from an object on the surface of the earth. The flux of incident sunlight over a given area reaches a maximum when that area is oriented perpendicular to the sun's rays. The more sun light is incident upon a surface, the more light will be scattered back into the satellite detector, which will result as higher image brightness values. The correction algorithm is as:[4]

$$BV_{original} = m_j cos(i) + b_j \tag{1}$$

$$c_j = \frac{b_j}{m_j} \tag{2}$$

$$BV_{corrected} = BV_{original}(\frac{cos(sz) + c_j}{cos(i) + c_j}) \tag{3}$$

where:

$BV_{corrected}$: brightness value of the corrected data
$BV_{original}$: brightness value of the raw data
sz : solar zenith angle
i : the solar incidence angle
$c_j = c_1$ if pixel is in sun-facing part
$= c_2$ if pixel is not in sun-facing part
Then we use corrected images to calculate NDVI

$$NDVI = \frac{NIR - RED}{NIR + RED} \tag{4}$$

where :

NIR: Near IR band
RED: Red band

3. Study results

The satellite remote sensing image we used was a Landsat TM image taken on June 18, 1998. The test site was near Mt. Hakusan in the center of Japan. In order to specify our study more clearly, we also chose a small subtest site with typical topographic conditions and covered with almost the same surface material, and with similar vegetation growth conditions. The NDVI in this area should be uniform, but with the topography, the NDVI calculated from raw data shows large differences on two sides of the mountain. It shows the topographic effect on NDVI. After we did the topographic correction, the NDVI in this area became flat, almost no topographic effect can be seen. This difference between the two NDVI is shown on Fig.1, 2. The NDVI in different facing part using different date are shown in Table. 1. The NDVI of flat area is 0.696. Because the topography, NDVI in shadow areas(0.684) is small than in sun-facing areas(0.721), and far from the NDVI in flat area(0.696). The NDVI calculated from the corrected data become 0.693 and 0.698, much near to the NDVI in flat area. It is show the improved algorithm's effectiveness.

Table 1: Comparison the NDVI calculating from different image

image	shadow parts	sun-facing parts
Raw image	0.684	0.721
Corrected image	0.693	0.698

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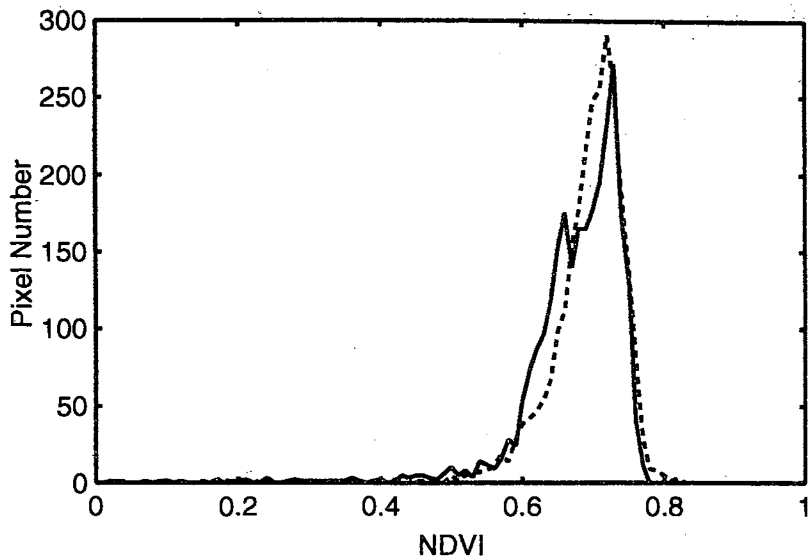

Figure 1: NDVI histograms. Solid line is NDVI calculated from raw data, dash line is NDVI calculated from corrected data

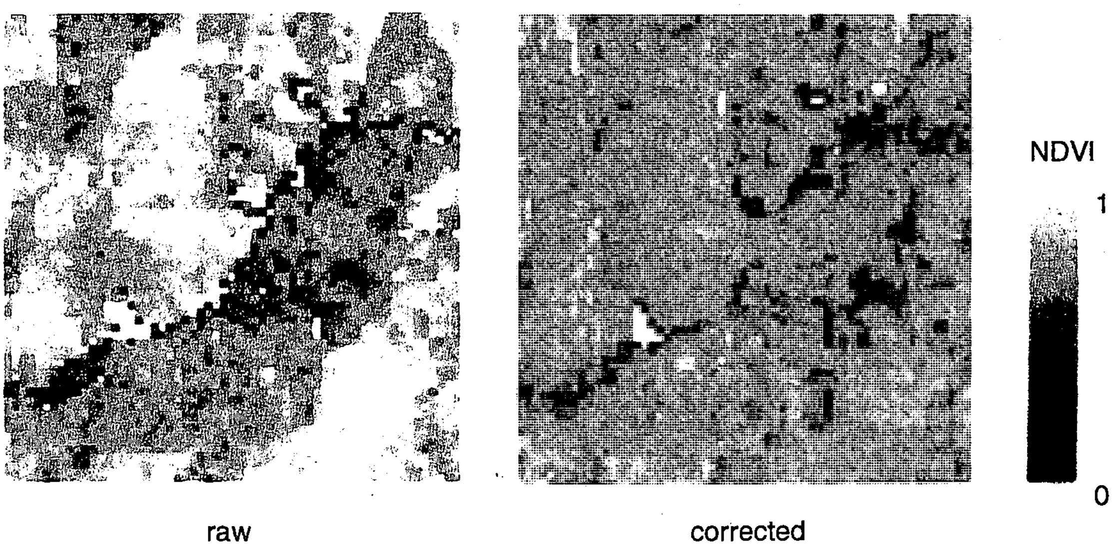

Figure 2: NDVI calculated from raw and topographic corrected Landsat data in subtest site