EXTRACTION OF ROAD SURFACE INFORMATION USING REMOTE SENSING

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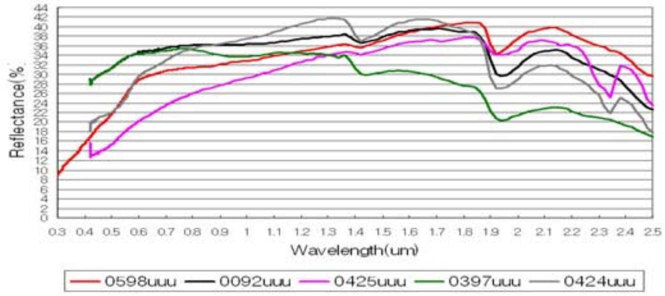
ABSTRACT

Analysis of land-cover using remote sensing is utilized in many fields. In this study, spectral information is extracted using ASTER and IKONOS Images during the same period. And characteristics of the roads surface were grasped through analysis of Spectral Information Library of Korea Institute of Geoscience and Mineral Resources (KIGAM) and NASA Jet Propulsion Laboratory (NASA JPL). As a result, deterioration of road is grasped and it will be expected to utilize as the basic data for road management connected with statistic data such as traffic information and so on.

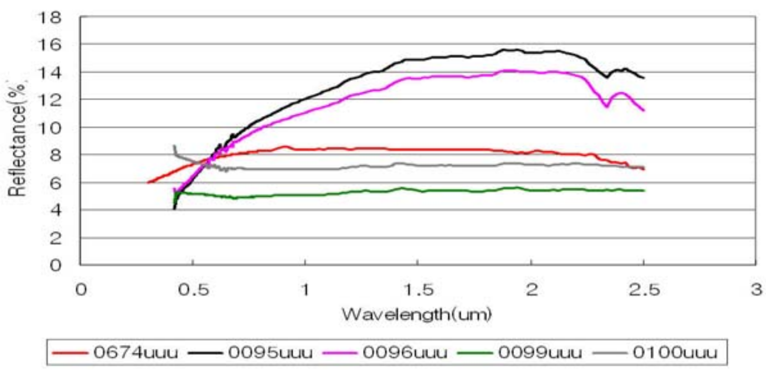
INTRODUCTION

The spectral characteristic of pixel value in satellite image has been utilized in many fields such as vegetation, forest fire, and detection of mineral resource. Also recently, interest of spectral information about urban area which was closely related to human life has been increased. Spectral library of artificial infrastructures involved in the road is prehistory compared with geology and agriculture, but interest of spectral library related to urban environment has been increased. The current status is focused on the construction of spectral library about typical land-cover, road, environment and landscape etc. for urban area. Figure 1~3 show the spectral characteristics of asphalt and concrete. Those are produced by NASA JPL and KIGAM (Korea Institute of Geoscience & Mineral Resources).



Feature	ID	Land-cover type
Concrete for ridged pavement	0092uuu	Gray and white weathered runway concrete. Sample had a flat surface, with a matte texture, and very little aggregate showing.
	0397uuu	Variegated bridge construction concrete, with quartz aggregate showing. Sample was gray, smooth, and clean.
	0424uuu	Variegated construction concrete, with quartz and limestone aggregate showing. Sample was gray, and slightly soiled. Concrete was from runway side strips.
	0425uuu	Variegated asphaltic concrete with mostly limestone and some quartz aggregate showing. Sample was rough and black in color. Concrete was from runway side strips.
Concrete for construction	0598uuu	Approximately30-year-old runway construction concrete with(mostly granite) aggregate showing. Sample was light gray and weathered.

Figure 1. Spectral library produced by NASA JPL (concrete).



Feature	ID	Land-cover type
Asphalt for ridged pavement	0095uuu	Gray and black construction asphalt. The sample was soiled and weathered, with some limestone and quartz aggregate showing.
	0096uuu	Gray and black construction asphalt. Sample was soiled and weathered, with some limestone and quartz aggregate showing.
	0674uuu	Weathered runway construction asphalt. Sample was black with little aggregate showing.
Tar	0099uuu	Black matte construction tar. Sample was weathered.
	0100uuu	Black, glossy construction tar.

Figure 2. Spectral library produced by NASA JPL (asphalt).

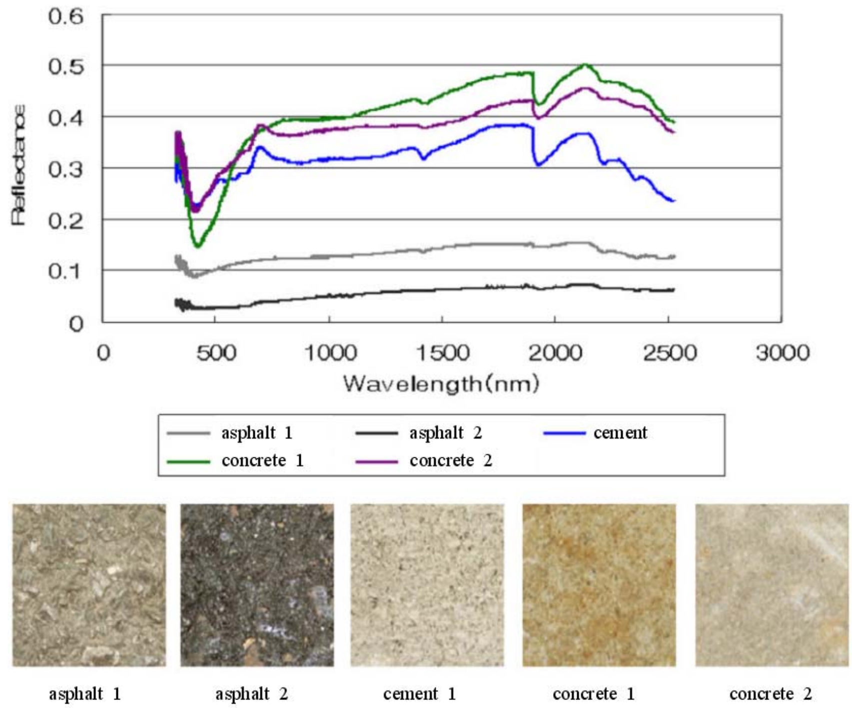


Figure 3. Spectral library produced by KIGAM.

The urbanization has an effect on change of land-use and land-cover. Especially, updating road network information in urban environments is very important to manage the road. However, it is difficult to obtain the database information of Road Surface about wide fields. The spectral characteristic of satellite image data can be in effective application in order to extract the broad surface information about this load network. Recently, a lot of study on artificial infrastructures like roads is carried out recently.

Ronnen Levinson and Hashem Akbari, University of California in USA, have applied spectral information for deterioration according to its duration. Dar Roberts, Meg Gardner, and Chris Funk, university of california, classified urban surface characteristics by Matched filtering and extract information about the road using spectral information. And Martin herold, University of Santa Barbara, has constructed spectral library about the urban land-cover.

In this study, the road surface characteristics of Daejeon city were analyzed using ASTER and IKONOS images. This result will be used basic data for management of the road and it should be able to very useful for urban environmental monitoring and etc.

IMAGE PROCESSING

In the analysis results of the spectral information about asphalt and concrete that are paved on the road, it was figured out that concrete and asphalt were classified clearly and value was various according to surface condition. It was analyzed that the value of a concrete pavement was higher than an asphalt pavement and asphalt pavement become superannuated was high value of the spectral characteristics. ASTER and IKONOS satellite image were processed and analyzed to extract the road surface information using the spectral information of satellite image. Table 1 shows the satellite image data used in this study.

Table 1. Satellite image data used in this study

Satellite image	Aquisition date	Sensor	No. of bands	Spatial resolution
IKONOS	2002/3/11	VNIR	4	4
ASTER	2003/3/9	VNIR/SWIR	3/6	15/30

Deviation correction about common properties was carried out by image process of each satellite image because pixel value must be converted into value of spectral reflectivity to analyze the road surface information using satellite image.

IKONOS Image Processing

IKONOS image has four VNIR wavelengths of 4-m spatial resolution. It has lower spectral resolution than ASTER image, but more excellent than ASTER image to distinguish the road network from the whole image. DN value was converted to Radiance value by the following equation to convert IKONOS image based on the spectral information. Table 2 and table 3 show Calcoef and bandwidth in this equation.

$$L = DN / ((Calcoef / 10) / Bandwidth)$$

Table 2. Calcoef of IKONOS (from Space Imaging Document Number SE-REF-016, Rev.N/C)

Spectral Band	Calcoef_k ($DN * [mW / cm^2 - sr]^{-1}$)
MS-1(Blue)	637
MS-2(Green)	573
MS-3(Red)	663
MS-4(VNIR)	503

Table 3. Bandwidth of IKONOS (from Space Imaging Document Number SE-REF-016, Rev.N/C)

Spectral Band	Lower50%(nm)	Upper50%(nm)	Bandwidth(nm)	Center(nm)
MS-1(Blue)	444.7	516.0	71.3	480.3
MS-2(Green)	506.4	595.0	88.6	550.7
MS-3(Red)	631.9	697.7	65.8	664.8
MS-4(VNIR)	757.3	852.7	95.4	805.0

Radiance value of IKONOS image was acquired value of spectral reflectivity by atmospheric correction using a method of Modtran.

ASTER Image Processing

Radiance value of ASTER image was acquired by the equation of (DN-1)*GainValue that is loaded with GainValue in ENVI 4.5. Value of spectral reflectivity about Radiance value was acquired by the Modtran model that is same module of atmospheric correction with IKONOS.

Combination of IKONOS and ASTER

The values of spectral reflectivity about two images were corrected by the equation $y = -0.00002x + 0.00001$ (y is the final value of spectral reflectivity about IKONOS image, x is the early value of spectral reflectivity) by the standards of ASTER image to analyze two images simultaneously on the supposition that relative spectral value about same properties is constant, between ASTER image and IKONOS image because two satellite images used in this study were acquired at 2-day intervals.

ANALYSIS OF ROAD SURFACE

It was selected eight points in study area and analyzed each value by end-member to confirm satellite image that has value of spectral reflectivity whether it reflects characteristics of the road surface. Figure 4 shows the study area.

Figure 4. End-member location for surface analysis of road (IKONOS image).

Figure 5 shows the analysis results for value of spectral reflectivity at eight points on the road of two satellite images.

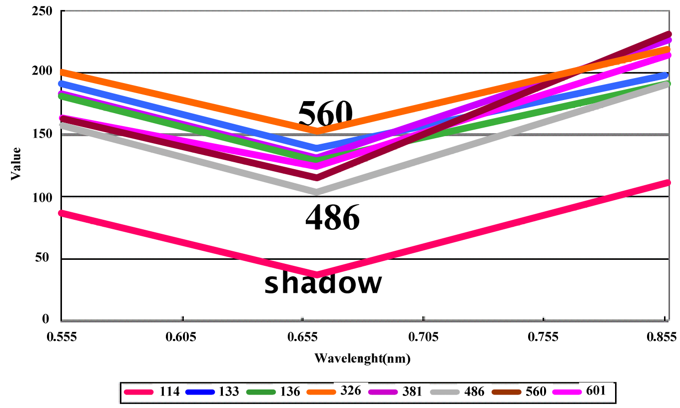


Figure 5. Spectral information of road(eight points) based on image.

The spectral value was analyzed based on image in the location of end-member that were decided one point of road involved the shadow and seven points of road. In result, it was the lowest value in the shadow and the highest value in the end-member at point of 560. It was inferred that the road surface of point of 560 was the oldest or contained the some error factor because the value increased according to the road deterioration in existing value of spectral information about asphalt road. Also, point of 486 was the lowest value second only to region of shadow. At this time, high value of spectral reflectivity by deterioration of road surface at the asphalt road and color loss of road surface was inferred from analysis results of spectral information of KIGAM and NASA JPL.

Therefore, the point value of 486 was selected for end-member and carried out Matched Filtering that was expected good condition of road surface. Figure 6 shows the result of Matched Filtering.

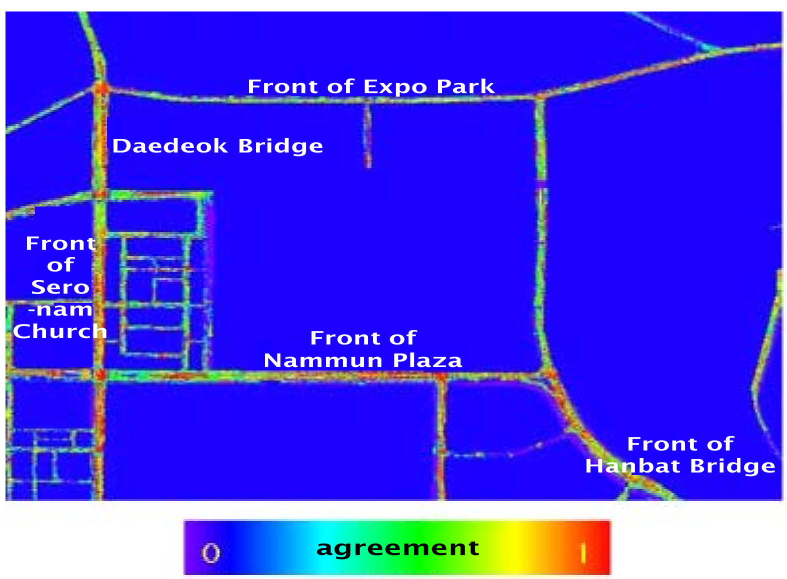


Figure 6. The result of Matched Filtering based on road (point of 486).

Figure 7 and 8 show the comparison results of spectral reflectivity between ASTER and IKNOS image about main points (Expo Park, Daedeok Bridge, Seronam Church, Nammun Plaza, Hanbat Bridge) based on the value of analysis result about road coverage condition compared with point of 486. It was almost the same spectral reflectivity distribution of common wavelength between IKONOS image that has four value of spectral reflectivity and ASTER image that has nine value of spectral reflectivity. Also, it was the lowest value of spectral reflectivity in the part of Hanbat Bridge.

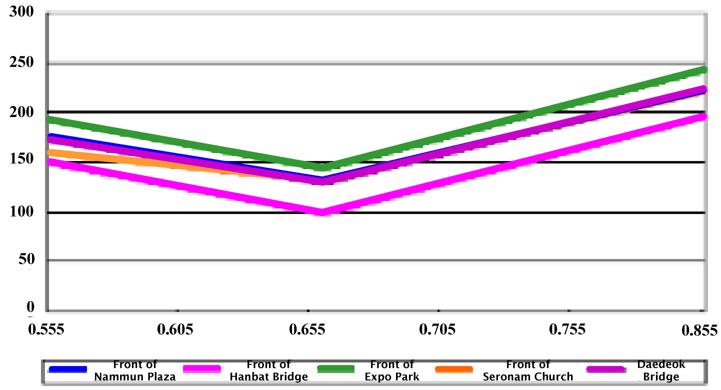


Figure 7. Spectral characteristics of IKONOS image in each point.

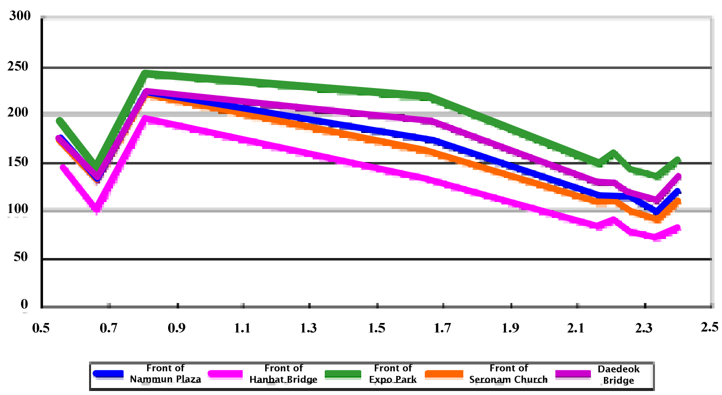


Figure 8. Spectral characteristics of ASTER image in each point.

CONCLUSIONS

The purpose of this study was to extract the road surface information using satellite information based on spectral information in some parts of Daejeon. As a result of this study, the possibility of collection about basic data was secured to manage the road pavement using spectral information of satellite image. However, it is necessary to verify the results using the field data about roads such as the year of road pavement and the volume of traffic to secure credibility. Also, methods to separate and get rid of effects blended into road feature such as skyscrapers and street trees are going to have to study additionally.

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