VICARIOUS GROUND CALIBRATION OF AIRBORNE MULTISPECTRAL SCANNER (AMS) DATA BASED ON FIELD CAMPAIGN

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The radiometric correction is prerequisite to derive both land and ocean surface properties from optical remote sensing data. Radiometric calibration of remotely sensed data has traditionally been accomplished by means of vicarious ground calibration techniques. The purpose of this study is to calibrate the radiometric characteristic of Airborne Multispectral Scanner (AMS) by field campaign. In order to calibrate the AMS data, four different spectral tarps which are 3.5%, 23%, 35%, and 53% were validated by GER-3700 that is the surface reflectance measurement equipment and were utilized. After validation of the spectral tarps, each reflectance from the spectral tarps was compared with Digital Number (DN) value of AMS. There was very high correlation between tarp reflectance and DN value of AMS so that radiometric calibration of AMS data has been accomplished by those results. The calibrated AMS data were validated with in-situ measured reflectance data from artificial and natural target. Also QuickBird image data were used for verifying the results of AMS radiometric calibration. This presentation discusses the results of the above tests.

KEY WORDS: KOMPSAT, AMS, Spectral tarp, Surface reflectance, GER-3700

1. INTRODUCTION

Recently optical remote sensors with high spatial resolution have become an important component of a wide variety of earth science studies. Remotely sensed spectral data have long been promoted for earth monitoring applications, such as land-cover classification, change detection, and etc. However, in order to fully realize the potential of spectral data for such applications, it is necessary that data should be calibrated and validated.

Traditionally, radiometric calibration of remote sensing systems has been accomplished by optical experiment in the laboratory, and been supported by vicarious ground calibration activities (Bowen, 2002). In recent years there has been an increasing demand of improved accuracy and reliability of remote sensing systems. The satellite remote sensing data are usually not ready for use directly, but need to undergo a series of preprocessing steps (Song, 2001), even aerial remote sensing system. Especially, the spectral information correction of remote sensing data is an important step to improve the data analysis in many ways. However, in the most case, data users have to utilize the remote sensing data that have already been collected and archived (Lee, 2004). Also each of calibration tasks requires substantial resources in terms of sensing instrument and ground.

The purpose of this study is to calibrate the radiometric characteristic of Airborne Multispectral Scanner (AMS) by means of vicarious ground calibration activities. In this study, discussion will be limited to simple interactions within reflectance of spectral tarp and Digital Number (DN) value of AMS data, ignoring atmospheric conditions and effects. The results from radiometric calibration of AMS were verified with in-situ measured reflectance data from artificial and natural target and QuickBird image data.

2. DATA AND EXPERIMENT

2.1 AMS and data acquisition

The AMS system which is a whiskbroom scanner accommodates four instruments, i.e., a dual port scan head, a digitizer, a data recorder/monitor, and a power distributor, for the mission of geologic mapping, forest inventory, water monitoring, and many more.

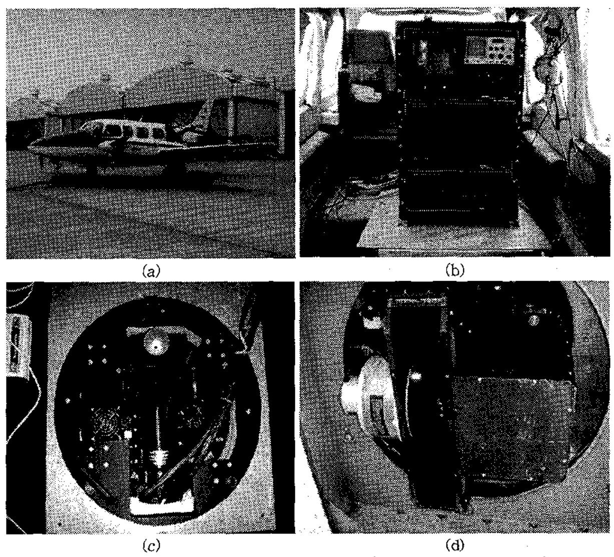
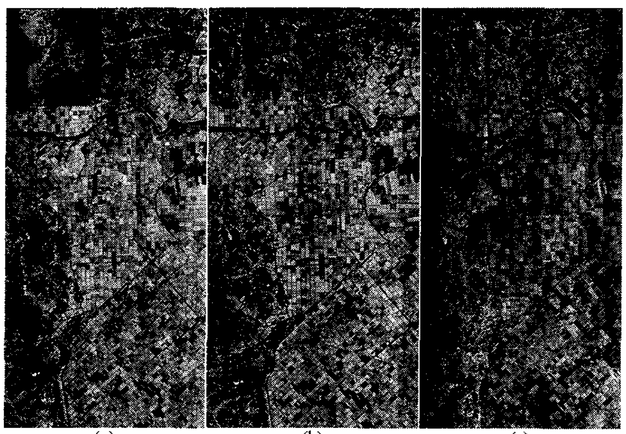


Figure 1. PA-31-350 aircraft (a), AMS system (monitor/ recorder, digitizer, and power distributor unit (b), scanner(c)) mounted in the aircraft, and scan mirror mounted under the aircraft (d).

The AMS system is a dual optical port multispectral scanner which records up to 6 spectral channels simultaneously directly onto an 8mm digital tap. The standard sensor configuration offers a dual element thermal infrared detector and 8 channels, visible/near infrared spectrometer so that a total of 10 spectral bands are available. Fig. 1 shows the AMS system on the aircraft.

The test site in this study is Dangjin area which is located in the western part of Korea. Fig. 2 shows the AMS imagery of test site. The AMS image data were acquired on October 25, October 26, and November 25, 2005. In Fig. 2, the AMS images obtained on 25 October and 25 November 2005 provided 0.8m spatial resolution with RGB channels and image of 26 October 2005 provided 1.2m spatial resolution with 6 spectral channels. The spatial and spectral resolutions of AMS data are depended on aircraft altitude and scan rate.



(a) (b) (c)

Figure 2. The test site and AMS image data of 25 October 2005 (a), 26 October 2005 (b), 25 November 2005 (c).

The GER 3700 was utilized to collect the field spectral data during AMS overflight. This instrument collects data from 350nm to 2500nm, but we only used data from 450nm to 900nm. In-situ field measurements from spectral tarps which are 3.5%, 23%, 35%, and 53% were used to calibrate the radiometric characteristic of AMS data. Also QuickBird data of 25 November 2005 were utilized to verify the results of radiometric calibration in terms of AMS data.

2.2 Experiment

Generally, radiometric calibration of remote sensing systems has been accomplished by optical experiment in the laboratory with integrating sphere and spectral lamp. So the system firstly could be calibrated and a calibration factor such as the relation between DN value (grey level) and radiance should be provided. In the AMS system, DN value can be converted to radiance by equation 1.

$$Radiance = (DN\text{-}Ref1) \times Gain \times (Radiance/count) \quad (1)$$

Where DN is a raw image data, Ref 1 is one of radiometric reference on AMS system. Radiance per count can be derived from the integrating sphere or AB532 test bench. However, unfortunately we did not know actual radiance per count in this study. Therefore, radiometric calibration of AMS data has been accomplished by means of vicarious ground calibration techniques. For this approach in this study, four different spectral tarps which are 3.5%, 23%, 35%, and 53% were utilized such as Fig. 3.

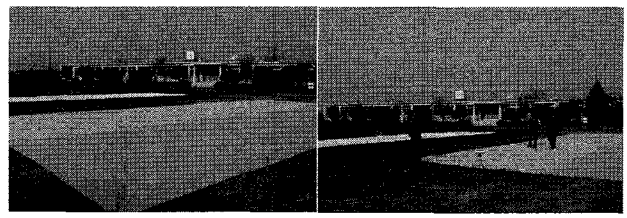


Figure 3. The spectral tarps (3.5%, 23%, 35%, and 53%).

Ideally, each spectral tarp has to continuously provide stable reflectance within radiometric accuracy that is almost ±10%. Fig. 4 shows that each spectral tarp had stable reflectance, except 53% tarp. In the case of 53% tarp, it seems to be saturated because 53% tarp provided more than value of 60%. So measured reflectance from 53% tarp did not use for calibration reference.

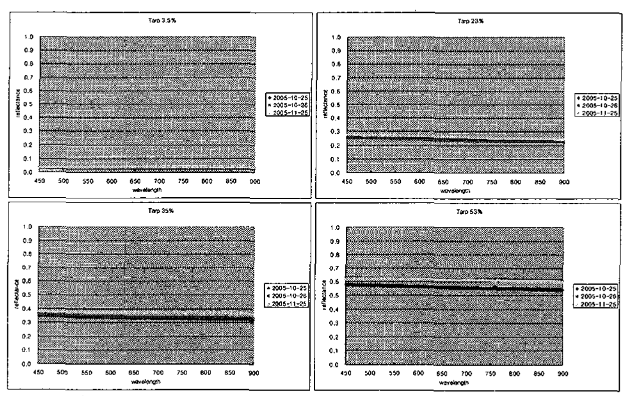


Figure 4. Verification of spectral tarp reflectance from three different dates.

After verification of the spectral tarps, each reflectance from the spectral tarps was compared with DN value of AMS. Fig. 5 shows one of the results in this study.

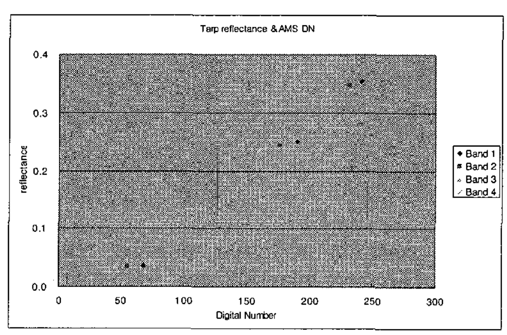


Figure 5. Correlation analysis between tarp reflectance and DN value of AMS for each band (26 October 2005).

In the results of liner regression analysis between tarp reflectance and DN value of AMS, there was very high correlation. The results from three different dates, coefficient of determination (R-square) is almost 0.99 so that radiometric calibration of AMS data has been accomplished by those results. Fig. 6 showed one of results that calibrated image of AMS was visually enhanced than original image. The result of Fig. 6 clearly shows that the original image quality has been improved by vicarious calibration.

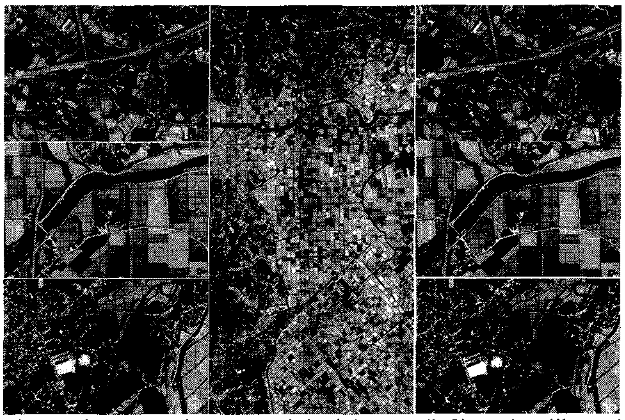


Figure 6. Comparison of original image (left) and calibrated image (right) of AMS (26 October 2005).

Vicarious ground calibration techniques in this study generated acceptable results with AMS image data. It is apparent from Fig. 7 that image-based reflectance from calibrated AMS data is very close to in-situ measured reflectance and its values are smaller than in-situ data.

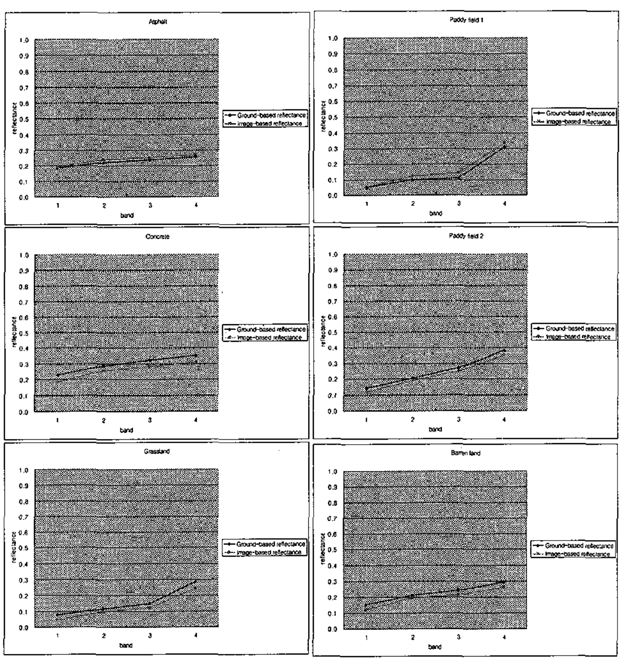


Figure 7. Comparison of in-situ measured reflectance and image-based reflectance from calibrated AMS data (26 October 2005).

3. RESULTS AND DISCUSSION

The results of radiometric calibration of AMS data were validated with other in-situ measured reflectance data from artificial and natural target. Fig. 8 shows that results of AMS calibration based on field campaign with spectral tarps were substantially suitable in this study.

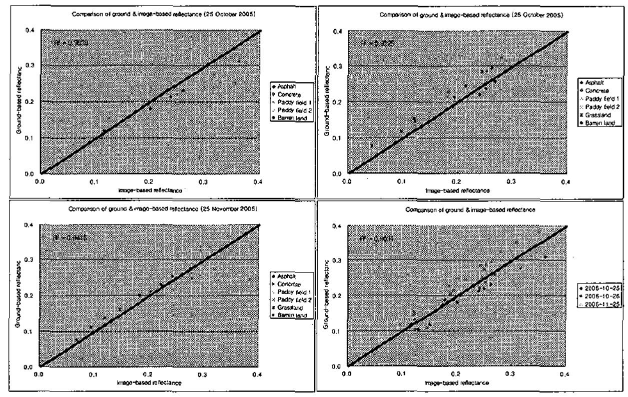


Figure 8. Results of validation between calibrated AMS data and in-situ measured reflectance from six surface targets.

The QuickBird image data obtained on 25 November 2005 were utilized to verify the results from radiometric calibration of AMS data on 25 November 2005. Also DN value of QuickBird image data were converted to reflectance data by using spectral tarp. The result shows in Fig. 9. There was very high correlation between both AMS and QuickBird image data.

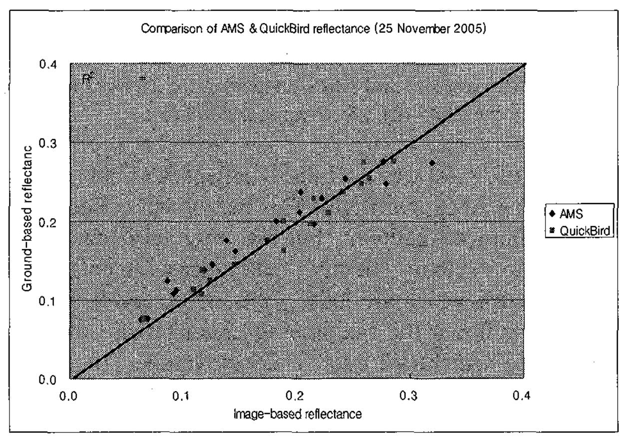


Figure 9. Correlation analysis of AMS and QuickBird image data (25 November 2005).

4. SUMMARY

The vicarious ground calibration technique was experimented to examine the radiometric calibration of AMS data that have quite similar spectral characteristics to the KOMPSAT-2 MSC and QuickBird using spectral tarp and in-situ measurements of surface reflectance. The present results indicate the possibility of radiometric calibration of AMS data by using the proposed method in this study. The results show that the proposed method based on field campaign is substantially suitable in terms of radiometric calibration of AMS data. This result was validated by in-situ measured reflectance data from artificial and natural target and QuickBird image data. However, we need further studies for better performance of such methodology because this experiment was limited to simple interactions within reflectance of spectral tarp and DN value of AMS, ignoring atmospheric conditions and effects. In the further study, input radiance of AMS shall be calculated by using Radiative Transfer Code (RTC) such as MORTRAN and compared with vicarious ground calibration activities.

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