COLOR CORRECTION OF FUSED IMAGES USING COLOR SPACE TRANSFORMATION

Tsukasa Hosomura and Kouichi Katou
Kanazawa Institute of Technology, Japan

Commission VII, Working Group 1

KEY WORDS: Remote_Sensing, Technology, Fusion, Algorithm, Multispectral, Method

ABSTRACT:

Several techniques have been developed to merge SPOT 10-m resolution panchromatic data with SPOT 20-m resolution multispectral data or Landsat TM 30-m resolution multispectral data. That is the effectively 10-m resolution multispectral images produced through the various merging methods contain the high resolution information of the respective panchromatic images while maintaining the basic color content of the original multispectral data. The utility of hue-saturation-intensity (HSI) transformation procedures for creating such composite image. For solving this problem, a method of color correction by transformed color space was developed. The method is simple and easy to implementation. Only intensity was changed. Hue and saturation was kept previous value. Two kind of points are set in the color space. One is Fixed point which is fixed in the transformation. Another is Reference point which is moved to target point in the transformation. Using this method, we can correct plural colors independently in a image. Dark forest area which were obtained by using HSI transform algorithm became bright. Forest area in obtained results was equivalent to the value of the same area in the original color image. This method is very useful for making multi-sensor fused images clear

INTRODUCTION

Many techniques have been proposed to merge SPOT 10-m resolution panchromatic data with SPOT 20-m resolution multispectral data or Landsat TM 30-m resolution multispectral data. The fused images are very useful for land cover classification , land use mapping and other wide application fields. However, there are several problems when multi sensor image fusion are tried. In order to solve these problems color adjust method was introduced in this research.

DESCRIPTION OF METHOD

The flow chart of this research is shown in Fig.1. Existing methods can be divided into following 2 groups. These method basically use RGB--HSI transformation. Where RGB means red, green and blue image and HSI means hue, saturation and intensity image.

(1) RGB--HSI transformation. I is replaced by panchromatic image. HSI--RGB inverse transformation.

(2) RGB--HSI transformation. I is added the high frequency components. HSI--RGB inverse transformation.

By using first method, obtained fused image contains high resolution information which come from panchromatic image. But density level of obtained fused image is different from that of original color image. Especially, this problem was caused when color composite image contains the near infrared band. Because panchromatic image don't has the information of near infrared band.

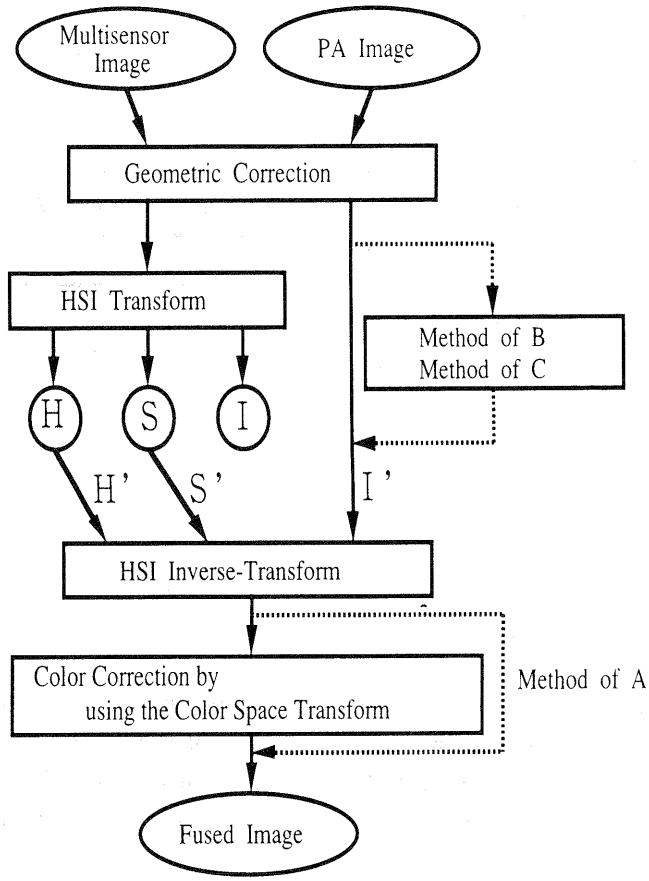

Fig.1 The Flow of The Processing Used in This Research.

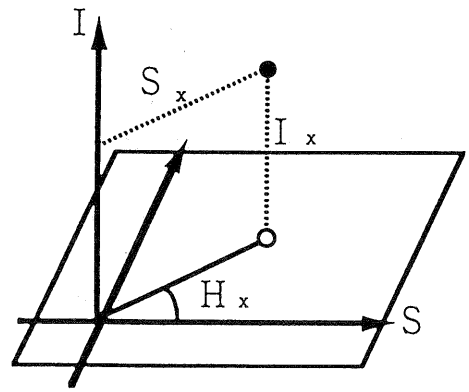

Fig.2 HSI Coordinate System

By using second method, obtained image can keep density level of original color image. High resolution information from panchromatic image are also included in obtained image. However, some area of obtained result has not high resolution information compare with first method. The fused image we would like to make is a mixed image of obtained result of first method and that of second method. Color adjust method was introduced to the first method. The area which has low contrast will be change to high by using color space transformation.

Geometric Correction

SPOT satellite image has large geometric distortion because of slant observation. Precise geometric correction of both images is necessary for multi sensor data fusion. Generally, satellite image will be geometrically corrected by using GCPs. Both images are transformed to map coordinate system by using GCPs. Both corrected images are geometrically transformed and coincided with each other by using control points.

HSI Transformation and Inverse HSI Transformation

HSI coordinate system is shown in Fig.2 Color images are displayed on the monitor by RGB color system. But, HSI color system is better to operate the color combination. Where H,S,I mean hue, saturation and Intensity of the color. HSI transformation are defined as the transformation from RGB color system to HSI color system. Inverse HSI transformation also defined as the transformation from HSI color system to RGB color system.

Color Adjustment by using Color Space Modification

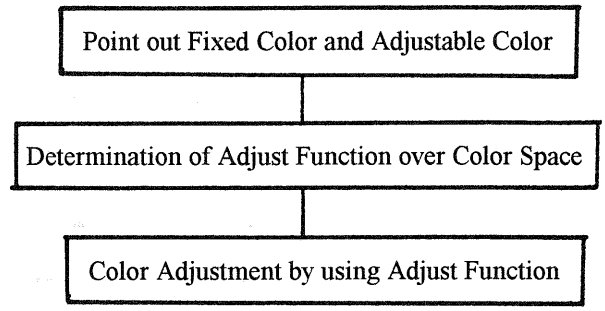

Fig.3 The step of color adjustment

Fixed color was selected from the object image. Desired color after adjustment was given for each fixed color. In fixed color and adjustable color, only one representative point is sufficient for adjustment. Neighboring colors are not considered. Because the amount of color adjustment given by the fixed color adjustable color pair can be propagate to surrounding color by smoothing color space modification. The influenced extent of the amount of color space is determined by the system based on following steps. Determination of adjust function over color space. Adjust function over whole color space is determined based on the boundary condition of the correspondence of fixed color and adjustable color. Precise steps are shown as follows.

Arbitrary color before color adjustment in HSI coordinate system denotes

$$S = (i,s,h).$$

The color after adjustment for S denotes

$$S' = (i',s',h').$$

S is the function of S.

$$S' = S'(S) \quad (1)$$

The amount of adjustment in S denotes

$$m = S' - S$$

m is also the function of S.

$$m = S(S) - S = m(S) \quad (2)$$

where, following equation can be written when fixed color and adjustable color pair Si,S'i (i=1,2,...,n).

$$mi = S'i-Si = S'(si)-Si = m(Si) \quad (3)$$

Various form could be considered for function m, the distance function from fixed point Si was used in this

research.

$$m(S) = f(|S-S1|,|S-S2|,....,|S-Sn|) \quad (4)$$

Adjust function which output the adjusted color S' for arbitrary color S, by solving the equation (4) as the boundary condition (3).

Color adjustment by using adjust function. Color adjustment was conducted for all pixels in object image.

EXPERIMENT

Object Images

Object images used in this study are SPOT PA image and Landsat TM image (band 2, band 3, band 4). False color image was made by assigning R,G,B to Band 4, Band 3, Band 2 respectively. SPOT PA image and Landsat TM image were collected on August 1991 and November 1991 respectively. Object area contains kanazawa city and suburbs of kanazawa. This area contains urban area, roads, rivers, rice fields, forest, sea. Forest area which is very important in this study occupied about 20% in object image. The size of object image is 1024 x 1024 pixels.

Evaluation of the fused image.

Following two methods are selected as the index of the evaluation of the fused image.

(1) Visual interpretation scores.

(2) Correlation between the Panchromatic channel and the derived intensity.

First method was widely used for the research of fused images. Second method is the correlation between the density level of original images (Iold) and the density level of adjusted image (Inew).

SUMMARY

In order to solve the problems which the exist method has satellite image fusion, color adjust method was introduced in the modification of color space. By using this method, color adjustment was conducted for only the necessary area, the area which is not necessary for the color adjustment can keep original density level. Therefore evident changes of density levels in specific area caused by replacing intensity levels obtained by exit method could be corrected. Proposed method has the advantages that the adjustment is not unnatural for the fused image by modifying the color space. In this study, one pair of images are tried by using proposed method. Same result can be expected for other images. Color adjustment steps should be improved in future research.

REFERENCES

W.Joseph Carper, Thomas M. Lillesand, and Ralph W. Kiefer, 1990a. The Use of Intensity-Hue-Saturation Transfermations for Merging SPOT panchromatic and Multispectral Image Data. Photogrametric Engineering & Remote Sensing, 56(4) pp. 459-467

Jeff R. Harris and Richard Murray, 1990b. IHS Transform for the Integration of Radar Imagery with other Remotely Sensed Data. Photogrammetric Engineering & Remote Sensing, 56(12), pp.1631-1641.

Manfred Ehlers, 1991a. Multisensor Image Fusion Techniques in Remote Sensing, ISPRS Journal of Photogrammerty and Remote Sensing, 46 pp. 19-31

Pat S. Chavz, Jr., Stuart C. Sides, and Jeffery A. Anderson, 1991b. Comparison of Three Different Methods to Merge Multiresolution and Multispectral Data: Landsat TM and SPOT Panchromatic, Photogrammetric Engineering & Remote Sensing, 57(3), pp. 295-303

A.H. J. M. Perremans, R.W.L. Jordans, and R. Allewijn,
1993a. Merging Multispectral and Panchromatic SPOT Images With Respect To Radiometric Properties of The Sensor. 59(1), pp. 81-87