AIRBORNE MULTIDIMENSION INTEGRATED REMOTE SENSING SYSTEM AMIRS AND IT'S DATA FUSION

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ABSTRACT:

A type of integrated remote sensing system (airborne multidimension integrated remote sensing system ----AMIRS) which can acquire hyperspectral images ,high special numeric stereo images and position-orientation-data at the same time is developed in 2005 to improve the efficiency of remote sensing system .In this paper the data processing flow of the system is listed briefly .An attempt of the data fusion to get classified map directly from hyperspectral images and high special images is introduced . The method workflow include pure pixel judgement by grads , pure pixel spectral diffusing according the edge of high spacial image, linear pixel decompose with already-known pure pixel spectral which simplified the equation ,and un-pure pixel spectral diffusing . In this article the image fusion method try to base on rough image register methods that means high register precision are not necessary,to do so, the radiation correlation of two kinds images synchronously acquired are used . Some of experiment result are listed .

1. INTRODUCTION

A type of high – special – resolution - and-high – spectral - resolution Airborne Integrated Remote Sensing System - AMIRS (Xu Weiming, etc,2008) is developed in Shanghai Institute of Technical Physics in 2005. The system can obtain hyperspectral images,high spatial resolution images, GPS/IMU data to calibration the pose of the plane at the same time (showed in figure 1).

To make better use of the data of this system, a set of data processing system is developpd. The data fusione introduced in this article is an attempt of the united-application of hyperspectral images and the high special images. Only those related with image fusion is introducfed.

The Parameters of the raw experiments images is showed below:

- Spatial pixels:
  - 610-660nm, 535-585nm, 430-490nm for multispectral image, 3 bands
  - 450-900nm for hyperspectral image, 124 bands, spectral resolution better than 5nm
- Instantaneous FOV:
  - 0.1m GSD(Ground Sample Distance) for panchromatic and multispectral image
  - 0.6m(across track)*1.2m(along track) GSD for hyperspectral image;

All the data that used in this article were collected by the integrated system. Of course, the data that used in image fusion are post-processed so some Parameters changed, for example, GSD for hyperspectral image are about 1m*1m after pose correction. This will not be mentioned later.

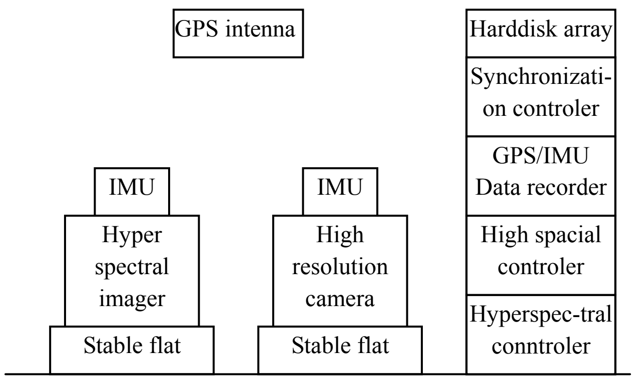

Figure 1 the structure of AMIRS

2. THE PREPROCESSING

The two kinds of images are both preprocessed before fusion .The workflow of the preprocessing is showed in figure 2.

2.1 Image correction

The radiation calibration and pose correction are general preprocessing for both data to any application. Both kinds of the images are Radiation calibrated and geometry corrected respectively on their own characteristics.

Both of the hyperspectral data and high special RGB data are calibrated in the lab with the same integrating sphere. The calibration of the two instruments not only is used to calibrate the image, but also guarantees the radiation correlation of two kinds images in register.

The images used in this article are not completely geometry calibrated, the platform pose was corrected only. More details are not discussed in this article.

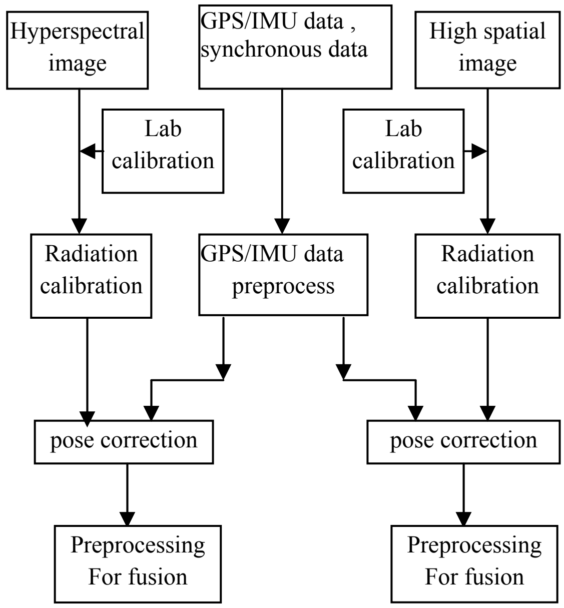

Figure 2 Data preprocessing flow

2.2 Preprocessing For fusion

Special filter are designed for the fusion .It is a filter called neighborhood- cluster vector filter-NCVF (Ma Yanhua, etc, 2006) which base the clustering of a pixel's neighborhood area to reduce the scattered minor spectrum. It can keep the spectral information unchanged when erasing noise and small areas of odd spectral, at the same time it can sharpen the edge of the images in some extension. A practicable algorithm that similar with the vector median filter (VNF) was designed to realize the filter.

Edge detection is used to segment the High special image for pure pixel spectral diffusing, and used to detect pure pixel for hyper-spectral, to be introduced more in this article .The hyper spectral edge detecting usually adopt a simple method: principal component transformation and then use ordinary Edge detection algorithm, such as sobel operator,etc.

2.3 register strategy

To meet different applications, all kinds of image fusion algorithms are realized ,include fusion algorithms that are now generally used, such as the PCA，high pass filter , wavelet transformation algorithm, etc, but most of them are depended on register precision(figure 3). The difference of GPS of the images that used in this article is very large, the low special resolution hyperspectral image has to be blurred, the spectral are blurred too, so the fusion result must be appended the effect of image re-sampling, just as showed in figure 4.

In figure 4,(a)shows a hyperspectral image of AMIRS after register; (b)is the high special image; (c)and(d) is the results of high pass filter fusion and PCA algorithm. The result shows that with such a resolution difference, the spectral after register has been blurred too bad to cite.

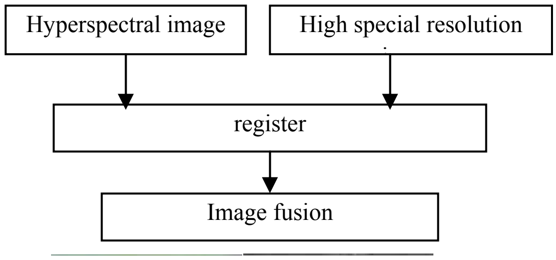

Figure 3 general image fusion flows

Figure 4 the low resolution image is blurred after register

At the same time, big resolution difference and short of precise geometry correction of the experiment images
Depresses the register precision, so a register strategy is put forward.

Rough registration means getting the spatial relationship of the pixels in two images, but the hyperspectral image are not re-sampled according to high special resolution image. General registration algorithms can be used.

Because the two kind images are captured at the same time and the two images are calibrated ,and the spectralwave are known and overlapped ,so the luminance in corresponding bands(the sum of several bands of hyperspectral image with one band of RGB image) are high correlation, the registration between the super pixel and the high special then with the brightness correlation, you can judge which block(in spatial segment image) a spectral belong to by moving the spectral image pixel in a initialized range around the rough registered position the RGB image .

By the strategy, the blur of re-sample ,the problem of register precision are resolved.

3. FUSION

In this article the target of fusion is to get classify information on spectral and spatial distributing information on corresponding high spatial images.

3.1 workflow

A workflow to carry out the target is sesigned as below. Showed in figure 5.

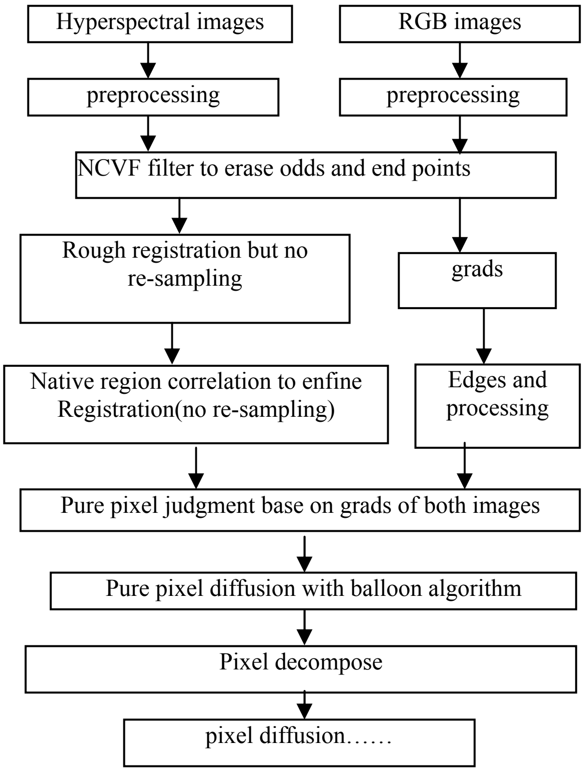

Figure 5. work flow of the fusion

3.2 fusion and sharpen

Scattered single points or small targets disturb during classification even though they usually are comprised with special target,but in some cases it is not necessary to pay more attention, So a special designed Vector filter (Ma Yanhua,etc,2006) is designed to erase odds and ends points, which is named a vector filter based neighborhood clustering(NCVF). The filter is used on both kinds of the images and it makes the fusion easier.

Polynomial registration algorithms were used to as a rough registration means to get the special relationship of the pixels in two images, the hyperspectral image are not re-sampled.

Because the two kind images are captured at the same time ,so the luminance in corresponding bands are high correlation, the registration between the super pixel and the high special resolution image pixel can be defined more accurately.

Next step is to get the grads of both image .The hyperspectral image grads can get vector grade first and then translate it to scalar quantity, such as ||x||.

Review every hyperspectral image pixel of their grads and the grade of corresponding high special image area to decide weather it's a pure pixel, the criterion can be set according with the image.

Produce the edge image of the high special resolution image to segment it as the map to be filled with spectral information or classifying information, edit it artificially if necessary.

The pure pixel spectral fill to the edge image in their registered position, and diffusing with a balloon algorithm to cover the other pixel in the same segments. If there are more than one spectral in a single segment, the spectral should be calculate their mean. Spectral will leak out if there are un continuousness in the edge, so restrict has to set up to avoid spectra's leaking out at small holes in the edge. Better image segment algorithms will be helpful.

The unpure pixel can be get by pixel decomposing. Now that the pure pixels are filled in the image, the indetermination during pixel decomposing is reduced. Linear decomposing ruler is used in this article.

The decomposing can be done step by step with spectra that already known in neighbor area of the pixel to be decomposed .First step decompose those composed with two types of material (super pixels that cover two segments in edge map) and one of then is known already, Then those composed with three types of material.Of cause, more step pixel decomposing is meaningless because of error.

After decomposing, the spectral are filled in the edge map just as the pure pixel before-mentioned.

3.3 experiments

The method is not well developed yet ,original experiments is just finished .One experiment images are showed in figure 6, the hyperspectral image is of 100*40pixel, and RGB image is of 328*235 (the images were acquired before the AMIRS finished ,so the resolution of the RGB image is lower relatively).The results is showed in figure 7 and figure 8.

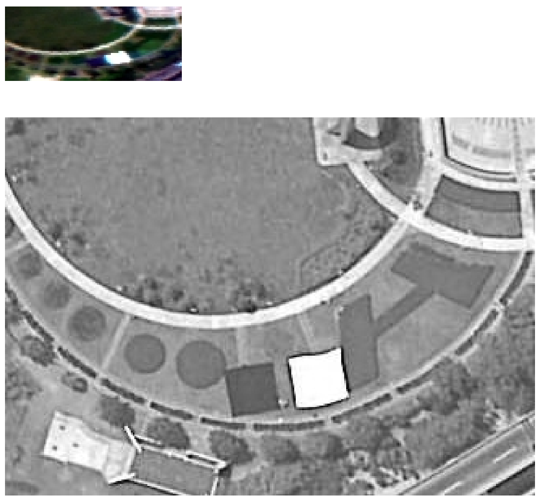

Figure 6. Hyperspectral image and high spatial resolution image

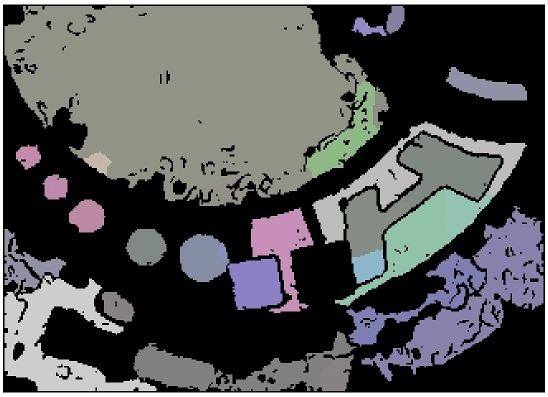

Figure 7 result after pure pixel diffusion

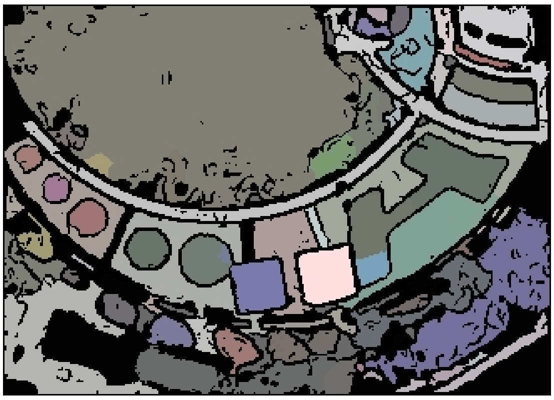

Figure 8 result after one step pixel Decomposing and diffusing

In figure 9 another fusion result is showed.The raw hyperspectral image is of 130*70 and the high spatial image is of 670*700. The left image is the raw hyperspectral image which is zoomed out; The middle one is the hyperspectral image after PCA fusion; And the right one is the image processed with the fusion method of this article.

Figure 9 another experiments

The results are spectral images ,with the spectral , it's easy to produce classified maps.

4. SUMMARY AND CONCLUSIONS

In this article a type of hyperspectral image fusion method is bring forward，its workflow is introduced and realized。In the hyperspectral image fusion flow，the edge information and the radiation correlation between hyperspectral images and high spatial resolution images is utilized to induce the demand for registration precision that hard to achieve。Experiments results with real remote sensing images are given。

The method need not re-sample the hyperspectral images, keep the spectral information unchanged, induced the undetermination of pixel decomposing, showed optimistically portend. The AMIRS system gives a opportunity to integration application of hyperspectral information and high special resolution images.

The actualization of the workflow simple and crude, only simple algorithms are adopted, the fusion results can be zchieved but a lot has to be done to improve and test the method.

5. REFERENCES

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