

A new Infrared multi-spectral image processing method based on radiometric and geometric correction

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Abstract. This paper presents a multi-spectral infrared image processing method, including image recovery, radiometric and geometric correction. Image recovery including pixel filled, positive and negative dislocation correcting sweep, reverse sweep consistency correction, within spectrum response consistency correction, B7 spectrum to interfere, B8 spectral, missing lines filled, B9 band interpolation, B9 band to pinstripe, B9 band to band tailing. Geometric correction includes cause deformation imaging projection, change curvature of the earth image distortion, the impact of atmospheric refraction, the earth's rotation correction. Compared with the prior methods, the research on image processing level has been significantly improved, this study method using technology to make the project a significant improvement in image quality than before.

Introduction

Remote sensing is a feature of electromagnetic radiation reflected by the level of gray scale information processing analysis and interpretation for feature identification and study of the topic. Remote sensing imaging process on various factors (for example, satellite speed changes, the atmosphere and surface reflectance and emission of electromagnetic waves interaction, random noise, etc.) affect the actual image intensity values are not entirely radiate electromagnetic energy feature size before reflecting, which also contains the results of the above-mentioned factors, thus making the remote sensing image processing, but also the need for correction processing (image restoration processing) to eliminate the impact of these factors. On these process commonly called pretreatment.

Satellite remote sensing image preprocessing main purpose is to eliminate the influence of two categories: namely, radiation sensing and remote sensing image distortion geometric distortion of the image. Remote sensing digital image processing must geometric distortion (including geometric correction and geometric precision correction rough), after radiation correction, noise suppression processing, image preprocessing to perform other special processing (such as processing and image enhancement according to the needs of practical problems image classification process).

Pretreatment is a large class of image processing technology, pre-treatment in the usual sense mainly includes the following:

Radiation Correction: The purpose is to use remote sensing remote sensors to effectively collect energy from the surface features of electromagnetic radiation, but due to the measurement process of the transmission of electromagnetic waves in the atmosphere and sensors, remote sensors by itself sensitive feature, the feature lighting conditions (such as the sun Effect of changes in elevation and topography, etc.) as well as the role of the atmosphere, the actual measured value and the feature spectrum emissivity remote sensors are inconsistent, there is radiation measurement distortion. In order to correctly evaluate the electromagnetic radiation characteristic feature, we need to eliminate the effects of these distortions, that radiation amount correction process. Depending on the cause radiation radiation distortion correction processing of remote sensing images may take four methods,

shown in Figure 1, the distortion correction that is sensor calibration, solar elevation and terrain as well as due to atmospheric scattering correction.

Geometric Correction: The image is a sense of geometric distortion in its imaging process is difficult to avoid factors that cause remote sensing image geometric distortion has three aspects, namely, sensors reasons, because remote sensing platforms (satellite) aspects and the reasons for the Earth itself.

Infrared multispectral scanner image data processing raw image data: image data signal encoded as eight, image: B6, B7, B8 of 1712×1536 pixels; B9 is 864×768 pixels. In B6, B7, B8, each swath width of 8 pixels; in B9, each swath width of 4 pixels.

Infrared multispectral scanner image acquisition system is to obtain the reflective surface features, and radiant energy through the scanning device forward and reverse sweep. Since the control precision level image data detector performance indicators, scanning system intercepts, satellite attitude and other issues, the infrared multispectral scanner data of the original image has some distortion (displacement, compression and tension, etc.), and because the detector response some of the differences caused by streaks. The physical mechanism for a variety of different problems, and make the appropriate correction. Content preprocessing includes data recovery, infrared multispectral scanner radiometric and geometric correction in four parts.

The prior methods are often directed to a method of a particular design flaws, and not systematic, the system can not solve the problems of the image for actual production; secondly, the prior methods for image processing Some areas, such as the restoration of all aspects of image processing is not very good.

Methodology

The purpose of this study is to provide a multi-spectral infrared raw image processing method for image defects, design appropriate data recovery method, according to the design characteristics of the sensor, to develop the image of absolute calibration and radiometric calibration and geometric correction method, In the imaging process to eliminate the influence of various factors operating satellites, the Earth's rotation and curvature of the Earth and remote sensing image data, etc. caused.

1) Image recovery: the image restoration include pixel filled, positive and negative dislocation correcting sweep, reverse sweep uniformity correction, response uniformity correction within the spectrum, B7 segment spectrum to interfere, B8-spectral lines to fill the vacancy, B9 band interpolation, B9 band go pinstripe, B9 band to band tailing.

Atmospheric refraction impact: For the propagation of light and electromagnetic waves, the atmosphere is not a homogeneous medium, because its density is increased with the height from the ground diminishes, so light, electromagnetic waves in the atmosphere is the refractive index with height change, so that the electromagnetic wave propagation path is not a straight line but turned into a curve, thereby causing the image displacement, displacement formula dots below, K is a sensor air condition and feature high point of elevation of atmospheric constant.

Reverse sweep dislocation Correction: Because infrared multispectral scanner image data starting at the ground to intercept forward and reverse scan data selection are inconsistent, so B6, B7, B8, the positive and negative swath there are n pixels dislocation, dislocation sweep reverse image before correction shown in Figure 12a; in B9, the positive and negative scanning band has m pixels dislocation, with reference to the forward scan, reverse scan with the corresponding translated to eliminate dislocation forward and reverse scan swath belt between; infrared multispectral scanner of B6, B7, B8 in eight sensing element, B9 is arranged between $\$ 4$ probe is not in a straight line on, but in between there are two odd idol yuan yuan as dislocation, using a method to eliminate translation.

Pixel padding: Since the data transmission system problems, although the surface radiation detection element has been receiving information down, but when transferring data sometimes missing element of the phenomenon to the ground, that the original image data infrared multispectral scanner of Some like the dollar value of 0; in B8 band image missing data for the fourth and seventh rows of detection elements the situation is the presence of two rows so that the data is 0, the image is

segmented by eight bands for each section of the image strips in each pixel and its surrounding pixels 8 lines 2 and 0 gray value by comparing the pixel value of 0 indicates a lack of pixel, to determine the location of missing element, and then use the left and right The method of interpolation to solve the shortage of dollars; the B9 spectrum sensing element is 4, so the form of the original image on the B9 manifested missing element is 4 rows a total of eight as two gray element is 0, the image Press the four bands segments, each segment of the image strips in each pixel and its surrounding four rows of pixels and the gray value 0 2 compares the pixel value of 0 indicates a lack of pixel, determine missing Location dollars, and then use the interpolation method was about to fill the missing element.

Respond within the spectrum consistency Correction: In B6, B7, B8-spectral Fourier transform, the image of each spectrum from the time domain to the frequency domain, then eight yuan a probe scanned image data in zero on the domain averaging to resolve very small change in the pixel gray detecting element 8 in response to the inconsistency, consistency within the spectral response of the image before correction strip phenomenon obviously, within the spectral response uniformity correction image strips disappears; and finally recover the use of an inverse Fourier transform to the time domain, so banding image is improved.

B9 band to band tailing: Reason strip is produced by the detector and preamplifier are ac-coupled, high-pass AC coupling circuit composed by the RC, at the time of scanning of the target will generate image defects. Target medium to large temperature differences, the signals are coupled to the front of the rectangular wave signal distortion generation DC-coupled fell and negative spikes, so distorted image of the target, the signal waveform diagram shown before coupling, high temperature small goals said that due to the averaging circuit output is low, the output signal in response after a positive signal will be accompanied by a lower amplitude but longer duration of response to negative signals from the image point of view, will have a more serious black smearing as shown 19a Fig. The method of treatment is the use of the spatial domain using differential method of detecting the edge of the strip and the sea, and the sea of gray threshold control, the use of positive sweeping strip of kickback bands were smooth and no tail bands for use trailing Article brought tail, as shown by the results of the image to strip trailing processed. This method can remove the strip and trailing on the sea, but the threshold required for a given experience, after the image processed with different threshold values, may have an edge portion of the land and sea or sea weakening weaker Information , the coupled signal waveform diagram in FIG.

Reverse sweep dislocation Correction: Because infrared multispectral scanner image data starting at the ground to intercept forward and reverse scan data selection are inconsistent, so B6, B7, B8, the positive and negative swath there are n pixels Dislocation; in B9, the positive and negative scanning band has m pixels dislocation, with reference to the forward scan, reverse scan with the corresponding translation in order to eliminate the swath between the forward and reverse scan band The dislocation; infrared multispectral scanner of B6, B7, B8 in eight sensing element, B9 is arranged between \$ 4 probe is not in a straight line, but in between there are two odd idol pixel dislocation cell using the method of translation will be eliminated.

Consistency reverse sweep correction: Because forward and reverse scanning speed of the scanning device is not exactly the same, after the image processing after the above there are still some misalignment between the positive and negative scanning band, using as a benchmark the forward swath In the adjacent reverse scan tape select a certain control points, and forward the reverse scan with registration, this set of control points can be read by a large number of images obtained experience, however, since the scanning imaging features, Scan speed forward swath nor uniform, in order to make the image does not generate new deformation, the use of this particular moment CCD camera image of an imaging forward and backward while scanning belt registration.

Respond within the spectrum consistency Correction: In B6, B7, B8-spectral Fourier transform, the image of each spectrum from the time domain to the frequency domain, then eight pixel a probe scanned image data in zero Take on the domain average, resolve very small change in the pixel gray detecting element 8 in response to the problem of inconsistent, and finally the use of inverse Fourier transform to return to the time domain, so that the image of banding improved.

B7 segment spectrum to interfere: because of the more obvious in the spectrum periodic noise B7, have an impact on the quality of the image, it should remove the noise, the use of two-dimensional Fourier transform in the Fourier spectrum of the spike-shaped noise component extraction removal, then inverse Fourier transform.

B8-spectral lines to fill the vacancy: B8 band image missing data for the fourth and the seventh row sensing element, the use of interpolation method to make up for the lack of lines, averaging the difference between the value of adjacent data processing and down two rows.

B9 band interpolation: B9 image will expand to its original width * height * 2 × 2 original size;

B9 band to pinstripe: due to temperature changes and the detector material, the transfer function of the detector are different from each other, and that the detector has a non-linear transfer characteristic, for these reasons that the image having a regular streaks, bands behave on B9 particularly serious, using image data with each of the two upper and lower adjacent stripes replace the original data after the band find the average, in order to reduce the strip.

B9 band to band tailing: Reason strip is produced by the detector and preamplifier are ac-coupled, high-pass AC coupling circuit composed by the RC, at the time of scanning of the target will produce image defects, the use of the use of the spatial domain differential method of detecting the edge of the strip and the sea, and the sea of gray threshold control, the use of positive sweeping strip of kickback bands were smooth and strip for use without smearing smearing smearing article brought.

2) radiometric correction:

Use of laboratory absolute calibration data radiometric calibration: calibration experiments using 6,7,8 source spectrum is a 500W solar simulator irradiation diffuse version, diffuse reflection plate in the focal plane of the collimator, the quasi collimator produce parallel light scanner. Change the output of solar simulators radiance, the amount of data measuring the scanner output, and thus the scanner calibration;

9 spectral calibration method is to use a black body placed in the focal plane of the collimator, the collimator generate parallel radiation scanner body, changing the blackbody temperature, measuring the digital scanner output spectrum scanner 9 scaling.

Satellite receives ground - gas system of the reflected radiation signal or radiation signal is an electrical signal and the counter output mode, radiance is proportional to the counter and satellite remote sensing by the receiver.

Lack padding: Since the data transmission system problems, although the surface radiation detection element has been receiving information down, but when transferring data sometimes missing element of the phenomenon to the ground, that the original image data infrared multispectral scanner of Some like the dollar value of 0; in B8 band image missing data for the fourth and seventh rows of detection elements the situation is the presence of two rows so that the data is 0, the image is segmented by eight bands for each section of the image strips in each pixel and its surrounding pixels 8 lines 2 and 0 gray value by comparing the pixel value of 0 indicates a lack of yuan, to determine the location of missing element, and then use the left and right The method of interpolation to solve the shortage of dollars; the B9 spectrum sensing element is 4, so the form of the original image on the B9 manifested missing element is 4 rows a total of eight as two gray element is 0, the image Press the four bands segments, each segment of the image strips in each pixel and its surrounding four rows of pixels and the gray value 0 2 compares the pixel value of 0 indicates a lack of yuan, determine missing Location dollars, and then use the interpolation method was about to fill the missing element.

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Radiometric calibration is Le and DN by different scaling factor is calculated using the least squares method G and DN.

3) geometric correction

The geometric correction includes a projection image distortion caused by changes in the Earth's curvature of image distortion, impact of atmospheric refraction, the Earth's rotation correction:

Induced deformation imaging projection: panoramic projection is a special form of line central projection, video projection surface is not a plane panorama, but a cylindrical surface, the feature point P on the image plane at point p panoramic scanning direction the coordinates of y.

Distortion generated by changes in Earth's curvature: curvature of the earth will cause the image displacement, so the scale image edge than the center of the small scale, through projection, an infrared remote sensing images will lose roughly 10 pixels.

When the sensor is used to measure the reflection and refraction of the target, the distortion caused by the sun position and angle, and the physical quantity of the target's spectral reflectance or spectral radiance is not consistent with the measured values. The spectral reflectance and spectral radiation characteristics of ground objects can be used to interpret and effectively use the satellite remote sensing images. Radiometric calibration of the absolute calibration data of the laboratory: the radiometric calibration of the satellite borne remote sensor. The aim of the infrared multi spectral scanner vacuum radiometric calibration is to determine the calibration coefficient of the scanner's each channel in the condition of simulating space environment. Measurement method is the known radiation measurement scanner output signal input conditions, and tested under different temperature conditions and different temperature is obtained when the calibration data, the experimental spectrum section 6, 7, 8 of the calibration source used is 500W solar simulated irradiation with diffuse reflection version, the diffuse reflection board is arranged on the collimator focal plane, through a collimator produced parallel light scanner. To change the output of the solar simulator and measure the amount of data in the scanner, so as to set the scanner.

Atmospheric refraction impact: For the propagation of light and electromagnetic waves, the atmosphere is not a homogeneous medium, because its density is increased with the height from the ground diminishes, so light, electromagnetic waves in the atmosphere is the refractive index with height change, so that the electromagnetic wave propagation path is not a straight line but turned into a curve, thereby causing the image displacement, displacement formula dots below, K is a sensor Air condition and feature high point of elevation of atmospheric constant, H is the sensor Hang high, considering atmospheric refraction on the x, y in both directions when the r respectively image coordinates x and y to replace the handle.

4) The impact of the Earth's rotation: the Earth's rotation is mainly produced dynamic deformation on the image sensor, particularly for satellite remote sensing images, when both satellites running from north to south, the Earth's surface also rotates from west to east, since each satellite images imaging time scanning lines are different, resulting in scan line projected on the ground turn westward shift, and ultimately makes the image distorted.

Summary

Compared with the prior research, this research on image processing level has been significantly improved, this study method using technology to make the result a significant improvement in image quality than ever before; and for the analysis of image data structures in production to solve the remote sensing data problems of the conventional method of using the software can not read, can significantly save data re-acquisition cost, ensure timely progress of the project.

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