

GF-1 Image Quality Evaluation and applications potential for

The Mining area Land use classification

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Abstract: To objectively evaluate the image quality of GF-1 and its potential for application of the mining Classification, the Pingshuo mining area in Loess Plateau is selected as the study area. Compared with the same temporal images of SPOT 6, the images of GF-1 were. The evaluation index from two aspects such as gray level feature and texture feature are to conduct the project Quality. Statistical results show that GF-4 images contain amount of gray information and rich feature types; which can describe the details of the surface information. To analysis the application potential of GF-4 image, the process of land cover classification is worked out by means of M Aximum Likelihood method Classification pixels-dased and nearest neighbor method classification object-oriented Vely. The comparing the classification results testified that GF-1 image ' s overall classification-effect was inferior to SPOT 6 Image, but the GF-1 image is still able to quickly and efficiently obtain the information depleted land and mined Surrounding, and could provided the base data for mine ecological restoration and vegetation.

Keywords: GF-4 Remote sensing image; Quality evaluation; land use; mining area; object-oriented classification</B1 1 >

High-score satellite (abbreviation GF 4) is the first of our country since master R /d, Check life requirements more than 5 Low Rail height for year Resolution remote Sensing satellite , track height 645 km , side-pendulum ability $\pm 25^\circ$. The star is equipped with two full panchromatic 2m , multi-spectral to 8 m High resolution camera and 4set [m resolution more spectrum wide camera , has now been sent down valid data tens of thousands of views . GF 4

Satellite Engineering achieves high altitude resolution of optical remote sensing , Multi-light Spectrum combined with high time resolution , multi-load image stitching Fusion and high precision , High stability control technology [1]. Its high spatial resolution rate and wide coverage scan features for homeland , Agriculture , Forestry and ringResource surveys and monitoring in departments have important roles , cause this , and to GF 4 satellite data for quality evaluation and application analysis tools

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Introduction to authors : Chen Ming (1989-), man ,, hunan Chenzhou , master 's , The main research direction for remote sensing image processing and GIS apply . Email: zysming208@sina.cn Newsletter author : zhouwei , men , Professor . Email: zhouw@cugb.edu. CN is relevant .

The core issue of the image quality evaluation is that the evaluation image contains information and recognition of feature extraction [2] , to current stop , A lot of relevant research has been done at home and abroad , The consists primarily of the Landsat^[3-5], MODIS^[6], ASTER^[7], IKONOS^[8], WorldView ~2^[9], CBERS^[1142], Environment Small sat-

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ellite [a] with and Beijing 1 no [A] The quality of satellite imagery such as is qualitative and Quantitative

Analysis . the qualitative analysis is based primarily on the reviewers ' vision interpretation to evaluate image quality , Its results with reviewers Experience , Different levels of knowledge show greater difference , so qualitative analysis can only be used as a tool for shadows quality evaluation of image . Quantitative analysis can also be divided into parameter models and computer automation model evaluation , The former is mainly by selecting the appropriate evaluation , Then use the mathematical statistics method for the Quality comprehensive analysis , as Literature [4, 1°,13] by selecting image geometric correction precision , Grayscale features and texture features such as The parameters of the surface engineering quality evaluation of images ; The latter is a priori knowledge build algorithm model , and take advantage of programming knowledge Implementing computer automation Simulation evaluation ^[1547] , This method is Enables Fast Image quality evaluation , but its expertise and High level requirements , And the algorithm is only suitable for a certain type of data features , is not universal in image quality evaluation . so , Here we use the parameter model evaluation method , and the same season SPOT 6 image as reference , By using grayscale information , texture features and categories Results Analysis comparison , Explore the objectively GF 4 of the image Engineering Quality and its application potential in mining area land use classification .

1. Data Introduction and evaluation indicator selection

1.1 Data Description

takes into account the subsequent GF 4 satellite data in mining area Research using taxonomy potential , so you've selected a complex object type and representative of the Loess Plateau area for research area , It contains the stope of the ping-shuo mining area , Industrial Site , Dump and duplicate Reclamation Land types , Chart 1 (a) shows. get GF4 data is 20134) 548 1 level product data , with 4 multi-spectral band , Space resolution 8 m; reference image is the same as season, SPOT 6 Data , Gets the time 2°13-3, also with 4 multispectral band , Space resolution is 6 m , As shown in figure 1 (b) shows . The basic information for the two images is as follows: 1 , as shown . from table 1 can see SPOT 6 data in spectral resolution , Spectrum Scope and spatial resolution are close to research data , with better The comparison reference value of the . But considering the relevance of the image , for reduces result errors due to different spatial resolutions , to SPOT 6 data for resampling processing (is convenient for presentation , will weigh sample SPOT 6 data for SPOT 6~ R,) the same as GF4 data has the same spatial resolution , then use before and after a reduced processing image andGF4 image grayscale Comparison analysis of information and texture features .

1.2 Select Evaluation indicator

satellite image quality assessment can be quantified for remote sensing data provides prior knowledge with and information extraction ^[1]. use parameter model quasiEvaluate the quality of the image the key is to choose a reasonable evaluation indicator ^[7]. based on current related research , here from grayscale information and texture features select metrics for Image Engineering quality Comment . The grayscale of the remote sensing image is a simulation of the radiation of a feature , shadow Image Grayscale value is a representation of the reflectivity of ground objects , its measures The size of the is mainly in the mean value , standard deviation , signal-to-noise ratio 3side face . texture characteristics Refer to changes in image grayscale levels , response diagram like even , detail , Rough Phenomena , Gray in common statistical methodsdegree co-occurrence matrix to express image grayscale in direction , adjacent interval and General information for changes to range ^[1] . The Its specific analysis is mainlyThere are : homogeneity , contrast , Corner Second moment , information entropy , Average gradient etc . The evaluation indicators selected by are as follows : 2 , . table 2Middle , m and n is the height and width of the image ; G (to point (

Grayscale ; E is the image grayscale mean ; ^ is the image mean variance ; ~ to noise standard deviation ; Ai .) is a normalized grayscale co-occurrence matrix elements ; L is grayscale ; SNA , HOM , EVA and ENT The signal-to-noise ratio for the image, respectively , homogeneity , Average gradient , Corner Second order moment and information entropy .

2. Image quality results evaluation and analysis

2.1 evaluate results based on image grayscale information

uses mathematical statistics to separate the GF 4 image and processing before and after SPOT 6 image average , Variance , Snr Gray degree information done statistics ,Data results such as tables 3 are shown in . can look at go to, SPOT 6 The image before and after the reduction treatment is in the gray statistical node the data on the fruit is basically close to, and after resampling SPOT 6 data in spatial resolution with GF4 data Close , on objective more comparable , So both can be used as GF4 image comparison reference . mean statistics show , feature in GF 4 image on 3 band higher radiation intensity ; To see from the Grayscale variance , GF 4 images 4 The value of the band is slightly lower than SPOT 6 image , description GF4 The information hierarchy of the image expression is not as good as SPOT 6; in the signal-to-noise ratio , only the first 3 The Band is higher than SPOT 6 , description GF - 1 image is more intrusive than . But statistics for grayscale information results show GF 4 image to better reflect object information , Table up to a rich feature type , to be satisfied with land survey , and city planning and agricultural production .

2.2 evaluate results based on image texture features

on Texture feature extraction , Two based on the grayscale co-occurrence matrix Sub-statistical analysis is one of the most common use methods . after multiple attempts after verification , determines the best window size for calculating textures is 3×3 , in on the basis of this grayscale co-occurrence matrix , extracted 3 image samequality , average gradient , Corner Second moment , information entropy 4 Texture Parameters , its statistics as table 4 shows .

homogeneity reflects local evenly of the image , The greater the value describes the The smaller the difference in texture changes . GF4 image only page 3 of the bandvalue is smaller , Other bands have higher values than SPOT 6 image , say Ming GF4 texture contrast in different areas of the image is small , between different objects The boundaries of are harder to distinguish from . Look at the average gradient ,GF4 image page 1 ,2,4 band values are less than SPOT 6 images , Description GF- 1 The relative clarity of the image is lower , has weak ability to express details to SPOT 6 Image . Corner Second-order moment is the measure of the evenly of the image , Can be used to determine the thickness of the texture , texture thicker image values larger , The statistic indicates that the gray distribution of both is evenly similar to that of the . picture information entropy used to describe , The size of the Entropy value table up to the amount of information . GF4 image only page 3 band the entropy value is slightly greater than SPOT 6 images , Other bands are smaller , description GF4 image contains less information than SPOT 6 images . base above analysis results , Description GF 4 The local evenly of the image is more than OK , Texture contrast between objects small , But the sharpness and letter of the image The amount has yet to be increased .

To remove the texture of the image for the correlation between bands Feature effect , using principal component Analysis PCA (Principal Component analysis) Remove redundant information for bands , yes to evaluate texture parameters for the transformed bands . from table 5 See 3 image before 3 The main component contains all band 99% More information , so take PCI,PC 2 and PC 3 for texture feature statistics . from table 6 indicators Statistic results can be seen ,GF4 homogeneity of first principal component of Image sex Average gradient and Angle Second moment and information entropy lower than SPOT 6 two images , Description GF4 image clarity and amount of information low , But more sensitive to feature details ; Second principal component in the gradient and information entropy slightly above SPOT 6 outside the image , other means subscript below The latter, description GF 4 The second principal component of the image perform better on texture features , image Clear , Texture exquisite , Letter Rest Rich ; Third principal component GF 4 The sharpness of the image is higher than the SPOT 6 resample Images , Other metric values display GF -1 The texture feature quality of the image is the same as the SPOT 6. Comprehensive analysis can be drawn , compared to SPOT 6 image , GF 4 image Clear degree and amount of information there is more room for improvement .

2.3 Comparative evaluation results based on feature extraction

The engineering quality evaluation of the image is mainly for the application of the image for reference, in turn, the quality of application of the image can be evaluated as The satellite research provides the basis for. This study will also pass the extract to GF 4 image data doing applied quality evaluation, because Institute in area for mining area, human disturbance Large, object type complex Miscellaneous, based on its land use / Override features, constructs the containing residents point, dry land, facilities for agricultural purposes, has woodland and artificial grasslands, etc. Ten type Typical object classification system [1], details such as table 7 are shown in.

is Terrace-like, The Ridge is significantly, because there is no vegetation With light green, Gray and color diablo, containing striped coal transport Road

Naked colors close to mining land, Fragmented distribution, more than the road

Classifying remote sensing images is a simple and effective feature Extract Information, Select the correct classification method is to improve the feature Information Extraction precision key. on a pixels based supervision category, Maximum likelihood (Maximum likelihood) apply wide with high precision; and based on an object-oriented classification method, the The objects composed of multiple adjacent pixels are processing units, considering light Statistical features, shape, texture and adjacency relation, etc. general letter @, to achieve higher level remote sensing classification and target features Take [2]. The closest to the object-oriented technology (nearest neighbors) classifier to Find the closest for each processing object sampling point for automatic information extraction [3]. so, using The maximum likelihood of pixels and the nearest neighbor method based on object-oriented two method of classification to GF 4 and SPOT 6 resampling image extracting information from row objects, Its categorized results are as shown in the figure 2 shows.

You can see the by visually comparing it to the original, Two categories of Parties The method can all be GF4 and SPOT 6 image Ten a typical extract effective. overall look at, GF4 image category knot fruit is more local than SPOT 6 Smooth some, Description GF4 images has better local uniformity, But in detail on terrain SPOT 6 table nowclearer, conforming to previous texture feature statistics. two There are some errors in the image, The in particular the maximum likelihood The supervision classification of dry land and artificial grassland confusion serious, main Because the dry land of the crops and the artificial grassland in the spectral expression on close; another, Road, settlements and facilities agricultural land three also The existence must be confusing. compared to a meta based supervised classification, mining with object-oriented classification result lines clearly, patches Smooth and compact, Classification Results even, to effectively avoid Salt and pepper Phenomenon, greatly The improves the classification precision. through the classification results of two images

facilities for agricultural purposes, artificial Grassland _ Industrial _ Naked dry land m have woodlands m mining land m Road m Idle

(a) GF-1 Maximum likelihood supervised category (b) SPOT6 Maximum likelihood supervised category (C) GF-1 Object-oriented category (D) SPOT6 Object-oriented category

diagram 2 Image Classification Results

contrast, can draw GF 4 Image objects are more evenly, can have To Extract all land types in mining areas, for complex terrain extract, But there's still a need to improve on the expression of feature details.

to make quantitative analysis of the classification results from an objective level, Mining A precision evaluation of the classification results with a obfuscation matrix. Validation sample from the same research area WorldView -2 High resolution image get, Classification Precision Statistics as table 8. from table Count to see, Two images The overall fine of the two classification results degrees all reached 80% above. GF4 Two categories of images total The body precision is i. 66% and 13% Kappa The factor is 0.79 and 0.86. and SPOT 6 Monitor classification precision for images and Kappa coefficients GF4 image close, but is based on to pair Images of the closest category overall precision is greater than GF4 image High 3.82 %,Kappa Factor high 0., Classification Overall precision and The comparison of Kappa coefficients shows that GF4 image overallClassification effect is on SPOT 6 image, to visually compare Results are the same. and the producer of the Different methods of sorting from the two degree, User-precision

statistics can be seen, supervised categories, GF4 image except for road precision below SPOT 6 image outside, Other types of land classification precision are higher or similar to the SPOT 6 Image; only in the nearest object-oriented taxonomy result for artificial grassland, Mining land and industrial land three types of precision is slightly higher on SPOT 6 Outside of the image, Other classes have more classification precision than their slightly lower, description GF 4 image capabilities for feature extraction close to SPOT 6 Image, can be applied to a variety of feature types mention take.

another, The statistic results also indicate that the GF4 Two types of images class results, only artificial grasslands and roads with lower sorting accuracy outside, Other land types have producer precision and user precision in 80% above, This description GF4 Image Classification precision of various land types High, in the artificially disturbed mining area land, has the potential to extract Complex terrain information and to monitor land changes in mining areas.

3. Conclusion Engineering and application angles to GF4 Satellite data

The Study area of the Loess Plateau Area, from the image The Quality of the is evaluated and analyzed, and compare it to the same season's

SPOT 6 images compared, can be obtained as a conclusion.

1) in grayscale information, GF4 image page 1, and 4 The information level of the band is less complex than SPOT 6. to Texture features, homogeneity, Corner Second moment two parameters quantitative said Clear GF4 Image Local evenly good, texture across objects anti difference is small; But the statistical results of the average gradient and information entropy indicate that GF 4 Image clarity and amount of information need to be improved. The points of the analysis Results explain GF4 image to better reflect object letter rest, Express Rich object type, can be satisfied with the land survey, applications for urban planning and agricultural production, to make up the country lack of application requirements for high-resolution satellite data, Decrease Dependencies on foreign high-resolution satellite data.

2) on image application, GF4 image to extract out of settlements, dry land, industrial land, rice mines and Fosun land Object Type, and both categories are more accurate than 80%. but a comparison of the visual effects and precision validation results of the - GF4 Image Overall classification effect is second to SPOT 6 image, Specialdo not make it difficult to distinguish between path and other details, and artificial grassland There is also a more serious confusion with arable land of crops. anotheroutside, higher classification producer precision and user precision display GF 4 image with better feature extraction, available for quick quick access to mining area land use and ambient information, and then general rules for ecological reclamation and environmental monitoring of mine land Design and technical implementation provides data support.

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