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# Optical Remote Sensing Image defogging algorithm Based on dcm-htm

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***Abstract:*** focusing on fog detection and correction of satellite remote sensing image, a defogging algorithm dcm-htm for R Emote sensing image is proposed by the combination of Dark channel map (DCM) and haze thickness map (HTM). Based on the principle of dark channel mean-shift filter and automatic histogram threshold are to used detect area t the same time, the HTM is obtained by nonoverlapping window. At last, the correction of fog is produced in the fog area. The results show that the algorithm can accurately detect the fog area, and the areas affected by the haze can be effecti Vely corrected in the premise of image normal areas not affected. The results are improved greatly compared with the fog correction of the whole image.

***Keywords:*** haze thickness map; Dark channel map; mean shift filter; fog detection; nonoverlapping window

receives cloud , effects of atmospheric environmental factors such as fog , Optical Satellite Image quality degradation of remote sensing images , Interpretation andmeasurement of images to decrease , Restrict further application of images . so , How to have effect eliminates or reduces fog effects on optical remote sensing images , full send image performance , has become a concern in the field of Earth observation Hot issues .

thin clouds and haze are distributed in near-Earth space , to the visible wave segment Image scattering basic _ to , on satellite images Similar features , can be classified as _ class for processing [a] . in Computer visual field , A typical way to fog is a dark channel transcendental theory [12-5] , homomorphic filtering [6] and retinex [7] andimprovements made based on [642] , is focused on close away from the ingested landscape image , features in imaging range fog is all Evenly distributed . so , Many academics also apply such methods to Remote Sensing image correction with uniform fog distribution b' ; in cloud detection and school

positive Aspect / Landsat Long-term acquisition plan Ltap ( Long Term acquisition Plan collect ) Global multiple sample data , to Landsat 7 and ETM+ launched the Automated Cloud Detection assessment System ACCA (Automated Cloud -Cover assessment,), to Thin cloud , thick cloud and normal area categories [M] ; because the algorithm is more than times Use brightness temperature image , Scaramuzza etc ^ for landstat 8 OLI (operational land Imager ) data , pass over synthetic brightness temperature image , development at " ACCA ( Artificial thermal-automated Cloud-cover Assessment ) algorithm ; Hot and its improved algorithm based on the correlation between image bands , to distinguish between clouds and normal surfaces by means of clear skies , effect is significant , fit With a wide range [M] ; Makarau , and so on [E 9] extracts by improving the an existing fog-going algorithm or a graph that is evenly distributed over fog like , or only one type of image can be processed , The algorithm is more versatile than difference . problems with the previous study , design _ combine dark channel image and fog thickness image DCM TM algorithm , in The basis for precise detection of fog areas in optical satellite remote sensing images on the , implements fog correction in fog areas .



# 1. algorithm Flow

The background of the original optical satellite remote sensing image includes a wide variety of feature features , hard to distinguish from grayscale features exactly fog area and background features . while the dark channel image mainly contains a darker grayscale background and fog area and a small number of areas with high reflection features

diagram 1 algorithm Flowchart

The algorithm process is mainly divided into the following 3 Section .

1) fog area detection and extraction . by selecting a Dark Channel window with a size of W darkc_wu,«), wide to (W,H ) original image fetch Dark channel image DCM, linear stretching to DCM make mean~shift smooth and automatically set according to histogram Set thresholds generate two-value images f 0 g_region , Two value image fog_regionGray values 1 The area of the is the Fog area .

2) fog thickness image HTM extract . to obtain a dark channel image selection size is ' X « ' no overlap window HTM_ WU ',¡î',¡î E 3,9] extract fog thickness image HTM,obtained HTM is the original start image wide 1/« ', so you need to filter it again , Heavy Sample Back to original size .

3) fog correction . through fog thickness image HTM and mentioning

taken by Fog _ Region Two value image , Extract Background contribution value back, to fix HTM , achieves the order of the normal area , : finally based on radiative transfer , in the detected DCM Fog area , through HTM The model corrects the original image .

# 2. fog Detection

He Keming [0] To count multiple image data , finds every _ the phenomenon of low channel values exists in the clear Sky image , and then root The suggests a priori theory of dark channels . where , Dark channel image $J^{Dark}$(x ) get formula to

$^{jdark}$(x)) = mi $^{n}$ ) ($^{min}_{ce\ \{}$"" ","() ,i} $J^{c}$ (y) ) -(1)

y <e x )

where : $J^{c}$ represents each channel of the original image , represents A GB three channels

(1) (x)) represents a pixel x is a central window .

because of the different effects of fog on different bands , its fog thickness chart Like it's not the same , So here are the windows given for each channel port size to take a dark channel image . definition Ji Show page i wave Segment original image , DCM ,(x) for its dark channel image , Gets the formula

DCM ,( x) = min ( J,(y)))-

(2) X) defines the total probability density & H (x)) is two rule probability

. s 2 r 2

density k ( h ) and k ( H ) ) Results of the product mean -shift The clustering principle expression on an image is

(3)where : $x^{s}$ is a coordinate space section ; x $^{R}$ is the corresponding color space section Sub ; H : and HR represents the core of coordinate space and color space, number of bandwidth ; C is a normalized correlation factor . used for filtering and splitting When a cut is required for a variable with a h =h (h : , hr , M ) for ; M The represents the number of pixels in a given range , The result of is that the zone is associated with the Its most similar sections are merged . _ case , number Bandwidth range plan on 4,] .

diagram 2 is the original image to be fetched DCM and make a linear pull after extension meamhift mean drift filter results . its medium , Dark Channel window to darkc_W(15,15); mean-shift parameter count to h (8,8,20) .

(a) Original image (b) DCM (c) DCM Mean-shift

diagram 2 Dark Channel image mean drift filter

diagram 2 (a) the white rectangular window in is the normal surface and fog Edge area , Chart 2 The three-dimensional grid diagram for in this area

# 3. Correction of fog Area

Is based on the Chavez [121] in traditional Bliss The transport model presents a short band synthesis algorithm . Its rationale is that the is far from the surface of the sensor, So assume that the scene object is the same distance from the sensor as , The radiation obtained by the sensor The brightness value can be represented as

$L' = L_{c+p} + Yoon$ (6)

where : L ' Indicates the radiation brightness received by the sensor ; Lg + P represents the surface reflection and atmospheric radiation and ; H and the caused by the fog Additional contribution value . due to original remote sensing image DN value vs radiationBrightness has a linear relationship , so (6) to simplify to

$DN;'(x,y) = DN^{0}(x,) + HTM;(x, y)$. (7)

where : DNi ' U ,) is the original image I band Point (x,) at grayscale values ; DN 0 (x,) The result image that corrects for it ; HTMJX ,) for fog thickness image .

fog thickness image HTM The is obtained primarily in the Dark channel diagram like DCM to get based on non-overlapping Windows . the window does not overlap primarily to avoid some non shaded areas and high The brightness target is included in the obtained fog thickness image HTM . makarau real , specific sensor type

its non-overlapping window size is _ constant , and the smallest window the surface area should be no lower than the sensor ground resolution 3 times ( such as Landsat 8 OLIm resolution multispectral image selected window floor space should be m X m , that does not overlap Windows size 3 pixel X 3 Pixel ) . but , When window is very hours , base on original image get HTM will contain more surface Reflection Information , If the direct generation (7) will cause the correction to be excessive , image severely distorted , As shown in figure 5 shows . Its solution is to pass short band ( 0.443 0 and 0.482 5 pm() image composite New Wave paragraph , So this is not suitable for some short band satellite images.

(a) Original image (b) htm (c) htm over-correction results

diagram 5 to Landsat 8 OLI Original image fetch HTM The correction result for shows the

to enhance the generality of short band compositing algorithms , here is a for improvements , about to be calculated on original image HTM to Dark channel image DCMcalculation . first assumes dark channel images DCM Wide height W and H based on selected not heavy Stack window U',«') to calculate the initial output HTM Large

Small , is DCM Wide 1/ « from the output of the HTM like Meta coordinates (x ',') start , reads DCM starting point U ' x x', x y'), Wide Height all $_{w}$size window' image meta value , is recorded as P (x ) ',y'); The finally takes the minimum value in the window as the current point , HTM value , evaluates to

HTM , (x',,') = min [] () [DCM , (y) } . (8)

Y e x ', y ')

where : DCM , (y) is the first I band Dark Channel image in Window

N (x',') pixels in scope ; HTM ^ x ',') is the corresponding with a height of (W / « ', H / « ') fog thickness image for .

because of the obtained through the preceding method HTM the size is the original Image 1 /«Images of a ( +) () () ()« ', so filter it (_ ) Select Median filter , template sizem x 3,9]) to smooth the matrix window noise and resample ( with double three times convolution ) to original size.

also , HTM The is primarily 3 The section consists of : atmospheric gas dissolve The scattering part of glue, etc. , Some high brightness surface and fog influence Department Sub . affects the first two to the atmosphere , with background Back Table : , revised fog thickness image HTM ' can be represented as

0, HTM , back ;

Htm' = {

HTM - Back , HTM > back .

Background Back The value is detected by the fog area and fog thick degree image Union to determine ; to HTM The background part of the is evaluated by value asback value . then (7) last changed to

dn^x ,) =dn 0 (x,y)) + $HTM_1$'(x ,y.

# 4. Experiment and Analysis

## 4.1 experiment 1

Select two sets of data to experiment with . data 1 is Henan login Seal Area Landsat 8 OLI 30 m multispectral satellite images , get time 2014-6-7, Size 1 pixel X 1 000 likeelement ; Data 2 is a zone in Wuxi, Jiangsu province m for resolution wide View field GF1- WFV 2 Image , Gets the time 2013.-9, Large Small to 570 pixels X 690 Pixel . Dark Channel windows ( + X 15) , does not overlap window take (3 X 3).

Experiment departs from the original image , Gets the dark channel image in turn DCM, fog thickness image HTM and the corrected results image . Landsat 8 OLI image correction processing results as shown in the figure 6 .

diagram 6 original image in , fog thickness image , Dark channel transcendental results ,ahot Results $^{M}$ and the school of the proposed method Positive results .

from Diagram 6 and Diagram 7 The correction result of looks at , Dark Channel transcendental The result hue is bright _ point , for dense fog areas has yet to be improved ;ahot The algorithm is based on a between the blue and red bands height dependencies , and manually select Normal area and fog

The area has an artificial interference factor , Has a smoother correction , But overall image tones change ; DCM - HTM correction effect at the same time that the image hue is not changed to a greater degree , , correction of a uniformly distributed fog region is more pronounced , is particularly suitable for restoring Normal surface below the dense fog area . DCM-HTM main Save the problem is that part of the corrected image is dimmed , Thick fog with normal surface boundary area remaining . main reason is fog thickdegree image HTM the ideal source for should be a smaller surface reflection while fog affects a larger shortwave segment original image , so with band growth , obtained by non-overlapping Windows HTM Less exact .

Table 1 gives the relevant quality parameters before and after the experimental correction index , table values are removed 3 The average value of the band is . can see ,The variation of parameters in the Dark channel prior method is greater than the original image deviation large , The is primarily because its correction result is 8 bit image ,and original Shadow like bit ; The standard deviation indicates the grayscale level after the fog correction divide , greater standard deviation , The smaller the difference between gray values , DCM - HTM The algorithm is more than the original image and ahot is biased small ; also , DCM - HTM algorithm and ahot The average gradient for is more than to close , significantly better than original data , This indicates original shadow enhanced image sharpness after correction , recognizable enhancement .

Table 1 image quality evaluation Parameters Table

| Data source | Landsat 8 OLI | | | | Gf1-wfv2 | | | |
|---|---|---|---|---|---|---|---|---|
| | Original image | Dcp | Ahot | Dike out algorithm | Original image | Dcp | Ahot | Dike out algorithm |
| Mean | Ten 206.20 | 68.79 | 9 526.26 | 9 018.43 | 534.78 | 70.14 | 506.05 | 470.79 |
| Standard deviation | 1 618.49 | 64.74 | 1 426.11 | 974.42 | 66.44 | 54.30 | 54.90 | 51.37 |
| Average gradient | 292.66 | 15.64 | 328.16 | 293.42 | 12.08 | 13.56 | 12.03 | 12.12 |

## 4.2 experiment 2

to react more clearly to the Dark Channel window from the details Port size selection effect on correction results , vs. 6 identically coordinates,, m Resolution Pan full-color image repeated Dark Channel Window extraction Experiment , a local image of its corrected result, such as Chart 9 : .

from Diagram 9 to see , when the Dark channel window darkc_WU, more hours , more fog cuts , Its hue is also darker ; and the some high-brightness surface , can cause excessive distortion , As shown in figure 9 (b) and the dry ) Farmland section of the (c) , Its center appears without the original image no some dark block shadows . when the window is too large , in thick fog area correction effect is not complete , as shown 9 ( HShow.) so , local When the face target changes dramatically and there are more High-brightness objects , Dark The channel window should be extended appropriately , one in ( x is preferable .so , to select higher resolution satellite image data into Row Experiment , respectively Beijing an area ZY-3 number 5.6 m Resolution
multispectral satellite imagery and in a region of Jiangsu ZY -3 number 2.1 M. , resolution face image , size 1 Pixel x 1 pixels , Dark Channel window fetch ( % x , do not overlap window size (3 x 3), As shown in figure Ten shows .

from Diagram Ten to see , DCM ~ HTM The method is darker than the dark channel Transcendental method more complete on fog correction , Show when dark Channel window port is defined as ( + x , The same method applies to higher-score resolution satellite image . The main problems with exist in the window

c) dcm-itm Experimental results ( D ) face original image

(e) Dark Channel method experiment results (f) dcm-itm results

diagram Ten dcm-htm To Compare the results before and after the result

The edge effect of the and the dimmed special on some highlighted surfaces sign , also go to _ Improvements to the step

# 5. Conclusion

Remote Sensing images of optical satellites with uneven distribution of fog , mentioning out a dcm-htm combined method for fog zone detection and to correct . withLandsat8 OLI, GF1- wfv2 and ZY -3 multi-spectral and face camera 4 Group image data validated by this method certificate , can draw the following 3 Point conclusion .

1) fog correction can be performed effectively , largely dependent on to determine whether the fog thickness image is accurate . based on dark channel image containsSmall amount of surface reflection information , takes the mean-shift and histogram automatic thresholds for more accurate fog area detection and extract .

2) to consider the details of preserving the surface while going to the fog , Avoid excessive distortion . based on detected fog area , combined fog thickness image HTMcalculate normal area background contribution value back to HTM make an amendment , largely preserves the normal region's grayscale values .

3) When the image is thick with fog thickness , especially the edge section still exist _ residual ; the and the window selection causes the _ to set the edge effect . This is aproblem for the next _ , step .

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