High Resolution Satellite Image Enhancement Using Discrete Wavelet Transform

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Abstract

In this paper, a high-resolution image enhancement wavelet-based algorithm is presented for edge smoothness of a Satellite Image. Initially apply the three-level discrete wavelet transform (DWT) and compute the subband images namely LL, LH, HL and HH. Then calculate the log energy of each and every subband. A Scalar index are created by weighted average value of log energy of each subband. The Scalar Smoothness Index (SSI) are representing the overall edge smoothness of image. This is used for filtering parameter and filter out to give the high-resolution image.

Keywords: Smoothness, Scalar Index, Subband, DWT, Image Sharpness, Wavelet Decomposition.

INTRODUCTION

Satellite images are most important for world wide applications like earth imagemonitoring, navigation and remote sensing, etc., here to enhance this satellite image because this kind images are very unclear it. More image enhancement algorithms are used but here wavelet-based image enhancement algorithms are considered to this satellite image. More wavelet transform is available but we have only considered discrete wavelet transform for good suitable of satellite image edge smoothness and sharpness. The multi-level DWT are used based on the sharpened image.

Picture Quality Restoration Framework for Contrast Enhancement of Satellite Remote Sensing Images is proposed by Shilpa Suresha et al [11]. chiefly centers around differentiate improvement of satellite remote detecting pictures. A few satellite remote detecting pictures were tried to sanction the viability of the proposed technique over other existing remote detecting improvement strategies and their quantitative outcomes.

DISCRETE WAVELET TRANSFORM

The main wavelet is discrete wavelet transform are very suit for satellite image enhancement, segmentation and restoration. In wavelet examination, the Discrete Wavelet Transform (DWT) breaks down a flag into an arrangement of commonly orthogonal wavelet premise capacities. These capacities contrast from sinusoidal premise capacities. It is nonzero over just piece of the aggregate flag length. Here based on multi-dimensional discretewavelets transform [12].

Figure 1. One-level, two-dimensional DWT. First, the one-dimensional DWT is applied along the rows; second, the one-dimensional DWT is applied along the columns of the first-stage result, generating foursub-band regions in the transformed space: LL, LH, HL and HH.
PROPOSED WORK

A Flow diagram portraying the entire procedure is given beneath. Contingent on the idea of yield Image the strategy coordinates to particular arrangement of procedures. The proposed fill in as appeared in the figure 1.

Figure 1. Flow Chart

The Log Energy is given by

\[ LE = ((1-W) \times ((LH+HL)/2)) + (W \times HH) \]  

(4)

Where, \( W \): Weightage.

The Scalar Sharpness Index is given by

\[ SSI = \sum_{n=1}^{L} 2^{L-n} LE_n \]  

(5)

\( L \): A Factor which is greater than or equal to \( n \)

\( n \): Number of Levels in Decomposition

In any case, at the season of the production of Block delineate of every 1 is covered both on a level plane and vertically with neighbor pieces Figure. 2.

Figure 2. Neighbor Block Overlapping

\[ PSNR(dB) = 20 \log_{10} \left( \frac{2^A - 1}{\sqrt{MSE}} \right) \]  

(6)

\[ MSE = \frac{\|x-x\|^2}{MN} \]  

(7)

Where, original (\( X \)) and reconstructed (\( \hat{X} \)), image of size MxN can be calculated using the equations 8 and 9 respectively. Here \( A \) represents bits per pixel (bpp).

RESULTS AND DISCUSSION

Here figure 5, 10 nos. of images are taken into consideration. The original images, enhanced images after use filtering with the factor SSI each of the enhanced images are presented below.

<table>
<thead>
<tr>
<th>Image</th>
<th>Color Image</th>
<th>Gray Scale Image</th>
</tr>
</thead>
<tbody>
<tr>
<td>IM1</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>
All the above three images are converted to gray scale and then type double for faster processing and analysis.
Here figure 6, the block based Scalar Sharpness Index (BSSI) of the original image has been used as the filtering parameter and the original image is filtered out to give the enhanced image.

### Table 1

<table>
<thead>
<tr>
<th>Image</th>
<th>MSE_SSI</th>
<th>MSE_BSSI</th>
</tr>
</thead>
<tbody>
<tr>
<td>IM1</td>
<td>2.86E+08</td>
<td>1.82E+07</td>
</tr>
<tr>
<td>IM2</td>
<td>4.66E+08</td>
<td>2.96E+07</td>
</tr>
<tr>
<td>IM3</td>
<td>2.79E+08</td>
<td>1.77E+07</td>
</tr>
<tr>
<td>IM4</td>
<td>3.59E+08</td>
<td>2.28E+07</td>
</tr>
<tr>
<td>IM5</td>
<td>3.49E+08</td>
<td>2.22E+07</td>
</tr>
<tr>
<td>IM6</td>
<td>4.68E+08</td>
<td>2.98E+07</td>
</tr>
<tr>
<td>IM7</td>
<td>5.47E+08</td>
<td>3.48E+07</td>
</tr>
<tr>
<td>IM8</td>
<td>6.62E+08</td>
<td>4.21E+07</td>
</tr>
<tr>
<td>IM9</td>
<td>5.17E+08</td>
<td>3.29E+07</td>
</tr>
<tr>
<td>IM10</td>
<td>5.52E+08</td>
<td>3.51E+07</td>
</tr>
</tbody>
</table>

### Table 2

<table>
<thead>
<tr>
<th>Image</th>
<th>PSNR_SSI</th>
<th>PSNR_BSSI</th>
</tr>
</thead>
<tbody>
<tr>
<td>IM1</td>
<td>42.48</td>
<td>30.52</td>
</tr>
<tr>
<td>IM2</td>
<td>44.60</td>
<td>32.64</td>
</tr>
<tr>
<td>IM3</td>
<td>42.38</td>
<td>30.41</td>
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<tr>
<td>IM4</td>
<td>43.47</td>
<td>31.51</td>
</tr>
<tr>
<td>IM5</td>
<td>43.35</td>
<td>31.39</td>
</tr>
<tr>
<td>IM6</td>
<td>44.62</td>
<td>32.66</td>
</tr>
<tr>
<td>IM7</td>
<td>45.30</td>
<td>33.34</td>
</tr>
<tr>
<td>IM8</td>
<td>46.13</td>
<td>34.17</td>
</tr>
<tr>
<td>IM9</td>
<td>45.06</td>
<td>33.09</td>
</tr>
<tr>
<td>IM10</td>
<td>45.34</td>
<td>33.38</td>
</tr>
</tbody>
</table>

**Figure 6**: Block Scalar Sharpness index

**Figure 7**: MSE Vs Various Images filter out with SSI and BSSI

**Figure 8**: PSNR Vs Various Images filter out with SSI and BSSI
Table 3

<table>
<thead>
<tr>
<th>Image</th>
<th>Elapsed time</th>
</tr>
</thead>
<tbody>
<tr>
<td>IM1</td>
<td>0.000138</td>
</tr>
<tr>
<td>IM2</td>
<td>0.000031</td>
</tr>
<tr>
<td>IM3</td>
<td>0.000025</td>
</tr>
<tr>
<td>IM4</td>
<td>0.000034</td>
</tr>
<tr>
<td>IM5</td>
<td>0.000025</td>
</tr>
<tr>
<td>IM6</td>
<td>0.00003</td>
</tr>
<tr>
<td>IM7</td>
<td>0.000042</td>
</tr>
<tr>
<td>IM8</td>
<td>0.000027</td>
</tr>
<tr>
<td>IM9</td>
<td>0.000025</td>
</tr>
<tr>
<td>IM10</td>
<td>0.000025</td>
</tr>
</tbody>
</table>

Figure 9: Elapsed time in sec Vs Various Images filter out use SSI and BSSI

CONCLUSION

For the improvement of Satellite pictures, a Simple and Dynamic for four set calculations (Decomposition, Sharpness Estimation, and Filtering) is introduced. Here alongside the Scalar Sharpness Index, a Block based calculation is exhibited (BSSI) determine the square based sharpness and in the wake of separating this with the picture comes about are introduced. From the outcomes it is anything but difficult to improve high determination the satellite pictures with help of DWT.

REFERENCES


