ABSTRACT: One of the first processes that is proposed about hyperspectral data due to the increased number of imaging bands and the possibility of increasing the radiometric accuracy, is their compression. In this paper, a method is provided for compressing the hyperspectral images. In the proposed compression method, at first compress the image using the wavelet transform method that is a spectral compression method, then the segmentation is performed on the image using watershed method, so that the image is divided into areas with pixels of similar properties. Considering the high volume of data, the hyperspectral image can be sent rather than the segmented hyperspectral image along with the estimated parameters such as mean, variance, seed pixel and texture block of any area that are obtained from the extraction of spectral feature of wavelet transform and in the receiver side, the image can be reconstructed using the transmitted information. This method, considering that it performs the compression using the image segmentation, identifies the small areas which could be removed in the other compression methods, and maintains them during the compression. This method has been implemented on AVIRIS image and created a high compression ratio and also maintained the information about classification.

Keywords: Hyperspectral Images, Watershed, Segmentation, Compression.
of approximate values $A_1$ and the category of coefficients details $D_1$ are at a same level. Then, low-pass and high-pass filters are again applied on the category of coefficients $A_1$ until the two categories of coefficients details $D_2$ and approximate coefficients $A_2$ are produced again. Thus, the two-level wavelet transform creates three categories of coefficients $(A_2, D_2, D_1)$ [4].

4. WATERSHED SEGMENTATION

Using segmenting the image can be divided into its constituent parts, so that the same pixels are placed in an area. Watershed conversion is one of the powerful morphology tools that using identifying continuous borders between areas the images segmentation be done. This conversion operates based on the gray scale of pixels and using the gradient of the image is applicable. In the gray scale of morphology, $f(x,y)$ is a function of the gray level of image and $B(s,t)$ is structural element. Expansion is represented by $d(x,y)$ and erosion is represented by $e(x,y)$ [5].

$$d(x,y) = (f \oplus b)(x,y) = \text{arg \, max}_{(s,t) \in B} \{\hat{d}(f(x + s, y + t), B)\}$$

(3)

So that

$$c_B = \frac{1}{m} \sum_s \sum_t f(s,t)$$

(4)

$$\hat{d}(f(x,y), B) = \text{dist}(f(x,y), c_B)$$

(5)

$$e(x,y) = (f \ominus b)(x,y) = \text{arg \, min}_{(s,t) \in B} \{\hat{d}(f(x - s, y - t), B)\}$$

(6)

According to this definition, the gradient is defined as follows:

$$G(f(x,y)) = d(x,y) - e(x,y) = (f \oplus B)(x,y) - (f \ominus B)(x,y)$$

(7)

The difference between expansion and erosion specifies the edges [6].

5. RECONSTRUCTION OF THE IMAGE

To obtain the mean and variance in the area, the histogram in the area is drawn and the histogram distribution of each Gaussian area was achieved. Based on the Gaussian distribution the mean and variance of each area of the image obtained by the wavelet method is calculated. With this mean and variance the image can be reconstructed on the receiver side but the resulted image is not a clear and transparent image, so other features such as seed pixel and texture block and segmented image. The proposed segmentation method is Metropolis method [7]. After the image reconstruction, in order to evaluate the work performance, the image is classified by the maximum likelihood method, and its accuracy and validity are obtained. Accuracy and validity criteria are achieved in this way:

$$p(i) = \text{i the number of correctly classified pixels in class}$$

$$r(i) = \text{i total number of pixels belonging to class}$$

$$s(i) = \text{i total number pixels with class labeled}$$

$$\text{Total accuracy} = \frac{\sum_{i=1}^{16} p(i)}{\sum_{i=1}^{16} r(i)} \times 100$$

6. SIMULATION RESULTS

To implement the image segmentation methods an image of an agricultural area was used which was taken by AVIRIS spectrometer.

The image has 220 bands and 145×145 pixels in each band. Its spectral range is 400nm to 2500nm. The segmented image using watershed is shown in figure 1. Wavelet transform is performed in two levels on AVIRIS image. The necessary bites to send are including allocated bites to mean and variance of areas, seed pixels of each area, texture block and segmented image. The first component image of the first compressed image using wavelet transform is shown in figure 2.
The reconstructed random image with sent mean and variance of first component of compressed image using wavelet transform method. b). Reconstructed image of figure A using proposed method.

Figure 3.a shows the lack of image clearance due to lack of information in order to reconstruction. Figure 4.b shows clearer and closer image to the original image which is constructed using proposed method.

The compression rate of image using some current methods of compression such as DCT [8], DWT [4], JPEG [9], Neural Network [10] and proposed compression method are shown in table 1.

Table 1. Compression rate of compression methods.

<table>
<thead>
<tr>
<th>Compression methods</th>
<th>Compression rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>DCT</td>
<td>4.38</td>
</tr>
<tr>
<td>DWT</td>
<td>4.96</td>
</tr>
<tr>
<td>JPEG</td>
<td>6.86</td>
</tr>
<tr>
<td>Neural Network</td>
<td>4.43</td>
</tr>
<tr>
<td>Proposed method</td>
<td>34.41</td>
</tr>
</tbody>
</table>

According to table 1 the compression rate of proposed method is highest to the current mentioned methods. The classification validity and accuracy of compressed images using wavelet transform and proposed methods are shown in table 2 and 3 in order to maintain the information related to classification.

Table 2. Classification validity and accuracy value of compressed image using wavelet transform method.

<table>
<thead>
<tr>
<th></th>
<th>Total accuracy</th>
<th>Total validity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>77.64</td>
<td>77.32</td>
</tr>
</tbody>
</table>

Table 3. Classification validity and accuracy value of compressed image using proposed method.

<table>
<thead>
<tr>
<th></th>
<th>Total accuracy</th>
<th>Total validity</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>76.51</td>
<td>76.23</td>
</tr>
</tbody>
</table>

There is high probability of error with high value due to high compression rate; however, the comparison results of validity and accuracy in classification of images using these two methods do not show visible and significant differences. This suggests that the necessary information for classification in maintained by spatial and spectral compression.

7. CONCLUSION

Using the Watershed segmentation method, the upper areas have been created. But the high number has caused the heterogeneous areas not to integrating, or avoids the areas' boundaries interference problem. The more the number of the areas, considering that the transmitted information is related to characteristics extracted from each area, the more information is transmitted and the compression ratio is reduced; but compared with the mentioned methods, the proposed method has a higher compression ratio. Due to the small sizes of the areas, however, the partial and small parts of the image have been preserved during the classification. With respect to the amount of the accuracy and validity, it can be concluded that the proposed method was also able to maintain the information required for the classification in addition to the high compression ratio.

REFERENCES


