

Satellite Image JPEG Compression

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Abstract

This paper proposes a novel compression scheme to compress multi band satellite images using JPEG in efficient manner. Satellite images are multiband images that constitute bands in several regions of the electromagnetic spectrum. Wavelet transform compression and Bendelet compression Techniques were generally used with satellite images. Here we proposed a scheme to compress satellite images using JPEG.

1. Introduction

The basic type of multiband aerial photography, multiband color photography, was developed during World War II as a means of identifying camouflaged objects from aerial photographs and subsequently came into wide use for various scientific and practical purposes. Multiband aerial photography is more effective than aerial photography in a single spectral region, because the reflectance of natural and man-made objects on the earth's surface depends on the wavelengths used.

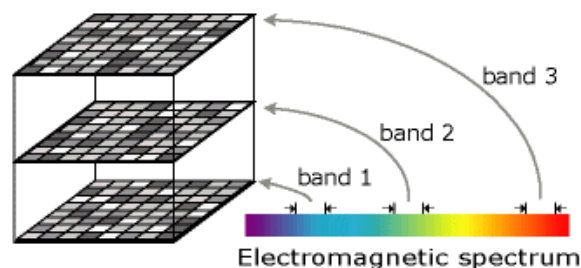


Fig 1 Multi Bands of satellite Image

Each band usually represents a segment of the electromagnetic spectrum collected by a sensor (including ultra-violet and infrared). The term "band" derives from the reference to the color band on the electromagnetic spectrum

Multiband imagery is usually stored in three formats: the band sequential method (.bsq), the band interleaved by line method (.bil), and the band interleaved by pixel method (.bip)[2]. The band sequential method stores the values of an image band as one file. If an image has seven bands then the data set has seven consecutive files, one for each band. The band interleaved by line method stores the values of all the bands in one file, row by row. The band interleaved by pixel method stores the values of all the bands by pixel in one file

2. Method

A satellite image, for example, commonly has multiple bands representing different wavelengths from the ultraviolet through the visible and infrared portions of the electromagnetic spectrum. Landsat imagery, for example, is data collected from seven different bands of the electromagnetic spectrum. Bands 1–7, including 6, represent data from the visible, near infrared, and mid-infrared regions. Band 6 collects data from the thermal infrared region. Another example of a multiband image is a true color ortho-photo in which there are three bands, each representing either red, green, or blue light.

The below method describes the operation of JPEG compression on satellite image.

1) The image constitute of 7 bands. Each band relate to different electromagnetic spectrum. We extract each band separately

2) Each of the Bands are partitioned into blocks of size 8×8 [3].

3) The DCT of each 8×8 block is calculated. Let $x(i, j)$ denote the (i, j) -th pixel in block, and $X(u, v)$ the (u, v) -th frequency in the DCT and $X(1, 1)$ is the "DC" coefficient, and remaining are "AC" coefficients. The quantization of DCT coefficients using a 8×8 matrix Q as follows:

$$X_Q(u, v) = \text{round} \left\{ \frac{X(u, v)}{Q(u, v)} \right\} \quad u, v = 1, \dots, 8. \quad \dots(1)$$

4) The quantized block X_Q is scanned in "zig-zag" order. DC value of the previously coded block is subtracted from the quantized DC coefficient and then it is stored [4].

5) We may decompress each band according to the below relation.

$$\hat{x}(u, v) = Q(u, v)X_Q(u, v),$$

$$u, v = 1, \dots, 8. \quad \dots(2)$$

\hat{x} will not be the same as X due to rounding. This will introduce some noise into the image.

6) Finally we recombine all the compressed bands together.

3. Multiband Images

Some images have a single band, or layer of data, while others have multiple bands. Basically, a band is represented by a single matrix of cell values, and an image with multiple bands contains multiple spatially coincident matrices of cell values representing the same spatial area. Most satellite imagery has multiple bands, typically containing values within a range or band of the electromagnetic spectrum.

There are three main ways to display single-band raster datasets:

- In a binary image, each cell has a value of 0 or 1 and is often displayed using black and white.
- Grayscale—In a grayscale image, each cell has a value from 0 to another number, such as 255. These are often used for black-and-white aerial photographs.
- Color map—One way to represent colors on an image is with a color map. A set of values is coded to match a defined set of red, green, and blue (RGB) values.

The three main ways to display single-band raster datasets are shown below.

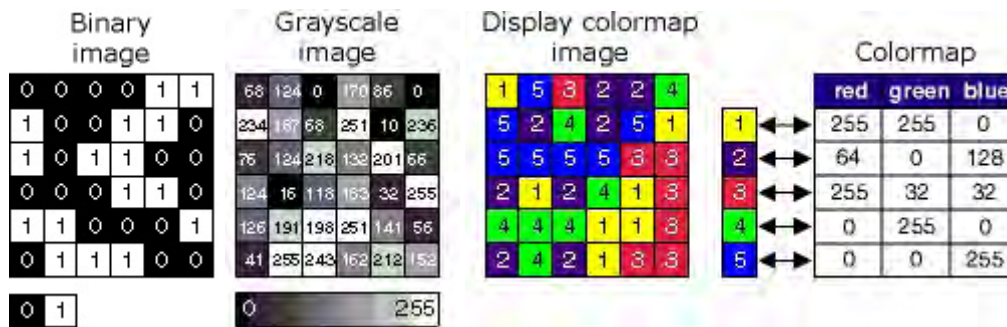


Fig 2 Binary, Grayscale and Color Image

When there are multiple bands, every cell location has more than one value associated with it. With multiple bands, each band usually represents a segment of the electromagnetic spectrum collected by a sensor. Bands can represent any portion of the electromagnetic spectrum including ranges not visible to the eye such as the infrared or ultraviolet sections. The term band originated from the reference to the color band on the electromagnetic spectrum.

4. The DCT Equation

$$D(i, j) = \frac{1}{\sqrt{2N}} C(i) \cdot C(j) \sum_{x=0}^{N-1} \sum_{y=0}^{N-1} P(x, y) \cos \left[\frac{(2X+1)i\pi}{2N} \right] \cos \left[\frac{(2Y+1)j\pi}{2N} \right] \dots(3)$$

The above equation computes the DCT of (i,j)th element of the image. Because DCT uses cosine functions, the resulting matrix depends on horizontal, vertical and diagonal frequencies.

Here $N=8$, $P(x,y)$ is the pixel element.

5. Quantization

Quantization is defined as division of each DCT coefficient by its corresponding quantizer step size, followed by rounding to the nearest integer:

$$X_Q(u, v) = \text{round} \left\{ \frac{X(u, v)}{Q(u, v)} \right\} \quad u, v = 1, \dots, 8. \quad \dots(4)$$

Dequantization is the inverse function, which in this case means simply that the normalization is removed by multiplying by the step size, which returns the result to a representation appropriate for input to the IDCT:

$$\hat{x}(u, v) = Q(u, v) X_Q(u, v), \quad u, v = 1, \dots, 8. \quad \dots(5)$$

In the Quantization, The Q matrix is fixed across a band.

$$Q_{50} = \begin{bmatrix} 16 & 11 & 10 & 16 & 24 & 40 & 51 & 61 \\ 12 & 12 & 14 & 19 & 26 & 58 & 60 & 55 \\ 14 & 13 & 16 & 24 & 40 & 57 & 69 & 56 \\ 14 & 17 & 22 & 29 & 51 & 87 & 80 & 62 \\ 18 & 22 & 37 & 56 & 68 & 109 & 103 & 77 \\ 24 & 35 & 55 & 64 & 81 & 104 & 113 & 92 \\ 49 & 64 & 78 & 87 & 103 & 121 & 120 & 101 \\ 72 & 92 & 95 & 98 & 112 & 100 & 103 & 99 \end{bmatrix}$$

The above matrix relate to 50 percent quantization , which relate to good quality to compression ratio. We can vary quantization matrix accordingly by multiplying with a appropriate scalar. The values of quantization matrix ranges from 1 to 255[7].

5. EXPERIMENTAL RESULTS

We used .lan multiband satellite image files containing 7 bands. MATLAB was used as the programming platform.

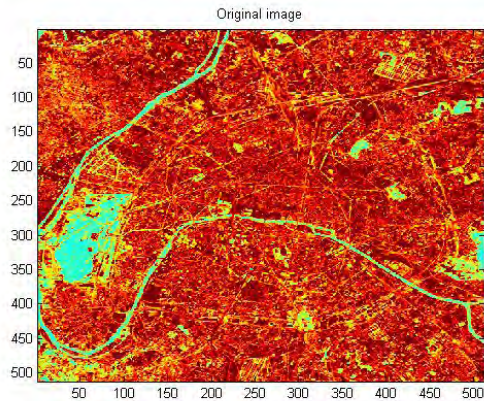


Fig 3.1 Original band of satellite image

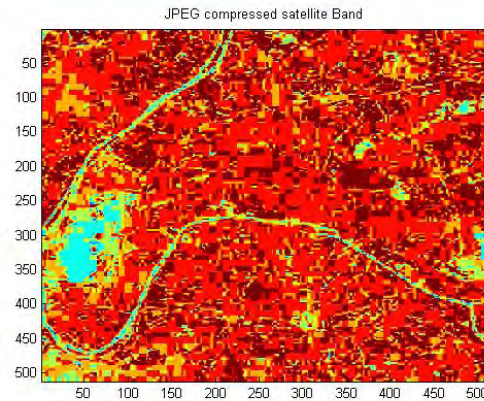


Fig 3.2 Compressed output of satellite Band with Q₁₀

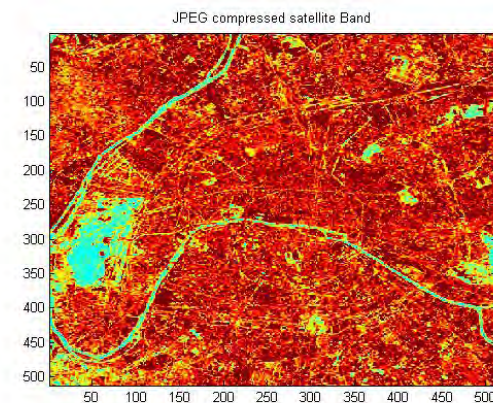


Fig 3.3 Compressed output of satellite Band with Q₅₀

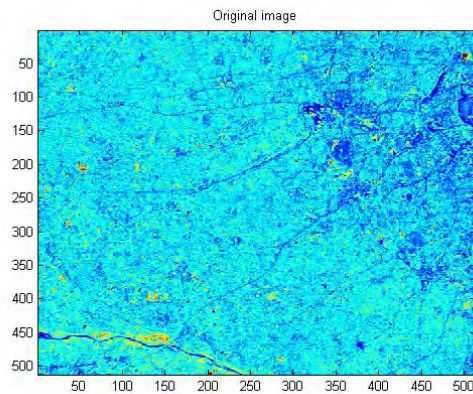
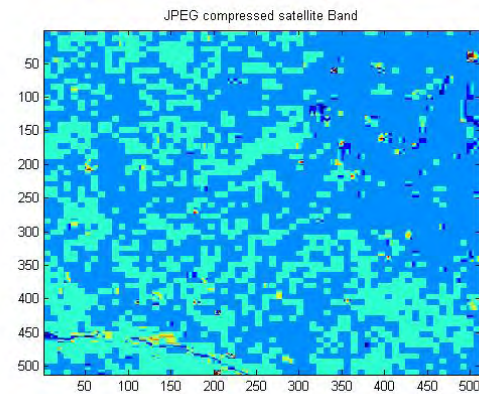
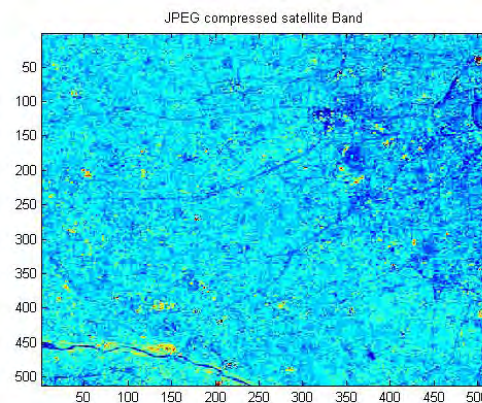


Fig 3.1 Original band of satellite image

Fig 3.2 Compressed output of satellite Band with Q₁₀Fig 3.3 Compressed output of satellite Band with Q₅₀

6. Conclusion

In this paper, we demonstrated a simple method to compress satellite images using JPEG

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