IMAGE FUSION OF SATELLITE IMAGES

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WHAT IS IMAGE FUSION AND WHY IS IT IMPORTANT?

• Process of combining information from two or more images to form a final fused image

• We will be using a low resolution multispectral satellite image and a high resolution panchromatic satellite image.

• It is more cost efficient

• The resulting Multispectral satellite images are used to
  • gather agriculture and resource data
  • gather information for urban and land development
Berlin Satellite Images

256 x 128

1024 x 512
MANIPULATING MATRICES

- Images are stored into the computer as large matrices
- Each entry corresponding from 0 (black) to 255 (white)
- For color images, each entry has a vector containing three entries
- We can manipulate the image by manipulating the matrix
Y-Cb-Cr

- It is a color space
- It is used to encode color images based on human perception

\[
Y = 219 \left( \frac{.299}{255} r + \frac{.587}{255} g + \frac{.114}{255} b \right) + 16
\]

\[
Cb = \frac{224 \left( \frac{b}{255} - Y \right)}{1.772} + 128
\]

\[
Cr = \frac{224 \left( \frac{r}{255} - Y \right)}{1.402} + 128
\]
Enlarged the color satellite image and separated it into its luminance and chrominance channels.
DISCRETE WAVELET TRANSFORM METHOD

- We used the Haar wavelet.
- Applied the Haar wavelet transform to each channel and the grey scale image.
- Applied multiple iterations to the blur.
• Due to the blur being downsized, we were limited on the amount of iterations we could compute.

• 2 iterations
4\textsuperscript{th} Haar Iteration

5\textsuperscript{th} Haar Iteration

6\textsuperscript{th} Haar Iteration

7\textsuperscript{th} Haar Iteration
DISCRETE WAVELET FRAME TRANSFORM METHOD

• Applying these filters to the image would not downsize the blur

1. Blur : applied the low pass filter to the rows and columns

2. Vertical edges : applied the low pass filter to the rows and the high pass filter to the columns

3. Horizontal edges : applied the high pass filter to the rows and the low pass filter to the columns

4. Diagonal edges : applied the high pass filter to the rows and columns
IMPROVEMENT OF SPATIAL CHARACTERISTICS

Peak Signal to Noise Ratio (PSNR)
- Measures how similar two images are by comparing each entry

YCbCr PSNR
28.8008 img w/ori
Entropy
• Measures length of shortest representation to encode the information

YCbCr Entropy
7.92296 fused image
PRESERVATION OF SPECTRAL CHARACTERISTICS

Correlation Coefficient
- Determines the degree to which two variables are associated
Spectral Discrepancy
• Measures the difference in the intensities of the corresponding spectral bands
CLOSE-UP

Original

4th Haar Iteration

DWFT (15th iteration)

Y-Cb-Cr
CONCLUSION AND FUTURE RESEARCH

• The DWFT seems to provide the best quality of the fused image
• Due to the amount of computations needed to compute the DWFT, it is not as practical as the others.
• Further research could include
  • Computing more iterations using the DWFT method
  • Manipulating the color transfer method by applying discrete wavelet transform methods along with the color transfer methods
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