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

COLOR TRANSFER METHOD

Y-Cb-Cr

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

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

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

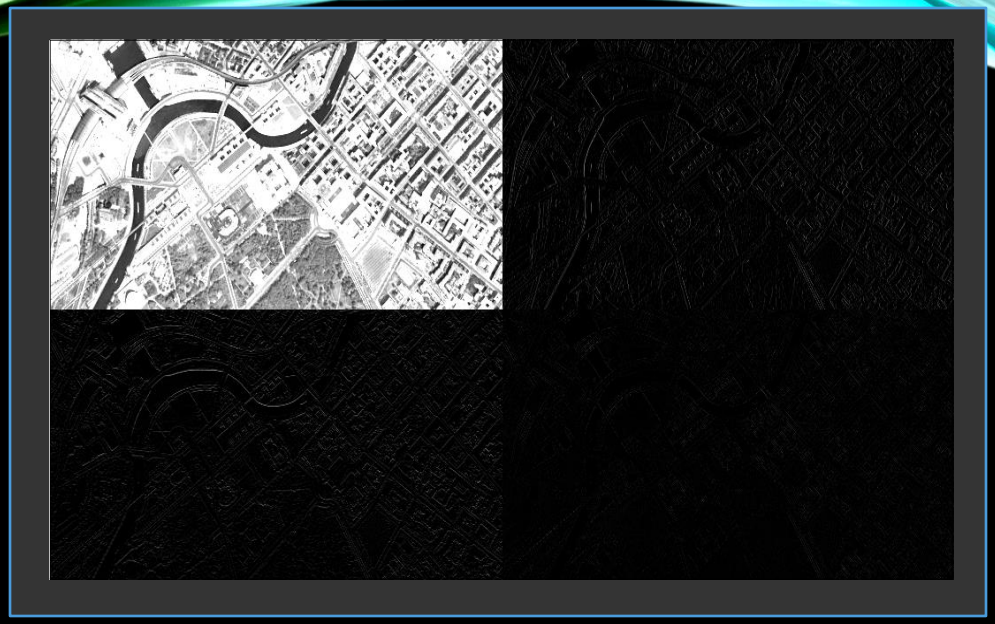
$$Cr = \frac{224\left(\frac{r}{255} - Y\right)}{1.402} + 128$$

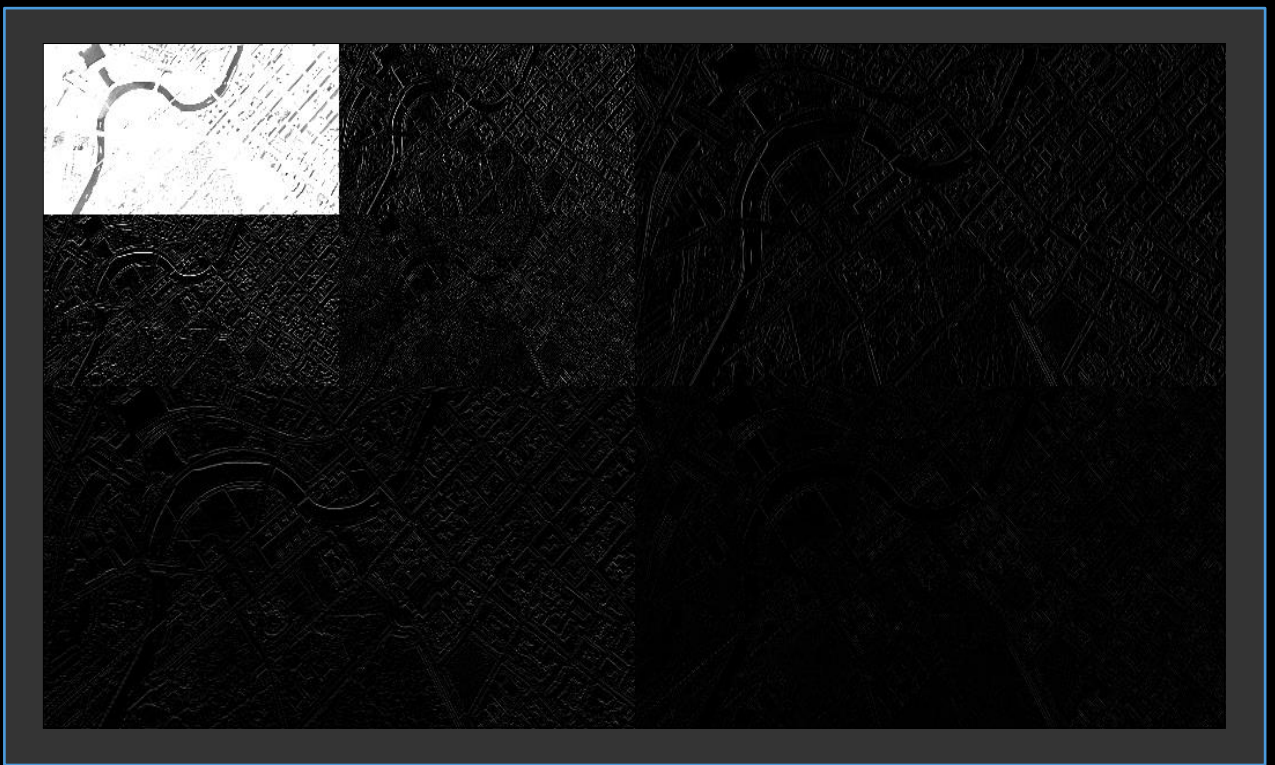
- Enlarged the color satellite image and separated it into its luminance and chrominance channels

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

4th Haar Iteration

5th Haar Iteration

6th Haar Iteration

7th Haar Iteration

DISCRETE WAVELET FRAME TRANSFORM METHOD

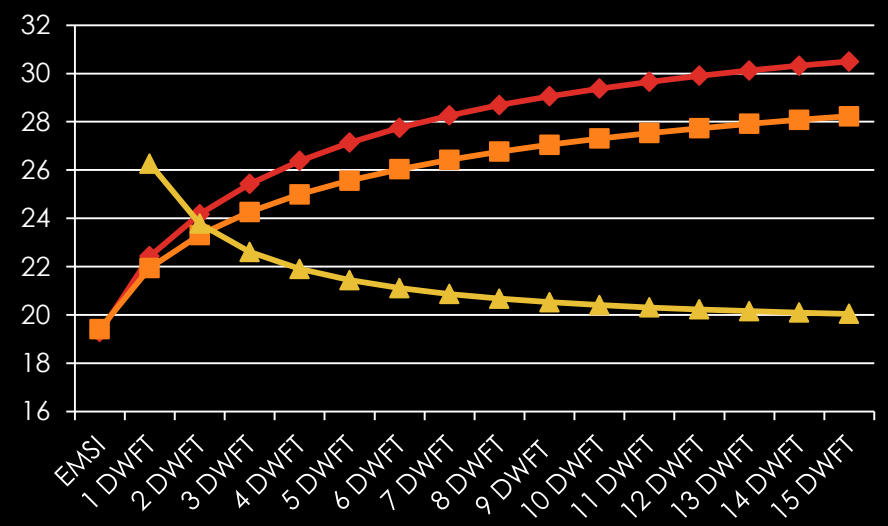
- Applying these filters to the image would not downsize the blur

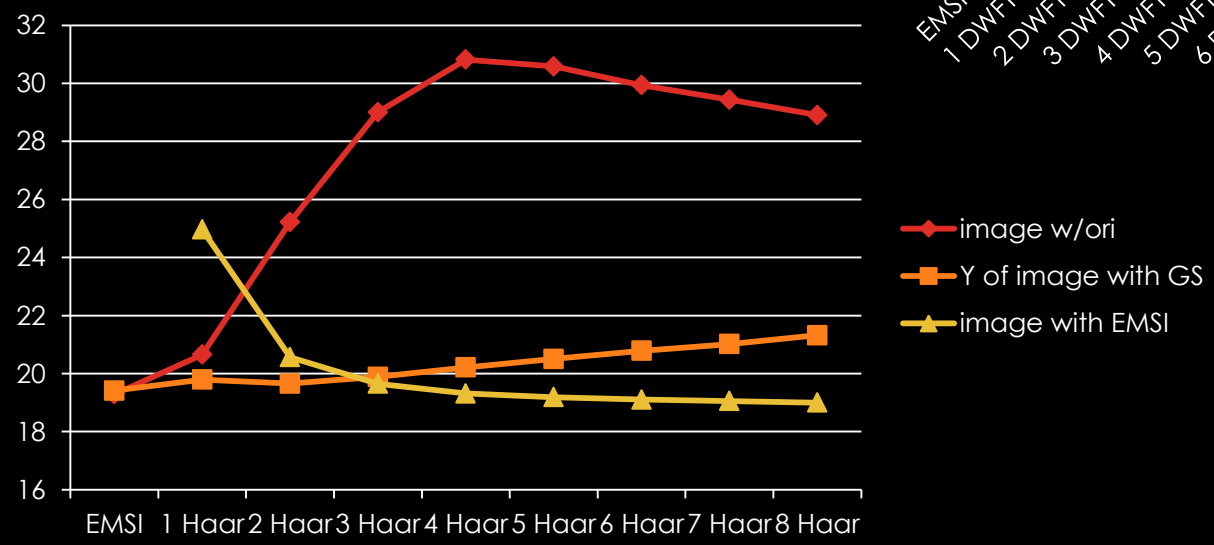
1. Blur : applied the low pass filter to the rows and columns
2. Vertical edges : applied the low pass filter to the rows and the high pass filter to the columns
3. Horizontal edges : applied the high pass filter to the rows and the low pass filter to the columns
4. Diagonal edges : applied the high 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



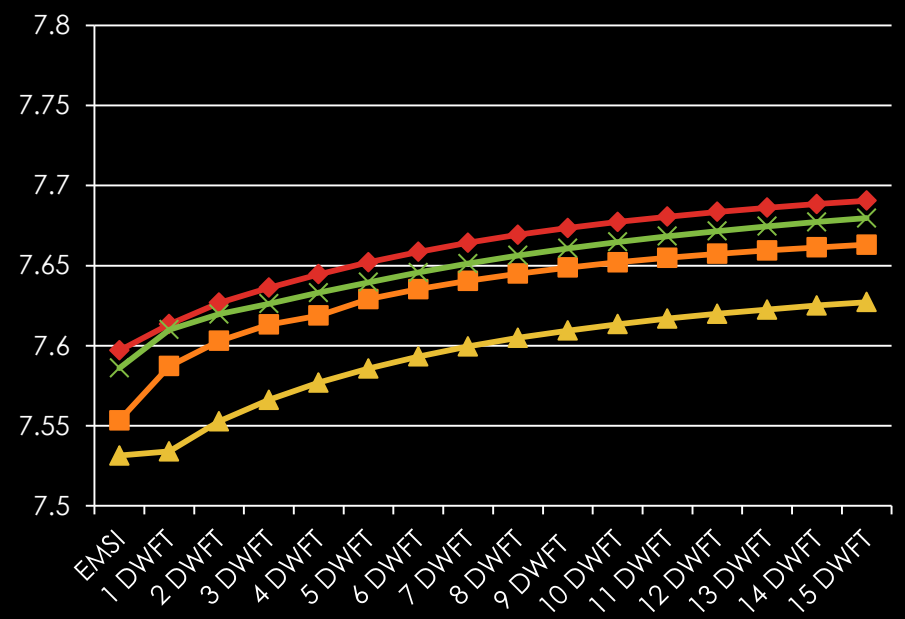


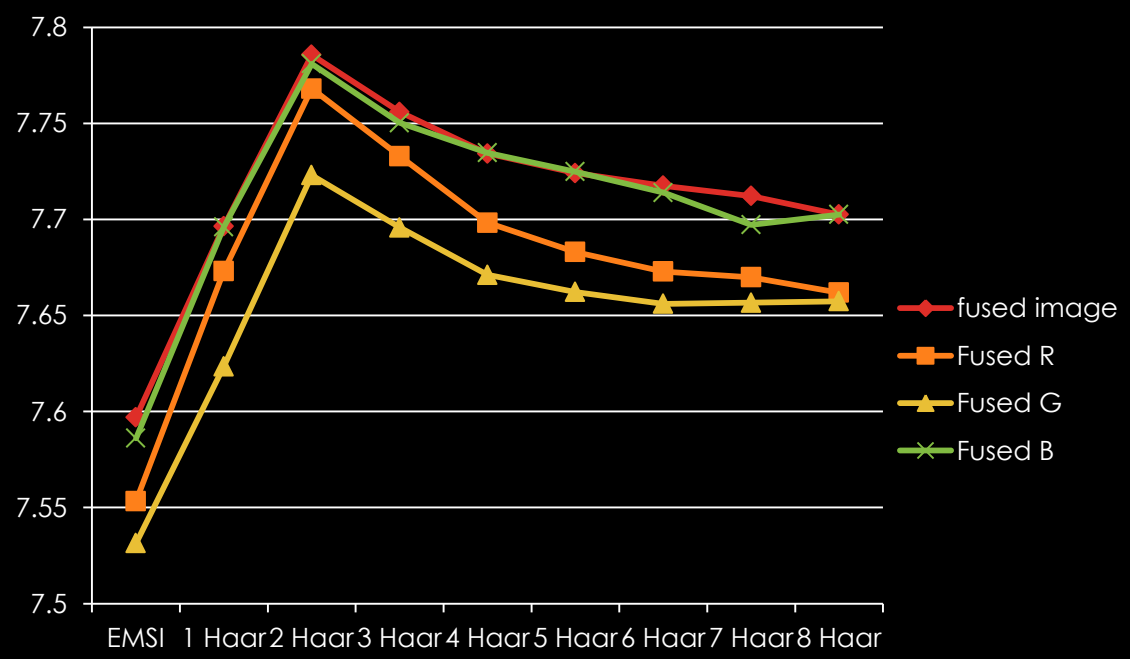
YCbCr PSNR

28.8008 img w/ori

Entropy

- Measures length of shortest representation to encode the information





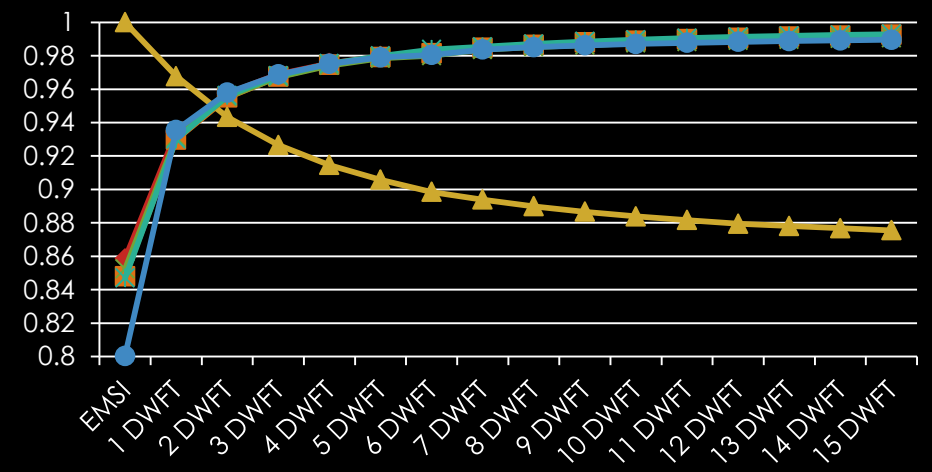
YCbCr Entropy

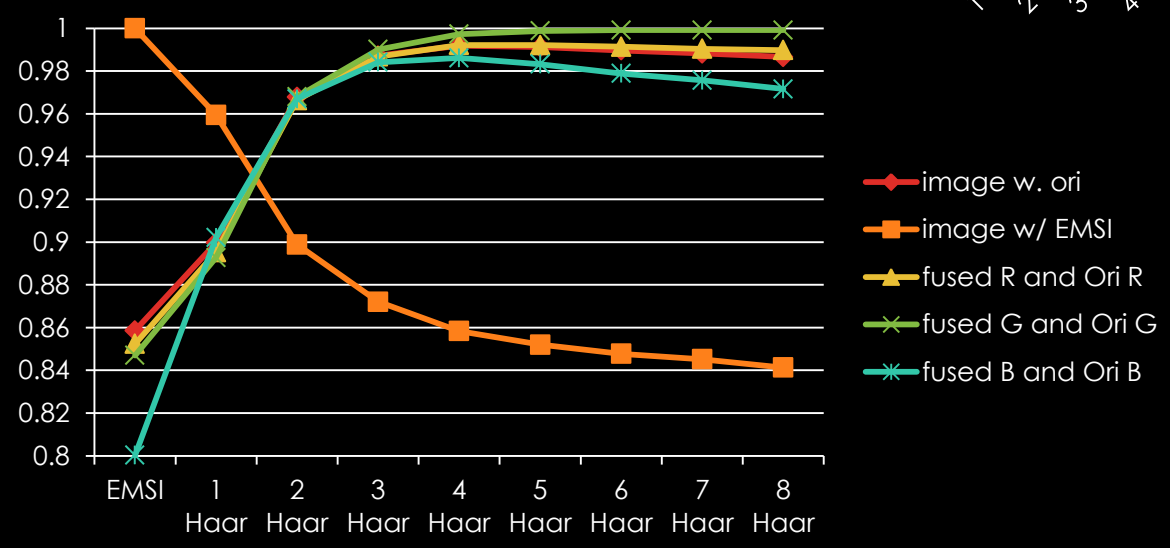
7.92296 fused image

PRESERVATION OF SPECTRAL CHARACTERISTICS

Correlation Coefficient

- Determines the degree to which two variables are associated



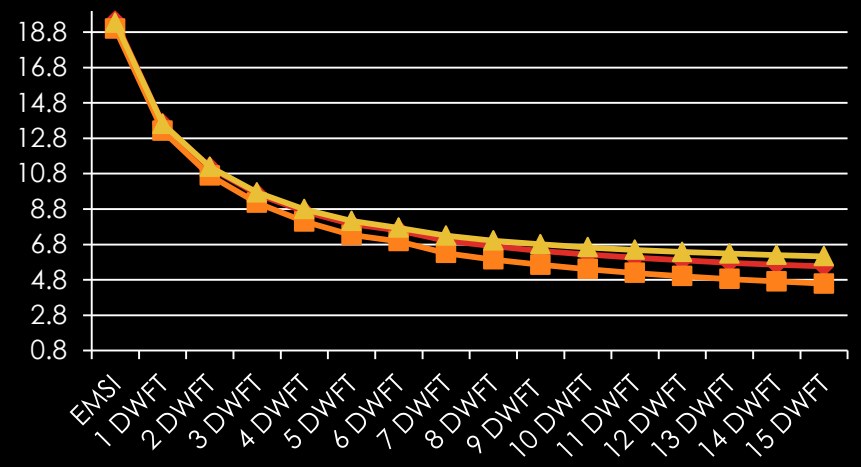


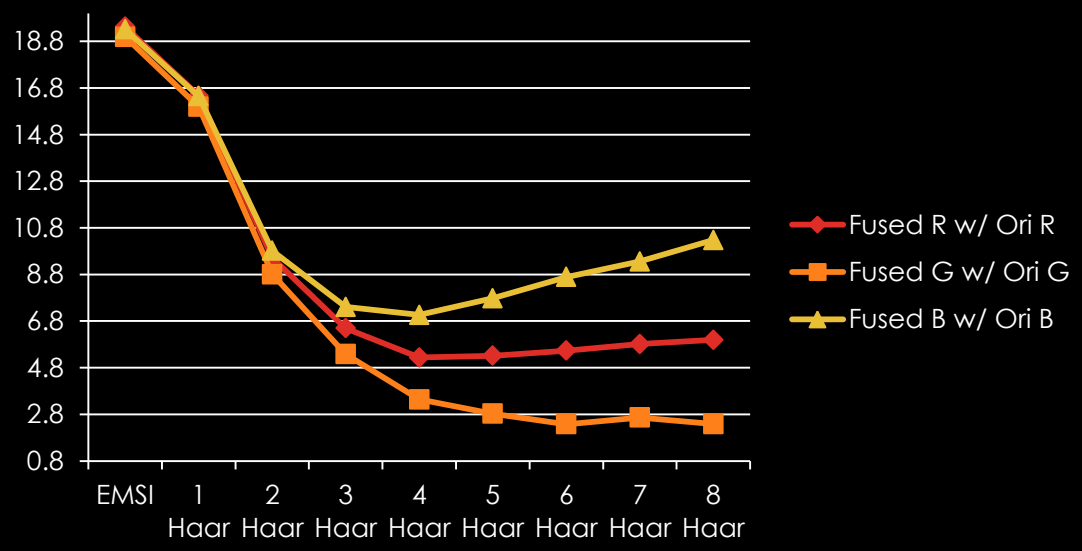
YCbCr correlation coefficient

0.99695 img w/ori

Spectral Discrepancy

- Measures the difference in the intensities of the corresponding spectral bands





YCbCr Spectral Discrepancy

7.2278 red channels
6.83007 green channels
7.93516 blue channels

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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