Spatial Filtering & Edge Enhancement

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Task 1: Image Filtering

Original Image: lambert_aster

Parts of this document have been redacted to prevent academic integrity violations and plagiarism

[redacted]

[redacted]

Question 1: Write out the kernels of 3x3 and 5x5 mean, median and Gaussian filters. What are the general visual results from mean, median, and Gaussian filtering? Comparing mean, median, and Gaussian filtering results, are there any noticeable differences around the edges of features?

MEDIAN

[redacted]

OTHER KERNELS

Kernel Equation

$$\text{New Value} = \frac{\sum(w_{ij} * x_{ij})}{N}$$

w is the weights matrix — *x* is the value from original image
ij are indexes — *N* is number of cells in matrix

Weight Matrices

Low Pass [redacted]

$$\begin{Bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{Bmatrix} \qquad \begin{Bmatrix} 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 \\ 1 & 1 & 1 & 1 & 1 \end{Bmatrix}$$

Gaussian

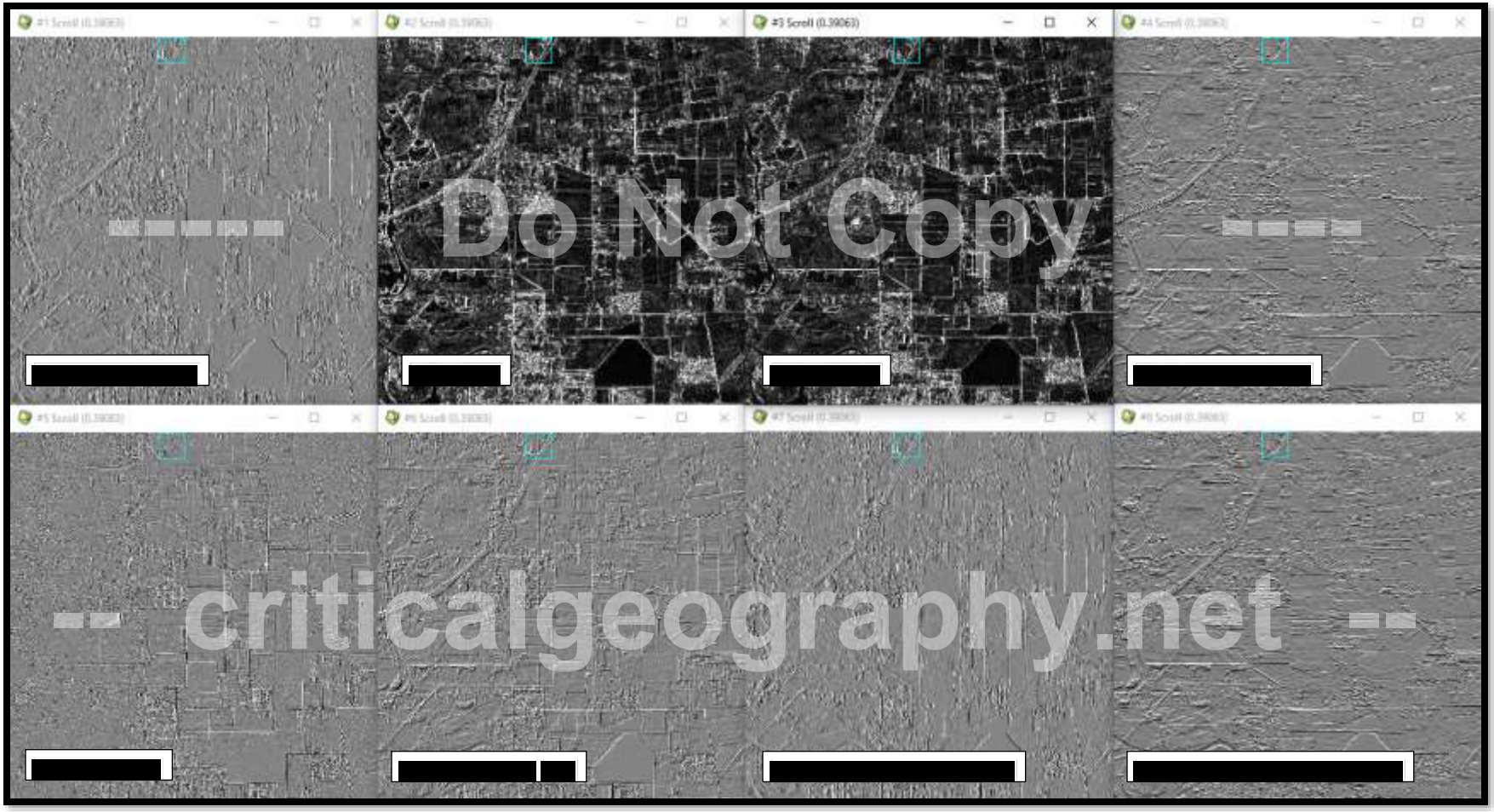
$$\begin{Bmatrix} 0.0007 & 0.0256 & 0.0007 \\ [redacted] \\ 0.0007 & 0.0256 & 0.0007 \end{Bmatrix}$$

The median and low pass (mean) kernels produced similar results [redacted]. Both the median and low pass, however, produced a sharper image using the 3x3 versus the 5x5 kernel.

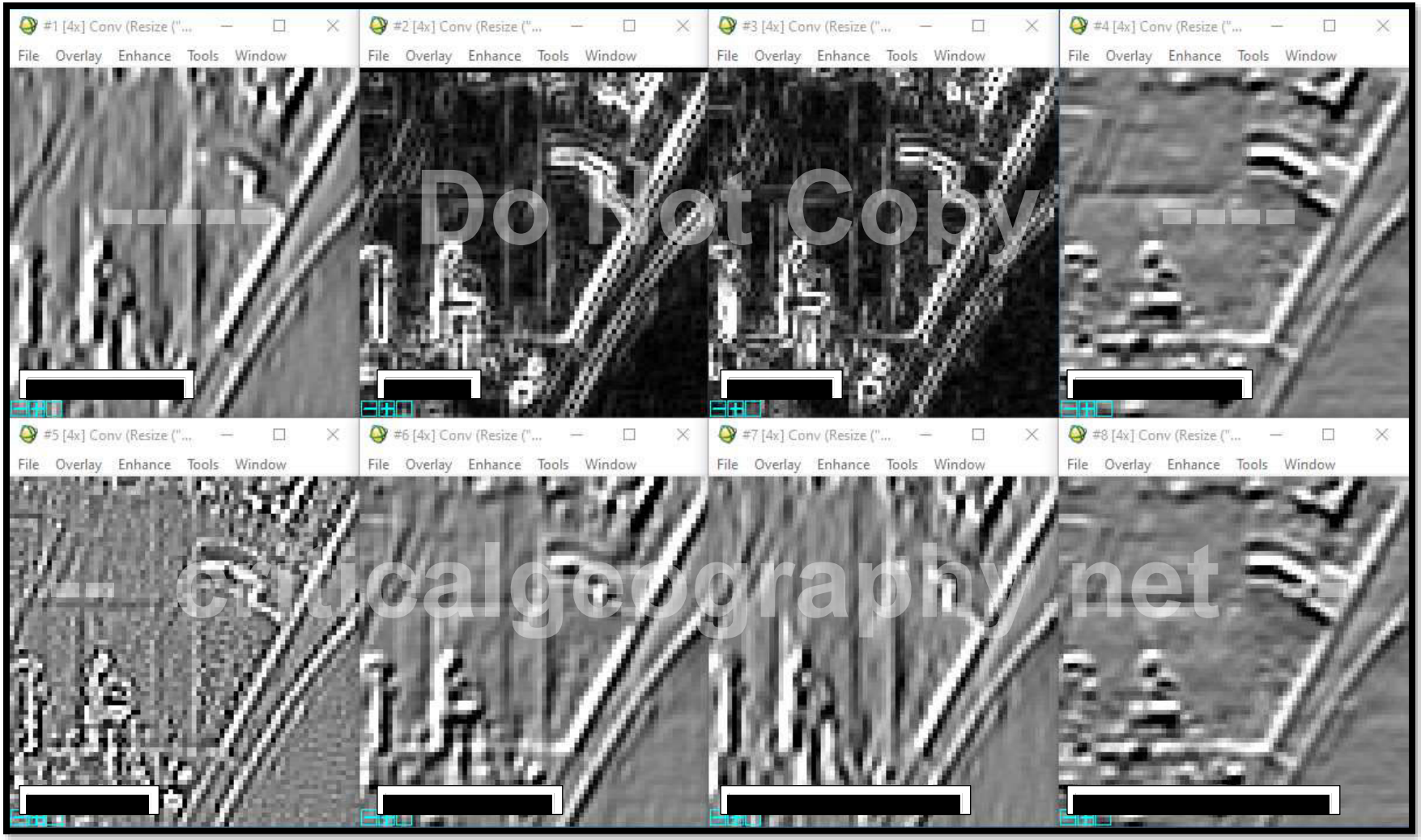
The [redacted] kernel produced the sharpest image of all, but again, I think the 3x3 was slightly better than the 5x5. Of course, depending on your purposes, you might prefer a visibly "smoother" image.

Task 2: Edge Enhancement

Original Image: agr_spot



Scroll View


#1 [4x] Conv (Resize ("...
File Overlay Enhance Tools Window
#2 [4x] Conv (Resize ("...
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#3 [4x] Conv (Resize ("...
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#7 [4x] Conv (Resize ("...
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#8 [4x] Conv (Resize ("...
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Zoom

Question 2: What are the kernels for the directional, Laplacian, Sobel, Roberts, and Prewitt edge detectors? What are the general visual results from these edge detectors? Describe what edges and linear features are highlighted with each of above edge operator. Which edge operators do you think are appropriate for enhancing and highlighting east-west oriented linear features and edges?

Directional

$$\begin{Bmatrix} 1 & 1 & 1 \\ 0 & 0 & 0 \\ -1 & -1 & -1 \end{Bmatrix}$$

Best for [redacted]

$$\begin{Bmatrix} -1.4142 & -0.7071 & 0 \\ -0.7071 & 0 & 0.7071 \\ 0 & 0.7071 & 1.4142 \end{Bmatrix}$$

Best for [redacted]
Can also be oriented to "point" towards any of the other corners

$$\begin{Bmatrix} -1 & 0 & 1 \\ -1 & 0 & 1 \\ -1 & 0 & 1 \end{Bmatrix}$$

Best for [redacted]

$$\begin{Bmatrix} 0 & -1 & 0 \\ -1 & 4 & -1 \\ 0 & -1 & 0 \end{Bmatrix}$$

Good to enhance/highlight borders, boundaries, and roads in multiple directions. Good for general sharpening, but [redacted] and adds a decent amount of noise.

[redacted]

$$\begin{Bmatrix} 1 & 0 & -1 \\ 2 & 0 & -2 \\ 1 & 0 & -1 \end{Bmatrix} \text{ and } \begin{Bmatrix} 1 & 2 & 1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{Bmatrix}$$

Produces a black and white image with minimal or no grey. White corresponds to edges and boundaries.

[redacted]

$$\begin{bmatrix} 1 & 0 \\ 0 & -1 \end{bmatrix} \text{ and } \begin{bmatrix} 0 & 1 \\ -1 & 0 \end{bmatrix}$$

Similar to [redacted] and produces a primarily black and white image, but the contrast is less sharp/intense.

[redacted]

$$\begin{Bmatrix} -1 & -1 & -1 \\ 0 & 0 & 0 \\ 1 & 1 & 1 \end{Bmatrix}$$

Similar to [redacted]. Best for [redacted]

[redacted]

$$\begin{Bmatrix} 1 & 0 & -1 \\ 1 & 0 & -1 \\ 1 & 0 & -1 \end{Bmatrix}$$

Similar to [redacted] Best for [redacted]

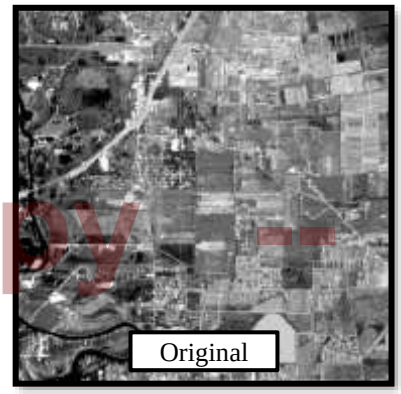
The [redacted] or [redacted] would be best for East-West oriented linear features and edges because the kernels are symmetrical across [redacted], and therefore only weight values that are horizontal to the [redacted]

[redacted]

Question 3: Modify the weight of the central cell in the Laplacian kernel and then apply it to original image. Have you obtained a sharpened image by applying this modified Laplacian kernel?

$$\begin{Bmatrix} -1 & -1 & -1 \\ -1 & 4 & -1 \\ -1 & -1 & -1 \end{Bmatrix} \rightarrow \begin{Bmatrix} -1 & -1 & -1 \\ -1 & 5 & -1 \\ -1 & -1 & -1 \end{Bmatrix}$$

By increasing the value of the central cell, we obtained a much clearer, sharper image than the original Laplacian kernel. Compared to the original image, the higher value kernel outputs a sharpend image where borders and boundaries have increased contrast and appear less "fuzzy." This is also noticable along roads and rivers.



Original Center Value 4 Center Value 5