CE671A:Introduction to remote sensing
Lab6: Filtering In Images

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1 Objective

To understand filtering in images in MATLAB by studying-

- Low High Pass filters, their effect on images and working.
- Edge Detection in Images.

2 Results and discussion

2.1 Importing given image in MATLAB

Given image is imported in MATLAB and displayed as follows-

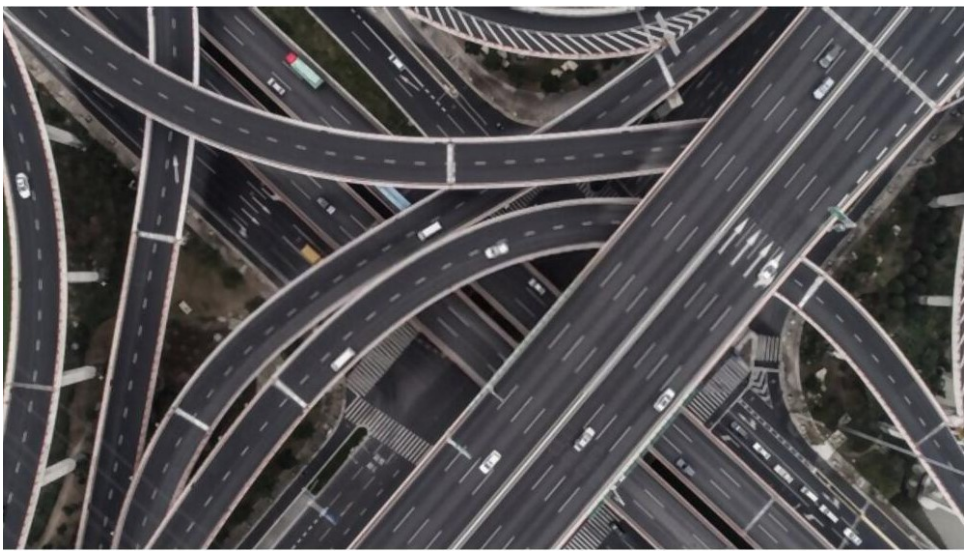


Figure 1: Original given image

2.2 Linear stretching of image

Linear stretching is carried out using imadjust function and image is displayed as follows-

Figure 2: Applying linear stretching

2.3 Applying average Filter

An average filter is created using fspecial function in MATLAB of dimensions 3x3 and 9x9.These filters are applied to image using imfilter function in MATLAB. Average filter of 3x3 can be expressed as follows:

$$f = 1/9 \begin{bmatrix} 1 & 1 & 1 \\ 1 & 1 & 1 \\ 1 & 1 & 1 \end{bmatrix} \tag{1}$$

After applying average filter to given image, images are displayed as follows-

Figure 3: Average filter 3x3

Figure 4: Average filter 9x9

2.4 Applying Median Filter

Median filter is applied to each band of image using medfilt2 function in MATLAB of dimensions 5x5 and 9x9.After applying median filter to each band of given image, these bands are compiled in one to form RGB image of corresponding median filter and displayed as follows:

Figure 5: Median filter image 5x5

Figure 6: Median filter image 9x9

- Comparison of 5x5 and 9x9 median filtered image:

The median filtering process is accomplished by sliding a window over the image. The filtered image is obtained by placing the median of the values in the input window, at the location of the center of that window, at the output image. Median filter thus reduces noise in image by replacing center pixel value by median of neighbouring values. After comparing 5x5 median filtered image and 9x9 median filtered image, it was observed that noise reduction is more noticeable in 9x9 filtered image because it covers wider number of neighbouring pixels for assigning median value to pixel of concern. That's the reason for vanishing of road arrow marks in 9x9 median filtered image.

2.5 Applying High pass filter

Histogram equalization is applied on each band of given RGB image and then all these histogram equalized bands were compiled to form new RGB image, image displayed as follows-

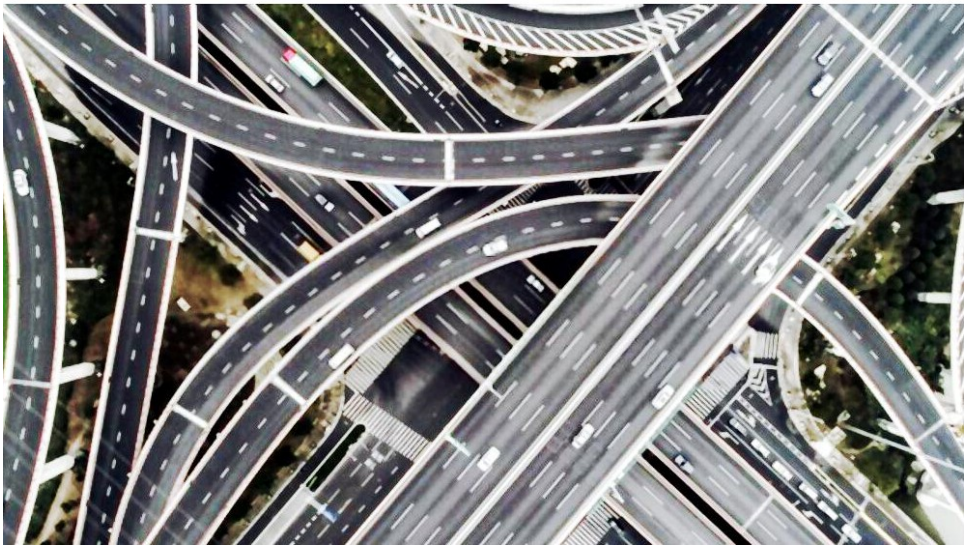


Figure 7: Histogram equalized image

High pass filter of two elements as follows was applied to this image-

- Horizontal High Pass filter
  Delfy = $\begin{bmatrix} 1 & -1 \end{bmatrix}$
- Vertical High Pass filter
  Delfx = $\begin{bmatrix} 1 \\ -1 \end{bmatrix}$

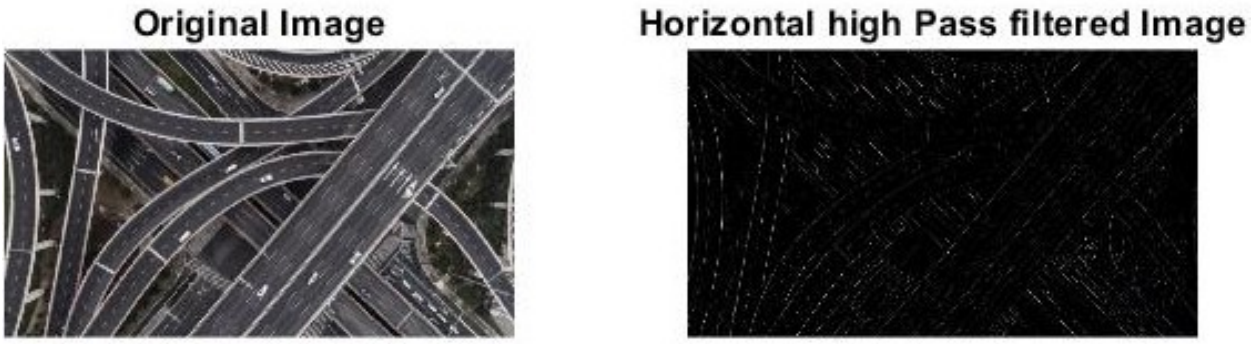


Figure 8: Horizontal high pass filter applied image

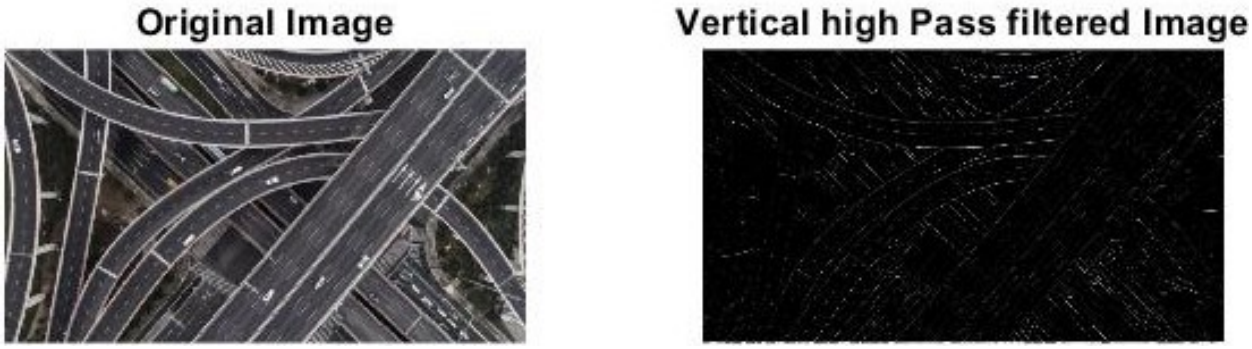


Figure 9: Vertical high pass filter applied image

2.6 Experimenting with Fspecial function in MATLAB

A function fspecial(type) creates a two-dimensional filter of the specified type. Some of the filter types have optional additional parameters. fspecial returns a filter is its designated variable, which is the appropriate form to use with imfilter function in MATLAB. Various inbuilt filters available in Fspecial are as discussed below-

- Motionblur
  h = fspecial('motion',len,theta)
  returns a filter to approximate, once convolved with an image, the linear motion of a camera. len specifies the length of the motion and theta specifies the angle of motion in degrees in a counter-clockwise direction. The filter becomes a vector for horizontal and vertical motions. The default len is 9 and the default theta is 0, which corresponds to a horizontal motion of nine pixels.

Figure 10: Motionblur filter applied image

- Disc filter:
  h = fspecial('disk',radius)
  returns a circular averaging filter (pillbox) within the square matrix of size 2*radius+1. A blurred image is obtained after applying this filter as follows-

Figure 11: Disc filter applied image

- **Edge detector filters: Prewitt and Sobel**
  h = fspecial('prewitt')
  returns a 3-by-3 filter that emphasizes horizontal edges by approximating a vertical gradient. To emphasize vertical edges, transpose the filter h'.

$$f = \begin{bmatrix} 1 & 1 & 1 \\ 0 & 0 & 0 \\ -1 & -1 & -1 \end{bmatrix} \tag{2}$$

  image is obtained after applying this filter as follows-

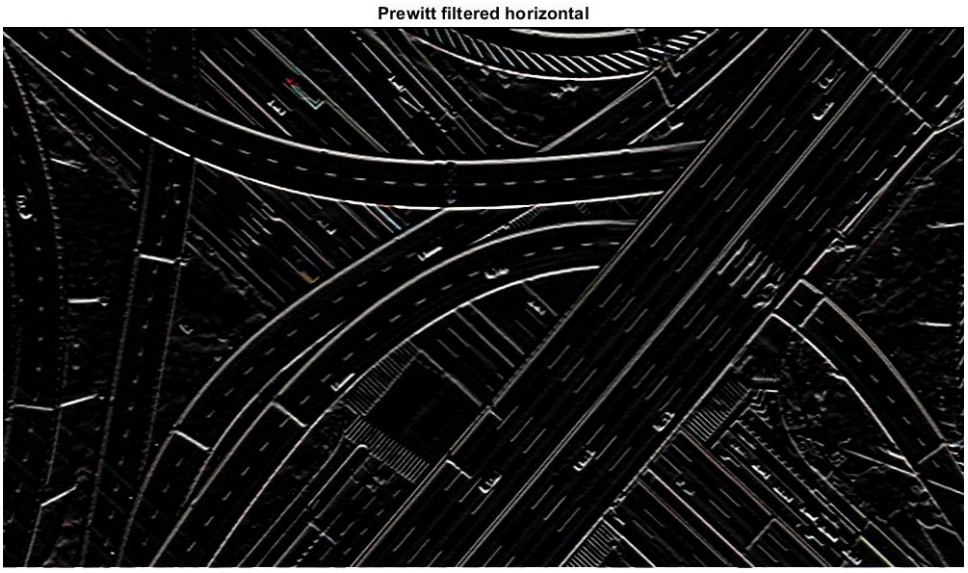


Figure 12: Horizontal Prewitt filter applied image

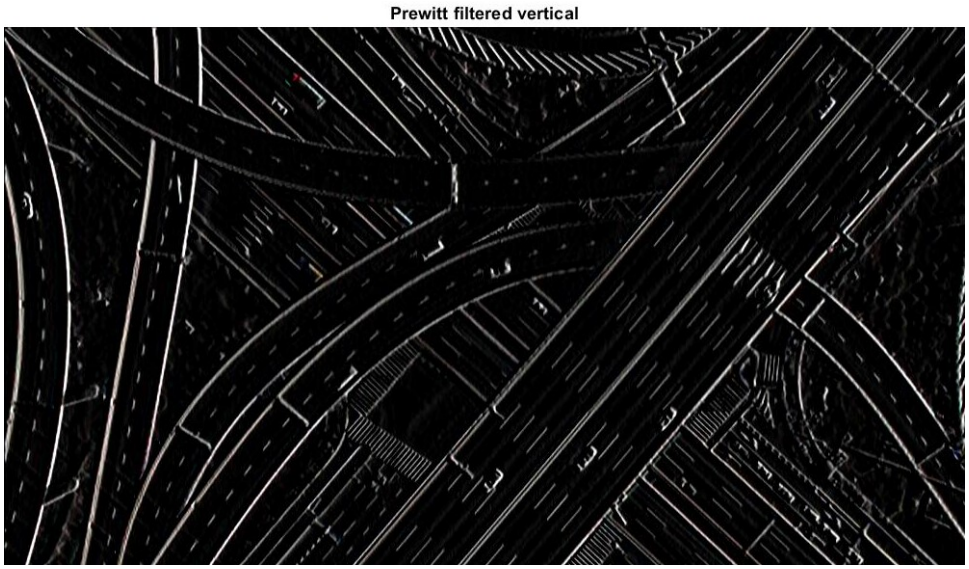


Figure 13: Vertical Prewitt filter applied image

h = fspecial('sobel')
returns a 3-by-3 filter that emphasizes horizontal edges using the smoothing effect by approximating a vertical gradient. To emphasize vertical edges, transpose the filter h'.

$$f = \begin{bmatrix} 1 & 2 & 1 \\ 0 & 0 & 0 \\ -1 & -2 & -1 \end{bmatrix} \tag{3}$$

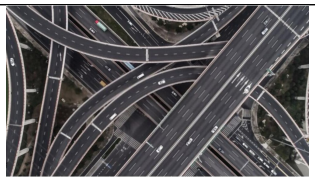
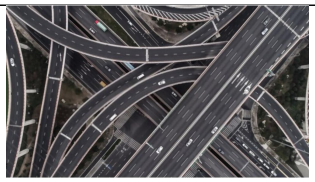
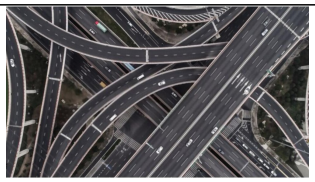
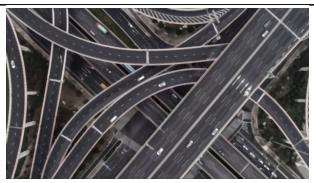
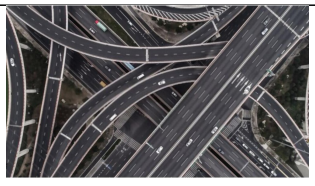
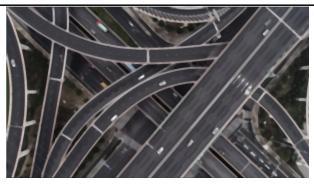
image is obtained after applying this filter as follows-

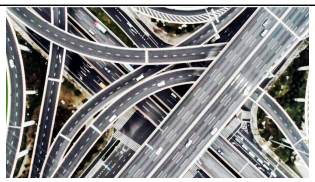
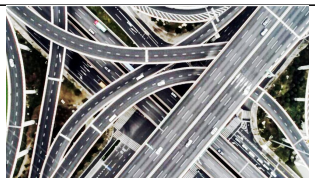
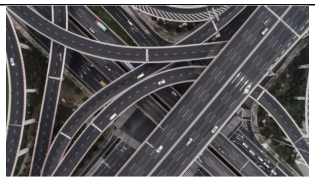
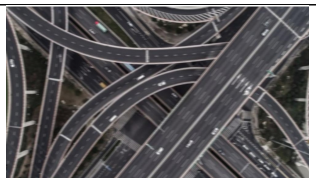
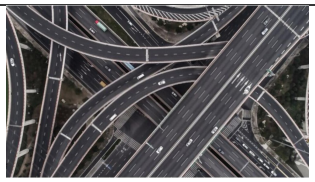
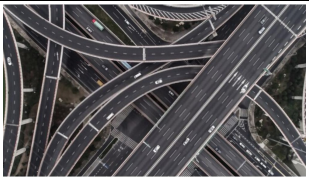
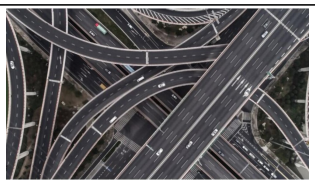
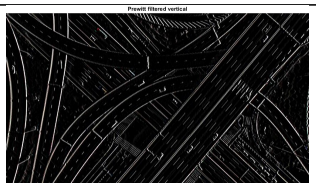
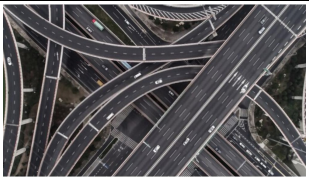
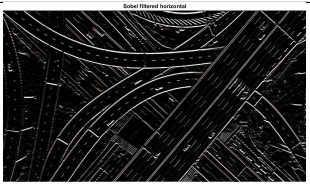
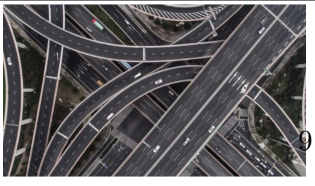
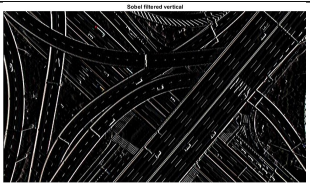
Figure 14: Horizontal sobel filter applied image

Figure 15: Vertical sobel filter applied image

By experimenting with fspecial function in MATLAB it can be concluded that horizontal and vertical prewitt and sobel filters can be used for linear edge detection.

2.7 Observation table

S.No.	filter	Input Image	Output image	Effect of filter
1.	Average Filter			Image was smoothed, intensity variation between adjacent pixels reduced
				Above mentioned effect was more pronounced in 9x9 average filtered image
2.	Median Filter			more smoothing compared to median filter, road marks blurred
				Above mentioned effect was more pronounced in 9x9 median filtered image

S.No.	filter	Input Image	Output image	Effect of filter
3.	Horizontal High Pass Filter			Vertical edges appeared white in colour and rest of image appeared dark.
4.	Vertical High Pass Filter			Horizontal edges appeared white in colour and rest of image appeared dark
5.	Motion blur Filter			image appeared blur than original
6.	Disc Filter			Blur effect was more noticeable than motion blur filter
7.	Prewitt Filter			In horizontal prewitt filtered image, horizontal edges in image appeared bright and emphasized
				In vertical prewitt filtered image, certical edges in image appeared bright and emphasized
8.	Sobel Filter			Same effect but more pronounced as that of prewitt filter, brighter image, horizontal edge detection
				Same effect as that of vertical prewitt filter but more pronounced and bright image

3 Conclusion

- Various filters available in image processing tools were applied to image and studied.
- Average filter do denoising, median filter do denoising and smoothning of image more effectively than average filter, High pass filters sharpens high spatial frequency areas in image.
- Edge detection filters such as pretitt and sobel were successfully applied on image and effect studied.