Leaksmy Heng

CS5330

HW4

Feb 01, 2025

Question & Answer

1. **Give an intuitive definition of the meaning of eigenvectors in the context of image analysis (think about the faces example).**

   An intuitive definition of the meaning of eigenvectors in the context of image analysis would be the feature that captures the most important variation in the image dataset or matrix.

2. **You have the set of eigenvalues 0.3, 0.25, 0.24, 0.12, 0.06, 0.02, 0.01**

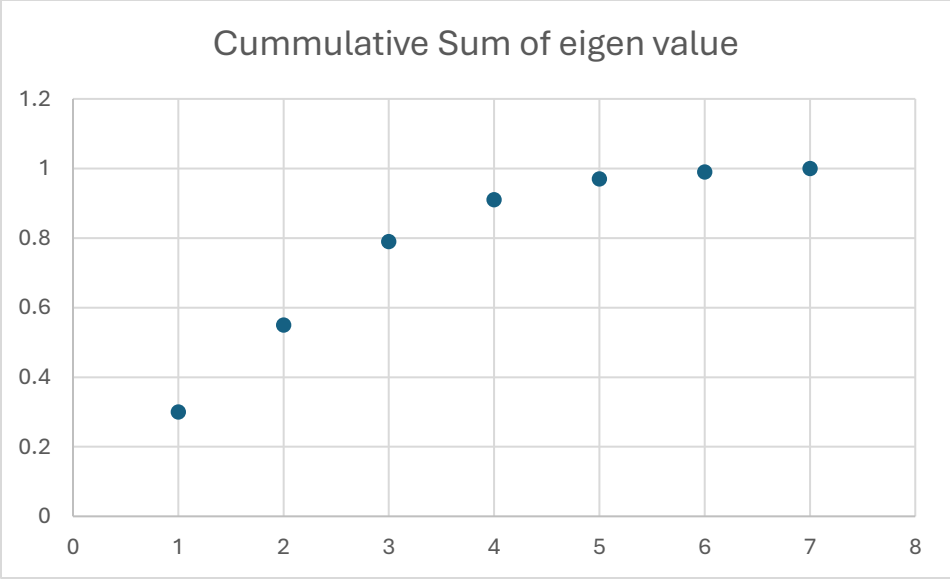
   A. **What is the dimensionality of original data?**

      There are 7 dimensionalities of original data since there are 7 eigenvalues provided.

   B. **How many dimensions of the data would you need to keep to represent 75% of the variation?**

      3 dimensions of the data would need to be kept representing 75% of the variable.

Eigenvalue	Cumulative Sum
0.3	0.3
0.25	0.55
0.24	0.79
0.12	0.91
0.06	0.97
0.02	0.99
0.01	1



C. How many dimensions of the data would you need to keep to represent 90% of the variation?

4 dimensions of the data would need to be kept representing 90% of the variable.

D. If you wanted to see best visualization of the data in 2-D, how would you do it?

To see the best visualization of the data in 2-D, I would like to conduct PCA (Principal Component Analysis).

- Based on the first 3 tasks, we will select 2 principal components (the first 2 eigenvectors corresponding to the largest eigenvalues).
- Project data onto the first two principal components (project matrix A onto the first two eigenvectors which correspond to 0.3 and 0.25 eigenvalue)
- Visualize the result 2D representations

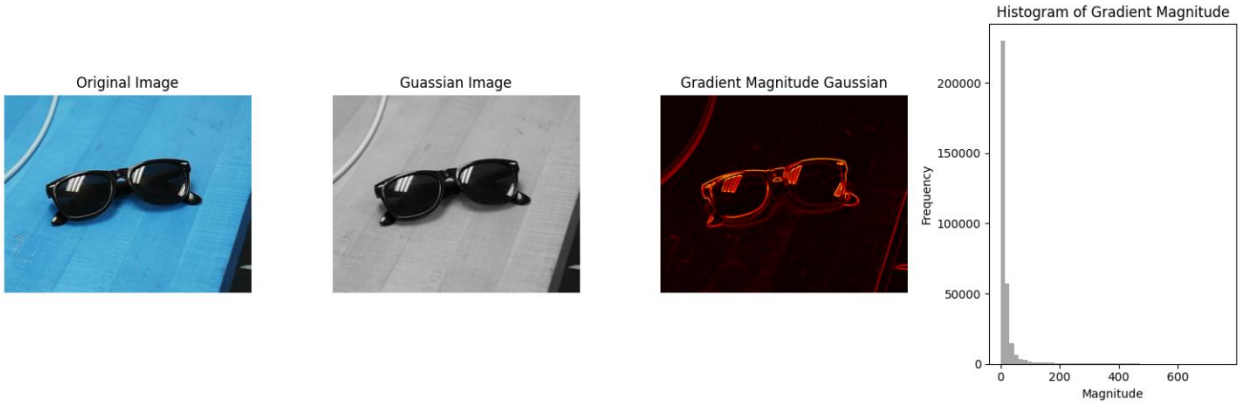
3. Find an example of aliasing in visual media. It can be spatial, temporal, or spectral aliasing. Include either a link to your example or the example itself in your submission, along with a description.

The first image used Canon D60 which has the antialias filter where as the second one used Signma SD-9 which does not have any antialias filter resulting in moire patters on the image.

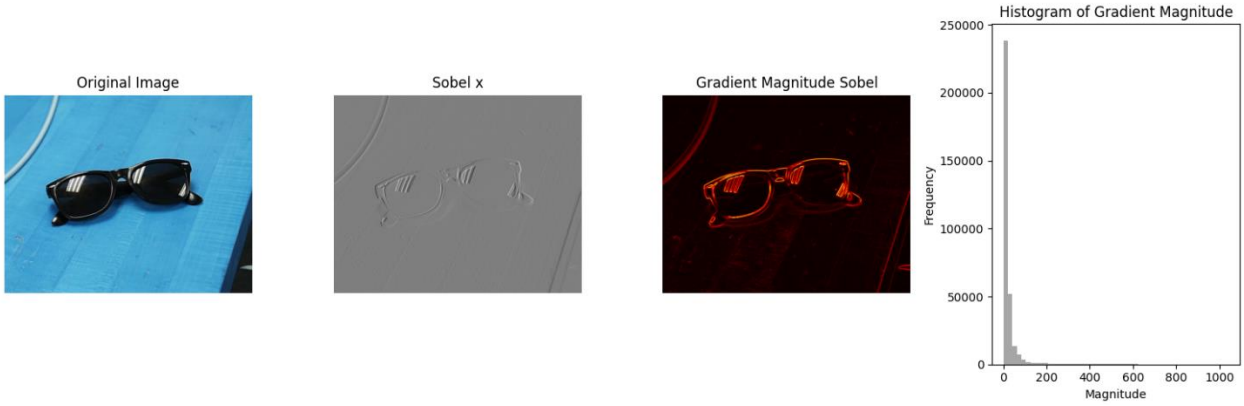
Source: https://matthews.sites.wfu.edu/misc/DigPhotog/alias/

4. Select two different textures and use your project 1 program to show the gradient magnitude for each texture. Would average energy of gradient magnitude be a useful feature for differentiating these two images?

Showing gradient magnitude image of Gaussian



Showing gradient magnitude image of Sobel



The average energy of gradient magnitude for

- Gaussian filter: 3183.28
- Sobel's filter: 5127.29

Yes, the average energy of gradient magnitude can be a useful feature for differentiating the two images. The first image, as we have applied gaussian filter in producing a lower average energy of gradient as with gaussian it helps blurring the image reducing the edge intensity. The second one, we applied Sobel filter. This filter is an edge detection filter therefore it is sensitive to sharp intensity transition which increases the average energy of gradient compared to gaussian. In summary, average energy of gradient magnitude help us quantify how edgy or smooth the text of the image is.

5. **When using Law's texture filters, why do you think it is helpful to divide the responses by the Gaussian filter (L5 x L5)?**

I think it is helpful to divide the responses by the Gaussian filter because it helps normalizing the result. In areas where there are sharp boundaries or high contrast, law's filter could produce responses with large magnitude. Therefore, dividing the response with Gaussian filter could help smoothing out the edges making the response more consistent and less sensitive to large intensity variations in the image.