Report: Secret message with Bandpass Filters

by: Ankita Dhar, Student Number: 1154197, University of Melbourne

Abstract:
This report provides an analysis and result of an experiment to understand and implement Gaussian bandpass filters in frequency domain. In this experiment, we will work on hiding an image with a secret message with a cover image of same size.

Theory:
Band-pass filters attenuate signal frequencies outside of a range (band) of interest. In image analysis, they can be used to denoise images while at the same time reducing low-frequency artifacts such as uneven illumination. [2]
Filtering out unwanted frequencies from the image is called filtering. The objective of image filtering is to process the image so that the result is more suitable than the original image for a specific application. Image filtering refers to a process that removes the noise, improves the digital image for varied application.[1]

Experiment:
For this experiment we have created a 1000 x 1000 pixels image with a secret message. And to hide the message we will be using a 1000 x 1000 pixels grayscale image.

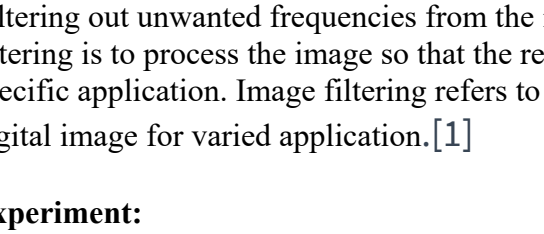


Figure 2.1: Secret message image

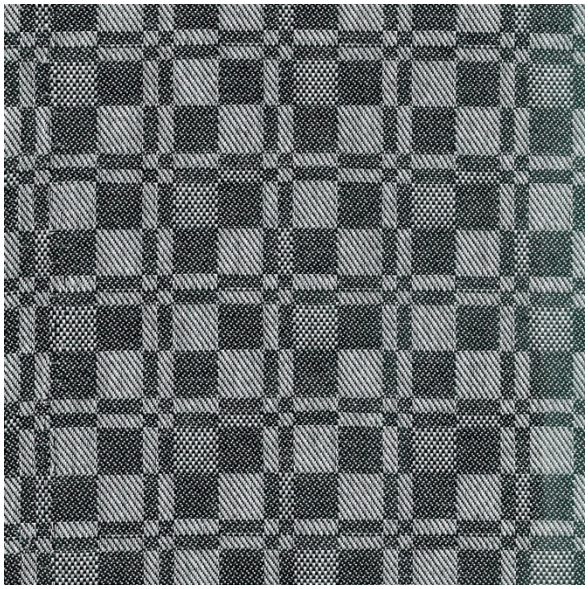


Figure 2.1: Cover image

We will be following the below mentioned steps to perform the experiment.

1. Apply high pass gaussian filter on our secret message image in Fourier domain.
2. Apply low pass gaussian filter on our cover image in Fourier domain.
3. Add the filtered images in Fourier domain, to hide the secret message.

Attempt 1:

Gaussian high pass filter radius: 60
Gaussian low pass filter radius: 60

Results

Image with low frequencies

Gaussian low pass filter

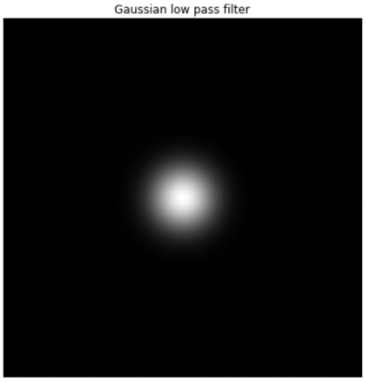
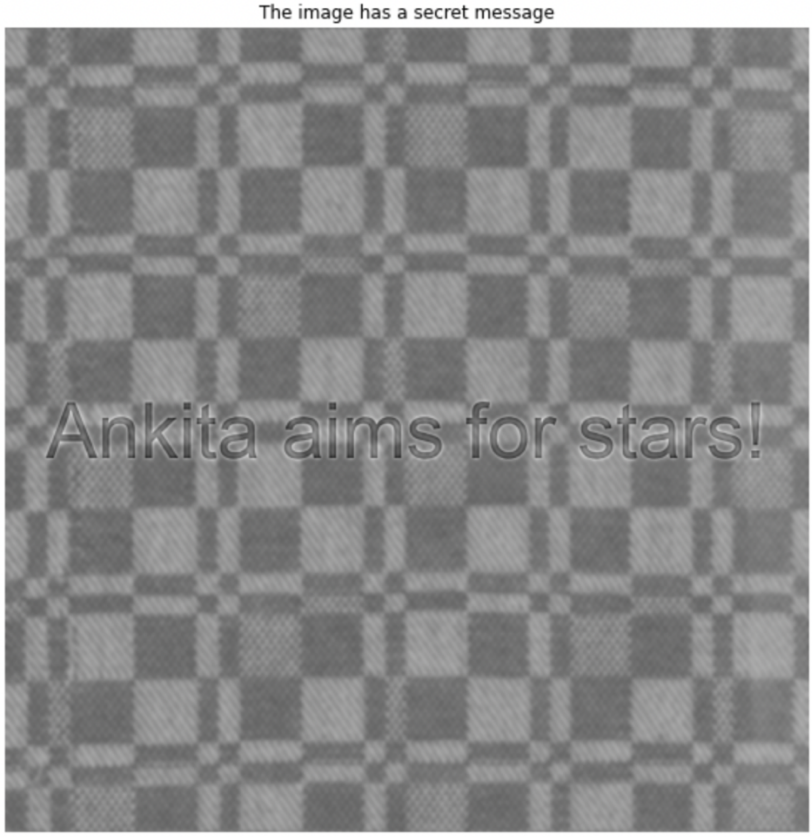


Image with high frequencies

Gauss high mask

The image has a secret message

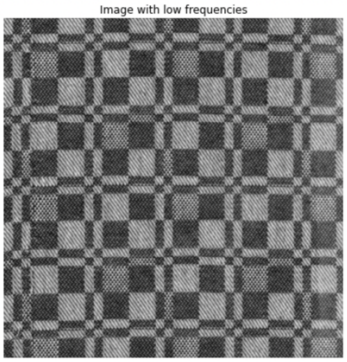


Attempt 2:

Gaussian high pass filter radius: 60
Gaussian low pass filter radius: 120

Results

Image with low frequencies

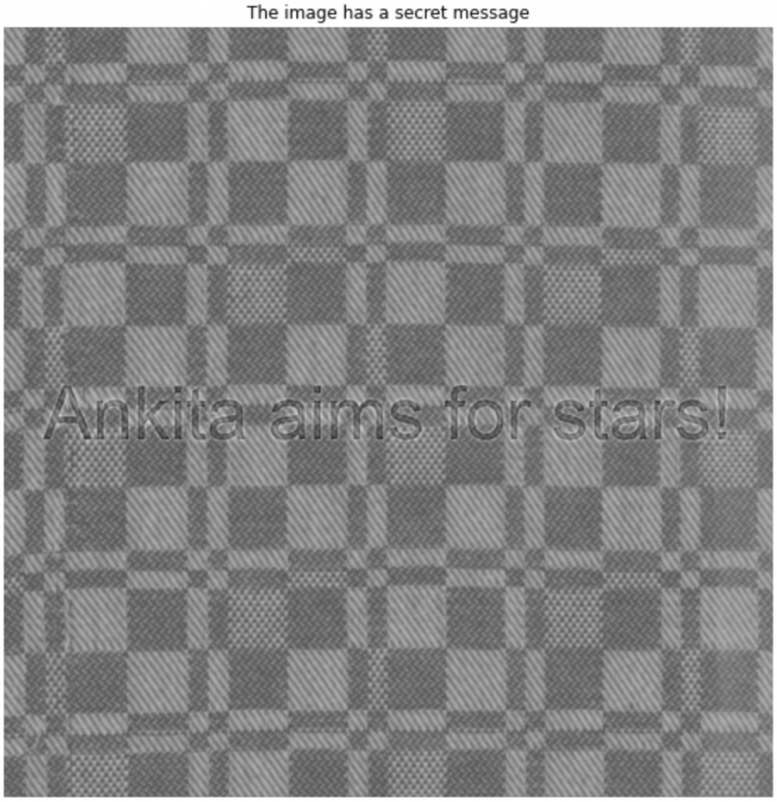


Gaussian low pass filter

Image with high frequencies

Gauss high mask

The image has a secret message



Attempt 3:

Gaussian high pass filter radius: 120
Gaussian low pass filter radius: 60

Results

Image with low frequencies

Gaussian low pass filter

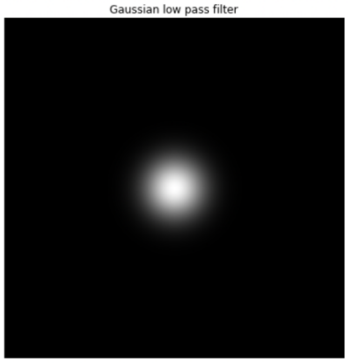
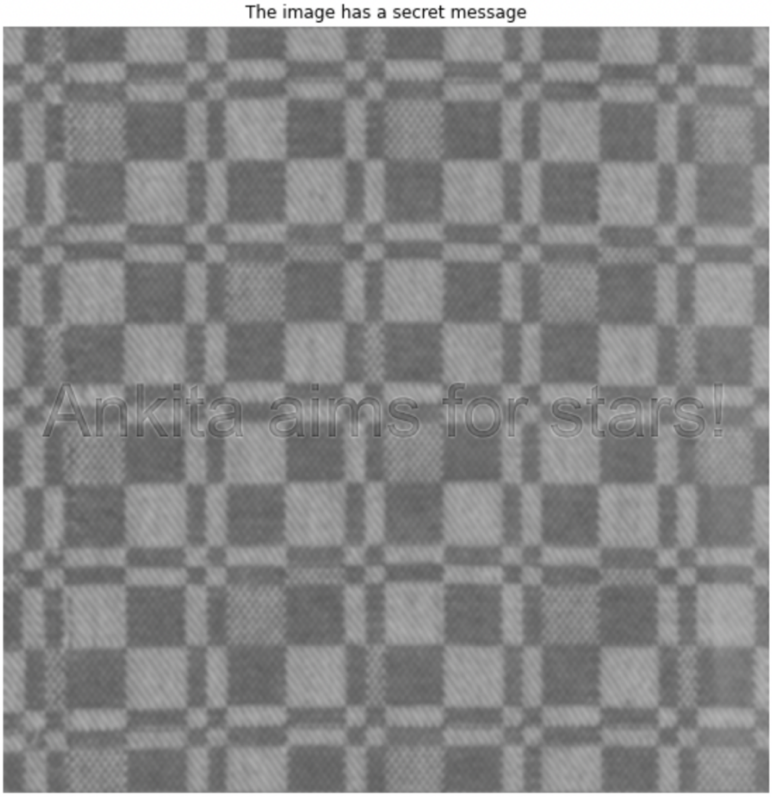


Image with high frequencies

Gauss high mask

The image has a secret message

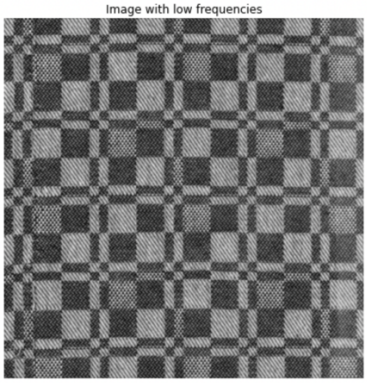


Attempt 4:

Gaussian high pass filter radius: 125
Gaussian low pass filter radius: 125

Results

Image with low frequencies

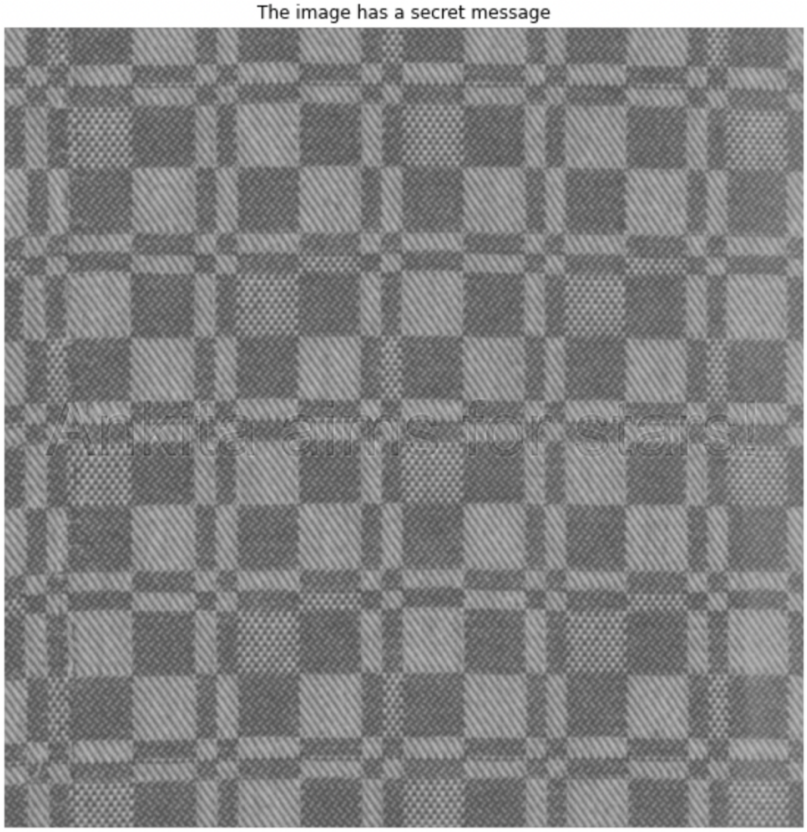


Gaussian low pass filter

Image with high frequencies

Gauss high mask

The image has a secret message



Findings:

Filters	*Threshold Radius*
Gaussian high pass	125
Gaussian low pass	125

Table 1.1: Threshold values

Analysis:

We found that with increase in radius of the filters the camouflaging of secret image became better. However, best threshold values for high pass and low pass filter were found to be 125 pixels. When threshold for low pass filter is increased beyond this point, it had a minimal effect on the camouflage; however, when threshold for high pass filter was increased above 125 pixels, it was found to lose information beyond recognition.

We can attribute this finding to the fact that low frequencies have high magnitude and hence as the high frequency radius is increased above 125 pixels, most of the high magnitude details are lost which is essential to read the message.

Conclusion:

The experiment was successfully conducted to find threshold values to hide secret message image with a cover image.

References:

[1] *Ayush Dogra and Parvinder Bhalla*, 2021. *Camera Models*. [online] Web.stanford.edu. Available at: <https://biomedpharmajournal.org/vol7no2/image-sharpening-by-gaussian-and-butterworth-high-pass-filter/>.

[2] https://scikit-image.org/docs/dev/auto_examples/filters/plot_dog.html