Project 1

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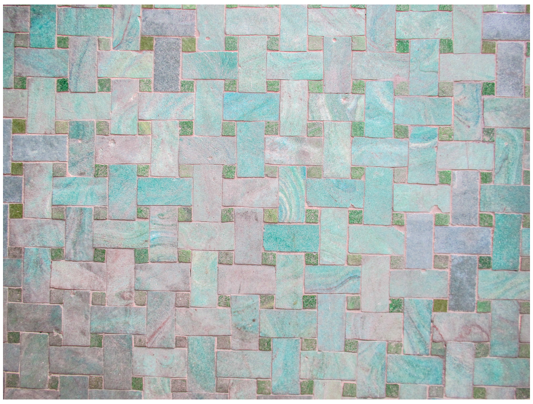
1 Color Spaces

For the first exercise, following images were chosen:

1.1 Task 1

First task was to find the HSV of pictures from RGB. Opencv library in python was used to read the pictures for that reason picture was first transfer to RGB. Then picture was transferred to HSV.
These are the resulting picture:


As seen in the pictures the colours with low intensity become red. The stone picture fully become red for this reason and more intense colours become green as we can see in the bird picture in the left.

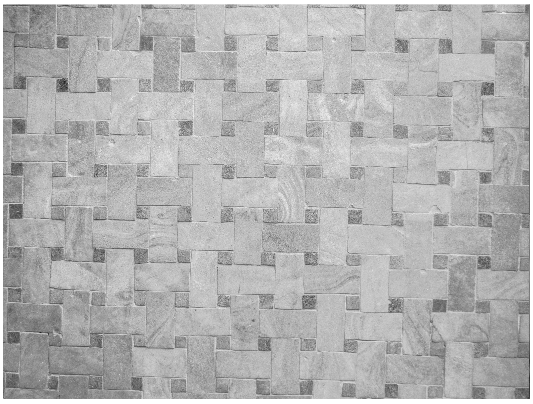
1.2 Task 2

For second task, RGB image was transferred to an intensity image “I” from HSI space and and intensity image “V” from HSV space by hand. The formula for these transformations are:

$$I = \frac{(R+G+B)}{3}$$

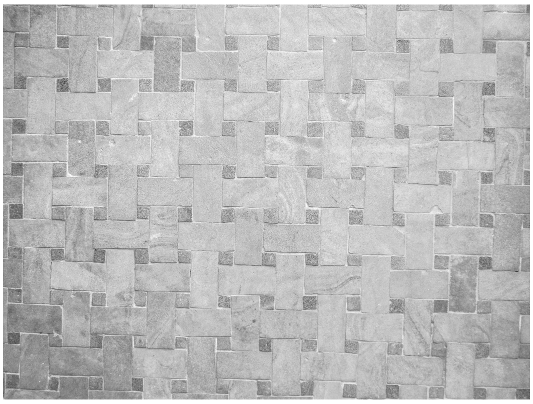
$$V = max(R, G, B)$$

The resulting intensity images “I” from HSI space are shown here:



In HSI, intensity level or “I” shows the brightness level of the colour and it's the average of the RGB values. For example as you can see in the bird image, all the point with colour white stay white. This phenomenon can be explained by the fact that RGB uses light and white colour can be made only by mixing R,G,B at equal intensity. So it make sense that when the average is calculated the values doesn’t change that much because it already have the similar amount of R,G,B. Next thing that can be notices is that the part with more red colour are brighter than blue and green as it was expected. The reason for that is the red component in G and R component of an image are really light especially for a colour like orange so it make sense that they have less intensity when we average it. However blue part and green part of the picture are not that distinguishable for this picture. It’s expected that blue parts have higher intensity but because of the amount of white colour in that parts the difference can’t be seen.

And here the resulting intensity images “V” from HSV space are shown here:



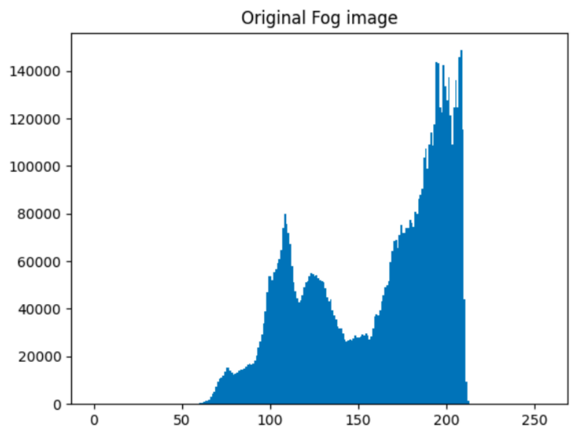
In HSV, intensity level “V” shows the amount of which the colour is mixed with black. So in each point we get the maximum value from R,G,B component of the image. 255 shows the total white and 0 shows the lack of colour or black so it make sense that the pictures here have more white component than “I” from last part, because they have the maximum value (closer to 255).
As shown we can see all the white lines, because they have closes value to 255 so they stay, and as it seen all orange part are white as well, this make sense because they have white value in R component of the picture and that is the one that has the max from G and B.

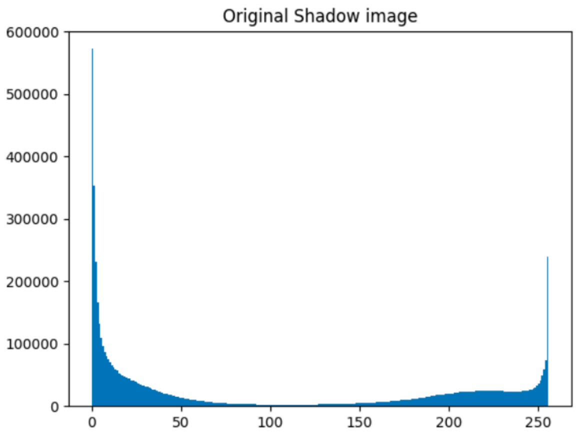
2 Pointwise transform, Histogram Equalisation

For the second exercise, following images were chosen: Left picture with low contrast and right picture with high contrast.

2.1 Task 1

The histogram of both pictures was found using inbuilt function plot.hist(). X axis here is the grey levels and Y axis is the number of pixels with that grey level. As expected the, histogram of low contrast image has lower range that mean they are not that many different grey levels that are in the image but the Y value is really high because they are more pixels that have same grey level. On the other hand the histogram of high contrast picture (in right) has much bigger range but the Y values are smaller.



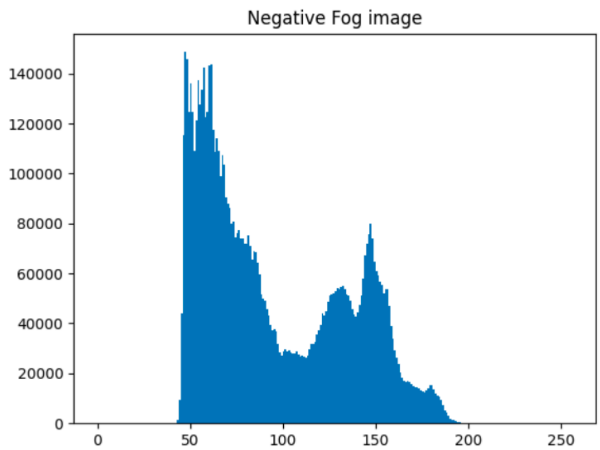


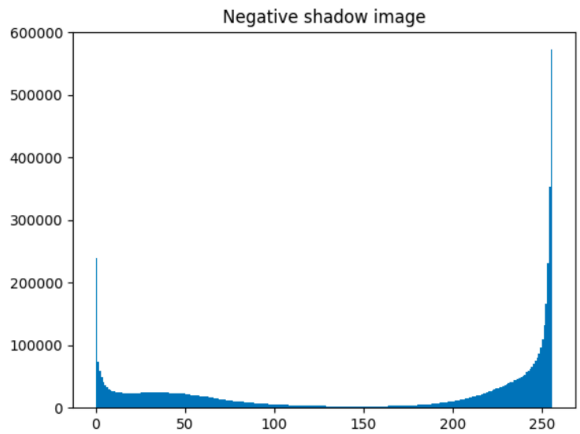
2.2 Task 2

The formula for the Negative pointwise transform is $s = L-1-r$, this means each new picture s is the maximum pixel value L - 1 minus original pixel value r. This transformation invert all the colours. The resulting pictures after Negative pointwise transform are shown below. As you can see in shadow image all the dark shadows become white and white background become black and we see same result from fog image.

2.3 Task 3

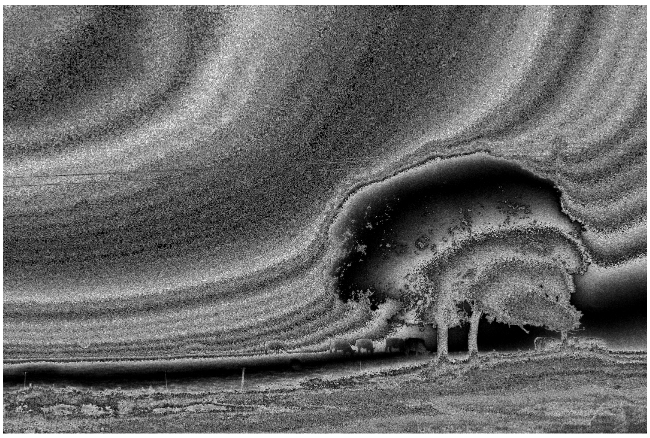
Here the histogram of negative pictures are displayed, as seen its just the original histogram but flipped that make sense because we are just changing all values r by L-1-r and that just going to flip the histogram.

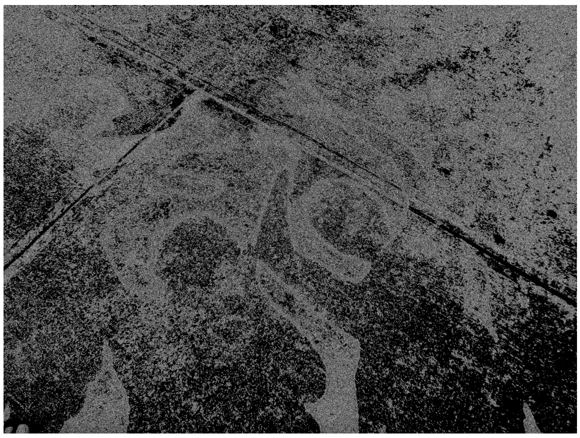




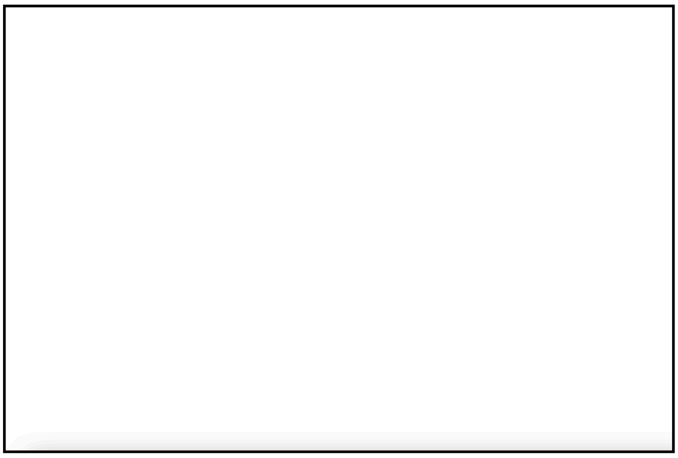
2.4 Task 4

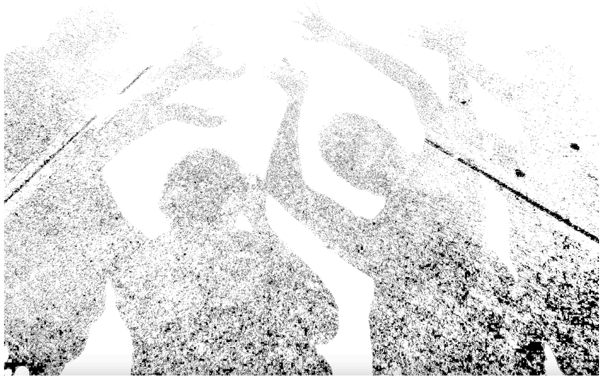
For this task a power law pointwise transform is made such that $s = r^n$ and different values of n is used (above or below 1) to change high contrast image to low contrast or vice versa.
First set of picture are with n = 2. With this value of n images have higher contrast, easily seen comparing both skys of fog image.



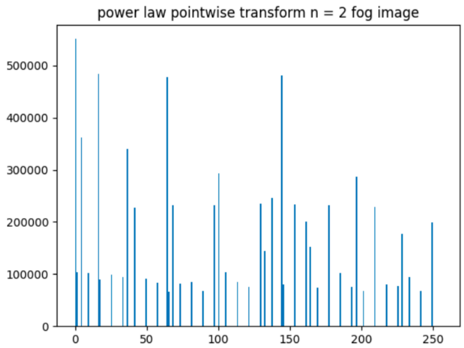


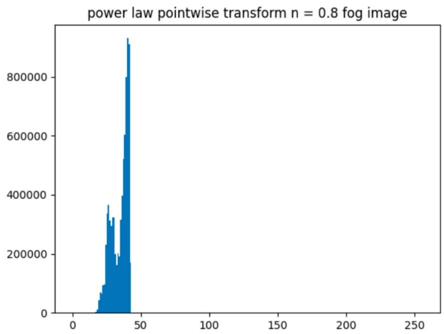
Below are the second set of picture with n value 0.8 and 0.7 from left to right respectively. As is shown, it look much more uniformed and both images are much whiter. Because fog image already had low contrast and by multiplying everything by 0.8 we make everything much lighter so image is only white but the changes can be seen easily from shadow image in right.

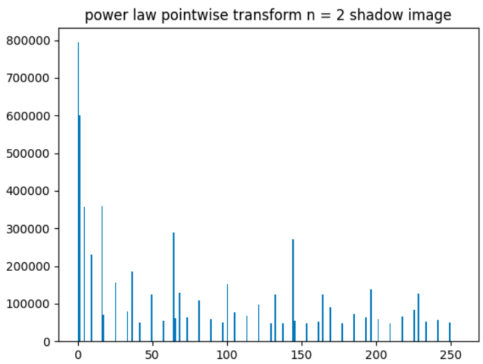


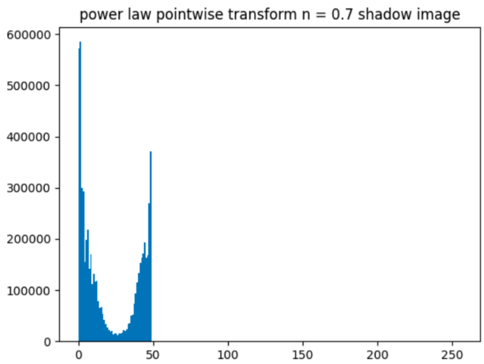


And here is the histogram of these pictures. It can can seen that with n > 1 images get higher contrast and with n < 1 get lower contrast.



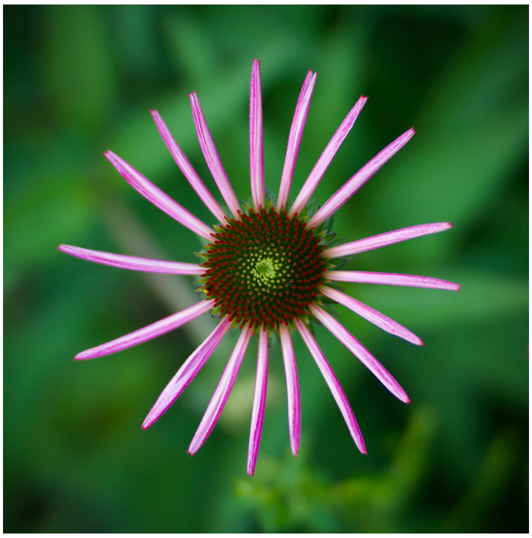






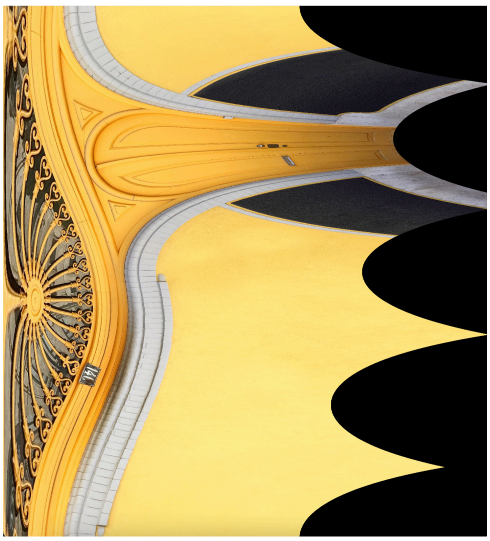
3 Special Effects

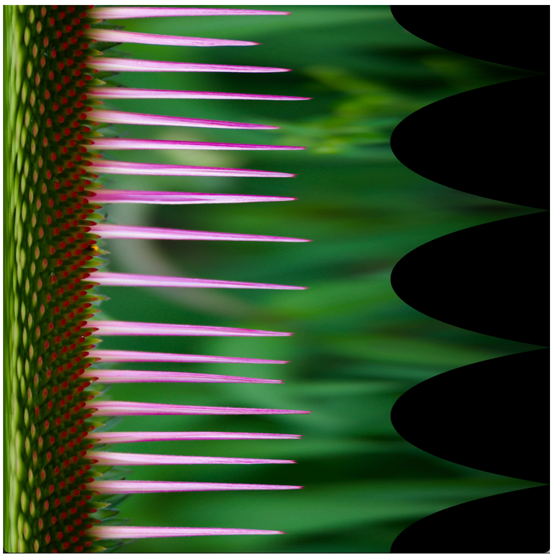
For the third exercise, following images were chosen:



3.1 Task 1

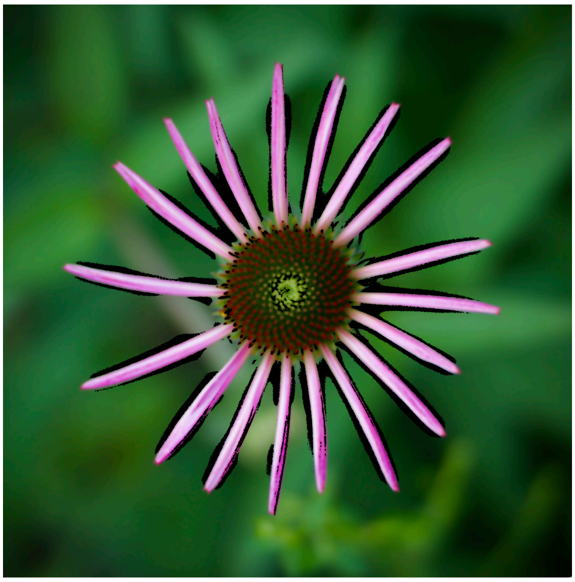
For first exercise images where converted to polar coordinates. Resulting image is shown here. Here horizontal axis is radius and vertical axis is angle. The door picture in left doesn’t show many thing but the influence of polar coordinates can be seen clearly in the flower picture that all the petals are straight now.





3.2 Task 2

For cartonhifying image with black outliers first the edges were found using treshholding given the grey picture but with a bit blurring to reduce the noise. Then the original picture was blurred to uniform the colour. Then the both images where combine to get the final image that is shown below.

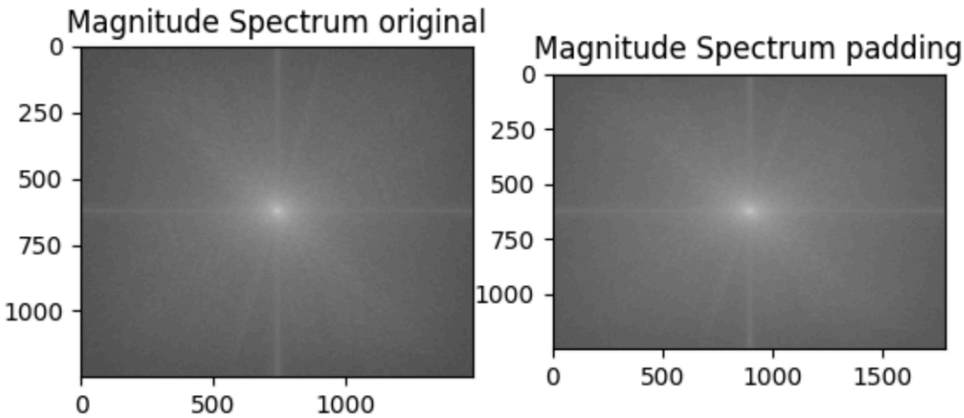


4 Frequency domain properties

For the fourth exercise, following image was chosen:

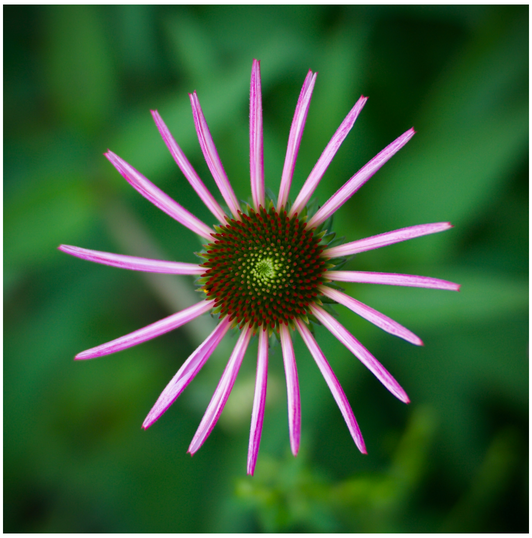
Here a padding of size 300 is added to the left of the picture:

Below are the plots of magnitude spectrum of original and new picture (with padding). As seen the magnitude spectrums are the same, the only difference is that the magnitude of image with padding is bigger and that's because the size of picture itself is bigger because of the padding.



5 Periodic noise removal

For this exercise the following image was used:

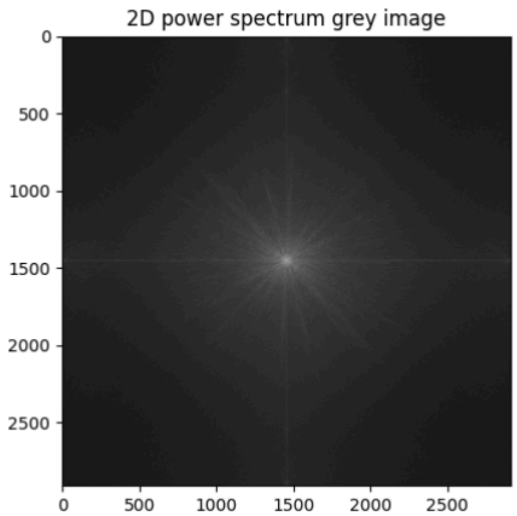


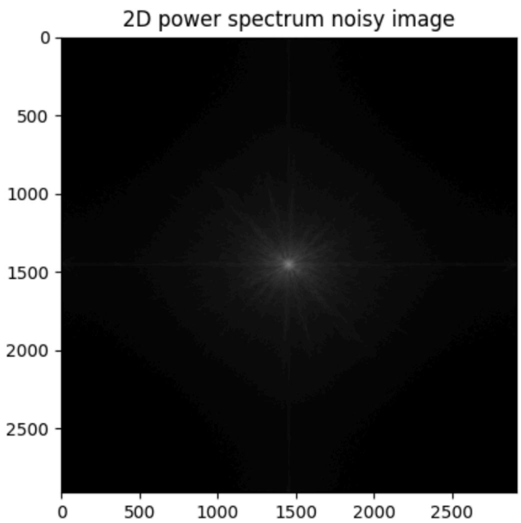
5.1 Task 1

To add periodic noise to the image, first image was transferred to grey and vertical lines were added as periodical noise using cosine. The resulting image is showed below.

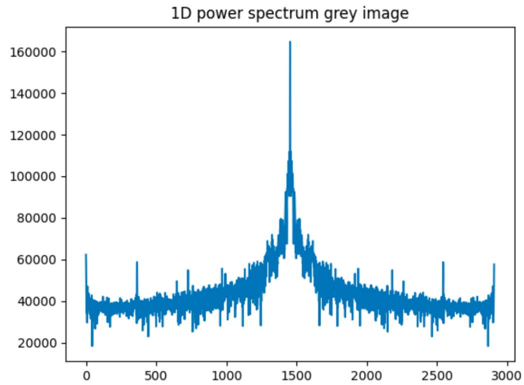
5.2 Task 2

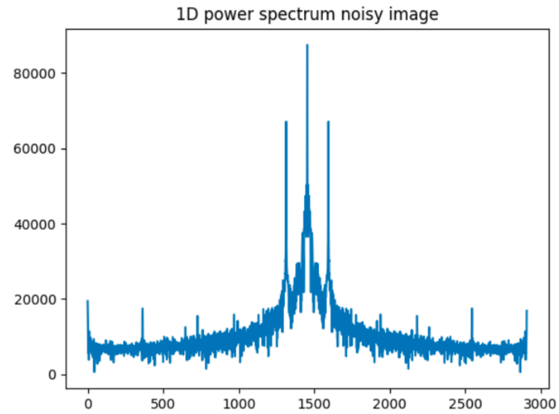
Here are the 2D power spectrum of grey image and the noisy image. The noisy PS is darker and doesn't have the obvious vertical and horizontal lines that is seen in grey PS. Because the noise added are really close to each other its like a grey layer on the image so it make some obvious patterns that we could see easily in original image disappear. But the same small patterns are seen in both, but darker in noisy image PS.



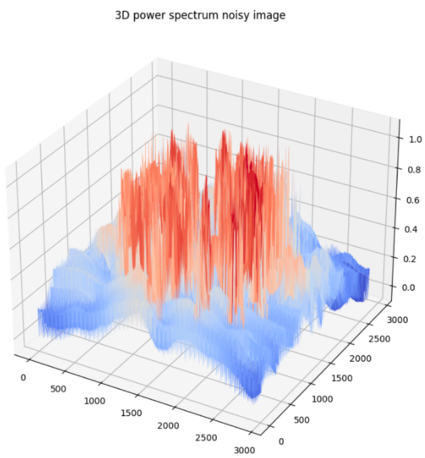


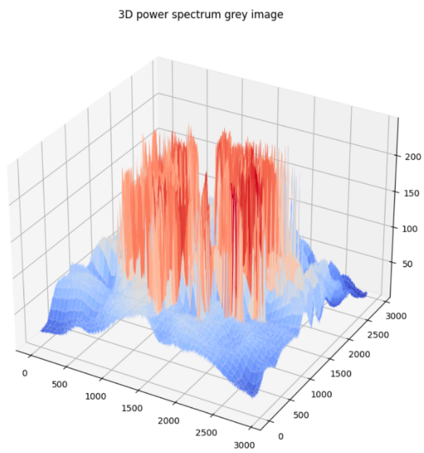
Below is the 1D power spectrum of both images. As seen noisy image has 3 picks as original image has only one, this can explain why the obvious vertical and horizontal line in grey image 2d power spectrum is more obvious because as seen in 1D its more dominated but in noisy there are 3 now so the middle one is not that dominated.





Here are 3D power spectrums of both images. We can get to the same result as 2D and 1D PS, the distance between red and blue part in the noisy image is much less than the grey one.





5.3 Task 3

To remove the periodic noise butter worth low pass frequency filter was used. The lines of noisy picture look close together so the higher value was used for cut-off frequency. The resulting image after noise removal and its power spectrum are shown below. The power spectrum have the same structure of original image but because the image was filtered only the low frequency stayed the colour are inverted kinda.