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Laboratory 1

Q2.1 Contrast Stretching

A picture containing text, screenshot, white

Description automatically generated

I learnt to load images into matlab and manipulate the image data using the image libraries, to perform contrast stretching, I found that using imsubtract and immultiply provided all the tooling needed to firstly set the minimal gray level to 0 by shifting the gray values down using imsubtract(img,13) then to stretch the contrast by multiplying the gray values by 1.335 using immultiply(newImg,1.335).

The results of contrast stretching is visualized above, and we can see that throughout the process, the contrast of the grey image improves gradually and I am very pleased with the final result which seems to be a significant improvement over the grey mess that we initially started with, which looked as if there was haze in Singapore, we managed to, in my opinion clear up the ‘hazy’ look by perform contrast stretching.

Printing out the min() and max() values also allowed us to better understand that we have corrected the contrast and set it to the appropriate min and max values of 0 and 255 respectively.

Q2.2

Chart, histogram

Description automatically generated

The histogram with 256 bin shows finer changes and more detail, as

Compared to the histogram with 10 bins, which has the same approximate

inclinations but contain much less details , and omits extreme spikes and data

changes such as the spike visible at 170-200 using 256 bins, but is

completely absent in the 10 bin histogram. Hence the 10 bin histogram is

more smooth, and generalized as the gray levels have been grouped into larger groups.

2.2b)

Chart, histogram

Description automatically generated

The histogram with 10 bins looks very equalized while the histogram with

256 bins still contain wild spikes but is now more distributed across the

entire range of values from 0-255.

2.2c)

Chart, histogram

Description automatically generated

The histogram stays the same, there is no effect, I believe this is because it has

it has already been equalized, as the equalization algorithm has already done it’s iteration across all the bins to try and equalize the gray levels across the different bins.

2.3a) Linear Spatial Filtering

Chart, radar chart

Description automatically generated

Filter 1 with sigma 1 and filter 2 with sigma 2 accordingly, we can observe that filter 2 seems to have a wider reach and can imply that it is a stronger filter than filter 1, and that sigma value affects the strength of the filter.

2.2b)

A collage of a building

Description automatically generated with low confidence

Original Image, in contrast to image after filter 1 and filter 2. We note that filter 2 seems to reduce the noise better.

2.2c)

Filter2 is more effective at removing the additive gaussian noise than

Filter1, filter1 barely improves upon the original image, and is almost

not noticeable. The trade off for using both filters, is that the image appears more

smoothened as compared to the original image, although noise is indeed

reduced, as seen in filter2, the image looks smoothened and more blurred,

due to the use of the gaussian filter which also ultimately means a loss of detail will occur, especially for filter2 which has a higher sigma level.

2.2d)

A picture containing text, outdoor, building, apartment building

Description automatically generated

Original Image^

Graphical user interface, application

Description automatically generated

Both filter 1 and 2 do not manage to remove the speckle noise from ntu\_sp

filter1 is ineffective and barely reduces any of the speckle originally observed.

filter2 performs slightly better, but at a cost it degrades the image by overly smoothening it and causes a loss of detail. Hence both filters do not improve the image at all, and

are not good at handling speckle noise.

Gaussian averaging filter works well to filter the image with gaussian noise,

Filter 1 is better at removing the gaussian noise from ntugn ,

Filter 2 with higher sigma value makes the image appear more smoothened

and blur.

2.4) Median Filtering (Gaussian picture)

A picture containing building, screenshot

Description automatically generated

Gaussian filtering works better than medfilt for gaussian noise, as

it preserves more of the sharpness of the image and also more effectively reduces

the noise, as compared to median filtering with neighbourhood of 3.

median filtering with neighbourhood of 5 produces very bad results where

the whole image looks overly smoothened and all many details are lost.

2.4) Median filtering ( Speckle picture)

Graphical user interface, application

Description automatically generated

Median filtering works better for the speckle noise image, as it manages

to remove most of the speckle and keep the image clear and sharp,

especially when the neighbourhood is 3,3, however, we have to be careful not to

overdo the median filtering neighbourhood sampling as the 5,5

neighbourhood turns the image into a smudged mess that looks like a

watercolor painting

Hence medfilt is better at handling speckle noise as compared to gaussian

filtering, but gaussian filtering is better at handling gaussian noise.

the tradeoff is that medfilt neighbour sampling needs to be carefully

controlled, else it will result in a smudged mess, that is overly

smoothened resulting in severe loss of information and detailing, as seen in Figure 11.

2.5) Suppressing Noise Interference Patterns

A close-up of a person's face

Description automatically generated with low confidence

2.5b)Original input image

A picture containing text, electronics, display, screenshot

Description automatically generated

After processing using fft2(image) , we obtain this image to view the power spectrum.

A computer screen capture

Description automatically generated with medium confidence

We can then proceed to use fftshift( S.^0.1) to visualize the power spectrum, with the points in the center. We are able to observe that there are some separable frequency peaks in the signal domain that correspond to the interference pattern, and can attempt to remove them to clean up the image as they correspond to the interference pattern.

2.5c) Power spectrum without fftshift

A picture containing text, electronics, display, screenshot

Description automatically generated

2.5d)

Using ginput(1) we are able to obtain the precise x and y coordinates of each peak.

Text

Description automatically generated

With the points known to us, x=16,y=248,x2=241,y2=9. We try to remove these features by setting the points on and neighbouring the peaks to 0. This is done using a for loop, where we remove 2 points, and its neighbours manually. (neighbours = 2)

Chart

Description automatically generated

This removal of signal at the high peaks allows us to remove that specific feature, and because the peak and its influence is concentrated around it, using the neighbours parameter allows us to control the strength, and to what extent we want that feature to be removed. The nature of the noise pattern being of high frequency in the frequency domain in this specific example allows us to easily remove the corresponding pattern from the image, and with some refinement we could set the other minor peaks that likely also correspond to the pattern to zero to remove more of the Noise interference pattern.

2.5e)

A picture containing text, person, indoor, old

Description automatically generated

The removal of the feature by setting the high peaks and its neighbouring elements to 0 works very well to isolate and remove the dominant diagonal lines, and is an effective demonstration of the power of working in the signal domain.

Additionally setting the neighbouring bounding box to 5 works exceptionally well

A picture containing text, old

Description automatically generated

2.5f)

A picture containing text, outdoor, close

Description automatically generated

Original Image

A picture containing text

Description automatically generated

Result

A picture containing text, electronics, display, screenshot

Description automatically generated

Fourier Transform

A picture containing text, monitor, electronics, display

Description automatically generated

Fourier transform after Fftshift

A screenshot of a computer

Description automatically generated with medium confidence

Have attempted to remove the cage by setting the neighbours around the

peaks to 0, the issue is that by using the crude

method of manually identifying these points and removing them using a

neighbour bounding box, I also remove features from parts of the image that

is not part of the 'cage'. This brute approach manages to remove the

strongly represented parts of the cage but also removes some details

because I am not able to more accurately and precisely remove the peaks, this is also because of the nature of the pattern in the frequency domain, it is not as clearly represented and gathered in a region in the power spectrum and hence will be more difficult to eliminate.

2.6a) Undoing Perspective Distortion of Planar Surface

A picture containing text, businesscard

Description automatically generated

Original Image

A picture containing text

Description automatically generated

Image after projection (taking points from top left, top right, bottom right, bottom left, into [X,Y])

2.6b)

Text

Description automatically generated

2.6c)

Text

Description automatically generated

The projection matrix used to compute the final projection was implemented as such.

2.6d)



Wrap the original image by using imtransform, which takes in the original image, bookImg, the projective T, and perform the matrix transformation to project the data onto the template size as defined where the output plane is x = 210 wide, and y = 297 tall.

2.6e)

A picture containing text

Description automatically generatedFinal Projected result.

The resulting image shows that no additional details are obtained from the

image but we are able to successfully crop the image, and obtain the

relevant pixels that we require, and to project those pixels and map them

to fit and scale to the dimensions that we expect it to with the use of

this projection matrix, this results in a visible improvement, at least

in the terms of presentation as images that otherwise may be disorderly,

when shot in a slanted manner, can be salvaged and transformed into useful

images using this projection function. This effect has also been observed

to be used in Microsoft's office lens application and I have been a big

user of it, and use it to scan my documents, it is fascinating to

see that the actual implementation is so straight forward and I am very

impressed by the results, perhaps by combining it with other functions we

may clean up the image and make it even better, this post-processing is

also done by office lens and have good enough results

All in all, have learnt many useful techniques from this lab experiment.