Spatial domain and frequency domain processing

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Abstract—This documentation include some description of my solution to the second assignment. Some results may not satisfied, but invork much speculation. Task 4, Task 5 make some error, but i can't find right solution to these task until the deadline.

Index Terms—filter, convolution, noise.

1 Introduction

This documentation just intend to description the thinking process of myself, the code with its explaination can be found in my MATLAB file.

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1.1 Task 1: Add different noise and filter it with embedded function imfilter().

It is very simple to add different types of noise to image by using imnoise() function. I tried four types such as ”gaussian”, ”salt and pepper”.

1.2 Task 2: Generate spatial gaussian filter.

Since we can use fspecial() function to generate various spatial filter, it is easy to complete this task. We can also define filter by ourselves, which is much similar to defining a matrix.

1.3 Task 3: Implement the 2D correlation/convolution operation.

By writing 2 loop structures, we can handle this task in a convenient way.

1.3.1 Step 1:

Expanding your original image to a 'mm + 1, nn + 1' matrix if your image is 'm, n' size.

1.3.2 Step 2:

```
for ii = 1:mm
    for jj = 1:nn
        "for each step, you should
        compute the sum of the pro-
        -duct of your 'conv factor'
        to the points corresponding
        to the image specified by
        jj and ii. Then adding the
        results to the newly defined
        image."
    end
end
```

1.4 Task 4: Generate 2D ideal/gaussian low pass and high pass filters and compare the results of filtering.

This task can be divided into 2 parts. The first one is the code of generating filters. The second one is filtering, since i'm not very familiar with filtering, and the details of FFT also confuse me, so i just tried in my code file, but the results seems disappointing. Maybe i should spend more time on the practices of filtering and the operation in frequency domain.

1.4.1 Generate filters

The core of the solution to these problem is understand meshgrid() which is the representation of axis in MATLAB. We should firstly compute the distance between origin point and other points. This step can be resolved by using

`sqrt(x.^2 + y.^2).`

Then, make the points that far away from zero to 0, and the remaining 1. Also you can use the formula:

$$H = e^{\frac{-D^2(u,v)}{2D_0^2}}$$

to generate gaussian filter.

1.4.2 Filtering

Filtering in frequency domain is mainly include the following details.Firstly using fft() and fftshift() functios to generate the frequency description of original image. Then, multiplying the fft with filter(elements to elements). Lastly, reverse the fft filtered to sparial domain through ifft() and ifftshift(). Attention should be paid on the data type.

1.5 Task 5: Periodic noise.

Periodic noise can be filtered using notchreject filter, since its frequency descriptions is a dot in fft image.

1.6 Bonus: Adaptive filter.

Actually, the main idea of the task is very similar to convolution. Because we also need 2 loop structures to complete this task. But this time, the details are much differ from convolution. We need to calculate the local variance and estimate the global variance of noise. By using the formula:

$$f(x,y) = g(x,y) - \frac{\sigma_\eta^2}{\sigma_L^2}[g(x,y) - m_L]$$

we can get what we want.

2 CONCLUSION

Some mistakes i made before deadline. Maybe i should spend more time on frequency opreations.

The authors would like to thank...

REFERENCES

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