

Advanced Digital Image Process

HW#5

作業#5

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Development environment :

OS : ubuntu18.04

Editing tools : VScode

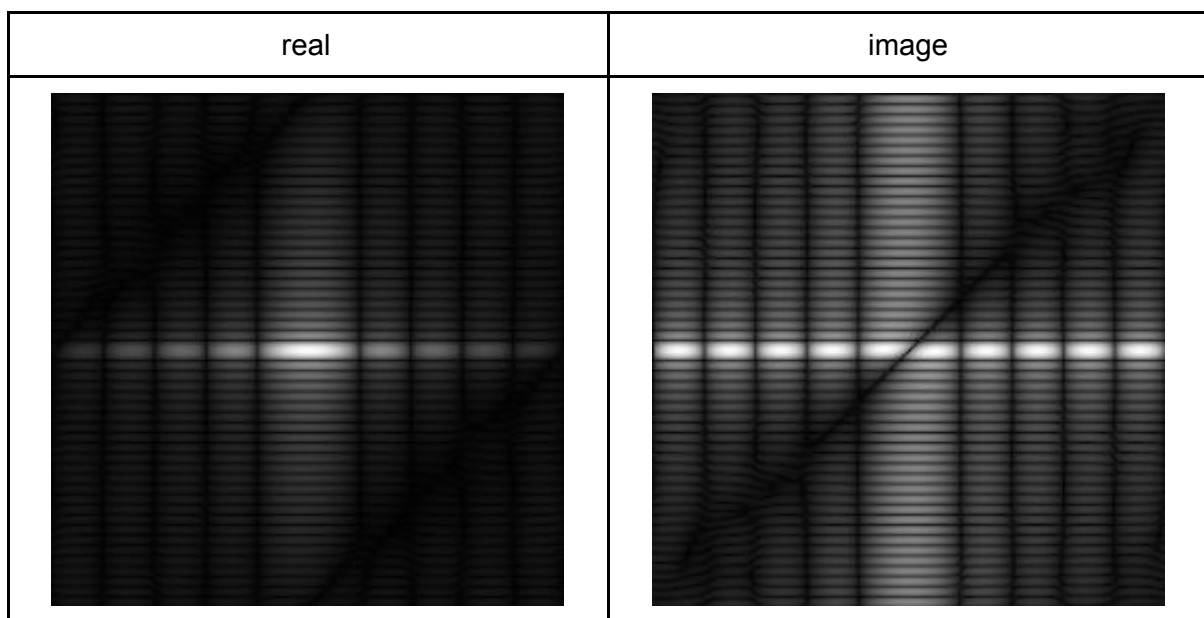
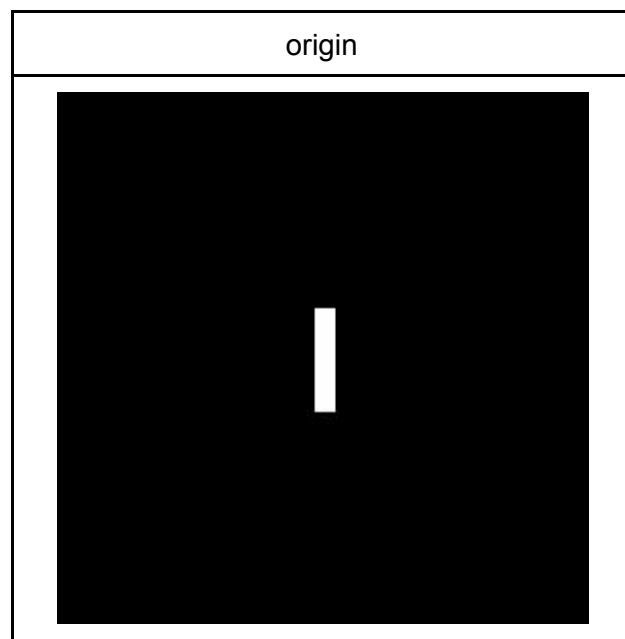
compilation tools : CMake

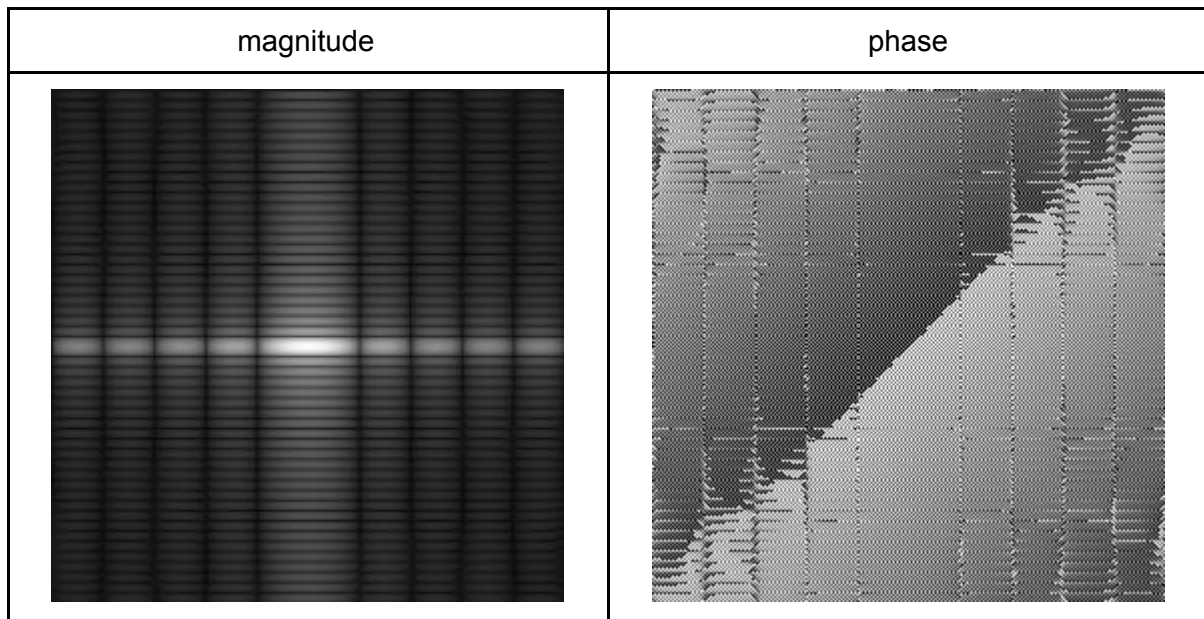
opencv version : 3.2.0

2.2D-DFT

- (a) Write your own DFT subroutine (with origin shift) and test on rect256.raw, rotate256.raw, circle256.raw, square256.raw. Show the output of both magnitude and phase spectra. Discuss the difference of each result image.

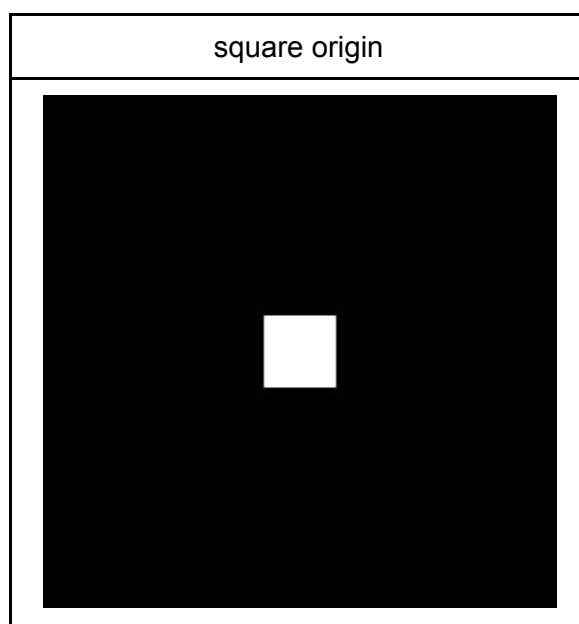
rectangle

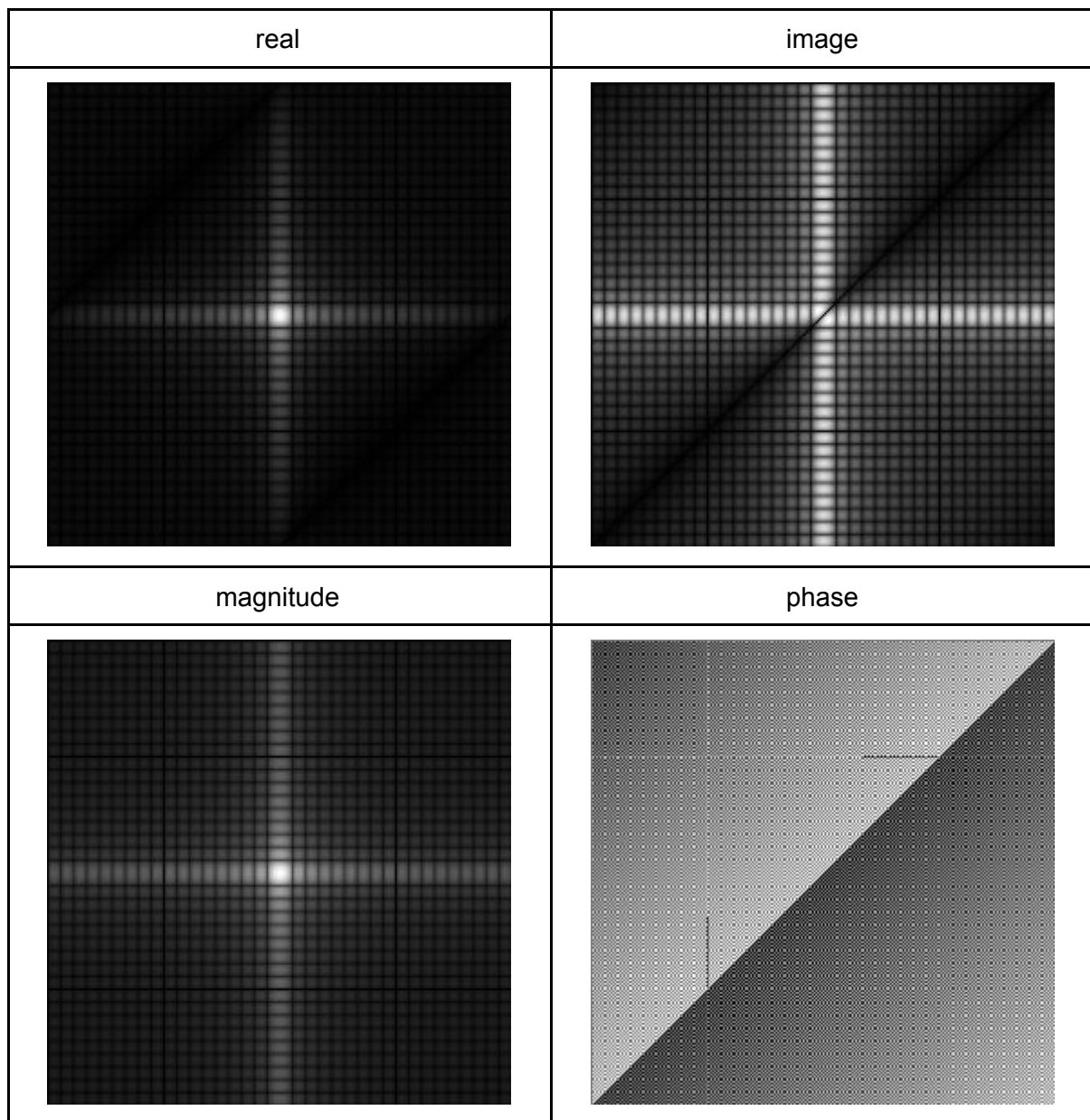




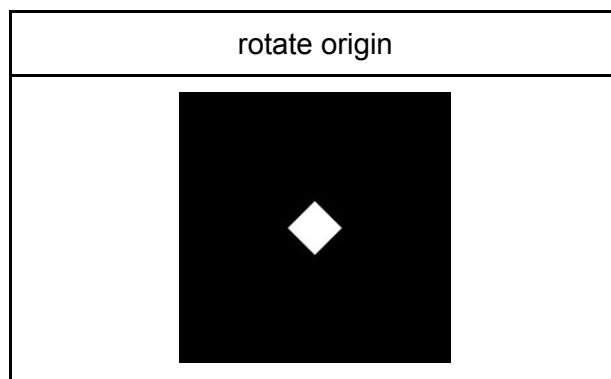
After 2D-DFT we'll have two image real part and image part we can use get the magnitude by doing $\sqrt{real^2 + imag^2}$. As we can see in real part and image part there is something missing but it was complementary so after magnituding we get a complete image. To visualize the image I do the absolute value and normalize and powerlaw $\gamma=0.4$. In spatial domain a vertical rectangle transfer to frequency domain becomes a horizontal sinc function.

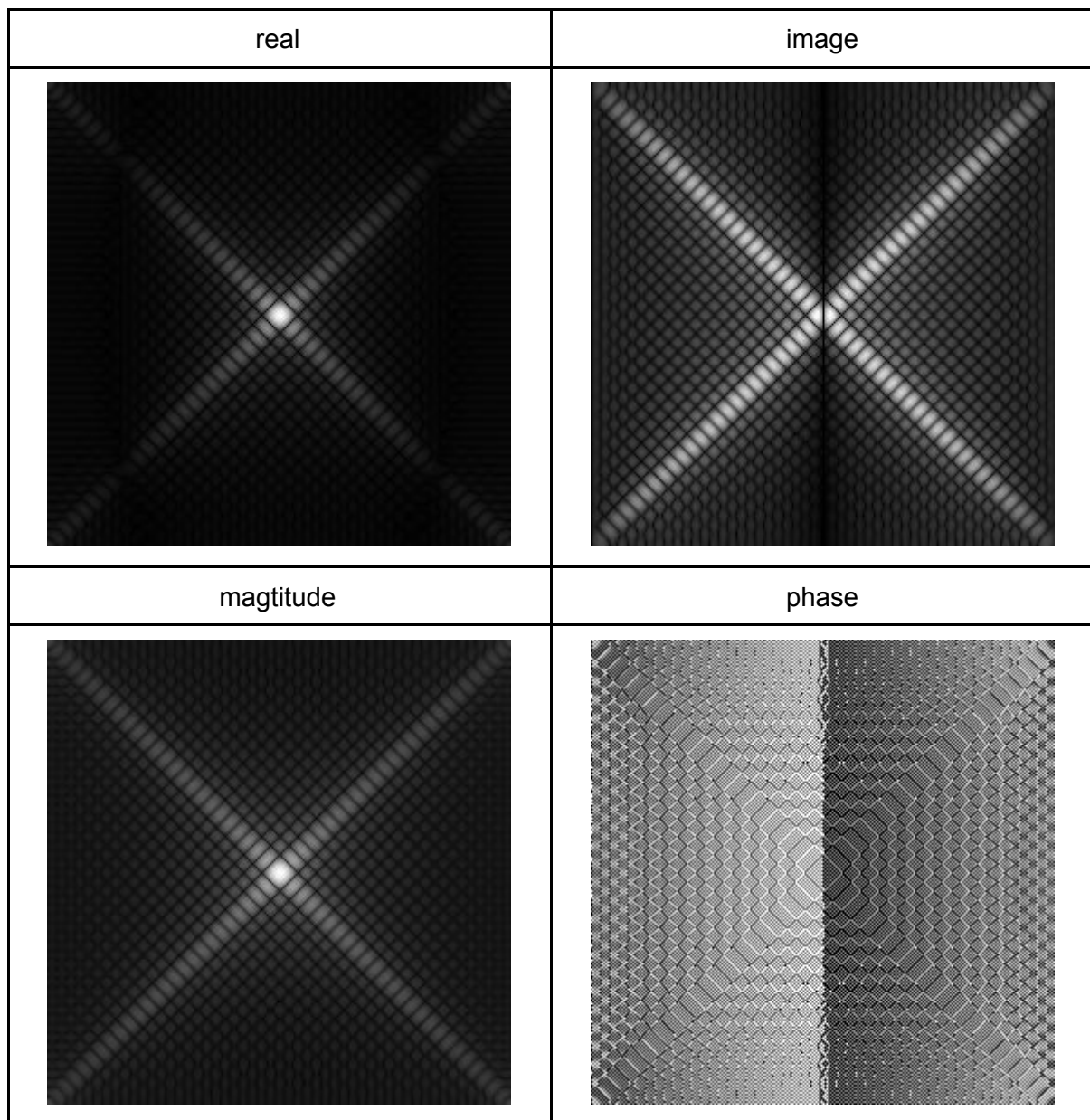
And we can get the image phase by doing $\arctan\left(\frac{Imag}{Real}\right)$ the values will be between π to $-\pi$. I shift the value by adding π to make value in range $0 \sim 2\pi$ and zoom in to $0 \sim 255$ to show it. In the corner of the DFT Image part is a little distortion so the phase at the corner is weird.



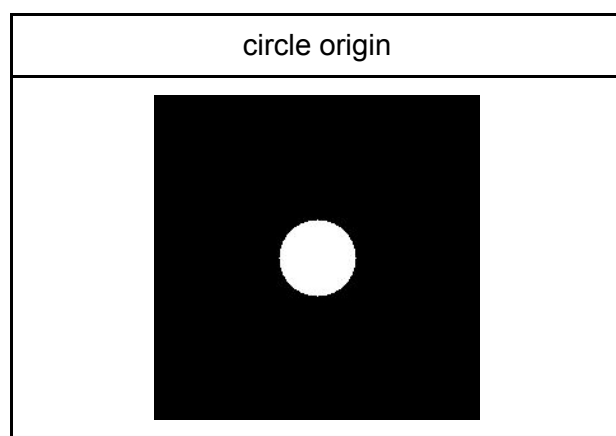


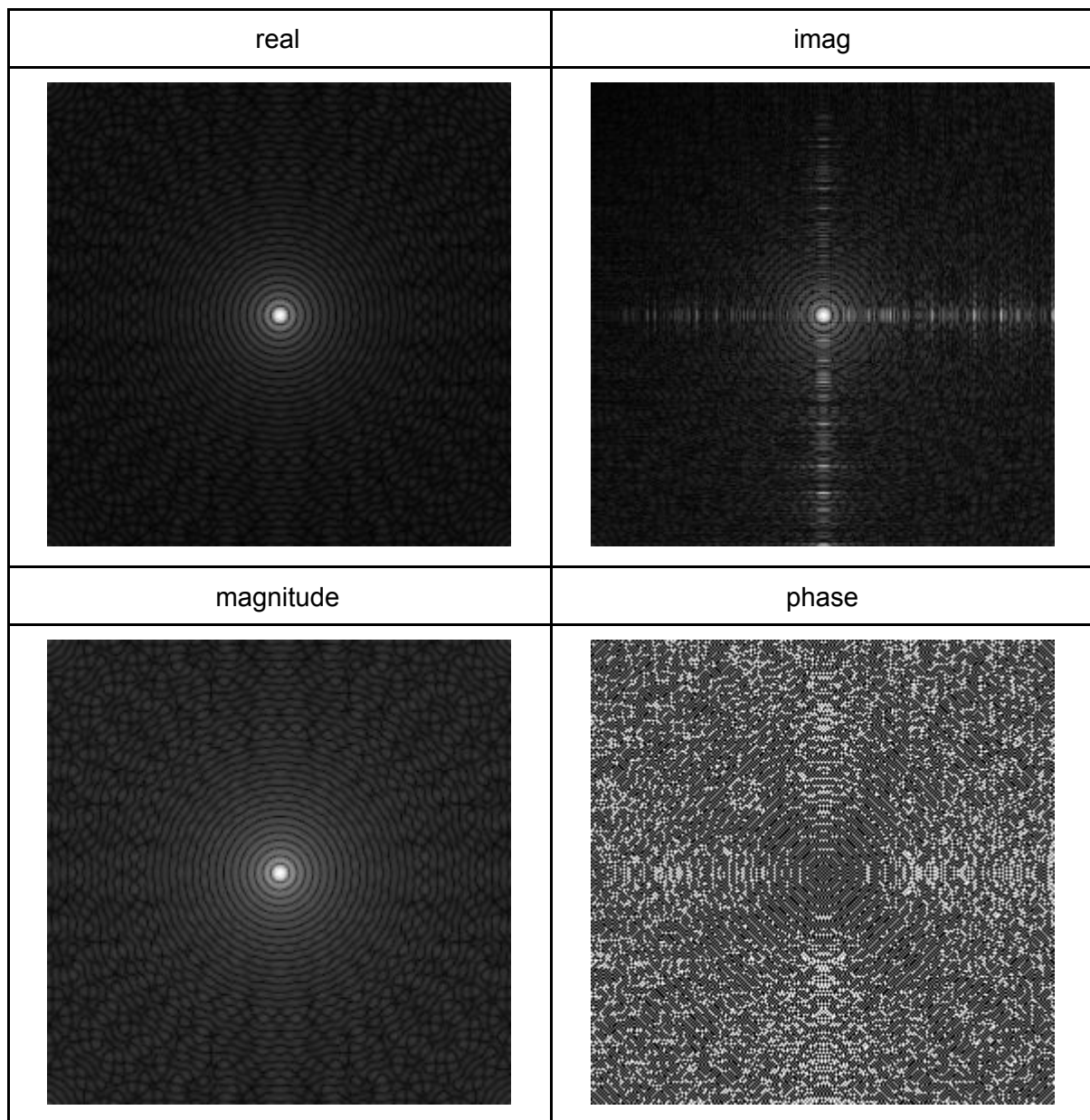
As we can see a lot of features are the same as rectangles because they are all quadrangular and each corner is right angle but square is more symmetry so in frequency domain it is more symmetry too. The phase of DFT is more smooth too.





As we can see. square diamond have a contour that is 45 degree , so In the frequency domain the feature is 45 degree too.





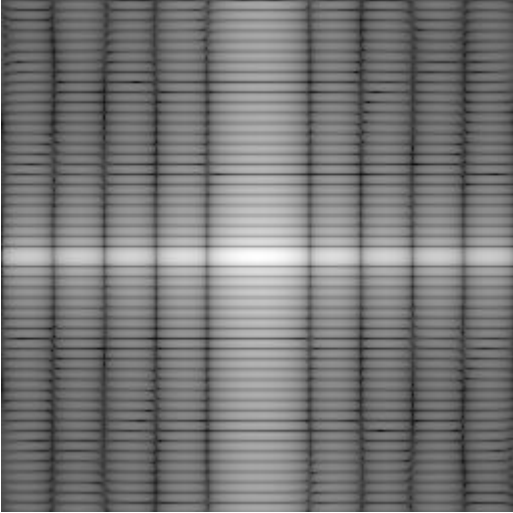
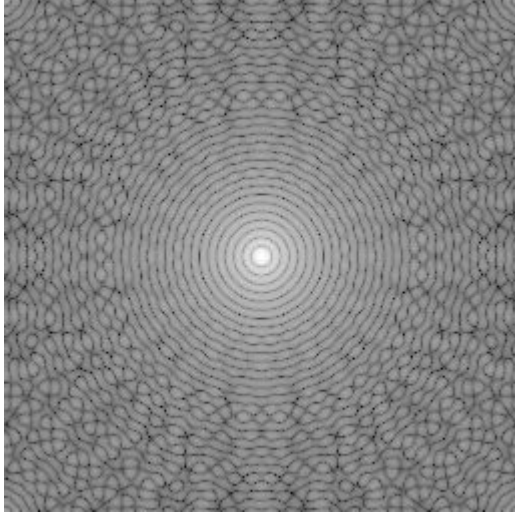
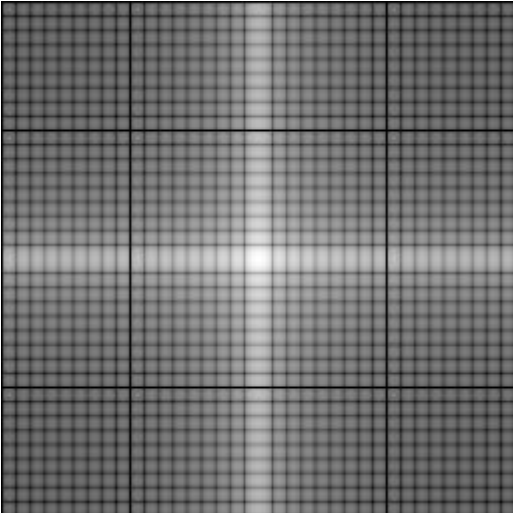
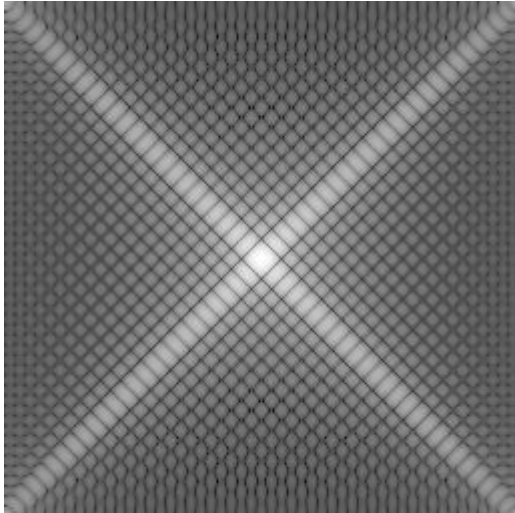
As we can see, because a circle is symmetry from any degree. So to frequency domain, it is symmetry from any degree too. but the phase is messy.

question:

There is some missing part in all DFT images except the circle. Why?

(b) Compare the output from (a) with output by using OpenCV DFT function. Discuss difference in execution time result images. Explain each other.

opencv

rect	circle
	
square	rota
	

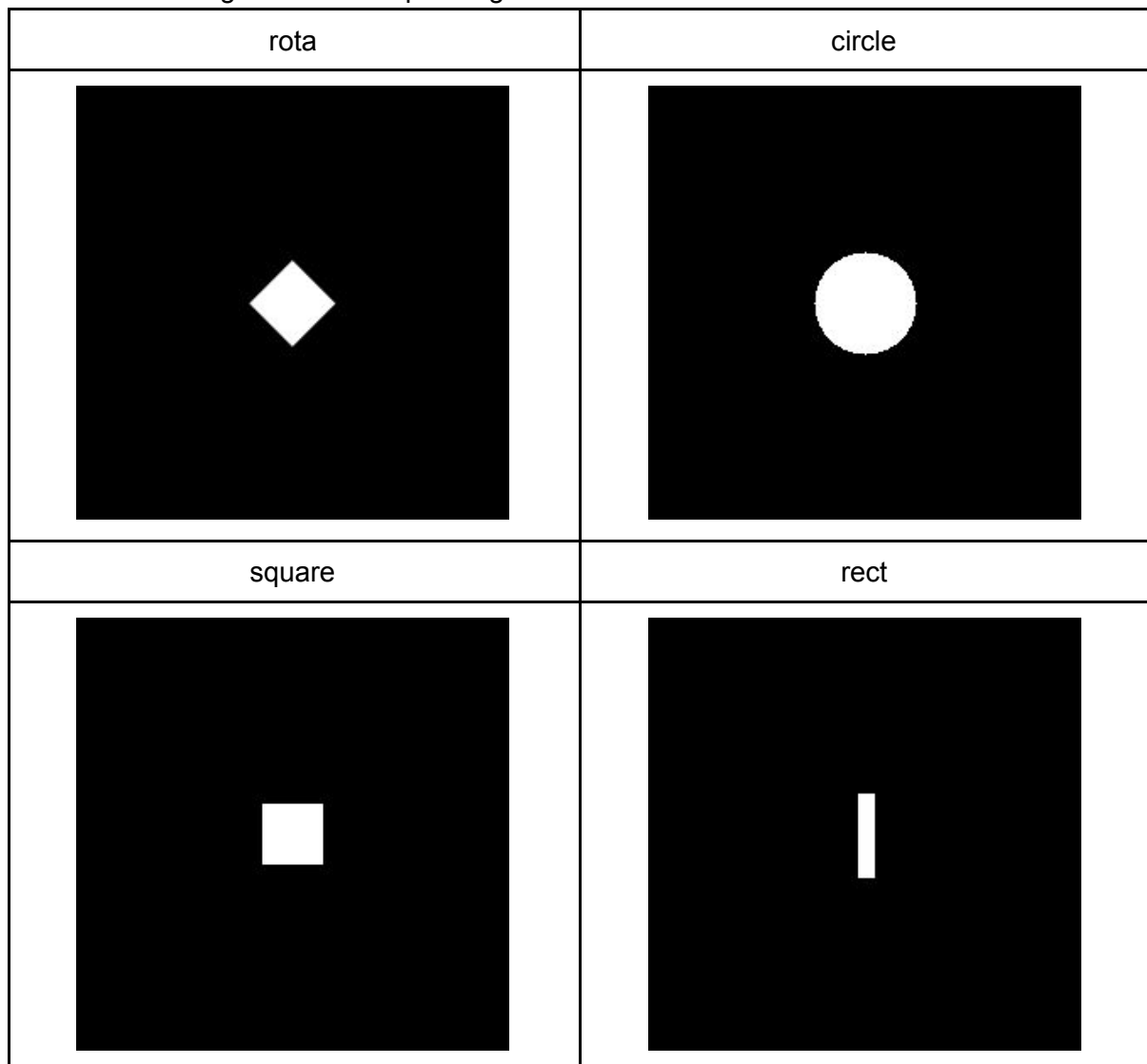
In the resulting image, except the contrast it is the same as my DFT.

Execution Time

	my	opencv
rectangle	2923ms	3798us
square	2920ms	2249us
rotate	2911ms	2109us
circle	2873ms	2111us

Doing 2D-DFT function can using a 4 layers for loop to scale the x,y,u,v but its Execution time is about 6 mins, so we can use 1D-DFT to transfer $f(x,y)$ to $F(x,v)$ then do 1D-DFT again to get $F(u,v)$, and a 1D-DFT only need 3 layers for loop. The time complexity of 4 layers for loop is n^4 and 1D-DFT is n^3 but we need to do it twice so the time complexity of 1D+1D DFT is $2n^3$ and the execution time is only 3 second. but it is still 1000 times opencv's DFT. (The Execution time result image is at the bellow.

- (c) Write your own IDFT subroutine and test on DFT output from (a). Show the results of these images and corresponding with MSE and PSNR values.



4-for-loop 2D-DFT Execution time and MSE PSNR

square	result
Execution time of the DFT and IDFT of square is 14 min 10s MSE of input and output is 0.000000 PSNR of input and output is inf	MSE=0 PSNR=INF
rect	
Execution time of the DFT and IDFT of rect is 14 min 22s MSE of input and output is 0.000000 PSNR of input and output is inf	MSE=0 PSNR=INF
rota	
Execution time of the DFT and IDFT of rota is 14 min 7s MSE of input and output is 0.000000 PSNR of input and output is inf	MSE=0 PSNR=INF
circle	
Execution time of the DFT and IDFT of circle is 14 min 53s MSE of input and output is 0.000000 PSNR of input and output is inf	MSE=0 PSNR=INF

3-for-loop 1D +1D DFT Execution time

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rect
DFT_startIDFT_startExecution time of the DFT of rect is 2923.56ms
MSE of input and output is 0.000000
PSNR of input and output is inf
please enter the question number
enter quit to exit
menu
rect square circle rota
cvrect cvsquare cvcircle cvrota
circle
DFT_startIDFT_startExecution time of the DFT of circle is 2873.2ms
MSE of input and output is 0.000000
PSNR of input and output is inf
please enter the question number
enter quit to exit
menu
rect square circle rota
cvrect cvsquare cvcircle cvrota
square
DFT_startIDFT_startExecution time of the DFT of square is 2920.53ms
MSE of input and output is 0.000000
PSNR of input and output is inf
please enter the question number
enter quit to exit
menu
rect square circle rota
cvrect cvsquare cvcircle cvrota
rota
DFT_startIDFT_startExecution time of the DFT of rota is 2911.06ms
MSE of input and output is 0.000000
PSNR of input and output is inf

```

To the result we can perfectly reduce the image by doing IDFT to the DFT image.

Result Image : [LINK](#)