Signal processing and analysis

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Major: Photogrammetry and Remote Sensing	Assignment Index: I
Course: Signal processing and analysis	Professor: LUO Bin TA: 韩承熙 Sigma

I. Proving a function to be a periodic function and expression function_(QN1&2)

SIGNAL PROCESSING AND ANALYSIS

1.

The fourier transformation:

$\delta_p(x)$:

$$\rightarrow \text{i} \quad F_{\delta p}(jw_0) = \frac{2\pi}{P}\sum_{n=-\infty}^{+\infty}\delta\left(w - n\frac{2\pi}{P}\right)$$

By using convolution and fourier transformation, $f(x) = F(jw)$

$$\rightarrow \text{ii} \quad F_p(jw) = F(jw)F_{\delta p}(jw) = \frac{2\pi}{P}F(jw)\sum_{n=-\infty}^{+\infty}\delta\left(w - n\frac{2\pi}{P}\right)$$

The Inverse of Fourier transformation of $F_p(jw)$:

$$\rightarrow \text{iii} \quad f_p(x) = \int_{-\infty}^{+\infty}\frac{2\pi}{P}F(jw)\sum_{n=-\infty}^{+\infty}\delta\left(w - n\frac{2\pi}{P}\right)e^{jw}dt = \sum_{n=-\infty}^{+\infty}f(x+np)$$

= this is function is periodic

2. at $x < -2N$, $t_N(x) = 0$

at $-2N < x < 0$, $t_N = \int_{-N}^{N+x}dt = 2N + x$

at: $0 < x < 2N$, $t_N \int_{-N}^{N+x}dt = 2N - x$

at: $x > 2N$, $t_N(x) = 0$

$$\Rightarrow \quad t_N(x) = \begin{cases} 2N - |x|, & \text{for } |x| < 2N \\ 0, & \text{others} + \ldots\ldots \end{cases}$$

but if we assume that: $N > 1$, $t_p(x)$ is to be convolution of $t_N(x)$ and $r_N(x)$, $t_p(x) = t_N(x)\cdot r_N(x) = \int_{-\infty}^{+\infty}t_N(t)r_N(x-t)dt$

$$\begin{cases} \rightarrow \text{for: } -4N \leq x \leq 1-4N, & t_p(x) = \frac{1}{2}(4N+x)^2 \\ \rightarrow \text{for: } 1-4N < x \leq -N, & \frac{1}{2}(4N+x-1)(4N+x) \end{cases}$$

III. Result

(3) Fourier transformation

$$F_{rN}(j\omega) = \int_{-N}^{N} r_N(x)\, e^{-j\omega x}\, dx$$

$$= \frac{e^{j\omega N} - e^{-j\omega N}}{j\omega} = \frac{2\sin \omega N}{\omega}$$

- for Fourier transformation, using convolutional property

$$F_{tN}(j\omega) = F_{rN}(j\omega)\, F_{rN}(j\omega)$$

$$= \frac{4\sin^2(\omega N)}{\omega^2}$$ and transformation of $P_N(x)$

can be demonstrated into this ways:

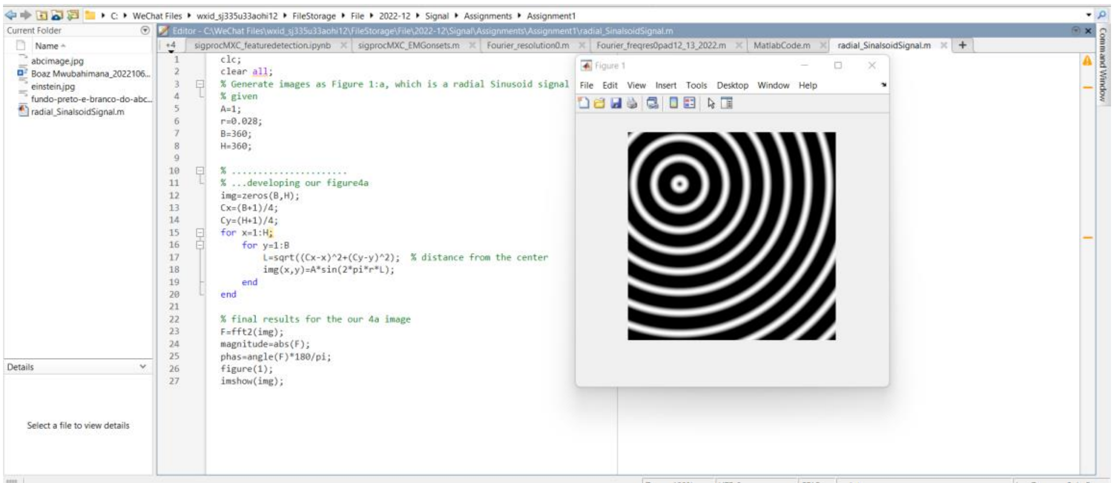
$$F_{PN}(j\omega) = F_{tN}(j\omega)\, F_{rN}(j\omega)$$

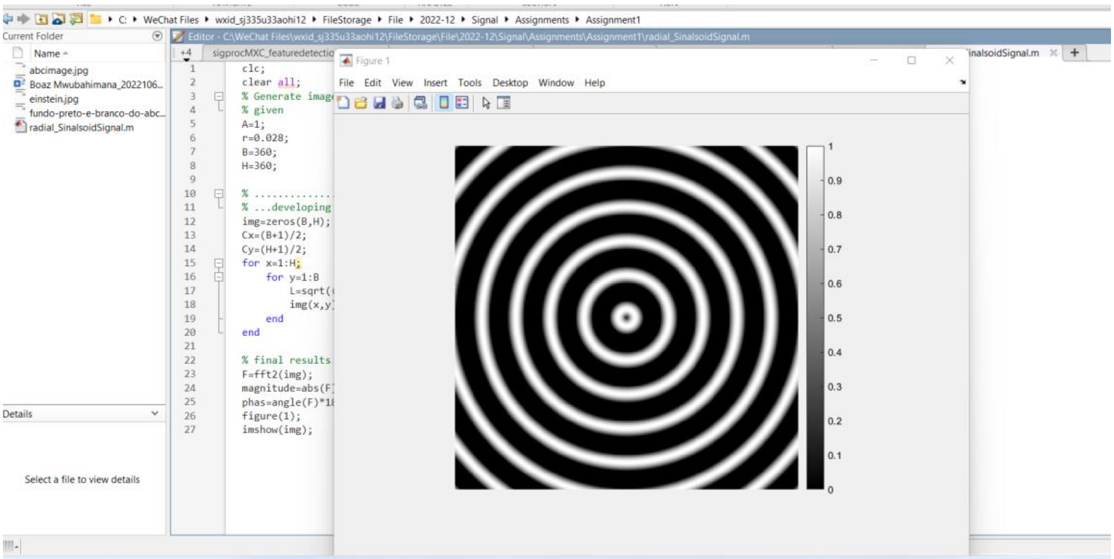
$$= \frac{4\sin^2(\omega N)}{\omega^2} \frac{2\sin \omega N}{\omega} = \frac{8\sin^3(\omega N)}{\omega^3}$$

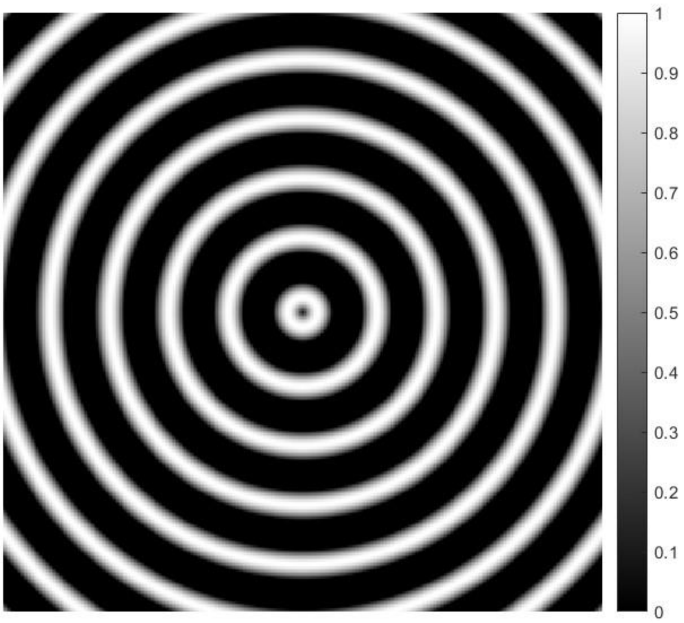
$$\Rightarrow \frac{8\sin^3(\omega N)}{\omega^3}$$

IV. Generate an image as Figure 4a, which is a radial Sinusoid signal.

a.

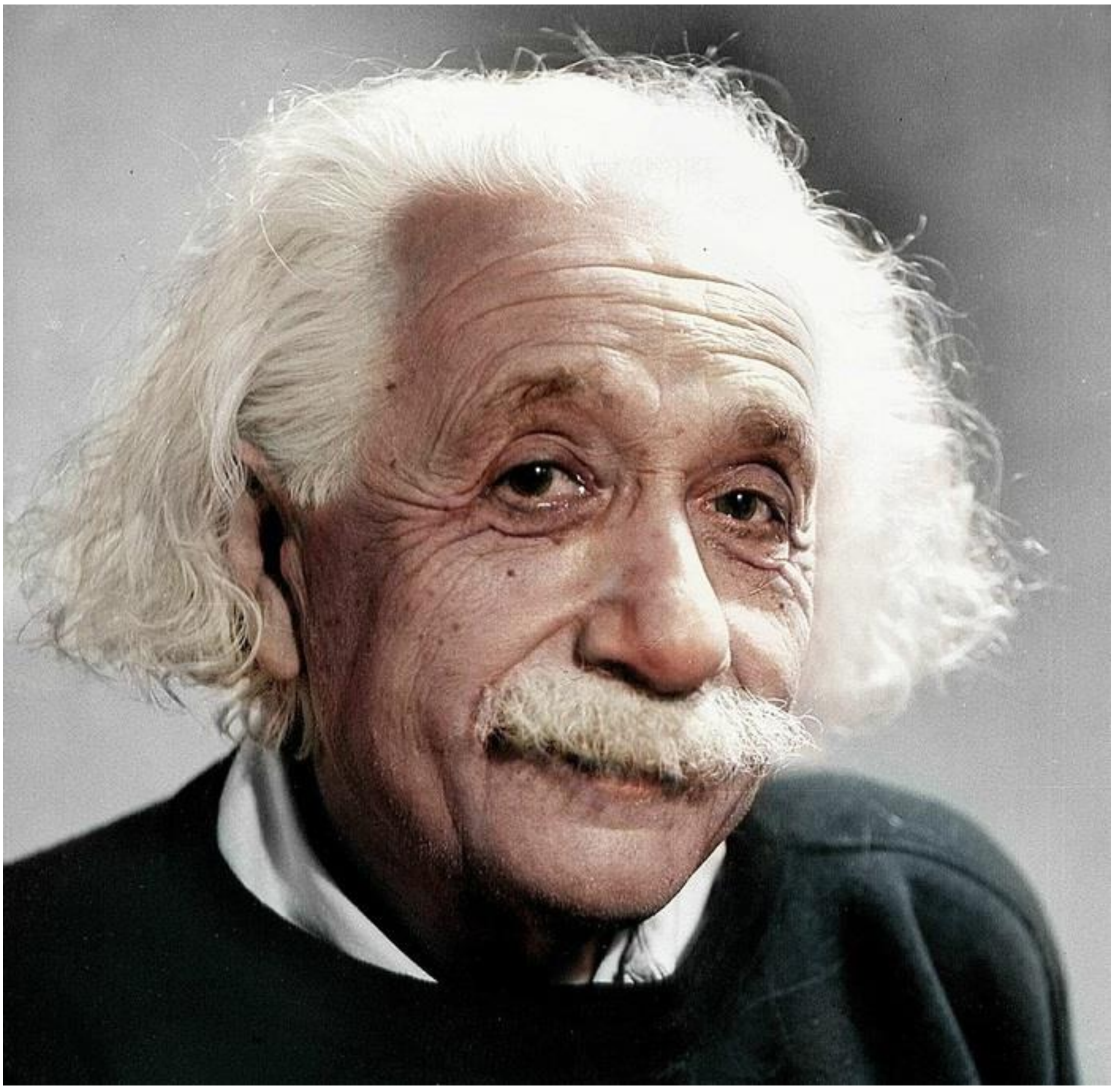



C: ▸ WeChat Files ▸ wxid_sj335u33aohi12 ▸ FileStorage ▸ File ▸ 2022-12 ▸ Signal ▸ Assignments ▸ Assignment1
Current Folder
Name
abcimage.jpg
Boaz Mwubahimana_2022106...
einstein.jpg
fundo-preto-e-branco-do-abc...
radial_SinalsoidSignal.m
Details
Select a file to view details
Editor - C:\WeChat Files\wxid_sj335u33aohi12\FileStorage\File\2022-12\Signal\Assignments\Assignment1\radial_SinalsoidSignal.m
sigprocMXC_featuredetectio
clc;
clear all;
% Generate image
% given
A=1;
r=0.028;
B=360;
H=360;
% ...developing
img=zeros(B,H);
Cx=(B+1)/2;
Cy=(H+1)/2;
for x=1:H;
for y=1:B
L=sqrt(
img(x,y
end
end
% final results
F=fft2(img);
magnitude=abs(F
phas=angle(F)*1
figure(1);
imshow(img);
Figure 1
File Edit View Insert Tools Desktop Window Help
1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0


1
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0

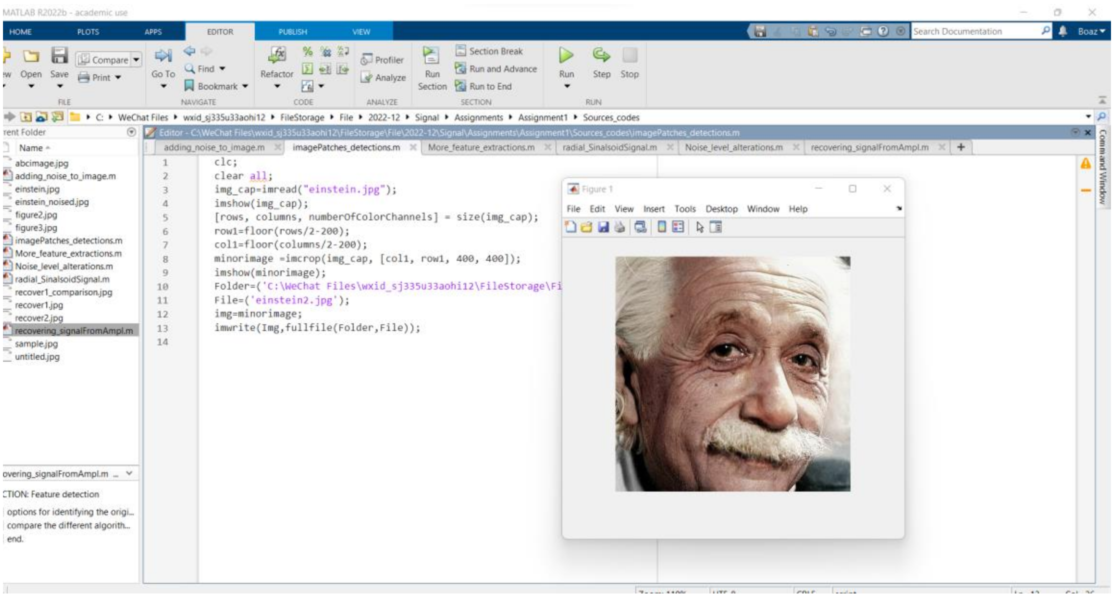
V.

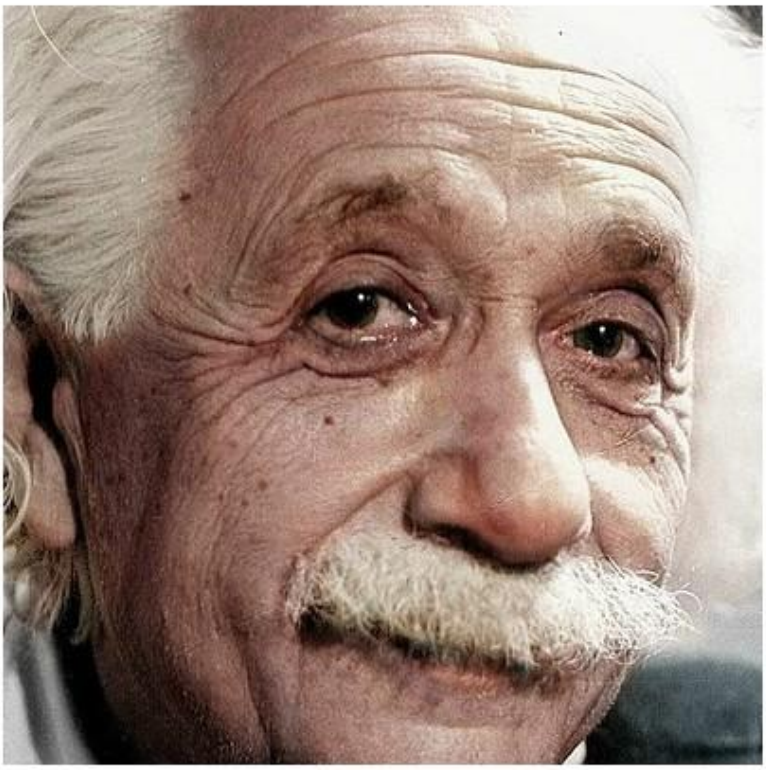
a.

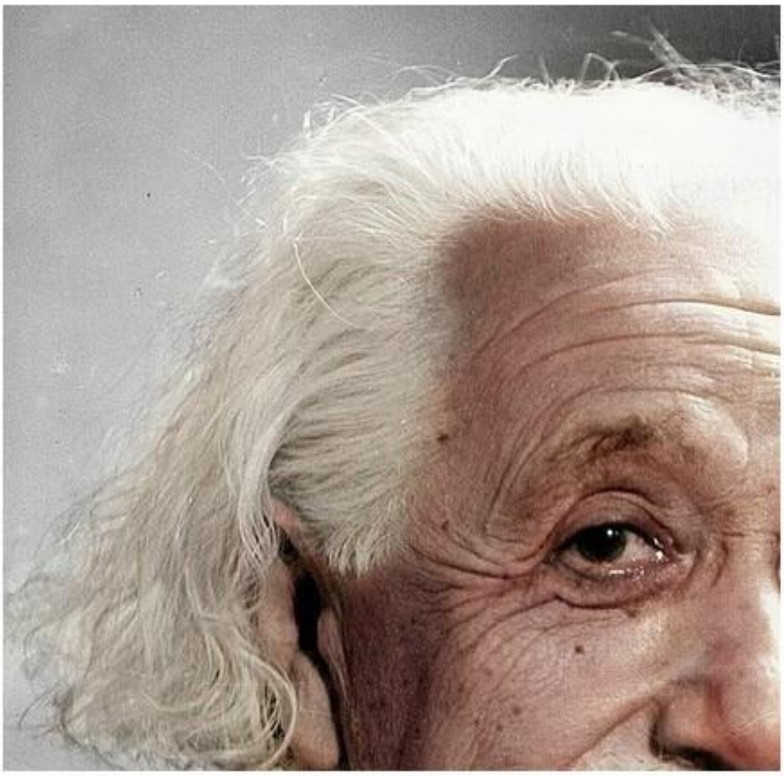


The original image (source: Wikipedia)

b.

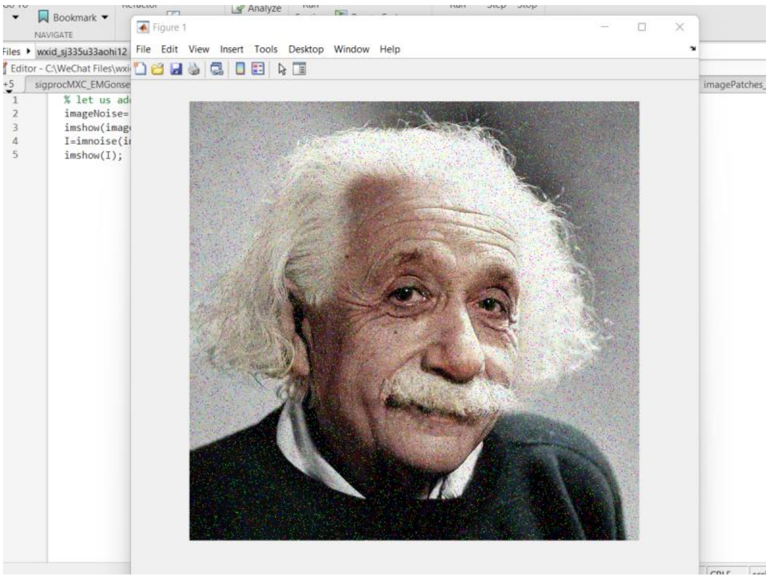


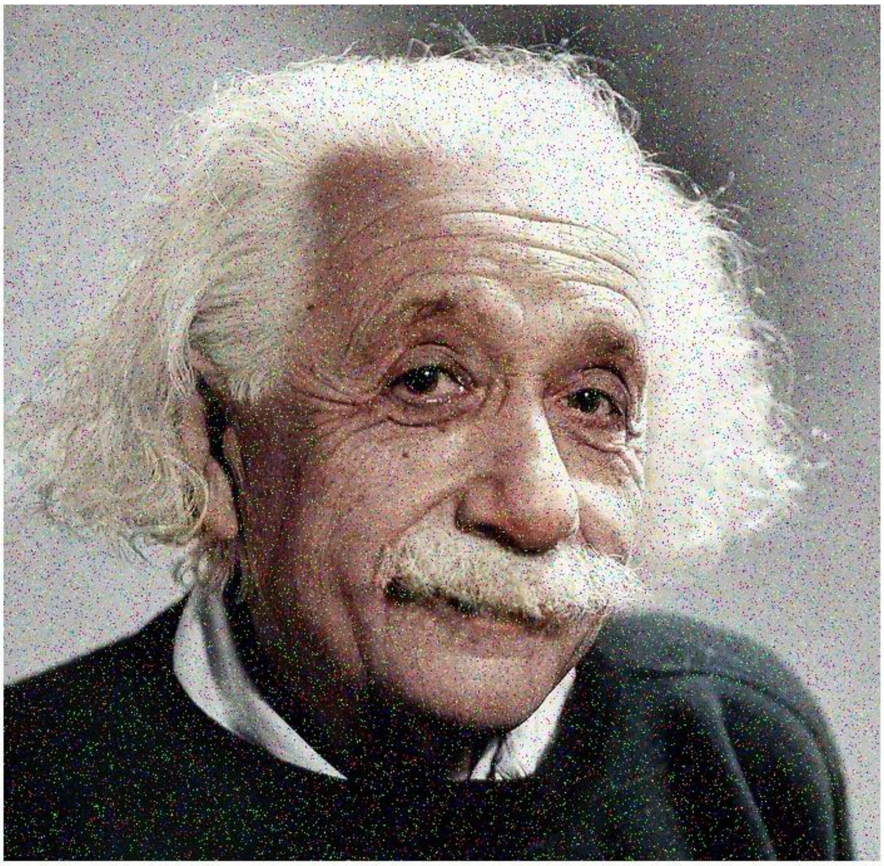




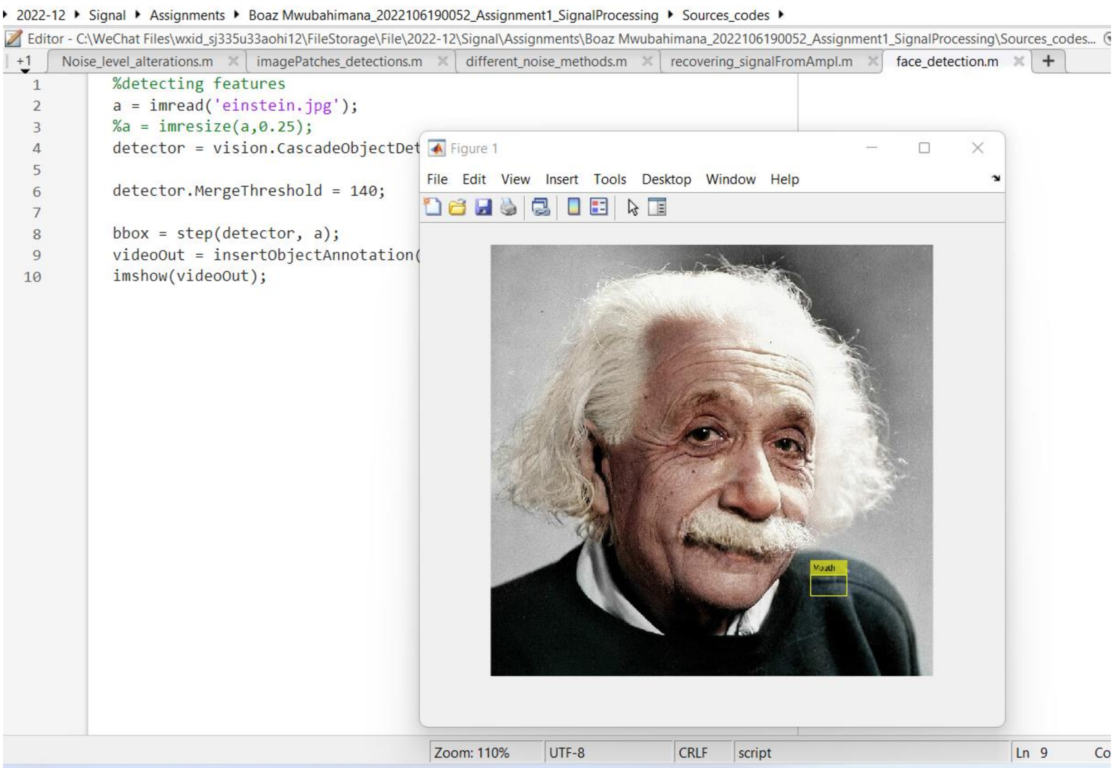
Subsisted original image and extractions of semple img

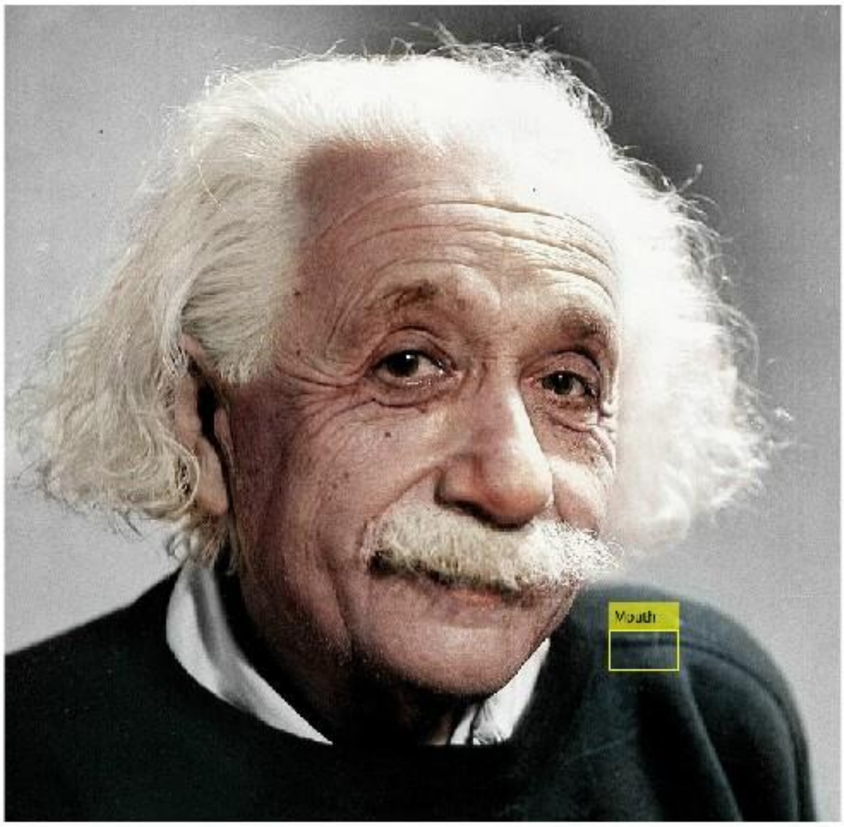
c. some noise added to the original image.





d. adding more detection to the image





trying to detect near the mouth of Einstein

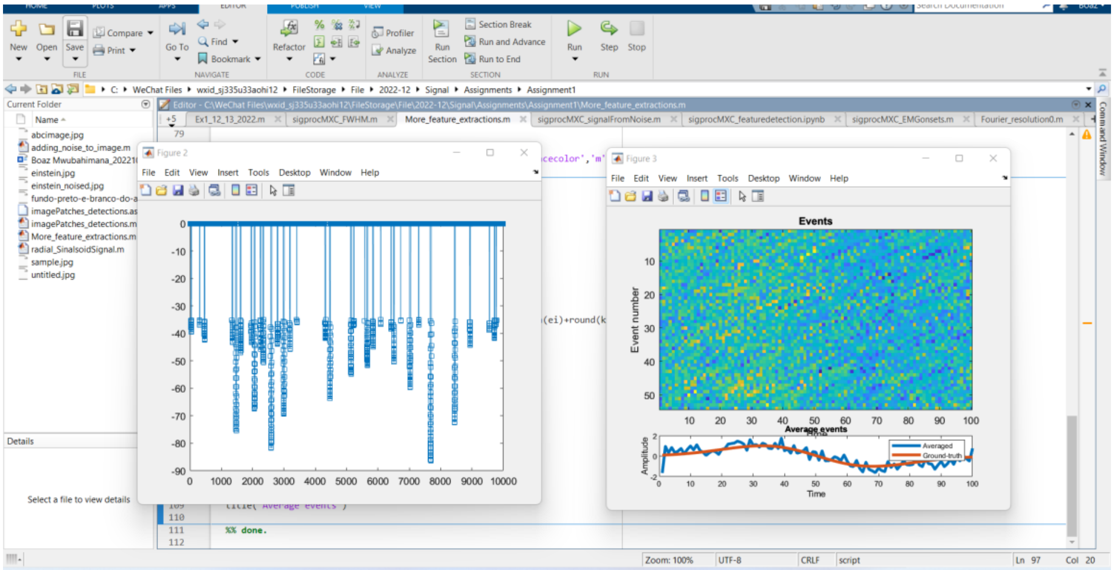
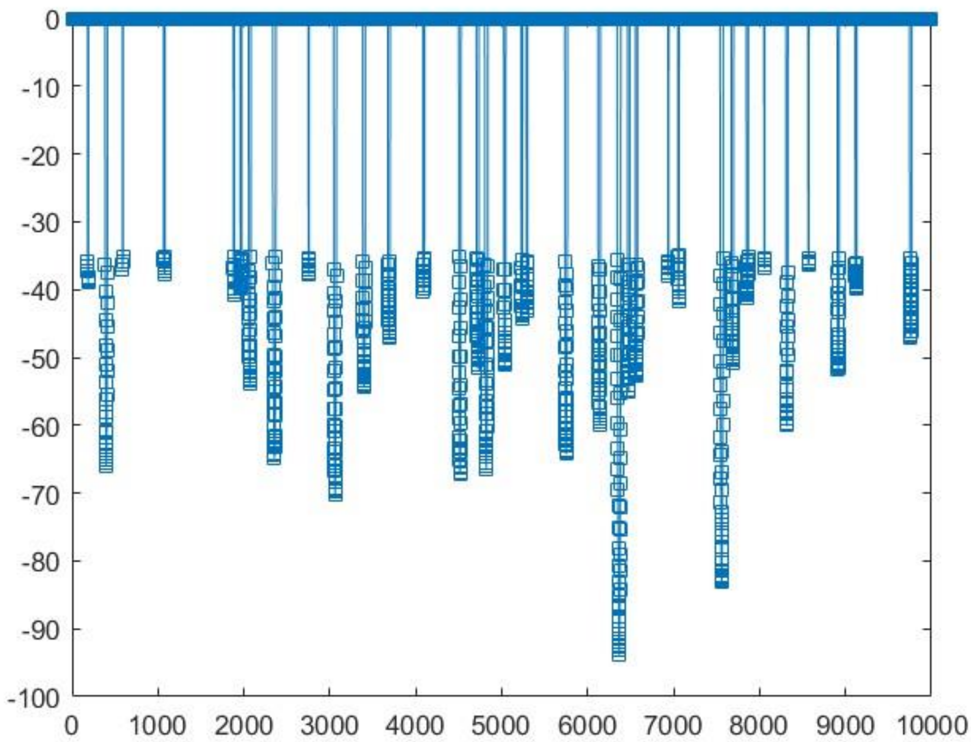
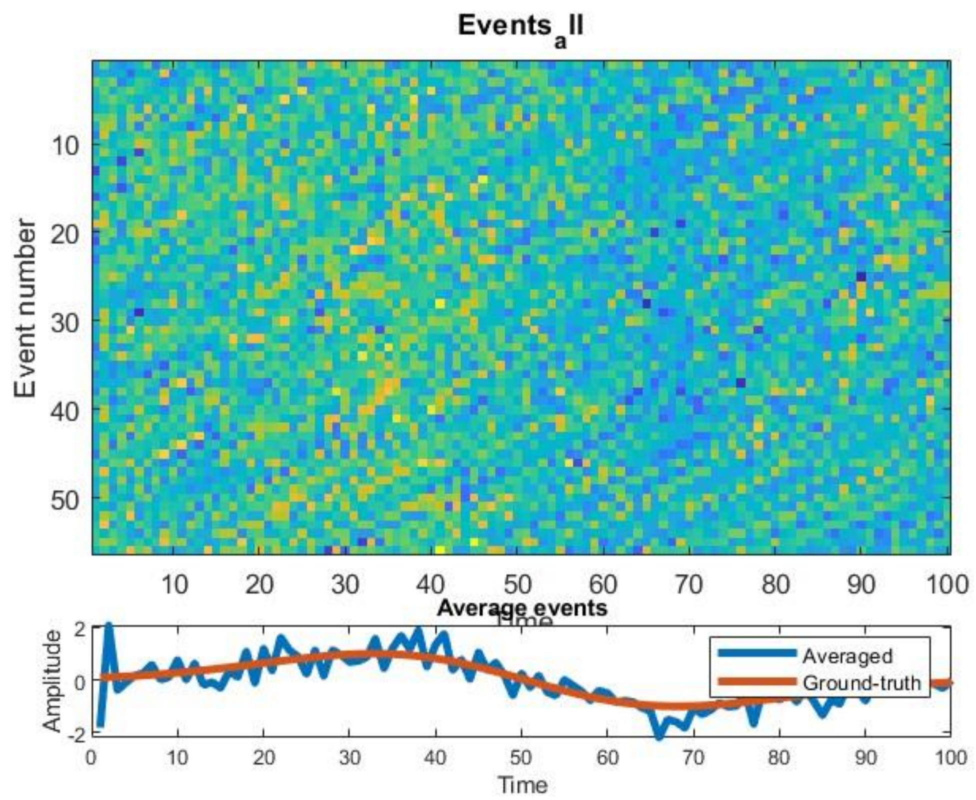
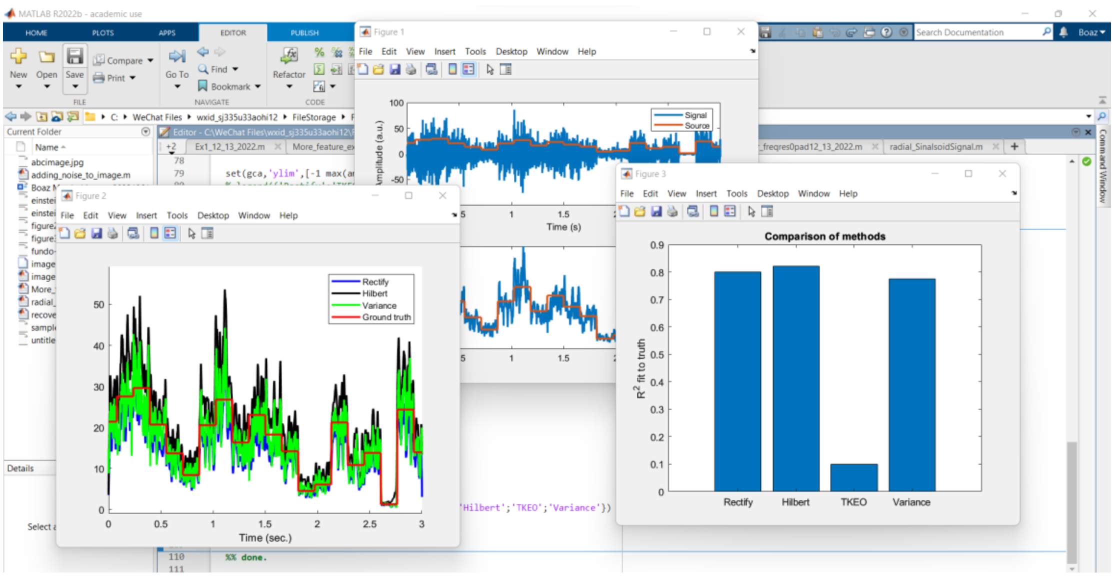


Figure 2
Figure 3
Events
Event number
Average events
Amplitude
Time
Averaged
Ground-truth
Select a file to view details
%% done.

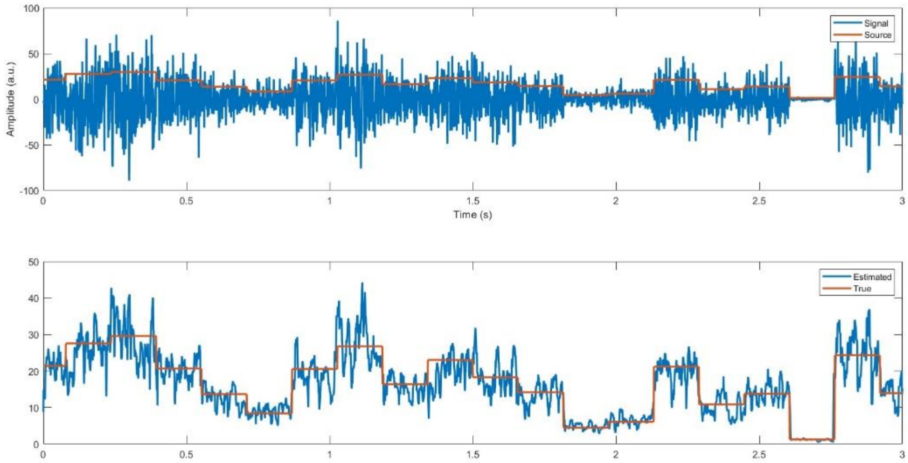

0
-10
-20
-30
-40
-50
-60
-70
-80
-90
-100
0
1000
2000
3000
4000
5000
6000
7000
8000
9000
10000

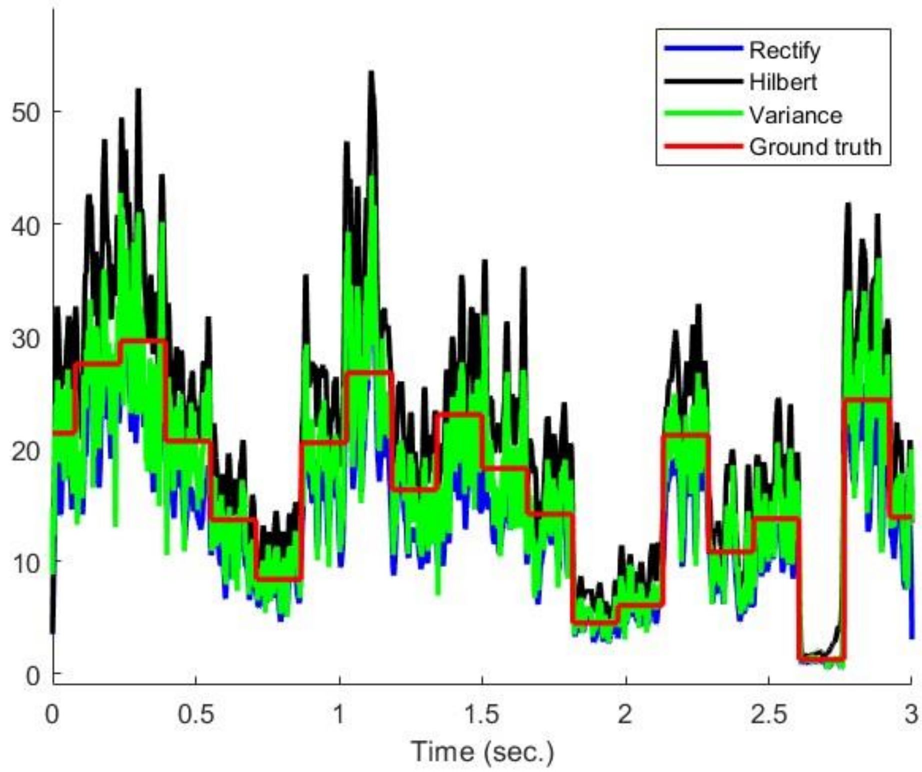


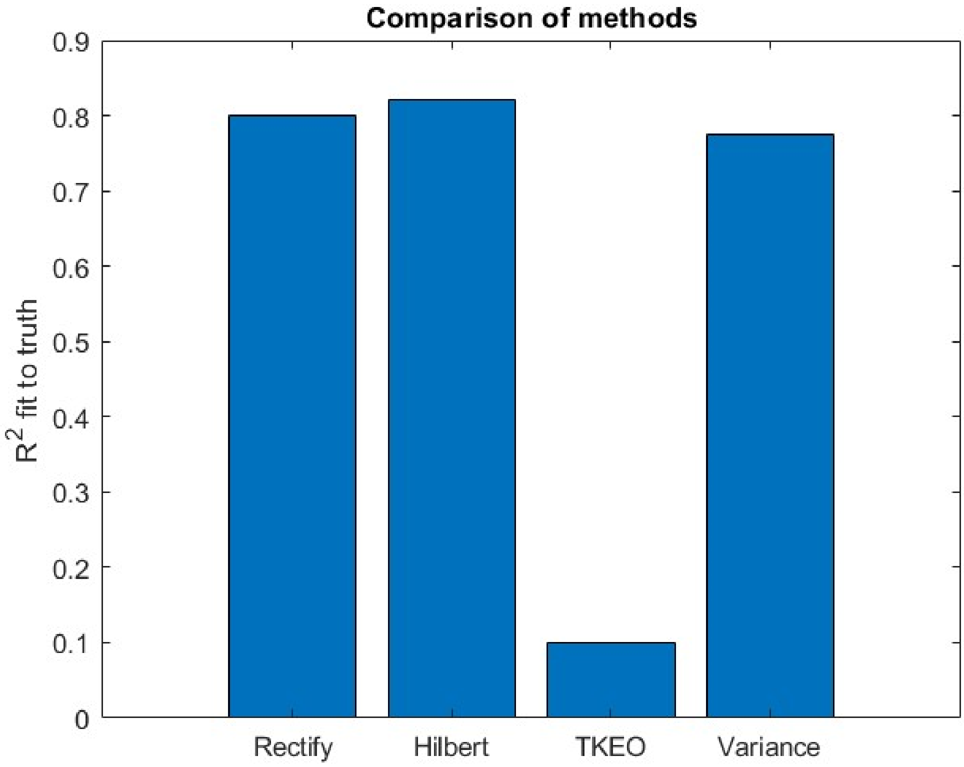
More: Recover signal from noise amplitude



Recovering signal from amplitude


Signal
Source
Amplitude (a.u.)
Time (s)
Estimated
True


Rectify
Hilbert
Variance
Ground truth
Time (sec.)



comparing the two methods