# EXPERIMENT 3 PRELIMINARY WORK

## Table of Contents



# GÜRAY ÖZGÜR

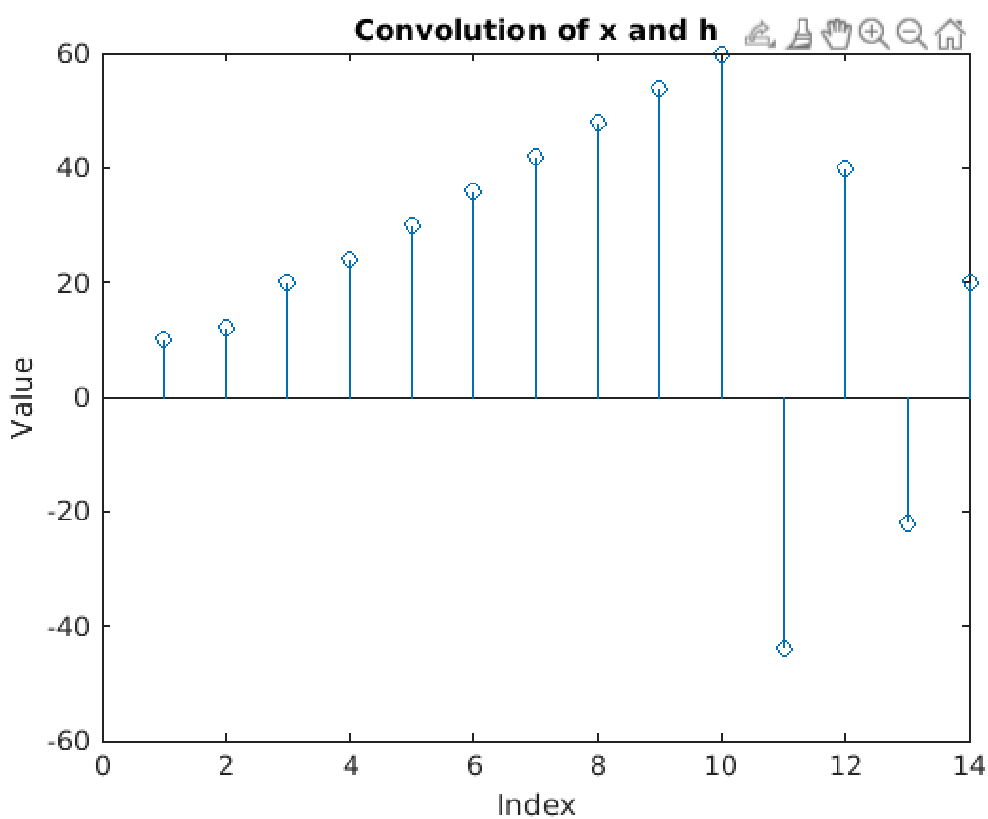
# 2167054

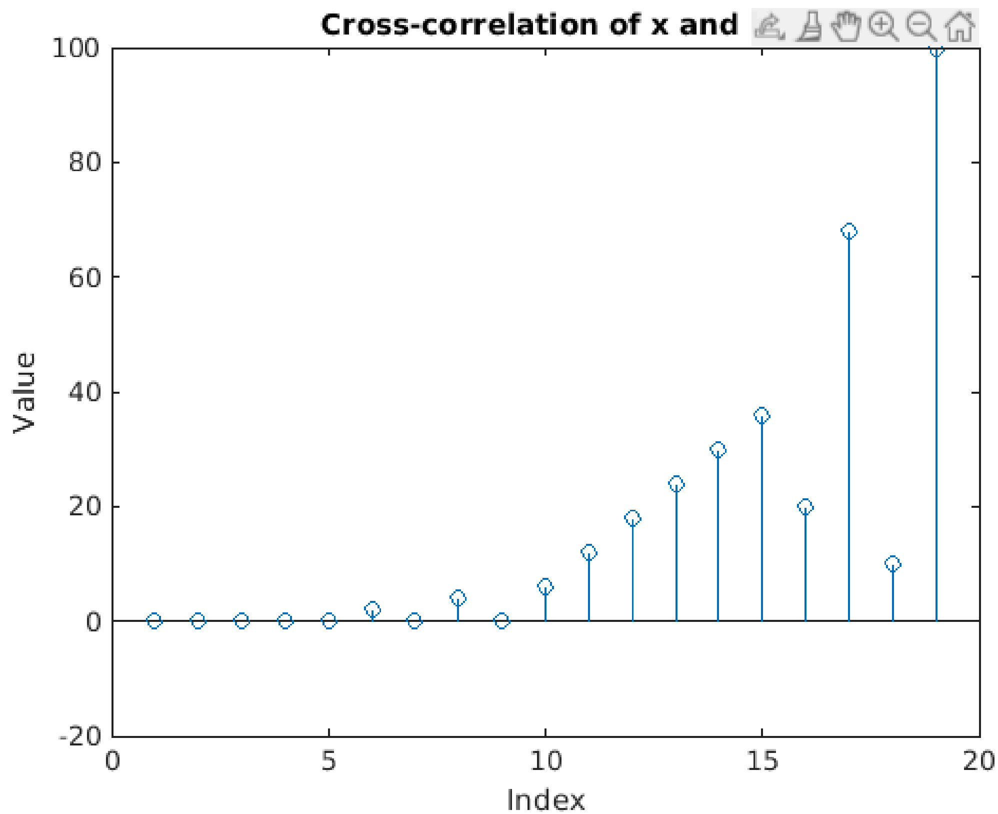
# PRE-Q1

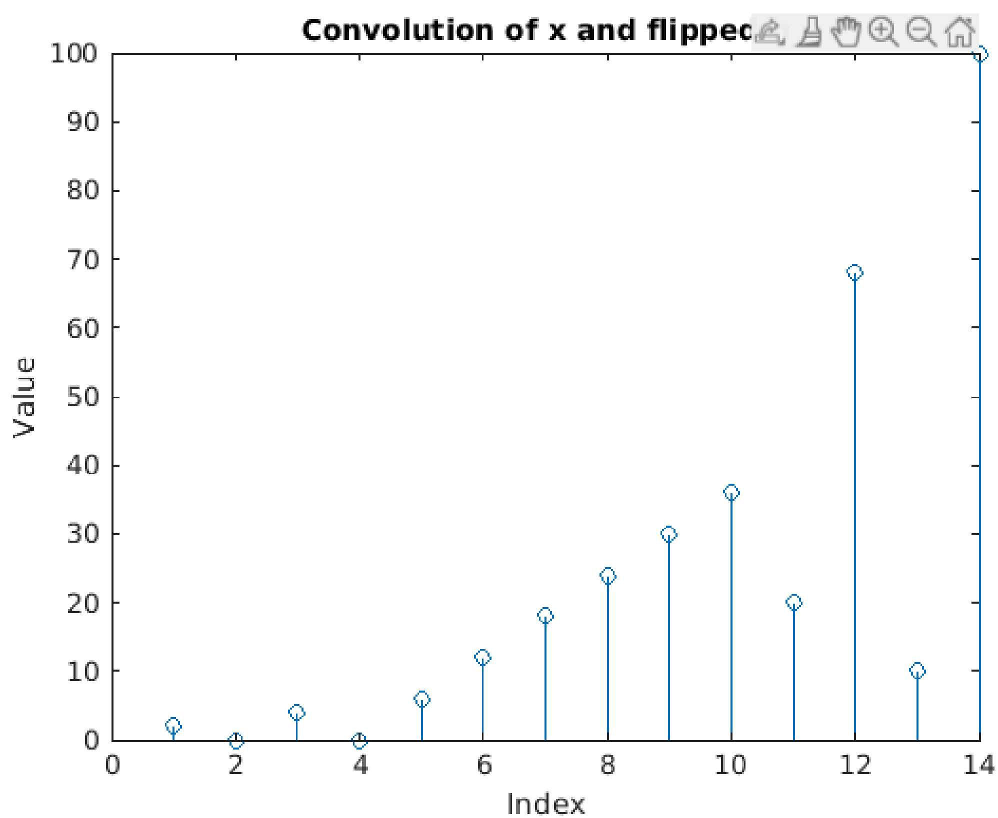
```
clear; clc; close all;
% Q1a
x = [ 1 2 3 4 5 6 7 8 9 10 ];
h = [ 10 -8 6 -4 2 ];

% Q1b
convy1 = conv(x,h);
figure
stem(convy1)
title("Convolution of x and h")
xlabel("Index")
ylabel("Value")

% Q1c
corry = xcorr(x,h);
figure
stem(corry)
title("Cross-correlation of x and h")
xlabel("Index")
ylabel("Value")

% Q1d
convy2 = conv(x,fliplr(h));
figure
stem(convy2)
title("Convolution of x and flipped h")
xlabel("Index")
ylabel("Value")

% Q1e
fprintf("\nQ1e\nThere is a similarity between convolution of x and
 flipped version of h and cross-correlation of x and h, which is
```

```
additional zeros at the beginning. For convolution operation, flipped
h is flipped again, as in part Q1d, and then convolution is completed
by sliding, that's why it was expected. Correlation is a measurement
of the similarity between two signals. Convolution is a measurement
of effect of one signal on the other signal. The mathematical
calculation of correlation is same as convolution in time domain,
except that the signal is not reversed, before the multiplication
process.")
```

*Q1e*
*There is a similarity between convolution of x and flipped version of h and cross-correlation of x and h, which is additional zeros at the beginning. For convolution operation, flipped h is flipped again, as in part Q1d, and then convolution is completed by sliding, that's why it was expected. Correlation is a measurement of the similarity between two signals. Convolution is a measurement of effect of one signal on the other signal. The mathematical calculation of correlation is same as convolution in time domain, except that the signal is not reversed, before the multiplication process.*




Cross-correlation of x and
Value
Index
100
80
60
40
20
0
-20
0
5
10
15
20


Convolution of x and flippec
Value
Index
100
90
80
70
60
50
40
30
20
10
0
0
2
4
6
8
10
12
14

# PRE-Q2

Q2a

```
fs = 10000;
T = 1/fs;
t = 0:T:0.08;
mysin = sin(2*pi*100*t);
figure
plot(t,mysin)
title("200 Hz sine sequence")
xlabel("Time(s)")
ylabel("Amplitude")

% Q2b
t2 = 0:T:0.16;
corrsin = xcorr(mysin,mysin);
figure
plot(t2,corrsin)
title('The correlation of the sine signal with itself')
xlabel('Time(s)')
ylabel('Amplitude')
% Q2c
mychirp = chirp(t,0,0.08,200);
figure
plot(t,mychirp)
title('A chirp signal with start frequency 0 and end frequency 200
 Hz')
xlabel('Time(s)')
ylabel('Amplitude')

% Q2d
corrchirp = xcorr(mychirp,mychirp);
figure
plot(t2,corrchirp)
title('The correlation of the chirp signal with itself')
xlabel('Time(s)')
ylabel('Amplitude')

% Q2e
fprintf("\nQ2e\nFor the autocorrelation of sinusoidal signal, it
 is seen that it increases and decreases, which is expected since
 sinusoidal is periodic and partially matches with itself due to
 periodicity. At 80 ms, the signals are matched, thus we see a peak.
 For the autocorrelation of chirp signal, it is seen that we have a
 sharp peak, it is like an impulse, which is expected since it has a
 varying frequency and it peaks when the signals match. In this case,
 we see a peak  at 80 ms, which was the length of the signal. After 80
 ms delay while sliding, the signals are matched. For this reason, it
 is used in RADARs and the range of the target is at the peak.")

% Q2f
corrchirpsin = xcorr(mychirp,mysin);
```

```
figure
plot(t2,corrchirpsin)
title('The correlation of the chirp signal and the sinusoidal signal')
xlabel('Time(s)')
ylabel('Amplitude')

% Q2g
mychirp2 = chirp(t,200,0.08,400);
corrchirpsin2 = xcorr(mychirp2,mysin);
figure
plot(t2,corrchirpsin2)
title('The correlation of the second chirp signal and the sinusoidal
 signal')
xlabel('Time(s)')
ylabel('Amplitude')

% Q2h
mychirp3 = chirp(t,400,0.08,600);
corrchirpsin3 = xcorr(mychirp3,mysin);
figure
plot(t2,corrchirpsin3)
title('The correlation of the third chirp signal and the sinusoidal
 signal')
xlabel('Time(s)')
ylabel('Amplitude')

% Q2i
fprintf("\nQ2i\nThe frequency range for the first chirp is 0-200 Hz,
 for the second chirp is 200-400 Hz, for the third chirp is 400-600
 Hz, thus the end of the first chirp and the beginning of the second
 chirp is more similar to our sinusoidal for frequency-wise. Since
 correlation implies the similarity, our first obsevation is that more
 similar means a higher correlation, which is observed in the plots.
 Correlation is higher for the first chirp than the others, and when
 the frequncy matches, we observe higher correlation, namely the end
 of the first chirp and the beginning of the second chirp. For the
 third chirp, correlation is so small implying a dissimilarity.")

% Q2j
mysquare = square(2*pi*200*t);
figure
plot(t,mysquare)
title('A 200 Hz square wave')
xlabel('Time(s)')
ylabel('Amplitude')

% Q2k
corrchirpsquare = xcorr(mychirp3,mysquare);
figure
plot(t2,corrchirpsquare)
title('The correlation of the third chirp signal and the square wave')
xlabel('Time(s)')
ylabel('Amplitude')
```

```
fprintf("\nQ2k\nHere the reason why we do not observe a low
 correlation as in sinusoidal case is that since the square wave is a
 sum of sinusoidals with different frequencies, contains a wide range
 of harmonics, which overlap with the frequencies of the third chirp,
 which was in the range of 400-600 Hz. That's why, a correlation is
 observed with the higher frequencies of the chirp.")
```

*Q2e*

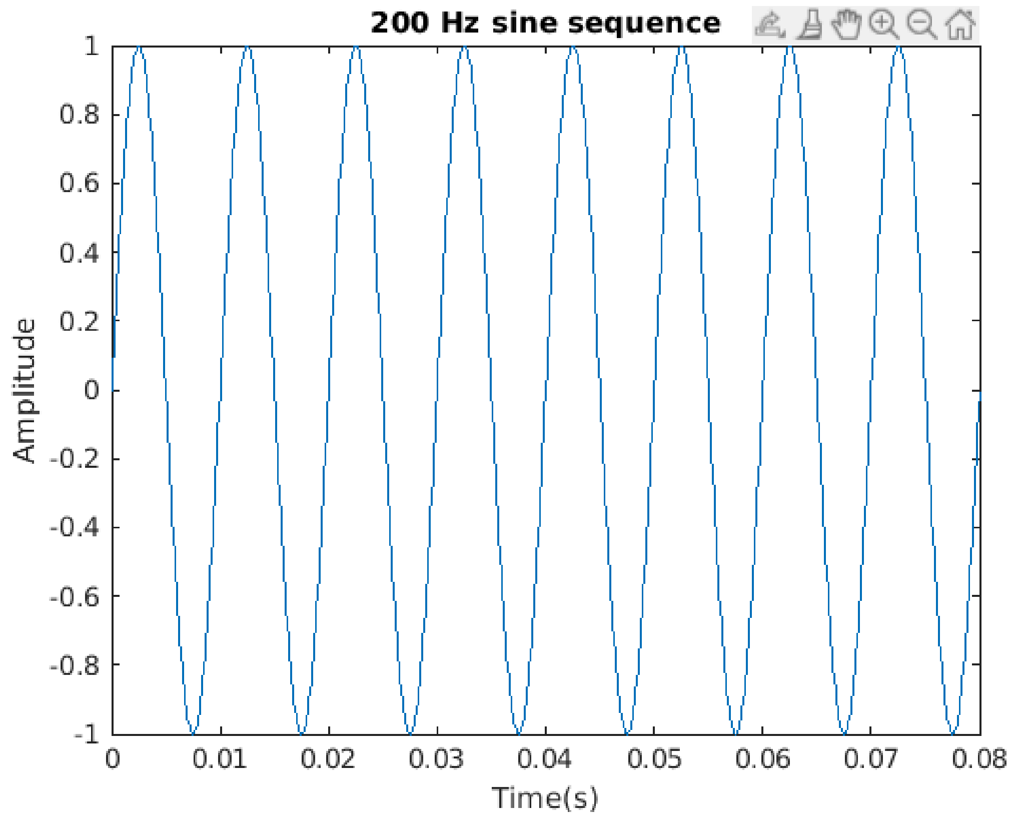
*For the autocorrelation of sinusoidal signal, it is seen that it increases and decreases, which is expected since sinusoidal is periodic and partially matches with itself due to periodicity. At 80 ms, the signals are matched, thus we see a peak. For the autocorrelation of chirp signal, it is seen that we have a sharp peak, it is like an impulse, which is expected since it has a varying frequency and it peaks when the signals match. In this case, we see a peak at 80 ms, which was the length of the signal. After 80 ms delay while sliding, the signals are matched. For this reason, it is used in RADARs and the range of the target is at the peak.*

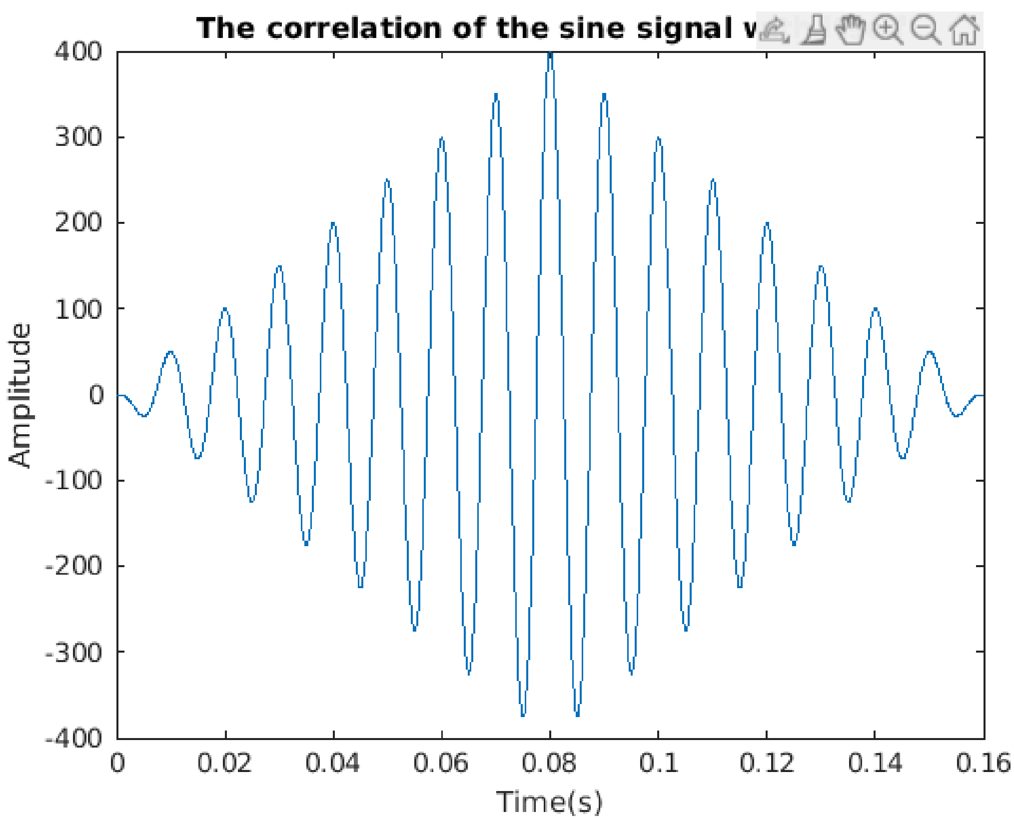
*Q2i*

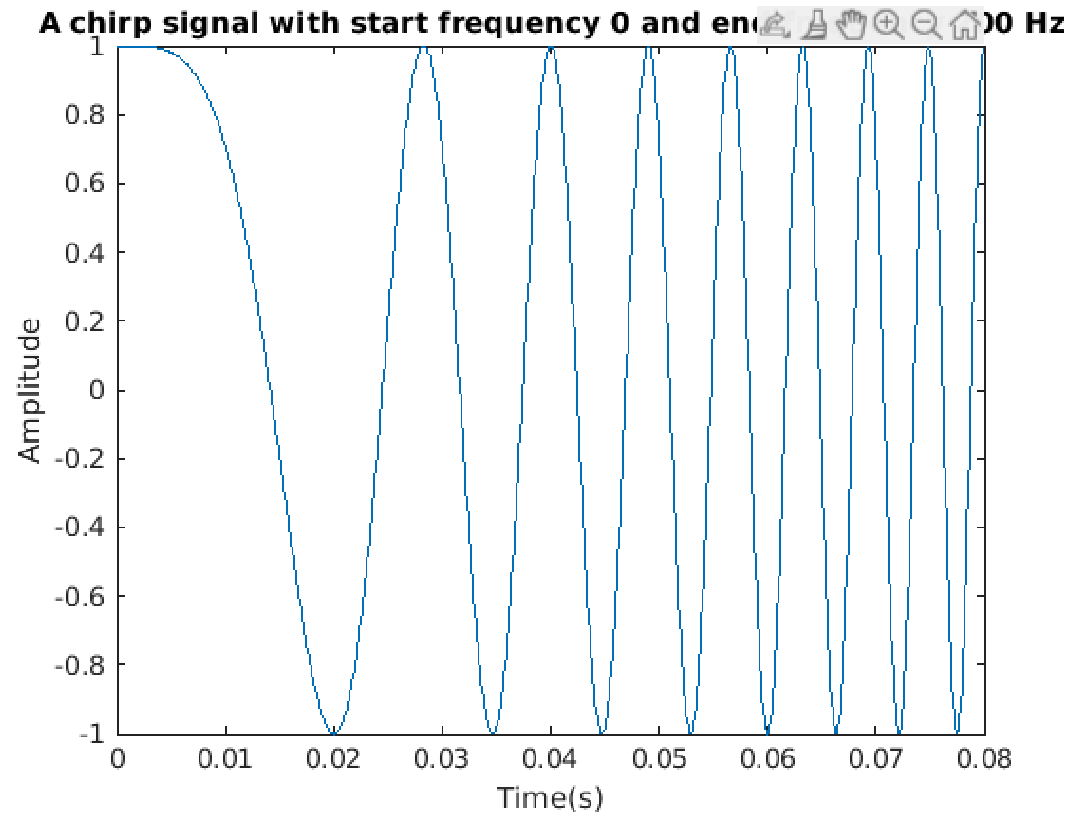
*The frequency range for the first chirp is 0-200 Hz, for the second chirp is 200-400 Hz, for the third chirp is 400-600 Hz, thus the end of the first chirp and the beginning of the second chirp is more similar to our sinusoidal for frequency-wise. Since correlation implies the similarity, our first obsevation is that more similar means a higher correlation, which is observed in the plots. Correlation is higher for the first chirp than the others, and when the frequncy matches, we observe higher correlation, namely the end of the first chirp and the beginning of the second chirp. For the third chirp, correlation is so small implying a dissimilarity.*

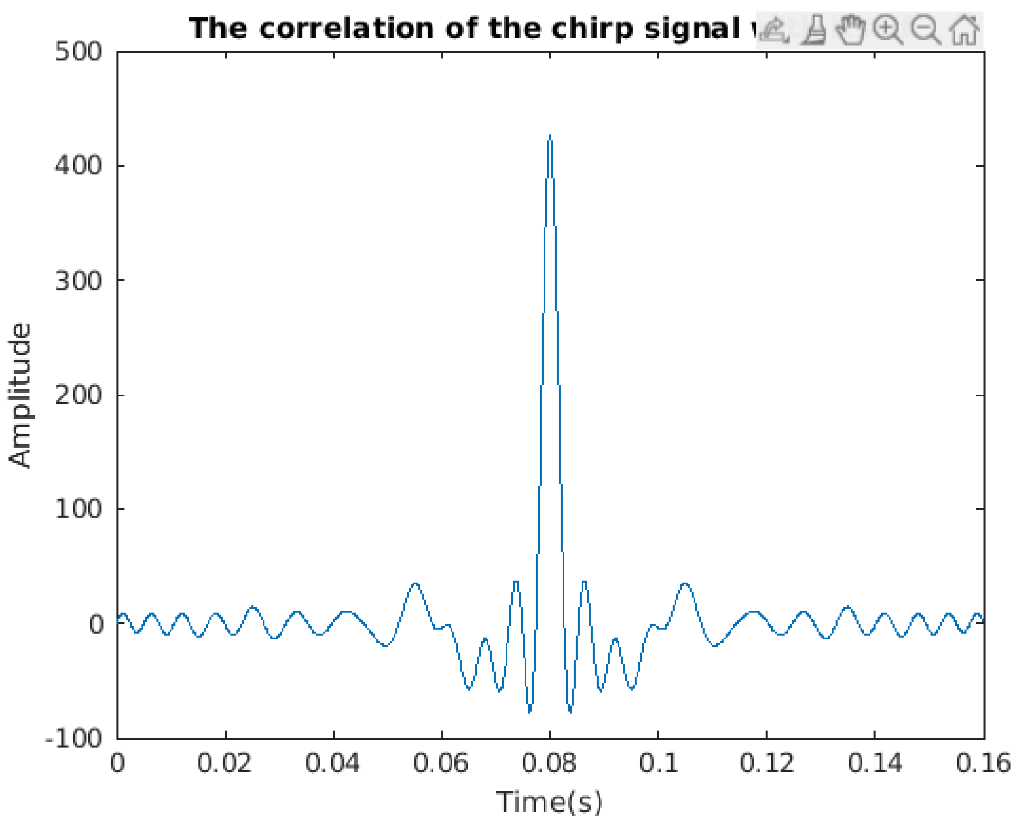
*Q2k*

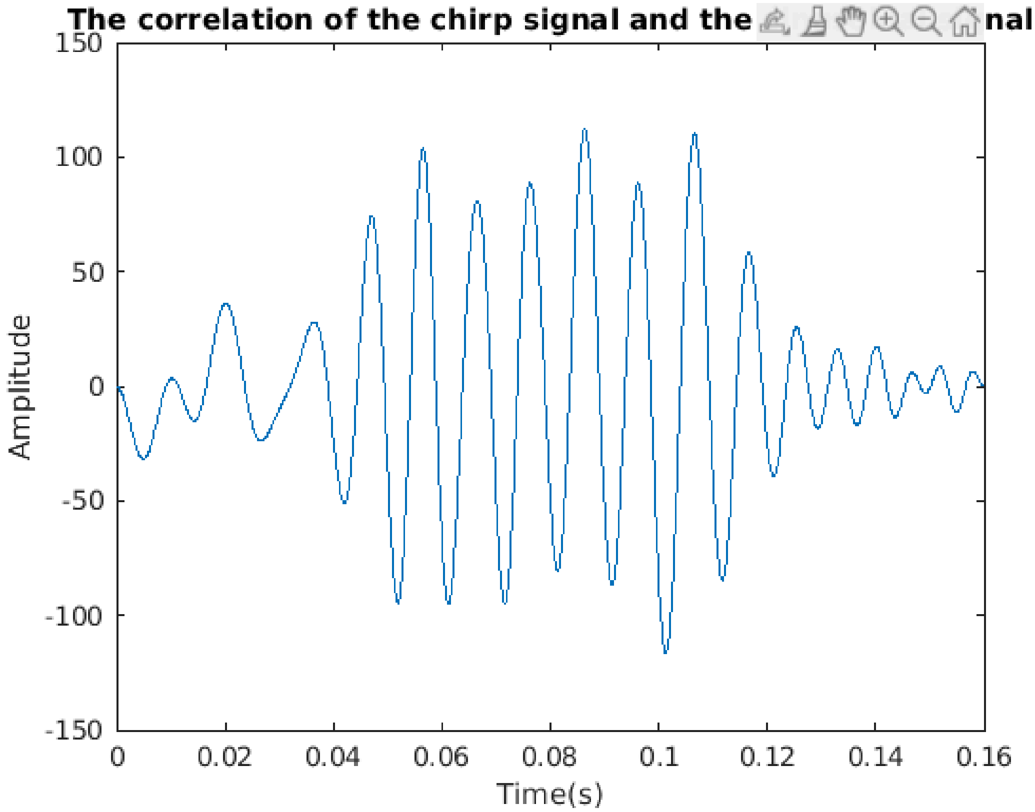
*Here the reason why we do not observe a low correlation as in sinusoidal case is that since the square wave is a sum of sinusoidals with different frequencies, contains a wide range of harmonics, which overlap with the frequencies of the third chirp, which was in the range of 400-600 Hz. That's why, a correlation is observed with the higher frequencies of the chirp.*

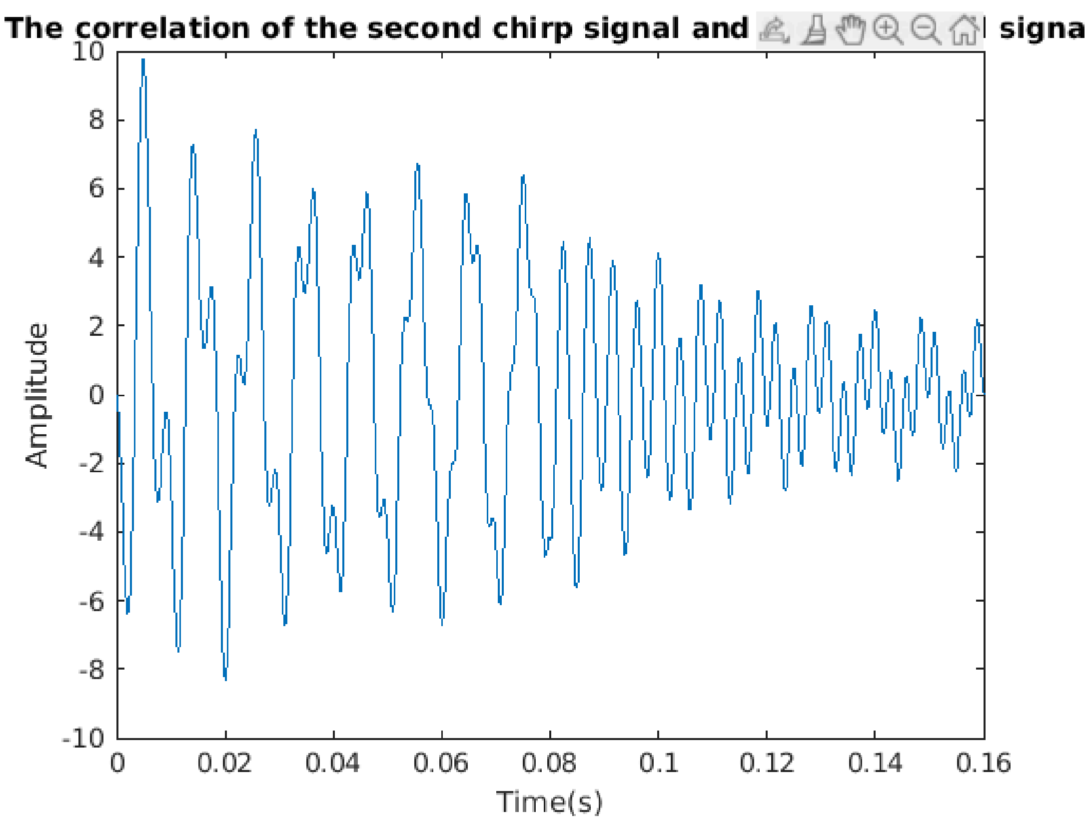

200 Hz sine sequence
Amplitude
Time(s)
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08

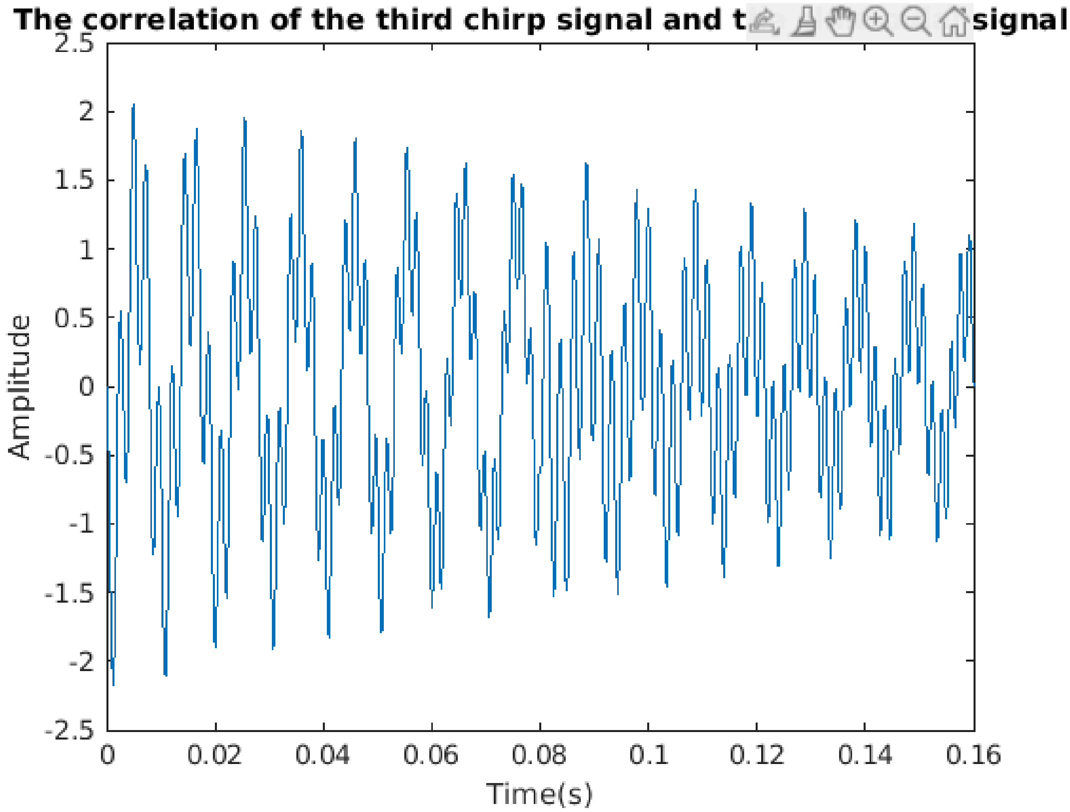

The correlation of the sine signal w
Amplitude
Time(s)
400
300
200
100
0
-100
-200
-300
-400
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16

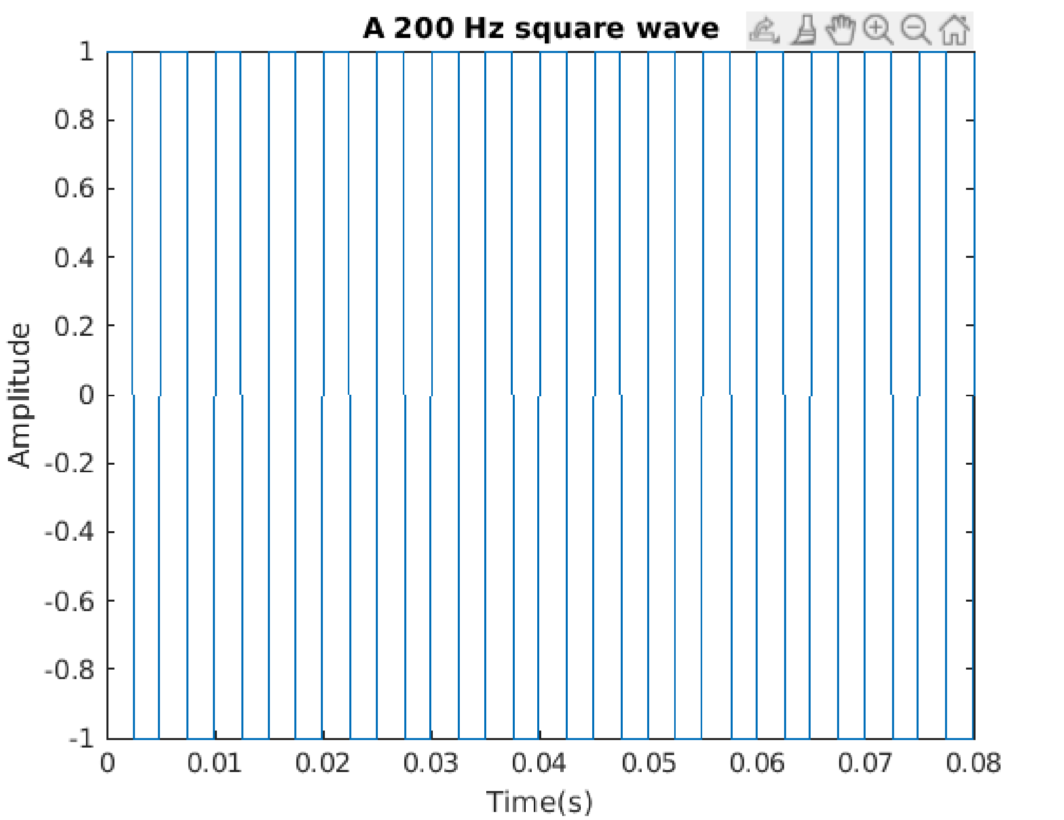

A chirp signal with start frequency 0 and en
0 Hz
Amplitude
Time(s)
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08

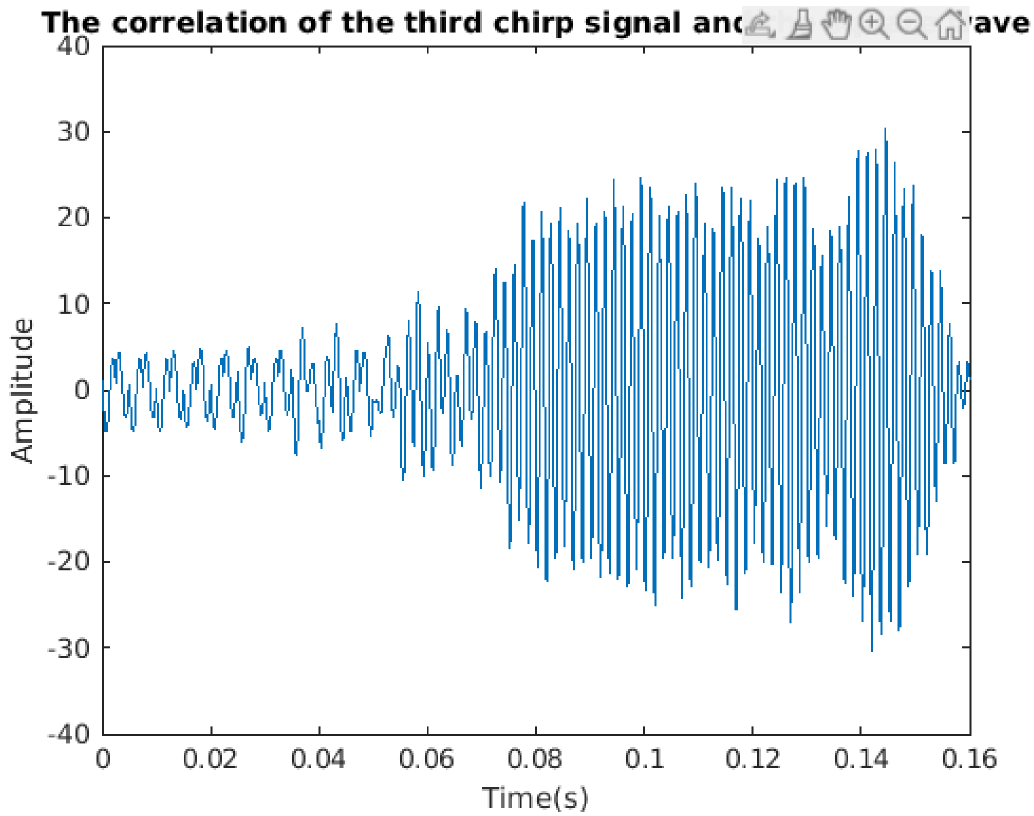

The correlation of the chirp signal
Amplitude
Time(s)
500
400
300
200
100
0
-100
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16


The correlation of the chirp signal and the nal
150
100
50
0
-50
-100
-150
Amplitude
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
Time(s)


The correlation of the second chirp signal and signal
10
8
6
4
2
0
-2
-4
-6
-8
-10
Amplitude
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16
Time(s)


The correlation of the third chirp signal and t
signal
Amplitude
Time(s)
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
-2.5
0
0.02
0.04
0.06
0.08
0.1
0.12
0.14
0.16


A 200 Hz square wave
Amplitude
Time(s)
1
0.8
0.6
0.4
0.2
0
-0.2
-0.4
-0.6
-0.8
-1
0
0.01
0.02
0.03
0.04
0.05
0.06
0.07
0.08

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