

Scilab Manual for  
Audio and Speech Processing  
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# Experiment: 1

## Basic operations on Audio signals.

Scilab code Solution 1.1 Program to Read and Play audio file

```
1 //This code Reads an audio file and plays it.
2 //
3 //OS: windows 7
4 //Scilab: 5.5.2
5 //
6 clc;
7 close;
8 clear;
9 [y,Fs] = wavread('C:\Users\ACER\Desktop\Two.wav');
    //read the audio file using the given path
10 sound(y,Fs); // sound(2*y,Fs); can be used for
    better quality
11 t=(0:length(y)-1)*1/Fs;
12 plot(t,y)
13 title('Speech signal waveform')
14 xlabel('Time in seconds')
15 ylabel('Amplitude')
```

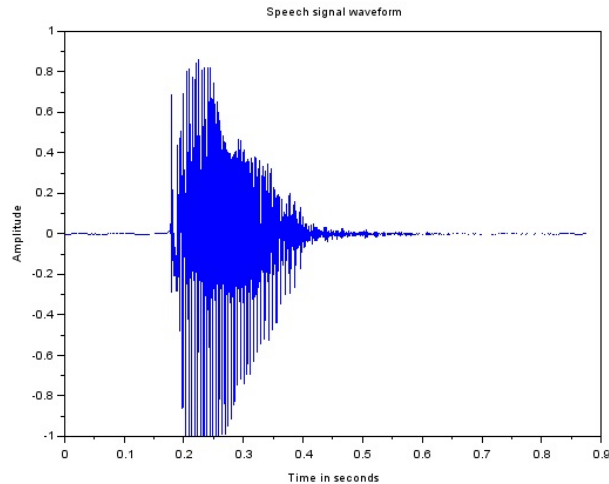


Figure 1.1: Program to Read and Play audio file

---

### Scilab code Solution 1.2 Effect of changing Sampling Frequency

```

1 //This code Reads an audio file and plays it by
  changing the sampling frequency.
2 //
3 //OS: windows 7
4 //Scilab: 5.5.2
5 //
6 clc;
7 close;
8 clear;
9 [y,Fs] = wavread('C:\Users\ACER\Desktop\Two.wav');
  //read the audio file using the given path
10 Fs_new=Fs/.8; // increasing Fs. Can be reduced by
  using command Fs_new=Fs/1.3;
11 sound(y,Fs_new); // sound(2*y,Fs); can be used for
  better quality

```

---

**Scilab code Solution 1.3** Program to Reverse and play audio file

```
1 //This code Reads an audio file and plays it by
  reversing the file .
2 //
3 //OS: windows 7
4 //Scilab: 5.5.2
5 //
6 clc;
7 close;
8 clear;
9 [y,Fs] = wavread( 'C:\ Users\ACER\Desktop\Two.wav ');
  // Give the path
10 z = y(:, $:-1:1); //Reversing the file
11 sound(z,Fs); // sound(2*y,Fs); can be used for
  better quality
12 t=(0:length(z)-1)*1/Fs;
13 plot(t,z)
14 title( 'Reversed file ')
15 xlabel( 'Time in seconds ')
16 ylabel( 'Amplitude ')
```

---



## Experiment: 2

# Time Domain Parameters of Speech Signal.

Scilab code Solution 2.1 Short Time Energy of Speech signal

```
1 // This program computes the short time energy of a
  signal using
2 // Rectangular and Hamming window
3 //OS: windows 7
4 //Scilab: 5.5.2
5 //
6 clc;
7 close;
8 clear;
9 [y,Fs]=wavread('C:\Users\ACER\Desktop\Two.wav');
10 t=(0:length(y)-1)/Fs; // Changing x axixs in to time
    in seconds
11 subplot(311)
12 plot(t,y)
13 xlabel('Time in seconds')
14 title('Original signal')
15 frame_durn = 0.02; // Duration of frame in seconds
```

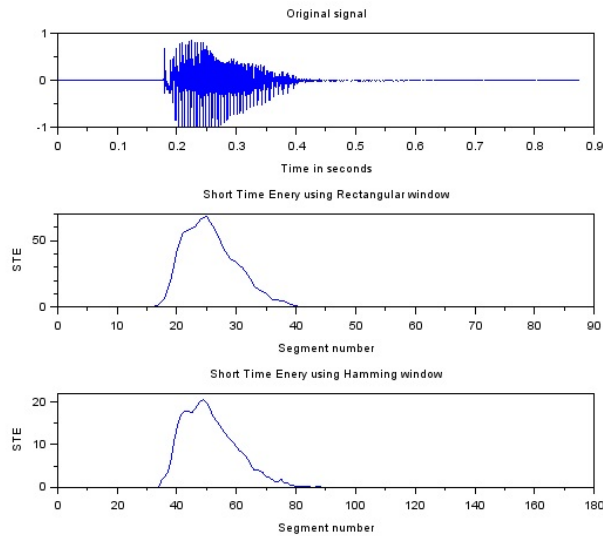


Figure 2.1: Short Time Energy of Speech signal

```

16 frame_len=Fs*frame_durn; // Length of frame
17 Rect_window=window('re',frame_len);
18
19 frame_shift=Fs*frame_durn/2; // 50% overlapping for
    Rectangular window
20 no_of_frames=floor(length(y)/frame_shift); //
    Computing total number of frames
21
22 frame_start=1;
23 frame_end=frame_start+frame_len-1;
24 for j=1:no_of_frames
25     En(j)=0;
26     if frame_end>=length(y) then // Adustment for
        the last segment
27         frame_end=length(y)
28         frame_len=frame_end-frame_start;
29     end
30
31
32     segment=y(frame_start:frame_end);

```

```

33     for k=1:frame_len
34         En(j)=En(j)+(segment(k)*Rect_window(k))^2
           // Computing the STE
35     end
36     frame_start=frame_start+frame_shift;
37     frame_end=frame_end+frame_shift;
38
39 end
40
41
42
43 subplot(312)
44 plot(En)
45 title('Short Time Enery using Rectangular window')
46 xlabel('Segment number')
47 ylabel('STE')
48
49 //////////////////////////////////////
50
51 // For Hamming window
52 Ham_window=window('hm',frame_len);
53
54 frame_shift=Fs*frame_durn/4; // 75% overlapping for
    Hamming window
55 no_of_frames=floor(length(y)/frame_shift);
56
57 frame_start=1;
58 frame_end=frame_start+frame_len-1;
59 for j=1:no_of_frames
60     En1(j)=0;
61     if frame_end>=length(y) then
62         frame_end=length(y)
63         frame_len=frame_end-frame_start;
64     end
65
66     segment=y(frame_start:frame_end);
67     for k=1:frame_len
68         En1(j)=En1(j)+(segment(k)*Ham_window(k))^2

```

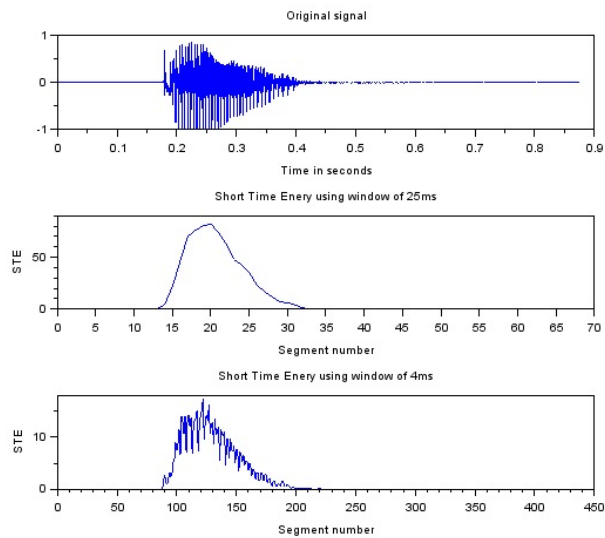


Figure 2.2: Effect of length of window on STE

```

69     end                                     // Computing STE using
        Hamming window
70     frame_start=frame_start+frame_shift;
71     frame_end=frame_end+frame_shift;
72
73 end
74
75 subplot(313)
76 plot(En1)
77 title('Short Time Energy using Hamming window')
78 xlabel('Segment number')
79 ylabel('STE')

```

---

**Scilab code Solution 2.2** Effect of length of window on STE

```

1 // This program shows the effect of window length on
  STE
2 //OS: windows 7
3 //Scilab: 5.5.2
4 //
5
6 clc;
7 close;
8 clear;
9 [y,Fs]=wavread('C:\Users\ACER\Desktop\Two.wav');
10 t=(0:length(y)-1)/Fs; // Changing x axixs in to time
    in seconds
11 subplot(311)
12 plot(t,y)
13 xlabel('Time in seconds')
14 title('Original signal')
15 frame_durn = 0.025; // Duration of frame in
    seconds
16 frame_len=Fs*frame_durn; // Length of frame
17 Rect_window=window('re',frame_len);
18 frame_shift=Fs*frame_durn/2; // 50% overlapping for
    Rectangular window
19 no_of_frames=floor(length(y)/frame_shift); //
    Computing total number of frames
20 frame_start=1;
21 frame_end=frame_start+frame_len-1;
22 for j=1:no_of_frames
23     En(j)=0;
24     if frame_end>=length(y) then // Adustment for
        the last segment
25         frame_end=length(y)
26         frame_len=frame_end-frame_start;
27     end
28     segment=y(frame_start:frame_end);
29     for k=1:frame_len
30         En(j)=En(j)+(segment(k)*Rect_window(k))^2
            // Computing the STE
31     end

```

```

32     frame_start=frame_start+frame_shift;
33     frame_end=frame_end+frame_shift;
34 end
35 subplot(312)
36 plot(En)
37 title('Short Time Energy using window of 25ms')
38 xlabel('Segment number')
39 ylabel('STE')
40 ///////////////////////////////////
41 frame_durn = 0.004;    // Duration of frame in
    seconds
42 frame_len=Fs*frame_durn; // Length of frame
43 Rect_window=window('re',frame_len);
44 frame_shift=Fs*frame_durn/2; // 50% overlapping for
    Rectangular window
45 no_of_frames=floor(length(y)/frame_shift); //
    Computing total number of frames
46 frame_start=1;
47 frame_end=frame_start+frame_len-1;
48 for j=1:no_of_frames
49     En(j)=0;
50     if frame_end>=length(y) then    // Adjustment for
        the last segment
51         frame_end=length(y)
52         frame_len=frame_end-frame_start;
53     end
54     segment=y(frame_start:frame_end);
55     for k=1:frame_len
56         En(j)=En(j)+(segment(k)*Rect_window(k))^2
            // Computing the STE
57     end
58     frame_start=frame_start+frame_shift;
59     frame_end=frame_end+frame_shift;
60 end
61 subplot(313)
62 plot(En)
63 title('Short Time Energy using window of 4ms')
64 xlabel('Segment number')

```

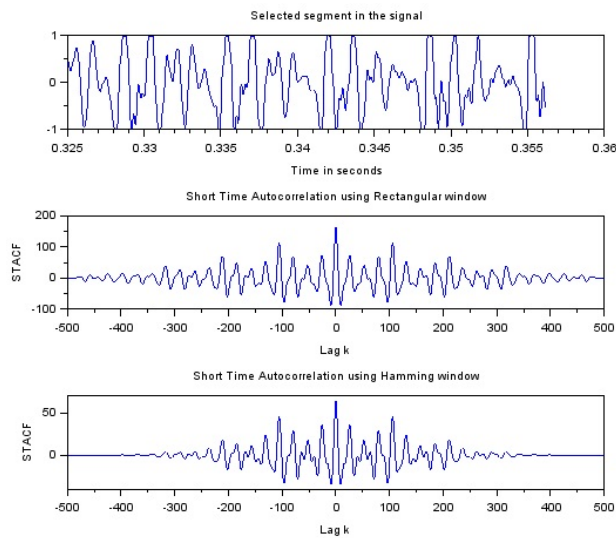


Figure 2.3: Comparing STACF using Hamming and Rectangular window

65 ylabel('STE')

---

**Scilab code Solution 2.3** Comparing STACF using Hamming and Rectangular window

```

1 // Program to find Short Time Autocorrelation
  Function
2 // using Rectangular and Hamming winow
3 //OS: windows 7
4 //Scilab: 5.5.2
5 //
6
7 clc;
8 close;
9 clear;
10

```

```

11 [y,Fs] = wavread('C:\Users\ACER\Desktop\Two.wav');
12
13 beg=5200; //Sample at which window is to be applied
14 N=500; // Length of window in samples
15 x=y(beg:beg+N-1); // Obtaining the required segment
16 whm = window('hm', N); // Hamming window
17 Ham_seg=x.*whm; //Multiplying window with the
    signal
18
19 wr=window('re',N); //Rectangular Window
20 Rect_seg=x.*wr;
21
22 t=(beg:beg+N-1)/Fs; // Adjusting the x axis to time
23 subplot(311)
24 plot(t,Rect_seg)
25 xlabel('Time in seconds')
26 title('Selected segment in the signal')
27 c1=xcorr(Rect_seg); // Autocorrelation
28 lag=(1:length(c1))-ceil(length(c1)/2); // Adjusting
    x axis to get peak at lag=0
29 subplot(312)
30 plot(lag,c1)
31 title('Short Time Autocorrelation using Rectangular
    window')
32 xlabel('Lag k')
33 ylabel('STACF')
34 ///////////////
35 c2=xcorr(Ham_seg);
36 lag=(1:length(c1))-ceil(length(c2)/2); // Adjusting x
    axis to get peak at lag=0
37 subplot(313)
38 plot(lag,c2)
39 title('Short Time Autocorrelation using Hamming
    window')
40 xlabel('Lag k')
41 ylabel('STACF')

```

---



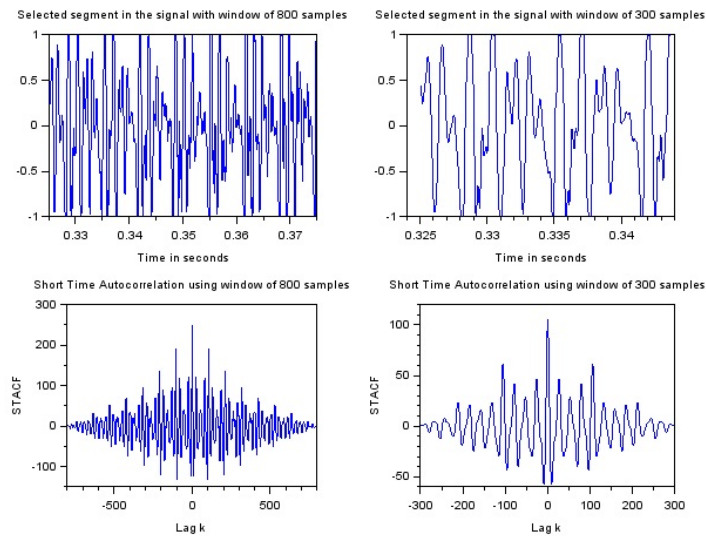


Figure 2.4: Effect of length of window on STACF

#### Scilab code Solution 2.4 Effect of length of window on STACF

```

1 // Program to find effect of length of window
2 //on Short Time Autocorrelation Function (STACF)
3 // using Rectangular window of different lengths
4 //OS: windows 7
5 //Scilab: 5.5.2
6 //
7
8 clc;
9 close;
10 clear;
11
12 [y,Fs] = wavread('C:\Users\ACER\Desktop\Two.wav');
13

```

```

14 beg=5200; //Sample at which window is to be applied
15 N=800; // Length of window in samples
16 x=y(beg:beg+N-1); // Obtaining the required segment
17 wr=window('re',N); //Rectangular Window
18 Rect_seg=x.*wr;
19
20 t=(beg:beg+N-1)/Fs; // Adjusting the x axis to time
21 subplot(221)
22 plot(t,Rect_seg)
23 xlabel('Time in seconds')
24 title('Selected segment in the signal with window of
      800 samples')
25 c1=xcorr(Rect_seg); // Autocorrelation
26 lag=(1:length(c1))-ceil(length(c1)/2); // Adjusting
      x axis to get peak at lag=0
27 subplot(223)
28 plot(lag,c1)
29 title('Short Time Autocorrelation using window of
      800 samples')
30 xlabel('Lag k')
31 ylabel('STACF')
32 //////////////////////////////////////
33 beg=5200; //Sample at which window is to be applied
34 N=300; // Length of window in samples
35 x=y(beg:beg+N-1); // Obtaining the required segment
36 wr=window('re',N); //Rectangular Window
37 Rect_seg=x.*wr;
38
39 t=(beg:beg+N-1)/Fs; // Adjusting the x axis to time
40 subplot(222)
41 plot(t,Rect_seg)
42 xlabel('Time in seconds')
43 title('Selected segment in the signal with window of
      300 samples')
44 c1=xcorr(Rect_seg); // Autocorrelation
45 lag=(1:length(c1))-ceil(length(c1)/2); // Adjusting
      x axis to get peak at lag=0
46 subplot(224)

```

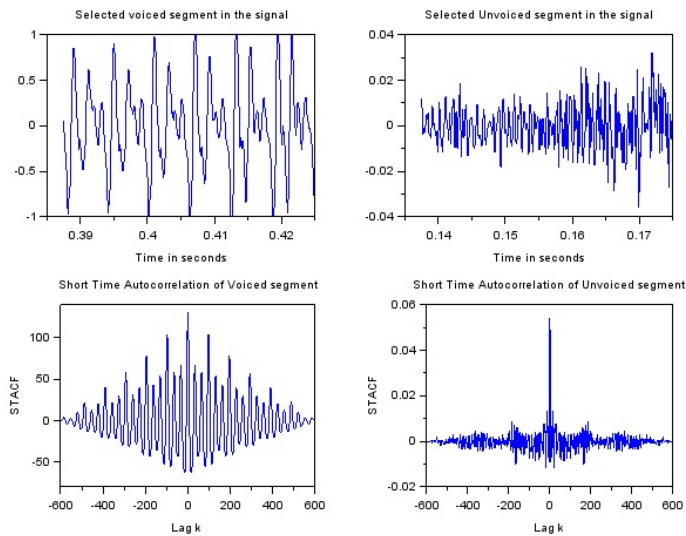


Figure 2.5: STACF for Voiced and Unvoiced speech

```

47 plot(lag,c1)
48 title('Short Time Autocorrelation using window of
      300 samples')
49 xlabel('Lag k')
50 ylabel('STACF')

```

---

#### Scilab code Solution 2.5 STACF for Voiced and Unvoiced speech

```

1 // Program to compare Short Time Autocorrelation
  Functions for
2 // Voiced and un voiced regions in speech signal
3 //OS: windows 7
4 //Scilab: 5.5.2
5 //
6
7 clc;

```

```

8  close;
9  clear;
10
11 [y,Fs] = wavread('C:\Users\ACER\Desktop\Number4.wav'
    );
12
13 beg=6200; //Sample at which window is to be applied
14 N=600; // Length of window in samples
15 x=y(beg:beg+N-1); // Obtaining the required segment
16 wr=window('re',N); //Rectangular Window
17 Rect_seg=x.*wr;
18
19 t=(beg:beg+N-1)/Fs; // Adjusting the x axis to time
20 subplot(221)
21 plot(t,Rect_seg)
22 xlabel('Time in seconds')
23 title('Selected voiced segment in the signal')
24 c1=xcorr(Rect_seg); // Autocorrelation
25 lag=(1:length(c1))-ceil(length(c1)/2); // Adjusting
    x axis to get peak at lag=0
26 subplot(223)
27 plot(lag,c1)
28 title('Short Time Autocorrelation of Voiced segment'
    )
29 xlabel('Lag k')
30 ylabel('STACF')
31 //////////////////////////////////////
32
33 beg=2200; //Sample at which window is to be applied
34 N=600; // Length of window in samples
35 x=y(beg:beg+N-1); // Obtaining the required segment
36 wr=window('re',N); //Rectangular Window
37 Rect_seg=x.*wr;
38
39 t=(beg:beg+N-1)/Fs; // Adjusting the x axis to time
40 subplot(222)
41 plot(t,Rect_seg)
42 xlabel('Time in seconds')

```

```
43 title('Selected Unvoiced segment in the signal')
44 c1=xcorr(Rect_seg); // Autocorrelation
45 lag=(1:length(c1))-ceil(length(c1)/2); // Adjusting
    x axis to get peak at lag=0
46 subplot(224)
47 plot(lag,c1)
48 title('Short Time Autocorrelation of Unvoiced
    segment')
49 xlabel('Lag k')
50 ylabel('STACF')
```

---

## Experiment: 3

# Frequency Domain Analysis of Speech Signal.

**Scilab code Solution 3.1** Plot STFT using Hamming and Rectangular window

```
1
2 //This Program plots the spectrum of a segment of a
   given signal obtained using Rectangular and
   Hamming window.
3 //
4 //OS: windows 7
5 //Scilab: 5.5.2
6 //
7 clc;
8 close;
9 clear;
10
11 [y,Fs] = wavread( 'C:\ Users\ACER\Desktop\Two.wav' );
12 t=(0:length(y)-1)/Fs;
13 subplot(311)
14 plot(t,y)
```

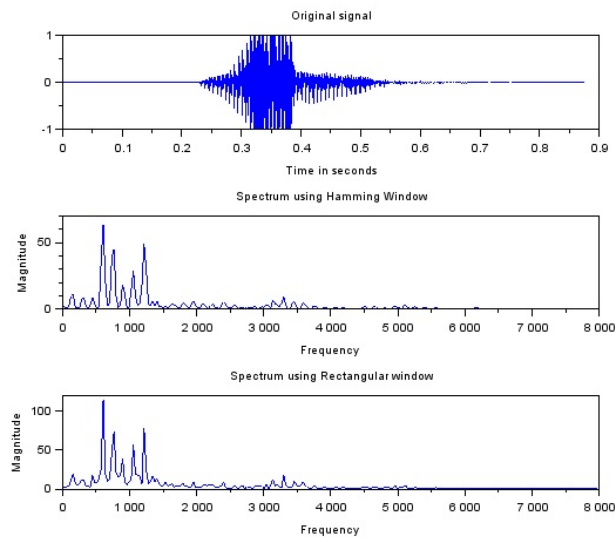


Figure 3.1: Plot STFT using Hamming and Rectangular window

```

15 xlabel('Time in seconds')
16 title('Original signal')
17 beg=5200; //Sample at which window is to be applied
18 N=500; // Length of window in samples
19 x=y(beg:beg+N-1);
20 whm = window('hm', N);
21 Ham_seg=x.*whm; //Multiplying window with the
    signal
22
23 wr=window('re',N); //Rectangular Window
24 Rect_seg=x.*wr;
25 f_Rect=abs(fft(Rect_seg)); // Spectrum of the
    segment using Rect window
26 f_Ham=abs(fft(Ham_seg)); //Spectrum of the segment
    using Hamming window
27 l=length(f_Ham)/2;
28 f=(0:(l-1))*Fs/(2*l); // Adjusting x axis to
    frequency
29 subplot(3,1,2)
30 plot(f,f_Ham(1:l))

```

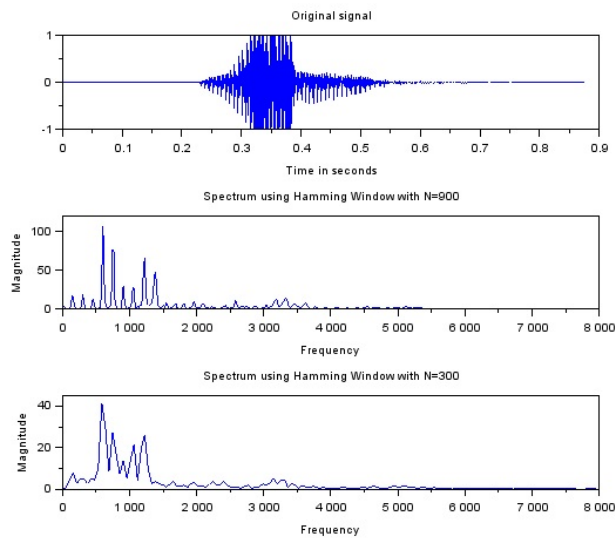


Figure 3.2: Effect of length of window on Short Time Spectrum

```

31 title('Spectrum using Hamming Window')
32 xlabel('Frequency')
33 ylabel('Magnitude')
34 subplot(313)
35 plot(f,f_Rect(1:1))
36 title('Spectrum using Rectangular window')
37 ylabel('Magnitude')
38 xlabel('Frequency')

```

---

### Scilab code Solution 3.2 Effect of length of window on Short Time Spectrum

```

1 // Program to compare the effect of length of window
  on STFT
2 // Using Hamming window
3 //

```



```

4 //OS: windows 7
5 //Scilab: 5.5.2
6 //
7 clc;
8 close;
9 clear;
10
11 [y,Fs] = wavread('C:\Users\ACER\Desktop\Two.wav');
12 t=(0:length(y)-1)/Fs;
13 subplot(311)
14 plot(t,y)
15 xlabel('Time in seconds')
16 title('Original signal')
17 beg=5200; //Sample at which window is to be applied
18 N=900; // Length of window in samples
19 x=y(beg:beg+N-1);
20 whm = window('hm', N);
21 Ham_seg=x.*whm; //Multiplying window with the
    signal
22 f_Ham=abs(fft(Ham_seg)); //Spectrum of the segment
    using Hamming window
23 l=length(f_Ham)/2;
24 f=(0:(l-1))*Fs/(2*l); // Adjusting x axis to
    frequency
25 subplot(3,1,2)
26 plot(f,f_Ham(1:l))
27 title('Spectrum using Hamming Window with N=900')
28 xlabel('Frequency')
29 ylabel('Magnitude')
30 //////////////////////////////////////
31 beg=5200; //Sample at which window is to be applied
32 N=300; // Length of window in samples
33 x=y(beg:beg+N-1);
34 whm = window('hm', N);
35 Ham_seg=x.*whm; //Multiplying window with the
    signal
36 f_Ham=abs(fft(Ham_seg)); //Spectrum of the segment
    using Hamming window

```

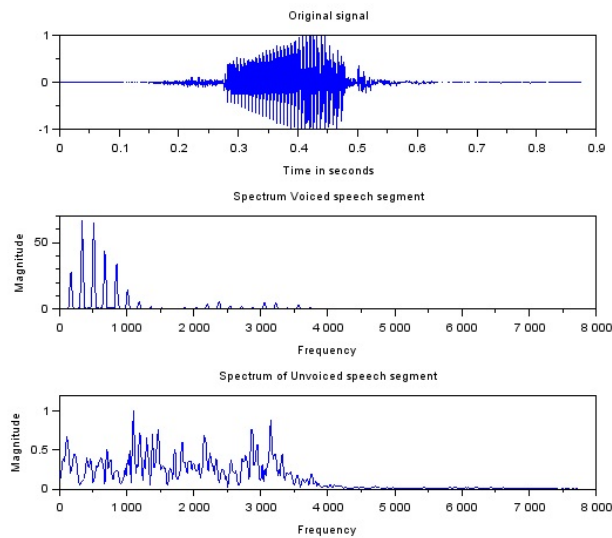


Figure 3.3: STFT of Voiced and Unvoiced speech

---

```

37 l=length(f_Ham)/2;
38 f=(0:(l-1))*Fs/(2*l); // Adjusting x axis to
    frequency
39 subplot(3,1,3)
40 plot(f,f_Ham(1:l))
41 title('Spectrum using Hamming Window with N=300')
42 xlabel('Frequency')
43 ylabel('Magnitude')

```

---

### Scilab code Solution 3.3 STFT of Voiced and Unvoiced speech

```

1 // Program to compare spectrum of Voiced and
    Unvoiced speech segments
2 // Using Hamming window
3 //
4 //OS: windows 7

```

```

5 //Scilab: 5.5.2
6 //
7 clc;
8 close;
9 clear;
10
11 [y,Fs] = wavread('C:\Users\ACER\Desktop\Number4.wav'
    );
12 t=(0:length(y)-1)/Fs;
13 subplot(311)
14 plot(t,y)
15 xlabel('Time in seconds')
16 title('Original signal')
17
18 beg=5200; //Sample at which window is to be applied
    // Selecting Voiced segment
19 N=900; // Length of window in samples
20 x=y(beg:beg+N-1);
21 whm = window('hm', N);
22 Ham_seg=x.*whm; //Multiplying window with the
    signal
23 f_Ham=abs(fft(Ham_seg)); //Spectrum of the segment
    using Hamming window
24 l=length(f_Ham)/2;
25 f=(0:(l-1))*Fs/(2*l); // Adjusting x axis to
    frequency
26 subplot(3,1,2)
27 plot(f,f_Ham(1:l))
28 title('Spectrum Voiced speech segment')
29 xlabel('Frequency')
30 ylabel('Magnitude')
31 //////////////////////////////////////
32 beg=2200; //Selecting unvoiced segment
33 N=900; // Length of window in samples
34 x=y(beg:beg+N-1);
35 whm = window('hm', N);
36 Ham_seg=x.*whm; //Multiplying window with the
    signal

```

```
37 f_Ham=abs(fft(Ham_seg)); //Spectrum of the segment
    using Hamming window
38 l=length(f_Ham)/2;
39 f=(0:(l-1))*Fs/(2*l); // Adjusting x axis to
    frequency
40 subplot(3,1,3)
41 plot(f,f_Ham(1:l))
42 title('Spectrum of Unvoiced speech segment')
43 xlabel('Frequency')
44 ylabel('Magnitude')
```

---