

Demonstration of the 'Missing Fundamental Effect' with Matlab

In this exercise we will demonstrate the 'Missing fundamental effect' using Matlab.

- a) Learn to generate a sinusoid of Amplitude A_x , frequency F_x Hz and phase Phix , with a duration of T_x seconds. Plot an interval of I_x seconds and listen to the generated sequence.

Use the following code as a guide and generate and plot sinusoids of harmonic frequencies (for example 150 Hz, 300 Hz, 450 Hz ...). Choose any value for the phase. Name the signals after the harmonic (x_1 , x_2 , x_3 ...). Check that they all are periodic with the fundamental period.

```
Fs=16000;Tx=3
t=0:1/Fs:Tx;
Ax=1;Fx=100;Phix=pi/4;
x=Ax*sin(2*pi*Fx*t+Phix);
Ix=0,01;
plot(t(1:200),y(1:200));title('With fundamental');

x1=Ax*sin(2*pi*Fx*t+Phix); %signal x1
x2=Ax*sin(2*pi*2*Fx*t+Phix); %signal x2
x3=Ax*sin(2*pi*3*Fx*t+Phix); %signal x3
x4=Ax*sin(2*pi*4*Fx*t+Phix); %signal x4
...
```

- b) Generate a periodic signal of period T_0 by adding the previously generated signals:

```
xp=x1+x2+x3+x4+x5+x6;

plot(t(1:Ix*Fs),xp(1:Ix*Fs));title(['periodic signal with Fund freq ' num2str(Fx) ' Hz']);
```

Listen to the generated signal. Which frequency are you hearing? Check with the individual sinusoids (x_1 , x_2 ...). Check the period of the signal on the waveform. Do they match?

Do this exercise with 2, 3, 4, 5 and 6 harmonics.

- c) Now, remove the fundamental from the periodic signal (use the signal with 6 harmonics):

```
xq1=xp-x1;
```

(Note that this is equivalent to generating a signal containing all the individual sinusoids except for the first harmonic:

```
xq1=x2+x3+x4+x5+x6; )
```

Plot and listen to xq1. Which frequency are you hearing? Check with the individual sinusoids (x1, x2...). Check the period of the signal on the waveform. Do they match?

- d) Now repeat the previous exercise, this time removing also the second harmonic:

```
xq12=xp-x1-x2;
```

Plot and listen to xq12. Which frequency are you hearing? Check with the individual sinusoids (x1, x2...). Check the period of the signal on the waveform. Do they match?

Continue the exercise by removing more and more harmonics. How many can you remove to continue hearing the same frequency? How can you explain this?