Matt Bachmeier

Table of Contents

ECE 203 Lab 4: Synthesis of Sinusoidal Signals -- Music Synthesis 2/17/2017

Section 2.2(a)

```
fsamp = 11025; %sampling frequency
x1 = syn_sin(800, 100, fsamp, (0.5 - pi/3), -pi/3);
tt = 0:1/fsamp:0.5; %creates time axis with sinusoid above
soundsc(real(x1)) %plays the created sinusoid
```

Section 2.2(b)

```
x2 = syn_sin(1200, 80, fsamp, (0.8 + pi/4), pi/4);
soundsc(real(x2))

% The sinusoid from part a sounds lower in pitch than the
% sinusoid from part b. This is probably due to the higher
% frequency in x2 than x1.
```

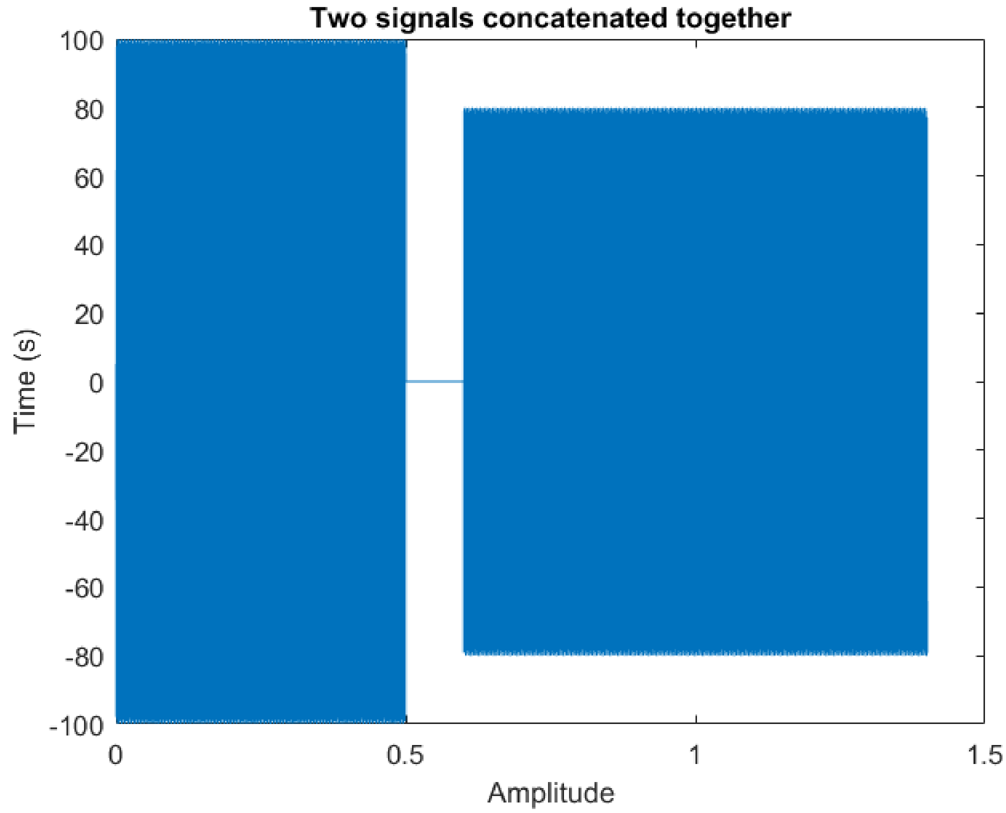
Section 2.2(c)

```
N = 1102; %One tenth of the sample rate
xx = [ x1, zeros(1,N), x2 ];
soundsc(real(xx)) %plays previous two signals in order with 0.1 second
 gap of silence.
```

Section 2.2(d)

```
% plot of the two signals concatenated together.
tt = (1/fsamp)*(1:length(xx)); plot(tt,xx);
title('Two signals concatenated together');
xlabel('Amplitude');
ylabel('Time (s)');
```

Warning: Imaginary parts of complex X and/or Y arguments ignored



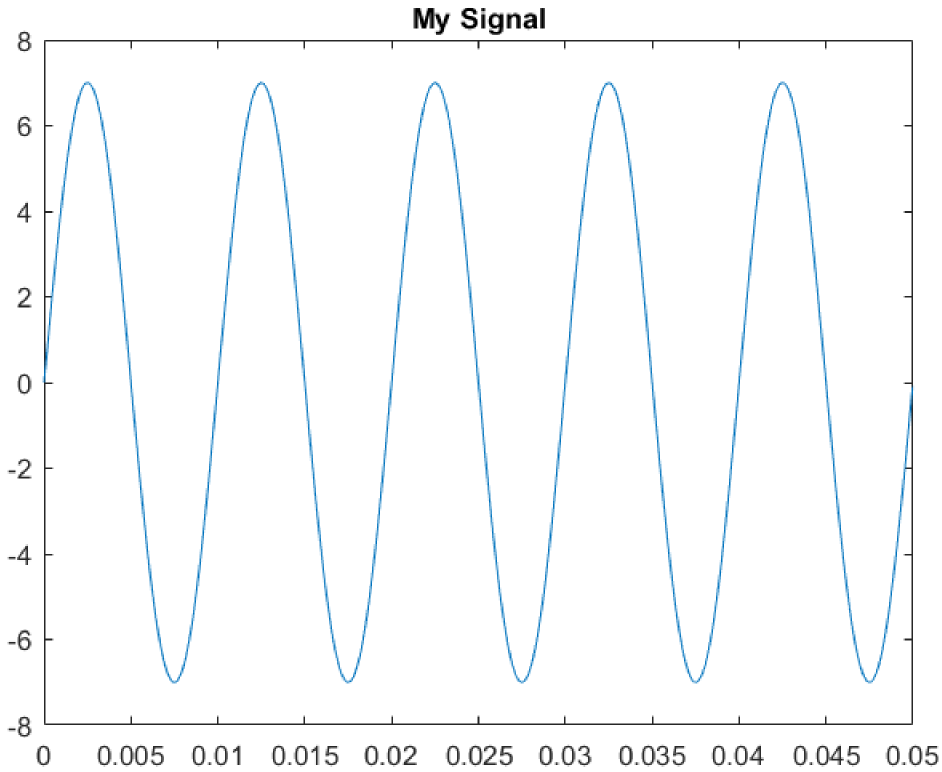
Section 2.2(e)

```
fs = 22050;
soundsc(real(xx), fs)

% Because we doubled the sampling period for the D-A converter
% the duration of the sound was much shorter, probably around half
% the time because the sampling rate was approximately doubled, and
% the pitch was much higher than the previous sounds for similar
 reasons.
```

Section 2.3

```
x.Amp = 7;
x.phase = -pi/2;
x.freq = 100;
x.fs = 11025;
x.timeInterval = 0:(1/x.fs):0.05;
x.values = x.Amp*cos(2*pi*(x.freq)*(x.timeInterval) + x.phase);
x.name = 'My Signal';
x            %---- echo the contents of the structure "x"
plot(x.timeInterval, x.values)
title(x.name)
```

```
x =

             Amp: 7
           phase: -1.5708
            freq: 100
              fs: 11025
    timeInterval: [1x552 double]
          values: [1x552 double]
            name: 'My Signal'
```



Section 3.1 (key2note function code)

```
%function xx = key2note(X, keynum, dur)
% KEY2NOTE Produce a sinusoidal waveform corresponding to a
%       given piano key number
%
%  usage: xx = key2note (X, keynum, dur)
%
%      xx = the output sinusoidal waveform
%       X = complex amplitude for the sinusoid, X = A*exp(j*phi).
%  keynum = the piano keyboard number of the desired note
%     dur = the duration (in seconds) of the output note
%
%fs = 11025;
```

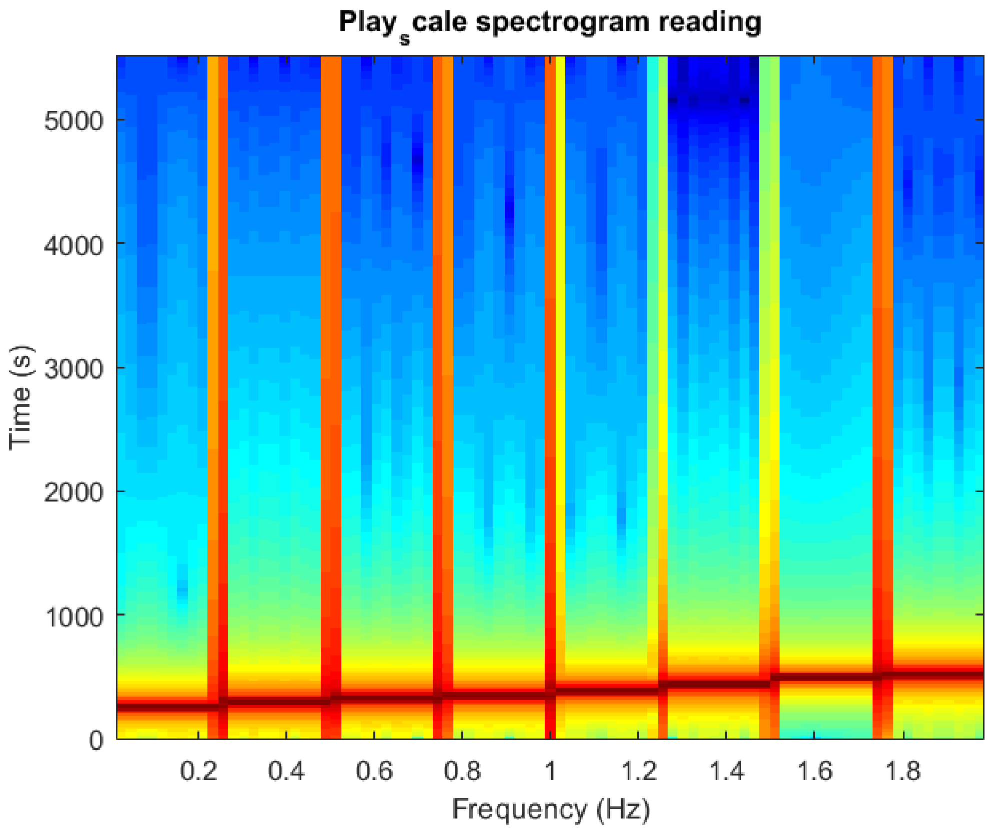
```
%tt = 0:(1/fs):dur;
%freq = 440*2^((keynum-49)/12);
%xx = real( X*exp(j*2*pi*freq*tt);
```

Section 3.2

```
%--- play_scale.m
%---
scale.keys = [40 42 44 45 47 49 51 52];
%--- NOTES: C   D   E   F   G   A   B   C
%  key #40 is middle-C
%
scale.durations = 0.25 * ones(1,length(scale.keys));
fs = 11025;
xx = zeros(1, sum(scale.durations)*fs+length(scale.keys));
n1 = 1;
for kk = 1:length(scale.keys)
    keynum = scale.keys(kk);
    dur = scale.durations(kk);
    tone = key2note(10, keynum, dur);
    n2 = n1 + length(tone) - 1;
    xx(n1:n2) = tone;
    n1 = n2 +1;
end
soundsc(xx, fs)
```

Section 3.3

```
% The signal for the scale was created in section 3.2

% Plots the scale as a spectrogram
specgram(xx,512,fs)
title('Play_scale spectrogram reading');
xlabel('Frequency (Hz)');
ylabel('Time (s)');

% When zoomed in you can see that the 440 Hz note is played from
% time 1.25s to 1.5s, meaning that is it key 49 or A-440.
```



Published with MATLAB® R2016a