EE 296 Exercise 1 STFT

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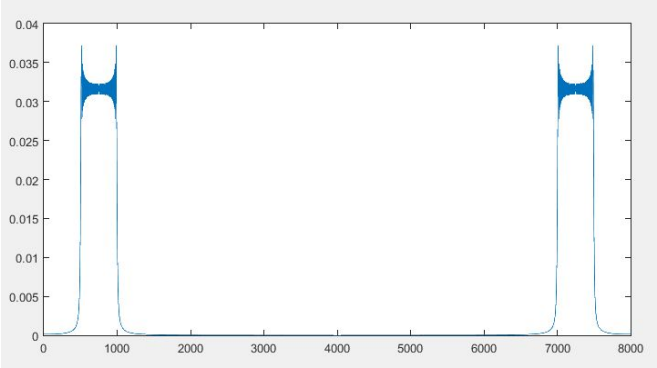
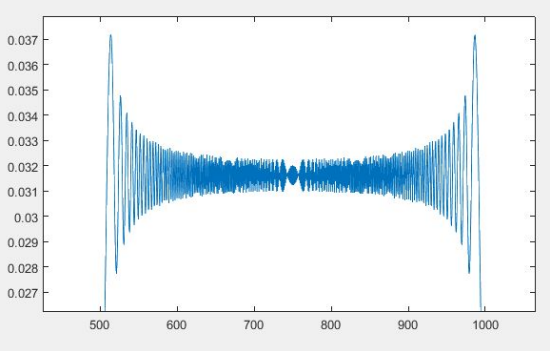
Given the chirp, what is the expected instantaneous frequency after 2 seconds?
Since the chirp method is linear, and increases by 250Hz per second, the frequency after two seconds is

$$500Hz + (250Hz * 2s) = 1kHz$$

What can you say about the pitch of the signal?
As time (and the frequency) increases, the pitch also increases.



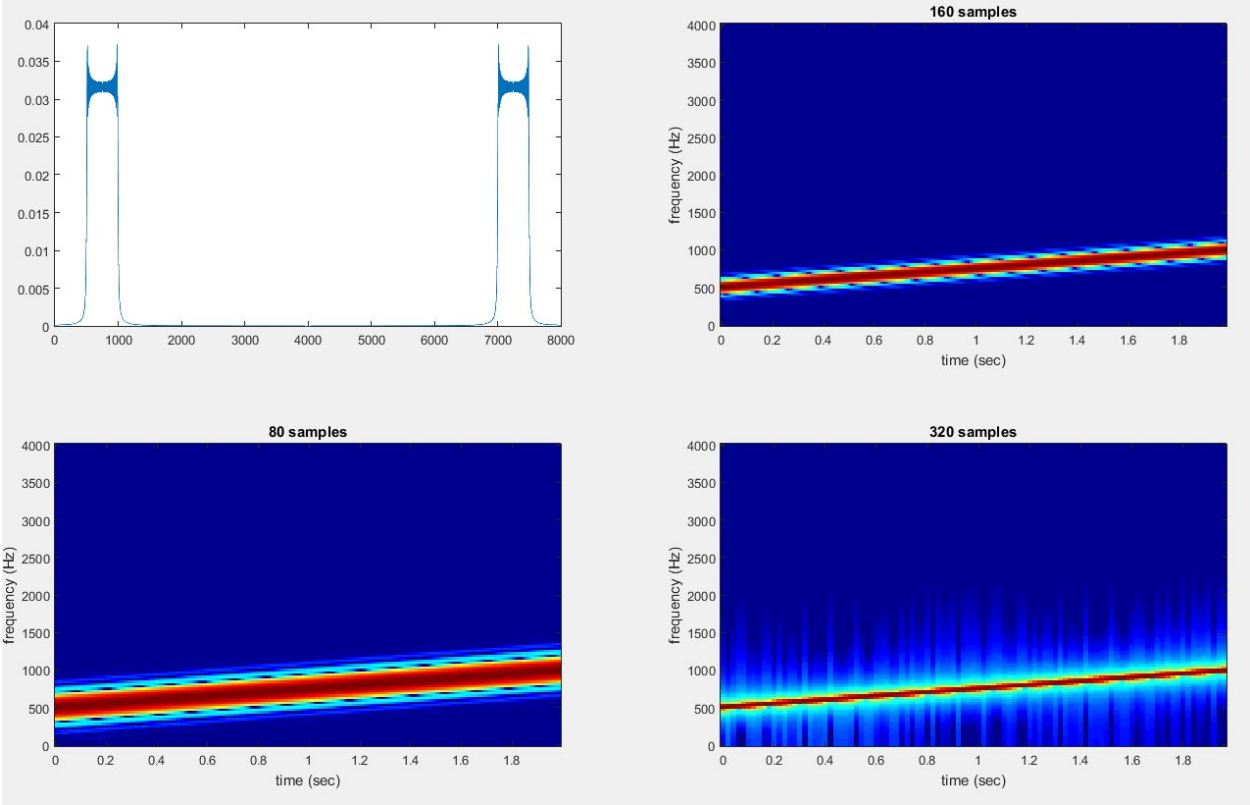


a. Based on the plot of the spectrum, describe its symmetry. Explain the reason behind this.
The spectrum is symmetric at the point fs/2 = 8kHz/2 = 4kHz.

b. At what range of frequencies can you observe the spectrum? Is this expected?
It is evident between 500Hz - 1kHz (frequency after 2 seconds) and it's mirrored frequencies, 7000kHZ (8kHz - 1kHz) - 7500kHz (8kHz - 500Hz).

c. Based on your knowledge about the chirp, how would you correlate the observed spectrum?

We can see that the energy is focused on the 500Hz to 1kHz frequencies.



a. Based on the code, what is the segment size in msec.?
If the sampling rate is 8000 Hz the period is then T = 1/8000 = 0.125 ms. If we are taking 160 samples/segment then the segment size is 0.125 * 160 = 20ms.

b. Based on the resulting spectrogram, correlate it with the behavior of the chirp.
The chirp we created increases its frequency linearly. This is evident in the spectrogram, where the signal's energy is at 500Hz at t=0 and increases linearly up to 1kHz after two seconds.

c. Re-run the STFT code using a segment size of a) 80 samples and b) 320 samples. Based on the results, discuss the trade-offs of varying the frame size.
We can observe that the higher the frame size, we achieve a higher resolution in the frequency domain, which means more spectral details are appearing in our spectrogram. But having a larger frame size also means that we will have a lower time-domain resolution.

d. Summarize your insights on the utility of STFT.
The STFT (along with the spectrogram) is a very useful tool for us to determine the different spectral content of the signal at a given time, especially when the input signal changes frequencies based on time.