HOMEWORK #1: SAMPLING AND ALIASING

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Aliasing pops up when a signal is sampled at a rate that is not enough to capture the changes in the signal. In order to grasp the concepts of signal sampling and aliasing, let us consider the following situations in which signals are sampled in a discrete manner:

- Retinal images are sampled in space by photoreceptors.
- Film and video are sampled in time by discrete frames.
- Sound is commonly digitally sampled for recording and communications.

That is, aliasing may pop up in situations where sampling is not done properly. Because the effects of aliasing may be calamitous, it is important to understand why aliasing occurs, to be aware of its consequences, and to know how to avoid it.

Further Reading:
`http://redwood.berkeley.edu/bruno/psc129/handouts/aliasing.pdf`

Exercise 1

Over a time range of $0 < t < 400$ms, the signal $x(t) = 3cos(20\pi t) - 2sin(30\pi t)$ is shown in Figures 1-4 (dashed lines), together with samples by different sampling intervals T_s: 1/120s, 1/60s, 1/30s, 1/15s. Assuming that the highest/maximum frequency contained in the signal is $f_m = 15$Hz:

- Which is the Nyquist frequency that allows us to reconstruct the original signal from its samples?
- Which is the sampling frequency for each case in Figures 1 to 4?
- Which of the four sampling frequencies allow us to reconstruct the original signal without aliasing?
- Which of the four sampling frequencies produce aliased signals?

Date: Assigned: September 29, 2013; Due: October 4, 2012 (in class); Visual Computing and Multimedia, Fall 2013-2014.

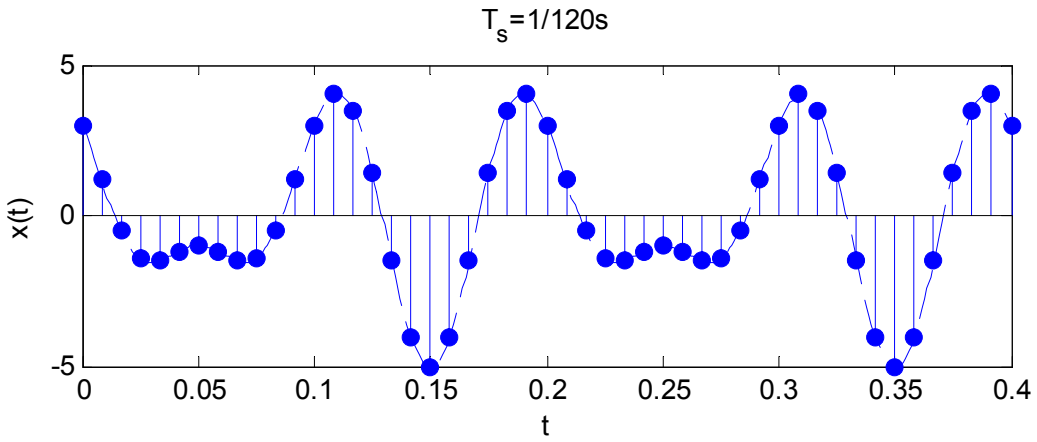

FIGURE 1. Signal sampled at intervals of 1/120s.

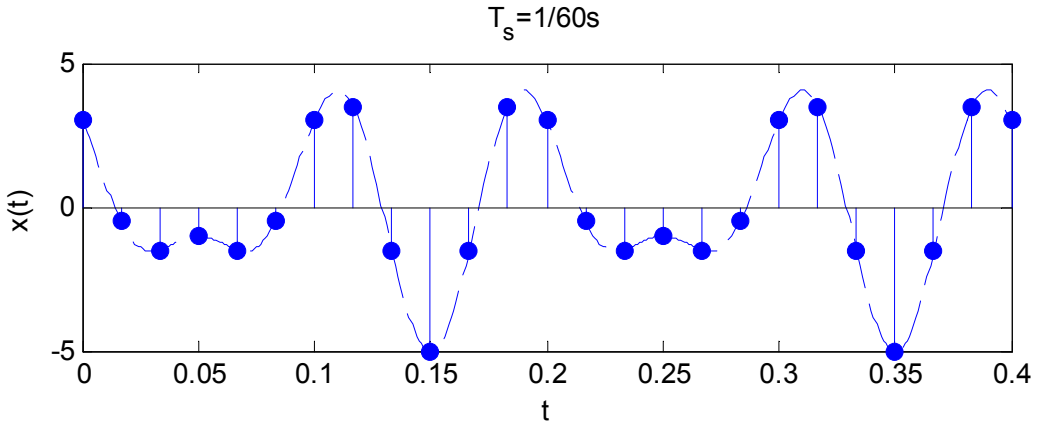

FIGURE 2. Signal sampled at intervals of 1/60s.

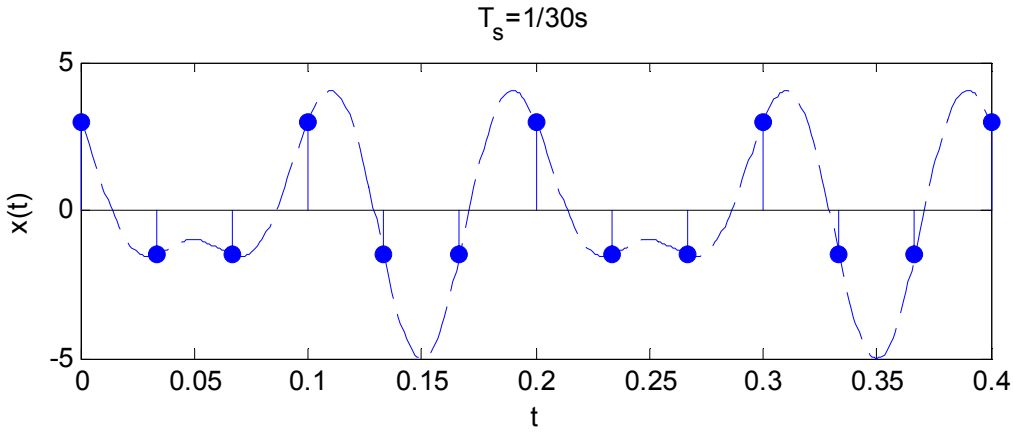

FIGURE 3. Signal sampled at intervals of 1/30s.

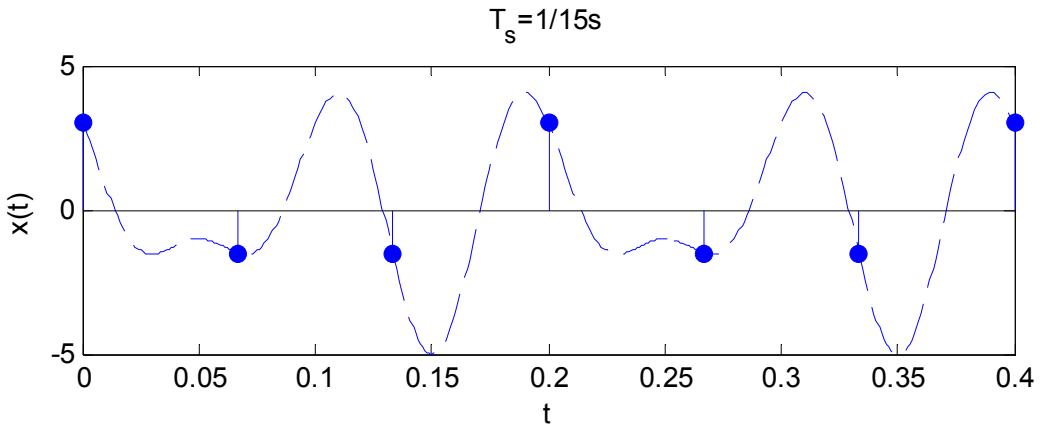

FIGURE 4. Signal sampled at intervals of 1/15s.