EECE 340 Project - Section 2.3 Aliasing and Ambiguity

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Introduction

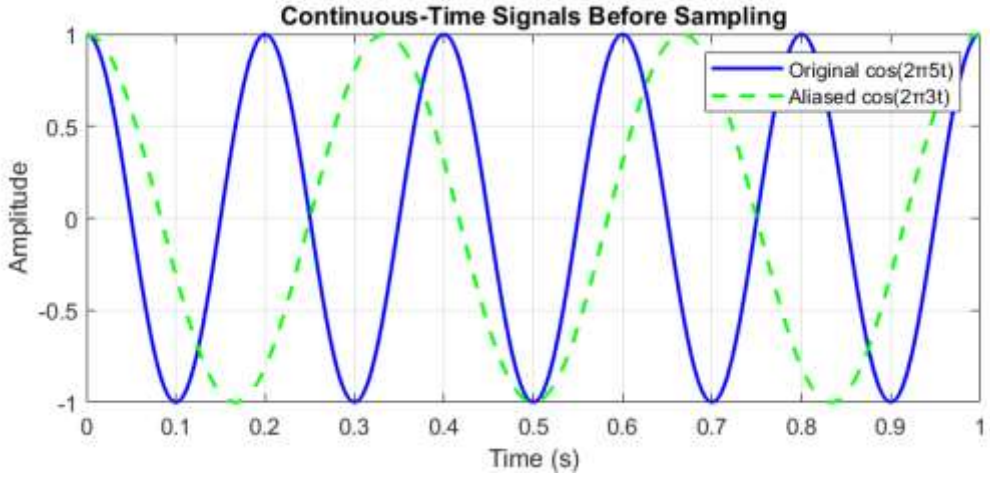
In this section, we demonstrate the phenomenon of aliasing by sampling the signal x(t) = cos(2π5t) at a sampling frequency fs = 8 Hz. We show how different cosine signals can produce the same sampled values, leading to ambiguity. Finally, we discuss how prior knowledge, such as knowing the signal is bandlimited, can resolve this ambiguity.

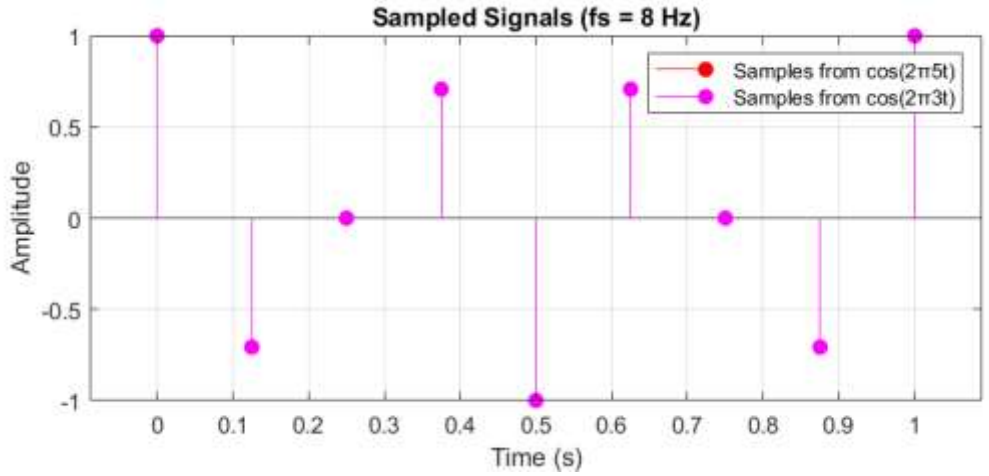
MATLAB Files Description

aliasing_ambiguity.m:
This script generates the original signal cos(2π5t) and an aliased version cos(2π3t), samples them at 8 Hz, and plots both the continuous signals and the sampled points. Additionally, it tests sampling cos(2π6t) at 8 Hz to observe aliasing behavior, demonstrating the ambiguity.

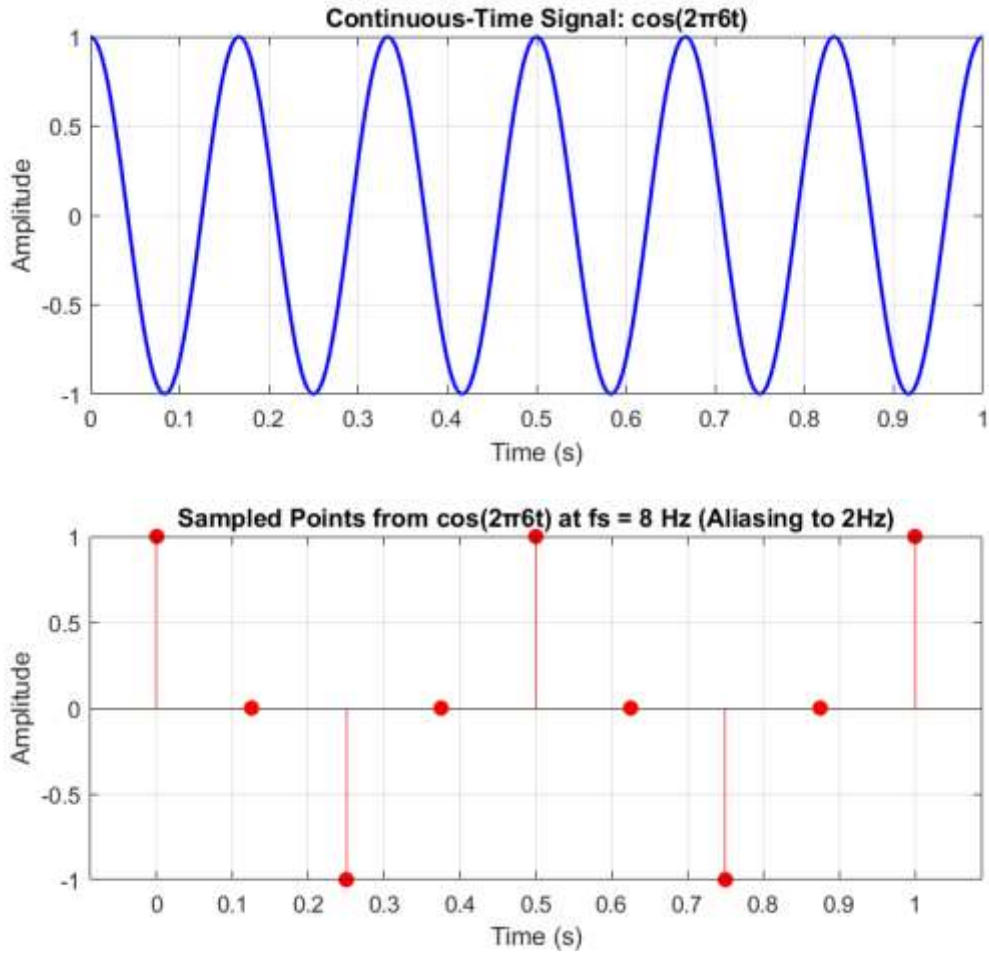
Aliasing Demonstration Results

First, the continuous-time signals cos(2π5t) and cos(2π3t) were plotted. While these signals are clearly different in the continuous domain, after sampling at 8 Hz, their sampled points overlapped, illustrating aliasing.





An additional test was conducted by sampling cos(2π6t) at 8 Hz. The continuous signal oscillates rapidly, but after sampling, the points resemble a slower 2 Hz cosine wave. This further highlights how sampling below the Nyquist rate causes higher frequencies to fold into lower frequencies.



Discussion

Aliasing creates ambiguity because different continuous-time signals can produce the same discrete sampled values. Without additional information, it becomes impossible to determine the true original frequency content solely based on the samples.

Prior knowledge such as knowing that the original signal is bandlimited (e.g., all frequencies are below fs/2) resolves this ambiguity. Bandlimiting ensures that no high-frequency components alias into the lower frequency range, making reconstruction possible and unambiguous.

Conclusion

This experiment demonstrated aliasing and ambiguity by sampling $\cos(2\pi 5t)$ at 8 Hz and comparing it to other cosine signals. The results emphasized the importance of the sampling theorem and prior knowledge about the signal's bandwidth to ensure correct signal reconstruction from discrete samples.