Name: ROTHA Dapravith

ID: e20190915

Group: I5-GIC(B)

Assignment Image Processing Lesson 10: Sampling

Research on Nyquist sampling theorem and summarize by your own knowledge? (maximum 1 page including 1 or 2 figures)

The **Nyquist sampling theorem** is a fundamental theory in signal processing that specifies the minimal sample rate needed to accurately record and reconstruct an analog signal into a digital representation. The theorem ensures reliable reconstruction of signals in the digital realm by addressing both frequency and time factors, preventing data loss during the conversion process.

The Nyquist theorem can be visualized in both the frequency and time domain:

- Frequency Domain: The frequency spectrum of the signal is displayed horizontally. Vertical lines depict potential sample frequencies spaced according to the sampling rate. Aliasing happens when the space between lines is less than twice the maximum signal frequency (2B).
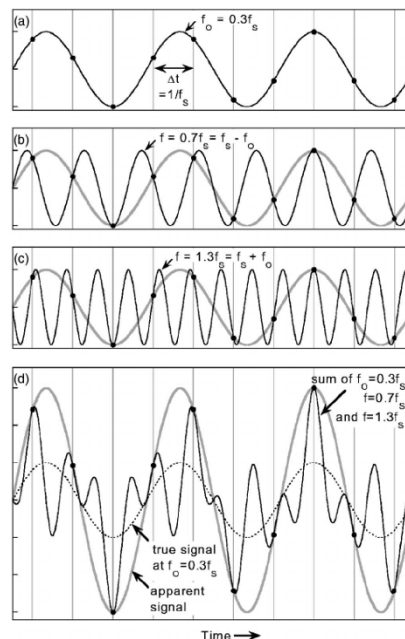

Figure 1: Frequency Domain signal

Figure 1 shows the frequency spectrum of the signal as a red line. The blue lines represent the sample frequencies. When the sampling rate is less than twice the maximum frequency (f_s 2B), the higher-frequency components (f_h) overlap with lower frequencies (f_l), resulting in aliasing.

- Time domain: The original continuous signal is reconstructed from its samples using an ideal low-pass filter. This filter removes any frequency components above the Nyquist rate (B), ensuring accurate reconstruction.
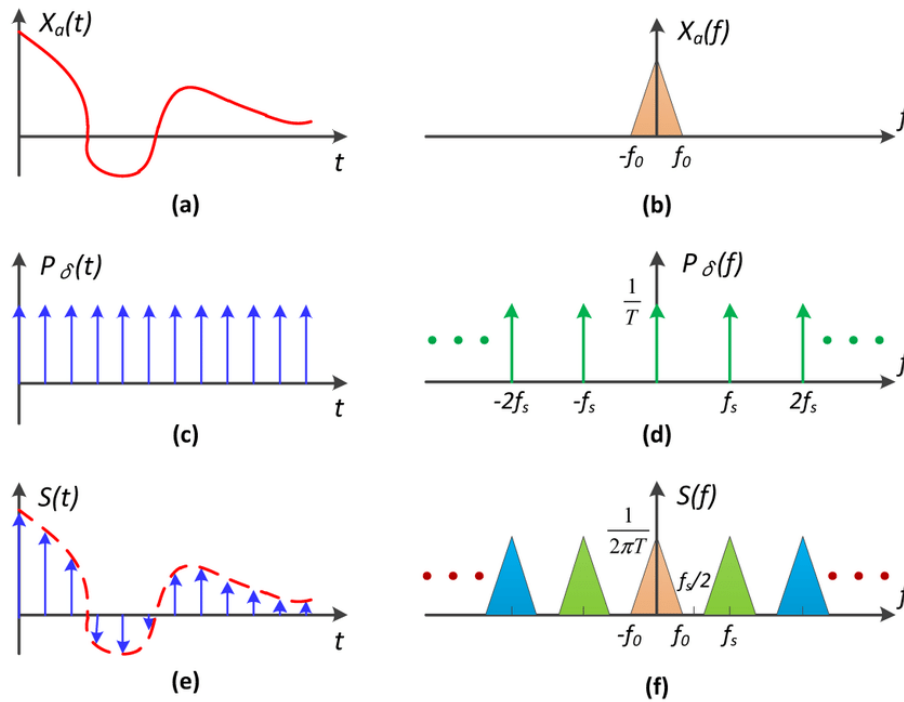

Figure 2: Time Domain signal

In Figure 2, the blue line represents the original continuous signal. The red dots represent the sampled values. The green line represents the reconstructed signal after filtering.

The Nyquist sampling theorem provides a key framework for understanding the conversion of analog to digital signals. We can ensure proper representation and manipulation of information in numerous industries by evaluating the behavior of signals in both the frequency and temporal domains, enabling various technologies that improve our everyday life.