

1 Signal & Systems (Fundamental)

1.1 Signal Definition

Definition 1.1.1 (Signal). Any "physical" quantity that varies with time or space (or other independent variables).

Example 1.1 (Ambulance Siren:).

$$s(t) = (1 + t)\sin(2\pi[1000t + 10t^2 + 300\sin(2\pi t/2)]) \quad (1)$$

- $(1 + t)$: amplitude term represents increasing loudness as ambulance approaches
- $1000t$: represents 1kHz siren oscillation
- $10t^2$: increasing pitch due to the *Doppler effect* as the ambulance approaches.
- $300\sin(2\pi t/2)$: the eeh-oooh-eeh-ohh periodic variation in pitch.

Definition 1.1.2 (Systems). A physical "device" that performs an operation on a signal.

Definition 1.1.3 (Signal Processing). Take some input signals and produce some related output signals.

Example 1.2 (audio amplifier).

$$S_{out}(t) = aS_{in}(t) \quad (2)$$

Emphasize on continuous-time of analog signals.

2 Classification of Signals

2.1 Dimensionality

- By the domain of the function, i.e. how many arguments a function has.
- By the dimension of the range of the function, i.e. the space of values the function can take.

2.2 Time characteristics

Definition 2.2.1 (Continuous-time Signal). A function defined for all times $t \in (-\infty, \infty)$, or at least some interval (a, b) .

Classify signals by time characteristics

- Continuous-time signals or analog signals
- Discrete-time signals