Correlation

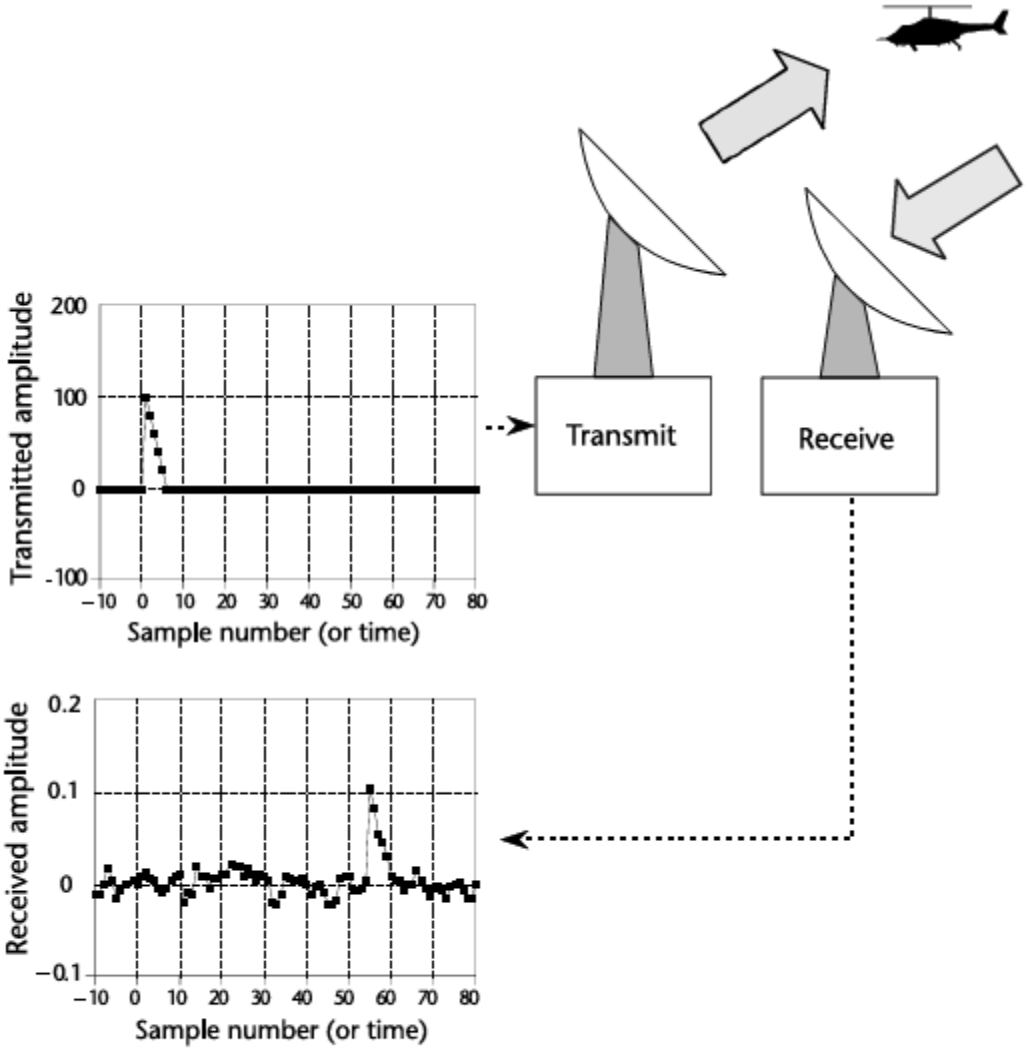


Figure Key elements of a radar system. Like other echo location systems, radar transmits a short pulse of energy that is reflected by objects being examined. This makes the received waveform a shifted version of the transmitted waveform, plus random noise. Detection of a known waveform in a noisy signal is the fundamental problem in echo location. The answer to this problem is *correlation*.

Cross-correlation and autocorrelation are two important concepts in DSP. Cross-correlation is a measure of similarity of two series as a function of the displacement of one relative to the other.

$$R_{x,y}(k) = \sum_{-\infty}^{\infty} x[n]y[n+k]$$

where k is the displacement.

Task1: What is the relation between convolution and correlation? (Discuss the expression and the use)

Correlation is a measure of how similar signals are:

For time-limited sequences

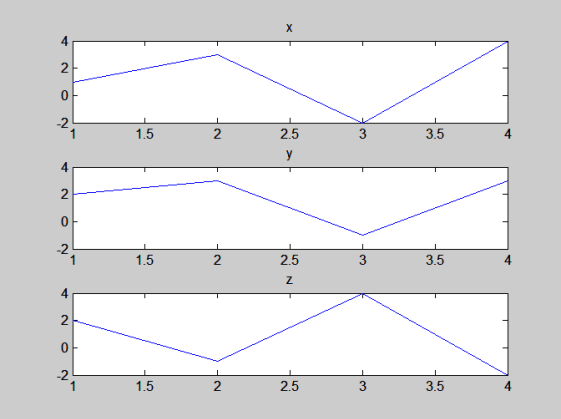
$$R_{x,y}(0) = \sum_{n=0}^{N-1} x[n]y[n]$$

Example:

Let x= [1 3 -2 4]

y= [2 3 -1 3]

z= [2 -1 4 -2]



$R_{x,y} = 25$

$R_{y,z} = -9$

It is clear that **y** is very similar to **x** than **z** snice $R_{x,y} > R_{y,z}$.

What about the following case:

If we modify z to w= [100 -1 4 -2] then $R_{y,w} = 187$

In this case, normal correlation fails! We turn into **normalized correlation** (correlation coefficient) instead which is defined as:

$$\sigma_{x,y} = \frac{\sum_{n=0}^{N-1} x[n]y[n]}{\sqrt{\sum_{n=0}^{N-1} x^2[n]}\sqrt{\sum_{n=0}^{N-1} y^2[n]}}$$

In this case

$\sigma_{x,y} = 0.95 > \sigma_{y,w} = 0.38$. It successes in identifying a similar sequence.

Task2: **check which one (standard or normalized) is more beneficial to identify how strongly one signal is present in two different signals. (Matlab)**

Let Si= cos(2*π*fi*t)

s_1: 1 Hz s_2: 4 Hz s_3: 10 Hz

The following signals contain the three sinusoids above

X = 2S1+ 4S2 + S3

Y = S1+ S2

a) Plot the generated signals for 1 sec. let the sampling interval 0.01 sec
b) Compare which is useful for identifying how strongly one signal (say S1) is present in another.

More tasks will be given later!