CLTI Correlation (2A)

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Please send corrections (or suggestions) to youngwlim@hotmail.com.

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Correlation

How signals move
relative to each other

Positively correlated — the same direction

Average of product > product of averages

Negatively correlated — the opposite direction

Average of product < product of averages

Uncorrelated

Correlation Function

$$R_{xy}(\tau) = \int_{-\infty}^{+\infty} x(t)\, y^*(t+\tau)\, dt = \int_{-\infty}^{+\infty} x(t-\tau)\, y^*(t)\, dt$$

Both real

$$R_{xy}(\tau) = \int_{-\infty}^{+\infty} x(t)\, y(t+\tau)\, dt = \int_{-\infty}^{+\infty} x(t-\tau)\, y(t)\, dt$$

Uncorrelated

Correlation and Convolution

Both real

$$R_{xy}(\tau) = \int_{-\infty}^{+\infty} x(t)\, y(t+\tau)\, dt = \int_{-\infty}^{+\infty} x(t-\tau)\, y(t)\, dt$$

Convoluion

$$x(t) * y(t) = \int_{-\infty}^{+\infty} x(t-\tau)\, y(\tau)\, d\tau$$

$$R_{xy}(\tau) = x(-\tau) * y(\tau)$$

$x(-t)$	$X^*(f)$
$R_{xy}(\tau)$	$X^*(f)\, Y(f)$

Power Signals

$$R_{xy}(\tau) = \int_{-\infty}^{+\infty} x(t)\, y^*(t+\tau)\, dt = \int_{-\infty}^{+\infty} x(t-\tau)\, y^*(t)\, dt$$

$$R_{xy}(\tau) = \lim_{T\to\infty} \frac{1}{T} \int_T x(t)\, y^*(t+\tau)\, dt = \lim_{T\to\infty} \frac{1}{T} \int_T x(t-\tau)\, y^*(t)\, dt$$

Both real

$$R_{xy}(\tau) = \int_{-\infty}^{+\infty} x(t)\, y(t+\tau)\, dt = \int_{-\infty}^{+\infty} x(t-\tau)\, y(t)\, dt$$

$$R_{xy}(\tau) = \lim_{T\to\infty} \frac{1}{T} \int_T x(t)\, y(t+\tau)\, dt = \lim_{T\to\infty} \frac{1}{T} \int_T x(t-\tau)\, y(t)\, dt$$

$$R_{xy}(\tau) = \lim_{T\to\infty} \frac{1}{T} \int_T x(t)\, y(t+\tau)\, dt \qquad R_{xy}(\tau) = \frac{1}{T} \int_T x(t)\, y(t+\tau)\, dt$$

Energy Signals

$$R_{xy}(\tau) = \int_{-\infty}^{+\infty} x(t)\, y(t+\tau)\, dt$$

$$R_{xy}(\tau) = \frac{1}{T} \int_{T} x(t)\, y(t+\tau)\, dt$$

Autocorrelation

$$R_{xy}(\tau) = \int_{-\infty}^{+\infty} x(t)\, y(t+\tau)\, dt$$

$$R_{xy}(\tau) = \frac{1}{T} \int_{T} x(t)\, y(t+\tau)\, dt$$

References

[1] http://en.wikipedia.org/
[2] M.J. Roberts, Signals and Systems,