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Cross-Correlation

The cross-correlation of two complex functions $f(t)$ and $g(t)$ of a real variable t, denoted $f \star g$ is defined by

$$f \star g \equiv \overline{f}(-t) * g(t), \tag{1}$$

where $*$ denotes convolution and $\overline{f}(t)$ is the complex conjugate of $f(t)$. Since convolution is defined by

$$f(t) * g(t) = \int_{-\infty}^{\infty} f(\tau)\, g(t-\tau)\, d\tau, \tag{2}$$

it follows that

$$f \star g \equiv \int_{-\infty}^{\infty} \overline{f}(-\tau)\, g(t-\tau)\, d\tau. \tag{3}$$

Letting $\tau' \equiv -\tau$, $d\tau' = -d\tau$ so (3) is equivalent to

$$f \star g = \int_{\infty}^{-\infty} \overline{f}(\tau')\, g(t+\tau')\, (-d\tau') \tag{4}$$

$$= \int_{-\infty}^{\infty} \overline{f}(\tau)\, g(t+\tau)\, d\tau. \tag{5}$$

The cross-correlation satisfies the identity

$$(g \star h) \star (g \star h) = (g \star g) \star (h \star h). \tag{6}$$

If f or g is even, then

$$f \star g = f * g, \tag{7}$$

where $*$ again denotes convolution.

SEE ALSO: Autocorrelation, Convolution, Cross-Correlation Theorem, Fourier Transform. [Pages Linking Here]

REFERENCES:

Bracewell, R. "Pentagram Notation for Cross Correlation." *The Fourier Transform and Its Applications, 3rd ed.* New York: McGraw-Hill, pp. 46 and 243, 1999.

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