Fast Fourier Transform Encyclopedia Article

Fast Fourier Transform

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Fast Fourier Transform

The fast Fourier transform is an equation that relates the amplitude, or strength, of an electrical signal as a **function** of frequency, instead of as a function of time. The computation of the transform has been one of the seminal events in spurring modern computer technological development and scientific discovery.

The Fourier transform is one of the core analytical tools of signal processing. X-ray crystallography, an application of Fourier analysis, was crucial to the discovery of the double helix structure of DNA. In biological research, Fourier analysis has been elegantly used to reveal the structure and arrangement of periodic arrays of protein that coat the surface of some bacteria.

The basic methodology of Fourier analysis had been known since around 1810. Expressed mathematically, the Fourier transform equation is capable of analyzing an electrical signal, which is made up of many different frequencies and wavelengths, to reveal the signal strength in a particular range of frequencies. The original calculation, called the discrete Fourier transform, was extremely laborious and consuming of both time and computing power. The fast Fourier transform devised by Cooley and Tukey sped up the analysis process--hence the name fast Fourier transform.

In 1965, James Cooley, then of the **IBM** T.J. Watson Research Center, and John Tukey of Princeton University published a paper relating the Fourier transform to computers. Their publication made it possible to harness the power of Fourier analysis in computational work.

The fast Fourier transform was almost immediately utilized by researchers to enable computer analysis of huge amounts of **data**. Examples include signal detection in radar systems, medical imaging techniques such as magnetic resonance imaging, and seismographic analysis of earthquakes.

In more recent work, the fast Fourier transform has shown great utility in the **design** of computer chips. A discrete Fourier transform processor implanted in a chip made possible the development of the wireless local area network, where computers are linked without the need for physical connection via wires. In this application, the Fourier transform is used to perform what is known as multiple tone modulation--the transmitting of a digital data signal over a number of discrete frequencies, and in the processing of the signal.