Impact of Fourier Transform/Series in Signal Processing and Communication

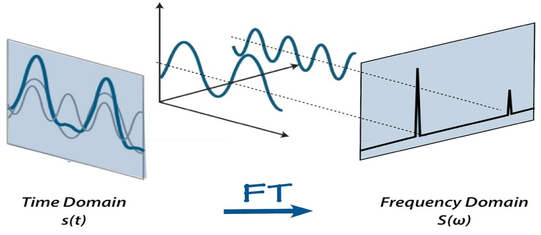
http://www.ece.iisc.ernet.in

Fourier's Contributions

Jean-Baptiste Joseph Fourier

(21 March 1768 – 16 May 1830)

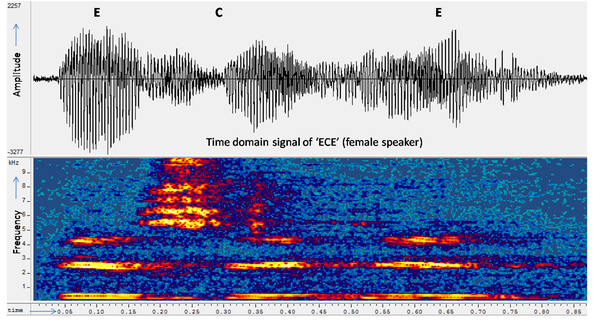
(source: https://www.azquotes.com)



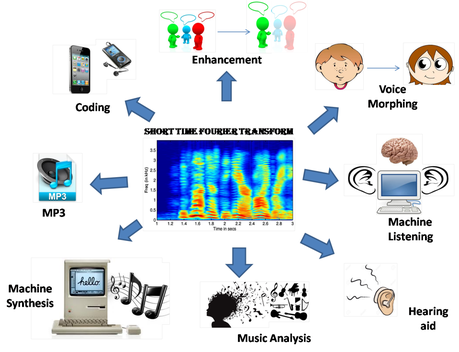
(source: http://http://mri-q.com/fourier-transform-ft.html)

- Fourier Series(FS): $f(t) = \sum_{n=-\infty}^{\infty} C_n e^{jn\omega t}; \quad C_n = \frac{1}{T}\int_t^{t+T} f(t)e^{-jn\omega t}dt$
- Fourier Transform(FT): $F(\omega) = \int_{-\infty}^{\infty} f(t)e^{-j\omega t}dt; \quad f(t) = \frac{1}{2\pi}\int_{-\infty}^{\infty} F(\omega)e^{j\omega t}d\omega$
- Discrete Time Fourier Series(DTFS): $x[n] = \sum_{k=0}^{N-1} X[k]e^{j2\pi nk/N}; \quad X[k] = \frac{1}{N}\sum_{n=0}^{N-1} x[n]e^{-j2\pi nk/N}$
- Discrete Time Fourier Transform(DTFT): $X(\omega) = \sum_{n=-\infty}^{\infty} x[n]e^{-j\omega n}; \quad x[n] = \frac{1}{2\pi}\int_{-\pi}^{\pi} X(\omega)e^{j\omega n}d\omega$
- Discrete Fourier Transform(DFT): $X[k] = \sum_{n=0}^{N-1} x[n]e^{-j2\pi nk/N} \quad ; x[n] = \frac{1}{N}\sum_{k=0}^{N-1} X[k]e^{j2\pi nk/N}$

Signal Processing

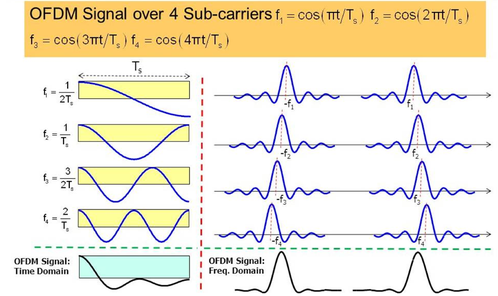


Short time Fourier Transform (Spectrogram)



(source: Speech and Audio Group, ECE, IISc)

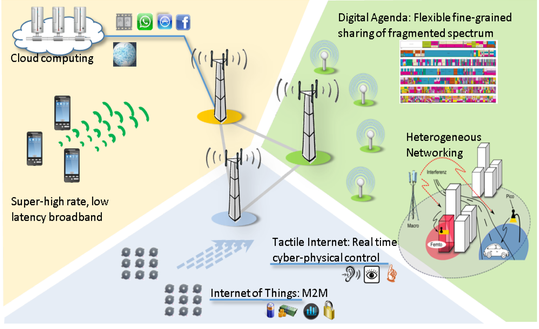
Communication



(source: https://www.ece.ucsb.edu)

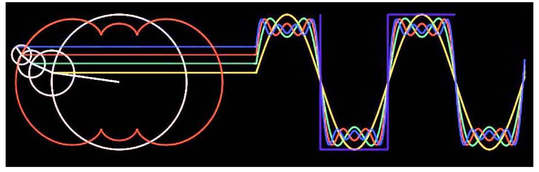
IFFT and FFT blocks are used in OFDM system which is a key technology in 3G, 4G and 5G communication systems.

5G Communication System



(source: http://webdemo.inue.uni-stuttgart.de)

Fourier Art



Generation of Fourier Art

(source: https://www.fourierart.com)

Overlap of phasors of multiple sinusoids constructs the Fourier pattern. The Fourier patterns of different signals are shown below.

(source: https://www.fourierart.com)