STATISTICAL METHODS FOR PROCESSING OF BIOSIGNALS

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Abstract
Meaning the use of mathematical tools in the analysis and processing of signals is that all real-world signals may degrade surrounding "sinusoid" and each, any real signal can recompose the "amount" of sinunsoide .. sinusoidal signal becomes the core of any special signals.

It is important to note that a non-periodic signal contains all frequencies in a certain range, not just certain frequencies as for periodic signals.

Mathematical tools that allow us calculate these parameters "sinusoid" composing signals are:

- Fourier theorem, for the particular case of periodic signals;
- Fourier transform for non-periodic signals.

Orice funcție u(t), continuă și periodică, având perioada $T_0 = \frac{1}{F_0} = \frac{2\pi}{\omega_0}$ *poate fi exprimată ca sumă dintre o componentă continuă plus o infinitate de funcții armonice, și anume:*

$$u(t) = U_0 + \sum_{k=1}^{\infty} \left[A_K \cdot \sin(k\omega_0 t) + B_K \cdot \cos(k\omega_0 t)\right]$$

$$\begin{cases} A_k = \frac{2}{T} \cdot \int_0^T u(t) \cdot \sin(k\omega_0 t) \cdot dt \\ B_k = \frac{2}{T} \cdot \int_0^T u(t) \cdot \cos(k\omega_0 t) \cdot dt \end{cases}$$

Teorema Fourier în domeniul real (formularea de bază)

$$u(t) = U_0 + \sum_{k=1}^{\infty} S_k \cdot \sin(k\omega_0 t + \varphi_k),$$

unde:

$$\begin{cases} S_k = \sqrt{A_k^2 + B_k^2} \\ \varphi_k = \mathrm{arctg}\frac{B_k}{A_k} \end{cases}$$

Teorema Fourier în domeniul real (a doua formulare)

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Using these two formulations, equivalent to determine valoriului function u (t) will lead to the breakdown of a periodic signal in "sinusoid" (fig. 1).

The lower part of the figure suggests recomposition with sufficient approximation to the original signal by summing continue with the first five harmonic component. If they used a higher number of harmonics, the final form of the function u (t) will be very close to the real one. The calculation was considered U_0 continue component, zero frequency sinusoidal component of calculating the average value of the function u (t) has the form:

$$U_0 = \frac{1}{T} \cdot \int_0^T u(t) \cdot dt$$

Harmonic order 1 (k = 1) is harmonic with period T_0, so even during the function u (t). Higher harmonics have frequency integer multiple of the base frequency. The set of these harmonic Fourier series form, or frequency spectrum of the signal u (t). The harmonic amplitudes decrease to zero when calculating their frequency tends to infinit.Pentru use coefficients A_k and B_k.

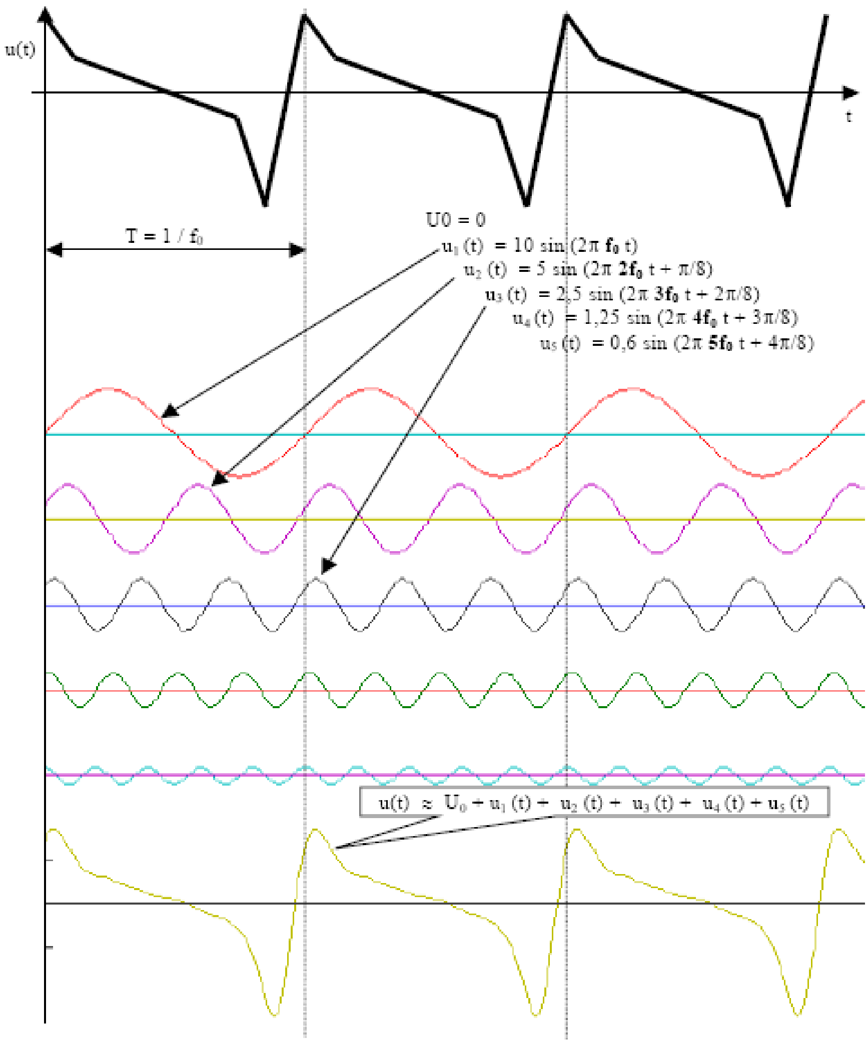

Figure 1. *Decomposition of a periodic signal in "sinusoid"*

Theorem for the complex Fourier is a mathematical tool extremely compact, easy to use and signal processing programs implemented by computer, return to 'real world signal "is simply considering only real part of the coefficients relationship:

$$C_k = |C_k| \cdot e^{j\varphi_k}$$

$$S_k = \sqrt{A_k^2 + B_k^2} = 2 \cdot |C_k|$$

$$\boxed{\varphi_k = \mathrm{arctg}\frac{B_k}{A_k} = \arg(C_k) = \angle C_k}$$

Teorema Fourier în domeniul complex

Fourier transform transforms time-varying function, u (t) to a new function that UTF (jω) depending on another variable ω named pulse. Basically it transforms time domain frequency domain.

*Având o funcție $u_{(t)}$, continuă și în timp continuu, **prin definiție**, transformata Fourier (**TF**) a funcției $u_{(t)}$ este:*

$$TF\{u_{(t)}\} = U_{TF(j\omega)} = \int_{-\infty}^{\infty} u(t) \cdot e^{-j\omega t}\, dt$$

unde $\omega \in R$

Transformata Fourier directă pentru semnale în timp continuu

Use unquestionable value and reverse Fourier transform is that you can make in the frequency domain analysis ciu spectacular results that would not be possible to foresee in time (fig. 2).

A Fourier transform application exception that reason is the recognition form of harmonic analysis, which is impossible for the function.

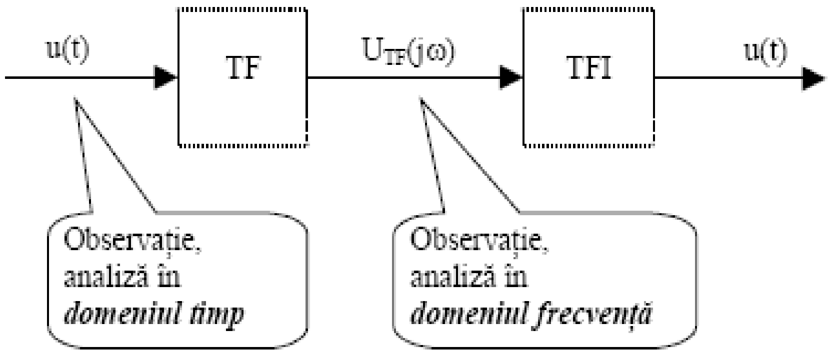

Figure 2. *Forward and reverse Fourier transform*

As in the case of continuous-time signals, write signals discrete Fourier transform:

*Având o tensiune discretă $u_{[nTe]}$, **prin definiție,** Transformarea Fourier Discretă (TFD) a N eşantioane din această tensiune este:*

$$\text{TFD}\ \{u_{[nTe]}\} = U_{\text{TFD}\ [n\ \Omega o]} = \sum_{k=0}^{N-1} u_{[kTe]} \cdot e^{-j n \Omega o\ k\, Te}$$

unde: $n = 0, 1, 2, \ldots, (N\text{-}1)$.

Transformata Fourier discretă TFD

where:

$$U_{\text{TFD}\ [n]} = \sum_{k=0}^{N-1} u_{[k]} \cdot e^{-j \frac{2\pi\, n\, k}{N}}$$

pentru $n = 0,1,2,\ldots, N\text{-}1$.

deducted from inverse discrete Fourier transform:

$$\text{TFDI}\{U_{\text{TFD}\ [n]}\} = u_{[n]} = \frac{1}{N} \cdot \sum_{k=0}^{N-1} U_{\text{TFD}[k]} \cdot e^{j \frac{2\pi\, n\, k}{N}}$$

Transformata Fourier discretă inversă TFDI

Fourier transformations are used to calculate the spectrum of a signal. If periodic signals have a discrete spectrum, by analogy, a discrete spectrum comes from a periodic sequence data. N sequence data to which it applies TFD comes from a periodic signal of period N You (Te - is sampling time). This process is recurring (fig. 3).

Other processes using TFD are ferestruirea triangular type, Welch and Hanning; calculation of power spectral density and convolution calculation of two signals (fig. 4).

Also TFD applies to both signals (providing the frequency spectrum), and system (by providing the frequency characteristic).

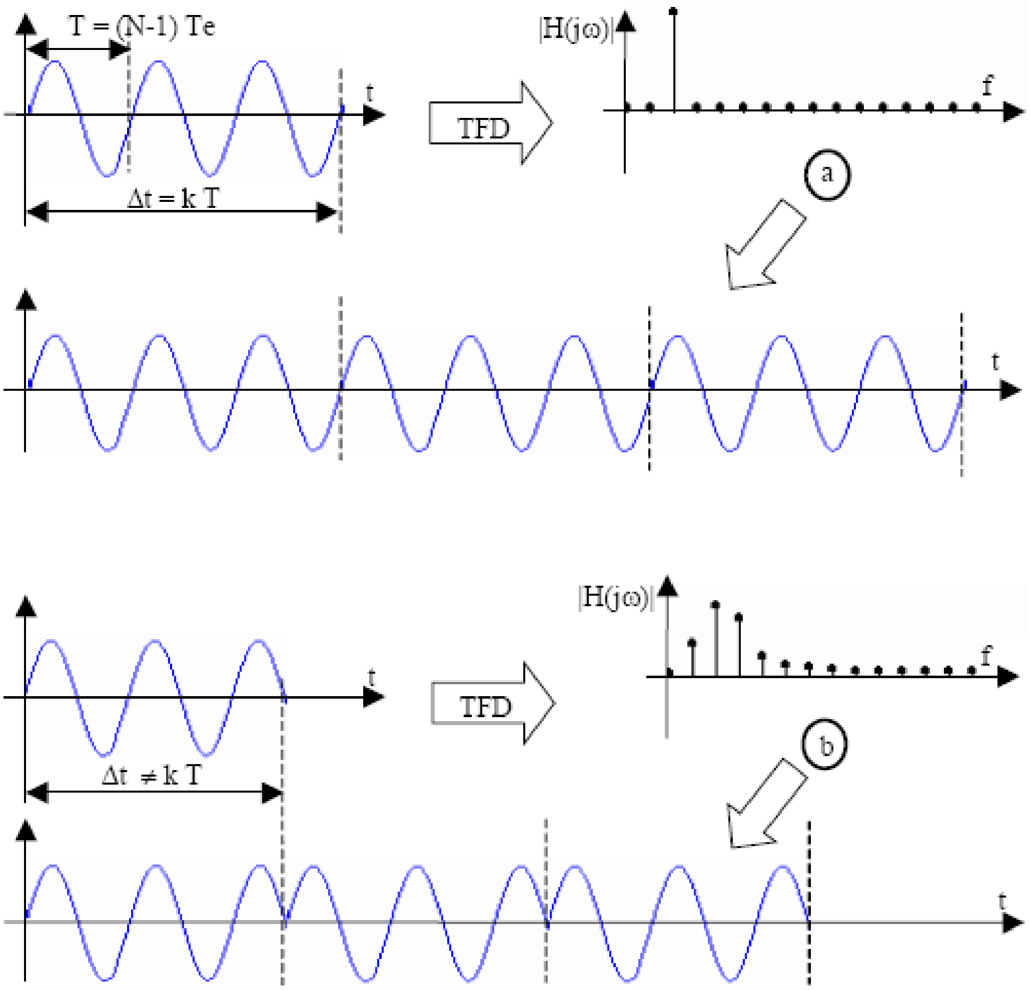

Figure 3. *TFD given spectrum for data sequences*

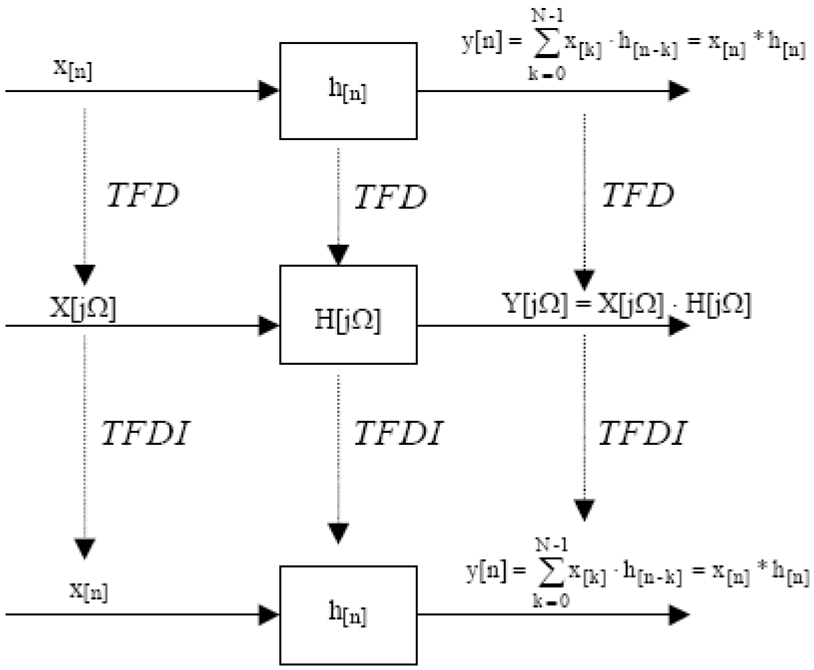

Figure 4. *Applied Fourier transform signals and system*

And discrete signals can be processed in time by: mediation, derivation, correlation (fig. 5), convolution, nonlinear processing, statistical processing.

The asemnea an important role in signal processing has it correct calculation of filters that can be used advanced design tools on the computer (MATLAB). In designing recursive filters using Laplace transform that applied a system transfer function changing relationships are fully differential or single multiplication or division.

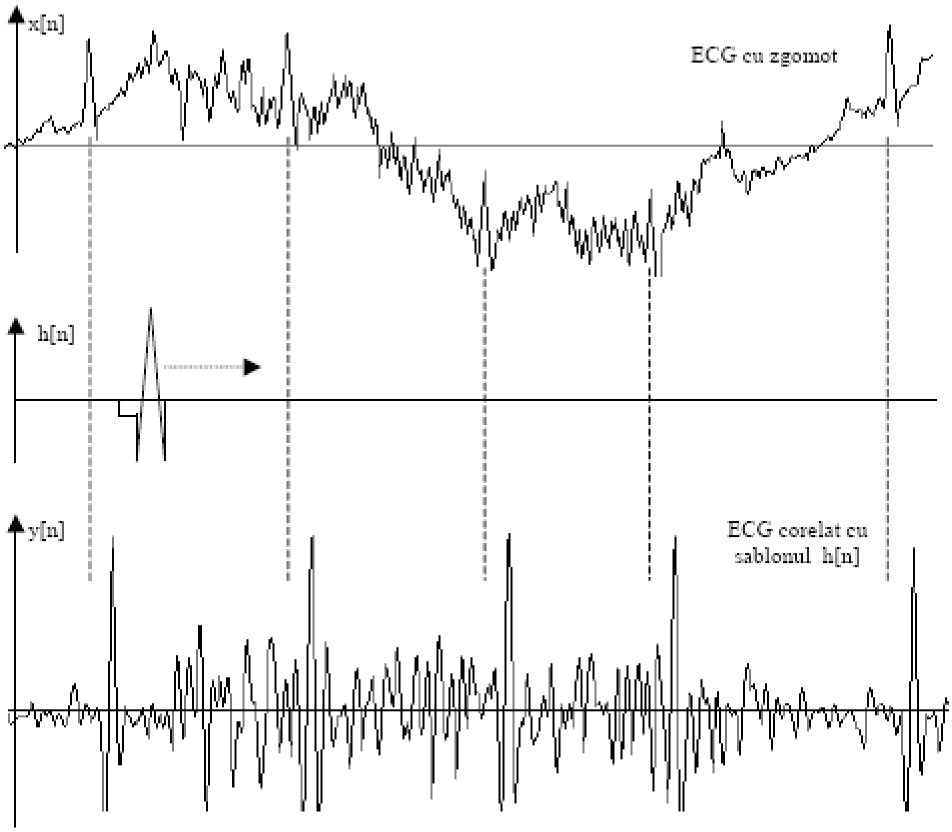

Figure 5. *Correlation ECG signal drowned in noise,*
with a particularly appropriate template.

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