The temporal and physical dimension of biosignals

A biosignal is a term denoting a physical event carrying information about a living system. This means that it carries abstract information at a certain time and has its physical character. If a biosignal is created by the active activity of an organism, we refer to it as a biosignal of its own, the manifestation of which can be movement, pressure, or temperature,... If the organism only affects an impulse sent from an external source, we speak of mediated biosignals, e.g. X-rays, ultrasound, and nuclear radiation. The source of the signal can be ultrasound waves, ionizing radiation,... However, there are more criteria according to which we can divide biosignals!

The time dimension of biosignals

Here we deal with the dynamic nature of the biosignal, whether it changes over time or not. Biosignals can be continuous (analog) - a curve is created or we observe movement, (sono), or discrete-time is defined only in isolated moments. Furthermore, we can divide them either according to the dimension of their vector or according to the dimension of the field.

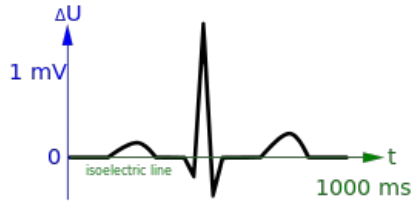
For the division according to the size of the field, we follow the time sequence of the fields by which the biosignal is given. From this point of view, we have one-dimensional, two-dimensional, and three-dimensional signals.

A one-dimensional signal is a time sequence of values of a measured parameter (body temperature), or the time sequence of vectors of measured values (for example, ECG, changes in electrical voltage on the surface of the body caused by the electrical activity of the myocardium can be recorded over time and a curve can be created from the measured values).

Two-dimensional biosignals correspond to a number of signals taken at one time. An example is sono, which can be used to monitor changes in the monitored object. Unlike one-dimensional, this is usually image data and not a curve. (A two-dimensional biosignal is not the same as 2D, it can also be created by cutting a 3D image, e.g. CT or sono! the dimension here means the dimension of the recorded vectors)

Three-dimensional biosignals are a representation of a biosignal taken with respect to the spatial distribution of its sources. Examples of timeless ones are data obtained from MRI and CT, and 4D sono is also included among the temporal ones.

For the distribution according to the vector dimension, it records the individual vectors of the given biosignal. We thus have an n-dimensional biosignal, e.g. 21-dimensional EEG.



Example of ECG curve

In terms of time, we could also divide biosignals into deterministic and stochastic. Deterministic can be expressed as a mathematical function, e.g. heart rate. this is, of course, idealistic, as we cannot rule out noises, etc... We divide them into transient processes (the action of the system, and therefore the measured biosignal, only happens once) and steady processes (the system changes periodically over time or does not change at all). Stochastic processes include a random element. This property is also reflected in the nature of the measured biosignal.

The physical dimension of biosignals

As follows from the previous text, a biosignal can be practically any physical quantity that changes over time and carries information about ongoing processes in the organism. This means that every biosignal carries certain information and has a physical essence. However, during the transmission of information, the physical nature can change, e.g. the alternation of electrical and chemical potential during the conduction of nerve impulses. However, the information carried remains the same.

The physical nature of a biosignal can be different. It can be mechanical, acoustic, thermal, or similar quantities. The concept of biosignal is most often associated with the electrical manifestations of the organism.

The physical dimension of the signal is not a dimensionless number, as it has its physical essence, it also has a unit, which we obtain by dividing the physical units of the output and input signals.

Examples of the physical nature of biosignals: Electrical, Magnetic, Electromagnetic, Chemical, Electrochemical, Optical, Mechanical, Acoustic, Thermal, Particle...

Links

Related articles

- Biosignals
- Electrical biosignals
- Biosignals from the point of view of biophysics

External links

- naseporodnice.cz: Detail fotky Ultrazvuk plodu (https://www.naseporodnice.cz/tehotenstvi/fotky-16-tyden-tehotenstvi-foto-12.html)

Sources

- Wikiversity:
  - Biosignals: Types (https://cs.wikiversity.org/wiki/Biosignály:_Druhy)
  - Biosignals: Species/Quixot (https://cs.wikiversity.org/wiki/Biosignály:_Druhy/Kychot)
  - Biosignals (lecture) (https://cs.wikiversity.org/wiki/Biosignály_%28přednáška%29#Biofyzik.C3.A1ln.C3.AD_rozd.C4.9Blen.C3.AD)
- Jaroslav Šrámek (2012): Biosignal – lecture (https://www.med.muni.cz/biofyz/doc/NMgr/biosignal_FO_2012.pdf), Institute of Biophysics, Faculty of Music, MU Brno.
- Gabriela Štěpánová (2007): Medical devices – lecture, KTeIV Faculty of Education, MU Brno
- Biosignály z pohledu biofyziky, Petr Heřman, Praha 2006

Literature

Biosignály z pohledu biofyziky, Petr Heřman, Praha 2006