Unipolar and bipolar connection of electrodes

The electrical potentials , sensed by the electrodes , have a very low amplitude. These low voltages must first be amplified in order to further process the given biosignal . A so-called *input amplifier* is used for this . However, the problem is the large number of interfering signals coming from various electrical devices that we are surrounded by on a daily basis. One way to minimize these interfering signals is to use a so-called *differential amplifier for amplification*. It has two inputs: active (direct) – this one measures the detected potential together with noise and inverted (reference) – this one measures only noise. The differential amplifier then subtracts the voltage at the reference input from the voltage at the active input and amplifies the difference.

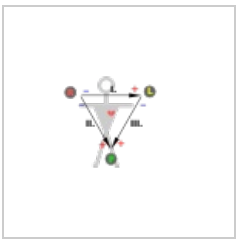
Connection of electrodes

We can connect two electrodes to one amplifier. We connect the active electrode to the direct input, the reference electrode to the inverted input. This connection can be used in invasive methods , when we use, for example, a concentric needle electrode consisting of two conductive parts, one of which represents a direct electrode and the other a reference (e.g. invasive EMG), but also in non-invasive methods.

Bipolar connection of electrodes

If we wanted to monitor the signal from a larger number of electrodes at once, we would need a larger number of amplifiers. One possibility is to connect "equivalent" electrodes to the inputs of amplifiers in pairs. Thus, we could record the potential difference between two sensing locations, and this connection of the electrodes is called bipolar. In that case, however, we would need twice the amount of electrodes against the amplifiers.

Einthoven (https://en.wikipedia.org/wiki/Willem_Einthoven) solved this problem in his EKG machine: he placed the electrodes on both wrists and the ankle of the patient's left foot. From every two electrodes, the voltage difference led to one amplifier (at the time of its action, a galvanometer), thus achieving the connection of three electrodes and three amplifiers (Einthoven's triangle).



Einthoven´s triangle

This type of bipolar connection can also be used in other examinations: e.g. EEG , where several tens of electrodes are used. The common principle remains the connection of one electrode to two amplifiers at the same time. In this way, not only closed cycles can be created, but also open chains.

Unipolar connection of electrodes

We use this type of connection if we want to monitor the progress of the signal under a certain electrode. This electrode is an active electrode. The reference electrode will either be common to all connected together reference inputs of all amplifiers and placed outside the active electrodes, or we will artificially create some electrically neutral point by connecting all the active electrodes through resistors of the same size to one point, where the arithmetic average of the potentials from all active electrodes. The potential difference between the sensed location where the active electrode is located and this neutral point is recorded. In the case of the ECG, this neutral point is called the Wilson clamp . This principle is also used in other examinations (e.g. EEG).

Links

related articles

- Biosignals from the point of view of biophysics/electrical biosignals in the organism

References

- HEŘMAN, Petr. *Biosignals from the point of view of biophysics.* 1. edition. Dúlos, 2006. 63 pp. ISBN 80-902899-7-5.

- NAVRÁTIL, Leoš – ROSINA, Jozef. *Medical Biophysics.* 1. edition. Grada, 2005. 524 pp. ISBN 80-247-1152-4.