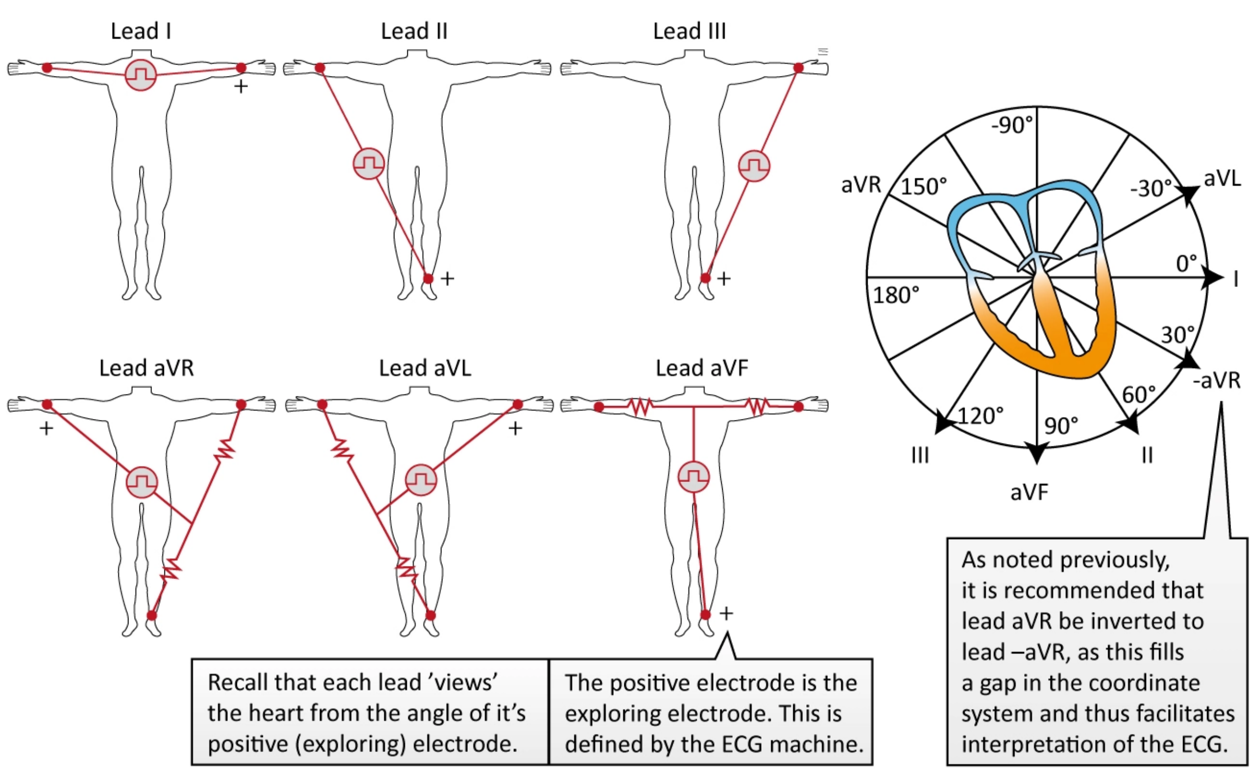
The database «The MIT-BIH Malignant Ventricular Ectopy Database» (MVED) [9] is selected as the primary source of ECG records. This database contains heart rhythm disturbances necessary for research. It is widely used for testing and comparative analysis of various algorithms for detecting dangerous arrhythmias.

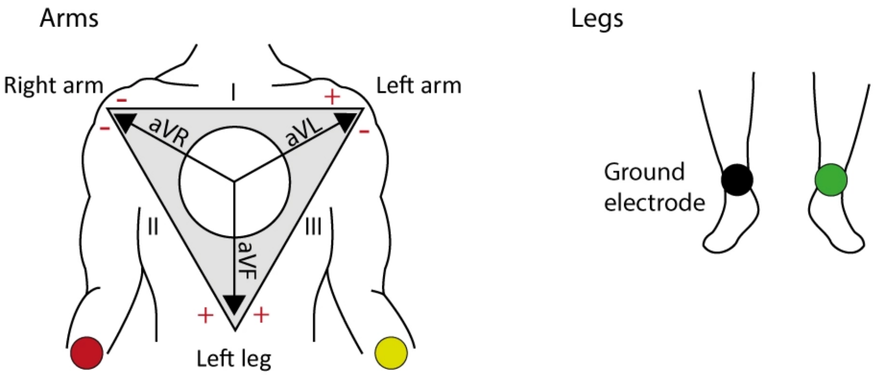
This database contains heart rhythm disturbances necessary for research and is widely used for testing and comparative analysis of various algorithms for detecting arrhythmia threats. The signal is a modified limb leadII (MLII).

Lead II compares the left leg with the right arm, with the leg electrode being the exploring electrode. Therefore, lead II observes the heart from an angle of 60°

A) The limb leads and their view of the heart's electrical activity



B) Einthoven's triangle



The arrhythmias classes included in the database are presented below in order of decreasing risk to the patient's life. Each of the classes includes 90 main ECG fragments.

1. Dangerous arrhythmias requiring urgent resuscitation:

- VFL – ventricular flutter;
- VF – ventricular fibrillation.

2. The early form of life-threatening arrhythmias:

- TdP – torsade de pointes.

3. Life-threatening ventricular arrhythmias:

- VT – ventricular tachycardia.

4. Potentially dangerous ventricular arrhythmias:

- B – ventricular bigeminy;
- HGEA - high grade ventricular ectopic activity;
- VER – ventricular escape rhythm.

5. Supraventricular arrhythmias:

- AFIB – atrial fibrillation;
- SVTA – supraventricular tachyarrhythmia;
- SBR - sinus bradycardia;
- BI - first degree heart block;
- NOD – nodal (AV junctional) rhythm.

6. Normal rhythm, including single extrasystoles:

- N – normal sinus rhythm;
- Ne – normal rhythm with норма с extrasystole.

The result is an ECG database containing short recording of ECG fragments and the result of the spectral transformation thereof in the form of calculations of spectral power density.

The base of ECG records is a single data block designated as "Samples_6_classes_by_90_fragments", containing 6 sections:

- «1_ dangerous_VFL_VF»;
- «2_ early_form _TdP»;
- «3_ life-threatening _VT»;
- «4_ potentially_dangerous»;
- «5_ supraventricular»;
- «6_ normal».

This database was used in [10, 11] to classify various arrhythmias by ECG spectral description. Several recognition algorithms were investigated that implement the weighted k nearest neighbors (kNN) method [12], the nearest convex hull method (LP-NCH) [10], linear discriminant analysis (LDA) [13], support vector machine (SVM) [14], and neural network methods.

The collected records were used in the development of algorithms for the spectral recognition of dangerous arrhythmias by spectral features, so it was necessary to obtain the spectra of the corresponding signals in the lower frequency range.

Spectral recognition?

The process of determining the frequency contents of a continuous-time signal in the discrete-time domain is known as spectral analysis. Most of the phenomena that occur in nature can be characterized statistically by random processes.

What is spectral feature extraction?

Spectral feature extraction is a crucial procedure in automated spectral analysis. This procedure starts from the spectral data and produces informative and non-redundant features, facilitating the subsequent automated processing and analysis with machine-learning and data-mining techniques.

obtained. For the frequency domain analysis, the power spectral density (PSD) estimates were derived at a step of 0.5 Hz. The spectrums of the corresponding signals are presented in the range from 0 to 180 Hz and are called the full spectrum.

The spectral feature set was also obtained in the range 0 - 15 Hz. Uncorrelated PSD estimates were calculated with a step of 0.5 Hz and averaged over adjacent spectral coefficients. The step along the frequency axis became equal to 1 Hz. This transformation has preserved the distinctive shape of the spectrum with the relative stability of the PSD obtained estimates. This spectrum is called smooth and has 15 features.

Another smoothed spectrum, which has 10 features, and a frequency step of 1.5 Hz, was obtained by averaging the spectrum with a step of 1 Hz.

The zero counts of each spectrum file retain full signal power.

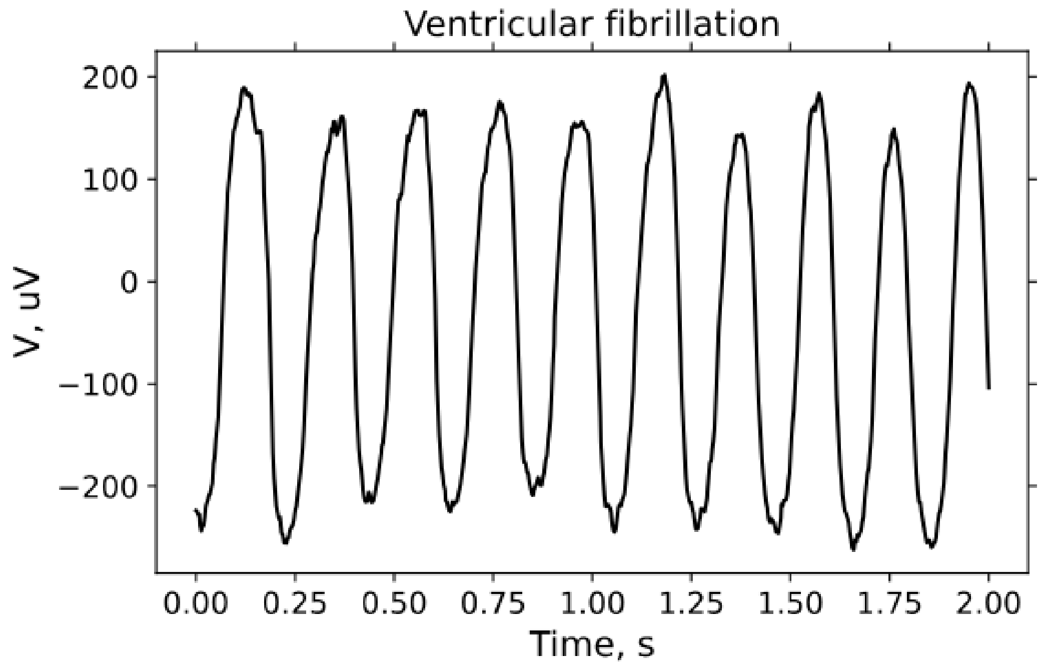


Fig. 1. Fragment of ECG signal ventricular fibrillation

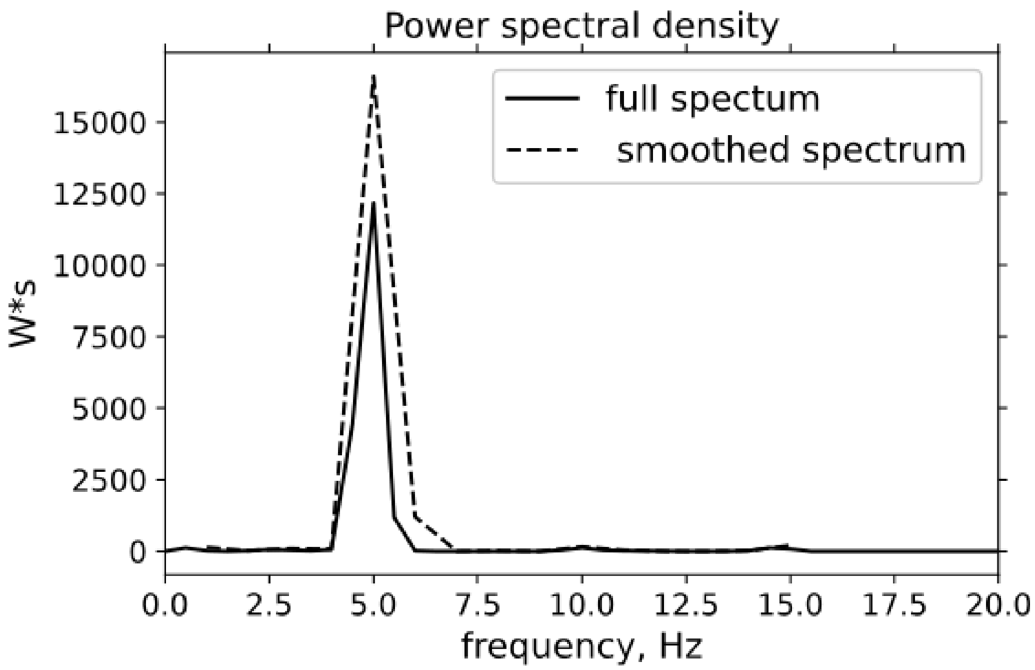


Fig. 2. Full and smoothed ventricular fibrillation signal spectrum

We see that the peculiarity of the original spectrumshape.

Datas : 418_C_VFL_277s and 419_C_N_182s

Fig. 3 shows a fragment containing a normal rhythm. Fig. 4 shows the spectra: full and smoothed.

These ECG forms refer to the normal rhythm form and do not require immediate resuscitation measures.

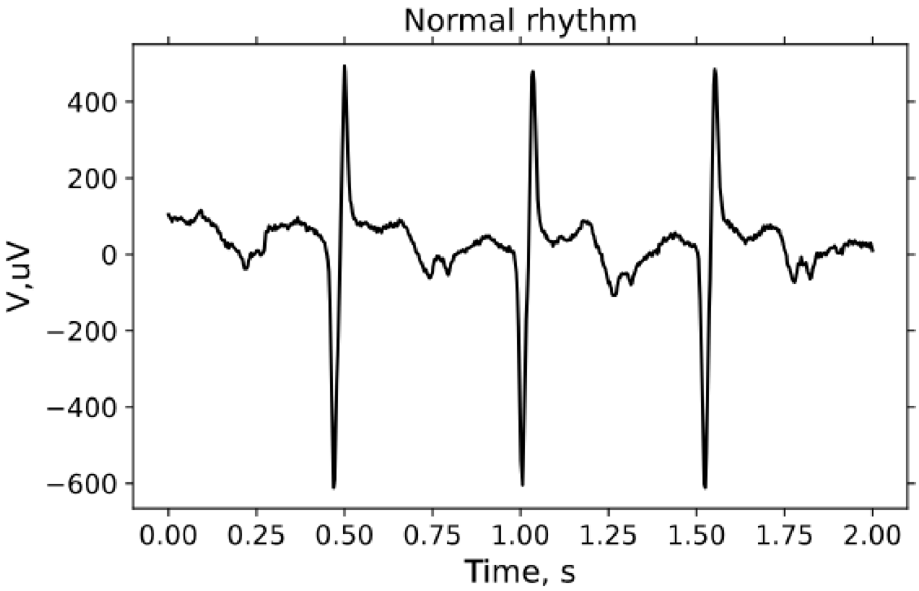
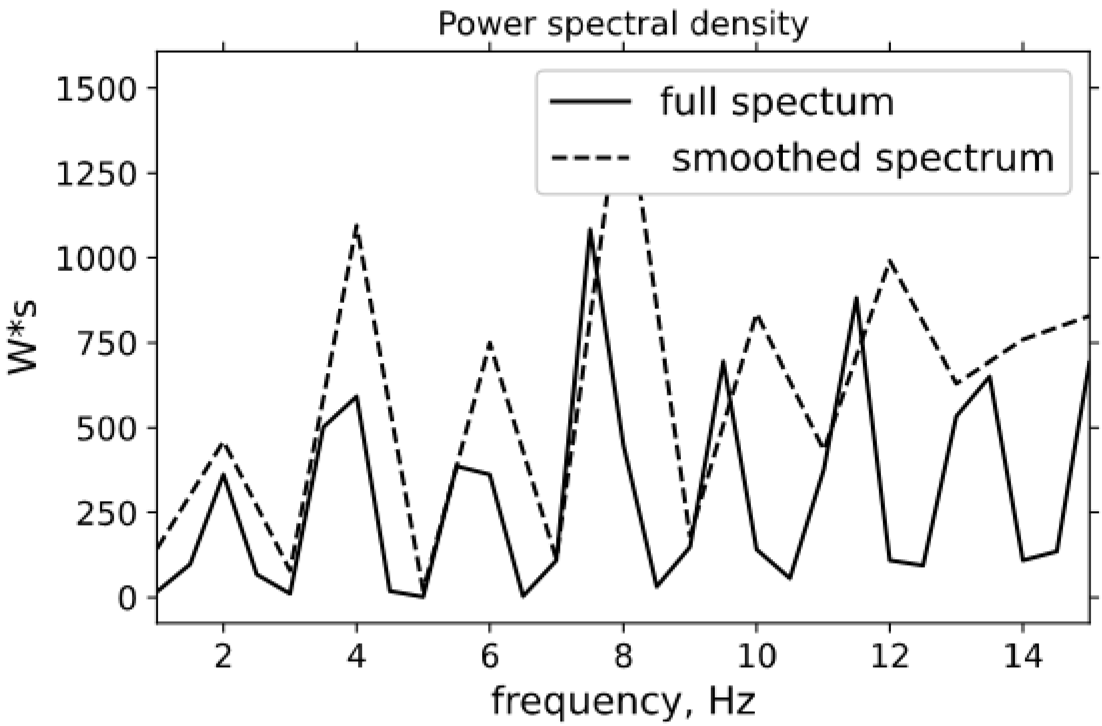


Fig. 3. Fragment of ECG signal normal rhythm



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