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EXPERIMENTAL RESEARCH OF DIGITAL FILTERING IN THE SEPARATION OF BREATHING SIGNALS AND HEART CONTRACTIONS TO ASSES THE CONTROL OF THE DRIVER'S CONDITION

Remote determination of the parameters of the heartbeat and respiration of a living organism is the main diagnostic task. This problem can be solved provided that a sufficiently sensitive radar sensor is created and algorithms for filtering background reflections are developed that can mask a useful signal.

The main goal of the work is to highlight the rhythms of breathing and heartbeat. For this purpose, a mathematical model of the signal processing system was developed in order to obtain the necessary spectrograms. This enables an in-depth analysis of both harmonics and their mixed works (intermodulation). The importance of a complete analysis is proved below, since the large amplitude of the harmonics of respiration, and sometimes of mixed derivatives, makes it difficult to measure the heart rate, especially when they are close to its frequency range.

Signal parameters due to respiration and heartbeat are significantly different. The developed algorithm for processing the generated signal and the information that it carries uses these differences. Signal processing is divided into analog and digital stages(Fig. 1).

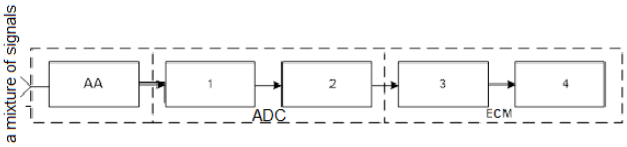

Fig. 1 – The block diagram of the signal processing: AU – analog amplifier; 1,2 – analog and digital part of the analog-to-digital converter; 3 – software driver; 4 – work program

The algorithm for processing a mixture of low-frequency signals with subsequent digital processing is shown in Fig. 2.

At the first stage, signals with specified parameters are generated that simulate the process of respiration and heartbeat, as well as some obstacle in the form of noise.

At the second step, a mixture of signals is obtained that simulates a biometric signal received from a bio-radar. At the third stage, band-pass filtering is performed in order to isolate the components of respiration and heartbeat from the general signal. Further spectral analysis of the received signals allows us to determine the frequency and conduct a comparative analysis of frequencies. This signal also includes a heartbeat signal, which is visible in the spectrum, although it is not so clearly highlighted in the spectrogram compared to the breathing signal.

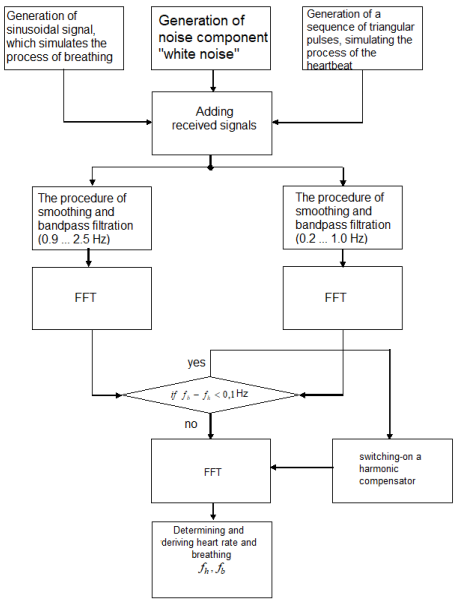

Fig. 2 – Algorithm for digital filtering of a mixture of bio signals

At the fourth stage, additional band-pass filtering is performed to isolate the components of the heartbeat. In the event that the respiration rate, as well as its higher harmonics, falls into the passband of this filter, the so-called harmonic compensator is turned on, the task of which is to shift the spectral components of respiration and its harmonics. Next, a spectral analysis of the received signal is carried out in order to determine the heart rate.