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DIGITAL FILTRATION OF A MIXTURE OF ULTRALOW FREQUENCY SIGNALS: METHODS RESEARCH

The most popular methods of separating a mixture of ultralow signals are analog, filtration and spectral. The most appropriate method for each separate task of our research work was chosen. A filtering method was chosen to separate a mixture of signals, and to measure the frequency of signals we chose the spectral method. It is more efficient to use digital methods, that ensure high accuracy and minimum hardware costs.

The main purpose of the study was to allocate the rhythm frequencies of breathing and palpitation. For this purpose, a mathematical model of a mixture of signals was developed. In this case, the signal model should take into account the effect of interference. Also, different frequency correlations of the signal components should be taken into account to determine their parameters more accurately.

The parameters of the signals caused by breathing 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 subdivided into analog and digital stages.

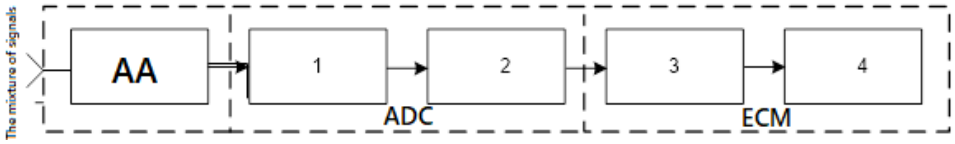

Figure 1 - Block diagram of signal processing

AA – analog amplifier;
1,2 – analog and digital part of the analog-to-digital converter;
3 – software driver;
4 – work programg.

List of operations and the procedure for their execution

Analogue information processing:

- Signal reception;
- Strengthening;
- Filtering.

Digital information processing:

- The sampling of the received signal;
- Filtration;
- Determination of harmonic frequencies.

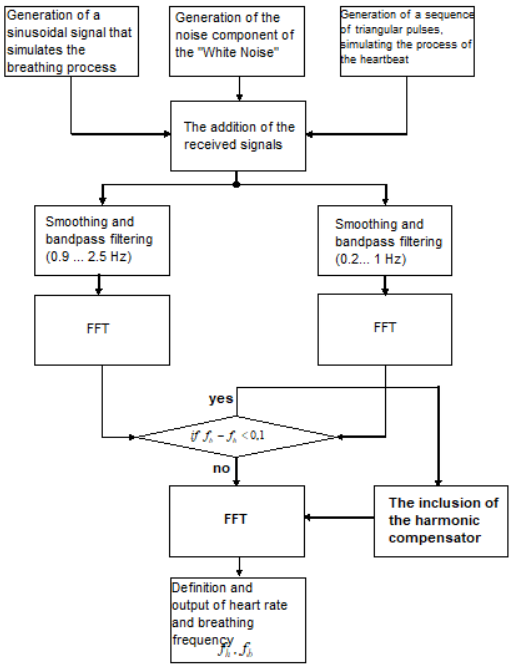

Figure 2 - Algorithm for digital filtering of the signals mixture

Simulation of a low-frequency biometric signal mix

The research is carried out for the following simulation parameters:

- Amplitude and breathing rate respectively $m_b = 0{,}005$ m & $f_b = 0{,}3$ GHz;
- Amplitude and heart rate respectively $m_h = 0{,}0005$ m & $f_h = 1{,}5$ GHz;
- Pulse duration of the heart beat $\tau = 0{,}3\ s$;
- The maximum amplitude of noise is 30% of the given breathing amplitude.

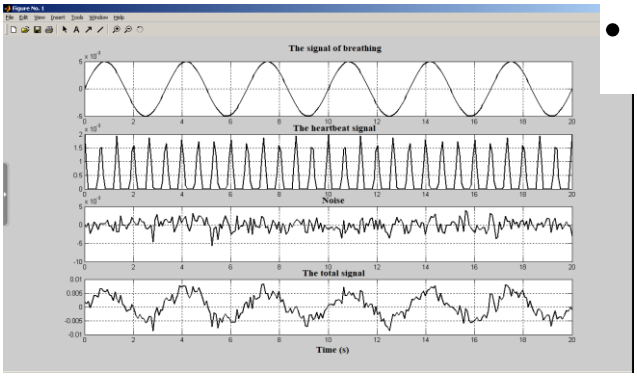

Figure 3 - Time plots for a biometric signal

Investigation of the filtration quality under the influence of own noise

Initial conditions: respiratory rate – $f_b = 0{,}3$ GHz, heart rate – $f_h = 1{,}5$ GHz, sampling rate – $F_d = 12{,}8$ GHz, bit size of fast Fourier transform – $N = 4096$, time of observation – $T_{\max} = 20$ s.

Results of the filtering quality and its own noise influence:

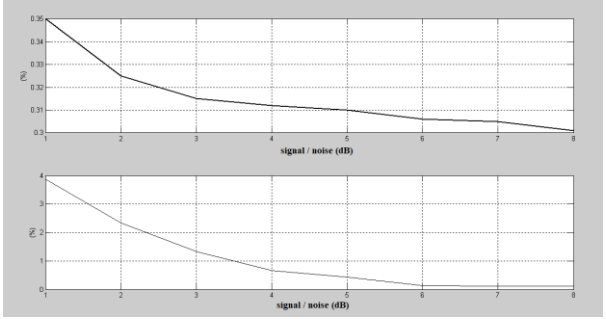

Figure 4 - Dependence of absolute error on signal / noise ratio

Thus, due to the mathematical model, the developed algorithm and the obtained r esults, it can be concluded that calculations, the chosen method and way of filtration are correct.