An algorithm of receiving the interval characteristics of information signal in the task of identification the recurrent laryngeal nerve

Mykola Dyvak*, Natalia Padletska†, Andriy Pukas°

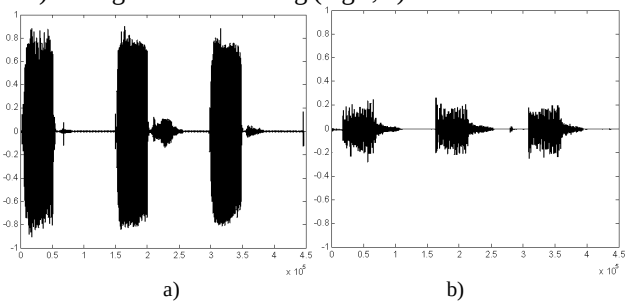
Faculty of Computer Information Technologies, Ternopil National Economic University, Yunosti Str. 9, Ternopil', Ukraine,
e-mail: *mdy@tneu.edu.ua, †p_r_ni@ukr.net, °apu@tneu.edu.ua

Abstract **The algorithm of signal processing for identification the recurrent laryngeal nerve during thyroid surgery is proved.**

Keywords **Recurrent Laryngeal Nerve, Signal Processing, Spectral Power Density.**

I. TASK STATEMENTS

Principles of identification the Recurrent Laryngeal Nerve (RLN) during the thyroid surgery consist in stimulating the surgical area by alternate current and fixing the results of this stimulation by sound sensor placed nearly to vocal cords in a larynx [1]. Sound sensor fixes a voice signal that arises in consequence of air passing through the larynx of patient during breathing. If the area of stimulation includes RLN, then the muscles, that stretch vocal cords, are contracting and that causes the change of amplitude and spectrum of sound signal. If stimulation is done on muscular tissue in surgical wound, then a reaction on stimulation will be insignificant. In the existent method of RLN identification as the basic parameter of information signal the interval estimation of maximal amplitude $[U^{-}_{\max};U^{+}_{\max}]$ of this signal $u(t)$ is selected [2]. In Fig.1 on the x-axis the time marks are putted and on y-axis the normalized amplitudes of information signal are putted. As shown in Fig.1 the amplitude of signal is so high if laryngeal nerve directly stimulated (Fig.1, a) and is sharply diminishing (to the noises level) at insignificant distancing (Fig.1, b).



a) b)

Fig.1. Fragments of information signal as reaction on the tissues stimulation in surgical wound

The disadvantage of noted approach is a low sensitivity and as a result – high risk of RLN damage during surgery.

Another way provides the spectral analysis of information signal or construction the autocorrelation function of this signal with further obtaining the spectral power density. As shown in [2], the received spectrum of information signal substantially depends from the features of patient's larynx. Considering the conducted analysis it was decided to research the influence of current's frequency of muscular tissue stimulation in surgical wound on the power spectrum of information signal.

II. RESEARCH RESULTS

Research showed that main power spectrum of information signal on low frequencies of stimulation the muscular tissue from 10 to 100 Hz is concentrated in a range from 0 to 300 Hz depending on the specific of patient's larynx and mainly independent from frequency of stimulation current. It is also determined during research that the energy of information signal, concentrated in the noted range of frequencies, substantially depends on approaching the stimulation point on muscular tissue to RLN. According to the research the new algorithm of information signal processing is proposed.

Step 1. Segmentation the information signal with purpose of selection the fragments received during inhalation and expiration of air by patient.

Step 2. Obtaining the autocorrelation function of selected segment with purpose of decreasing the noises influence on the power spectrum of signal.

Step 3. Obtaining the spectral power density of information signal by applying the Fourier transformation.

Step 4. Estimation of signal energy in a range 0-300 Hz. This step is proved by the spectral characteristics of information signal, which is typical for the group of patients, found during research.

Step 5. Normalization the obtained energy due to comparison with energy of information signal in the same range of frequencies, but obtained after stimulation the muscular tissue.

As a result of implementation the fifth step, unlike to existent method, the bounds of information signal energy $[E^{-};E^{+}]$ are obtained.

As a result of application of the noted algorithm to the group of patients consist of 45 persons it was found that proposed algorithm provides a higher sensitiveness during RLN identification.

III. CONCLUSIONS

Based on conducted research it is possible to consider that the offered algorithm provides a higher sensitiveness during RLN identification and accordingly reduces the risk of its damage during surgical operation.

IV. REFERENCES

[1] Dyvak M.: "Device for identification of laryngeal nerves", Proc. (forum catalogue) of the 3th International Forum on Innovative Technologies for Medicine, Bialystok, Poland, 2009, p.34.

[2] Dyvak M., Kasatkina N., Pukas A., Padletska N.: "Spectral analysis of information signal in the task of identification the recurrent laryngeal nerve during thyroid surgery", Proceedings of the 13th International Workshop "Computational Problems of Electrical Engineering", Grubow, Poland, 2012, p.55.