to lessen discomfort. By the end of the study, an experimental prototype of the ergonomic nanosensor is to be developed.

It is very important to find new ways to improve the prosthetic bioengineering technologies such as electrophysiological interfaces development, which allow designing efficient prosthetic devices to improve the life quality of disabled people. One of this ways is enhancing signal recording technologies and developing high sensitive and resistant sensors which will allow developing more stable devices and controlling systems for prosthetics.

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Electrocapacitive transducer to control in-process cable linear capacitance

The linear capacitance is a significant parameter of insulated electric cables, particularly, of radiofrequency cables, LAN-cables and communication cables. The value of the linear capacitance is normalized by the standard of an appropriate type of the cable. The technique of cable capacitance measurement is regulated by GOST 27893-88. This technique is used to control the capacitance of a finale cable segment. The disadvantage of this technique is that the cable cannot be controlled along its intire length and the conclusion about the wire quality is drawn after the cable has been produced only. Therefore, it is essential to perform the control of the cable in the process of its manufacturing. In this case the capacitance can be measured with a tubular electrode immersed in a bath of cooling water.

To perform the control the capacitance of a cylindrical capacitor is to be measured. This capacitor consists of a cable core as a cylinder-type plate of the capacitor, and the cooling water the cable is immersed into as the second cylinder-type plate of the capacitor.

Figure 1 shows a schematic diagram of the electrocapacitive transducer. The electrocapacitive transducer consists of a cylindrical metal housing 1, tubular measuring electrode 2, a pair of cylindrical guard electrodes 3 and dielectric 4. This dielectric is placed between metal housing 1 and electrodes 2 and 3.

The cable under control (5) is moving permanently along the common axis of the three electrodes. The guard electrodes provide a uniform electric field in the adjacent ends of the measuring electrode. The cable core and cylindrical metal housing are earthed.

The effect of water electrical conductivity on the results of cable capacitance measurement has been studied. To perform the experiment we used the cable samples of the capacity ranging from 160 pF/m to 460 pF/m. The cable linear capacitance was determined in compliance with GOST 27893-88.

The change in the water electrical conductivity was provided by solving NaCl in fresh water. The water salinity varied from 0 ‰ to 2.5 %.

Figure 2 demonstrates the hodographs of the signal from the electrocapacitive transducer depending on change in the cable linear capacitance C and water salinity λ. As the linear capacitance increases, the current amplitude linearly grows. Change in the water salinity changes the current amplitude in the range from 35 % for large capacitance values to 70 % for small capacitance values. Measurement of the cable linear capacitance with no account for water salinity causes a large measurement error.

The second part of the research is dedicated to simulation of the electrocapacitive transducer with Comsol Multiphysics 3.5a program. The transducer providing the most high uniformity of the electric field between the inner surface of the measuring electrode and the cable core is considered to be optimal.

Variable β is introduced as a criterion of the electric field uniformity. Variable β is equal to the ratio of the linear capacitance in the central path of the measuring electrode (C_0) to the linear capacitance along the total length of the measuring electrode. For an optimal transducer design β equals 1.

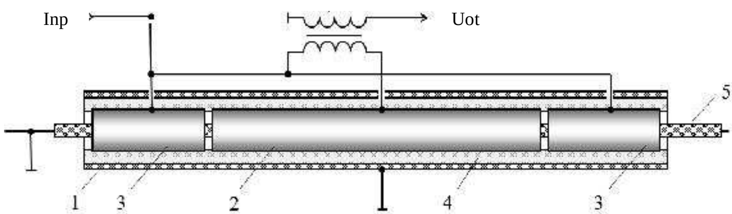

Figure 1. Schematic diagram of the electrocapacitive transducer:

Cylindrical metal housing (1); measuring electrode (2); guard electrodes (3); dielectric (4); cable (5)

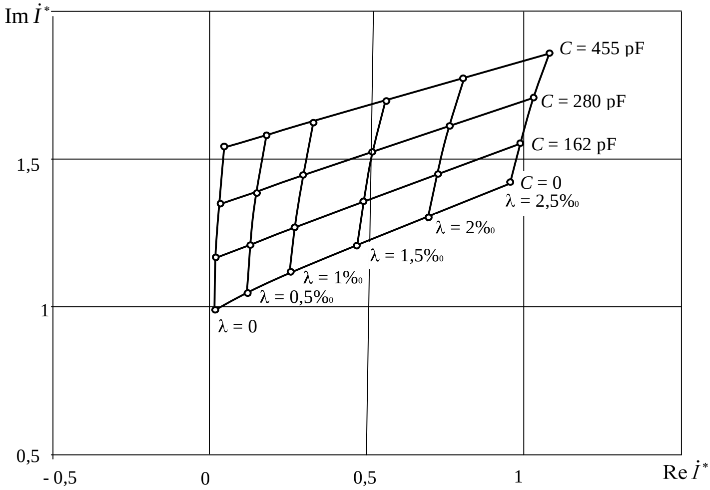

Figure 2. Hodographs of the signal of the electrocapacitive transducer relative to change in cable linear capacitance C and water salinity λ

Figure 3 shows the electric field created by the electrocapacitive transducer.

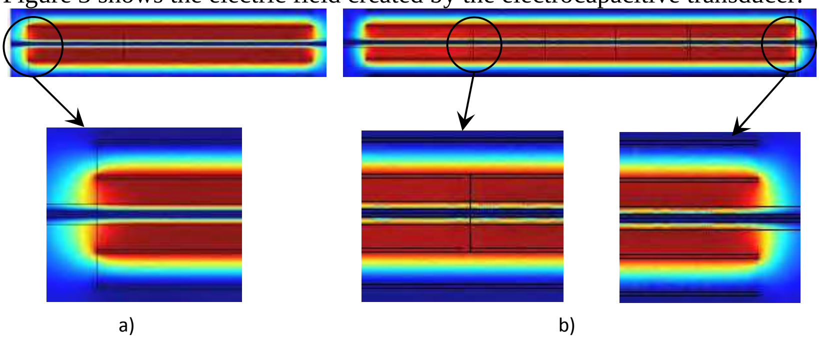

Figure 3. Electric field created by the electrocapacitive transducer: without guard electrodes (a), with guard electrodes (b)

If no guard electrodes are applied, the electric field spreads at the ends of the measuring electrode (Fig. 3a). In this case β equals 0.8, and hence the truncation error of the cable linear capacitance measurement is 20%.

The guard electrodes displace the electric field spreading to the distant edges of the guard electrodes (Fig. 3b). In this case the uniformity of the electric field is high and β equals 1.

The results obtained in simulation of the electrocapacitive transducer with Comsol Multiphysics 3.5a program have been analyzed. The recommended design parameters of this transducer are as follows:

- the inner diameter of the electrode is to be no less than 2 times greater than of the isolation cable diameter.

- the inner diameter of the cylindrical housing is to be no less than 2 times greater than of the electrode inner diameter.
- the measuring electrode is to be equal to 200 mm.
- the length of the guard electrodes are to be no less than 2.5 times greater than of the isolation cable diameter.
- the gap between the measuring electrode and the guard electrode is to be minimal.

Thus, the research conducted has shown that change of water salinity affects the results of the cable linear capacitance control.

An optimal electrocapacitance transducer design was simulated by means of the Comsol Multiphysics 3.5a program. The design is considered to be optimal if β tends to 1.

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Simulation of cardiac electrical activity with electrocardiograph based on nanosensors

Abstract. The problems related to cardiovascular diseases are considered. The method to solve some of the problems has been proposed. We also consider a two-component Aliev-Panfilov model and the algorithm of the hardware- software complexes. The obtained results are presented.

According to World Health Organization (WHO), over 17 million people worldwide die annually from cardiovascular diseases (CVDs). Moreover, according to WHO, an estimated number of almost 23.6 million people will die from CVDs by 2030. In 2012, 1 million 232 thousand 182 people died from CVDs in Russia (Fig.1) [1].