Joint Event

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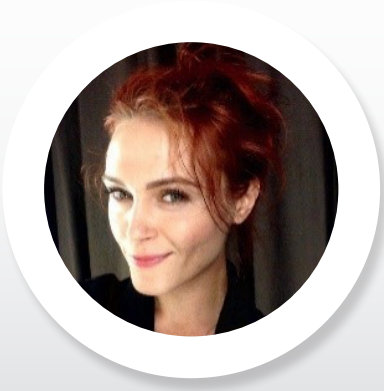
The development of ideas about the characteristics of the near-field interaction of electromagnetic radiation in a wide frequency band with the biological environment being diagnosed to create on this basis a new technology of non-invasive glucometer: part 1 - first results



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Introduction: In view of the fact that existing portable blood glucose meters have sufficient accuracy only with direct blood sampling taken from a patient's finger, now numerous studies are aimed at developing non-invasive technologies for analyzing blood glucose concentrations. Such an opportunity will allow the prevention and early diagnosis of the population to identify violations of carbohydrate metabolism, which will lead to a decrease in the number of diabetes diseases, as well as save the huge costs associated with consumables. However, despite the intensive development of the market for non-invasive blood glucose meters, their technology has not yet been fully developed. The complexity of the task is explained by the huge number of factors affecting the reading of a non-invasive glucometer, which must be optimized in order to obtain an effective device. These factors range from the influence of the skin to the percentage of glucose. In fact, the question boils down to extracting reliable information from noise, or to identifying an empirical relationship between the observed phenomenon and the level of blood glucose. To date, the accuracy of non-invasive blood glucose meters created is poor and, above all, due to the presence of a protective skin and muscle cover of a person. As a rule, it is the skin and the parameters of the internal environment that introduces significant errors in the measured data.

Purpose: This project proposes a study of the characteristics of the near-field interaction of electromagnetic radiation with the diagnosed biological environment in order to create a non-invasive glucometer technology on this basis. When conducting a detailed analysis of the existing technologies of non-intrusive blood glucose meters, it was found that the protective cover of a person (skin, muscles) makes a significant contribution to the rather high error of these devices. Overcoming this cover, as a rule, introduces significant errors in the measured data (signal-to-noise ratio). The original solution of this problem to the authors of the project is seen in the study of the so-called near-field effect. Each radiator (antenna) has near itself two spatially distributed zones - the near and the far. Based on our previous studies, the boundaries of the near and far zones are sufficiently localized. In the near zone, the weakening (exponential) of the electromagnetic field is not associated with the absorption of radiation, but in the far zone, absorption (exponential) does occur. The near field of the emitter penetrates deeply enough, since it does not experience significant absorption in a conducting medium. This allows you to maximize the signal-to-noise ratio. The fact is that in the near field the field is quasi-static. The field takes the form of a wave only outside the near zone. When the emitter is located directly on the surface of the probed medium, for example, on the skin, the electrophysical properties of the cover do not affect the phase structure of the field within the near zone. By aligning the wave zone with the location of the vein, it will be possible to increase the unambiguous interpretation of the result in order to determine the glucose concentration. The magnitude of the clamping force of the radiator, that is, contact with the body, does not play a fundamental role in this case. The amount of glucose (sugar) dissolved in a liquid is reliably determined by the rotation of the plane of polarization of the radiation. The key here is the possibility of combining the border of the near zone of the emitter with a vein without invasive intervention, which solves the problem of "delivering" the field through the skin and muscle integument without loss.

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Conclusion: At the first stage of these studies, a physico-mathematical model of the interaction of the electromagnetic field of the near zone with a model of the biological environment based on the human hand (the top layer of skin, tissues, muscles, blood vessels at different depths with a controlled variation of glucose concentration) was developed. The results of the calculation and analysis of the recorded responses, based on the model understanding of the dielectric properties of normal biological tissues and tissues that are subject to the negative effect of an excess of sugar content in the blood vessels, show high sensitivity to different concentrations glucose. Developed a near-field sensor antenna matched with biological tissue. The features of electromagnetic field interaction radiation in a wide frequency band with a diagnosed biological environment allow to create on this basis a new non-invasive glucometer technology for treating and preventing diabetes.

Biography

Zavialova Kseniia Vladimirovna is a Research Scientist at the Department of Radiophysics at Tomsk State University. She has obtained her Master's degree in Radiophysics and defended PhD in the field of Physical and Mathematical Sciences in 2015. Since 2016, she has been researching and developing methods of radio wave tomography of biological objects

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