Abstract

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Development of innovative experimental research techniques enabling microstimulation and brain activity recording as well as measurements of spatial therapeutic dose distribution in the case of photon radiotherapy

This work combines two research topics at the intersection of physics, biology, medicine and software engineering. The first of them concerns the implementation of the *Neurostim-3* device into the testing phase. It was designed to simultaneously record and stimulate brain activity with the resolution of individual neurons. This system provides 512 independent channels optimized to support brain-implanted multi-electrode arrays, enabling high-resolution (both spatial and temporal) *in vivo* experiments. In recent years, brain research has been intensified because learning about algorithms, schemes and dependencies between neurons could solve many problems (including those of paralyzed people). The thesis presents the general characteristics of *Neurostim-3* at the level of signal processing quality within electronics, as well as the results obtained on the basis of *in vivo* measurements on rats. In this case, the main goal was to observe the response of the animal's brain to the current pulses generated by the *Neurostim-3* system.

The second part of the work presents the *Dose-3D* system. Its goal is to enable precise absorbed radiation dose spatial distribution determination for the purposes of planning and verification of cancer radiotherapy. Due to the complexity of the interactions of radiation with matter, this process is difficult for accurate simulation, especially in such a complex environment as a human body. The thesis presents the device that is measuring spatial dose distribution using the multi-channel approach in a tissue-like phantom made of scintillation material. This project's success primarily depends on obtaining the linear response of the recording system with the absorbed radiation dose. Here the operation of the individual basic components of the system is shown. Brought together they guarantee the correctness of the generated data based on the recorded input signals.

The systems above also require software that enables the decent and correct conduction of measurement procedures. In this regard, there have been proposed solutions based on the *Python* programming language. In both cases concurrent processing techniques were employed to maximize processing efficiency. However, thanks to opportunities that have emerged relatively recently, it was decided to implement them using a few innovative approaches to improve CPU resource utilization.

17.05.2023

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