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CONCEPT AND REALIZATION OF BACKPACK-TYPE SYSTEM FOR MULTICHANNEL ELECTROPHYSIOLOGY IN FREELY BEHAVING RODENTS

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Анотація

Сьогодні науковий світ має багато різної техніки для мозкового відображення і дослідження, проте вимір електричної діяльності в різних масштабах - істотна частина, щоб розуміти принципи мозкового функціонування. При роботі нервова система кодує інформацію у формі різних електричних подій - від індивідуальних спайків (чи потенціалів дії), локальних потенціалів до складних осциляцій.

Ключові слова: модель прогнозування, індивідуальна реабілітаційна програма, відновлення, серцево-судинні хвороби нездатності.

Abstract

. Today's scientific world has many different techniques for brain imaging and investigation, however the measuring of electrical activity in different scales is essential part to understand the principles of brain functioning.

Nervous system works and codes information in the form of various electrical events: series of individual spikes, local potentials and up to complex brain oscillations.

Keywords: recording systems, unit activity, amplifier array, multichannel electrophysiology, neural signals.

Introduction

Nowadays this field of research undergoes rapid increasing in numbers of channels for recording systems and fast evolution in hardware and software. Systems that enable recordings in freely behaving animals are typically complex and do not have enough flexibility. Even rapid growing low-cost open –source systems do not fully correspond to the needs for experiments, which require animal to be completely freely behaving. Most of such systems work with animals with implanted electrode array and head stages connected with data acquisition modules by cables and tethers.We present here the concept of low-cost backpack system for multichannel recordings in freely behaving animals.

Material and methods

System was developed for unit activity and LFP recordings in anaesthetized and freely behaving animals. DAQ-module powered with mini-battery was designed to be mounted as back-pack in animal and should be connected with electrode array with flat flex cable

DAQ card for multichannel electrophysiology based on core Intan RHD2132 chip. This chip includes fully integrated low-noise amplifier array, adjustable analogue filters and 16-bits ADC. ADC operation is 1.05 MSamples per second and supports sampling 32 amplifier channels at 30 kSamples/s sampling rate for each channelю Also chip includes optional on-chip DSP high-pass filters for amplifier offset removal and auxiliary ADC inputs for interfacing additional sensors [6].

To test the accuracy of data acquisition we conducted several bench tests. The first stages of system validation were performed with generated signals. Signals were sent and detected with known signals on the different channels of the system. Tests werecarried out in different frequency range, sampling rates and connection of electrode array to DAQ card to check the functionality and accuracy of recordings.

On the next stage system was validated on the anaesthetized rats. 8-channel microware array was implanted in the hippocampal area of adult Wistar rat. Experiment was carried out in accordance with the National general principles for experiments on animals. Rat was anaesthetized with ketamine (100 mg/kg) –xylazine (10 mg/kg) as intraperitoneal injection and was given subcutaneous injection of lidocaine to minimize pain [23]. Craniotomy was made in the projection of right hippocampus (4.2 mm – P, 3.6 mm - L). Dura was pricked and microelectrode array was implanted. Array consisted of 8 tungsten wire with d = 12 µm/each electrode

Electrode array had integrated reference coil and ground wire, which were placed around drilled hole under the skull. Using custom made micromanipulator, electrode array was moved into the targeted brain area with the 5μm step, until stable neural signal was recorded. Verification of single unit activity was proved with wireless 8-channel system for extracellular electrophysiology [24, 25, 26] with simultaneous visualization of signal on oscilloscopes [29,30].

In the current version, our system does not include several necessary options, such as synchronization with external devices, visualization of data, spike detection and sorting modules. We plan to expand functionality in the next modifications.

Conclusions

Designed open source low-cost system for multichannel electrophysiology was built on widely used parts and can record simulated and neural signals with high accuracy. It can be used in different modes for particular experimental requirements. It has several limitations -lack of memory for stable recordings at high sampling rates, does not have option to be precisely synchronized with other devices, absence of real-time data visualization and spike detection and sorting functions. Further optimizations of the system are underway and can overcome most of these limitations to extend the modes of data acquisition and increase experimental flexibility.

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