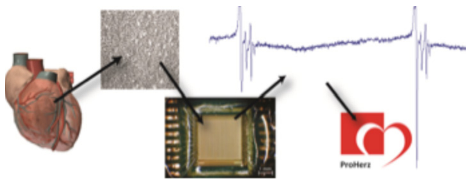
Bern University of Applied Sciences
Engineering and Information Technology



Institute for Human Centered Engineering HuCE

HuCE – BME Lab

Project Description

Fast Data Processing for Multi-Electrode-Arrays

Abstract

Multi Electrode Arrays (MEAs) provide a powerful interface to obtain an integrative understanding of the physiology and pathophysiology of excitable cells and are likely to find applications in drug screening studies. The computational needs to acquire and process the data over extended periods of time are huge and surpass the capabilities of commercially available conventional computer techniques. The development of dedicated hardware algorithms running in real-time on a FPGA to isolate biological signals, extract important parameters and discard the irrelevant parts of the data, solved this problem.

State of the Art

With current software solutions, the evaluation of an experiment recorded with a 64 channel MEA takes from hours up to days. Results of an experiment are not available before the evaluation process of the recorded data is completed. While performing an experiment with MEAs, researchers have no information on the actual state of their tissue under investigation (e.g. the activity of the cells). Thus, they are not able to react on special events or conditions. Each experiment is therefore very time consuming and for drug screening application not suitable.
The acquisition and analysis process has to be optimized to enable researchers to perform their experiments in a pleasant end more efficient way.

Novel Approach

Electrophysiological signals measured using a MEA have long periods (between two occurring action potentials) that are not of interest when studying cell activation and excitation propagation and therefore dispensable (see figure).
Dedicated and solid hardware algorithms to detect action potentials, isolate biological signals, extract parameters of interest and discard the rest of the data were developed in this project.

The algorithm runs for multiple channels (all the 64 electrodes) in parallel and was implemented using a semi-pipelined approach on a FPGA to meet the real time demand of the researchers. Such a dedicated system outperforms any software solution.

Results

The new acquisition process has big advantages compared to the existing situation.
Due to the fact that the signals are evaluated directly on a hardware level, the amount of data transmitted to the computer could be reduced to at least 90%.

Through on-line extraction of physiological parameters a real-time visualization has become possible. Therewith, researchers can implement different feedback loops which open the door to a wide range of novel, unprecedented experiments.

Conclusions

The newly developed system not only facilitates the MEA experiments, but also allows the acquisition and analysis of the signals is in real-time. Existing experiments can be performed faster and cheaper. Furthermore can the system now be used not only for basic physiological experiments, but also for drug screening.

Novel MEAs tend to have a higher amount of electrodes as well as a higher spatial resolution. The implementation of the high speed detection and extraction algorithms on a FPGA, allows an easy scalability to handle MEAs with several times more electrodes. Sole limit is the data transfer capacity towards the computer.

Project Partner

Prof. Dr. Stephan Rohr, Institute of Physiology, University of Bern

Project Team at HuCE

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Award

The project was awarded the 2010 Burgdorfer Innovation Award.

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