IDEC Chip Design Contest

A Multi-Channel Neural Recording System with Adaptive Electrode Selection for High-Density Neural Interface

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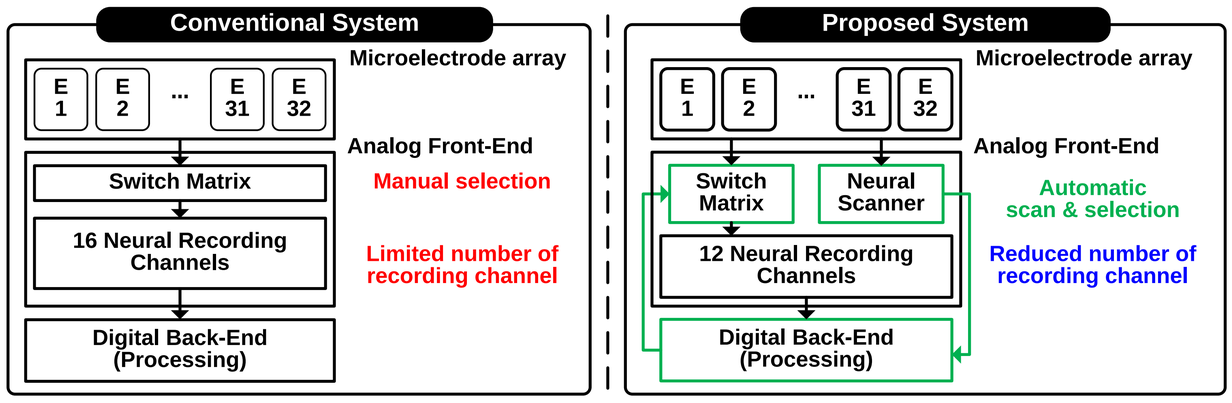
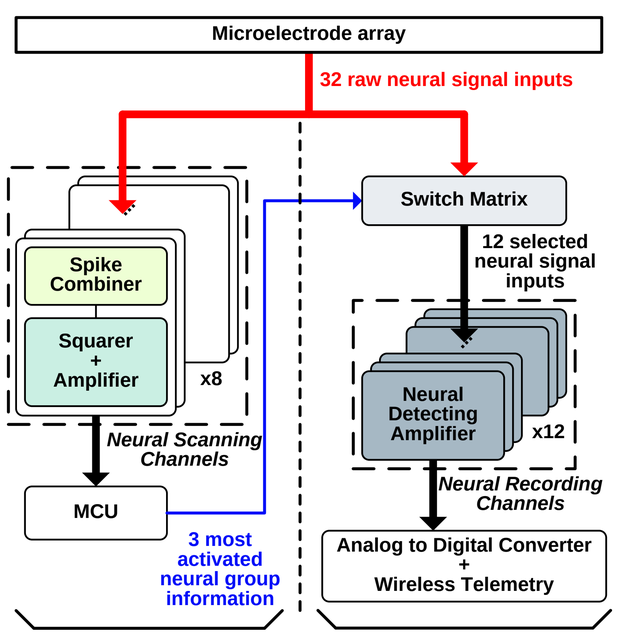
Ⅰ. Abstract

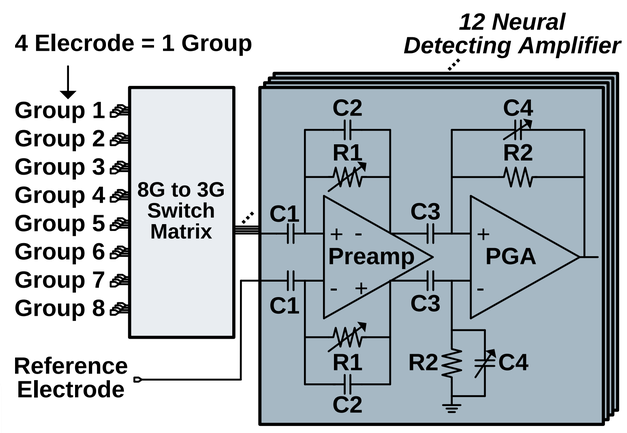


- For high resolution neural recording system, multiple neural recording channels are essential
- The number of neural recording channels implemented on IC is limited by power, bandwidth, and area

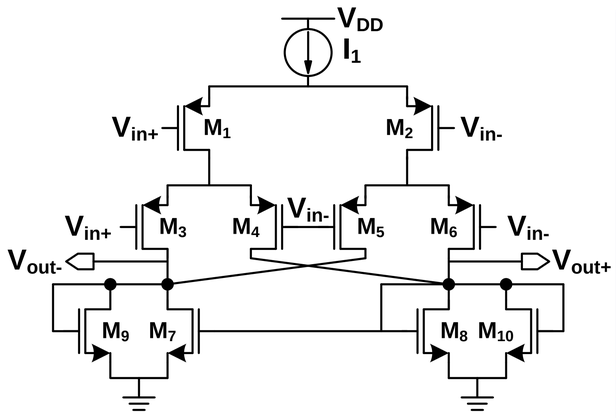
Ⅱ. Proposed System & Implementation



[Proposed System]



[Neural Recording Channels]



[Squaring circuit]

Neural Scanner

Switch Matrix
- Connect 12 electrodes from 32 electrodes into 12 detecting channels

Neural Detecting Amplifier
- Amplify selected neural signals with low noise

Multiplexor & Buffer
- Time multiplexing buffer is used for following ADC stage

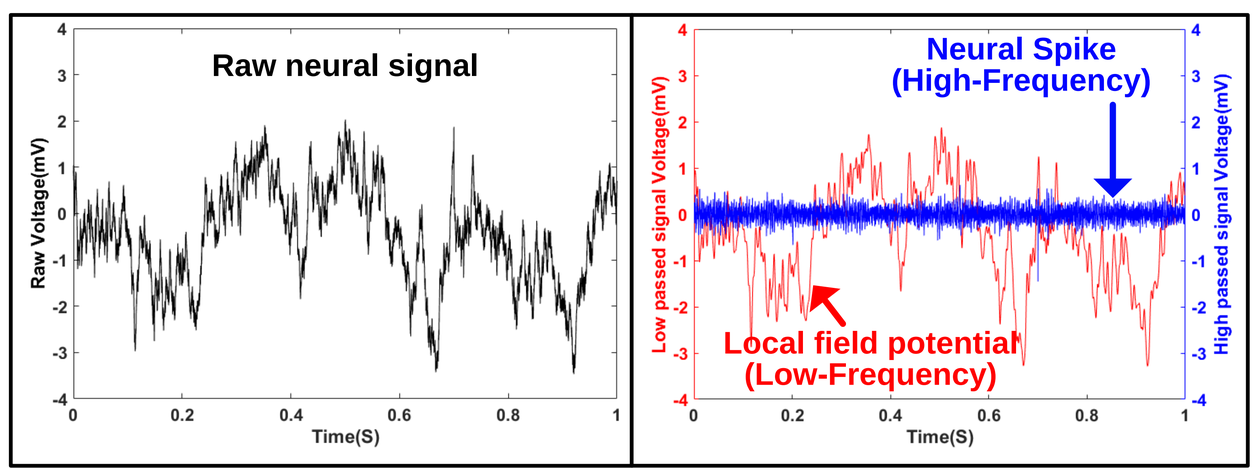
Neural Detector

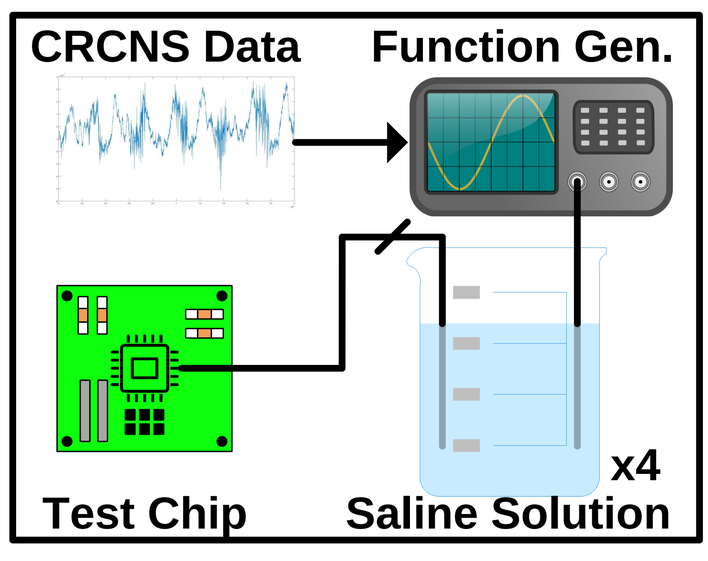
Spike Combiner
- Combine multiple neural electrodes into single group

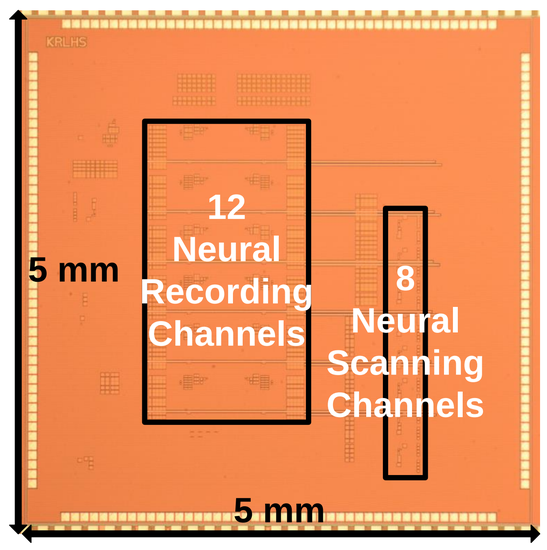
Neural Scanning Amplifiers
- Amplify combined neural spikes and square them

Neural Scanning Processor
- Choose 3 most activated neural group information

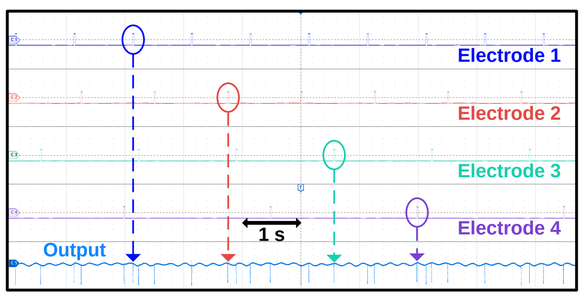
Ⅲ. Experiment

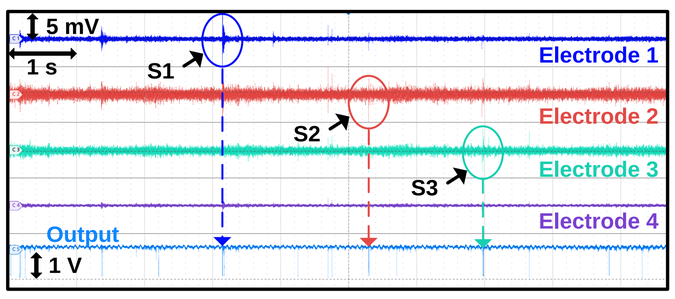


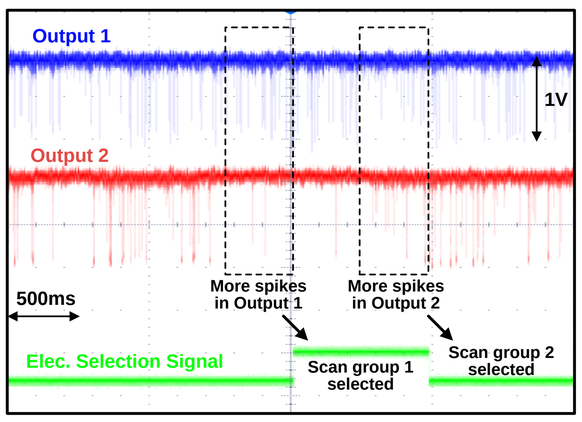




- In-vitro experiment using Collaborative Research in Computational Neuroscience(CRCNS) database was used
- Function generator with Matlab processed CRCNS data input simulates neural signal







Overall chip specification	
Process / Supply Voltage	180 nm / 1.8 V
Neural scanning channels	
Number of electrodes	32
Target neural signals	Neural Spike
Number of channels	8
High-pass cutoff freq.	317 Hz - 1.055 kHz
Power consumption / Ch.	1.85 μW
Die area / Ch.	0.0451 mm^2
Neural recording channels	
Electrode Selection	Automatic, 32 to 12
Target neural signals	Neural Spike, LFP
Number of channels	12
Voltage gain (3-bit control)	41.3 dB to 58.1 dB
Input-referred noise (1 Hz to 12.8 k Hz)	7.61 μV_{rms}
Low-pass cutoff freq. (4-bit)	5 Hz - 15 Hz
Power consumption / Ch.	14.4 μW - 25.2 μW
Die area / Ch.	0.18 mm^2

Ⅳ. Conclusion

- Adaptive electrodes selection system is presented and tested
- In vitro experiment was performed with pre-recorded neural signal(CNCRS PFC-2) database
- Real-time counting of neural scanner output can be performed with MCU

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