Improving Neural Spike Sorting Performance using Template Enhancement

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OVERVIEW

• This poster presents a novel method for improving the performance of template matching in neural spike sorting for similar shaped spikes, without increasing computational complexity.
• Mean templates for similar shaped spikes are enhanced to emphasise distinguishing features.
• Template optimisation is based on the separation and variance of sample distributions.
• Improved spike sorting performance is demonstrated on simulated neural recordings with two and three neuron spike shapes.
• The method is designed for implementation on a Next Generation Neural Interface (NGNI) device at Imperial College London [1].

MOTIVATION

• Neural recording is fundamental to many emerging neuroscience applications
• Implantable recording units will make long-term real-world recording possible
• For very large electrode arrays, the rate of data acquisition will exceed the capacity of wireless data transmission
• Possible solution: online on-chip spike sorting (or two phase spike sorting) [2]
• Online SAD template matching has performance limitations

DATA SIMULATION

• Realistic spike data from NeuroCube [3]
• Two or three single-unit neurons
• Increasing Gaussian noise levels and background spiking
• 3 minute datasets, 5 Hz firing frequency
• 9 two-spike datasets used, with varying levels of spike shape similarity
• Results are for most challenging datasets
• Filtering between 300 Hz and 3 kHz
• 15 kHz sampling rate, 16 samples per spike

PERFORMANCE TESTING

• Initial clustering using WaveClus [4]
• Spike sorting in Matlab
• Single threshold spike detection
• Baseline testing using basic SAD
• Enhanced templates calculated from cluster mean templates
• Enhanced results compared to baseline
to determine improvement
• Classification thresholds set to establish 95% specificity

Specificity = true spikes
Sensitivity = true spikes + false positives

REFERENCES


ILLUSTRATION OF DISTORTION

TEMPLATE OPTIMISATION ALGORITHM

1) Templates optimised sample-by-sample
2) Sample variance estimated by noise and template slope
3) Distribution separation = mean distance
4) Separation calculated over ±2 standard deviation range
5) Enhanced template position chosen as minimum distortion producing a separation at least 90% of the maximum (to ensure near maximal improvement with optimally efficient distortion magnitude)

CONCLUSION

• Template enhancement improves SAD template matching performance without affecting computational complexity
• Key concepts:
  • SAD with mean templates decreases spike cluster separation
  • Template enhancement optimises cluster separation
  • Significantly improved performance for datasets with two similar shaped spike templates
  • Also effective for datasets with more than two spike shapes
  • Template enhancement will be incorporated into the NGNI system