INTRODUCTION

- Parkinson's Disease: A movement disorder with some disabling symptoms such as tremors
- DBS Surgery: Deep Brain Stimulation Surgery
- Stereotactic DBS Surgery
  - Implant a microelectrode stimulator in a specific anatomic structure of a subject's brain
  - Stimulation results in the suppression of the disabling symptoms
  - Anatomic structures for implanting: Targets
    - STN: Subthalamus Nucleus
    - GPi: Globus Pallidus Internus

OBJECTIVES

- Detecting the presence of tremors in a microelectrode signal
  - Neurosurgeons can make more objective and reliable decisions regarding the presence of tremors
- Estimating the tremor frequency accurately

INTRODUCTION

[Comparison of a Normal and Parkinson's Disease Brains]
INTRODUCTION

- What is a MER signal?
  √ MER: Microelectrode Recording
  √ Injecting a microelectrode recorder through a predetermined trajectory prior to implanting a stimulator to locate the targets accurately
- STN and GPI have a high neuron density
- A neuron's activity: Action Potential
- Neurosurgeons can hear the audio sound of the neuron's activity, action potential, recorded through the microelectrode recorder

BINARY SPIKE TRAIN

- What is a ‘Spike’?
  √ A single neuron's action potential
  √ It has high energy and an unique morphology
- Firing Rate: The number of spikes per second
- Tremor: Fluctuation of a firing rate
- Goal: Detecting the presence of tremors in a MER signal and its frequency

MER Visual Data: Tremor cell and Non-Tremor cell in GPI

MER Audio Data: Tremor vs. Non-tremor

BINARY SPIKE TRAIN

- Detection of action potentials
  √ Threshold Method

BINARY SPIKE TRAIN

- Creation of a binary spike train
  √ Put 1's at the sample points where action potentials are detected
  √ All other sample points are suppressed to zero

Nonparametric Power Spectrum Estimation

- Typical tremor frequencies: 3 ~ 5 Hz
- Estimation of the PSD of a binary spike train at low frequencies (<30 Hz)
- Blackman-Tukey Method
  √ Autocorrelation window
    - Blackman window
    - Length: 0.6 seconds
The PACF of A Binary Spike Train

• The Interpretation of the PACF
  ✓ A measure of the dependence between $x_t$ and $x_{t-lag}$ after the effect of the intervening values has been removed

• Inference
  ✓ If a MER signal has tremors with a frequency of 5 Hz
  ✓ Then, the PACF coefficients of its binary spike train will be greater at every 0.2-second lag than they are at other lags

RESULTS

• The estimated PSD's of tremor cell binary spike trains

• The estimated PSD's of non-tremor cell binary spike trains

DISCUSSION

• The optimal length of microelectrode recording for detection of the presence of tremors in a MER signal

CONCLUSION

• The estimated PSD of a tremor cell binary spike train is a good indicator of the presence of tremors in a MER signal

• The PACF of a tremor cell binary spike train is different from that of a non-tremor cell binary spike train: It is hard to quantify the difference

• 1 second is a long enough recording time to detect the presence of tremors in a MER signal.

• detected
  ✓ All other sample points are suppressed to zero