Potential for Optimising Deep Brain Stimulation Through Tremor Quantification

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Introduction

- Deep Brain Stimulation (DBS) can be used to minimise tremor when pharmaceutical therapies fail
- DBS devices emit a bi-phasic pulse train with variable:
  - » Amplitude » Pulse Duration » Frequency
- These parameters are set based on clinical observation of tremor and side-effects

Aims

- Develop an objective measure of tremor severity
- Determine the influence of each stimulus parameter on measured tremor

Method

- 6 adults with DBS implants in the Posterior Subthalamic Area to alleviate tremor were recruited
- Tremor was recorded using a sensitive motion tracking system with sensors placed on the elbows and wrists
- Stimulus amplitude, pulse-duration & frequency were systematically adjusted
- Patients were asked to hold their arms out and complete finger-nose exercises during measurements
- Following objective measures of tremor were calculated:
  - » RMS Amplitude » Velocity » Power Spectral Density
  - » Frequency » C90 Volume
- C90 Volume is the volume of an ellipsoid that covers 90% of the data when plotted on a x, y, z plane
- Pearson's Correlations were calculated between:
  - » Each objective measure
  - » Angular & translational measures
  - » Clinical ratings & objective measures

Results

- As expected all measures except frequency were significantly ($p < 0.05$) inter-correlated
- Correlations between angular and translational data were marginal
- Clinical ratings were correlated ($p < 0.05$) to angular RMS in all patients
- Best correlations with clinical ratings were seen with C90 volume in 3 patients ($p < 0.01$)

Conclusion

- The proposed objective measures can be used to quantify tremor severity
- Further investigation is required to determine the best objective measure
- Real-time implementation might lead to automated stimulus optimisation

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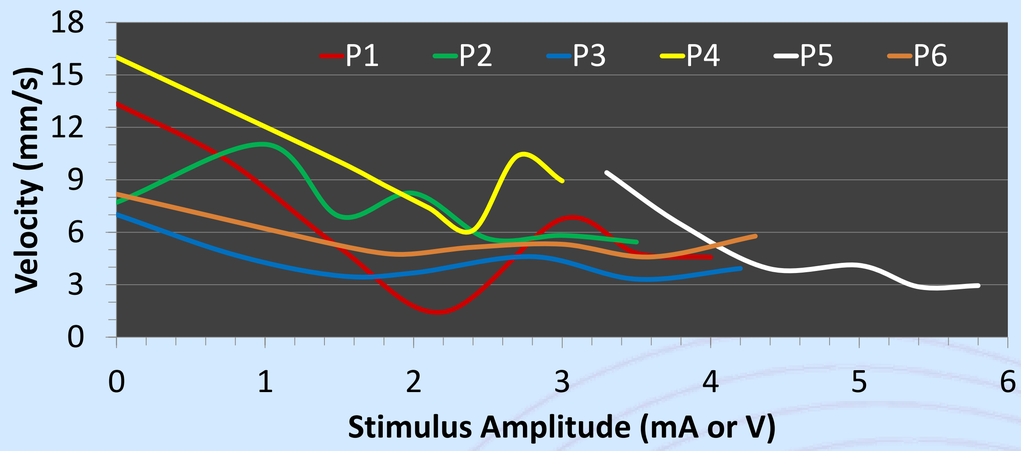
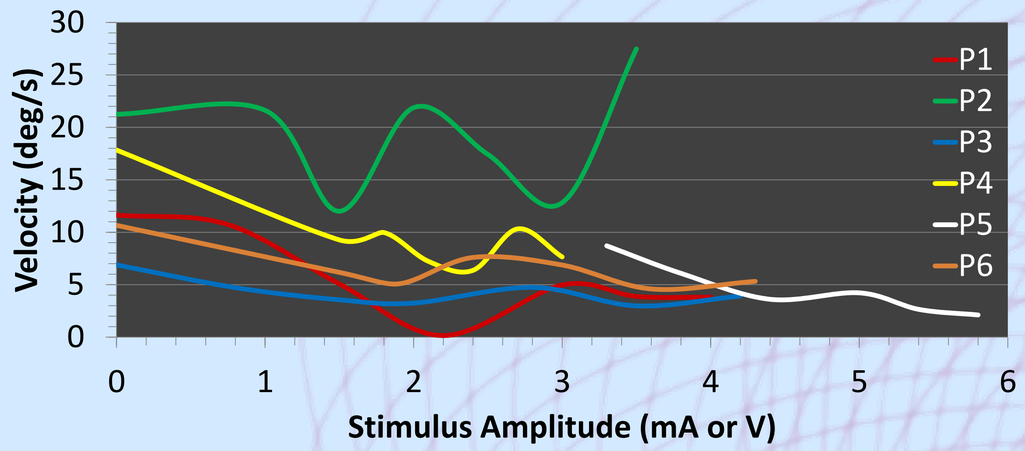
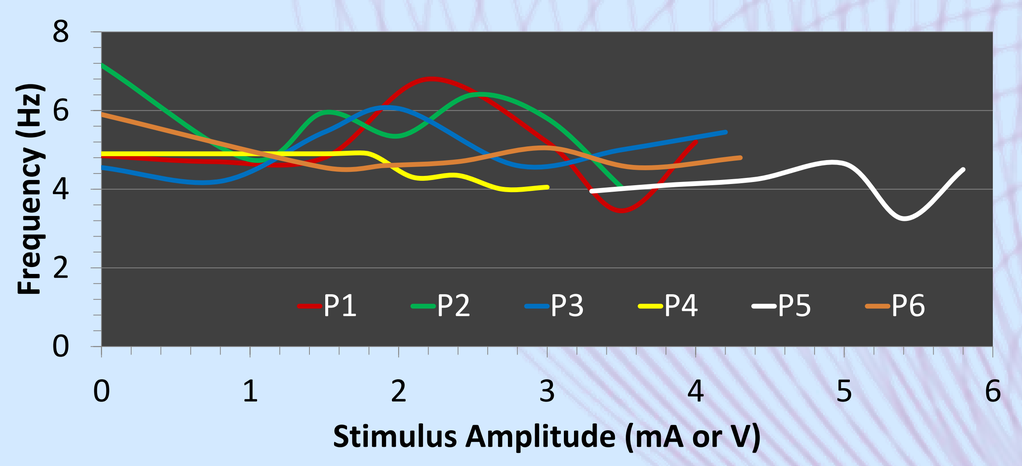
Tremor Velocity



Tremor Angular Velocity



Tremor Frequency



- Figures show tremor measures for six participants (P1 to P6) during the finger-nose exercise with variable unilateral stimulus amplitudes
- Low stimulus levels in P5 resulted in severe emotional responses

Correlation Matrix

		Rotational				
		PSD	Velocity	RMS	Frequency	
Rotational	Volume	6	6	6	0	
	PSD		4	5	0	
	Velocity			6	1	
	RMS				1	

		Translational			
		Frequency	RMS	Velocity	PSD
Translational	RMS	2			
	Velocity	1	6		
	PSD	2	6	6	
	Volume	0	6	6	6

- Matrices show number of patients (out of 6) that showed significant ($p < 0.05$) correlations between measures

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