

A Novel Quantitative / Functional Evaluation System For movement Disorders

1. Outline

The classical neurological examination is not suitable to develop a new treatment because it is poorly quantitative and recordable.

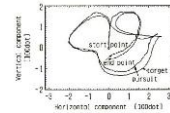
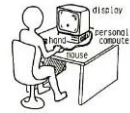
We propose a functional evaluation system for movement disorders. Our system may provide an optimal treatment program for each patient with neurological disorders.

2. Conventional examination

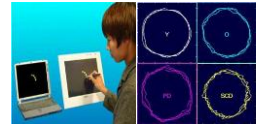


Conventional neurological examination is highly subjective. Poorly quantitative & recordable

Trials for quantitative evaluation



Nakamura 1999



Murayama 1999

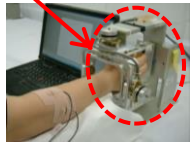
but parameters extracted are not easy to interpret or understandable.

Necessity of more functionally understandable evaluation.

3. Solution

<< Basic system >>

Manipulandum



Kinect

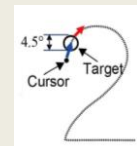


Leap Motion



Input device

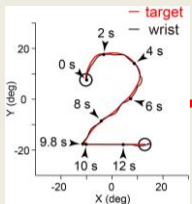
Analysis software



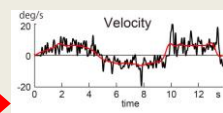
Assignment example
A visually guided pursuit movement

- Subjects control cursor position With the manipulandum.
- The target circle moves smoothly at a constant speed.
- Practice trials before recording.
- Non-invasive & easy to perform.

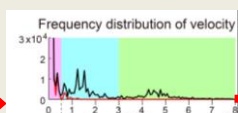
<< Basic analysis >>



measurement example

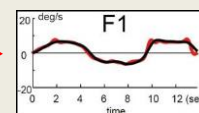


Movement kinematics

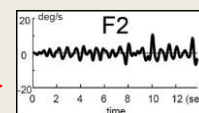


Three frequency components

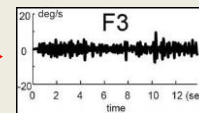
Dissociation



Low Freq :
Predictive movement



Intermediate Freq :
Feedback movement



High Freq :
Involuntary noise (Microsteps)

Analysis of movement kinematics

<< Functional visualization >>

1. Quantitative evaluation of Tremor-like movement

Power of Microsteps: the amount of motor noise

2. Brain State Map (BSM)

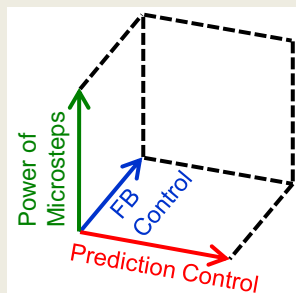
Visualization of Neurological Disorders(Stroke, PD, SCD) with the 3 parameters:

Predictive control (F1), Feedback control (F2), Power of Microsteps(F3)

⇒ in 2D: Predictive control, Feedback control

⇒ in 3D: Pred. control, FB control, Power of Microsteps

Different neurological disorders show different combinations of these parameters.



<Brain State Map>



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4. Visualization of treatments

Patho-physiological tracking of Cerebellar infarct.

Follow-up evaluation

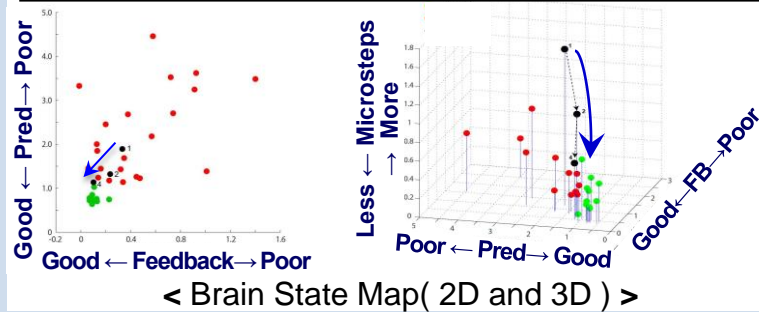


1 month after onset



4 months after onset

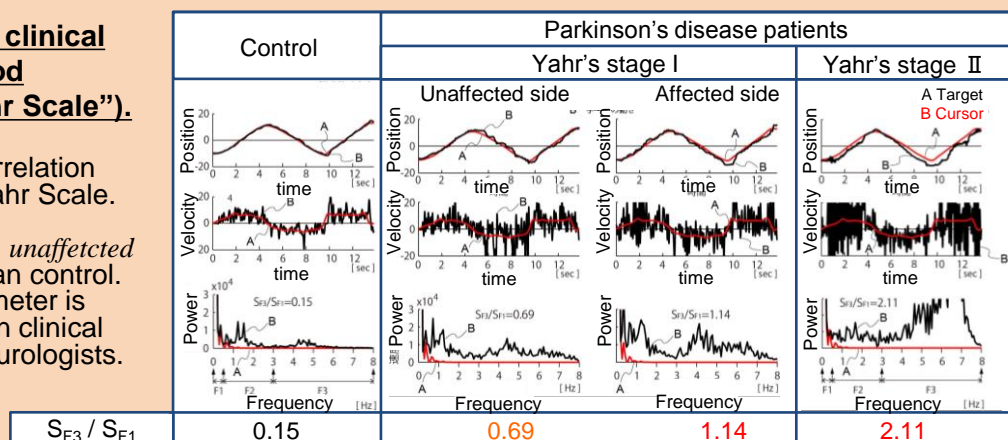
● Cerebellar atrophy ● Control ● Cerebellar infraction



Quantitative evaluation of PD

1. Comparison with clinical evaluation method ("Hoehn and Yahr Scale").

- Microsteps has correlation with Hoehn and Yahr Scale.
- Microsteps even in *unaffected* side, get higher than control. Namely, this parameter is more sensitive than clinical examination by neurologists.



2. Evaluation of L-DOPA treatment

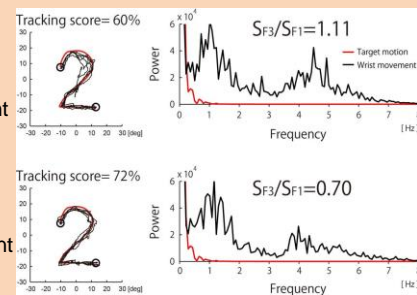
No treatment at the first visit. Yahr's stage I, UPDRS* (Part 3) 25

- Microsteps showed a correlation with UPDRS score. Similar results was obtained from other patients tested.

	Pre	Post
Tracking score	60%	72%
UPDRS (Part3/hand)	25	14
Power of Microsteps	1.11	0.70

Pre-treatment

Post-treatment



*: Unified Parkinson's Disease Rating Scale

- Age distribution of control subjects: from 20s to 70s (approximately 100 cases)
- Cerebellar ataxia: 49 cases, Parkinson's disease:136 cases, Stroke: 64 cases

5. Service concept (Providing an optimal treatment program)

1. Brain State Map provides an easy-to-understand summary of neurological disorders.
2. BSM database, which is under construction, covers various types of neurological diseases and results for their treatments.
3. BSM DB offers an optimal treatment program for each patient.

Brain pathology map

