

# A MOTION CONTROL FUNCTION EVALUATION SYSTEM EMPLOYING A PEN TABLET

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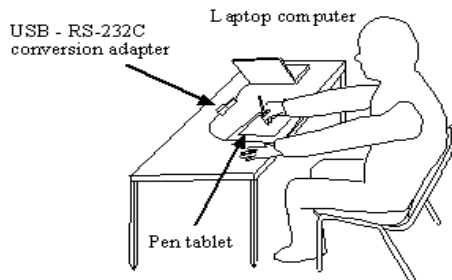
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## INTRODUCTION

The arm and hand movement functions are evaluated by many various tests, such as the electromyogram, Jebsen hand function test, finger function quotient, arm function test, manual function test and the motor age test. The electromyograms are recorded from biceps brachii muscle and triceps brachii muscle during ballistic movement simultaneously. The phase relation between the electromyograms enables the estimation of the arm movement function. The other tests evaluate function by movements of grasping small objects, turning over cards, moving the hand to the back and touching the hand to the head. These tests are very important in the evaluations of disease states, and early detection can reduce the symptoms and/or delay the further progression of the disease.

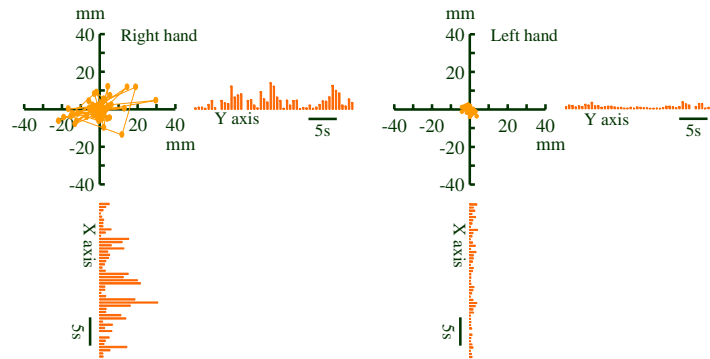
## SYSTEM DESCRIPTION



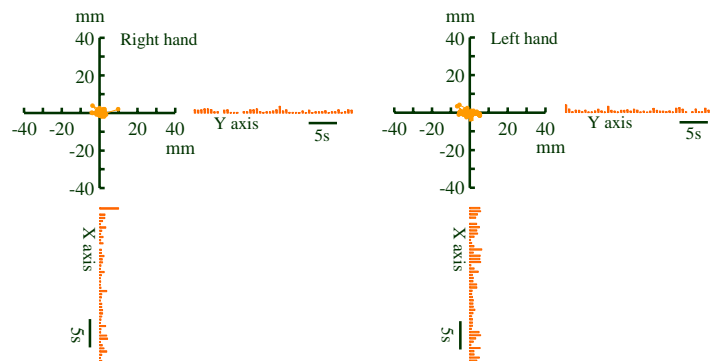
**Figure 1** Block diagram of the motion control function evaluation system. The system consists of a pen tablet (intuos2 i-620SGIB, WACOM) and a laptop computer (CF-R3, Panasonic). The pen tablet and laptop computer are connected by a USB - RS-232C conversion adapter (USB-RSAQ2, I-O DATA). The tablet size is 343 mm (W) × 258 mm (D) × 14mm (H), and the active drawing area is 203.2 (W) mm × 152.4(D) mm. The resolution is 0.01mm, and the accuracy is ± 0.25 mm. A maximum data rate is 200 points per second.

When the subject taps the pen on the tablet, the tablet transfers the pen tap position to the laptop computer.

## RESULTS

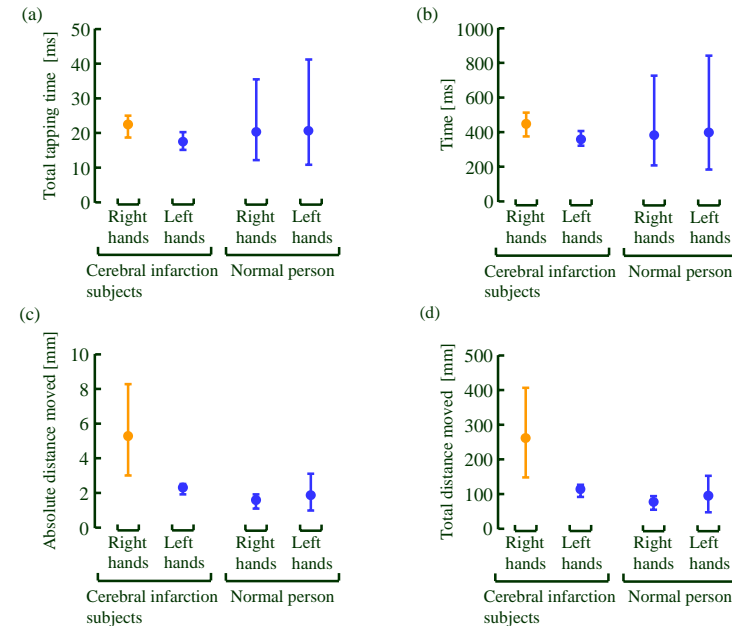


(a) Cerebral infarction subjects



(b) Normal person

**Figure 2** The typical locus of pen tap positions and X and Y axes distance moved between each two successive tap positions. Maximum X and Y axis distance moved by the cerebral infarction subjects were 30 mm and 11 mm in the right hand, and 5 mm and 3 mm in the left hand. However, maximum X and Y axis distance moved by the normal subject were 10 mm and 3 mm in the right hand, and 7 mm and 3 mm in the left hand. The X and Y axis distance moved by the cerebral infarction subject's right hand changed more than their left hand and more than both hands of the normal subjects. The X and Y axis distances moved by the normal subject were almost identical.



**Figure 3** The total tapping time during 50 taps (*plot a*), the tapping period between each two successive tapped positions (*plot b*), the absolute distance moved between each two successive tap positions (*plot c*), the total distance moved during 50 taps (*plot d*). (a) and (b) show there were not significant differences between the cerebral infarction subjects and the normal subjects. (c) shows the cerebral infarction subject's right hands was 220% greater than with their left hands. In normal subjects, both hands were almost identical and also in approximately 30% of the cerebral infarction subject's right hands. (d) shows the cerebral infarction subject's right hands was 230% greater than their left hands, and 370% greater than the normal subjects.

## CONCLUSION

The tablet based system was developed for evaluation of hand motion control function as it might be influenced by brain disease. The system can quantitatively evaluate hand motion control function in certain patients by measurement of total moved distance and absolute distance moved.