Movement Fluidity of the Impaired Arm during Stroke Rehabilitation

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***Abstract*—We present an initial study on the measure of movement fluidity of the upper arm for 4 stroke patients for a duration of 3 weeks as they performed an archetypal activity of daily living – '*making-a-cup-of-tea*' in an uncontrolled environment. Results of two complimenting measures – jerk metric and peak number computed from accelerometer data on the wrist are in agreement with the clinical scores from the Box and Block test and the Nine Hole Peg test.**

I. Introduction

The rate of recovery of an impaired arm post-stroke is usually rapid in the first few weeks. The Box and Block test [1] and the Nine Hole Peg test [2] are reliable measures of gross manual dexterity and arm functionality, performed by clinicians to assess rehabilitation in clinical settings. However, there is an ever increasing demand for assessing the functional ability of patients at home settings which has been further aided by the advent of low-cost, wireless body sensors capable of recording kinematic movement for long durations.

II. Experiment & Results

We had informed consent from 4 stroke patients (age range 45 to 73, both sexes and both left and right arm dominant) who performed four trials of an archetypal activity of '*making-a-cup-of-tea*', including multiple occurrences of extension, flexion and rotation of the forearm over 3 weeks. Kinematic data was collected using Shimmer wireless sensors consisting of tri-axial accelerometers placed on the wrist and analyzed to determine the *jerk metric* [3] and the *peak number* on each orthogonal sensor axes and their moduli. The *jerk metric* is the negative mean rate of change of acceleration normalized by the maximum velocity and will ideally increase with time as the patient improves. By comparison, the *peak number*, obtained from gradient analysis of the acceleration data, represents tremor during arm movement and will ideally decrease as the patient improves. The patients also undergo three trials of the Box and Block and Nine Hole Peg test at the beginning of each experiment session, performed over the same 3 week period. An increase in the number of blocks transported per minute and the number of pegs placed per second indicates an improvement in arm functionality. The results presented in Table I and illustrated in Fig. 1 and 2 demonstrate that the features extracted from the kinematic data support the clinical findings.

TABLE I. Test results assessing arm dexterity over 3 weeks

Subject	Box & Block (blocks/min)		Nine Hole Peg (pegs/sec)	
	Week1	*Week3*	*Week1*	*Week3*
Subject1	29	49	0.25	0.31
Subject2	17	19	0.065	0.067
Subject3	12	34	0.10	0.12
Subject4	47	59	0.35	0.41

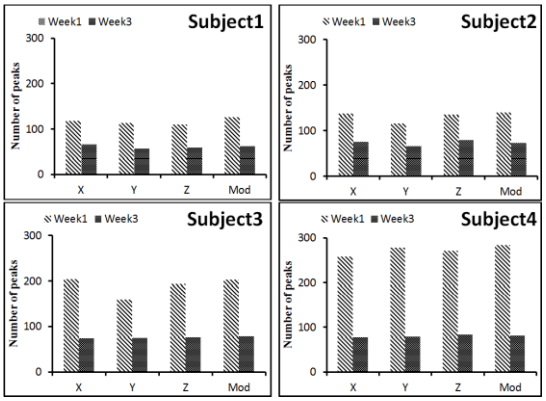

Figure 1. *The decrease in number of peaks for 4 subjects from week 1 to week 3 on x, y, z, modulus (horz. axis) of the accelerometer data.*

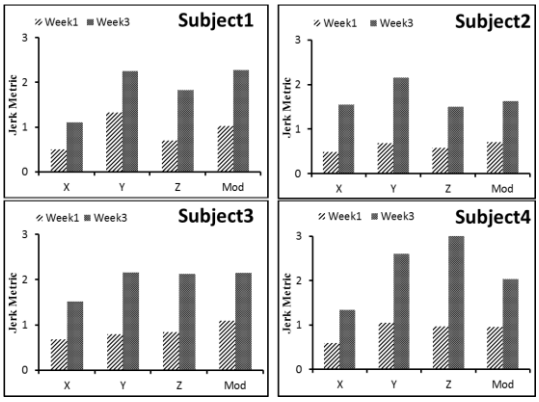

Figure 2. *The increase in jerk metric for 4 subjects from week 1 to week 3 on x, y, z, modulus streams (horz. axis) of the accelerometer data.*

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