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A NEW PORTABLE 3-D GYROSCOPE SYSTEM FOR THE EVALUATION OF UPPER LIMB FUNCTION

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INTRODUCTION

The shoulder joint is extremely important for the positioning of the hand in order to interact with the environment and interest in the restoration of good function to the upper limb is becoming increasingly important. Current clinical methods for functional assessment are limited to subjective pain questionnaires and physical examination which relies largely on the experience of the clinician. While motion analysis techniques have become widely used in research environments, they are not suitable for use in a clinical environment due to their requirement for long and complex testing procedures. The use of kinematic sensors have shown great promise in gait analysis [1, 2] but these systems have tended to be heavy and bulky.

This study aims to develop a lightweight, portable and cost effective system for 3D motion analysis of the upper limb which can be readily applied within a clinical environment.

METHODS

The 3D gyroscope system consists of three identical units (figure 1a) and uses a total of 9 single axis gyroscopes (Murata ENC 03JA). Each gyroscope unit holds three single axis gyroscopes securely at right angles to one another within a rigid plastic housing to allow the recording of angular velocity in three dimensions. The plastic housing (figure 1b) consists of an inner core to which the gyroscopes are mounted, a circular base, and a conical shaped lid.

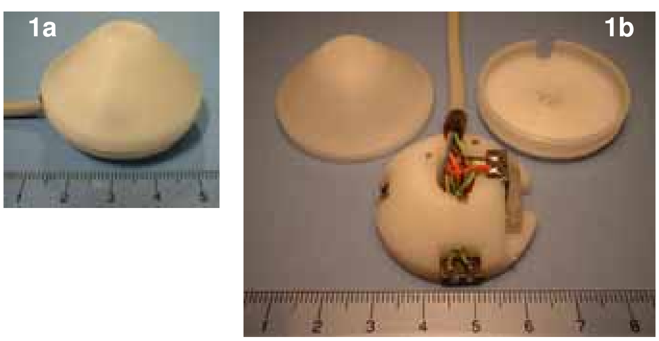

Figure 1: **(a)** one 3D gyroscope unit, **(b)** components of the plastic housing.

Each 3D gyroscope unit is small (40mm diameter by 25mm high) and lightweight (20g approximately) and is mounted onto the body independently of other system components, thereby minimising size and weight so as not to affect the production of movement when attached to the upper limb of the subject.

Figure 2a and 2b shows the 3D gyroscope system mounted onto the chest, upper arm and forearm. Data from the 3D gyroscope system were sampled simultaneously with an 8 camera Vicon 612 motion analysis system while the subject performed a variety of movements including maximal flexion and extension, and movements to simulate activities of daily living such as brushing hair and dressing.

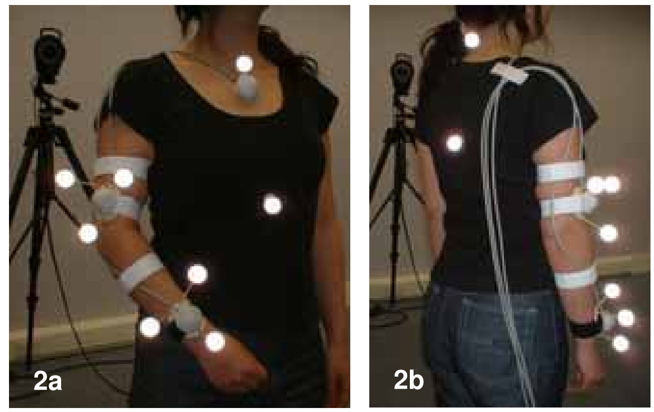

Figure 2a and 2b: Front and rear view of 3D gyroscope system and retroreflective markers mounted onto healthy subject.

RESULTS AND DISCUSSION

Angular velocity data were filtered and integrated to obtain angle data. Figure 3 shows angle data for the upper arm 3D gyroscope unit during a 'reach up back' activity.

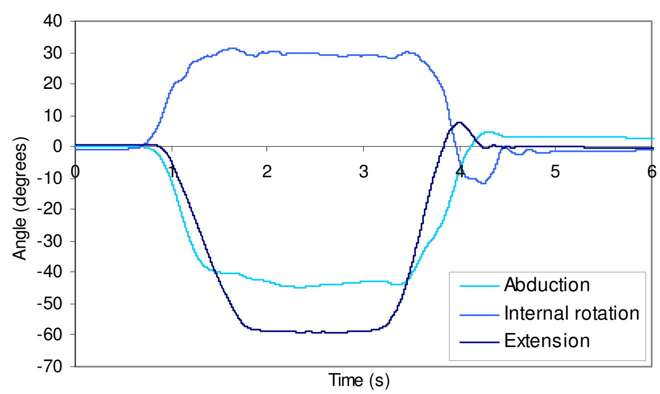

Figure 3: Upper arm 3D gyroscope output for 'reach up back' activity.

The results of this research indicate that the 3D gyroscope system shows potential for use within a clinical setting as a portable motion analysis system for the upper limb.

REFERENCES

1. Mayagoitia, RE, et al. *J Biomech* **35,** 537-542, 2002.
2. Tong, K, and Granat, MH. *Medical Engineering and Physics.* **21,** 87-94, 1999.

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