Comparison of low-cost hand-monitoring devices for motor rehabilitation

J. GODLOVE, A. TSU, K. GANGULY

Neurology & Rehabilitation, SFVAMC, Neurology, UCSF, San Francisco, CA

Summary

Impaired individuation of the fingers is now being recognized as an important impediment to recovery of upper limb function. Computer-based rehabilitation tools can be used to improve hand/finger function while keeping the user engaged and more likely to perform the exercises on a daily basis.

We assessed 3 hand kinematic devices and their potential use in a clinical setting for hand rehabilitation:

- Leap Motion IR Camera
- S-OT 34 Sensor Data Glove
- Vhand DGTech 5 Sensor Data Glove

The Leap Motion device was the most accurate and easiest to use for fully functioning subjects but failed to capture hand kinematics of stroke patients due to obstructed view of their partially closed hands.

The S-OT data glove produced the most reliable performance during computer driven rehabilitation tasks but fails to give accurate real-world joint angles of the subject.

The Vhand DGtech data glove could only detect large finger movements, lacking the sensitivity to be used in fine motor rehabilitation tasks.

Device Calibration

While being video-taped wearing each device, non-impaired subjects moved their fingers to a variety of finger angles between 0° and 90° under the direction of a MATLAB-based behavioral program that sampled the entire finger movement space.

Video recordings from the side of the hand were used to calculate the actual angle of the MCP joint. The true joint angles were then compared the raw values of the devices to estimate a transition function.

Rehabilitation Task

To practice controlled finger movements, subjects played a target acquisition game for 1 hour.

After a brief calibration phase of opening and closing the hand to the best of the subject’s ability, gold targets slowly moved across the screen within the subject’s movement range.

The subject moved the game cursor in the shape of a flapping bird by moving their index finger up and down without moving their middle finger. As targets were acquired or missed, the difficulty of the game adapted by adjusting a series of game parameters to keep the success rate at 80%.

Conclusion

A virtual reality based exercise system for hand rehabilitation post stroke: transfer to the real world. Restorative and functional improvements and independence in hand tasks were observed as a result of the virtual reality based exercise system.

References


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