1-1-2013

Markerless Analysis of Upper Extremity Kinematics during Standardized Pediatric Functional Assessment with a Low-Cost Motion Analysis System

Gerald F. Harris
Marquette University, gerald.harris@marquette.edu

Susan A. Riedel
Marquette University, susan.riedel@marquette.edu

Published version. *Proceedings of the Marquette International Research Poster Session and Forward Thinking Poster Session and Colloquy, December 3rd, 2013*, (2013). Permalink.

ABSTRACT

PROJECT TITLE: "Markerless Analysis of Upper Extremity Kinematics during Standardized Pediatric Functional Assessment with a Low-Cost Motion Analysis System"

FACULTY NAMES: Gerald F. Harris, PhD, PE & Susan A. Riedel, SM, PE

STUDENT NAME: Jacob R. Rammer, BS

INTRODUCTION

Hemiplegic cerebral palsy (HCP) is a disorder that presents in children as a motor impairment in the affected upper extremity (UE), resulting in reduced potential to perform activities of daily living. Therapists typically evaluate UE motion to gauge response to intervention using clinical evaluations or clinical motion analysis technologies, each having significant limitations. Many clinical evaluation protocols rely on subjective scoring by trained therapists [1], with a documented lack of sensitivity to detect change following interventions in the scoring of results [2]. Clinical motion analysis systems can precisely and reliably quantify UE motion in terms of angular kinematics, thus eliminating observer bias or subjectivity while increasing sensitivity in results, but require expensive equipment in a permanent laboratory setting and markers that are placed on the patient to detect motion [3]. The first generation Microsoft Kinect-based UE motion analysis system previously developed by the authors uses the low-cost video game accessory to determine the location of body segments [4], using algorithms developed to allow markerless skeletal tracking during standardized activity performance. The system has been pilot tested with normal adolescent subjects with favorable results and evaluated extensively to provide directions for future work.

SIGNIFICANCE

The Kinect system has many advantages over traditional motion analysis, including significantly lower cost, higher portability, and markerless operation, while maintaining reasonable accuracy. In order to enhance clinical evaluation in terms of therapist usability, patient enjoyment and motivation, and quality of results, the Kinect can be used to track and record body motion, thus including objective data in an otherwise subjectively scored evaluation. In this project, a comprehensive rehabilitation and clinical evaluation platform will be developed that includes a second-generation Kinect platform with enhanced kinematic tracking of UE motion and clinically actionable performance indicators. Focus will then shift to developing adaptive therapeutic games targeted to specific UE kinematic impairments in children with HCP based on input from clinicians, with an interface for activity selection, modification, and monitoring by therapists. Game selection and play by patients that permits home-based rehabilitation is also provided. In the future, the system will be expanded to address other populations of need, including adults with HCP, spinal cord injury, stroke, and other conditions. With the proposed system, therapists will have expanded flexibility to develop rehabilitation programs tailored to individual patients, with continuous feedback in performance metrics based on UE kinematics.

FORWARD THINKING/INNOVATION

The future development of this project is unique because the resulting system will improve kinematic reporting of a patient's condition when compared to typical clinical UE evaluations, and integrate therapeutic gaming, all in a system that is extremely low-cost, highly portable, and easy to operate. Patient enjoyment will significantly increase using this system through integrated gaming and elimination of both the repetitive nature of clinical rehabilitation and the difficulties of marker-applied clinical motion analysis. There is a need for a system that provides high-quality therapy and progress reporting at a low cost in the home environment.

STUDENT INVOLVEMENT

Jacob Rammer will lead technical development of the integrated Kinect therapy and evaluation system and organize the design of research studies to test the system with patients who have cerebral palsy. Support will continue from advisors Dr. Gerald Harris and Prof. Susan Riedel along with clinical collaborators.

REFERENCES

1) Gilmore, R., Sakzewski, L., and Boyd, R. (2010). Upper limb activity measures for 5- to 16-year-old children with congenital hemiplegia: a systematic review. *Developmental Medicine & Child Neurology*, 52, 14-21.
2) Davids, J., Peace, L., Wagner, L., Gidewall, M., Blackhurst, D., and Roberson, M. (2006). Validation of the Shriners Hospital for Children Upper Extremity Evaluation (SHUEE) for Children with Hemiplegic Cerebral Palsy. & Supplemental Manual and Scoring Sheets. *Journal of Bone and Joint Surgery*, 88-A(2), 326-333.
3) Klotz, M.C.M., Kost, L., Braatz, F., Ewerbeck, V., Heitzmann, D., Gantz, S., Dreher, T., and Wolf, S.I. (2013). Motion capture of the upper extremity during activities of daily living in patients with spastic hemiplegic cerebral palsy. *Gait & Posture*, 38, 148-152.
4) Microsoft Corporation (2013). Kinect for Windows Resources and Documentation. Retrieved from http://www.microsoft.com/en-us/kinectforwindows/develop/resources.aspx