Chapman University Digital Commons

Student Scholar Symposium Abstracts and Posters

Center for Undergraduate Excellence

Spring 5-14-2015

Reliability of Precision in Motion Software

Nicole Laura
Chapman University, jndowden@gmail.com

Kristen Petrillo
Chapman University, petri109@mail.chapman.edu

Marybeth Grant-Beuttler
Chapman University, beuttler@chapman.edu

Richard Beuttler
Chapman University, richardbeuttler@gmail.com

Follow this and additional works at: https://digitalcommons.chapman.edu/cusrd_abstracts

Part of the Physical Therapy Commons

Recommended Citation

Laura, Nicole; Petrillo, Kristen; Grant-Beuttler, Marybeth; and Beuttler, Richard, "Reliability of Precision in Motion Software" (2015). *Student Scholar Symposium Abstracts and Posters*. 112.
https://digitalcommons.chapman.edu/cusrd_abstracts/112

This Poster is brought to you for free and open access by the Center for Undergraduate Excellence at Chapman University Digital Commons. It has been accepted for inclusion in Student Scholar Symposium Abstracts and Posters by an authorized administrator of Chapman University Digital Commons. For more information, please contact laughtin@chapman.edu.

Reliability of Gait Utilizing Precision in Motion Software

N.T. Laura, SPT, K.M. Petrillo, SPT, M. Grant-Beuttler, PT, PhD, PCS
R.C. Beuttler, PsyD
Crean College of Health and Behavioral Sciences,
Chapman University, Harry & Diane Rinker Health Science Campus, Irvine, CA

Introduction

Physical therapists evaluate and treat patients who have all types of movement issues and diagnoses. It would be beneficial to be able to objectively capture movement in order to accurately document patient progression and justify treatment for a variety of consumers.

Current challenges in movement analysis:

- •Functional movement occurs at a high speed.
- •Data are unreliable without 3-D equipment.
- •Motion analysis systems are cost prohibitive for clinics
- •PTs do not typically have access to a motion analysis system. They may be time consuming and difficult to learn.

Purpose:

- •Compare data from inexpensive 3-D motion capture system using the Kinect, to the Codamotion, a traditional active marker, motion analysis system
- •Determine reliability of the Kinect data vs. Coda to evaluate aspects of gait (stride length, and stride time) and joint range of motion important to physical therapy.
- •Examine the feasibility of using the Kinect system in clinical and research situations.

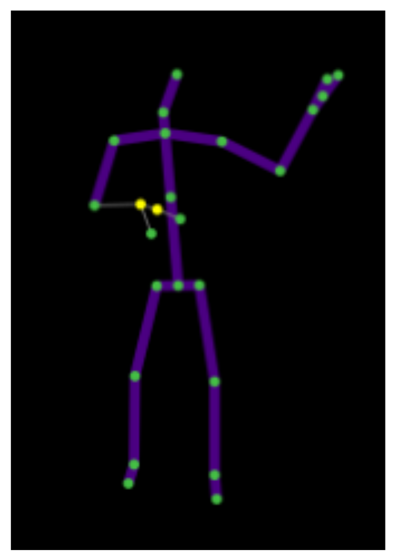

Figure 1. Kinect Skeletal Model.

Figure 2. Coda Skeletal Model.

Hypothesis

We anticipate that the Kinect will be able to produce reliable clinical data for maximum joint angles and gait characteristics including stride length and time with high value ICCs and low value mean differences compared to the Coda. This is a preliminary study, with the understanding that the Kinect markers and software may need to be adjusted mathematically.

Subjects

Sample of convenience as follows:

- Subjects: n=17, 9 females, 8 males

*1 subject data was not collected due to technical issues with Coda sensors

Mean Age:	Mean Height:	Mean Weight:
26 years +/-1.8	67 inches +/- 4.3	171.5 lbs +/- 42.2

Equipment

Kinect 2 sensor and PC using SDK-skeletal model
Codamotion 3D motion capture system

Procedure

Coda markers were placed on subject's left side using hypo-allergenic double stick tape and pre-wrap. (Figure 3).

Subjects were instructed to walk down marked runway, arms crossed on chest, until 12 good trials recorded.

Coda was located on subjects' left. Kinect was located on subjects' right (opposite side) for 6 trials and left (same side) for 6 trials (Figure 4).

Data was recorded simultaneously for Kinect and Coda

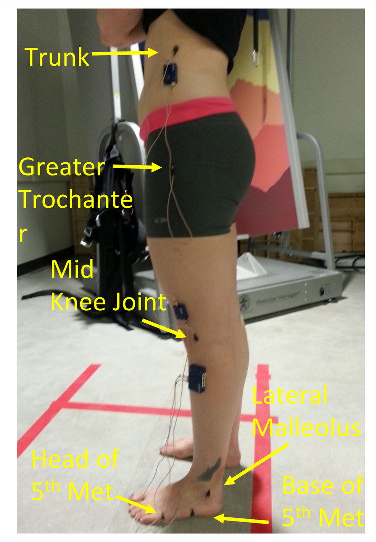

Figure 3. Coda Marker placement

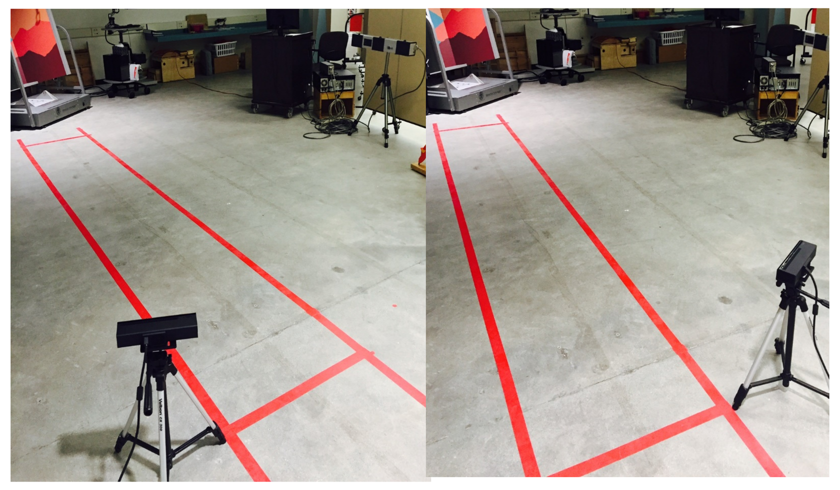

Figure 4. The left picture shows the walkway setup for opposite side trials, the right picture shows the walkway setup for same side trials

Coding and Analysis of Data

1. Trials Selected and Matched- Kinect Trial was selected for each subject same and opposite side with 2 clear steps. Corresponding Coda data was matched.

2. Coda Data Exported- Coda system software was used to build a setup that exported calculated marker position and hip, knee, and ankle joint range over time in three dimensions.

3. Data interpolated- Coda and Kinect data were interpolated using cubic spline to smooth data, which was then normalized for comparison to account for difference in data collection speed; Kinect 30Hz vs Coda 200Hz.

4. Foot Contact Determined- A program for heel strike detection was written in R for both systems which allowed stride length and stride time to be determined.

5. ICC's Calculated- Interclass correlation coefficients (ICC 3,1) were calculated for stride length (Table 1) and stride time (Table 2) for all subjects. ICCs for each joint and each step were calculated and categorized by clinical reliability standards (≥ 0.75, 0.50 – 0.74, < 0.50) and percent of steps falling into these categories were determined. (Table 3)

Table 1. ICC(3,1) for Stride Length

Measurement	ICC(3,1)	Mean difference in values (meters)	p
Stride Length Opposite Leg Step 1	0.75	0.0444	0.00016
Stride Length Opposite Leg Step 2	0.75	0.0305	0.00016
Stride Length Same Leg Step 1	0.70	0.0170	0.00057
Stride Length Same Leg Step 2	0.70	0.0292	0.00057

Table 2. ICC(3,1) for Stride Time

Measurement	ICC(3,1)	Mean difference in values (seconds)	p
Stride Time Opposite Leg Step 1	0.47	0.0751	0.024
Stride Time Opposite Leg Step 2	0.75	0.0554	0.00016
Stride Time Same Leg Step 1	0.76	0.0342	0.00011
Stride Time Same Leg Step 2	0.70	0.0435	0.00057

Table 3. Absolute values of ICC data for Range of Motion suggesting level of clinical relevance

Absolute Values	Hip Same Side	Hip Opposite Side	Knee Same Side	Knee Opposite Side	Ankle Same Side	Ankle Opposite Side
ICC values ≥ 0.75	4/27 (14.8%)	0/31 (0%)	21/27 (77.8%)	11/32 (34.4%)	0/27 (0%)	0/32 (0%)
ICC values 0.50 - 0.74	5/27 (18.5%)	8/31 (25.8%)	4/27 (14.8%)	7/32 (21.9%)	1/27 (3.7%)	3/32 (9.4%)
ICC values < 0.50	18/27 (66.7%)	23/31 (74.2%)	2/27 (7.4%)	14/32 (43.7%)	26/27 (96.3%)	29/32 (90.6%)

Results

Stride Length /Stride Time

- •All stride length ICC ≥ 0.70 - acceptable clinical reliability (Table 1).
- •One stride time ICC < 0.70 for opposite leg step 1 likely due to occlusion of test leg by other leg during this step (Table 2).
- •Occlusion necessitates large amounts of interpolation and could cause erroneous data.

Joint Range of Motion

- •Joint value comparisons show high variability in the reliability of the Kinect software (Table 3).
- •77.4% of the same side knee data from the Kinect is clinically reliable.
- •14.8% of the hip same side data was also reliable.
- •Kinect and Coda use different skeletal models; results suggest Kinect software needs to be altered for improved accuracy.
- •Graphs displaying the interpolated, normalized data from the Kinect and the Coda over the same two strides give a visual representation of similarities in the normalized data from the two systems (Figure 5).

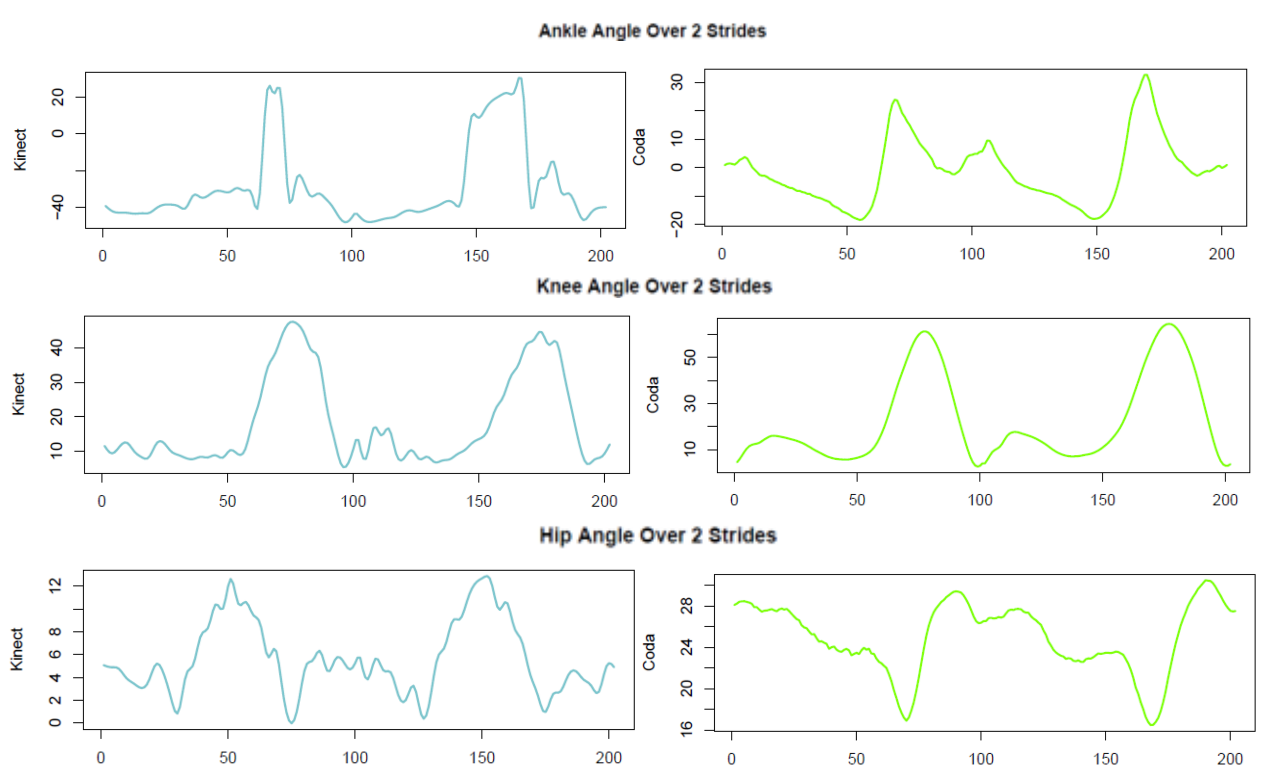

Figure 5. Graphs comparing the interpolated data from Kinect with the data from the Coda

Conclusions

The high variability in ICC data may be accounted for by the following:

- Different sampling rates (30Hz vs. 200Hz) of the systems required interpolation
- Old markers and old drive boxes in our Coda system may be less reliable
- Coda marker placement may be subject to human error
- Loose clothing may affect Kinect visual analysis and movement of Coda markers
- Wires may occlude Coda marker visibility during gait.
- Kinect Software requires mathematical/coding adjustments for joint placements and missing data.

Ease of use Kinect vs. Coda:

- Coda requires time-consuming application of markers and drive boxes
- Coda markers and drive boxes must be visible to the sensor at all times during trials. Bad trials must be re-recorded.
- Coda drive boxes can run out of batteries and the cords on the markers are easily damaged.
- Kinect SDK software uses proprietary skeletal model, Coda relies on user built marker model.

Ease of use Kinect vs. Ascension Motion Monitor:

- Unable to collect data using Ascension due to inability to build successful skeletal model.
- Ascension sensors were not cordless and were difficult to don

Chung and Ng described comparisons between 3D motion analysis and accelerometer ICCs between 0.73 and 0.82 to be "good" clinical reliability.[2] This indicates the Kinect software has potential for use in clinics.

Clinical Relevance

- The Kinect system may be a cheaper alternative to traditional motion analysis systems that could be used by clinicians in multiple settings to monitor patient progress
- Additional studies would need to be conducted with larger sample sizes and for other populations such as pediatric and geriatric populations.
- Testing of the Kinect 2 and software in the clinical setting required to determine test-retest reliability and clinical benefits.
- Additional studies establishing reliability of Kinect on populations with pathological conditions such as CVA, TBI, MS, PD, and RA that significantly alter movement patterns would be beneficial.

References

1. Shrout P, Fleiss J. Intraclass correlations: Uses in assessing rater reliability. *Psychological Bulletin*. 1979;86(2):420-428.
2. Chung PYM, Ng GYF. Comparison between an accelerometer and a three-dimensional motion analysis system for the detection of movement. *Physiotherapy.* 2012;98:256-259.