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KINEMATIC COMPARISON OF MS KINECT AND INERTIAL MOTION CAPTURE SYSTEM IN LOAD LIFTING TASK

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SUMMARY

The present study is part of an under development research project, which consists in the comparison of MS Kinect[1] with MVN Biomech[2] inertial motion capture system in order to evaluate kinematic parameters of the console. The comparison is being held due to the known [3, 4] advantages of MS Kinect, such as low cost, markerless and open source features. In the other hand, MVN Biomech is considered the most reliable untethered system [5], which provides the comparison a higher ground for evaluation. The framework of this study consists in gathering data from three situations: two laboratorial experiments and a study case based in work environments of oil and gas laboratories in the Ergonomic Work Analysis (EWA) context. This paper displays the framework and preliminary results (upper limb global displacement) from the second experiment. This experiment was based in load lifting task from a fixed location, meeting repeatability conditions, as described by ASTM standards [6].

INTRODUCTION

From a design and ergonomics perspective, “often in the workplace layout, kinematic elements are considered in the initial planning of the geometry of the work situation”. [7] Motion capture has the potential to expand user research approach in new products development [8] and in applications “ranging from the development of more intelligent human-computer interfaces and visual surveillance systems to the video-based interpretation of mobility disorders.” [9] But due to the need of high investments, most designers and/or other professionals who could benefit from the results cannot afford this tool. With that in mind, this research is being conducted in order to evaluate MS Kinect kinematic parameters in the EWA context.

The relevance of biomechanical study field for this research is the possibility to accurately evaluate kinematic data acquired from the devices.

Data was gathered simultaneously from the systems. MVN Biomech has its own software, while MS Kinect was recorded using iPiSoft. This software was chosen since it can acquire data from two consoles at the same time, minimizing occlusion areas. Also, its biomechanical model consists on 22 segments, unlike currently available MS Kinect applications [3].

METHODS

Data acquiring from two MS Kinect consoles through iPiSoft is based in two steps: recording and processing. A calibration process is needed, which consists in recording a 2D rectangular plane in order to allow the system, in the post processing, to identify the edges of this object and align the images acquired from the sensors. The object of study is then recorded performing a T pose before, after or in between the activity. With the calibration settings, the biomechanical model can be positioned in the resultant point cloud during T pose and movement can be tracked.

MVN Biomech’s process consists in the positioning of the inertial sensors in the volunteer’s body followed by calibration and input of subject’s measurements. No post processing needed.

In order to compare the data acquired from the systems, a 3D Digital Platform was built. This platform is based on a game engine and can be considered a neutral ground for importing data from different MOCAP systems. It calculates kinematic parameters from the data files (global orientation, global rotation, local angular velocity and joint rotation) and converts them into a file that can be imported in a database with common aspects for comparison and statistical analysis.

The Platform reconstructs the body segments based on the data file in a biomechanical model, where data are conserved from the original model, minimizing error accumulation - which happens specially when re-targeting is done.

The volunteer was asked to lift three different sized boxes (20, 30 and 40cm wide), weighting 5kg each, from the floor, up to the elbow bent at 90 degrees and back to the floor from a fixed location. This set of movements was chosen in order to obtain kinematic parameters from arms and column arching, as well as evaluate how the devices capture object interaction.

MS Kinect consoles were positioned at 80-90 degrees from each other, at a 3.5m distance from the volunteer and calibrated. Calibration results given by the system resulted in an average angle error between the consoles of 0,05 degrees and average position error of 0,012 meters.

Calibration process was performed by both systems with the volunteer at the fixed position, in order to maintain same orientation and direction.

MVN Biomech recorded the whole session, whilst iPiSoft was started before each movement, where the volunteer was asked to perform T poses at beginning and end of task in order to have synchronism points and also to position iPiSoft's biomechanical model.

Filters were used in data acquired from both systems: MVN Biomech processed the captured data with LXSolver and iPiSoft provides jitter filters in order to reduce data noise. Jittering was used at a low level, eliminating only excessive noise thus avoiding data altering.

RESULTS AND DISCUSSION

Two of the three captures acquired from iPiSoft/Kinect showed valid tracking for comparison. The movements with the larger box (40cm wide) had limitations regarding occlusion areas caused both by the box, and by the volunteer's own body. This occlusion resulted in lower-limb data invalidation.

One limitation found in the comparison was regarding the local coordinate systems original from the biomechanical models, which different from each other. This issue is being studied in order to fit ISB recommendations [10] and allow local parameters to be calculated. Therefore, for the moment, only global parameters are being compared. Due to size limitations of this paper, the results showed bellow only cover global displacement during T pose of right shoulder (figure 1), elbow (figure 2) and wrist (figure 3). Global axes were defined following ISB recommendations.

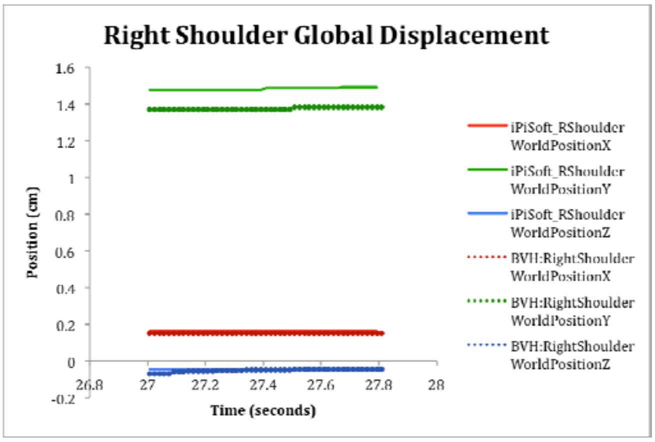

Figure 1: Right Shoulder Global Displacement during T pose

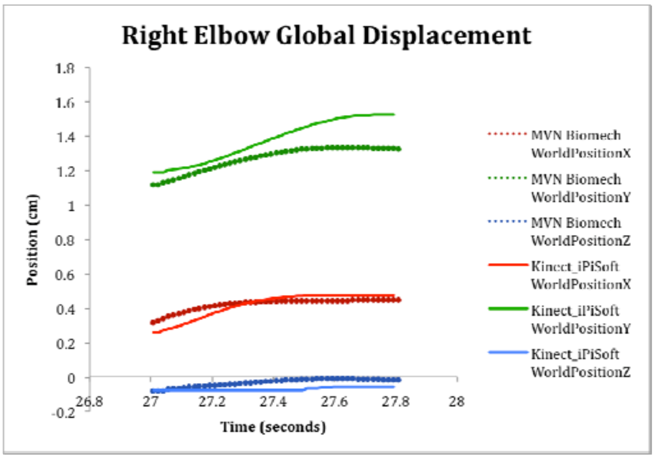

Figure 2: Right Elbow Global Displacement during T pose

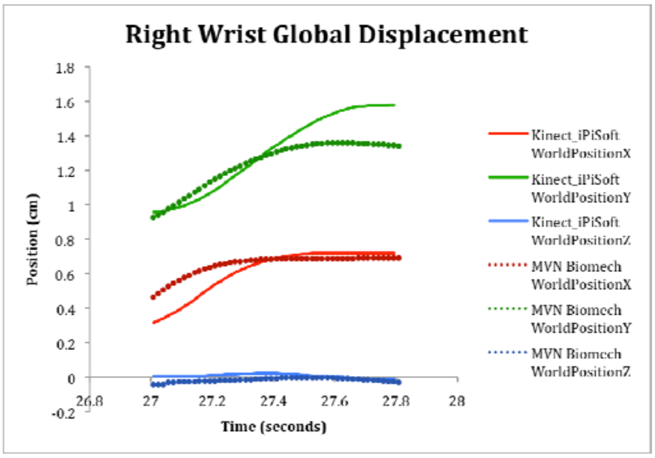

Figure 3: Right Wrist Global Displacement during T pose

Differences in the vertical axis (Y) were expected since MVN Biomech has a more accurate calibration process, which considers subject's segments measurements.

CONCLUSION

Considering the motion captures were held in a controlled environment, MS Kinect through iPiSoft results have shown that, under these circumstances, product analyses and motion capturing for other purposes can be performed by MS Kinect. It is recommended to avoid large objects or activities that imply any sort of occlusion by the consoles.

Further analyses of this experiment are being conducted in order to produce statistical results from motion-captured data and more detailed conclusion. Motion captures of the study case based on the EWA are currently being held.

REFERENCES

1. Microsoft Xbox. Kinect.
2. MVN Biomech. Xsens Technologies.
3. Chang Y, et al., *A Kinect-based system for physical rehabilitation: A pilot study for young adults with motor disabilities.* Research in Developmental Disabilities. Volume 32, Issue 6. 2011
4. Berger K, et al. *Markerless Motion Capture using multiple Color-Depth Sensors.* Vision, Modeling, and Visualization. The Eurographics Association 2011.
5. Kider JT, et al., *UMCE-FM: Untethered Motion Capture Evaluation for Flightline Maintenance Support.* Air Force Research Laboratory. 2008.
6. ASTM, 2010. *Standard Practice for Use of the Terms Precision and Bias in ASTM Test Methods.* ASTM International.
7. TICHAUER ER. *The biomechanical basis of ergonomics. John Wiley & Sons.* 1978.
8. Xin X, et al., *Motion Capture as a User Research Tool in "Dynamic Ergonomics".* International Association of Societies of Design Research. 2007.
9. Dockstader SL, et al., *A Kinematic Model for Human Motion and Gait Analysis.* Workshop on Statistical Methods in Video Processing. 2002.
10. Wu G, et al. ISB Recommendations for Standardization in the Reporting of Kinematic Data. Journal of Biomechanics, Vol. 28. No. 10.