Determination of the Optimal Location of Kinect Sensor for Upper-Limb Virtual Reality

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Abstract:

The Kinect sensor is an inexpensive motion tracking device as compared with other classical systems. A high level of interest exists to use Kinect for low-cost virtual reality (Pastor et al., 2012). The Kinect sensor, however, suffers from limited accuracy. The objective of this study was to quantify accuracy of the upper limb kinematic information obtained from Kinect, and to determine the optimal location of the Kinect sensor relative to a person to minimize kinematic errors.

Seven healthy young subjects reached towards 21 pre-placed targets that were evenly distributed in front of them in a random sequence using their right hand, from the initial posture of the hand and arm resting on a table. The kinematic error was determined as the root mean square of the difference in the shoulder and elbow joint angles computed from the position data obtained by Kinect vs. Optotrak (classical system), over the entire movements. The kinematic error was compared for 9 different Kinect sensor locations: zero elevation with -60°, -30°, 0°, 30°, 60° azimuth angles, 30° elevation with -60°, 0°, 60° azimuth angles, and 45° elevation with 0° azimuth angle from the subject's right shoulder (Figure1). Optotrak markers were placed on the chest, shoulders, elbow and wrist to estimate the joint centers.

Mean kinematic error ranged from 21° to 50° depending on the Kinect sensor location ($p<.05$). The kinematic error was the least when the Kinect sensor was located directly in front of the subject, elevated at 45°, among the 9 Kinect locations (Figure1). The kinematic error was the highest when the Kinect sensor was on the shoulder level and 60° to the left.

In conclusion, the Kinect sensor accuracy depended on the Kinect sensor location relative to the user. The best location to place the Kinect sensor for upper limb motion tracking may be directly in front of the subject, elevated at 45°. In addition, placing the Kinect sensor in the opposite side of the moving arm may result in poor motion tracking accuracy. The results of this study guide the optimal Kinect sensor location for upper limb virtual reality applications.

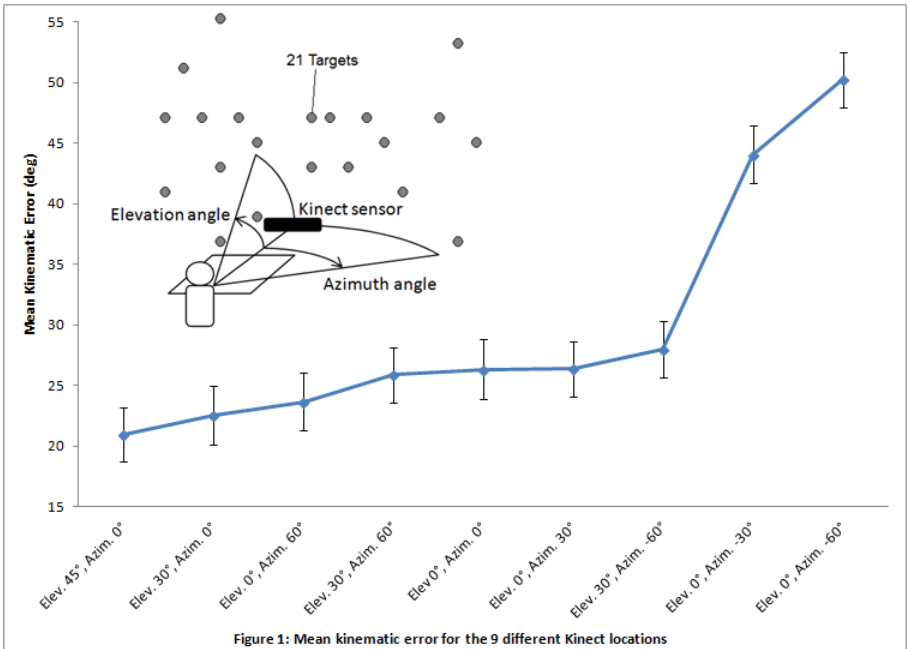

Figure 1: Mean kinematic error for the 9 different Kinect locations

REFERENCE:

I. Pastor, H. A. Hayes, and S. J. Bamberq, "A feasibility study of an upper limb rehabilitation system using kinect and computer games," in Proceedings of the 34th Annual International Conference of the IEEE Engineering in Medicine and Biology Society (EMBS '12), pp. 1286–1289, August-September 2012.

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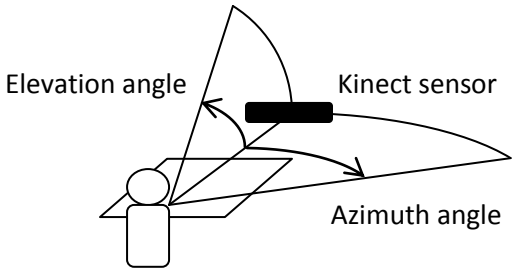
Elevation angle
Kinect sensor
Azimuth angle