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USING THE MICROSOFT KINECT SENSOR IN KINEMATICS ANALYSIS

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SUMMARY

In this work was shown the feasibility of Microsoft Kinect sensor in a biomechanical analysis. Using the Open NI library was developed a basic code for generating body representation and related motion angles. The code was tested in experiments of treadmill walking and running The Kinect methodology was compared with the cinemetry traditional methodology, in which the limbs position are manually picked from a video footage. The Kinect methodology uses his depth sensor to get and analyse data in real time. The data resulting from either methodology was compared and Kinect´s error and precision in those biomechanical analyses were quantified. The results points for the Kinect sensor as a fast, cheap e accessible tool for biomechanics with a reasonable precision.

INTRODUCTION

The cinemetry encompasses a set of methods to determine location and orientation of body segments, aiming to obtain kinematic parameters, i.e., location, orientation, velocity and acceleration. A well-known method to kinematic measurements [1,2,3], consists in the use of video cameras to capture the motion.

The first step in a biomechanical analysis of motion is to acquire the body representative segments [2]. The Kinect sensor allows to acquire the tridimensional coordinates of some body joints, such as, wrist, elbow, ankle, shoulders, and knee. See figure 1a and 1b.

With the sensor placed frontally to the human subject, is possible to identify the joints coordinate and representative body segment vectors. In this way, further analysis of those coordinates and vectors during the motion can be performed

METHODS

The Kinect was coupled with a PC via OpenNI driver and the SimpleOpenNI library. The programming language used was JAVA. In Figure 1 is showed some snapshots of the code GUI.

As shown in the Figure 1a, the body main segments representation allowed that motion properties, such as angles and angular velocities were obtained. Those properties can be seen in the Figure 1b.

For calculating the angle between joints the vector scalar product was employed. For instance, if **a** is the position vector for the shoulder, **b** is the elbow position vector, **c** is the position vector for the wrist. Furthermore, if **A** e **B** are two vector, such **A=b-a** and **B=c-b**, the elbow relative angle can be calculated by the equation 1.

$$\theta = \arccos \frac{\mathbf{A}\cdot\mathbf{B}}{\|\mathbf{A}\|\,\|\mathbf{B}\|}$$

Equation 1: Expression that allows the calculation of the angle between the vectors A and B.

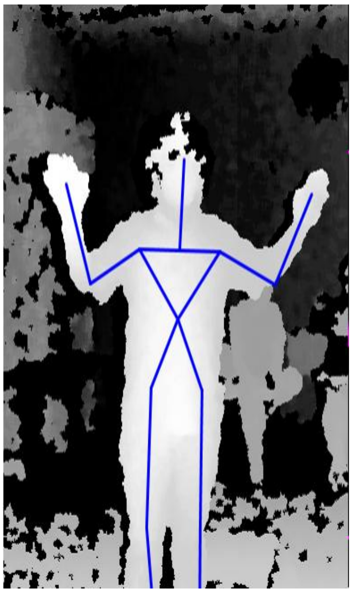

Figure 1a

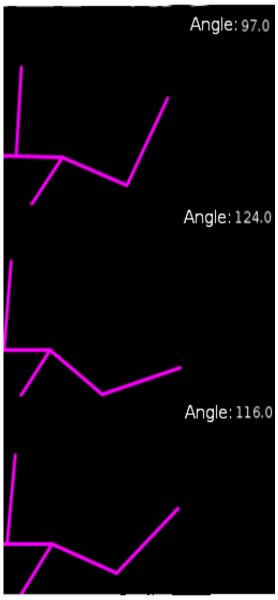

Figure 1b

Figure 1: Graphical User Interface of the code. (a) body segment capture by the Kinect, (b) Representation of calculated angles from the elbow.

The experiment consists in a subject in treadmill walking at different speeds, namely, 3.6, 4, 4.2, 4.5, 5 km/h. The left knee angles were used as the parameter for the comparison. The Kinect and the video camera were placed suitably during the experiment. The video camera recorded the walking and was perpendicular to the movement plan. In the subjects body was placed three different markers, in the hip, in the knee, and a third in the malleolus, all in right hemibody.

The method following the video recording was traditionally employed in the conventional two-dimensional biomechanical analysis. A reference frame was placed in order to allow the two-dimensional reconstruction of the markers in space. In this way, the vídeo recorded on tape was digitalized. The software SkillSpector was used to place the markers in the vídeo. The resulting two-dimensional coordinates, was employed in a Matlab script to calculate the angles as function of time. All the process took an hour and a half.

By his turn, the results were obtained using the Kinect system and code developed. All the angles and plots were generated in real time using the SimpleOpenNI library.

RESULTS AND DISCUSSION

The results from both methods were strongly correlated. To have a measure of precision to the Kinect results, the amplitude and angle were calculated for both methods.

The data analysis showed that the angle covariance for the Kinect method and video camera method were 10.36 e 20.20 degrees, whereas the linear correlations were 0.88 and 0.91. Therefore, we conclude both data are strongly linearly correlated, increasing the reliability of the data of amplitude and maximum angle using the Kinect system.

In the results, could be seen the increasing of average errors with speed, showing that in applications with faster motions the Kinect data loses quality. In addition, the errors follow some proportionality with the movement amplitude.

CONCLUSIONS

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During this work were developed some coding for testing the Kinect viability in the biomechanical analysis. The Kinect method was compared to another method.

It is noteworthy to accent the use or not of Kinect rely on the precision need of the biomechanical application. However, unconcerning the efficacy, the Kinect unveiled to be a fast and cheap analysis tool in comparison to other methods. During the calculations for angle analysis, the time differences were significant. It was seen that in his actual state, the Kinect does not have precision capability as the other methods. In summary, in applications where attributes such as velocity of analysis, price and availability are emphasized the Kinect can be a solution.

REFERENCES

1. Hamill, J.; Knutzen, K.M. Bases *Biomecânicas do Movimento Humano*. São Paulo, Brazil: Manole, 1999.
2. Amadio, A.C.; Lobo da Costa, P.H.; Sacoo, I.C.N.; Serrão, J.C.; Araujo, R.C.; Mochizuki, L.; Duarde M.. *Introdução à Biomecânica para Análise do Movimento Humano: Descrição e Aplicação dos Métodos de Medição*. Laboratório de Biomecânica, escola de Educação Física da Universidade de São Paulo, São Paulo, Brazil.
3. Adrian, M.; Cooper, J. . *Biomechanics of Human Movement*. McGraw-Hill, Boston, 1995.

Table 1: Summary of collected data.

Speed [km/h]	Knee maximum flexion angle. Kinect [degrees]	Knee maximum flexion angle. cinemetry [degrees]	Difference [degrees]
2.1	55.50	51.33	4.17
3.1	59.99	58.65	1.34
3.6	61.95	59.34	2,43
4	58.26	59.52	−1.26
4.2	63.54	60.63	2.91
4.5	62.04	61.74	0.3
5	63.72	62.55	1.17
5.3	65.35	62.61	2.74