KINEMATICS OF UPPER LIMB MOVEMENT IN RHINO:GRASSHOPPER

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Introduction

Every research on human motion is highly dependent on collected data. The accuracy and reliability of gathered data favourably impacts final result. Data processing, interpretation and proper analysis are also essential to retrieve useful joint health information from the system data [2]. The musculoskeletal systems of humans and animals are mechanically very complex and computational models must be highly simplified in order to be reasonably efficient [4]. To be able to gather and process biomechanical data compromises must be made to define boundary conditions. Even so, most of them are investigating gait and lower body activities. The scarcity of upper body models and calculation tools available limit the accessibility of resources for further researches to be made. Every additional software or model that calculates upper body kinematics or dynamics increases diversity. This gives a new approach on the solution and increases accessibility which might result in more research being done in a field. The aim of this paper is to develop and investigate Rhino Grasshopper software and kinematics computational model, which was done to introduce an additional tool that could be used for body motion analysis.

Methods

In this study, 6 *BTS Smart DX-600 (BTS Bioengineering, Italy)* cameras were used, together with Plug in Gait marker set. In order to study the movement characteristics of the upper body and limbs, a transfer movement was chosen. It is combination of 3 basic motions: lift, pivot, put down. Specifically, a healthy male subject (184 cm, 82 kg, 27 years old) transferred a patient weighing 57 kg from wheelchair to a bed in accordance with safe lifting guidelines. Total 5 measurements have been taken and 3 most consistent ones selected for further analysis. After initial data processing with *BTS Bioengineering* software, it was exported to .csv file that is easily accessible to most of the software. This serves as a baseline for further calculations that are being made by *Rhino Grasshopper* software. This software was chosen to bring low-cost solution to the field of bioengineering. It is based on 3D modelling and node element solutions that offers broad range of easy customisable tools. The extreme values of each joint movement were found and the range of motion (ROM) as the difference between these values was calculated. ROMs are calculated for the shoulder, elbow and wrist joints of the upper limb. To ensure that acquired and calculated data is correct, it has been compared with *Biomechanics of bodies BoB* software processed data of the same measurement. Finally, the difference (Δ) between the result mean values is calculated.

Results

Difference between results mean values are not exceeding 5% for upper body limbs. Right shoulder range of motion results can be seen in Figure 1. It has mean difference of 1,89° between native *BoB* and created *Rhino Grasshopper* models.

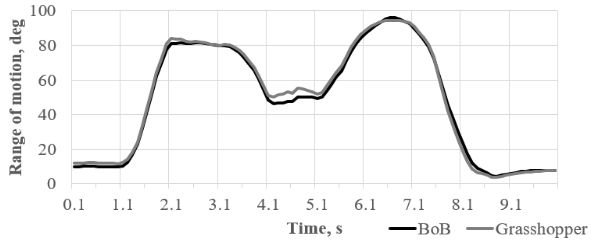

Figure 1: Right shoulder range of motion (Flexion / Extension) calculation between kinematic BoB and Rhino:Grasshopper models

The deviation can be explained in different reference usage. In *Rhino Grasshopper* model collarbone, together with C7 vertebra and shoulder marker creates main shoulder line plane, while reference of *BoB* model is unknown.

Discussion

Conceptual, physical and mathematical models have all proved useful in biomechanics [1]. Bringing more tools to the field encourages bigger array of researches and data by increasing availability and accessibility. Regardless of the use, confidence in computational simulations is only possible if the investigator has verified the mathematical foundation of the model [3]. Based on this statement, it is critical to check and evaluate data of every new model or modeling application prior to stating its usability.

References

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