Preliminary evaluation of motorcycle suit impact on rider range of motion

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1 Introduction

The undressed human range of motion (ROM) has been already deeply studied by Hamilton (2012). These ranges concern mainly the rotational motions and they were implemented in the Virthuman (VH) model by Hynčík (2013) as the dependence of the torque on the angle for the specific body joints. This implementation is enough and suitable for representing the human which is wearing soft clothing (cotton, silk, polyester, etc.), however, the protecting clothing is usually made of stiffer materials (bovine leather, kangaroo leather). Therefore, the ROM of the motorcycle driver, which could wear the protective garment, should be subjected to the constraints of the motorcycle suit. This leads to the need for the measurements of the human joint motion ranges using personal protective equipment (PPE).

2 Method

The measurement was done on two volunteers (one male, one female) using two types of motorcycle suits for each volunteer (full racing suit, split motorcycle suit). The motorcycle garments were made based on the anthropometry of each volunteer (it was done to assure the close fit). The measurement was made by the Vicon optical system. Each of the volunteers, with each of the garments, was to perform a series of 11 poses (Figure 1). Afterward, the digital data has been post-processed and fused with the existing ROM data of the un-clothed human. The measurements were made based on the local Ethical Committee approval from 23 January 2017 and further local Ethical Committee approval from 29 April 2019.

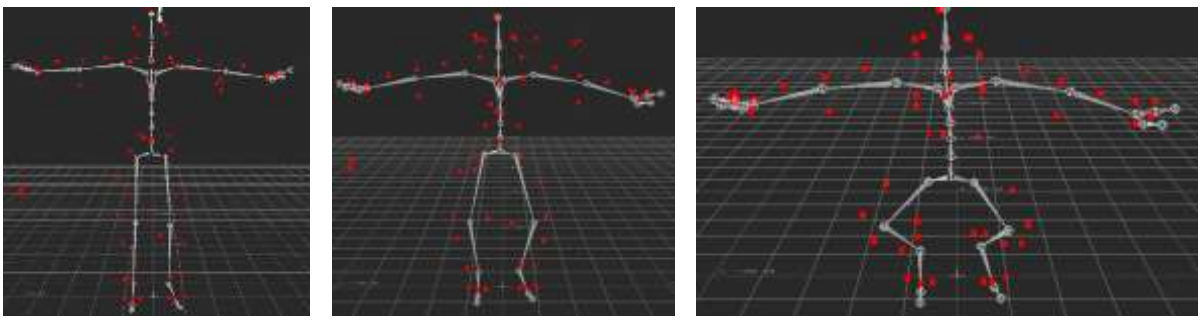

Figure 1: Example of the pose (squat).

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3 Measured data

The maximum ranges of motion of the joints were measured in the following 11 poses and placed on undressed ROM curves (Figure 2):

- Hands up / hands back (sagittal plane)
- Hands front/hands back (transverse plane)
- Hands down / hands up (coronal plane)
- Elbow up (coronal plane)
- Side bend
- Squat
- Knee both legs
- Splits
- Legs up and back / both, knee straight (sagittal plane)
- Upper limb, 90 degrees, elbow rotation (one limb each time start from right)
- Upper limb, coronal plane up and down (one limb each time, from right)

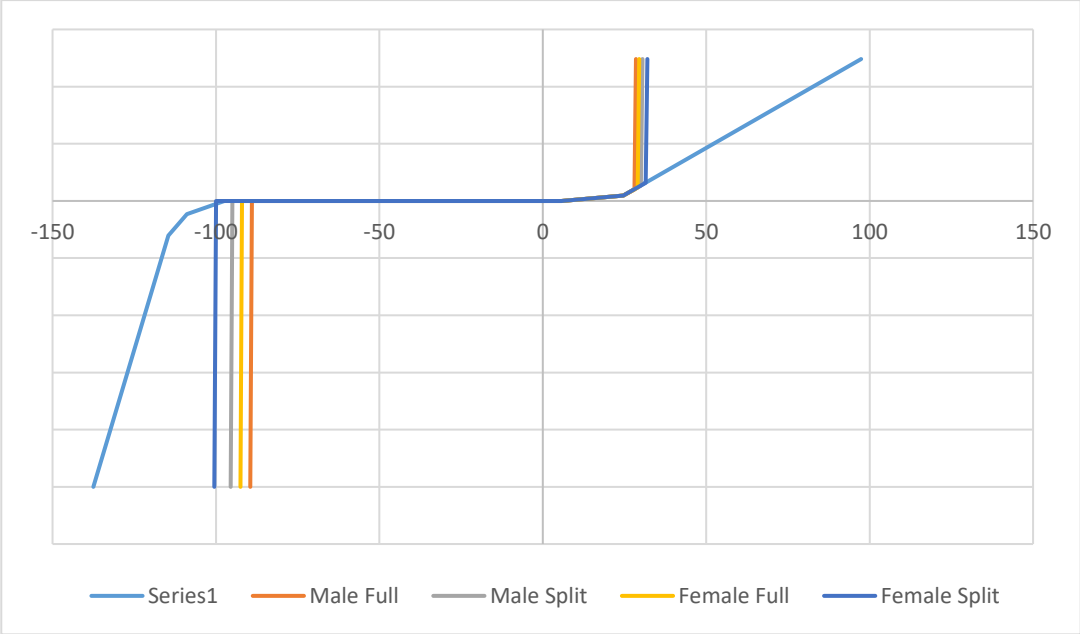

Figure 2: Example of the curve with the garment imposed limits [degrees].

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References

Hamilton, Nancy, Wendi Weimar, and Kathryn Luttgens (2012) *Kinesiology: Scientific Basis of Human Motion*. New York, N.Y: McGraw-Hill.

Hynčík L., Čechová H., Kovář L. Bláha P. (2013) On scaling virtual human models. *SAE Technical Paper 2013-01-0074*, doi:10.4271/2013-01-0074.