The coupling of the scaled Virthuman and the motorcycle helmet

Tomasz Bońkowski[1], Lukáš Šoltés[2], Luděk Hynčík[3]

1 Introduction

According to MAIDS database (ACEM (2009)), 67.3% of the PTW (Power Two Wheelers) drivers are using the full face helmets. Therefore the accident reconstruction, in the numerical environment (Finite Element Method - FEM, Multibody System - MBS), should take the helmets into account. During the procedure of coupling the helmet with the full human body model (HBM), which is scaled down (smaller head diameter - due to the higher age of the driver), the lack of contact between the chin strap and the chin was found (Figure 1). The aim of this paper is to find and present the strategy, which could solve the coupling problem for scaled down HBM.

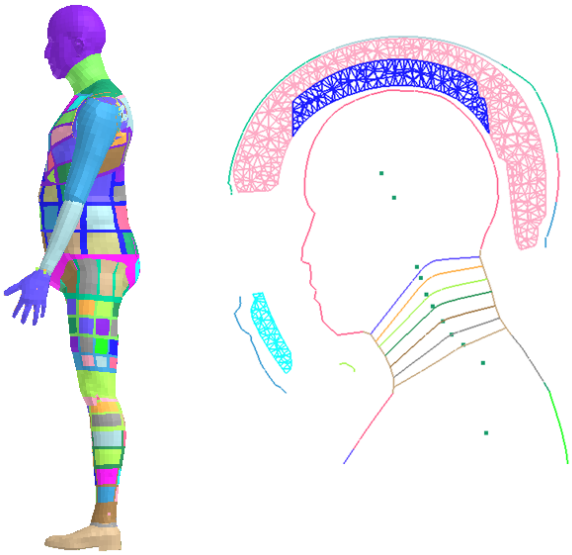

Figure 1: The scaled Virthuman and coupling problem.

2 The Virthuman and the helmet coupling

In our case, the Virthuman is used as the HBM. The Virthuman (Vychytil at al. (2014)) is scalable HBM based on two numerical approaches: explicit FEM and MBS. The motorcycle helmet is represented by the FEM numerical model of T-2 AGV helmet (Ghajari at al. (2011)). Coupling the helmet model with non-scaled Virthuman did not show any problems (perfect fitting of the helmet to the head). However, after the scaling procedure, the chin strap has no contact area with the HBM chin. This situation could generate an artificial detachment of the helmet from the head during the simulation.

[1] student of doctoral study programme Applied Science and Informatics, field Mechanics, specialization Applied Mechanics, e-mail: tomasz@ntis.zcu.cz
[2] NTIS – New Technologies for Information Society, e-mail: soltesl@ntis.zcu.cz
[3] NTIS – New Technologies for Information Society, e-mail: hyncik@ntc.zcu.cz

First solution step was the helmet model cleaning. The shell elements of the strap were deleted. Next step was to generate the properly meshed geometry which could envelop the chin (Figure 2). This step was automatized by the "Seatbelt" VPS built-in tool. The third step was to assign proper material model for the new chin strap. The material model parameters (E = 1000 MPa, ρ = 870 kg/m^3, ν = 0.3 and thickness 1.3 mm) were taken from Ghajari at al. (2011). Based on those parameters, 2 material models were created and assigned to corresponding elements (elastic shell and elastic bar models). Finally, the interface between the head and the helmet was set by a "Symmetric node to segment with edge treatment" (CNTAC Type 33) contact with a friction coefficient equal to 0.5. After this procedure, the coupled HBM-helmet model was run. The test run did not show any numerical or kinematic errors.

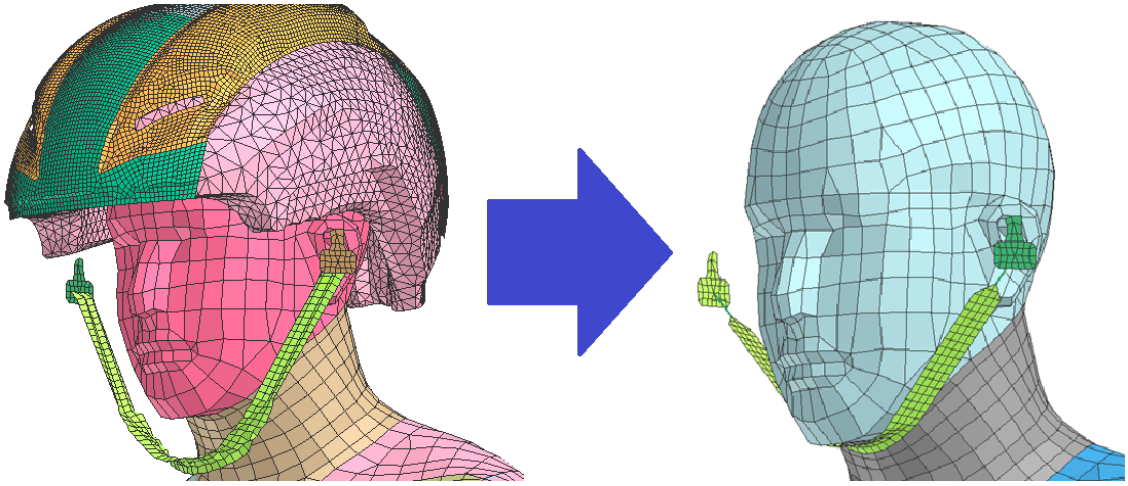

Figure 2: The coupling problem solution.

3 Conclusion

The scaled Virthuman-helmet coupling problem was solved. The new application of the "Seatbelt" VPS built-in tool was presented. The coupled model can be used for the complex PTW scenario reconstruction, with realistic head injury criteria assessment.

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Bibliography

ACEM (2009) MAIDS – „In-Depth Investigation of Motorcycle Accidents", the Association of European Motorcycle Manufacturers (ACEM)

Ghajari M., Galvanetto U., Iannucci L., Willinger R. (2011) Influence of the body on the response of the helmeted head during impact, *International Journal of Crashworthiness*, 16:3, 285-295.

Vychytil, J., Manas, J., Cechova, H., Spirk, S. et al. (2014) Scalable Multi-Purpose Virtual Human Model for Future Safety Assessment, *SAE Technical Paper* 2014-01-0534, 2014, doi: 10.4271/2014-01-0534.