HUMAN BODY MODEL FOR DYNAMICAL SIMULATIONS

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1 INTRODUCTION

The paper describes a human body model applicable for wide spectra of dynamical simulations. The model is developed using so called multibody dynamics approach as a coupled system of bodies. Pedestrian impact simulation as a particular validation is provided.

2 MODEL

The reference anthropometric model of the human body is based on Robbins (1983). The average male model of the weight 77 kg and the height 179 cm from the Robbins anthropometric data set is chosen. The 3D model is based on rigid bodies coupled by kinematic joints. The rigid bodies represent 15 segments, namely head, neck, thorax, abdomen, pelvis, upper arm (right and left), lower arm (right and left), upper leg (right and left), lower leg (right and left) and foot (right and left). Local coordinate system, mass, centre of gravity and inertia matrix are defined for each segment. The kinematic relations between rigid bodies are represented by joints. There are 14 joints in the model. Each joint position is defined in the particular segment local coordinate system. The range of motion, whose value is based on physiological human motion, is defined further. There are only rotational (knee, elbow) and spherical (elsewhere) joints used in the current model.

The human body model is created in the ADAMS system as a mechanical system. The used geometry is created in the CATIA system. Physiological limits are defined by joints torques depending on the motion angle. The values of physiological limits consist of the combinations of a step functions multiplied by motion angle and stiffness. A damping member into the equation to ensure the real behaviour of the human body model is added. This member consists of the angular velocity multiplied by the damping coefficient.

3 VALIDATION

It is necessary to validate any model to the real experimental results. Impact simulation between a pedestrian and a van is used here. The simulation is compared to the results from the experiment performed at CTU in Prague according to Kovanda et al. (2005), see Figure 1. Human body model is not fixed to any frame. Model of the van is fixed to the frame by translational joint. The initial velocity of the van is set to 28 km/h and the initial deceleration is set to 0,8 m/s^2. The mass of the van is insignificant comparing to the type of link. Human body model and van model are close enough to each other to minimize the influence of the human body free fall. The initial and boundary conditions in the simulation and the experiment are met. For the comparison between the simulation and the experiment, the head centre of gravity acceleration is used. The maximum value in simulation is 630,35 g in time 0,06590 s. The experimental maximum value is 638,12 g

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in time 0,084506 s. With respect to the maximal values of acceleration and the curves trends, the simulation is comparable to the experiment, see Figure 2.

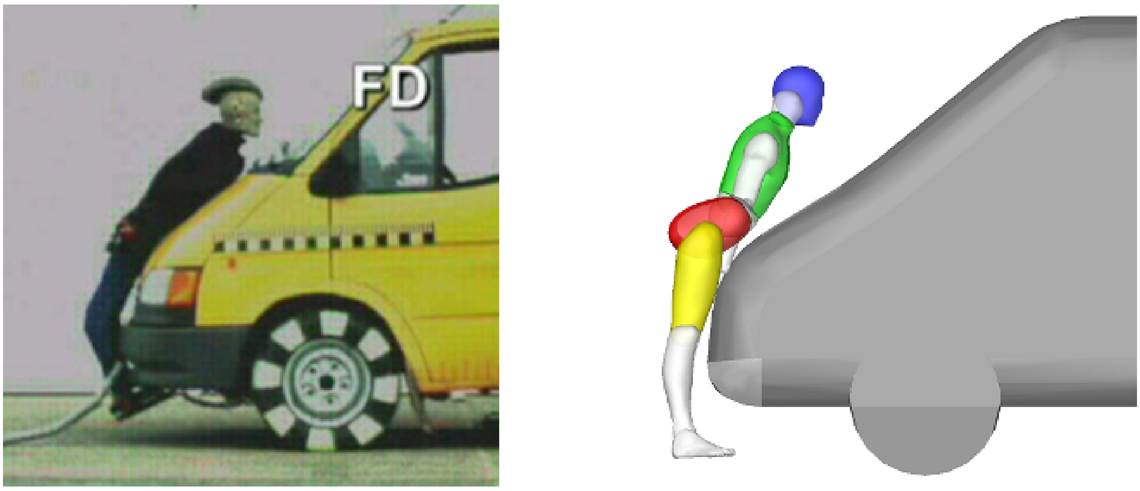

Fig. 1: Comparison between experiment and simulation

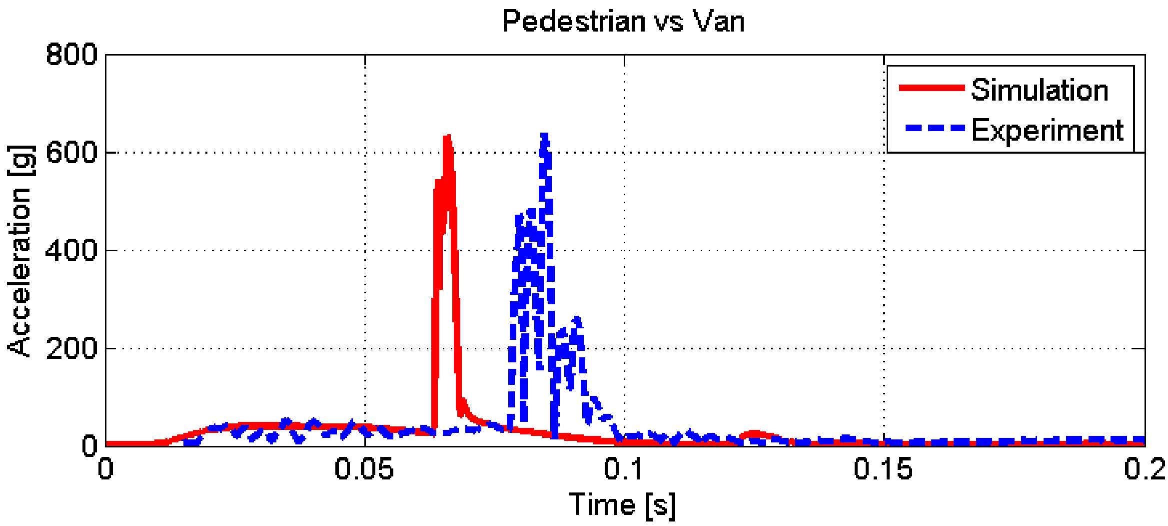

Fig. 2: Comparison of simulation and experiment

4 CONCLUSION

Human body model in the ADAMS system useful for wide spectra of dynamical simulation is developed. Basic anthropometric specifications and physiological limits of motion of the human body are taken into account. The impact simulation between a pedestrian and a van compared to experimental data is provided as a particular validation.

REFERENCES

Kovanda, J., Lenk, J., First, J., Mičunek, T., Scuderi, F., Maršik, J., Kovandová, H., Schejbalová, Z., 2005. *Models of Driver and Passengers for Application in Road Transport, Road Vehicles Computer Model in Suitable Enviroment, Road Vehicles Non-Protected Passenger (Driver), Pedestrian Impact.* Report for MPO, Project FT-TA/024.

Robbins, D.H.,1983. *Anthropometry of Motor Vehicle Occupants.*Transportation Research Institute, Vol. 2-3. UMTRI-83-53-2.