Preface

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Digital human modelling and simulation has been a booming research topic for the past decade. The human body is a highly redundant multi-body system with high degrees of freedom, and thus computational simulation and experimental analysis of human motions are challenging tasks. Researchers in biomechanics and ergonomics are using digital human models to analyse and design various activities in industry, military, and clinical research. Efficient static and dynamic analyses of human motion are the key elements in developing a high-fidelity human model. The main topic of this special issue is 'dynamics in digital human modelling and simulation'. It includes experiment-based methods, motion prediction, impact and vibration, injury and fatigue prediction, and human safety and protection.

It is a great honour to serve as guest editors on this special issue. We would like to thank everyone who contributed to this issue and the referees who provided the evaluations promptly. We hope this special issue will stimulate further research in this field. Here is a short description of the goals and achievements of each paper.

Acar and Esat investigate the injury level for pregnant drivers in frontal crashes. The 3D finite element model, 'expecting', is developed in the simulation which embodies a detailed multi-body model of a fetus. The results suggest that the frontal airbag together with the correctly worn seatbelt provide better protection for the pregnant drivers.

Alphin and Sankaranarayanasamy develop a finite element (FE) model for human trunk-neck-head structure and analyse its free vibration characteristics. The beam element is used to build the model. The natural frequencies are obtained for the trunk-neck-head model. The resonance frequency, mode, and deflection are analysed.

Joshi et al. perform a fastening ergonomic study based on state-space modelling of hand-arm system. The hand-arm is modelled as a single degree of freedom rotational system in state-space. The model parameters are extracted from the measured tool rotation and torque data during the fastening operation. The model is then used to determine the response and reaction forces during the operation. Good agreements are observed between the predicted and measured responses.

Ozsoy et al. present an optimisation method to simulate the vertical human jumping motion. An inverse dynamics algorithm is used in the optimisation process to calculate the ground reaction forces and joint torques; therefore, direct integration of the equation of motion is avoided. The 2D model has seven degrees of freedom. The optimisation problem is formulated to maximise the height of the centre of mass and the take off velocity, subjected to associated physical constraints. The effects of arm swing for the jumping motion are investigated and the cause and effect illustrated.

Rahmatalla et al. develop a validation framework to evaluate the motion of a predictive human model. Two qualitative and two quantitative benchmark tests are designed and used to assess the strengths and weaknesses of the model and to localise abnormalities in the predicted motion. It is shown that the proposed framework is very effective in identifying the flaws in the model under investigation and in giving guidelines for improvement of the simulation.

Tan and Przekwas report a novel computational model for articulated human body dynamics. An implicit multi-body solver with the exact linearisation is used to solve for the motion. The inertial properties are calculated using a finite element method. The method is demonstrated by simulating a gas blast situation and the primary injury mechanism is revealed from the simulation.

Xiang et al. present an enhanced optimisation-based inverse kinematics (IK) method which transfers the human motion from Cartesian space into joint space. A joint discomfort function is used in the spine-shoulder-neck area to solve the coupling issue. The proposed IK algorithm is used to solve the braking, throwing, and sprinting motions from motion capture experiments. The validity of the method is presented.

Zhou and Przekwas present a robust whole-body control algorithm for simulating human running in real-time. A proportional derivative (PD) feedback control rule is used to compute desired joint acceleration at each time step from the given joint trajectories. The joint torques obtained from inverse dynamics are used to drive the model by running forward dynamics in each control loop. Normal and load-carriage running are simulated by using the proposed control algorithm.