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Numerical simulation of hemorrhage in human injury KWITAE CHONG, CHENFANFU JIANG, ANAND SANTHANAM, PEYMAN BENHARASH, JOSEPH TERAN, JEFF ELDREDGE, University of California, Los Angeles — Smoothed Particle Hydrodynamics (SPH) is adapted to simulate hemorrhage in the injured human body. As a Lagrangian fluid simulation, SPH uses fluid particles as computational elements and thus mass conservation is trivially satisfied. In order to ensure anatomical fidelity, a three-dimensional reconstruction of a portion of the human body –here, demonstrated on the lower leg– is sampled as skin, bone and internal tissue particles from the CT scan image of an actual patient. The injured geometry is then generated by simulation of ballistic projectiles passing through the anatomical model with the Material Point Method (MPM) and injured vessel segments are identified. From each such injured segment, SPH is used to simulate bleeding, with inflow boundary condition obtained from a coupled 1-d vascular tree model. Blood particles interact with impermeable bone and skin particles through the Navier-Stokes equations and with permeable internal tissue particles through the Brinkman equations. The SPH results are rendered in post-processing for improved visual fidelity. The overall simulation strategy is demonstrated on several injury scenarios in the lower leg.

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