

A Heterogeneous Model of the Human Knee

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We present a finite element model for the mechanical behavior of the human knee joint, containing bones, articular cartilage, and the major ligaments. The model is heterogeneous in the sense that bones and cartilage are described using standard three-dimensional continuum mechanics, while the ligaments are modelled as one-dimensional rods with an orthonormal director triad (Cosserat rods). The entire model is geometrically exact and we present fully dynamic simulations of large knee movements.

The implementation combines several grid managers. UGGRID is used for the tetrahedral bone grids and prismatic cartilage grids, while ONEDGRID is used for the ligaments. We currently arrive at a total number of nine different grid objects. The mortar method used to discretize the bone–cartilage coupling and the cartilage–cartilage contact is implemented easily using the infrastructure from DUNE-GRID-GLUE.