Dynamic Local Remeshing for Elastoplastic Simulation

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I describe methods for simulating physical domains that are substantially reshaped by plastic flow or fracture. We combine standard Lagrangian finite element methods with algorithms for dynamic remeshing, which update a volume mesh undergoing radical deformations so that its tetrahedra do not deteriorate below a fixed quality threshold. Our dynamic mesher is conservative: it replaces as few tetrahedra as possible, and thereby limits the visual artifacts and artificial diffusion that would be introduced if we repeatedly remeshed the domain from scratch. It also locally refines and coarsens a mesh, and even creates anisotropic tetrahedra, wherever a simulation requests it. Our simulation method addresses a range of material behavior from purely elastic to highly plastic, with particular advantages for objects that span both extremes at once. We illustrate these features with animations of elastic and plastic behavior, extreme deformations, and fracture.

More briefly, I discuss the use of a simpler form of dynamic meshing for simulating brachytherapy treatment of prostate cancer.