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An inextensible model for the robotic manipulation of textiles. (English) Zbl 07419839

Summary: We introduce a new isometric strain model for the study of the dynamics of cloth garments in a moderate stress environment, such as robotic manipulation in the neighborhood of humans. This model treats textiles as surfaces that are inextensible, admitting only isometric motions. Inextensibility is derived in a continuous setting, prior to any discretization, which gives consistency with respect to remeshing and prevents the problem of locking even with coarse meshes. The simulations of robotic manipulation using the model are compared to the actual manipulation in the real world, finding that the difference between the simulated and the real position of each point in the garment is lower than 1cm in average even when a coarse mesh is used. Aerodynamic contributions to motion are incorporated to the model through the virtual uncoupling of the inertial and gravitational mass of the garment. This approach results in an accurate, when compared to the recorded dynamics of real textiles, description of cloth motion incorporating aerodynamic effects by using only two parameters.

MSC:
65Nxx Numerical methods for partial differential equations, boundary value problems
53Cxx Global differential geometry
68Uxx Computing methodologies and applications

Keywords:
inextensible cloth; FEM simulation; physical modeling; experimental validation; robotic manipulation

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