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Dynamic Simulation of Fabric and Clothes

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ABSTRACT

Computer animation, whether for movies or games, require fast time dependent simulations together as a good rendering of the underlying physics. The ultimate aim is to be "realistic" i.e. to build consistent approximations, (but not necessarily convergent ones).
We will detail our contributions to the animation of fabrics. The fact that fabrics are in general nearly inextensible is not properly treated in most available models. Rather, a penalty type extension modulus is introduced. This leads to stiff differential equations that are numerically difficult to integrate as we approach inextensibility.
Limiting ourselves to principal fiber directions, we introduce a rigorous treatment of inextensibility, using constrained Lagrangian mechanics. The inextensibility constraint is treated implicitly. To be computationally effective we use an original fast projection method on the constraint manifold. Results show a better 'realistic' behavior while being computationally savvy.
Using similar machinery, we introduce a new algorithm for handling contact for cloth simulation. We prevent collisions by applying unilateral constraints (obstacles) and fabric-fabric (self) contact constraints. The method can be applied together with the inextensibility constraints, or with traditional, elastic treatment of the fabric. State of the art collision-reaction algorithms are explicit and are applied at the end of the time stepping. Hence there is no interaction with the actual material properties (shear, stretch, or bend). The first contribution is in the simultaneous treatment of material properties and collision reaction; this leads to reduced strain and therefore allows taking larger time steps. Second contribution involves an implicit constraint for handling self-collisions; the constraint is invariant to rigid body transformation, an important property for momentum preservation.
Examples of animation are given.