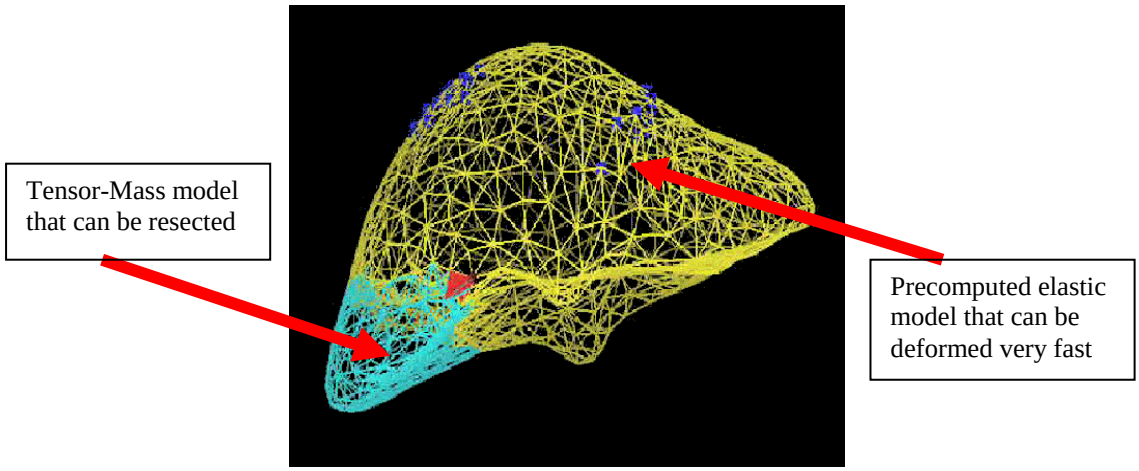
Patent entitled :
"Electronic Device for processing image-data,
for simulating the behaviour of a deformable object"

French Patient Number : FR 9714506
European Patient Number : EP 0 953 168 B1
Us Patent Application Number : US 10/061 455
International Patent Number : WO9926119A1

Summary of patent content :

The patent covers the simulation of soft tissue deformation. Given an object discretized as a set of tetrahedra, we propose a methodology for computing efficiently its deformation even when this object undergoes topological changes (tearing, cutting …). We assume that the object material is linear elastic but potentially anisotropic and non homogeneous.
To optimize performance, the process described in the patent consists in combining two approaches. The former approach precomputes the inverse of the stiffness matrix thus leading to fast deformation but without allowing topological changes. The latter called "Tensor-Mass" approach uses a specific data structure to compute deformation in a dynamic way (time integration). This data structure is designed to optimize the addition or removal of tetrahedral elements and the "Tensor-Mass" model performs well when simulating cutting or tearing. The combination of those methods is a very powerful solution to simulate efficiently (possibly in real-time) deformable structures submitted to topological changes. Applications of this process include the simulation of soft tissue deformation (surgery simulation, biomechanical modeling), the deformation of mechanical parts in the context of virtual reality applications,...

See publication : S. Cotin, H. Delingette, and N. Ayache. **A Hybrid Elastic Model allowing Real-Time Cutting, Deformations and Force-Feedback for Surgery Training and Simulation**. *The Visual Computer*, 16(8):437-452, 2000.



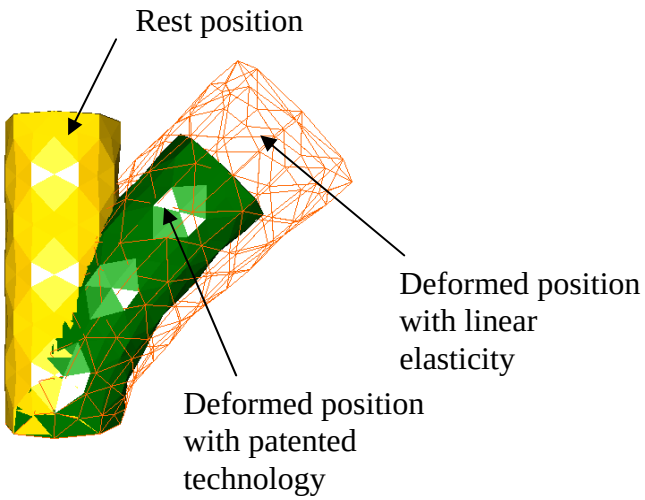
Patent entitled:

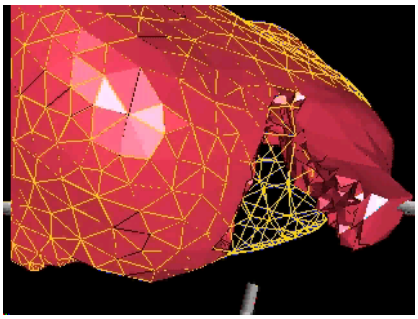
“Material deformations simulation device specially for soft body tissues”

Us Patent Application Number : US2002183992-A1
European Patent Number : EP1231568
French Patent Number : FR2820534-A1

Summary of patent content :

The patent covers also the simulation of soft tissue deformation. Given an object discretized as a set of tetrahedra, we propose a methodology for computing efficiently the deformation of such an object even when it is subject to large rotations or large displacements.
A common method to compute in real-time the deformation of a tetrahedral mesh has been to add a linear spring at each edge of the mesh. While achieving good computational performance, the “spring-mass” approach is not mechanically realistic because it is a discrete formulation that does not rely on continuum mechanics. Setting the stiffness of each spring to a realistic value is often a difficult task.
Another common approach is to use the theory of hyperelasticity and the finite-element method to simulate the deformation of structures. Because the displacement of each node from its reference position may be large (finite strain hypothesis), this approach usually leads to lengthy and complex computations.
The method described in this patent combines the advantages of both approaches. First, its formulation only depends on the variation of each edge lengths, just as springs. Second, it relies on continuum mechanics and therefore it can be used to model any hyperelastic material (especially the St-Venant Kirchoff material). To summarize the methodology patented here is ideal for the efficient simulation of deformable structures undergoing complex deformations. Applications of this process include the simulation of soft tissue deformation (surgery simulation, biomechanical modeling), the deformation of mechanical parts in the context of virtual reality applications,...





Real-time deformation and cutting of liver parenchyma with patented technology