

SIGGRAPH2011

Sensitive Couture for Interactive Garment Editing and Modeling



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Creating a New Pattern is Difficult





Drawing a pattern



Fitting on a mannequin



Clothing Design for Virtual Creatures is Also Difficult



Can we design clothing for the Armadillo ?



Interaction is essential for design





Live Demo





Related Work on Fast Cloth Simulation

Mass-spring system

Pre-computation



All assume a fixed clothing pattern



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[Vassilev01]





[Wang10]



[Aguiar10]

Related Work on Interactive Garment Design



P.Volino and N.Magnenat-Thalmann [2005]

We build a system using sensitivity analysis

What does it take to enable interactive simulation and design for high-resolution meshes?

Attempt #1: Dynamic Simulation Fails



Attempt #2: Sensitivity Analysis is Promising



Sensitivity Analysis

- Studied in engineering [Keulen05, Kuang-Hua95, Jeff97, Dailey89, Sobieszczanski90, Seonho00]
- Used mainly in offline optimization
- Linear prediction



[Gleicher and witkin 91]



[Smith et al. 05]



[Alexandre et al. 10]

Statics = Zero Force Residual



R=0 : Static equilibrium

Equilibrium Shape is Function of Cloth Patternth shape Equilibrium **R=0 Newton's Iteration**

²D cloth pattern



2D Pattern Mesh Movement with Mouse



We Remesh and/or Remap Current Mesh

Remap with positive mean value coordinates [Lipman et al .07]

We occasionally perform remesh





Linear sensitivity is not enough for large mouse movement



Nonlinear Approximation - During Mouse Dragached solutions & sensitivities



Newton's iteration with the sensitivity approximation





Progressive Nonlinear Augmentation



Result of Nonlinear Augmentation



Sensitivity for Contact & Friction



RESULT

A variety of cloth pattern designs is possible with our system

Live Demo



Paper Craft





[°] FUTURE WORK

Self Contact



Flicker photo by "Nemo's great uncle"



Flicker Photo by "Tomas Fano"

More Materials

- Hair
- 3D solid
- Elasto-plastic material
- Fluid

Now is the time for IDSI



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IVERSITY



Standard Finite Element Method

Solve 3D cloth shape X assuming fixed 2D cloth pattern X



Linear Sensitivity Analysis

Compute response to changing cloth pattern



Customized Cloth Design



We can design clothes for our dogs!!

Armadillo Tailoring





Robust & Fast Cloth Model

Membrane	Bending
Stabilized StVK CST	Isometric Bending Model [Bergou06]
StVK CST [Volino09] Discrete Shell [Grinspun03] Edge Spring Model [Delingette08] Co-rotational Linear Triangle [Bittnar96]	Discrete Kirchhoff Triangle [Batoz80] Nonlinear Hinge [Bridson03,Grinspun03]

We applied stabilization [Teran05] assuming quasi-static state

Cloth Wrinkle in Naïve Method



Timings

	coarse	fine	bending	stretching	area density	drag operations (fps)			coarse solve (fps)			fine solve (fps)			remesh (ms)	mesh (ms) sens		ms)	GMLS interp. (ms)
examples	nodes	nodes	stiffness (Nm)	stiffness (N/m)	(kg/m^2)	avg	max	min	avg	max	min	avg	max	min	avg	avg	max	min	avg
Blue Armadillo (Fig. 4)	1682	10168	10-8	10	0.20	17.0	19.9	10.1	17.4	20.4	15.3	2.4	2.7	1.9	233	145	178	82	0.38
Man (Fig. 9)	1634	10149	10-8	10	0.20	15.0	17.2	11.1	20.4	22.7	18.8	2.4	3.2	2.0	227	316	492	170	0.36
Woman (Fig. 9)	1580	10040	10-8	10	0.20	19.5	23.0	16.0	25.1	28.5	22.9	2.9	3.8	2.6	144	310	440	155	0.38
Armadillo (Fig. 9)	1600	10073	5x10 ⁻⁶	200	0.15	19.3	22.0	17.0	25.1	26.3	23.8	3.1	3.2	3.1	146	228	513	116	0.40
Heart (Fig. 10)	1543	5032	3x10 ⁻⁴	2000	0.08	20.7	22.2	19.3	24.2	25.5	22.7	7.2	10.0	5.1	123	639	419	767	0.39

Table 1: SC session parameters, statistics, and timings: all timings were measured on an Intel Core 2 Duo 2.66 GHz laptop, 4Gb memory.



