Reference List for 15-464 / 15-664 Feb 24, 2020

We started by looking at the following paper. If you really want to get a spring mass cloth simulation right, my favorite reference is this one. Features to look into include (1) how collisions (including self collisions) are handled by applying impulses to the cloth particles so that these collisions are never allowed to happen and (2) how impulses are similarly applied for "strain limiting" so that the cloth never stretches beyond a desired amount.

Bridson R, Fedkiw R, Anderson J. Robust treatment of collisions, contact and friction for cloth animation. ACM Transactions on Graphics (ToG). 2002 Jul 1;21(3):594-603. http://dl.acm.org/citation.cfm?id=566623

Going back to cloth, one problem with spring mass systems is that it can be difficult to set parameters for realistic appearance and to illustrate the different properties of different types of cloth. These two papers attempt to set parameters by optimizing to fit measurements taken on actual cloth swatches.

Wang H, O'Brien JF, Ramamoorthi R. Data-driven elastic models for cloth: modeling and measurement. InACM Transactions on Graphics (TOG) 2011 Aug 7 (Vol. 30, No. 4, p. 71). ACM. http://graphics.berkeley.edu/papers/Wang-DDE-2011-08/

Bhat, Kiran S., Christopher D. Twigg, Jessica K. Hodgins, Pradeep K. Khosla, Zoran Popović, and Steven M. Seitz. "Estimating cloth simulation parameters from video." In *Proceedings of the 2003 ACM SIGGRAPH/Eurographics symposium on Computer animation*, pp. 37-51. Eurographics Association, 2003. http://graphics.cs.cmu.edu/projects/clothparameters/

This paper addresses perceptual issues, trying to understand how simulation parameters might map to perception of cloth properties.

Sigal, Leonid, Moshe Mahler, Spencer Diaz, Kyna McIntosh, Elizabeth Carter, Timothy Richards, and Jessica Hodgins. "A perceptual control space for garment simulation." *ACM Transactions on Graphics (TOG)* 34, no. 4 (2015): 117.
https://dl.acm.org/citation.cfm?id=2766971
https://www.youtube.com/watch?v=LJ_zxvsdcrw

Getting a good looking simulation is difficult, yet there are quite a number of great systems out there. Here are two which have source code available. We took a look at the second of these.

Umetani, Nobuyuki, Danny M. Kaufman, Takeo Igarashi, and Eitan Grinspun. "Sensitive couture for interactive garment modeling and editing." *ACM Trans. Graph.* 30, no. 4 (2011): 90-1. http://www.cs.columbia.edu/cg/SC/

Narain, Rahul, Armin Samii, and James F. O'Brien. "Adaptive anisotropic remeshing for cloth simulation." *ACM transactions on graphics (TOG)* 31, no. 6 (2012): 152. http://graphics.berkeley.edu/resources/ARCSim/

This paper used ArcSim in a data-driven technique which used precomputation to get real-time display of clothing simulation.

Kim, Doyub, Woojong Koh, Rahul Narain, Kayvon Fatahalian, Adrien Treuille, and James F. O'Brien. "Near-exhaustive precomputation of secondary cloth effects." *ACM Transactions on Graphics (TOG)* 32, no. 4 (2013): 87. http://graphics.cs.cmu.edu/projects/exhaustivecloth/

This paper looked at untangling layers of clothing using implicit functions

Buffet, Thomas, Damien Rohmer, Loïc Barthe, Laurence Boissieux, and Marie-Paule Cani. "Implicit untangling: a robust solution for modeling layered clothing." ACM Transactions on Graphics (TOG) 38, no. 4 (2019): 1-12. https://hal.archives-ouvertes.fr/hal-02129156/file/main.pdf

This paper explores GPU programming to speed cloth simulation:

Tang, Min, Zhongyuan Liu, Ruofeng Tong, and Dinesh Manocha. "I-cloth: incremental collision handling for GPU-based interactive cloth simulation." In *SIGGRAPH Asia 2018 Technical Papers*, p. 204. ACM, 2018. http://gamma.cs.unc.edu/CAMA/

This paper creates a cloth simulation model that is differentiable so that it can be used as part of the inner loop in learning software (e.g., learning to match visual appearance from video):

Liang, Junbang, Ming Lin, and Vladlen Koltun. "Differentiable Cloth Simulation for Inverse Problems." In Advances in Neural Information Processing Systems, pp. 771-780. 2019. http://papers.nips.cc/paper/8365-differentiable-cloth-simulation-for-inverse-problems.pdf

This paper uses a mixed grid and particle based representation of cloth (remember the example of sliding off the clothesline?)

Weidner, Nicholas J., Kyle Piddington, David IW Levin, and Shinjiro Sueda. "Eulerian-on-lagrangian cloth simulation." ACM Transactions on Graphics (TOG) 37, no. 4 (2018): 1-11. http://faculty.cs.tamu.edu/sueda/projects/eol-cloth/

We quickly glanced at this paper which tries to get contact friction right.

Li, Jie, Gilles Daviet, Rahul Narain, Florence Bertails-Descoubes, Matthew Overby, George E. Brown, and Laurence Boissieux. "An implicit frictional contact solver for adaptive cloth simulation." *ACM Transactions on Graphics (TOG)* 37, no. 4 (2018): 52. http://www-users.cselabs.umn.edu/~lixx4611/contact_friction.html

This paper pioneered simulating cloth at the yarn level.

Kaldor, Jonathan M., Doug L. James, and Steve Marschner. "Simulating knitted cloth at the yarn level." In *ACM Transactions on Graphics (TOG)*, vol. 27, no. 3, p. 65. ACM, 2008. https://www.cs.cornell.edu/projects/YarnCloth/

Here is a more recent paper building on that work to simulate both woven and knitted cloth:

Cirio, Gabriel, Jorge Lopez-Moreno, and Miguel A. Otaduy. "Yarn-level cloth simulation with sliding persistent contacts." IEEE transactions on visualization and computer graphics 23, no. 2 (2016): 1152-1162. https://ieeexplore.ieee.org/document/7516643 https://www.youtube.com/watch?v=bDZQDRp0rSg

A deep learning approach to cloth simulation:

Lahner, Zorah, Daniel Cremers, and Tony Tung. "Deepwrinkles: Accurate and realistic clothing modeling." In Proceedings of the European Conference on Computer Vision (ECCV), pp. 667-684. 2018. http://openaccess.thecvf.com/content_ECCV_2018/papers/Zorah_Laehner_DeepWrinkles_Accurate_and_ECCV_2018_paper.pdf https://www.youtube.com/watch?v=xVaLmiuIxHw

The topic of these papers is designing with cloth:

Leaf, Jonathan, Rundong Wu, Eston Schweickart, Doug L. James, and Steve Marschner. "Interactive design of periodic yarn-level cloth patterns." In *SIGGRAPH Asia 2018 Technical Papers*, p. 202. ACM, 2018. https://graphics.stanford.edu/projects/yarnsim/

Minchen Li, Alla Sheffer, Eitan Grinspun, and Nicholas Vining. 2018. Foldsketch: enriching garments with physically reproducible folds. *ACM Trans. Graph.* 37, 4, Article 133 (July 2018). http://www.cs.ubc.ca/labs/imager/tr/2018/FoldSketch/

Narayanan, Vidya, Kui Wu, Cem Yuksel, and James McCann. "Visual knitting machine programming." ACM Transactions on Graphics (TOG) 38, no. 4 (2019): 1-13. https://textiles-lab.github.io/publications/2019-visualknit/

I mentioned a couple of other papers along the way, in the context of discussing Geri's game. These are the papers:

Baraff, David, and Andrew Witkin. "Large steps in cloth simulation." In Proceedings of the 25th annual conference on Computer graphics and interactive techniques, pp. 43-54. 1998. https://www.cs.cmu.edu/~baraff/papers/sig98.pdf

Baraff, David, Andrew Witkin, and Michael Kass. "Untangling cloth." ACM Transactions on Graphics (TOG) 22, no. 3 (2003): 862-870. https://graphics.pixar.com/library/UntanglingCloth/paper.pdf

I also mentioned this article and the book it discusses.
https://www.fxguide.com/fxfeatured/cloth-simulation-opening-the-kimono/