15-464/15-664 Reference List for February 27, 2019

We started out with a recent paper that builds on Eulerian techniques but attempts to minimize dissipation during the projection step.

Zehnder, Jonas, Rahul Narain, and Bernhard Thomaszewski. "An advection-reflection solver for detail-preserving fluid simulation." *ACM Transactions on Graphics (TOG)* 37, no. 4 (2018): 85. https://jzehnder.me/publications/advectionReflection/

We then turned to this paper which attempted to characterize perceptual differences in simulation techniques

Um, Kiwon, Xiangyu Hu, and Nils Thuerey. "Perceptual evaluation of liquid simulation methods." *ACM Transactions on Graphics (TOG)* 36, no. 4 (2017): 143. https://ge.in.tum.de/publications/2017-sig-um/

As background, we reviewed the various fluid simulation approaches which they compare.

MP and LS methods are due to Nick Foster's Eulerian approach, with LS indicating a level set method to smooth out and track the fluid surface.

Foster, Nick, and Dimitri Metaxas. "Realistic animation of liquids." Graphical models and image processing 58, no. 5 (1996): 471-483.
http://www.cbim.rutgers.edu/dmdocuments/gmip96%20Foster.pdf

Foster, Nick, and Ronald Fedkiw. "Practical animation of liquids." In *Proceedings of the 28th annual conference on Computer graphics and interactive techniques*, pp. 23-30. ACM, 2001. https://dl.acm.org/citation.cfm?id=383261

PIC and FLIP methods involve switching between grid based and particle based representations to try to obtain the best of both worlds, and are well discussed in these course notes and slides:

SIGGRAPH 2007 course: Robert Bridson and Matthias Müller-Fischer, "Fluid Simulation for Computer Animation" http://www.cs.ubc.ca/~rbridson/fluidsimulation/

The APIC method attempts to conserve affine transformations in the mapping to and from particles and is covered in this paper

Jiang, Chenfanfu, Craig Schroeder, Andrew Selle, Joseph Teran, and Alexey Stomakhin. "The affine particle-in-cell method." *ACM Transactions on Graphics (TOG)* 34, no. 4 (2015): 51. https://dl.acm.org/citation.cfm?id=2766996

WCSPH and IISPH try to solve the problem of simulating incompressibility in SPH fluid simulations efficiently and are covered in the following papers.

Becker, Markus, and Matthias Teschner. "Weakly compressible SPH for free surface flows." In *Proceedings of the 2007 ACM SIGGRAPH/Eurographics symposium on Computer animation*, pp. 209-217. Eurographics Association, 2007. https://dl.acm.org/citation.cfm?id=1272719

Ihmsen, Markus, Jens Cornelis, Barbara Solenthaler, Christopher Horvath, and Matthias Teschner. "Implicit incompressible SPH." *IEEE Transactions on Visualization and Computer Graphics* 20, no. 3 (2014): 426-435. https://ieeexplore.ieee.org/abstract/document/6570475

Texturing Fluid

We briefly looked at this paper on adding texture to a fluid.

Sato, Syuhei, Yoshinori Dobashi, Theodore Kim, and Tomoyuki Nishita. "Example-based turbulence style transfer." *ACM Transactions on Graphics (TOG)* 37, no. 4 (2018): 84. http://nishitalab.org/user/syuhei/TurbuStyleTrans/turbu_styletrans.html

Fluid control

Next, I spoke about fluid control – how do we coerce a fluid into taking on keyframes. The go-to references are the first two, while the third shows an extension by previous 15-464 students. We talked exclusively about the second of these papers, but the others are included for reference.

Fattal, Raanan, and Dani Lischinski. "Target-driven smoke animation." In *ACM Transactions on Graphics (TOG)*, vol. 23, no. 3, pp. 441-448. ACM, 2004.

McNamara, Antoine, Adrien Treuille, Zoran Popović, and Jos Stam. "Fluid control using the adjoint method." In ACM Transactions On Graphics (TOG), vol. 23, no. 3, pp. 449-456. ACM, 2004. http://grail.cs.washington.edu/projects/control/

Alfred Barnat, Zeyang Li, James McCann, and Nancy S. Pollard, Mid-Level Smoke Control for 2D Animation, Proceedings of Graphics Interface 2011 http://graphics.cs.cmu.edu/projects/mlsc/

Fluids Motion Capture

We also looked briefly at using real-world images or 3D point clouds to help guide a simulation. Here are the examples we saw:

Wang, Huamin, Miao Liao, Qing Zhang, Ruigang Yang, and Greg Turk. "Physically guided liquid surface modeling from videos." In *ACM Transactions on Graphics (TOG)*, vol. 28, no. 3, p. 90. ACM, 2009. http://vis.uky.edu/~gravity/Research/WaterRec/WaterRec.html

Li, Chuan, David Pickup, Thomas Saunders, Darren Cosker, David Marshall, Peter Hall, and Philip Willis. "Water surface modeling from a single viewpoint video." *Visualization and Computer Graphics, IEEE Transactions on* 19, no. 7 (2013): 1242-1251. http://www.staff.science.uu.nl/~li000042/Water.html

Gregson, James, Ivo Ihrke, Nils Thuerey, and Wolfgang Heidrich. "From Capture to Simulation-Connecting Forward and Inverse Problems in Fluids." *ACM Transactions on Graphics* 33 (2014): 11. http://www.cs.ubc.ca/labs/imager/tr/2014/FromCaptureToSimulation/#files

SIGGRAPH 2013 course

You may find this course interesting:

Nils Thuerey, Theodore Kim, Tobias Pfaff, "Turbulent Fluids," http://www.ntoken.com/course2013.html

Heightfields

We didn't talk about procedural water and heightfields, but these are still good techniques to know about for fast water to create some kinds of effects.

Procedural water has a long history as you might expect. I mentioned Darwin Peachey's paper on the topic, which you can find here.

Peachey, Darwyn R. "Modeling waves and surf." ACM Siggraph Computer Graphics. Vol. 20. No. 4. ACM, 1986. http://dl.acm.org/citation.cfm?id=15893

Also check out this paper for procedural waves:

A. Fournier and W. T. Reeves. A simple model of ocean waves, SIGGRAPH 86, pages 75–84 http://dl.acm.org/citation.cfm?id=15894

Here is a good explanation of a heightfield technique:

J. O'Brien and J. Hodgins, Dynamic simulation of splashing fluids, In Computer Animation 95, pages 198–205 http://graphics.berkeley.edu/papers/Obrien-DSS-1995-04/