15-464/15-664 Reference List for April 12, 2017

I began by talking about some research we have done on hand motion, using it as an example of creating PD controllers from motion capture data.

Pollard, Nancy S., and Victor Brian Zordan. "Physically based grasping control from example." *Proceedings of the 2005 ACM SIGGRAPH/Eurographics symposium on Computer animation*. ACM, 2005. http://dl.acm.org/citation.cfm?id=1073413

This recent paper uses contact invariant optimization (CIO) to obtain hand motions from very sparse information such as a final object pose.

Mordatch, Igor, Zoran Popović, and Emanuel Todorov. "Contact-invariant optimization for hand manipulation." *Proceedings of the ACM SIGGRAPH/Eurographics symposium on computer animation*. Eurographics Association, 2012. http://dl.acm.org/citation.cfm?id=2422377

The following paper mixes simulation and interactive control in an interesting way:

Laszlo, Joseph, Michiel van de Panne, and Eugene Fiume. "**Interactive control for physically-based animation**." In Proceedings of the 27th annual conference on Computer graphics and interactive techniques, pp. 201-208. ACM Press/Addison-Wesley Publishing Co., 2000. http://www.dgp.toronto.edu/~jflaszlo/interactive-control.html

My group was inspired by that paper to create real-time interaction techniques that operated more directly on characters, allowing the user to direct the character in its local space:

Kim, Junggon, and Nancy S. Pollard. "Direct control of simulated nonhuman characters." *IEEE Computer Graphics and Applications* 31.4 (2011): 56-65. http://www.cs.cmu.edu/~./junggon/projects/directcontrol/directcontrol.htm

Our simple, real-time approach relies on linearity in the relationship between actuated and controlled parameters (at least local linearity which can be assumed for each timestep). To get a better handle on the dynamics equations, see my handout "spatial.pdf" which walks through how to create a forward dynamic simulation of the Luxo lamp character using Featherstone dynamics and associated Spatial Vector notation. http://graphics.cs.cmu.edu/nsp/course/15-869/slides/spatial.pdf

For me, the easiest way to implement and understand forward dynamics was by implementing and using Featherstone inverse dynamics. However, there is an efficient recursive forward dynamics algorithm courtesy of Roy Featherstone. The go-to reference for learning this algorithm from the ground up is Brian Mirtich's 1996 dissertation (Chapter 4). Note that the Appendix in Mirtich's thesis also contains some very useful mathematical information and derivations.

Mirtich, Brian Vincent. "**Impulse-based dynamic simulation of rigid body systems**." PhD diss., University of California, 1996. http://citeseerx.ist.psu.edu/viewdoc/summary?doi=10.1.1.108.783

The following paper is a practical overview of using the Featherstone forward dynamics algorithm from a game development perspective:

Kokkevis, Evangelos. "**Practical physics for articulated characters**." In Game Developers Conference, vol. 2004.
http://www.computerscience.nl/docs/vakken/mgp/literature/Practical%20Physics%20for%20Articulated%20Characters.pdf

If you want another view on recursive inverse dynamics, see the following tutorial from Karen Liu (Chapter 7). This tutorial also includes a derivation of Lagrangian dynamics, from which the familiar equations of motion can be obtained. This tutorial was written in the context of introducing Karen Liu's simulator RTQL8. http://www.cc.gatech.edu/~karenliu/RTQL8_files/dynamics-tutorial.pdf
http://www.cc.gatech.edu/~karenliu/RTQL8.html

The following three papers use creative techniques to obtain artist control over simulated character motion.

Coros, Stelian, et al. "Deformable objects alive!." *ACM Transactions on Graphics (TOG)* 31.4 (2012): 69.
http://dl.acm.org/citation.cfm?id=2185565

Jones B, Popovic J, McCann J, Li W, Bargteil A. Dynamic sprites. InProceedings of Motion on Games 2013 Nov 6 (pp. 39-46). ACM. https://cal.cs.umbc.edu/Papers/Jones-2013-DS/

Bai Y, Kaufman DM, Liu CK, Popović J. Artist-directed dynamics for 2D animation. ACM Transactions on Graphics (TOG). 2016 Jul 11;35(4):145.
http://www.cc.gatech.edu/~ybai30/artistic_dynamics/artistic_dynamics.html