

REVIEW OF SEVERAL TECHNIQUES FOR ACCELERATING PHYSICAL SIMULATIONS ON THE GPU³

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Abstract: This paper reviews several techniques for accelerating physical simulations on the graphics processing unit (GPU). In the current paper they are applied to mass-spring cloth model and cloth-body and cloth-cloth collision detection, but they can be utilized in many other paradigms, where computations can be parallelized. The first technique uses OpenGL GLSL with compute shaders and shader-storage buffers for implementing the entire simulation, cloth model and image space based collision detection, on the GPU. The second utilizes CUDA (OpenCL) for implementing the cloth model with image space based collision detection and visualization in OpenGL. The last one uses again CUDA for the cloth model, but NVidia OptiX ray tracing engine for accelerated collision detection on the GPU. The last approach overcomes some drawbacks of the image space based collision detection. The conclusion compares the three techniques with their advantages and disadvantages and give ideas of possible applications.

Keywords: Physical Simulation, Cloth modelling, GPU programming, Parallel programming

REFERENCES

Terzopoulos D., J. Platt, A. Barr, K. Fleischer (1987). Elastically deformable models. *ACM Proceedings of SIGGRAPH* 21 (4), 205-214.

Magenat-Thalmann N., P. Volino (2005). From early draping to haute couture models: 20 years of research. *The Visual Computer*, 21, 506-519

Nealen A., M. Müller, R. Keiser, E. Boxerman, M. Carlson (2006). Physically based deformable models in computer graphics. *Computer Graphics Forum*, 25 (4), 809-836.

Provot X (1995). Deformation constraints in a mass-spring model to describe rigid cloth behaviour. *Proceedings of Graphics Interface*, 141-155.

Vassilev T.I., B. Spanlang, Y. Chrysanthou (2001). Fast cloth animation on walking avatars. *Computer Graphics Forum* 20 (3), 260-267.

Müller M, B. Heidelberger, M. Teschner, M. Gross (2005). Meshless deformations based on shape matching. *ACM Transactions on Graphics* 24(3), 471-478.

Bender J., D. Weber, R. Diziol (2013). Fast and stable cloth simulation based on multi-resolution shape matching, *Computers & Graphics* 37 (8), 945-954.

M. Müller, B. Heidelberger, M. Hennix, and J. Ratcliff (2007). Position based dynamics, *J. Visual Commun. Image Representation*, vol. 18, no. 2, 109-118.

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