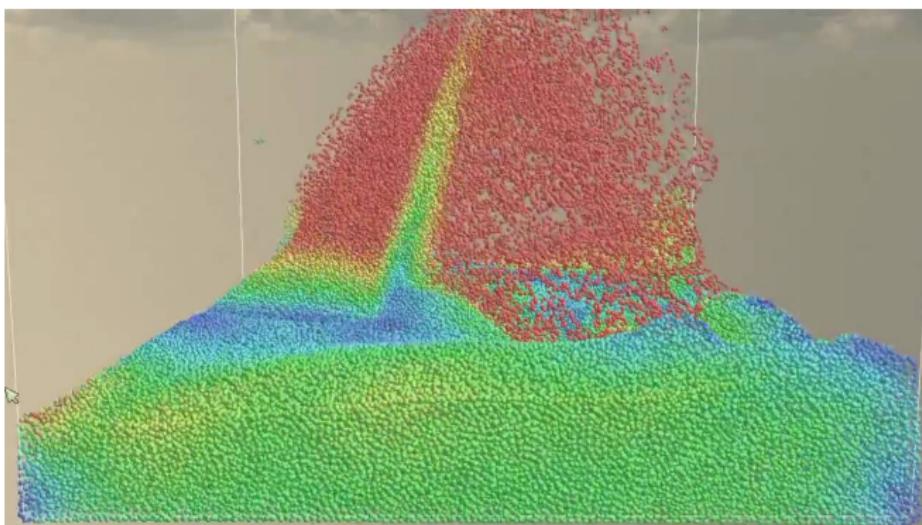


Screen space fluid rendering with curvature flow

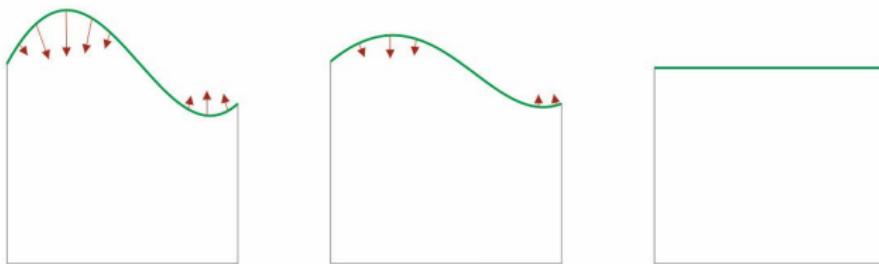
Bram Musters Maarten Terpstra

March 5, 2015

Screen space fluid rendering



Curvature flow



Who, where and when?

- ▶ Wladimir J. van der Laan et al.
- ▶ NVIDIA
- ▶ Rijksuniversiteit Groningen
- ▶ 2009

Why?



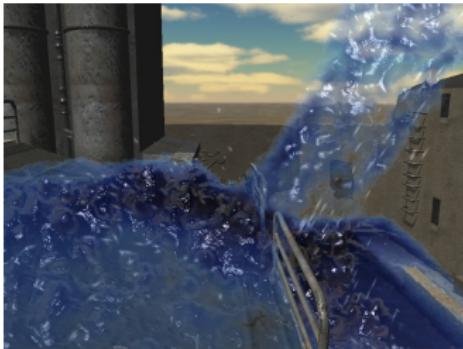
Related work

- ▶ Marching cubes
- ▶ Ray metaballs



Overview of method

1. Surface depth is written to render target
2. Surface depth is smoothed
3. Thickness is written to second render target
4. Dynamic noise texture is generated on the surface of the fluid
5. Smoothed surface depth, noise texture and an image of the scene behind the fluid is combined into the final rendering fluid

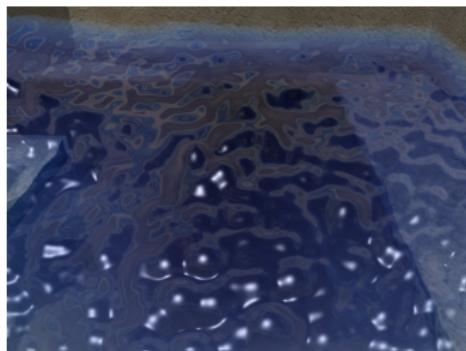
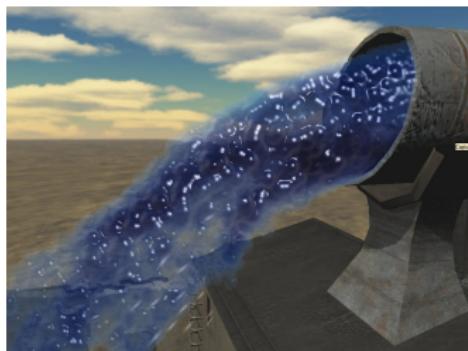


Surface depth

- ▶ Particles rendered as spheres
- ▶ Native depth test
- ▶ No explicit splatting

Surface depth smoothing

- ▶ Remove jelly-like appearance
- ▶ Gaussian blur is unsuitable
- ▶ Curvature flow

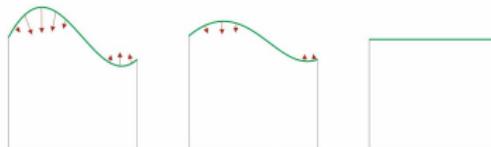


Curvature flow

- ▶ Minimize curvature
- ▶ Transform the surface along the z direction
- ▶ Amount of transformation depends on the magnitude of the mean curvature

$$\frac{\partial z}{\partial t} = H \quad (1)$$

$$H = \frac{\nabla \cdot \hat{n}}{2} \quad (2)$$



Thickness

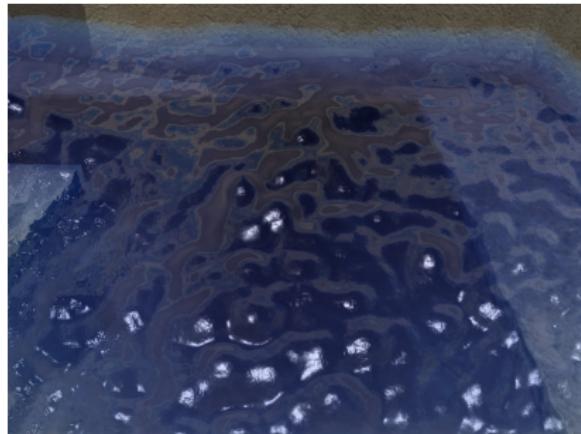
- ▶ Objects become less visible if water is in front of it
- ▶ Attenuate colour of object based on "thickness"

$$T(x, y) = \sum_{i=0}^n d\left(\frac{x - x_i}{\sigma_i}, \frac{y - y_i}{\sigma_i}\right) \quad (3)$$

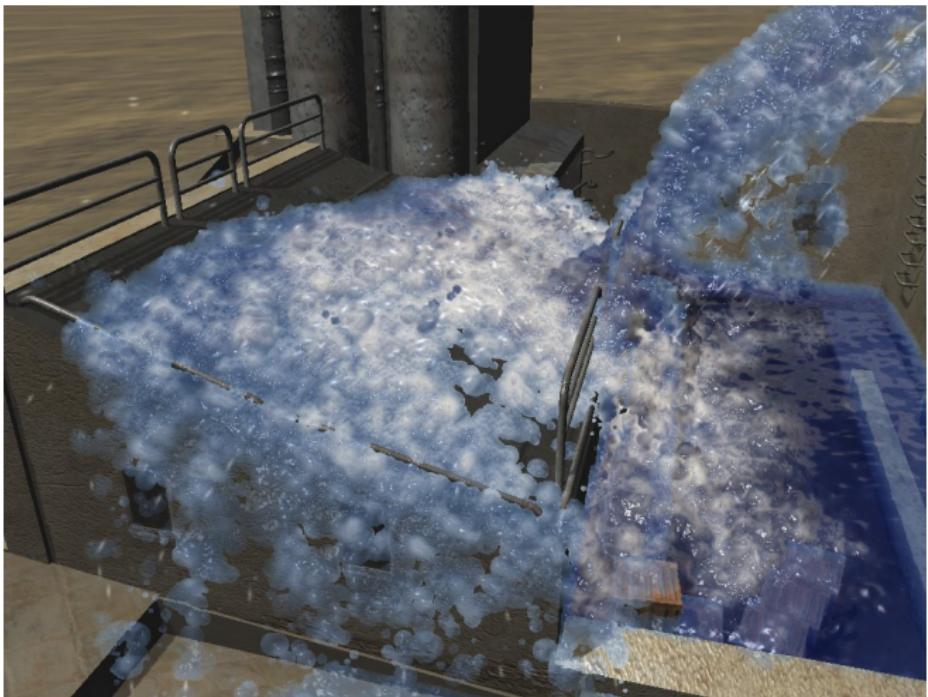
- ▶ Additive blending based on this measure

Noise

- ▶ Assign Perlin noise to each particle
- ▶ Make noise contribute less as particles submerge

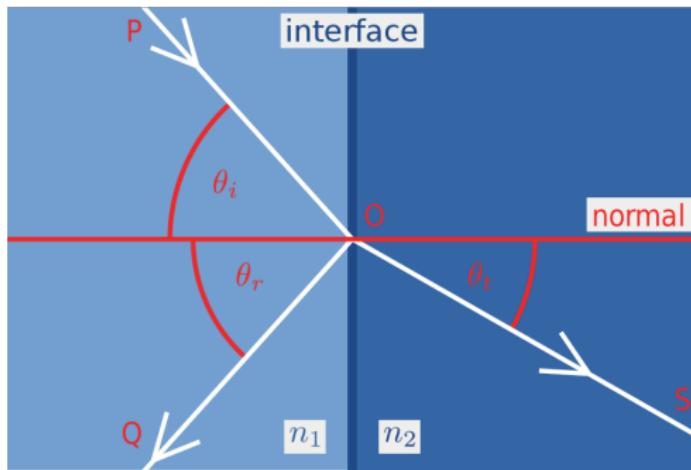


Foam

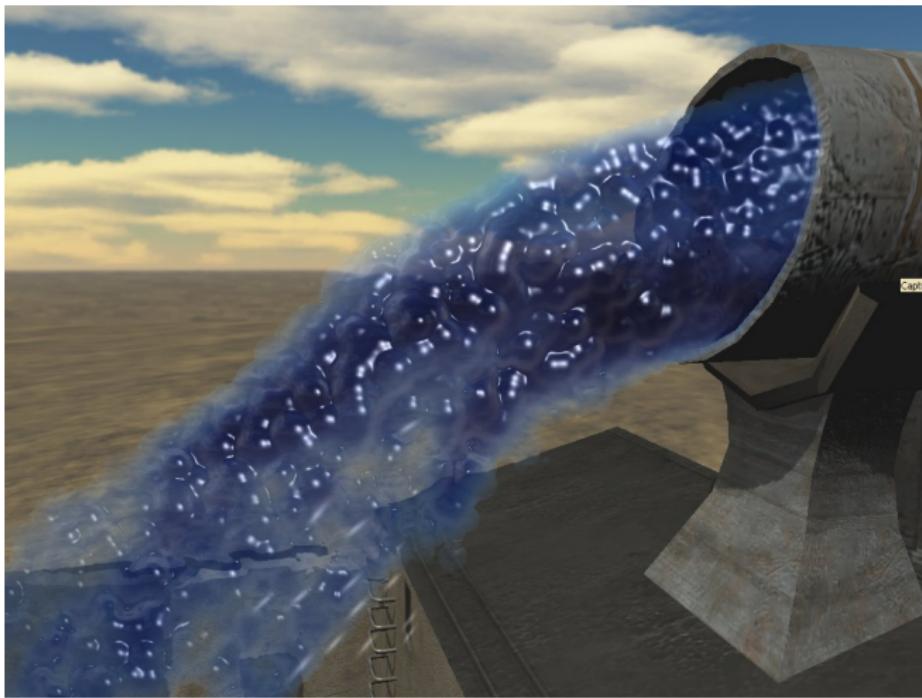


Rendering

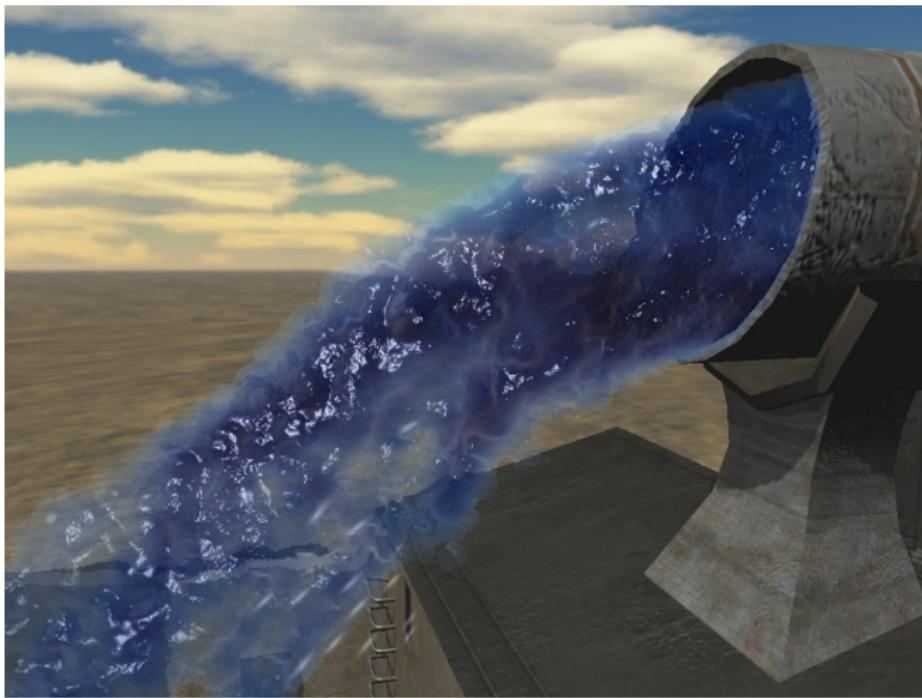
- ▶ Per frame multiple smooth steps performed.
- ▶ Rendered using Phong and Fresnel equations



Results



Results



Future work

- ▶ CUDA
- ▶ Better thickness measure

References

- ▶ van der Laan, Wladimir J., Simon Green, and Miguel Sainz. "Screen space fluid rendering with curvature flow." Proceedings of the 2009 symposium on Interactive 3D graphics and games. ACM, 2009.
- ▶ Zhang, Yanci, Barbara Solenthaler, and Renato Pajarola. "Adaptive sampling and rendering of fluids on the GPU." Proceedings of the Fifth Eurographics/IEEE VGTC conference on Point-Based Graphics. Eurographics Association, 2008.
- ▶ Williams, Brent Warren. Fluid surface reconstruction from particles. Diss. The University Of British Columbia, 2008.