WAVE PARTICLES

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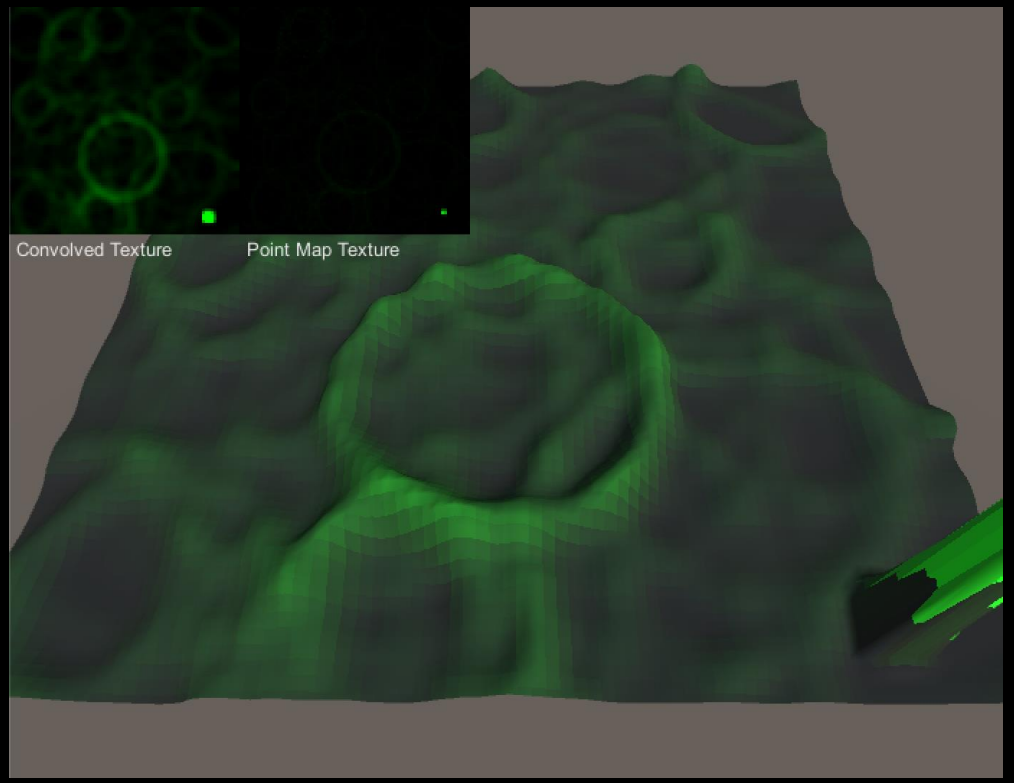
THE BASICS

- Wave Particles [1] are a method to give a convincing (not accurate!) simulation of how water waves form and propagate.
- Can't handle topology-changing water-interactions (splashes, foam, breaking waves etc.)
- Represents a solution to the second order wave equation: $\frac{\partial^2 z}{\partial x^2} + \frac{\partial^2 z}{\partial y^2} = \frac{1}{v^2}\frac{\partial^2 z}{\partial t^2}$
- Objects in water generate particles that represent water disturbances.
- The particles have a constant radius and speed, each with an amplitude, dispersion angle and (normalized) velocity.
- Can generate complete distortion field by drawing particles to texture as single pixels and convolving with a kernel representing the per-particle distortion function.
- Goal is to implement technique in a commercial game-engine (Unity) with extensions!

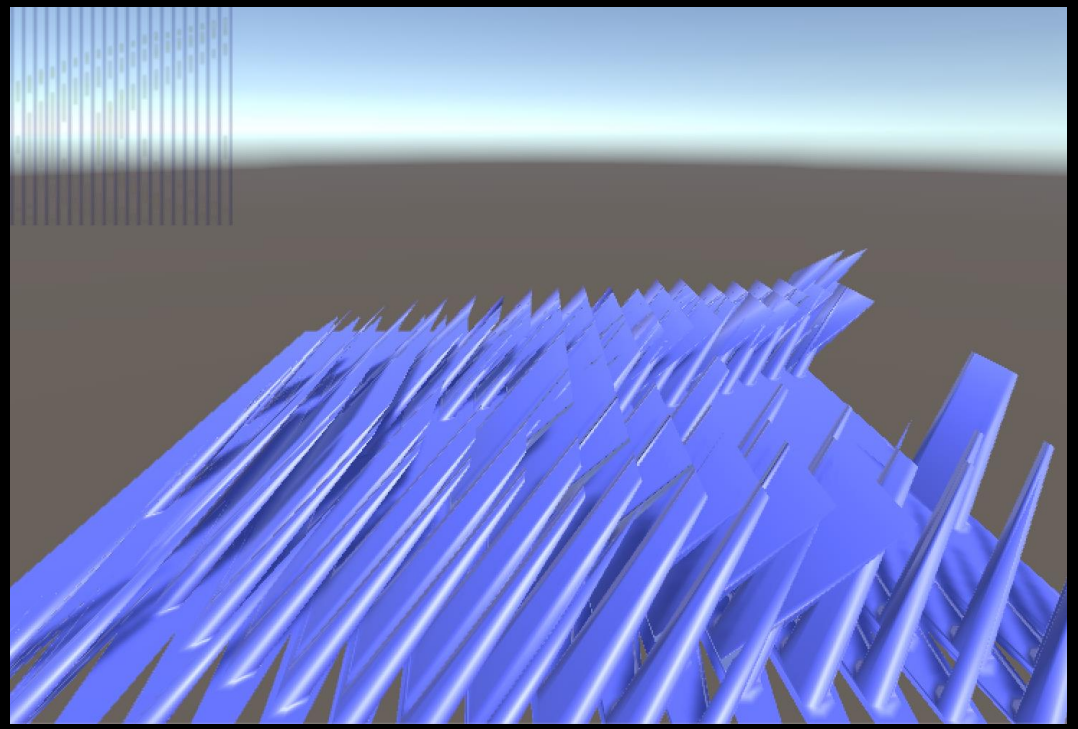
CURRENT STATUS

- Have basic Wave Particles system running on the GPU and CPU
- Can select and change implementation details of components at runtime
- Implemented everything on CPU
- On GPU using:
  - Compute shader to perform basic Wave Particle iteration
  - Pixel shader to convolve point map texture
  - Vertex shader to then apply height-map distortions
- 100, 000 wave particles at ~70FPS on laptop



ISSUES ENCOUNTERED

- GPU different from CPU!
  - CPU-side code must take GPU limitations into account
  - Things WILL silently fail (see image)
- Object serialization in Unity
  - Configurable parameters must be in serialized objects
  - Unity fails to mention this!



GOING FORWARD

- Code cleanup
- Implement buoyancy
- Measure and compare code performance
- Optimise code!
- Extension ideas
  - Multiple planes of wave particles, (to overcome limitation of constant radius and speed)
  - Using above for LOD based on camera position
  - Combining with some kind of 3D fluid-sim
  - Handling rain

SPECIAL THANKS

- Dr. Ian Wassell and Prof. Lawrence Paulson
- Dr. Rafal Mantiuk
- Huw Bowles from Studio Gobo

REFERENCES

[1] Cem Yuksel, Donald H. House, and John Keyser. Wave particles. ACM Transactions on Graphics (Proceedings of SIGGRAPH 2007), 26(3), 2007