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# Introduction

## Motivation

Fluids like liquids and gases are ubiquitous parts of the environment we live in. For instance we all know how it looks like when milk gets filled into a drinking glass. In realtime computer graphics, where we traditionally try to reproduce parts of our world as visually realistic as possible, it’s unfortunately hard to simulate such phenomena. Computational fluid dynamics is a relatively old and well known research topic, but most applications (like in aerodynamics research) aim at results that are as accurate as possible. Therefore the simulations are mostly calculated offline and realtime visualization is mostly used only to render precomputed data sets, if at all.

Realtime applications that do allow the user to interact with authentically (but not necessarily accurately) simulated and rendered fluids (like i.e. water) are today rare. For all types of virtual realities, like surgical training environments or computer games, there’s always demand to cover more aspects of our world and so realtime simulation and rendering of fluids is an interesting field of study. In 2003 Müller, Charypar and Gross sparked additional interest in realtime fluid simulation, with a paper that proposed a relatively simple, particle based fluid-model [Mul03]. Since then different aspects of realtime particle based fluid simulation where covered in a couple of papers from authors around the world. This thesis gives an overview on the topic, as it discusses my implementation of the particle simulation and a suitable water renderer.

## How to simulate fluids

In the nineteenth century Claude Navier and George Stokes created the fundamentals of modern fluid dynamics as they formulated the well known Navier-Stokes equations. With these equations, which describe the conservation of momentum, together with two additional equations for mass and energy conservation, it’s possible to simulate the flow behavior of Newtonian fluids (which cover most of the every-day-seen liquids like water and many oils and gases).

# Fluid simulation

# Visualization

## Optical characteristics of water

# Conclusion

## Summary

## Improvements and alternatives

# References

**[Mul03] Müller M., Charypar D., Gross M. 2003.** Particle-Based Fluid Simulation for Interactive Applications. *Proceedings of 2003 ACM SIGGRAPH Symposium on Computer Animation.* 2003, pp. 154-159.