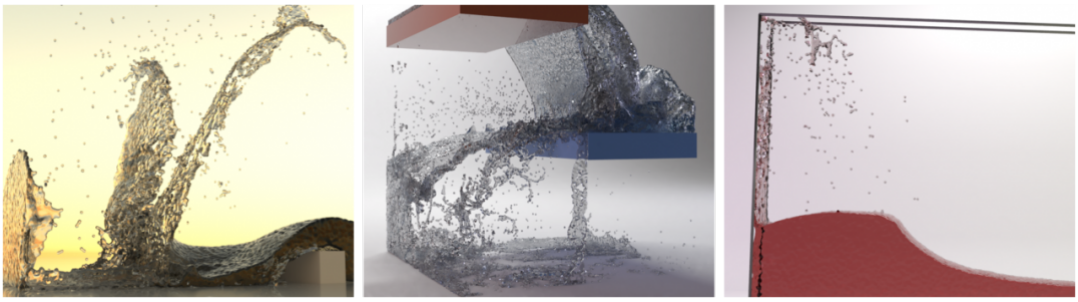
Liquid Simulation Enrichment using Deep Learning

This project aims for developing an efficient and effective method that enriches the visual fidelity of liquid animation by employing machine learning (ML) techniques. The topic requires thorough understanding of partial differential equations, in particular, the Navier-Stokes equations that model a variety of fluid flows and good programming skills in C/C++ and Python. Moreover, you should be able to use open-source tools such as TensorFlow and mantaflow.



Objectives

The first goal of this project is to understand the fundamental knowledge of fluid simulation and review/revisit the *de facto* standard fluid solver, fluid implicit method (FLIP) [2,3]. In conjunction with neural network [6], you will acquire practical implementation experiences of FLIP and its ML-based variant, MLFLIP [1]. The code-base[1] that is an implementation of the MLFLIP algorithm will be provided; thus, as a first step, you are asked to accustom the open-source libraries, mantaflow[2] and TensorFlow[3], which are employed for MLFLIP. Once you understand the basics of both fluid simulation and machine learning with the code-base, you will extend the given model such that, e.g., it enables different droplet sizes, adds secondary effects such as bubbles and waves [4,5], etc. Please note that this project is a research-oriented topic. Thus, you are strongly encouraged to autonomously investigate the domain and lead this project for the potential extensions.

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References

[1] 2017, Um et al., Liquid splash modeling with neural networks, Computer Graphics Forum.
[2] 2015, Bridson, Fluid simulation for computer graphics, CRC Press.
[3] 2005, Zhu and Bridson, Animating sand as a fluid, ACM Trans. Graph.
[4] 2012, Ihmsen et al., Unified spray, foam and air bubbles for particle-based fluids, The Visual Computer.
[5] 2015, Mercier et al., Surface turbulence for particle-based liquid simulations, ACM Trans. Graph.
[6] Neural networks and deep learning, http://neuralnetworksanddeeplearning.com/

1 https://github.com/kiwonum/mlflip
2 http://mantaflow.com/
3 https://www.tensorflow.org/