Differentiable Stable Fluid Solver using TensorFlow

This project aims to implement a stable fluid solver [1] using machine learning library, TensorFlow[1], such that the solver can be differentiable and integrated into training processes [2]. This topic requires good understanding of partial differential equations in particular, the Navier-Stokes equations that model a variety of fluid flows as well as good programming skills particularly in Python. The student will be able to make good use of TensorFlow.

Objectives

In this project, you aim to implement a smoke simulation solver using math APIs of TensorFlow. To begin with, you will first start with a 2D version solver. The implementation requires a good understanding and use of TensorFlow APIs. For the 2D version, you need to visualize simulation results using simple visualization tools such as matplotlib. Once you achieve the 2D version, you extend it to 3D. To this end, the core part will not change much, but, you should investigate its visualization method. As an example, OpenVDB can be used for saving/loading the simulation results and Blender for rendering. You need to figure out how to use those open-source libraries for the given tasks.

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References

[1] Jos Stam. 1999. Stable fluids. In Proceedings of the 26th annual conference on Computer graphics and interactive techniques (SIGGRAPH '99). ACM Press/Addison-Wesley Publishing Co., USA, 121–128. DOI:https://doi.org/10.1145/311535.311548

[2] Nils Thuerey, Philipp Holl, Maximilian Mueller, Patrick Schnell, Felix Trost, and Kiwon Um. Physics-based Deep Learning. https://www.physicsbaseddeeplearning.org/intro.html

1 https://www.tensorflow.org/