VirtuaSchlieren: A GPU Based Numerical Schlieren Image Simulator for the Investigation of Non-Ideal Compressible Flows.

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Abstract

A computational post-processing tool for the generation of numerical Schlieren images, suitable for the numerical investigation of Non-Ideal Compressible Fluid Dynamic flows, is presented in this paper.

When dealing with fully three-dimensional flows information inside the domain cannot be, in general, measured without affecting the motion of the fluid itself. As a result, a direct comparison of quantities from the numerical fluid dynamic solution against experimental data is often impossible to carry out. By means of the Schlieren technique, an experimental visualization method which exploits light-medium interaction phenomena, it is possible to retrieve information regarding the inner domain without affecting the flow-field.

The *VirtuaSchlieren* post-processing tool provides an encoded library which allows to elaborate numerical data, produced by a fluid dynamic solver, in order to predict expected experimental Schlieren images. Different mathematical models for the estimation of medium refraction index are implemented within the *VirtuaSchlieren* framework. Such collection is comprehensive of the simple Gladston-Dale model and the Lorentz-Lorenz equation. Since nowadays Non-Ideal Compressible Fluid Dynamic Flows are gaining more momentum among the scientific community, also mathematical models suitable for the computation of the refraction index in Non-Ideal flows are available. The *VirtuaSchlieren* post-processing tools is able to reproduce the behaviour of diverse experimental set-up such as the single pass or the double-pass reflected Schlieren.

The *VirtuaSchlieren* is a modular framework designed to exploit massively parallel architectures, such as multi-processor systems and the NVIDIA Graphic Card Unit technology, resulting in an hybrid code based both on Message Passing Interface protocol and on CUDA programming language.

Numerical Schlieren predictions from *VirtuaSchlieren* are in good agreement with both theoretical and experimental data available from literature.

References

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