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·Editorial·

Simulation and interaction of fluid and solid dynamics

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Fluid and solid simulation is to generate a realistic simulation of fluids and solids, in particular for the fluids such as water and smoke, with computation of Euler equations or Navier−Stokes equations conducted to govern the real fluid physics. Fluid simulation is an important field by its wide applications in many fields and industries, such as film and game simulation, weather forecasting, natural disaster simulation and protection, simulation in maritime and aviation. There are basically two main categories of methods for fluid simulation, data-driven methods and physically-based methods. The data-driven models establish a direct mapping between variables and extract their relationship from historically measured data by the algorithms developed in the fields of statistics, computational intelligence, machine learning, and data mining. The physically-based models mainly express interior behavior through solving some mathematical equations that represent the motion of objects. The complicated interaction of fluid and solid is also an important topic in fluid simulation. Fluid-solid interaction happens in various forms in our lives.

We have selected in this special issue seven papers that provide the latest updates on the development of Data-driven simulation in fluids animation, and various physically based approaches such as the smoothed particle hydrodynamics (SPH), two-phase liquid simulation, cumulus cloud modeling.

The field of fluid simulation is developing rapidly, and data-driven methods provide many frameworks and techniques for fluid simulation. Chen et al. presented a survey of data-driven methods used in fluid simulation in computer graphics in recent years. They conclude that the fluid simulation combined with data-driven methods has some advantages, such as higher simulation efficiency, rich detail presentation and different pattern styles, in comparison with traditional methods under the equal parameter framework. It can be seen that the data-driven fluid simulation is not only feasible but also demonstrates its broad prospects.

Interaction of gas and liquid is able to generate many interesting phenomena, such as bubbles rising from the bottom of the liquid. The simulation of two-phase fluids is also a challenging topic in computer graphics. Lyu et al. presented a novel velocity transport technique for two individual particles based on the affine particle-in-cell (APIC) method.

SPH method has been widely used in the simulation of water scenes. As a numerical method of partial differential equations, SPH is capable of easily dealing with the distorted and complex boundary. In order to further improve the performance of SPH method and expand its application scope, Yang et al. introduced the idea of Helmholtz decomposition into the SPH framework and proposed a novel velocity projection scheme for three-dimensional water simulation. Zeng et al. designed an adaptive SPH fluid simulation method with a variable smoothing length, where the smoothing length is adaptively adjusted according to the ratio of the particle density to the weighted average of the density of the neighboring particles.

The imperfect material effect is one of the most important themes to obtain photo-realistic results in rendering. Textile material rendering has always been a key area in the field of computer graphics. Zheng et al. introduced techniques for simulation of staining effects on textiles. Pulling, wearing, squeezing, tearing, and breaking effects are more common imperfect effects of fabrics, these external forces will cause changes in the fabric structure, thus affecting the diffusion effect of stains. Based on the microstructure of yarn, the proposed method handles the effect of the stain on the imperfect textile surface.

The homogenization theory is a perfect match to simulate inhomogeneous deformable objects with its coarse discretization, as it reveals how to extract information at a fine scale and to perform efficient computation with much less DOF. Zhao et al. proposed a homogenization method for the efficient simulation of nonlinear inhomogeneous elastic materials. The proposed homogenization method for nonlinear inhomogeneous elastic materials is capable of capturing the nonlinear dynamics of the original dynamical system well.

Cumulus clouds are important elements in creating virtual outdoor scenes. Zhang et al. developed a deep learning-based method to address the problem of modeling 3D cumulus clouds from a single image. The method employs a three-dimensional autoencoder network that combines the variational autoencoder and the generative adversarial network.

This special issue covers the latest advances in the theories, technologies, and applications of fluid and elastic materials simulation that have been achieved by researchers and engineers in this field. We hope that through the publication of this special issue, useful references will be provided for readers engaged in the related technology research and applications. We would like to thank Virtual Reality & Intelligent Hardware for the guidance and assistance in the publication of this special issue and also thank all reviewers for their timely, patient, and detailed reviews.

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