Yiwei Tu

CSSSKL 594

# METHODOLOGY/SYSTEM DESIGN

…Instruction of the method chapter

1. Application Requirements
2. Implementation platform - Unity3D
3. Fluid Simulation model - Lattice Boltzmann equations (LBE) vs. traditional Navier-Stokes (N-S) equations

Numerical fluid simulations have been used by graphics experts in the last ten years to increase the fidelity of computer-generated animations. They often adopt the conventional methodology, beginning with the Navier-Stokes (N-S) equations, which provide a macroscopic description of the fluid. Given how challenging it is to solve the N-S equations, numerous approximate numerical approaches have been put forth. The lattice Boltzmann method, which has its origins in Ludwig Boltzmann's 1872 Boltzmann equation, is the technique utilized in this project to simulate fluid dynamics. The Boltzmann equation uses kinetic theory to explain the microscopic behavior of a gas. In a single-particle phase space, it provides the statistical distribution of the particles. The main idea of the LBE approach is to model the fluid dynamics using a simplified particle kinetic model.

Short introduction on the N-S equation.

Introduction on the LBE

* History
* Introduction on lattice
* Particle distribution function within a lattice -> density and velocity equations based on the distribution functions
* Streaming step in the LBE
* Collision step in the LBE

Why LBE?

1. It does not involve Poisson equations
2. All operations are simple and local
3. It is easy to incorporate physics that is hard to describe macroscopically
4. Kubelka-Munk Reflectance Model

In order to display the color variance on the watercolor painting generated by the computer, I used the Kubelka-Munk Reflectance (KM) model. The KM model is a physically based model that simulates the scattering and absorption of light by materials. There is an alternative approach to rendering the resulting watercolor artwork, employing the CMY color system to calculate the resulting color. However, CMY color synthesis works best for purely transmitting materials, and pigmented surfaces have both transmitting and reflecting characteristics. Therefore, the KM model, which calculates the transmittance and reflectance of the colored layer, is proposed to calculate the illumination of colorful pigment.

Short introduction on CMY color system

Introduction on the KM model

* Define absorption coefficient K and scattering coefficient S using user-defined values Rw and Rb
* Demonstrate the calculation of Transmittance T and Reflectance R of one layer

1. Programming on GPU