1. Introduction

In grid-based fluid simulations, an issue is that while highly detailed fluids with small eddies can be obtained by increasing the number of grid cells, it costs much more computational time. To address this, various methods for adding details or up-scaling resolutions have been proposed. However, these methods typically generate tiny eddies on a whole surface of fluid, and the result appears too noisy.

We consider the distribution of kinetic energy in the spatial frequency domain and then apply it to two existing methods for adding details. By using our method, noises or external forces can be added to the appropriate positions of fluids and consequently natural-looking details can be achieved.

2. Related Works

Up Resolution

Wavelet Turbulence[1] is a representative method for up-scaling resolution using noise function, which synthesizes high frequency noises to a coarse velocity field based on Kolmogorov’s five-thirds law[3].

Adding Details

Vorticity Confinement[2] introduces external forces that produce eddies into simulated fluid velocities, without changing the grid resolution.

However, in comparison with actual high-resolution simulation results, the result of adding details is too noisy (having small eddies or noise on a surface of the fluid), due to the addition of eddies to a whole surface of fluid uniformly.

3. Our Method

Application to Wavelet Turbulence

After coarse grid simulation, We execute wavelet decomposition to a velocity field, and compute cascade ratio.

If the ratio follows Kolmogorov’s law, we synthesize the noise texture. Otherwise, we simply apply a linear interpolation to a low-res velocity field.

Application to Vorticity Confinement

For each frame of the simulation, we compute the cascade ratio from original simulation. In only places where the ratio follows the law, we add external forces, to produce eddies.

References