# Project: GPU Physics on Water Physics Simulation

Project Description:

The objective of this research is to design and implement a water physics simulation method using GPU programming, which is suitable for video game utilities. The system will have the following key features:

- Real-Time Simulation
- Low Memory Consumption
- Realistic
- Dynamic Interaction with Objects

The water simulation project is based on height field method. Height field method only considers the diversity of height of the water surface waves, but does not consider other complex shaped waveform with horizontal displacement. The height field method is the fastest existing method for water simulation, which is very suitable for game applications.

To accelerate the simulation by utilizing GPU computation power, the technique called Vertex Texture Fetching is used as support Shader Model 3.0 provided by DirectX 9.0c. Vertex Texture Fetching is a technique used in the Vertex Shader stage, which is able to fetch the information from an input texture, and then use it to modify the parameters of the vertices. With this technique, we are able to modify the height of the waves on the height field within GPU, to achieve the maximum processing speed. Algorithm based on the 2D Wave Equation is used as the simulation function in the simulation.
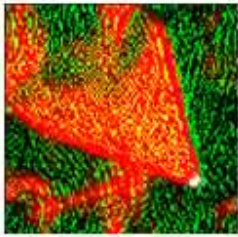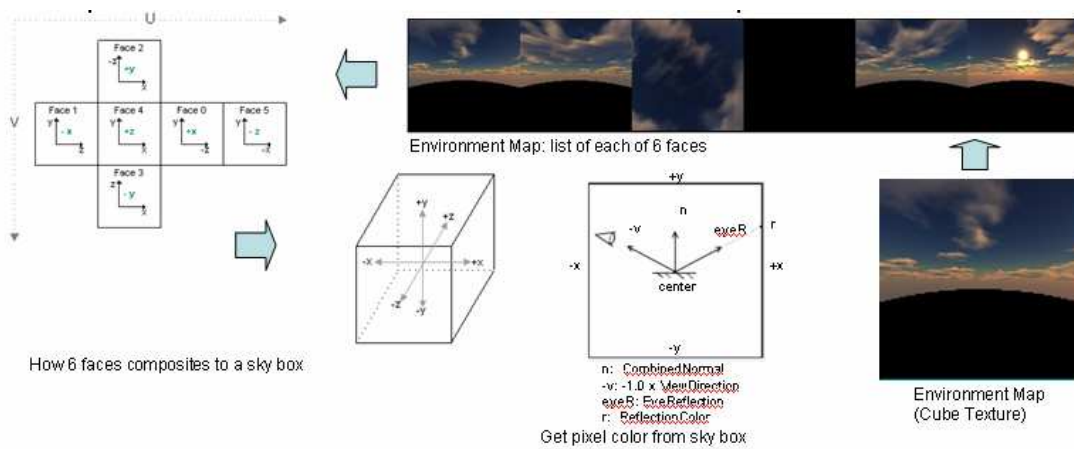
Input texture reflecting height of wave
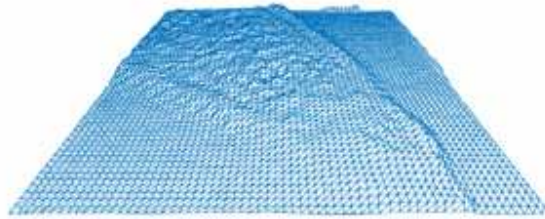
Resultant wave on the grid

To render the water, the following techniques are used:

- Phong Shading Algorithm
- Time-dependent Displacement on Normal Map for Ambient Moving Wave Effect
- Skybox Reflection
- Dynamic Shadow Calculation
- Fresnel Effect

How 6 faces composites to a sky box

Environment Map: list of each of 6 faces

n: Combined Normal
-v: -1.0 x View Direction
eyeR: Eye Reflection
r: Reflection Color

Get pixel color from sky box

Environment Map (Cube Texture)

Skybox Reflection

Dynamic Shadow Calculation

The result of the water simulation is: