REAL-TIME WATER RENDERING & PARTICLE SYSTEM

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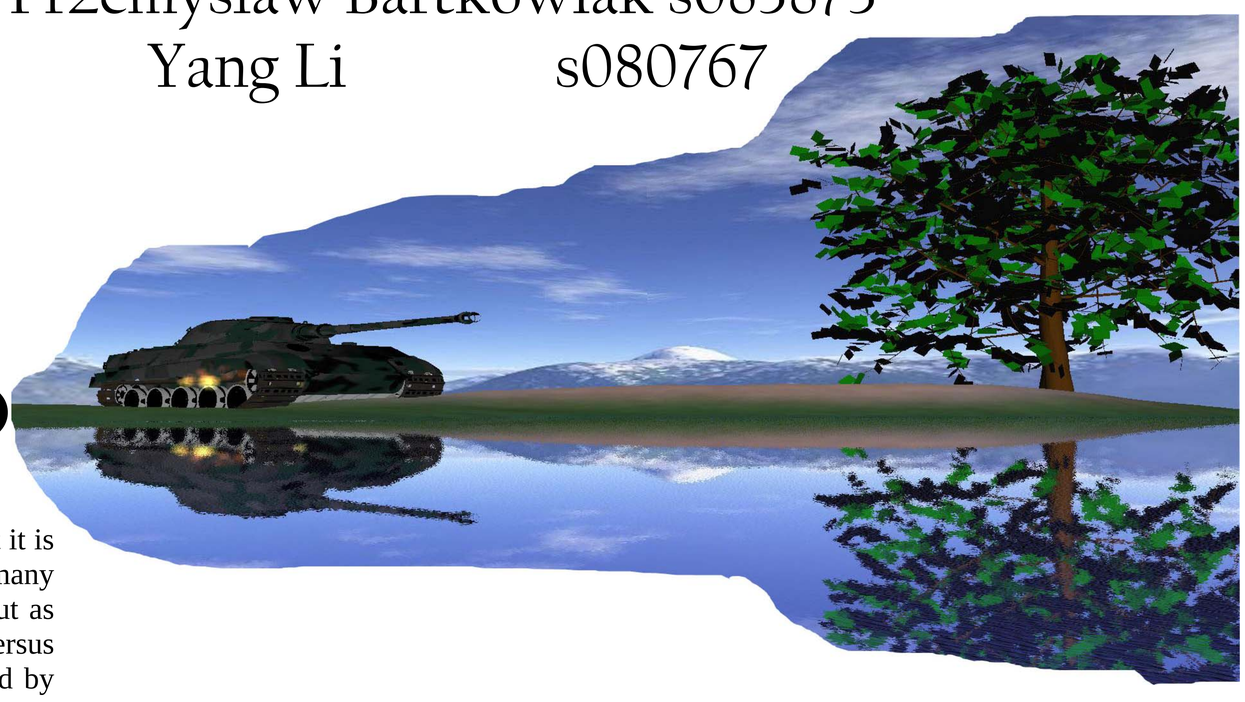


Introduction

WATER RENDERING: Adding flowing water can strengthen realistic visual appeal of a scene, but it is rather hard to make it real time. Nowadays with the advance of programmable 3D hardware, many algorithms previously limited to offline processing have become available for real time usage. But as always when implementing complex effects in interactive contexts such as video games, quality versus performance tradeoffs must be made. A lot of the visual properties of water can be approximated by efficient techniques that, even though not physically correct, look convincing to the human eye.

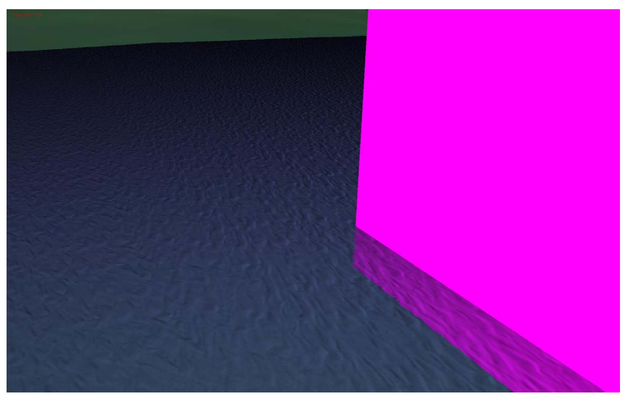
PARTICLE SYSTEM:The term particle system refers to a computer graphics technique to simulate certain fuzzy phenomena, which are otherwise very hard to reproduce with conventional rendering techniques. Examples of such phenomena which are commonly replicated using particle systems include fire, explosions, smoke, moving water, sparks, falling or abstract visual effects like glowing trails, magic spells, etc.

Pure refleciton

Reflection

The first optical effect that strikes the eye is the reflection of the environment in the water. Incoming light from the environment is reflected by the surface, which essentially acts like a large mirror. This reflection is not perfectly stable and clear, but distorted by the turbulences of the surface.

Pure refleciton with bump mapping



Refraction and depth with bump mapping

Refraction

From a visual point of view, refraction distorts the image of all objects under water, again according to the dynamics of the surface. Now, it seems light can sometimes be reflected by the surface and sometimes be transmitted through the water body. The ratio of reflected versus transmitted light at a certain point on the surface is determined by several factors. The most important one is the angle of the viewer to the surface. When looking straight down into the water, at a very large view angle, the surface is almost fully transparent and no reflection takes place. However, when looking at the surface from a distance, the view angle becomes smaller and the amount of reflection increases. At the same time, the transparency decreases, until the water surface becomes almost completely opaque. This optical property is called the Fresnel effect.

Specular highlights

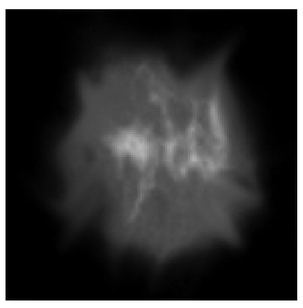
Specular highlights are important in 3D computer graphics, as they provide a strong visual cue for the shape of an object and its location with respect to light sources in the scene.

Specular highlights with bump mapping

Simulation of fire

To simulate fire, particles should rise every frame and get smaller before its lifetime ends. Meanwhile, new particles must be created based on spawning rates and the interval between updates, and each of them is spawned in a specific position in 3D space based on the emitter's position and the spawning area specified.

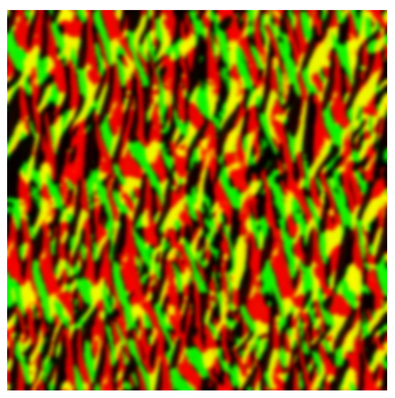
Fire simulation



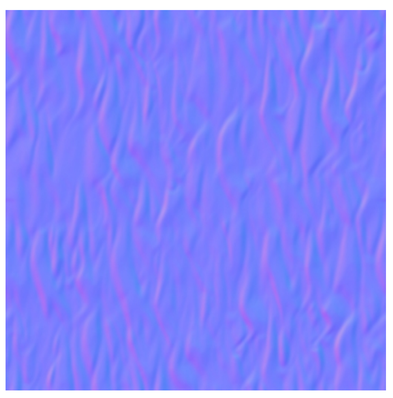
Particle texture

Billboard textured Particles

Each particle is rendered in the form of a textured billboarded quad, which is always facing the viewer.



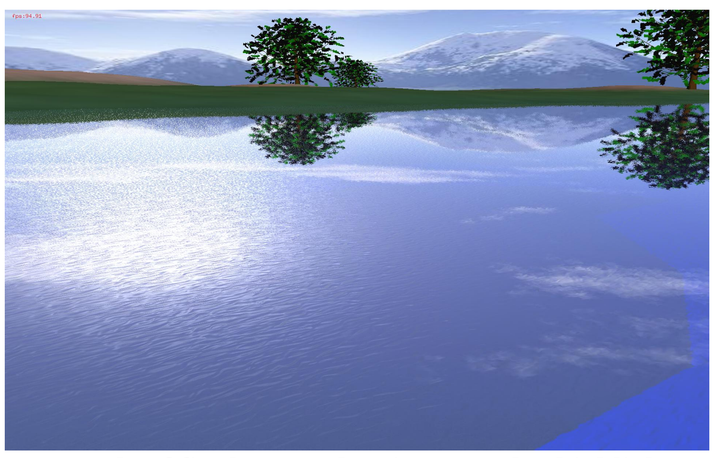
Dudv map



Normal map

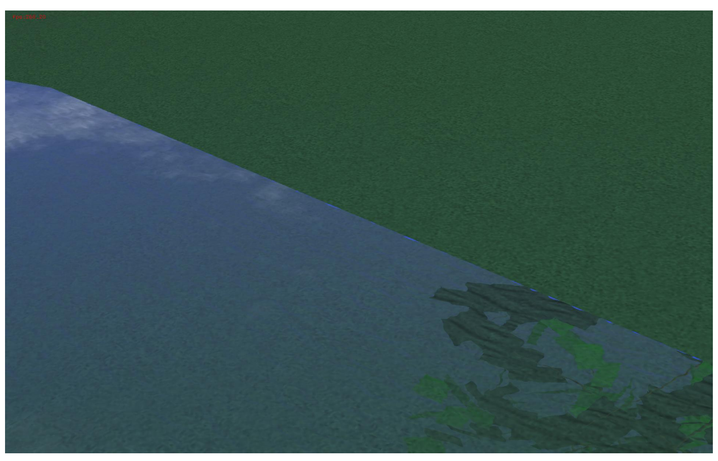
Bump mapping

Bump mapping is a computer graphics technique where at each pixel, a perturbation to the surface normal of the object being rendered is looked up in a texture map and applied before the illumination calculation is done. The result is a richer, more detailed surface representation that more closely resembles the details inherent in the natural world. Dudv map give a way to calculate refraction and how the light will react and bend on the object(in this case it is water). Basically, if we didn't have a normal map we would just depend on the normal of the water surface, which is pointing straight up. The light would look horrible and the realism would be absent.



Example of final water showing specular highlights

Example of final water showing depth



Example of final water showing transparency and refraction