Sea Surface Visualization in World of Warships

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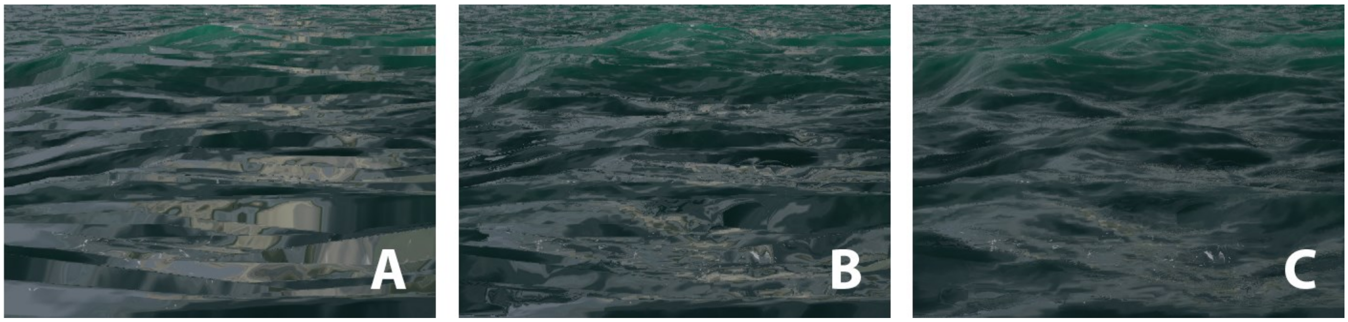

A) Original Projected Grid. *B) After two Newton's iterations.* *C) Additional AA: 6 samples x 1 Newton*

Figure 1: *Quality Improvement of projected grid using Newton's accelerated ray casting.*

Abstract

We describe algorithms used for the visualization of the sea in World of Warships. Being an MMO project, it requires excellent scalability for a wide range of hardware, while still satisfying artistic requirements. We achieve good image quality both near and far from the viewpoint. Moreover, our approach gives us reliable geometric stability and preserves wave structure at a distance. We also describe how to create foam, deformations, reflections, shadows and other features related to the visualization of water.

Keywords: water, visualization, real-time, antialiasing, height maps, ray casting, Newton's method, reflections

Concepts: • Computing methodologies ~ Ray tracing; Antialiasing; Reflectance modeling; • Mathematics of computing ~ Nonlinear equations

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1 Improvements

- Improved water approximation by correcting polygonal mesh at pixel and sub-pixel levels by applying Newton's method.
- Improved lighting and reduced repetition in the wave textures by providing an alternative to hardware mip-mapping.
- Improved reflections with a new formula for calculating texture coordinates for sampling reflection image.
- Achieved scalability across a wide range of GPUs with the same content

2 Overview

In any project dedicated to warfare on the sea, the water surface and the related details are the most important elements for the emotional and visual impact of the exciting gameplay. However, it is difficult to achieve high quality and performance simultaneously in water visualization due to complicated optical effects and dynamic variability. We use the superposition of height maps [Kryachko 2005] for the synthesis of waves. It provides a high-speed simulation and easy artistic control. Instead of using hardware mip-mapping for height fields and normals, we eliminate aliasing effects by averaging multiple samples of the most frequently changing components; this gives better lighting quality and reduces regular patterns on the water at a distance. We approximate the geometry of the water surface using the Projected Grid (PG) method [Johanson 2004]. Unfortunately, the PG has a serious drawback - instability during movement of the viewpoint. Therefore, this method is often rejected in favor of one that is less effective in its approximation, or its application is limited to the near region. For example, [Bruneton et al. 2010] fades out waves at far distances and employs a special mode for lighting. As an alternative, we refine the wave structure and keep the same lighting method for all scales and views. We use PG results as the initial conditions and then correct approximation errors by fast ray casting based on a modified Newton's algorithm and by applying some techniques to improve convergence. As a result, we have reduced the geometric aliasing that is expressed as waves popping and shaking when the viewpoint moves. We have considerably decreased image flickering and the visibility of bright artifacts on the crest of the waves and in deformation areas.

3 Reflection

We propose a new method to calculate texture coordinates based on the reflection vector. We obtain more realistic results, especially for heavy swells on the sea, than the widely used 2D texture distortion method [Johanson 2004] in which distortion degree is proportional to water normal vectors.

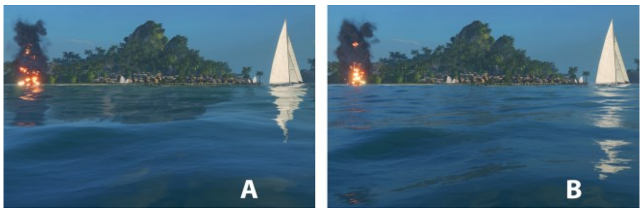

Figure 2*: Reflections. A) 2D Distortion. B) Our method*

4 Deformations

We implement water deformation using a combination of special particles. It provides a high speed rendering technique, simplifies content development and allows higher resolution deformations than in other wave simulation methods.

Figure 3: *Deformations and foam after Nagato shot*

5 Shadows

Shadow realism is increased by taking into account an additional volumetric component which is responsible for underwater light scattering. To calculate this component we use special ray-casting techniques on the shadow map. We use upsampling from a low-resolution buffer and jittering of rays to achieve a good balance of quality and optimization.

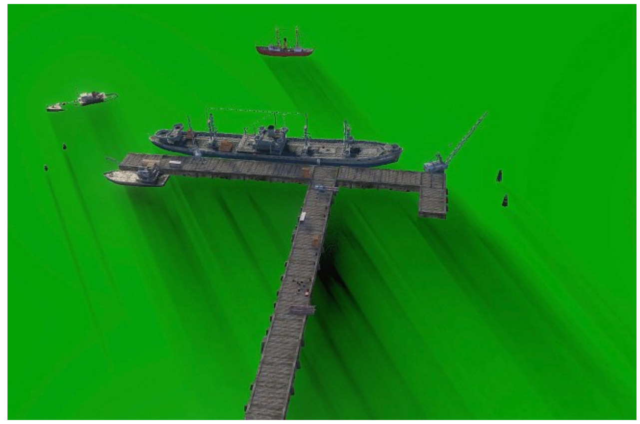

Figure 4: *Volumetric components using ray casting*

6 Conclusion

Finally, we describe effective optimization techniques which gave us a good balance between the quality and performance. We tested our solution on the AMD HD 7970 GPU at 1920x1080 at the maximum quality preset with six AA samples. It takes 4.2ms of GPU time on average.

References

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