Diplomarbeitspräsentation

FAKULTÄT FÜR !NFORMATIK

Faculty of Informatics

Improving Real-Time Rendering Quality and Efficiency using Variable Rate Shading on Modern Hardware

Masterstudium:

Visual Computing

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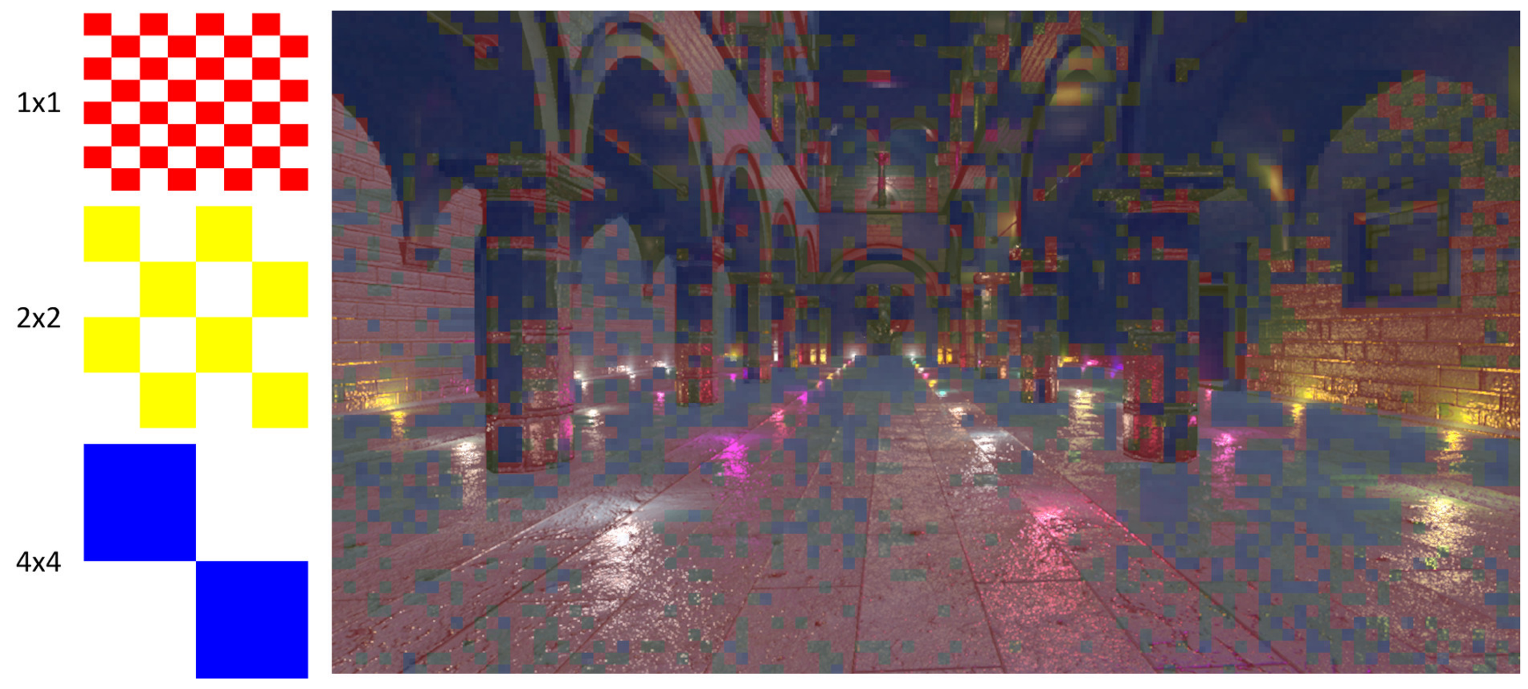
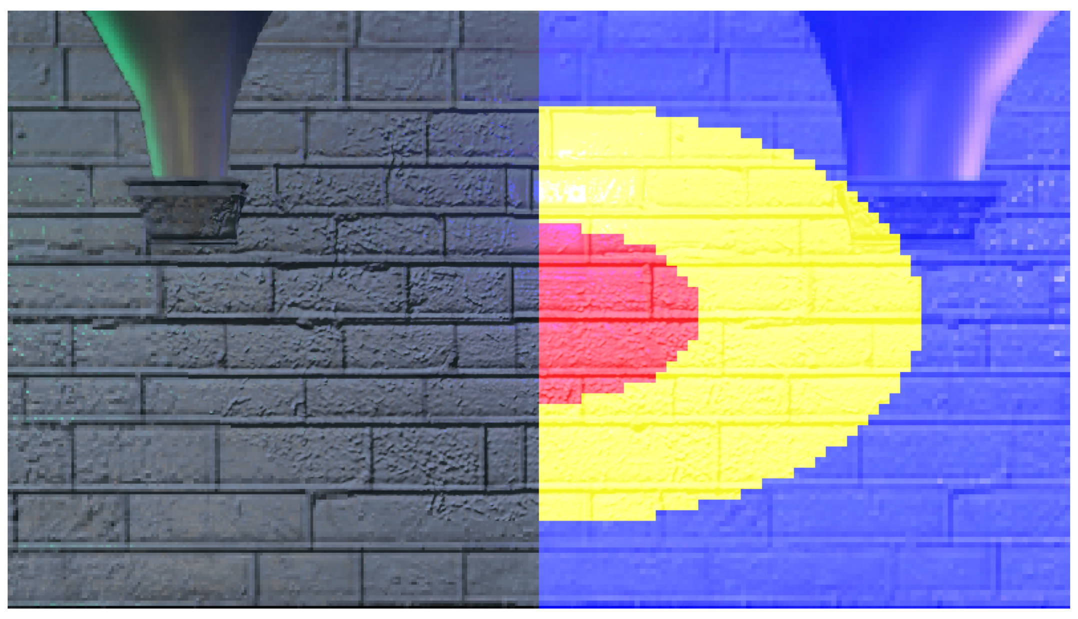
Motivation / Problem Statement

An elegant way to improve performance and to increase the quality of applications that render in real time is to devote more processing power to the rendering of high-detail parts of a scene and, in turn, devote less processing power to the parts that show little visual detail. NVIDIA's Turing Architecture provides us with a new tool to achieve this, namely Variable Rate Shading (VRS). VRS allows varying the shading rate dynamically for a scene by increasing or decreasing the resolution of screen regions, which results in performing shading calculations at, e.g., full resolution (1x1), 1/4 resolution (2x2), or 1/16 resolution (4x4).



Shading Rate Image

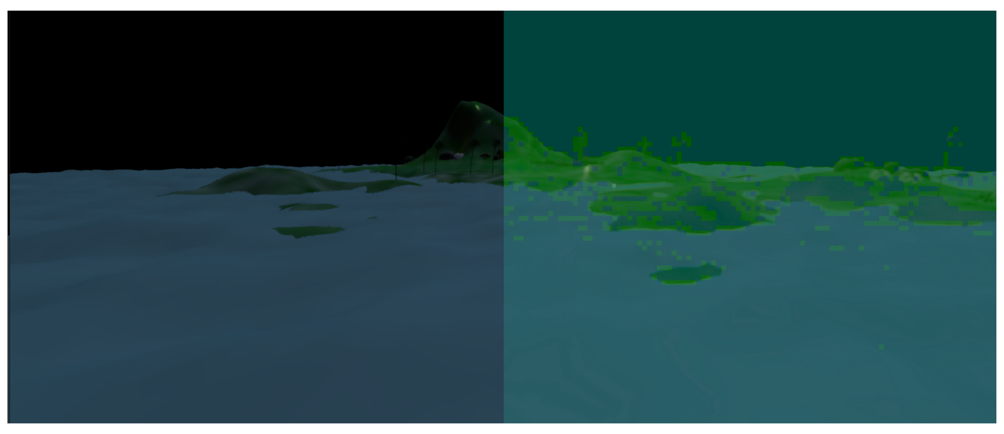
The varying resolution, or the *shading rate*, which is used during rendering for a specific screen region is specified with the so-called *shading rate image*. In order to dynamically adapt the shading rate image to the actual contents of a scene, regions that should be rendered with higher or lower resolution have to be identified before the actual rendering of the scene. There are multiple approaches for identifying such regions.



Content-Adaptive Shading

Edges / Texel Differntials

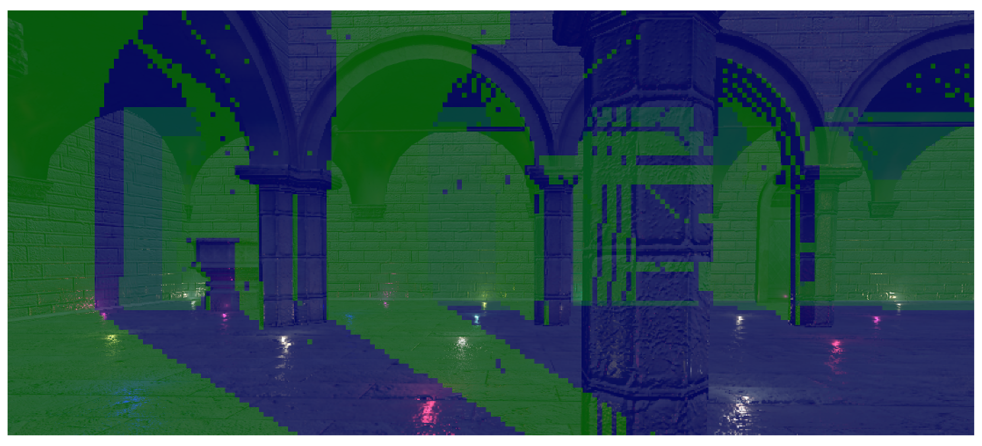
Differentials of certain properties can be used to detect the high and low frequencies of an image. High-frequency regions are rendered with a higher resolution than low-frequency regions. Our algorithms use local differentials of texture coordinates and edges.



Motion-Adaptive Shading

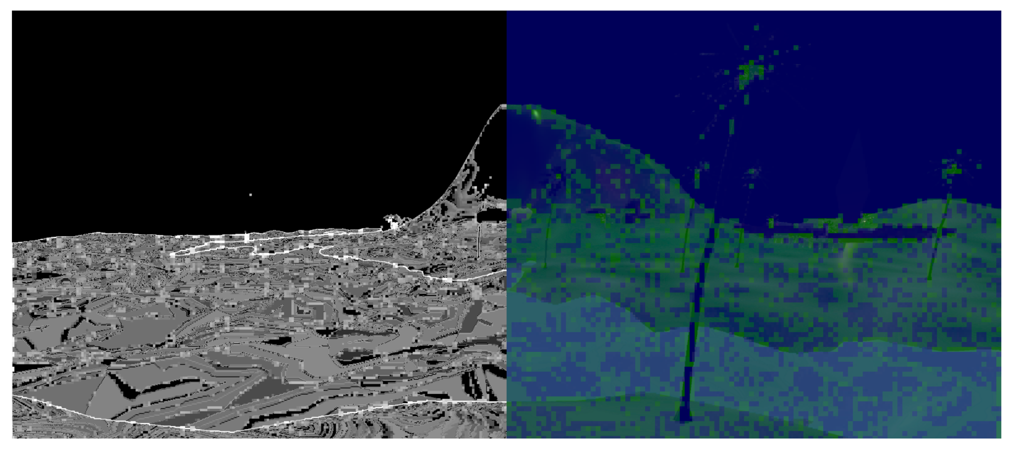
Motion Projection

Objects in motion appear blurred to the human visual system and can be rendered with a lower resolution. Our approach for Motion Adaptive Shading utilizes motion vectors combined with a forward projection for a better estimation of the development of motion.

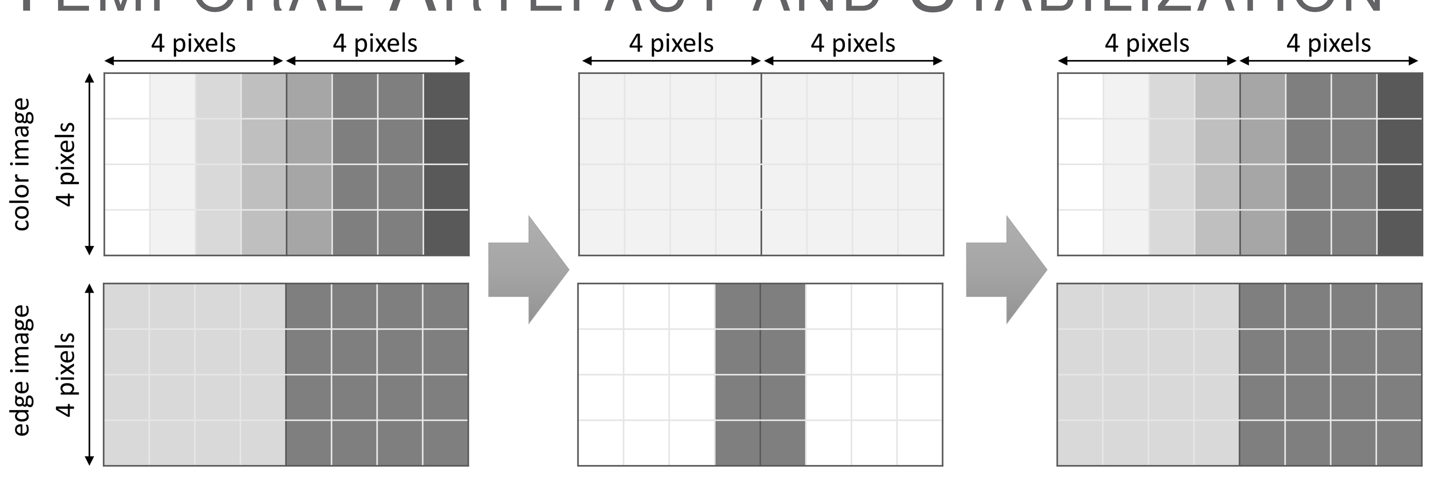


TAA-Adaptive Shading

Temporal anti-aliasing (TAA)[2] clips color values to reduce artefacts from deviating history color information. A high color-deviation from previous frames signifies under-sampling. Our novel approach increases the shading rate for such undersampled regions and reduces it for regions with a similar history color value.

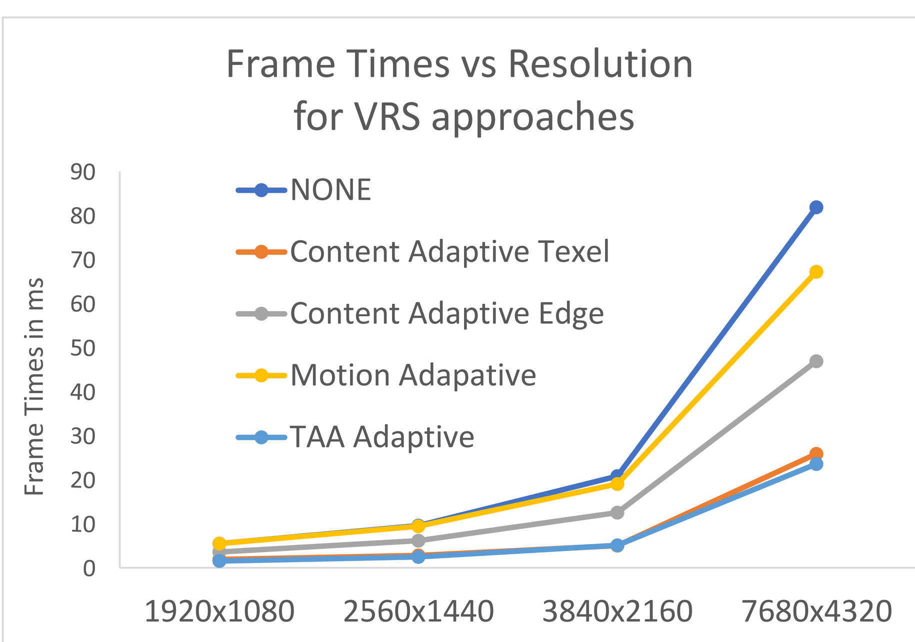


Temporal Artefact and Stabilization



When the shading rate is based on the content of the scene, a temporal artefact caused by shading rate flips can occur. Due to the direct influence of the shading rate on the details of the rendering, shading rates can oscillate for specific screen regions. The image on the left illustrates how this artefact can emerge for edge-based Content-Adaptive Shading. TAA Adaptive Shading is prone to this artefact too. We counter this artefact by temporally anti-aliasing the shading rate image itself.

Results



Some of our VRS techniques are able to render a scene with a resolution of 3840x2160 in the same time as rendering at a resolution of 1920x1080, showing similar FPS. The results were generated for a setting with high fragment-shader complexity (phsyically based lighting/100 light sources) on an NVIDIA GeForce 2080 Ti. In terms of image similarity, the VRS techniques are close to the original images when single images are compared. However, temporal artefacts can not be eliminated completely and can be noticeable. The major advantage of our VRS techniques is that some of them enable up to 4x higher rendering resolution with the same performance or up to 4x better performance at the same resolution.

References

[1] NVIDIA Turing Architecture Whitepaper, 2018
[2] Brian Karis. High-quality temporal supersampling. Advances in Real-Time Rendering in Games, SIGGRAPH Courses, 1:1–55, 2014.

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