New Fast Shadow Visualization Method

Shadows are important visual cue in 3D visualizations, computer aided design (CAD) and computer games. The figure 1 shows the terrace of the house of the figure 2. The shadows on the figure 1 are using widely used shadow technique of computer games and some visualization software called shadow mapping. As we can see, there are number of visual problems. The table seems to be flying because the shadow mapping offsets all the shadows in the scene including the shadow at the table's leg. Shadow from guardrail on the figure 1 is rather confusing and sampling artefacts appear as 6 thick light strips instead of 33 thin light strips as shown on the figure 3 with proper shadows.

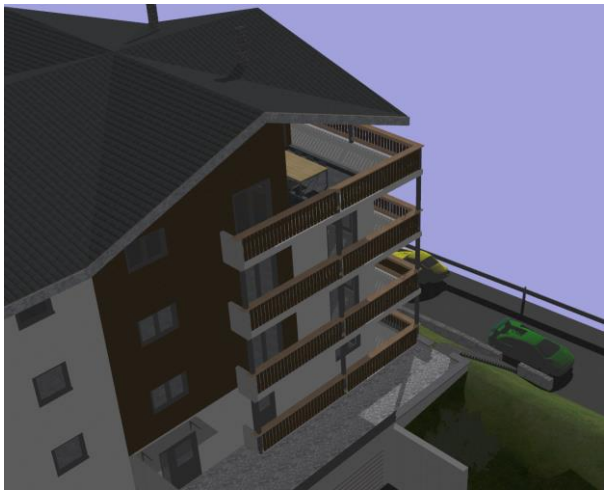


Figure 2: High-detail house visualization

Figure 1: Shadow map artefacts

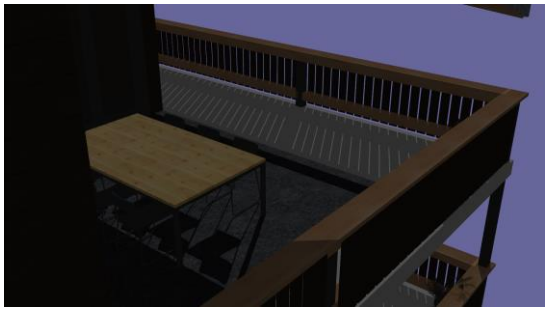


Figure 3: Precise shadows of shadow volume method

The figure 3 uses different shadow technique called shadow volumes. There are no artefacts and although we do not see the chairs, we have the impression how the chairs look like from the shadow. On the figure 1, we cannot do that for the limited resolution of shadow maps. Why then not use shadow volumes?

Shadow maps were considered faster technique therefore it is used in computer games. All the visual problems are dealt with by careful scene design that hides all the visual imperfections. However, this is often not an option in technical visualization and CAD systems. So, we have been put before the need of research of fast precise shadows.

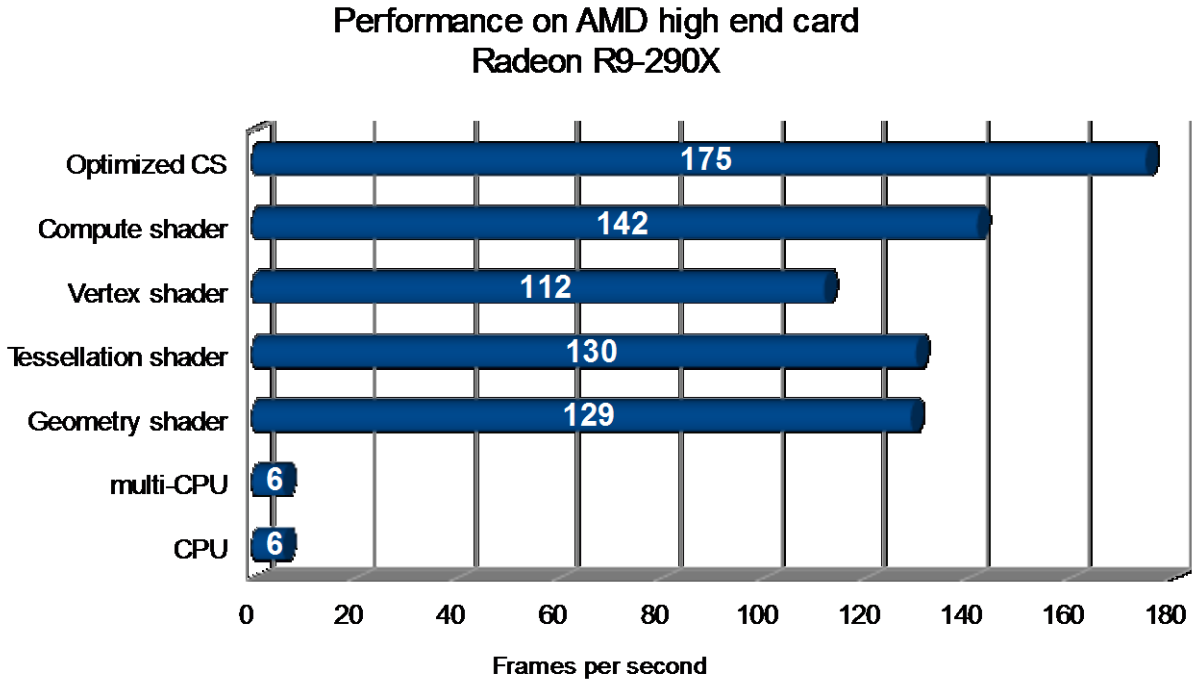
Our research

Our initial tests on a CAD model showed that shadow volumes are 25 times slower than shadow mapping. It took about 0.2 second to compute the final image with shadows on the computer. It essentially means that we were able to produce 5 images per second. For smooth interaction, 20 images per second is considered a minimum for human perception. So, we started our research for higher performance.

Our story started by running our shadows on computer's processor. 6 images per second were not much, but we just started. Many people nowadays know that graphics cards are huge computing machines with amazing performance. Much higher than computer's processor. So, we started to look for a way how to compute our shadows on a graphics card.

Graphics card provides various computing units called shaders. We used the one designed to process geometry, called geometry shader. After resolving number of complicated technical problems, a great success followed. We have got 120 images per second. It was 20 times speed up. Then, we tried to develop the solution using other shaders – the one designed for enhancing details, called tessellation shader. The speed up was about 22 times. Compute shader excelled on AMD's platform, providing nearly 30

times speed up. All the performance results measured in images per second are shown on the graphs bellow for the most powerful graphic card we had at the moment.



Applications

We designed fast and robust solution to visualize shadows for both – computer games and visualization and CAD systems. The algorithms were based on shadow volumes with great deal of our own technology inside.

Our precise shadows are already used in CAD applications by Swiss company Cadwork Informatik AG. Precise shadows are important for them and they are very happy for excellent performance they got by our solution.

Another very important application of our shadows are web browsers and very popular new WebGL technology. With WebGL, web pages may contain interactive 3D graphics just inside the web browser. Czech company Wood Software s.r.o. made their plans not to only put all their furniture as 3D models on their web pages, but to create application to virtually design a room, furnish it and make it visually perfect before the customer buys the furniture and start to furnish in reality. We are now working on a shadow solution for them based on vertex shaders as this is the only available option in WebGL.

For the future, we hope to get in touch with more CAD and game development companies, so that people may profit from our research.

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