PSI 2015: 10TH INTERNATIONAL ANDREI ERSHOV MEMORIAL CONFERENCE

PRELIMINARY PROCEEDINGS, TO BE AVAILABLE AT THE CONFERENCE

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DEVELOPMENT OF HIGH PERFORMANCE VISUALIZATION MODULE FOR WEB HYDRODYNAMIC SIMULATOR

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Abstract. The paper describes development of a specialized visualization module for web simulator of oil and gas fields. Both process of creation the mentioned module and tests of software on data taken from open sources are described. Also several specific tests have been generated for testing of the performance and capabilities of the module. Presented visual comparisons with similar simulators of leading manufacturers and large data tests used to check the performance.

1 Introduction

Development of modern computing technologies allowing operating with ekzaflops range of the data has led to the necessity of the data display method developing. For this purpose the high-performance visualization techniques are developing.

The main task of the work was creation of high-performance visualization module for use in web environment. To achieve high-performance it was decided to use Ray Tracing algorithm [1]. During the research it was found that a thin client technology allowing the creation of such program does not exist. So for implementation of the algorithm its native implementation is to be transported to the thick client.

A special graphics library NVIDIA Optix [2] is used in the module. Given library works on CUDA (Compute unified device architecture) technology and allows to ease programming implementation of Ray Tracing algorithm.

Also, many examples of the module are given for comparison with similar software products of Schlumberger Petrel [3]. Features and performance of the module demonstrated by specially targeted stress tests.

2 Problem description.

When the visualization attached to calculation it is possible to use special computers designed to maximize the performance of rendering. Unfortunately, the presented visualization module is not among such cases, since it is focused on the remotely use

from a wide variety of devices, including mobile devices that support the hardware acceleration of calculations on the GPU. The software offered in the form of application on the device and as a web application on a browser, which must properly display the results of calculations carried out on computational clusters with the performance of several teraflops. The article aims to cover only the visualization and its optimization, data transmission to the client will not be considered here. For given software it is crucial to get maximal performance, both hardware and algorithmic means.

3 Implementation method

As it was noticed above thick client was chosen as implementation of the program. It was decided to create desktop version and then transport it to the web environment.

To implement a desktop module NVIDIA Optix framework have been used. That framework uses CUDA technology and the Ray Casting algorithm [1], which is particular case of Ray Tracing algorithm. In the algorithm ray built for each output pixel calculates the intersection with only one polygon in the scene. Ray Casting algorithm widely used to draw a large amount of data. It is important when the number of primitives in the model can be equal or even bigger than the number of pixels on the screen.

As it was noticed above the next step is implementation of the web application. It was done by the Java Applet integrating the existing software to the web environment as a special application that must run on the client side. CUDA technology uses GPU, therefore applet must have access to the devices on client side. It is possible only when the applet is privileged, this can be done by signing it. Even in that case user must decide to give it all necessary permissions every time. Due to the fact that the task can not be executed on thin client and that the module will be used by experts familiar with the simulator that inconvenience is acceptable.

4 Examples

The results of the presented visualization module and similar visualization software Schlumberger Petrel [3] comparison are given below. Here are the visualization results of Eastern Moldabek site Kenbai oil field [4] from JSC " KazMunaiGas Exploration Production" on Petrel (Figure 1) and using presented module (Figure 2).
There were also drawn and compared the results to the public MATLAB Reservoir Simulation Toolbox [5] reservoir models:
- Data of the "Geological Storage of CO_2: Mathematical Modelling and Risk Analysis" (MatMoRA) preject [6], with 100x100x21 size (Figure 7).
- Data of the “Sensitivity Analysis of the Impact of Geological Uncertainties on Production” preject [7], with 40x120x20 size (Figure 9).

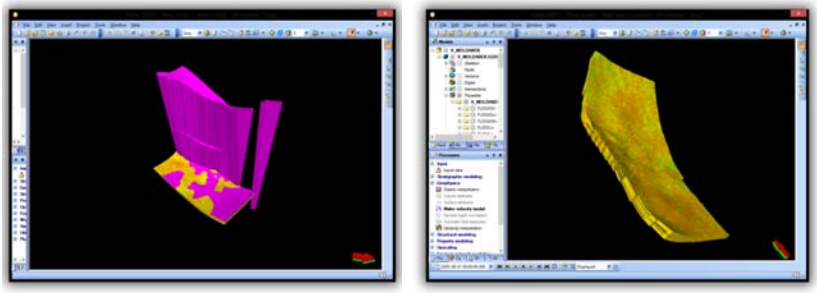

Fig. 1. - Model of the Eastern Moldabek fields drawn in Petrel.

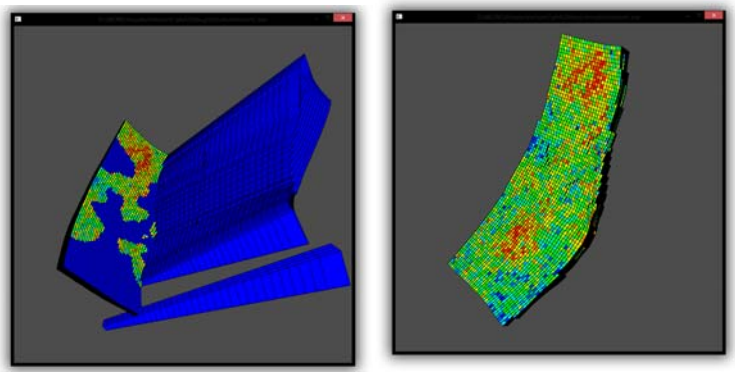

Fig. 2. - Model of the Eastern Moldabek fields drawn in the presented visualization module

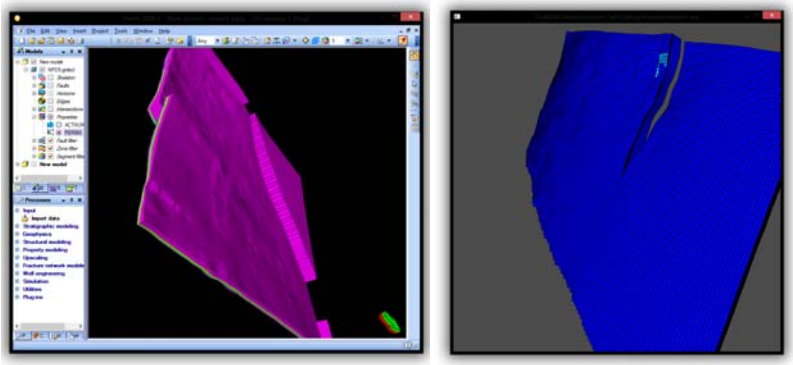

Fig. 3. – Screenshots of the 100x100x11 size model in Petrel (left) and presented module (right)

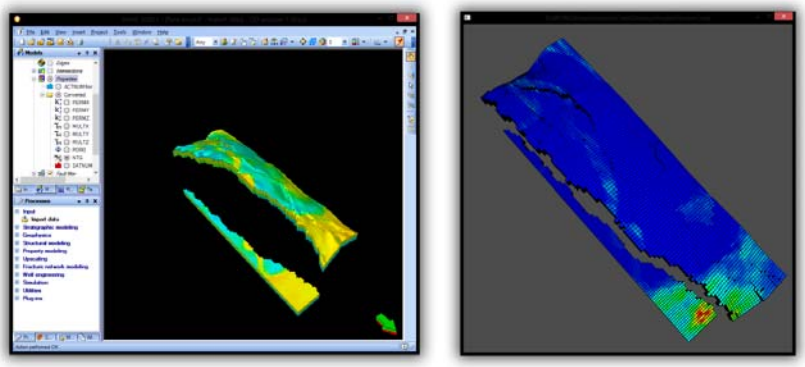

Fig. 4. - Screenshots of the 40x120x20 size model in Petrel (left) and presented module (right)

5 Web application

Java Native Interface [8] – a special set of tools distributed with the Java Developer Kit (JDK) and aimed at the convenient use of native modules with Java. JNI tools at a minimum allow creating a wrapper for the native functionality of the module in order that it can be called without any difficulties during the work of Java program.

Figure 5 shows the results of the program developed to web environment with the Java console. Since the web application must use client side video adapter as freely to have possibility to implement Ray Tracing algorithm, i.e. with functionality as deep as GPGPU then using the Java Applet is not the worst scenario. The prototype was tested under 32 and 64 bit Windows operating systems.

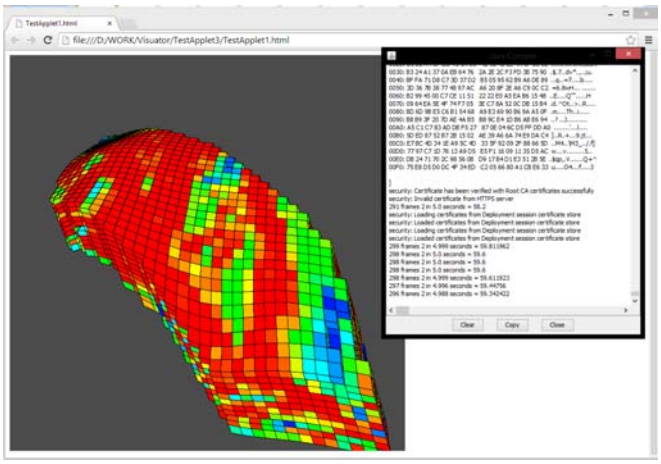

Fig. 5. – Demonstration of web application

6 Testing of the module performance

After implementation of module using NVIDIA OptiX series of tests on generated big data has been made.

Noticed issues have not significantly affect to frames per second (FPS) amount even on a big models. Speaking of the larger models on Figure 6 there is a demonstration of 6,6 million polygon model testing. As well as on Petrel it appears on presented module without significant drop of FPS. These tests have been conducted on desktop version of the program.

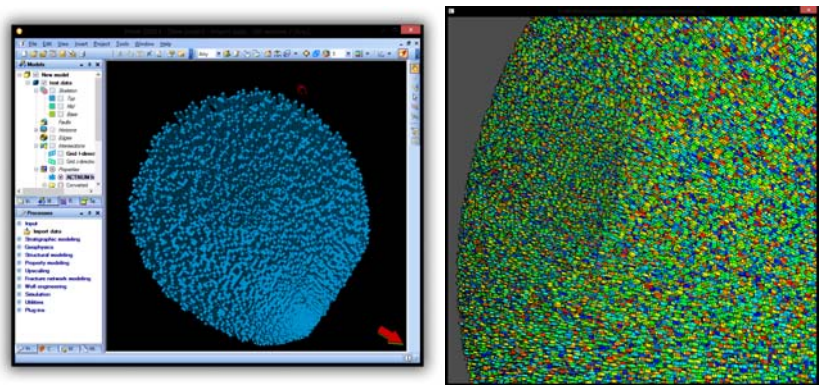

Fig. 6. – Testing of the visualization module on model 100x100x100 with 6611916 triangle polygons on Petrel (left) and presented module

The complexity depends on the number of polygons visualized because rendering function complexity must be calculated and therefore the module can at least partially be compared with similar programs from other areas.

7 Conclusion

The paper describes process of development of the visualization module for web hydrodynamic simulator. It shows the multiple comparisons with advanced simulators as well as the results of stress tests.

Also presented thick client implemented as web applet that carries the program in the Internet browser environment. And this high-performance visualization can be used without downloading / installing special software (excluding Java utility that is supported by a variety of systems by default). In the description of this element it has been assumed that the traffic necessary for the applet to download data will not be considered. But this assumption does not affect the complexity of the render function as the data is downloaded once and used from the local data store during visualization.

References:

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