Accelerated Multi GPU Tsunami run-up simulation

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ABSTRACT

High resolution and high speed wave simulation was implemented on multi Graphics Processing Unit (GPU) system. The wave is assumed as Tsunami which is generated by earthquake at the seabed. Tsunami is one of the most dangerous phenomena for human life because it sometimes damaged at coastal region and runs-up on ground, moreover the speed of the wave is very fast.

The target area of the simulation is around Toyama-bay in Japan. The bay is located in middle of main island of Japan and faces the Sea of Japan. Almost of all area is over 1,000m in depth and it is one of the deepest bays in Japan and the bathymetry is suddenly dropped near the coast. Tsunami has very long wave length and the speed is approximated by $\sqrt{gh}$, here g is gravitational acceleration and h is depth. When the earthquake is occurred in the Toyama-bay, very fast Tsunami will hit the coastal area immediately and run-up on residential areas around the bay. It is very serious scenario because of Toyama-bay has some active faults in the seabed.

A Tsunami simulation is one of the important technologies for protecting human life around coastal area. It predicts the Tsunami height at the coast and also provides the running-up area of the wave. Furuyama & Maihara simulated Tsunami wave at the part of Toyama-bay [1,2,3]. They got 78.5 times faster computation speed by using GPGPU than normal CPU calculation. However the simulation was not sufficient for the real phenomena because their target area was only around Toyama New Port and the initial wave was assumed as simple conditions. Therefore the purpose of this study is to calculate the wide area (whole Toyama-bay) by faster computation technique. To achieve the simulation, a high resolution calculation is required for the running-up Tsunami simulation because artificial structures on the ground such as roads, buildings, and houses are very small. On the other hand the huge area simulation is also required. In the Toyama-bay case the area is 42[km] x 15[km]. If 5[m] x 5[m] size computational grids are used, as a result the simulation uses over 26,000,000 computational grids. To achieve the simulation, multi GPGPU system (NVIDIA TESLA K20x, InfiniBand, MVAPICH) was used for the calculation. As a result 2.22 times faster calculation on three GPUs than one GPU, it is 74% efficiency of the parallel calculation.

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