Waves for Ship Simulation

Executive summary

This project concerns the real-time computation of waves for ship simulation.

Challenge overview

Our group contacted MARIN (http://www.marin.nl/) to explain the expertise we have in fast solvers for simulators. In the company there are a number of mathematicians (PhD alumni of the TU Delft), so the communication went smoothly. After a first discussion we decided that the best strategy is to define a Masters Student project.

Implementation of the initiative

The implementation went well. An excellent masters student located for 4 days a week at MARIN and 1 day at the TU Delft. MARIN paid Euro 400 per month and housed the student. The supervision at MARIN was high quality.

As usual part of the project was confidential but that does not lead to problems for the master thesis. It is on the web:

http://ta.twi.tudelft.nl/nw/users/vuik/numanal/wout_eng.html

The problem

The waves around the ship should be computed in a wide region. Since they should be refreshed every millisecond, the computing time must be very small. At the start of the project it was only possible to simulate a small region of 50m x 50m. This is insufficient for a realistic wave pattern. For instance at this scale the waves do not interfere with the ship or the banks of the river. Therefore the problem boils down to a fast iterative method for a Poisson type problem.

Results and achievements

We proposed to use a fast Conjugate Gradient with a parallel preconditioner but it appeared that the speedup was not good enough. After combining it with a second level preconditioner (coarse grid acceleration) the speedup was good enough to simulate a 200m x 200m area. The next step is to accelerate the method further by using video cards (GPU), then it should be possible to simulate a 2km x 2km area.

The project was completed by implementing a subroutine in the C++ package used by MARIN. A masters thesis was written (the grade lead to a "cum laude" distinction), and the results were presented at the International Conference on Computational Science 2010 (ICCS 2010), May 31 - June 2, 2010.

Figure 1. Wave pattern around a ship sailing through the river Ijssel.

Lessons learned and replicability

Good mathematical knowledge, communication skills, hard work are crucial ingredients for success.

Company details:

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