

# Real-time visualization of ship and wavy surface motions based on GPGPU computations

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# Virtual testbed project

Global goal: Decision support system that analyses data from ships in sea, models the environment and predicts (and prevents) dangerous situations.

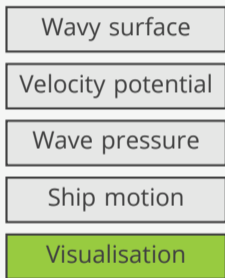
Current goal: Real-time simulation environment for ships with visualisation.

Key features:

- ▶ Real-time. We have 16–33 ms to compute everything.
- ▶ Realistic marine objects. We load ships from IGES files.
- ▶ Arbitrary-amplitude ocean waves (work-in-progress).

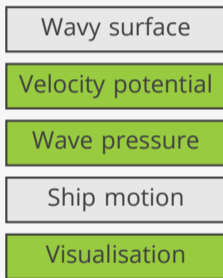
# Project timeline (2018)

Aug



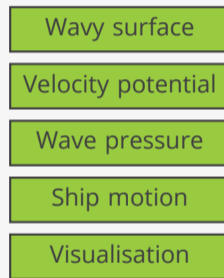
No copying, but slow.

Sep



Faster, but a lot of copying (30 FPS).

Dec

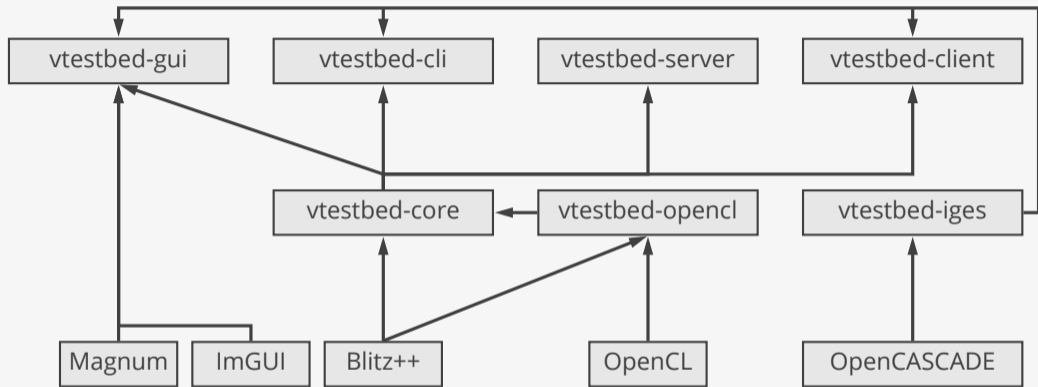


Expected to be much faster with no copying.

CPU

GPU

# On the shoulders of giants



- ▶ Takuya Ooura. "General Purpose FFT Package." Kyoto University (2006).
- ▶ V. Volkov, B. Kazian. "Fitting FFT onto the G80 architecture." University of California, Berkeley (2008).

## Zero copy

Q: How to synchronise ship position and orientation between OpenCL and OpenGL without copying to RAM?

A: Use OpenCL/OpenGL interoperability (*cl\_khr\_gl\_sharing* extension).

- ▶ Create OpenCL buffer from OpenGL buffer.
- ▶ Lock the buffer with *clEnqueueAcquireGLObjects*.
- ▶ Update the buffer.
- ▶ Unlock the buffer with *clEnqueueReleaseGLObjects*.
- ▶ Draw the buffer.
- ▶ Wait for completion with *glFinish*.



## Ship

▼ Ship

Application average:  
16.661 ms/Frame (60.0 FPS)

Time: 0.000 sec  
Speed: x1

Show

ship

surface

▼ Generators:

▼ Plain wave surface generator

Choose wave type:  
Propagating cosine wave ▼

10.000 - + amplitude

25.000 - + wavelength

0 deg angle (?)

▼ Irregular wave surface generator

Choose wave type:  
Standing cosine wave ▼

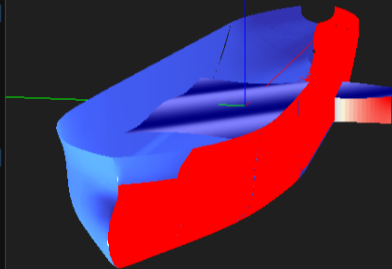
Number of waves:  
1 - +

Wave 1

1.000 - + amplitude

25.000 - + wavelength

0 deg angle (?)



Visualisation

# Wavy surface

▼ Ship

Application average:  
16.663 ms/Frame (60.0 FPS)

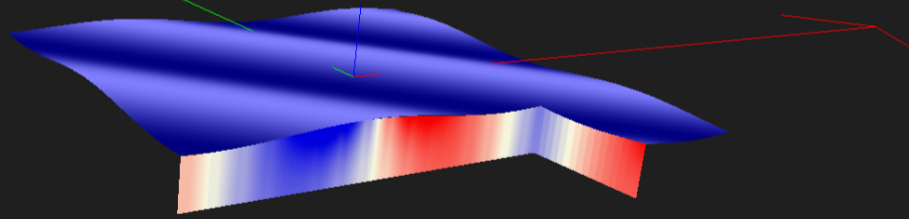
Time: 2.025 sec  
Speed: x1

Show

ship

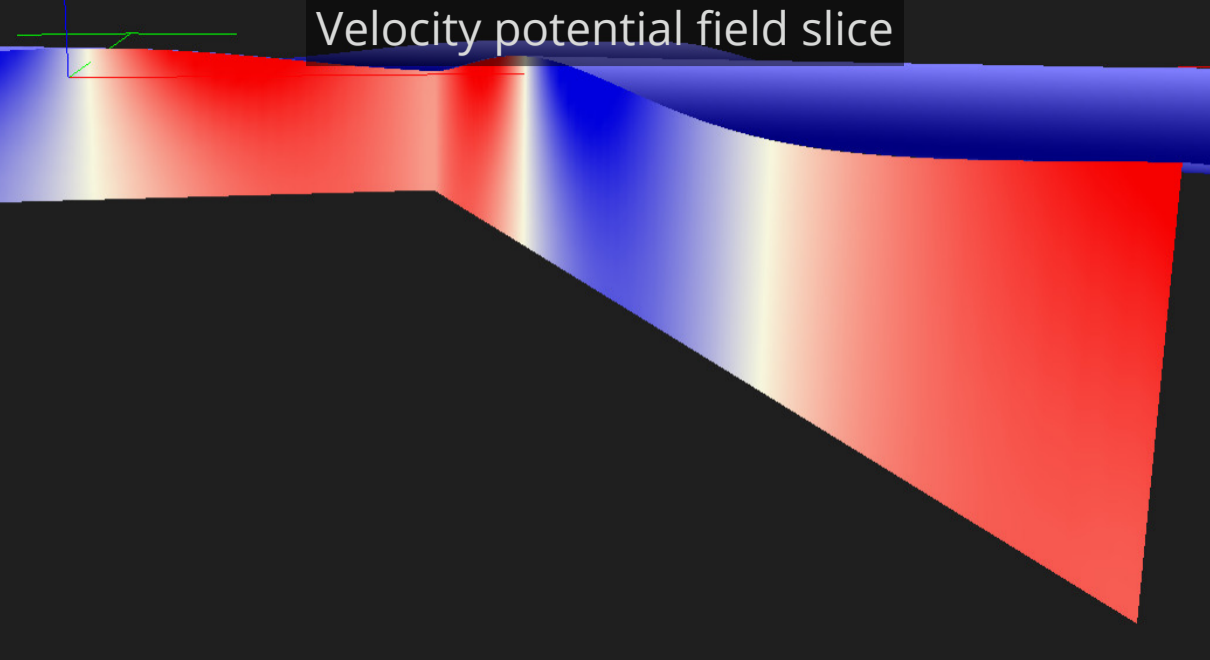
surface

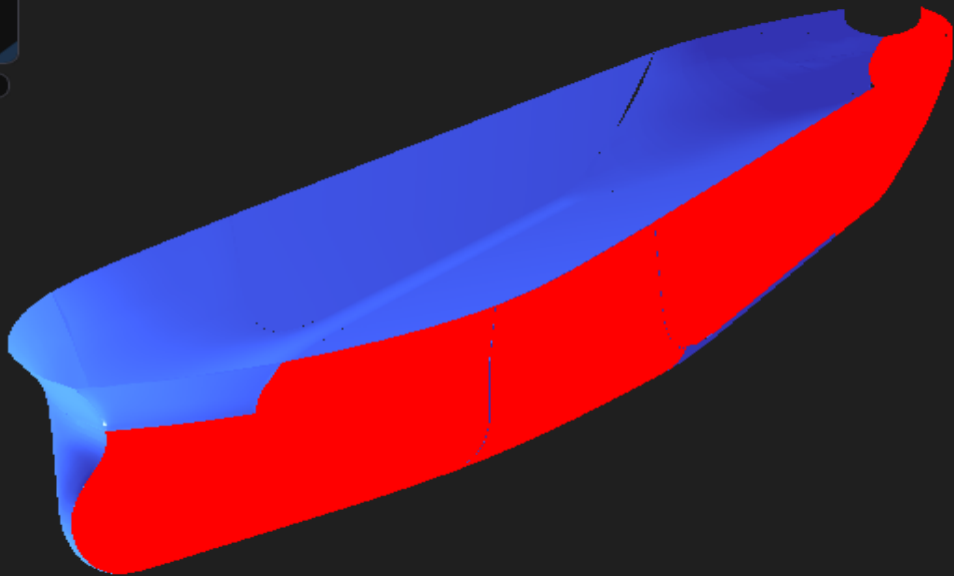
► Generators:





# Velocity potential field slice





Ship

▼ Ship

Application average:  
16.667 ms/frame (60.0 FPS)

Start Stop

Time: 0.000 sec

Speed: x1

x1 x2 x3 x5 x10

Show

ship

surface

▼ Generators:

▼ Plain wave surface generator

Choose wave type:

Propagating cosine wave ▼

10.000 - + amplitude

25.000 - + wavelength

0 deg angle (?)

Apply

▼ Irregular wave surface generator

Choose wave type:

Standing cosine wave ▼

Number of waves:

1 - +

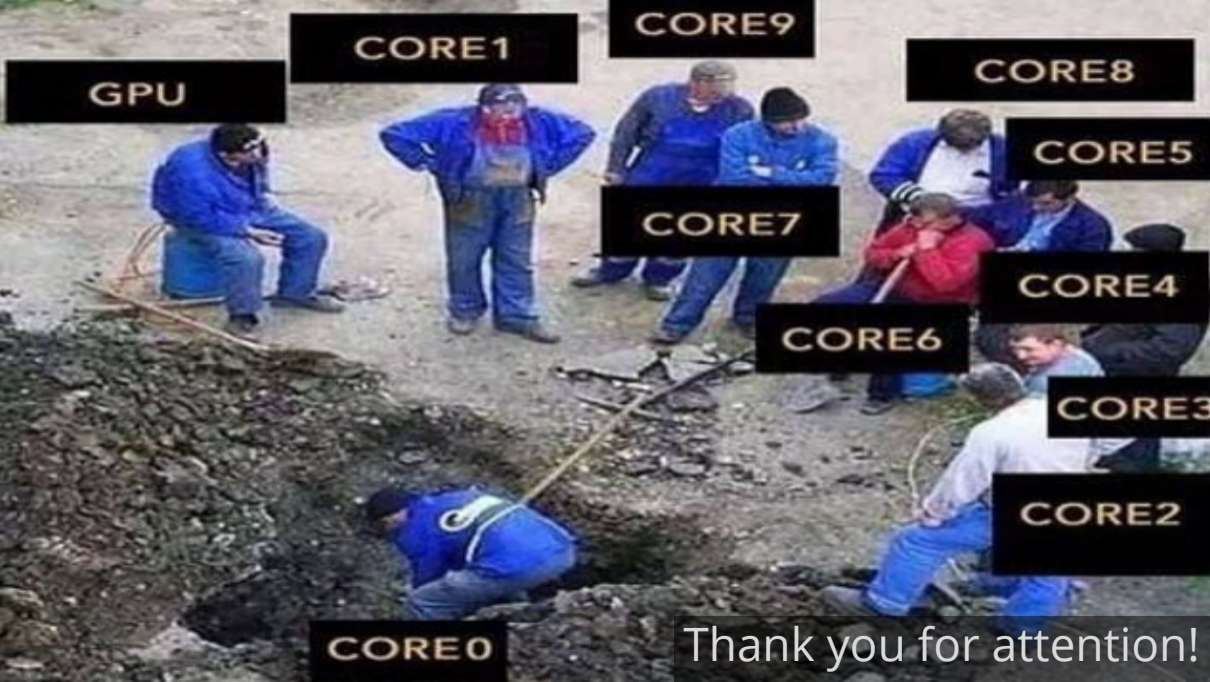
Wave 1

1.000 - + amplitude

25.000 - + wavelength

0 deg angle (?)

Apply



CORE1

CORE9

CORE8

GPU

CORE5

CORE7

CORE4

CORE6

CORE3

CORE2

CORE0

Thank you for attention!