Chapter 1

Example problem: Solving the Helmholtz equation on an unstructured mesh

In this document we revisit the solution of the Helmholtz equation and demonstrate how to simulate the scattering of a planar wave from a circular cylinder using an unstructured mesh.

1.1 A specific example: Scattering of an acoustic wave from a sound-hard obstacle.

We revisit the problem considered in `another tutorial`: the scattering of a planar sound wave impacting on a rigid, impermeable obstacle as shown in this sketch:
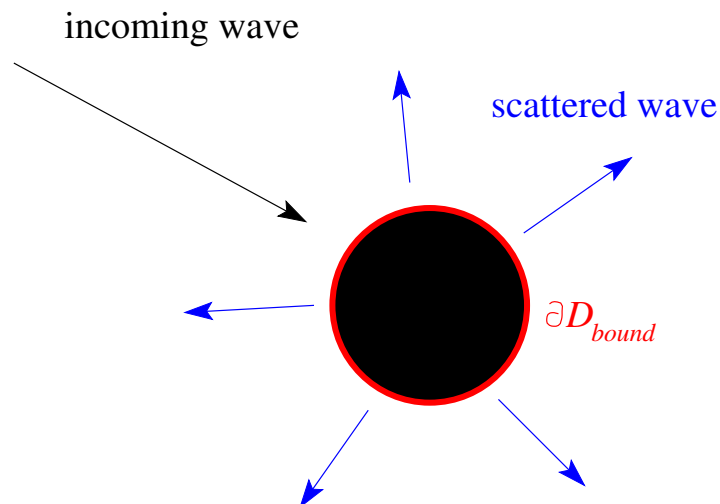

Figure 1.1 Scattering of an incoming wave from a sound-hard obstacle -- the scatterer.

1.2 Results

The figure below shows plots of the real and imaginary parts of the fluid's displacement potential ϕ (a measure of the fluid pressure). The red and green lines correspond to the computed and exact analytical solutions, respectively. (We refer to `another tutorial` for details.)
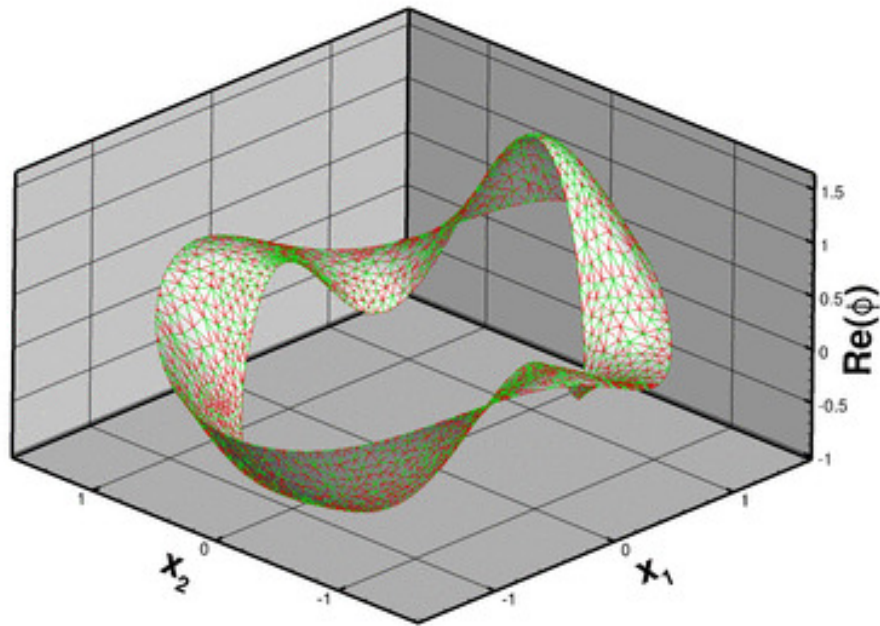
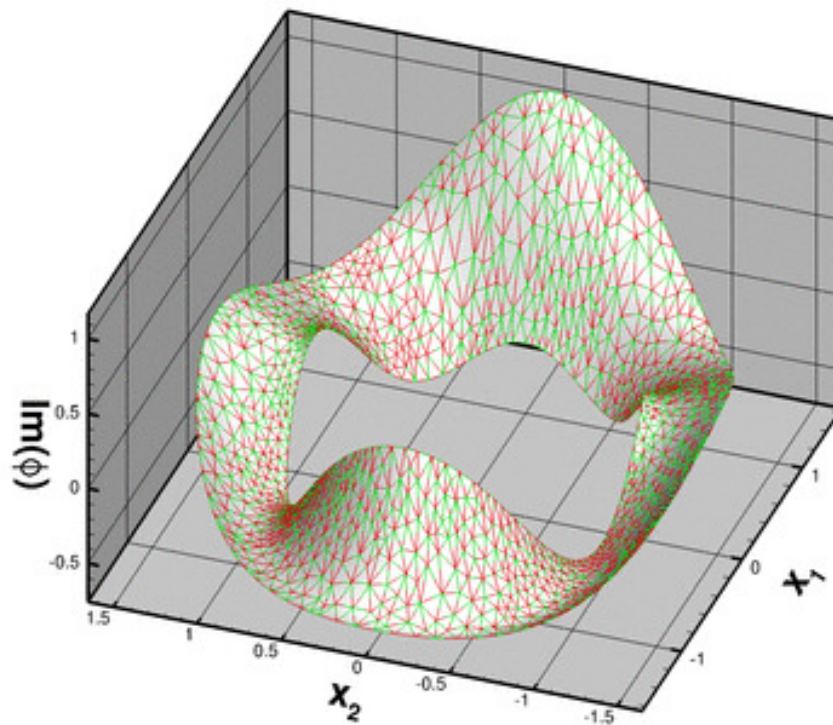**Figure 1.2 Real part of the displacement potential (red: computed; green: exact).**

Figure 1.3 Imaginary part of the displacement potential (red: computed; green: exact).

1.3 The numerical solution

The driver code for this problem is very similar to the one discussed in another tutorial. Running sdiff
on the two driver codes

demo_drivers/helmholtz/scattering/scattering.cc

and

demo_drivers/helmholtz/scattering/unstructured_scattering.cc

shows you the differences, the most important of which are:

- the setup of the unstructured mesh, ensuring that mesh adaptation respects the curvilinear boundaries.

- the re-assignment of element properties following any mesh adaptation – we refer to another
  tutorial for a more detailed discussion of why this is necessary.

That's all!

1.4 Source files for this tutorial

- The source files for this tutorial are located in the directory:

demo_drivers/helmholtz/scattering/

- The driver code is:

    demo_drivers/helmholtz/scattering/unstructured_scattering.cc

1.5 PDF file

A pdf version of this document is available. \