Wake cloaking simulated in lab - objects move through water without leaving a trace

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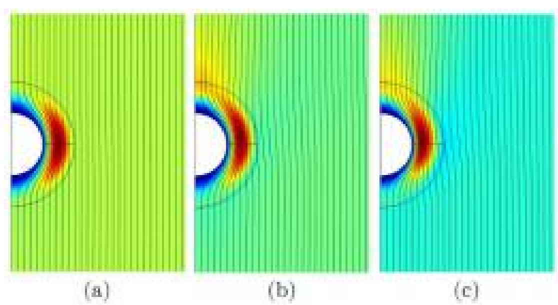

Velocity pro le and streamlines of flow around and through the porous spherical shell surrounded by a viscous fluid. (See ref. below for details). Image credit: arXiv:1106.2282v1

(PhysOrg.com) -- Metamaterials researchers Yaroslav Urzhumov and David Smith, working at Duke University have built a simulation of an object that can move through water without leaving a trace and claim it's a concept that could be built and used in the real world provided more research is done. In their paper, published on *arXiv*, the two describe how they programmed the use of metamaterials applied to an object, along with tiny water pumps, into a model to simulate an actual object moving through water without dragging some of the water with it that would normally cause turbulence.

The two show, by use of a sphere, how an object could be covered with several layers of a mesh of wire or blades, from large ones nearest the object, too much smaller ones farthest away. The idea is to make up for the difference in movement between the object, and the stillness of the water it's moving through, all while parting the water in ways gentle enough to cause cloaking and then allowing it to reseal after the object passes. The metamaterials provide the cloaking, while pumps are used to move the water at differing speeds in the different layers to keep the water from being dragged along as the object moves through it.

The paper comes after what seems like one announcement after another in new cloaking technologies; first an invisibility cloak, then ones that cloaked sound, electric and ocean waves and even a time cloaking device; all are based on new so-called metamateriasl (materials with properties not found in nature).
The advantages of the use of such technology are obvious; without drag, boats or submarines could go farther and faster while using less fuel, and if they ran nearly silent in doing so, it would herald the age of new stealth boats and ships that would be difficult if not impossible to detect by enemies looking for them.

In the model created, the object was bullet sized and moves just a few millimeters per second, but the authors suggest that if an actual boat was to be made, it might make more sense to try to reduce just the drag, rather than try to hide the wake as well, as that would likely be much easier to actually make. The authors do not plan to try to build a real world boat, due they say, to lab constraints, but suggest a collaboration with another facility might be feasible.

More information: Fluid flow control with transformation media, Yaroslav A. Urzhumov, David R. Smith, arXiv:1106.2282v1 [physics.flu-dyn] arxiv.org/abs/1106.2282

Abstract
We introduce a new concept for the manipulation of fluid flow around

three-dimensional bodies. Inspired by transformation optics, the concept is based on a mathematical idea of coordinate transformations, and physically implemented with anisotropic porous media permeable to the flow of fluids. In two different situations - for an impermeable object situated either in a free-flowing fluid or in a fluid-filled porous medium - we show that the object can be coated with a properly chosen inhomogeneous, anisotropic permeable medium, such as to preserve the streamlines of flow and the pressure distribution that would have existed in the absence of the object. The proposed fluid flow cloak completely eliminates any disturbance of the flow by the object, including the downstream wake. Consequently, the structure helps prevent the onset of turbulence by keeping the flow laminar even above the typical critical Reynolds number for the object of the same shape and size. The cloak also cancels the viscous drag force. This concept paves the way to energy-efficient, wake-free propulsion systems, which control and prevent wake formation through a smart spatial distribution of propulsion forces.

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