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NTU Singapore Researchers Discover Way To Manipulate Water Waves To Precisely Control Floating Objects

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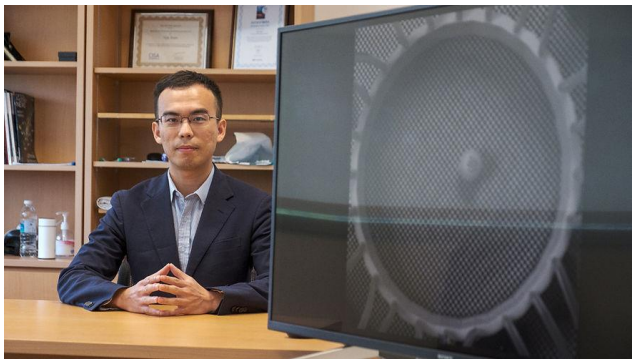
What if you could bend water waves to your will to move floating objects?



NTU Singpaore Assistant Professor Shen Yijie with a photo of a water-waves experimental set-up. Credit: NTU Singapore

This is the idea behind the new scientific breakthrough from a team of international scientists co-led by Nanyang Technological University, Singapore (NTU Singapore). The scientists developed a technique that generates and merges waves to create complex surface patterns in a water tank, enabling them to precisely move floating objects, as though an invisible force were guiding it.

Their experiments showed that these surface patterns can pull in and trap nearby floating objects. Some patterns even act like a “tractor beam” of sorts, holding floating objects in place on the water surface and preventing them from drifting away.

Meanwhile, others can cause objects to spin about on their centres and move precisely along a spiral path within the pattern itself. For example, the researchers were able to get a ping pong ball floating in a water tank to spin about its centre and move in a fixed circular path by using the waves they generated.

The wave patterns also remain stable even when disturbed by minor external waves.

The scientists said the breakthrough, which was published in the scientific journal Nature on 5 February 2025, opens the possibility of using water waves in new ways. One example of which is helping in the cleanup of spilled chemicals that float on water. The technique could be developed further to corral split liquids and chemicals making them easier to collect.

The method can also be scaled up to guide larger floating objects, and possibly vessels, along a desired path on the water. For example, using the method, water waves can be manipulated to steer a boat to a specific direction, even if its engines are not functioning. For this, however, researchers would need to factor in disturbances from natural waves at sea which could destroy the water patterns if these sea waves are too strong.

The structure used to generate waves in an experiment. Credit: Henan University

“Our findings are the first step in exploring how water waves can be shaped to move objects, with many potential applications in the future,” said Assistant Professor Shen Yijie, one of the co-leads of the research from NTU Singapore’s School of Physical and Mathematical Sciences, and School of Electrical and Electronic Engineering.

“We’ve shown that water waves can be used to precisely move floating objects as small as rice grains. Future research could study even smaller waves such as those on the scale of cells that are hundreds of times smaller, as well as much larger sea waves that are a thousand times bigger,” he added.

Shen Yijie’s team plans to research further whether the same water patterns can be created underwater, not just on the surface, to perform the same function – control and move objects.

One independent reviewer of the Nature paper said the breakthrough “presents very exciting results that can provide valuable insights into using water waves or similar fluidic waves to manipulate particle motion on different scales”.

The idea for the breakthrough was inspired by Shen Yijie's previous work with light, where he used light waves to create complex structures or patterns of light.

- A team of international scientists co-led by NTU Singapore has discovered a way to manipulate water waves to precisely control a floating object.
- The technique generates and merges waves to create complex surface patterns in a water tank, which can pull in and trap nearby floating objects.
- The breakthrough can help in the cleanup of chemicals in water, splitting them from corrals and making them easier to collect.

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