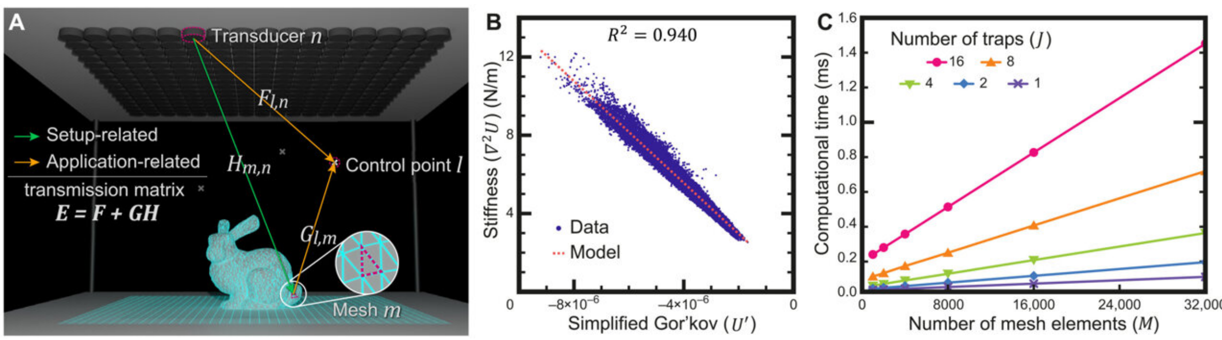
Levitating objects with sound could revolutionize virtual reality and 3D printing

June 21 2022



Performance of the proposed technique.(**A**) Schematical explanation of our two-step scattering model, adapting the BEM. (**B**) Correlation between trapping stiffness $\nabla^2 U$ and the simplified form of the Gor'kov potential U', justifying the use of U' as our metric. (**C**) Computational performance of our acoustic holographic technique after precomputation, depending on the numbers of mesh elements (M) and traps (J). Credit: *Science Advances* (2022). DOI: 10.1126/sciadv.abn7614

Using sound to levitate something when there are other objects in the way has been shown for the first time by UCL researchers and could lead to advances in the manufacturing and entertainment sectors.

The findings open up possibilities for more advanced interactive entertainment through virtual reality and mixed reality at theme parks, arcades and museums. Technology using 3D levitation could lead the way to fully immersive real-world simulations without the need for clunky headsets or goggles.

The technique could also improve 3D printing by allowing manufacturers to build more sophisticated, multi-material objects as opposed to the layer-by-layer, single material build approach that is currently used.

Previous research has already shown that levitation using soundwaves is possible. Objects can be held and moved in mid-air using the force from high intensity ultrasound waves (which have a frequency higher than humans can hear) to hold something in place, known as acoustic levitation. This technique also makes it possible to create interactive 3D images, such as holograms, in mid-air that you can see, feel and hear.

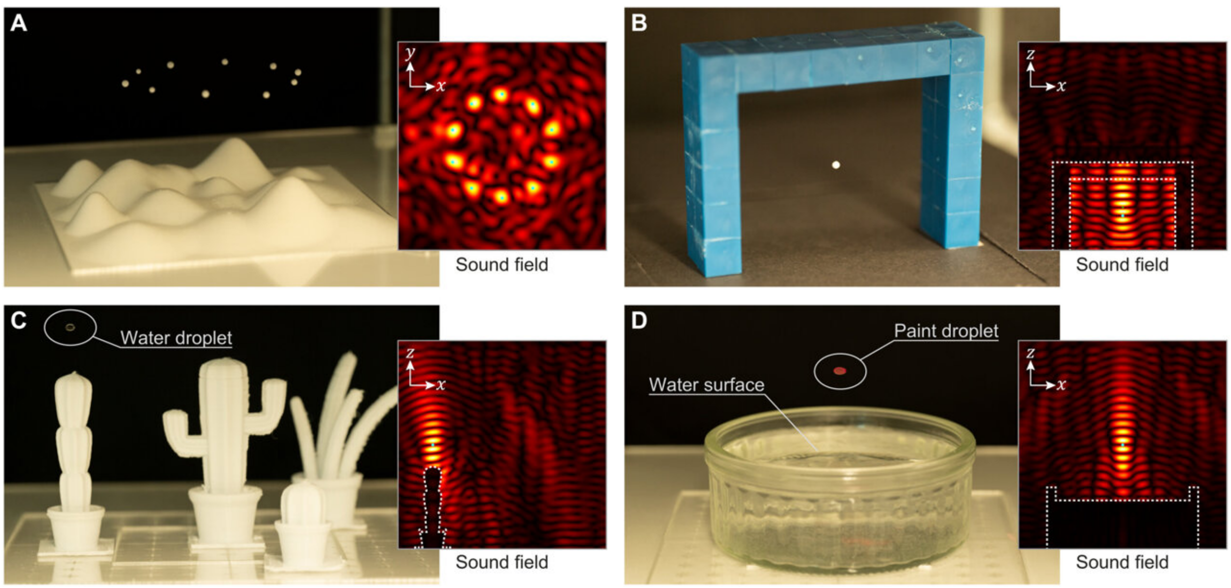
However, until now, this could only be done in an empty space; anything in the way of the soundwave would cause the levitated objects to fall.

For the paper, published in *Science Advances*, the research team has gone one step further by showing how acoustic levitation is possible outside of such a controlled environment, and can be achieved with objects nearby, such as walls, a car dashboard or other common appliances.

Co-author Dr. Diego Martinez Plasencia (UCL Computer Science) said, "In the past, our 3D displays had to exist in a vacuum, but now we can create 3D content right there in front of you. No eye-wear or tricks required, simply 3D shapes sharing the very space in which we live."

Lead author Dr. Ryuji Hirayama (UCL Computer Science) said, "Until now, we've only been able to demonstrate acoustic levitation for virtual reality and holograms in controlled environments without any other objects nearby that could interrupt and scatter soundwaves. In this paper, we've shown how we can float objects and even create digital content such as holograms in real-world environments by accounting for nearby objects in [real-time](). It opens up the possibilities for fully immersive [virtual reality]() experiences and interactive holograms."

The team levitated different objects including polystyrene beads, water and fabric, by combining two new steps. Firstly, they computed how the soundwave's path looked at any time when different speakers are turned on, and how they bounce off objects in the environment.



Levitation capabilities of the proposed technique. (A) Our technique can create and manipulate multiple traps individually (i.e., there are 10 traps in the photograph). (B) Traps can be created even under sound-scattering obstacles by using scattered waves. (C) Materials that can be manipulated in midair include both solids and liquids (i.e., a water droplet is levitated). (D) Our scattering model works on scattering surfaces of liquids as well. The inserted boxes show simulated sound fields in the xy plane λ/4 above the trap positions for (A) and the xz plane on the trap positions for the others (B to D), normalized using the maximum amplitude. The white dashed lines in these figures represent the positions of the scattering objects in the planes. Credit: *Science Advances* (2022). DOI: 10.1126/sciadv.abn7614

The second step involved working out a fast technique to turn the speakers quickly off or on so that after the soundwave had scattered, the environment was able to hold the object in air.

This technique could modernize how products are designed and built through multi-material 3D printers. Current printers use one dispenser to release each material in the object. This is particularly important to avoid material cross-contamination when chemicals or biological materials are used.

Acoustic levitation would enable numerous materials to be used without cross-contamination or moving the dispenser inside the fabrication space (contactless fabrication). The technique makes building the object more flexible, as material can be added from any direction, avoiding layer-by-layer fabrication and allowing for more sophisticated multi-material objects to be produced.

Lead researcher Sri Subramanian (UCL Computer Science) said, "I am excited for how this work opens the door for mixing many different materials in additive manufacturing and 3D printing. Acoustic levitation has huge potential in precision manufacturing and this work paves the way for realizing this opportunity."

More information: Ryuji Hirayama et al, High-speed acoustic holography with arbitrary scattering objects, *Science Advances* (2022). DOI: 10.1126/sciadv.abn7614

Provided by University College London

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