Acoustic tweezers can pick up objects without physical contact

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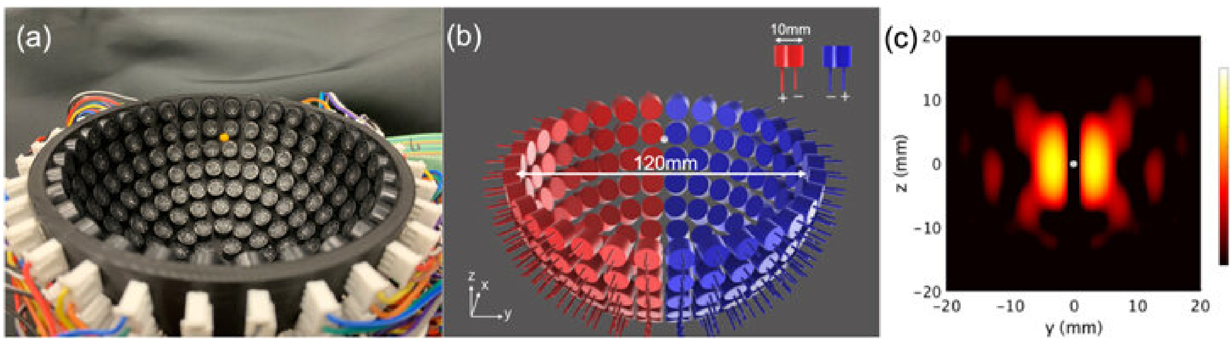

Fig. 1. (Color online) (a) Levitation by hemispherical transducer arrays (b) mounting of transducers on the array of diameter is 120 mm. (c) Distribution of the relative acoustic pressure on the vertical cross-section calculated by numerical simulation based on geometrical acoustics when capturing a particle at the center of the hemispherical array (the origin). Credit: Tokyo Metropolitan University

Researchers from Tokyo Metropolitan University have developed a new technology which allows non-contact manipulation of small objects using sound waves. They used a hemispherical array of ultrasound transducers to generate a 3D acoustic field that stably trapped and lifted a small polystyrene ball from a reflective surface. Their technique employs a method similar to laser trapping in biology, but adaptable to a wider range of particle sizes and materials.

The ability to move objects without touching them might sound like magic, but in the world of biology and chemistry, technology known as optical trapping has been helping scientists use light to move microscopic objects around for many years. In fact, half of the 2018 Nobel Prize for Physics, awarded to Arthur Ashkin (1922–2020) was in recognition of the remarkable achievements of this technology. But the use of laser light is not without its failings, particularly the limits placed on the properties of the objects which can be moved.

Enter acoustic trapping, an alternative that uses sound instead of optical waves. Sound waves may be applied to a wider range of object sizes and materials, and successful manipulation is now possible for millimeter-sized particles. Though they haven't been around for as long as their optical counterparts, acoustic levitation and manipulation show exceptional promise for both lab settings and beyond. But the technical challenges that need to be surmounted are considerable. In particular, it is not easy to individually and accurately control vast arrays of ultrasound transducers in real time, or to get the right sound fields to lift objects far from the transducers themselves, particularly near surfaces that reflect sound.

Now, researcher Shota Kondo and Associate Professor Kan Okubo from Tokyo Metropolitan University have come up with a new approach to lift millimeter-sized objects off of a reflective surface using a hemispherical array of transducers. Their method of driving the array does not involve complex addressing of individual elements. Instead, they split the array into manageable blocks and use an inverse filter that finds the best phase and amplitude to drive them to make a single trap at some distance from the transducers themselves. By adjusting how they drive the blocks over time, they can change the position of their target field and move the particle they have trapped. Their findings are supported by simulations of the 3D acoustic fields that are created by the arrays, and of course, by their experiments with a polystyrene ball, which speak for themselves.

Though challenges remain in keeping particles trapped and stable, this new technology could yield big advances in acoustic trapping.

More information: Shota Kondo et al, Mid-air acoustic tweezers for non-contact pick up using multi-channel controlled ultrasonic transducer arrays, *Japanese Journal of Applied Physics* (2021). DOI: 10.35848/1347-4065/abfebd

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