Non-invasive brain surgery with an ultrasound transducer array

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Problems in Treating Brain Diseases

- UK is spending £27 billion every year on treating brain diseases.¹
- Treating brain diseases is difficult due to the skull and healthy brain tissue blocking direct access to the disease.
- Non-invasive surgery can be achieved with focused ultrasound. However, it is challenging to do this across the thick human skull.
- Research challenge: The skull changes the direction and speed of the ultrasound, which leads to poor focusing and an inaccurate focus location.

Solution: An Ultrasound Array System for Non-invasive Brain Surgery

- A new transducer that can emit and receive short pulses of ultrasound was designed and built.²
- 32 transducers were assembled onto a 3D-printed frame to form a focused transducer array.
- In combination with circulating microbubbles, this device can be used to focus ultrasound through the human skull and monitor treatments.

Focus and Steer Ultrasound

- The array was able to focus ultrasound and steer the focus by 40 mm in each direction.

Focus through The Skull

- The array was able to focus through an ex vivo human skull.
- The focus achieved was as planned. The focus size and location were the same as when without the skull.

Monitor the Focus through The Skull

- The array was able to image the microbubbles through the ex vivo human skull.
- Hence it can be used to monitor focused ultrasound treatments of the brain.

Conclusion & Future Work

We built an ultrasound array system for non-invasive brain surgery. It can focus and steer ultrasound, focus through the human skull and monitor the treatment. Our next steps involve testing this system on a large animal model.

References