Chair: Physics of Fluids group

Super-resolved flow imaging using microbubbles and deep learning

Description

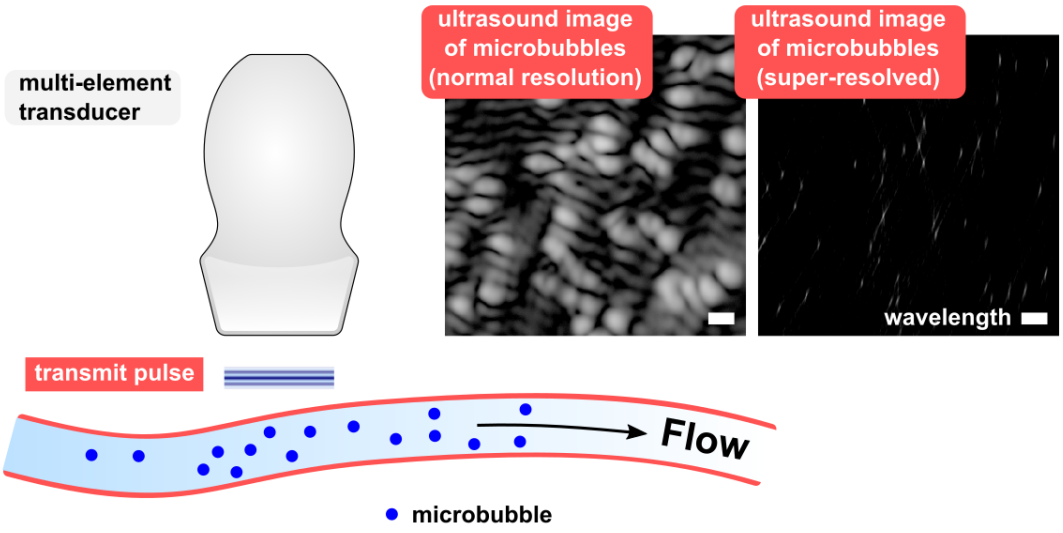
Ultrasound imaging is the most commonly used medical imaging technique: it is non-invasive, real-time, safe, portable, and inexpensive. Microbubbles exhibit a unique resonant response to pressure waves [1], which makes them excellent ultrasound scatterers. They are therefore used as blood pool contrast agents for ultrasound imaging. However, the resolution of ultrasound images is diffraction-limited. In deep tissue, into which only low ultrasound frequencies can penetrate, this limit is on the order of a millimetre. This is insufficient to detect the detailed features of the flow pattern in fast-flowing arterial blood.

Our research group has developed an artificial neural network that can achieve super-resolution of ultrasound contrast agents. However, this artificial intelligence approach has not been tested on real bubbles flowing through a blood vessel.

Assignment

You will build a setup in which we can control blood flow through a tube, as a simple model for arterial blood flow. You will inject microbubbles into this flow and record the ultrasound echoes scattered by these bubbles using an ultrafast ultrasound research machine and a multi-element transducer. You will then process the image sequence to acquire super-resolved flow profiles. Depending on your interest, you can further:

- optimise our artificial neural network for flow mapping,
- use laser-PIV (particle image velocimetry) to identify and quantify the shortcomings of our approach,
- use the Navier-Stokes equation to identify and quantify the shortcomings of our approach.



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References

[1] T. Segers, E. Gaud, M. Versluis, and P. Frinking, "High-precision acoustic measurements of the nonlinear dilatational elasticity of phospholipid coated monodisperse microbubbles," *Soft Matter*, vol. 14, no. 47, pp. 9550–9561, 2018