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Geometric Ultrasound Localization for Super-Resolution Medical Imaging

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Keywords	Ultrasound Localization Microscopy (ULM), Perfusion, Contrast Enhanced Ultrasound (CEUS), Microbubble
Inventors	Christopher Hahne, Raphael Sznitman
Reference	"Geometric Ultrasound Localization Microscopy", MICCAI 2023, Vancouver
Background	Contrast-Enhanced Ultrasound (CEUS) has revolutionized cardiovascular visualization. ULM achieves a tenfold resolution increase over CEUS, by taking advantage of delay-and-sum (DAS) beamformers, currently defining the forefront of ultrasound imaging technology for enhanced precision in medical diagnostics and research.
Invention	Geometric ULM overcomes the use of beamformers, but leverages a geometry framework based on *time difference of arrival* (TDOA) information, enabling fast, precise and reliable localization of contrast agent particles. The method's key features include enhanced distinction between overlapping and clustered spots, improving precision, reliability, and computational efficiency. This inventive approach achieves high precision with minimal computational cost and memory demand.
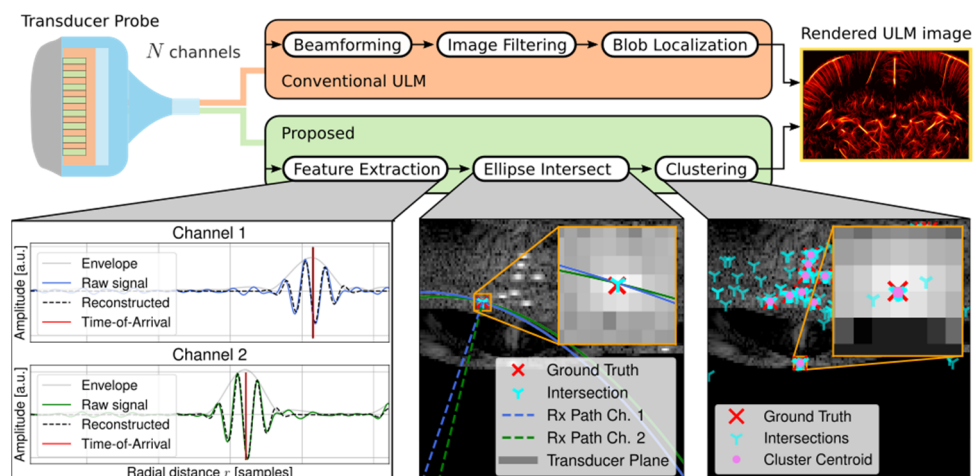
Fig: Comparison of ULM pipelines: Classical ULM (top) via beamforming and image filters for localization. Our geometric ULM (bottom) consists of a cross-channel phase-consistent Time-of-Arrival detection (left) to form ellipses that intersect at a microbubble position (middle). Clustering (right) is an optional refinement.

Application	Medical diagnostics:
	a) early cancer detection in the abdominal area (liver, kidney)
	b) monitoring of stroke-related diseases
Patent Status	Priority Patent Application filed
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