Docket #: S23-113

Differentiable Beamforming: Dynamic Optimization of Ultrasound Imaging Parameters for Enhanced Image Quality and Diagnostic Accuracy

Stanford researchers have developed a novel approach to ultrasound imaging using the differentiable beamforming pipeline, which optimizes critical imaging parameters, significantly enhancing image quality and diagnostic accuracy in ultrasound imaging.

Ultrasound imaging is a well-established diagnostic tool in medicine, due to its non-invasive imaging capabilities. While the performance of ultrasound imaging relies on the accuracy of the imaging parameters, these parameters are often empirically determined and remain fixed for a given imaging device. This reliance on fixed parameters can result in images of poor quality in situations where the initial assumptions fail and might not accurately reflect the underlying biological structures. This limitation hinders achieving high-quality imaging necessary for an accurate diagnosis.

To address this need, Stanford researchers have developed a novel approach to ultrasound imaging using the differentiable formulation of the beamforming pipeline which adjusts parameters based on the specific imaging context. The software allows the system to learn and continuously optimize parameters during the imaging process, ensuring that the settings are always aligned with the current imaging environment. This approach differs from the static parameters used in traditional ultrasound imaging which is set for a given imaging device. Stanford researchers have demonstrated the efficacy of this technology in optimizing sound speed and element position for flexible arrays which are critical for accurate ultrasound imaging, resulting in more reliable imaging parameter estimates. By leveraging the

differentiable formulation of the beamforming pipeline, our invention offers an innovative solution through optimization of imaging parameters, thereby enhancing diagnostic accuracy and driving the future of ultrasound imaging technology.

Stage of Development:
Proof of Concept. The algorithmic formulation and initial tests have been run on computer simulations and small selection in-vivo data samples.

Applications

- Medical ultrasound fields
- Diagnostics
- Industrial inspections
- Non-destructive testing for assessing the integrity of materials and structures
- Treatment planning
- Biomedical research

Advantages

- Precise high-quality imaging
- Increased diagnostic accuracy
- Versatile and adaptive system
- Automated adjustment process reducing the need for manual fine-tuning
- High operational efficiency leading to cost savings

Publications

- Simson, W., et al (2023). Differentiable Beamforming for Ultrasound Autofocusing. *In: Greenspan, H., et al. Medical Image Computing and Computer Assisted Intervention* – MICCAI 2023. MICCAI 2023. Lecture Notes in Computer Science, vol 14229. Springer, Cham.

Patents

- Published Application: 20250072870

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