A Hybrid High-frequency Ultrasound Imaging System and Method

IITM Technology Available for Licensing

Problem Statement

- Presently, one of the major challenges in translating the state-of-the-art clinical imaging (<15 MHz) performance to **Pre-clinical Imaging (PCI) application is associated with the manufacturing of the high-frequency (HF) ultrasound array transducers.**
- Although using high-frequency ultrasound (US) waves can yield better spatial resolution, the **thickness of the crystal must be correspondingly reduced**. However, manufacturing an array with thin crystals is a challenge.
- Therefore, there is a need for better techniques to **improve ultrasound image quality for high-frequency imaging without an array transducer.**

Technology Category/ Market

Category - Lifesciences, Ultrasound Imaging
Applications - Pre-clinical imaging, Ophthalmic imaging, High-resolution imaging during minimally-invasive procedures like in dermatology.
Market - Ultrasound transducer market was valued at USD 3,582.81 M in 2023, and it is expected to reach USD 4,631.02 M with a **CAGR of 4.35% during 2023 - 2028.**

Technology

- This Invention is a **High-Frequency (HF) Ultrasound (US) imaging system** which utilizes HF US waves (> 15 MHz) to obtain **higher spatial resolution (<100 µm)** using only a **2 - element transducer array.**

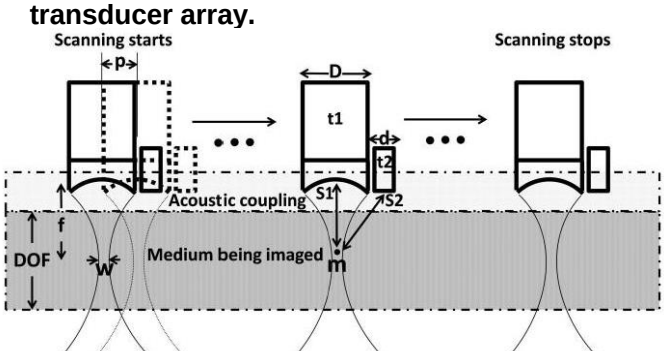

Fig. 1. A scanning mechanism performed by a hybrid high frequency ultrasound imaging system with focused (t1) and unfocussed (t2) transducers scanning the medium from left to right (in Lateral direction).

SYSTEM

1. A first ultrasound transducer configured to **transmit high frequency ultrasound waves** in a medium being imaged.
2. A second ultrasound transducer and the first ultrasound transducer simultaneously, configured to **receive reflected ultrasound waves from the medium being imaged and convert the reflected ultrasound waves into a plurality of electrical signals.**
3. A processor **electronically coupled** to the first ultrasound transducer and the second ultrasound transducer.
4. The processor is configured to **receive and process electrical signals along with the tracked position** of the first ultrasound transducer and the second ultrasound transducer **for generating an image.**

Intellectual Property

- IITM IDF Ref. **2359**
- **IN 202241043215**

TRL (Technology Readiness Level)

TRL 3/4 , Proof of concept (PoC) stage
A PoC device set up was made to demonstrate its performance on **tissue mimicking phantoms** and example in-vivo targets.

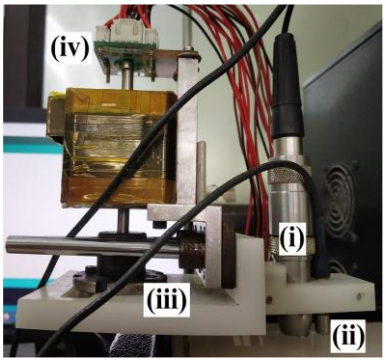

Fig. 2. Developed PoC mechanical US probe with
(i) focused and
(ii) unfocused transducers along with
(iii) Scanning mechanism and
(iv) Position sensing system

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Industrial Consultancy & Sponsored Research (IC&SR)

Key Features / Value Proposition

- The present invention is a novel hybrid two element combination of focused and unfocused ultrasound transducers produces better image quality **without increasing array complexity.**
- Further, the focused ultrasound transducer is provided to **transmit high concentrations of energy** thereby making it possible **to achieve better signal to noise ratio and deeper penetration.**
- Whereas, during the reception both the focused and the unfocused ultrasound transducer are utilized which contributes to **better localization during beamforming.**
- Since, two elements are used during reception, due to **better triangulation**, the overall performance of the system is enhanced.

Advantages - Reduced weight and Packaging size of the proposed system.

Results

- Experimental images of CIRS® (VA , USA) phantom obtained from PoC device are compared to those obtained with those obtained using recently proposed prior-arts of Virtual Source in front of transducer for DAS (VS-DAS) and F-DMAS (VS-DMAS).
- It can be readily appreciated that visually the image reconstructed by PoC device (Fig 4 (d)) is very close to 'Reference' (Fig 4 (a)) compared to others. Also, **from Fig 4 (e-g) the contrast of the blood vessel is better in the than the others**. PoC device reconstructed image.
- Proposed technology improved **spatial resolution by more than 63 %**, and **Contrast (CR and GCNR) by more than 57 % over others.**
- Thus, the results clearly demonstrate that **proposed technology provides superior image quality**.

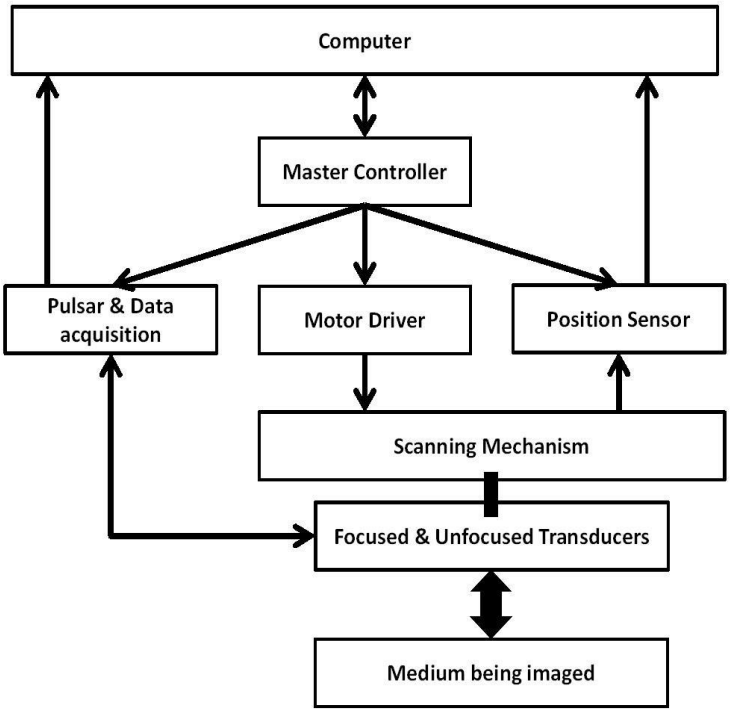

Fig. 3. Block diagram of developed PoC device

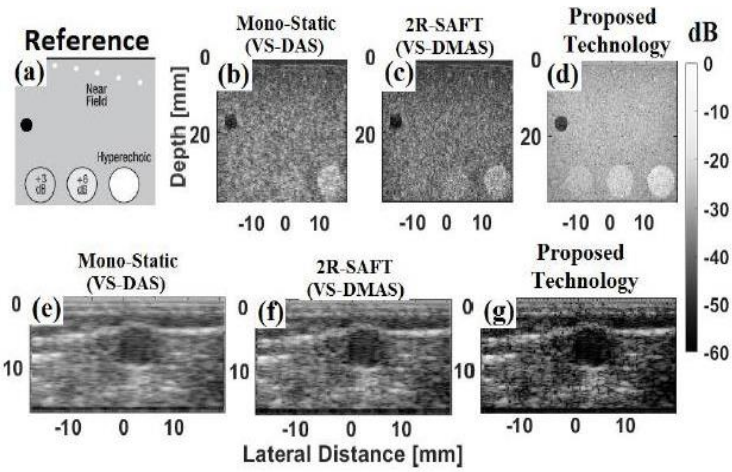

Fig. 4. Illustrates experimental results

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