Docket #: S14-053

Thermoacoustic imaging for handheld medical diagnostic and security screening applications

Stanford researchers have demonstrated the use of a coherent frequency-domain technique in microwave thermoacoustic imaging, which significantly improves signal-to-noise ratio (SNR) and reduces peak-power requirements without sacrificing resolution or other performance metrics.

These advantages enable portable, handheld thermoacoustic (TA) devices benefitting various medical diagnostic and screening needs. The proposed systems are implemented with solid-state electronics (as opposed to bulky vacuum sources) and open the way to a new generation of hand-held and even battery-operated screening tools. The team obtained TA images of multilayer relatively complex muscle-fat structures and believes that these are the first TA images obtained with solid-state electronic sources.

Figure

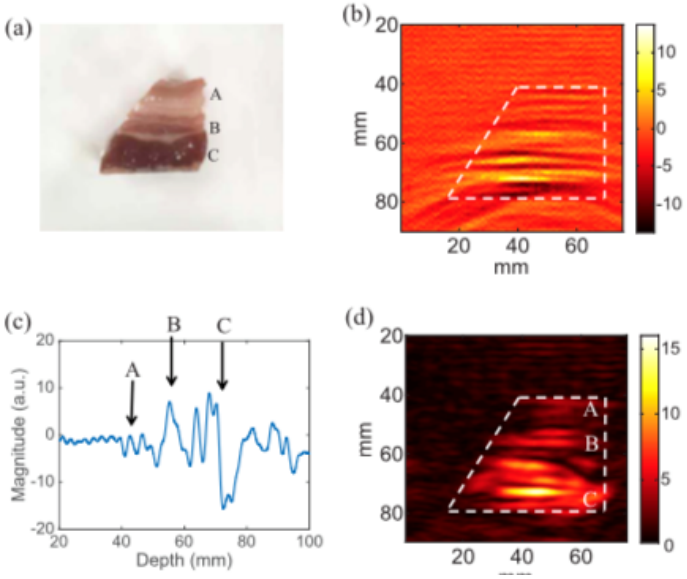

Figure Description (a) Pork belly tissue used in the experiment. (b) 2D raw matched filtering image. (c) 1-D matched-filtering result between measured signal and transmit reference signal. (d) Reconstructed image using FD-SAR. In the figures, A–C denote the top skin, middle muscle, and bottom muscle layers.

Stage of Research
Proof-of-concept
Proposed frequency-domain TA method demonstrated a sufficient soft-tissue contrast and resolution with a pork belly sample of layered structure

Applications

- Medical imaging
- Cancer Screening
- Security Scanning
- Food safety Screening

Advantages

- **Efficient, portable and handheld devices** due to:
  - **Significant signal-to-noise (SNR) improvements** achieved by the coherent processing techniques (27-dB SNR improvement over the pulse method)
  - **Significant reduction of required peak RF power levels** from the transmitter
- Implemented with **all solid state electronics**
- Possibility of **real-time imaging** with a transducer array
- **Non-ionizing radiation** - Induced TA imaging combines the soft-tissue contrast of microwave signals with the resolution of ultrasound (US) imaging
- These **TA images may be the first** to be obtained with solid-state electronic sources

Publications

- US Patent Application 20160007859 "Coherent Frequency-Domain Microwave-Induced ThermoAcoustic Imaging" January 14, 2016
- Nan, H. and Arbabian, A., 2017. Peak-power-limited frequency-domain microwave-induced thermoacoustic imaging for handheld diagnostic and screening tools. *IEEE Transactions on Microwave Theory and Techniques,* 65(7), pp.2607-2616.
- Nan, H. and Arbabian, A., 2014, June. Coherent frequency-domain microwave-induced thermoacoustic imaging. *In Microwave Symposium (IMS), 2014 IEEE MTT-S International*(pp. 1-4). IEEE.
- Nan, H. and Arbabian, A., 2014. Stepped-frequency continuous-wave microwave-induced thermoacoustic imaging. *Applied Physics Letters,*104(22), p.224104.

Patents

- Published Application: 20160007859
- Issued: 10,856,740 (USA)

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