## Super-resolution Transcranial Vascular Imaging for Cynomolgus Monkey Based on Low Frequency Compounded Chirp Transmission

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## **Background, Motivation and Objective**

For transcranial ultrasound vascular imaging (TUVI) techniques which use contrast microbubbles (MBs), most studies have been validated through small animal experiments using high frequency plane waves. However, there is a large gap between these techniques and clinical applications due to human skulls' obvious diversity of acoustic properties. In this study, we use low frequency compounded chirp waves (CCW) to obtain deep intracranial vessel images with super- resolution.

## **Statement of Contribution/Methods**

A 5-angle compounded chirp waves (CCW-5) transmitting with a low frequency was used for penetrating skull. Next, spatial-temporal filtering (STF) based on singular value decomposition (SVD) was used for separating blood flows from tissues and then locations of identified MBs were recorded by peak detection. Finally, it performs multiple MBs tracking using a modified Markov chain Monte Carlo data association (MCMCDA) algorithm. The performance of this method was first evaluated using a designed vascular phantom and then a male cynomolgus monkey.

## **Results/Discussion**

Reasonable threshold of STF filter would effectively reduce background noise and reflection artifacts which may lead to false blood flows and incorrect vessel diameters. In our research, the threshold was set by 0.6 in order to restrain noise and retain more MBs signals. The diameter of vessels in designed phantoms was 0.50mm for measurement and  $0.49\pm0.05$ mm for proposed method. In vivo experiment shows the deep vascular images of the monkey brain obtained by proposed method could be matched with its physiological characteristics in the depth of 35 mm.



Fig.1.Results of phantom and in vivo animal experiments. (a)B-mode images; b)STF images; (c)STF image overlaid with tracking result,all for the vessel with diameters of 0.5 mm in phantoms.(d)CEUS images; (e)MB trajectories showing blood flows from detection and tracking; (f) STF image overlaid with tracking result, all for deep vessels in the monkey brain.