Noise Estimation and Reduction in Power Doppler images of the Gut: preliminary in-vivo results

Dr. Jacob Broughton-Venner[1], Dr. Antonio Stanziola[1],
Professor Kevin Murphy[2] and Professor Mengxing Tang[1]

[1]Department of Bioengineering, Imperial College London, London, SW7 2AZ, UK
[2]Department of Medicine, Imperial College London, London, SW7 2DD, UK
Email: jacob.broughton-venner13@imperial.ac.uk, mengxing.tang@imperial.ac.uk

Background and Objective:
It is estimated as many as two thirds of adults are overweight or obese in the UK. Obesity is a risk factor for many health complications, including heart disease, diabetes and cancers, but current treatments are impractical or ineffective. Understanding how the gut signals information regarding nutrient intake to the brain may identify new therapeutic targets. Ultrasound can quantify blood flow non-invasively, imaging capillaries on the order of 10s of micrometres using contrasting agents and super-resolution [*S. Harput et al.*, *IEEE UFFC, 2018*]. However, the gastro-intestinal tract is a relatively deep organ, this degree of penetration would typically result in ultrasound images with relatively poor signal-to-noise ratios (SNRs). Therefore, techniques that improve the SNR are critical in studies of the gastro-intestinal blood flow and hence the spatial/temporal relations to gut hormones.

Methodology:
In-vivo data from anaesthetised rats was collected from the arteries leaving the aorta to the supply the gastro-intestinal tract, i.e. the superior mesenteric artery, and of the gastro-intestinal tract itself. Acquisition used plane wave transmissions with 15 compounding angles and transmit frequency of 18 MHz. The images were also processed using a high-pass wall filter. To show the importance of noise reduction methods, we applied ASAP processing [*Stanziola, IEEE TMI, 2018*] to the filtered data by splitting odd and even channels to beamform two images and cross correlating them.

Results, Discussion and Conclusions:
Figure 1 demonstrates that processing with ASAP highlights structures in the deepest region of the image that were not visible in the power Doppler (PD) image, substantiating the need for noise reduction methods in gut imaging. The signal-to-noise-ratio was increased from 17.7 dB in the PD image to 27.3 dB in the ASAP image - further demonstrating that noise reduction is needed. Currently, research is focused on evaluating and optimising different noise reduction techniques, by maximising SNR while minimising artefacts.

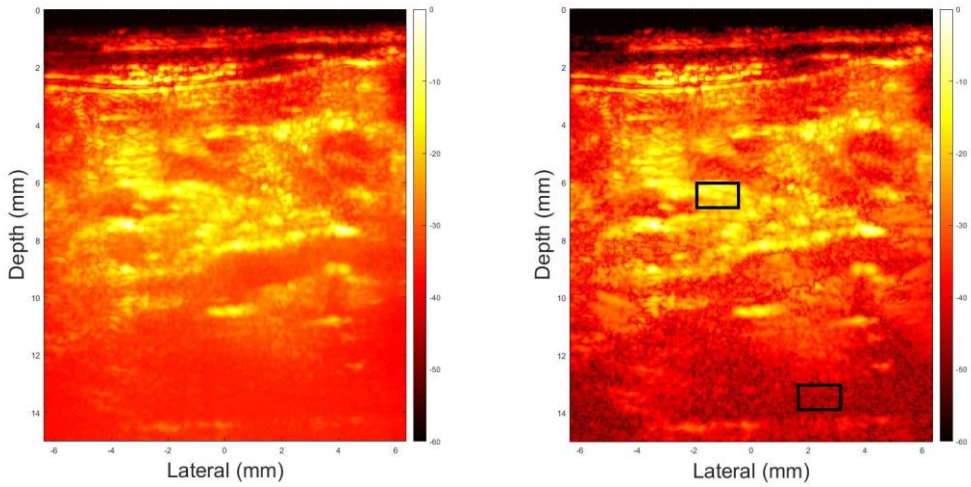

Figure 1: In-vivo data of rat gastro-intestinal tract. (Left: Power Doppler image. Right: Image processed with ASAP. Black box illustrates where the signal-to-noise ratio was calculated in each image.)