QIBA Ultrasound SWS System Dependencies Subcommittee Meeting
July 17, 2015
Call Summary

Notes provided by Keith Wear, PhD

1. Review of Minutes from Previous Meeting – Minutes were not available.

2. Phase I and II Phantom Study Update

   Phase I phantoms are at Zonare. Zonare has done some measurements. Zonare isn't sure where the phantoms are to go next. It was decided that the Phase I phantoms should be sent next to Samsung.

   Phase II Set 1. These were recently re-measured at Duke to test stability of SWS values. Duke measurements indicated stable SWS values. The next steps are to ship to U. Rochester, then Zonare, then Samsung. They are still at Duke and will be shipped to U. Rochester on Monday.

   Phase II Set 2. Location unknown. It was agreed that Set #2 should be sent to Duke for stability testing before being sent to Samsung. There is fear that the phantoms might not survive a round trip to Korea in good shape.

3. Get feedback from manufacturers about timeline for processing digital phantom data.

   Zonare downloaded the data. Siemens, GE, and Zonare agreed to analyze data by Labor Day.

4. Presentation: System-dependent sources of uncertainty and bias in quantitative shear-wave imaging – Yufeng Deng, Ned Rouze, Mark Palmeri and Kathy Nightingale.

Introduction: Several research groups have developed quantitative shear-wave imaging methods to measure the speed of propagating shear waves following acoustic radiation force (ARF) excitations to reconstruct tissue elasticity.(1-3) These methods estimate tissue motion from ultrasound data before and after the ARF excitation and then reconstruct shear-wave speed (SWS) from temporal-spatial tissue motion data using time-of-flight (TOF) methods.(4-6) This work investigates the sources of uncertainty and bias arising from ultrasound system-dependent parameters, such as spatial location and timing, in quantitative shear-wave imaging.
Methods: Errors arising from both spatial and temporal uncertainties lead to errors in TOF-SWS measurements. System-derived temporal errors include master clock jitter, pulse repetition frequency (PRF) and arrival time estimation noise. Sources of spatial errors include phase aberration, beamforming misalignment and coupling medium sound speed mismatch. Beamforming errors include pitch errors in linear and phased arrays as well as radius of curvature (ROC) and sector angle errors in curvilinear arrays. Each of the error sources is investigated with the aid of Field II simulation,(7) full-wave acoustic propagation simulation(8) and experimental validation.
Results/Conclusions: Beamforming errors, coupling medium sound speed mismatch and PRF noise cause biases in SWS measurements (accuracy errors) while the other error sources cause uncertainties (variance). Arrival-time estimation noise is the dominant source of uncertainty,

often leading to ~5% error; however, this error can be reduced by averaging over the number of beams used in the SWS reconstruction. Incorrect transducer parameters result in beamforming errors. A 5% pitch error would lead to biases in SWS measurements of 5% in linear arrays and ≤ 5% in phased arrays. The steering effect and the parabolic delay profile in phased array focusing bias SWS measurements in opposite directions. For curvilinear arrays, a 5% error of sector angle would lead to 5% errors in SWS measurements, while a 5% error of ROC would lead to < 5% errors depending on the imaging depth. In our experience, the calibration of transducer parameters in research systems is likely to be less rigorous than in commercial systems. Calibration of these sources of error is an important step in the development of shear wave imaging systems. Spatial errors can be characterized by calibrating the lateral beam positions, which can be accomplished by imaging point targets with known lateral translations. Supported by NIH grant R01EB002132 and RSNA/QIBA studies.

***(1) UMB 24, 1419-1435 (1998). (2) IEEE UFFC 51, 396-409 (2004). (3) JASA 115, 2781-2785 (2004). (4) UMB 34, 546-558 (2008). (5) UMB 36, 802-813 (2010). (6) IEEE UFFC 57, 2662-2670 (2010). (7) *IEEE ISBI* (2004). (8) *IEEE UFFC 56*, 474–488 (2009).

5. The September SWS System Dependencies subcommittee meeting will devote substantial time to considering the manufacturer's analysis of digital phantom data. The subcommittee would like to request that RSNA extend the usual one-hour time allotment to two hours if possible.

6. There was tentative agreement to have a face-to-face meeting concerning the manufacturers' analysis of digital phantom data in conjunction with the SRU conference Oct. 24, 25 in Chicago, IL.

7. People were reminded that the reports on QIBA Round 4 projects are due by AUGUST 30.