IPEM conferences

Physics and QA of Ultrasound
9th February 2021 online

PROGRAMME

09.35 – 10.05	**Therapy Ultrasound – current status** Gail ter Haar, The Institute of Cancer Research, Sutton
10.05 – 10.35	**Measurement and calibration to support the evolving clinical applications of ultrasound** Bajram Zeqiri, National Physical Laboratory, Teddington
10:35 – 10:50	**Assessment of the accuracy and precision of three commercially available b-mode ultrasound quality assurance test objects** Piero Miloro, Ultrasound and Underwater Acoustics, National Physical Laboratory, Teddington TW11 0LW,
10:50 – 11.05	**Break**
11.05 – 11.35	**Ultrasound Capsule Endoscopy: What can be Imagined? What is Possible?** Sandy Cochran, James Watt School of Engineering, University of Glasgow Group
11.35 – 11:50	**Towards an impartial acceptance criteria for point of care ultrasound scanners used for COVID-19 patient management.** David Rowland, Medical Physics and Engineering Department, Leeds General Infirmary
11:50 – 12.05	**An adaptation of the ultrasound transducer element test for multi-row arrays** Nick Dudley, United Lincolnshire Hospitals NHS Trust, Lincoln, UK and Multi-Medix Limited, Barrow upon Soar, Leicestershire, UK
12:05 – 12.20	Abstract 2 **Novel in-house string-phantom – a viable alternative to a commercial string-phantom for Doppler velocity measurements?** Aleksandra Kraska, Vascular Studies Unit, Oxford University Hospitals NHS Foundation Trust, UK.
12.20 – 12.30	**Question session**
	Break / posters
13:45 – 14:15	**The role of anthropomorphic phantoms in Diagnostic ultrasound for training and performance evaluation** Jacinta Browne, TU Dublin
14.15 – 14.30	**Survey of a Range of Ultrasound Systems used in Trans-rectal Ultrasound Guided Prostate Brachytherapy using task-specific Contrast Detail Phantoms for the determination of Contrast Detectability Performance** A J Doyle, Centre for Industrial and Engineering Optics, FOCAS, Dublin Institute of Technology, Ireland
14.30 – 14.45	**Introducing automated and objective methods to routine diagnostic ultrasound quality assurance** Dr Tom Lister, Royal Berkshire Hospital.
14:45 – 15:00	**An investigation of machine learning techniques to classify ultrasound QA images by test type.** Nick Gibson, Nottingham University Hospitals NHS Trust, UK.
15:00 – 15:15	Tea break
15:15 – 15:30	**TBC** Sander Dekker of Cablon
15:30 – 16:00	Discussion session (including VP to lead on future of US QA and US profession) Final comments and close

ABSTRACTS AND SPEAKER BIO's

Please note these are the details received from the speakers by the deadline

Therapy Ultrasound – current status

Gail ter Haar, The Institute of Cancer Research, Sutton

Biography

Prof. Gail ter Haar took her first degree in Physics from Oxford University. Following a Masters degree in Medical Physics from Aberdeen University, she studied for her PhD in Physics at Guy's Hospital, in London. She also holds a D.Sc. in clinical medicine from Oxford.
Gail's research interests have always lain primarily in understanding the way in which medical ultrasound interacts with tissue, especially the physical mechanisms involved in producing bio-effects (primarily heating & acoustic cavitation) with a view to understanding its safety when used in diagnosis, and to harnessing these effects for therapeutic benefit. Most recently her research has concentrated on developing devices and protocols for ultrasound based treatments of cancer. Her pre-clinical work encompasses the use of therapy ultrasound for immune stimulation, and the combination of therapy ultrasound with other therapeutic modalities, including radiotherapy. In collaboration with colleagues at the Royal Marsden Hospital Gail's team have been running phase I clinical trials for the use of High Intensity Ultrasound for the palliation of pain arising from bone and gynaecological tumours.
Gail is founding President of the International Society for Therapy Ultrasound (ISTU). She is an honorary member of BMUS, honorary fellow of the American Institute for Ultrasound in Medicine, and fellow of the Acoustical Society of America and IPEM. Gail runs the UK based ThUNDDAR network (Therapy Ultrasound Network for Drug Delivery and Ablation Research). The aim of this is to stimulate collaboration between British and European groups working with therapy ultrasound. She is Deputy Editor of "Ultrasound in Medicine and Biology", associate editor of "Ultrasonics" and on the editorial boards of International Journal of Hyperthermia and Medical Physics. Gail has written 5 books and 32 book chapters, and over 250 peer reviewed research papers.
In 2014 her team was recognised by being made a Centre of Excellence for HIFU physics and bone studies by the Focused Ultrasound Foundation.

Abstract
The use of ultrasound for therapeutic purposes is gaining rapid recognition. The versatility of ultrasound delivery allows it to be used at low intensities for physiotherapy and enhancing drug delivery, at medium intensities for reducing the chemo- or radiotherapy doses required in the treatment of cancer, and at high intensities for thermally ablating tumours. Both the heating and mechanical capabilities of ultrasound are called into play. In this talk, examples of these treatments will be discussed, as will ultrasound's role in stimulating the body's immune response.

Measurement and calibration to support the evolving clinical applications of ultrasound

Bajram Zeqiri, National Physical Laboratory, Teddington

Abstract

Measurements to determine the acoustic output of medical equipment are crucial in terms of underpinning the continued safety and efficacy of diagnostic and therapeutic applications of ultrasound. For approaching four decades, NPL has played a pivotal role in ensuring users worldwide are able to carry out measurements of the essential properties of clinically applied equipment, in a valid and traceable way that is comparable across the globe. This presentation will review NPL's specific contribution in establishing primary standards for realising the acoustic watt (for power measurement) and the pascal (for acoustic pressure). It will also describe the Measurement Services NPL provides to industry and hospitals to ensure that these key derived-SI units are disseminated to user community. Other mechanisms of impact delivery will also be highlighted: through the standardisation process and through key comparisons undertaken with other National Metrology Institutes. In addition to the remit of disseminating the two base units, NPL has a considerable programme of R&D targeted at developing measurement methods supporting the development of a range of emerging clinical techniques such as high frequency pre-clinical imaging, High Intensity Therapeutic Ultrasound and Photoacoustic Imaging. The current status and direction of the research in these areas will also be described.

Assessment of the accuracy and precision of three commercially available b-mode ultrasound quality assurance test objects

Piero Miloro, Ultrasound and Underwater Acoustics, National Physical Laboratory

Background. Ultrasound test objects are routinely used in quality assurance (QA) procedures for assessment of clinical ultrasound systems. There are several test objects available in the market, which differ in materials and arrangements of internal targets. The purpose of this work was to compare the accuracy and precision of measurements of three commercially available b-mode test objects (CIRS 040GSE, Gammex Sono403 and ATS 539).

Methods. Three different machine models (Siemens Acuson S300, 8C3, Samsung HM70A, CA1-7AD and GE Logic E10 Curvilinear 1-6 MHz) were used for imaging. An alignment jig was used to position the transducer to eliminate freehand movement of transducers during scanning, reducing user dependency. Tests were performed using the abdominal pre-set (4 MHz, 18 cm depth, 4cm focus 100% acoustic power). QA tests were performed based on IPEM report 102. Calliper accuracy was assessed manually. Subjectivity of measurements was reduced using UltraIQ software [Cablon, Leusden, The Netherlands] to assess axial and lateral resolution.

Results. The calliper accuracy (percentage error) and the spatial resolution (mm) were compared between systems and phantoms. Results were analysed using t-tests. Calliper measurements differed significantly between phantoms ($P>0.01$). Pin measurements for the ATS phantom gave significantly higher values than for the other phantoms ($P<0.05$) (Figure 1). The absolute value difference did not always match the significance of the results, suggesting the difference is a systematic shift.

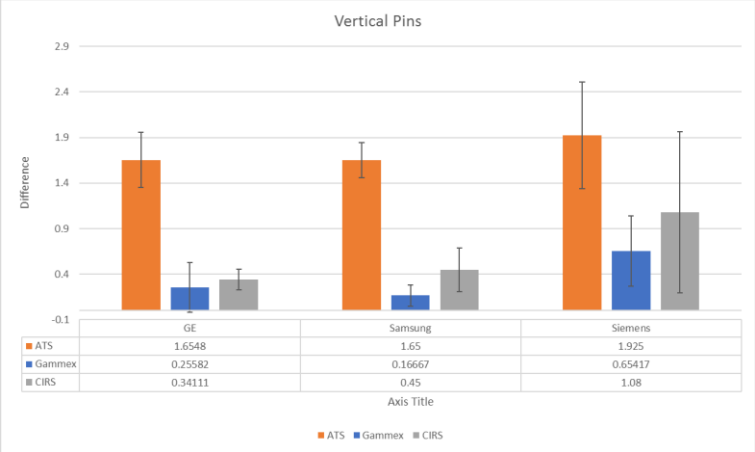


Figure 1. Comparison of QA measurements using three different TOs.

Discussion and Conclusions. The ATS phantom, made from more durable materials had reduced accuracy of measurement, but all three phantoms had similar levels of precision using the jig system and UltraIQ analysis. Each can be used for routine testing, but it is important to assess relative values and trends for each phantom and report results according to phantom limits.

Ultrasound Capsule Endoscopy: What can be Imagined? What is Possible?

Sandy Cochran, James Watt School of Engineering, University of Glasgow Group

Video capsule endoscopy was developed as a viable clinical technique around twenty years ago. This has led to more than one project addressing the possibility to implement the same clinical approach with ultrasound as the imaging modality, either combined with optical imaging or individually. Such an idea follows the precedent set by conventional endoscopy, in which it has been argued that ultrasound imaging was the most important single development after the optical origination of the technique. There are also clinical reasons to expect benefit, particularly in the ability of ultrasound to penetrate and image the full depth of the wall of the gastrointestinal tract and for it to provide a therapeutic function. However, there are major technical barriers to overcome, including the difficulty communicating with a capsule as it passes through the gut, the need for sufficient power for the capsule to function throughout the useful part of its passage, and implementation in the very small volume that can be ingested comfortably.

This paper will consider work done to date on this problem, with a particular focus on two prototype endoscopic ultrasound capsules, ERIC, the epithelial imaging research capsule, and CAIT, the capsule for autonomous imaging and therapy. The engineering approach to the research programme in which their development was completed will be considered first, followed by a detailed analysis of the prototypes and their capabilities and limitations. Both ERIC and CAIT completed successful trials in porcine specimens *in vivo*; detailed consideration will be given to the means by which they were characterised prior to these tests, including a description of the range of phantoms and *ex vivo* tissue that were used to determine both functionality and safety for the animals, and the relevant protocols. The paper will conclude with discussion of the research necessary for ultrasound capsule endoscopy to progress to a technology readiness level for human testing and the likely focus for such tests.

Towards an impartial acceptance criteria for point of care ultrasound scanners used for COVID-19 patient management.

David Rowland, Leeds General Infirmary

Background

It has been shown that point of care ultrasound scanners (POCUS) are an important additional imaging tool for managing patients with acute respiratory conditions such as COVID 19 [1]. The UK Department of Health loaned the trust 16 POCUS units in response to the COVID 19 pandemic as part of an overall national strategy. These were subject to acceptance testing before being introduced into service. A rapid response was required and the time available for acceptance testing was limited to a maximum of 5 working days. Dudley 2019 [2] highlighted anomalies that can be observed on new equipment using simple acceptance tests and has shown that there is correlation with genuine faults. These simple tests can be implemented without the requirement for expensive equipment or additional staff resources [3]. Availability of a relatively large number of scanners of the same model allows for the potential to define pass-fail criteria for measures that are normally used as relative tests. If successful, the pass-fail criteria can be used at acceptance for any scanner of the same configuration to trigger further investigation to confirm faults.

Methods

Acceptance tests were undertaken on 48 probes across 16 General Electric Healthcare™ Venue systems (Chicago, Illinois). Each scanner was fitted with similar probes: a L4-12t-RS or 12-L-RS; a C1-5-RS convex array probe; and a 3Sc-RS phased array probe. The tests completed were: acquisition and analysis of air reverberation patterns; measurement of in air reverberation depth, measurement of threshold noise levels in B-mode and Colour Doppler imaging and assessment of image uniformity using a Gammex SonoTE® Ultrasound Transducer Evaluation Device (UTED). A standardised quality assurance protocol was used to achieve the same test conditions for each scanner. Analysis of the images were undertaken using measurement tools available on the scanner and automated algorithms developed locally using macros in ImageJ.

Results

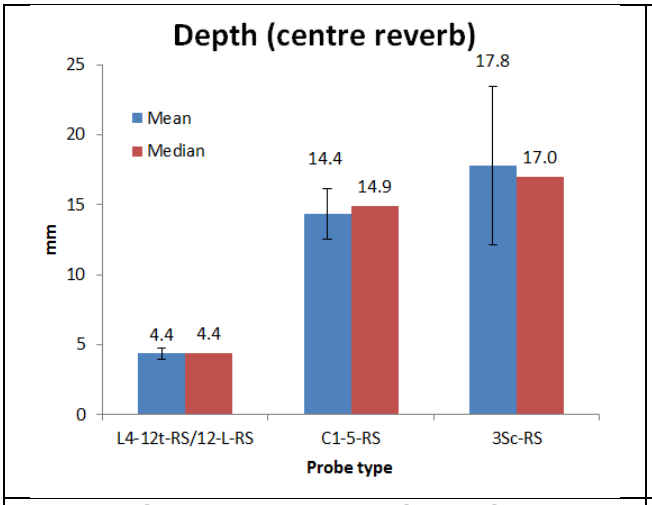


Figure 1: Automated Results

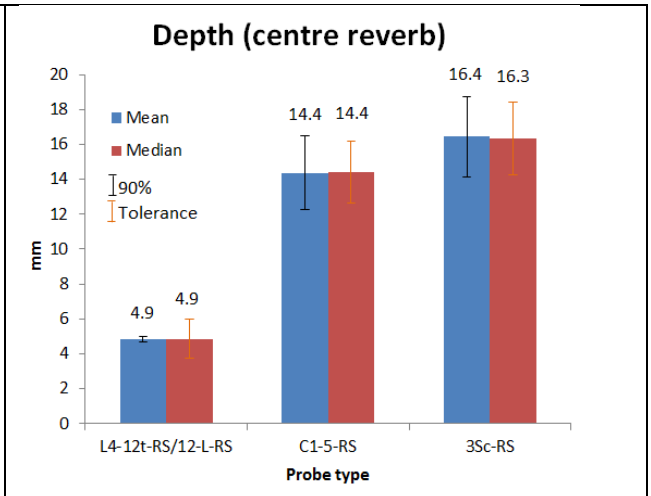


Figure 2: Manual Results

Automated and manual results for the reverberation pattern are shown in figures 1 and 2 above.

Conclusions

Initial results suggest that a pass-fail acceptance criteria can be defined for the depth to the last in-air reverberation plane; B-noise and C-noise gain level; uniformity of reverberation pattern; signal and uniformity of a test object image. These criteria can be defined from the mean and 90pecentle data and reverberation pitch (reverberation depth only) but will only be valid for specific settings.

References

1. Volpicelli G, Elbarbary M, Blaivas M, et al. International evidence-based recommendations for point-of-cares lung ultrasound. Intensive Care Med 2012; 38: 577–91.
2. Nicholas J. Dudley and Darren J Woolley, Assessment Of Repaired Diagnostic Ultrasound Probes, Ultrasound in Med. & Biol., Vol. 45, No. 10, pp. 2844 - 2850, 2019

Nicholas J Dudley and Darren J Woolley, A multicentre survey of the condition of ultrasound probes, Ultrasound OnlineFirst, published on August 1, 2016

An adaptation of the ultrasound transducer element test for multi-row arrays

Nick Dudley, United Lincolnshire Hospitals NHS Trust

Background: A simple “paperclip test” for the function of individual elements in a diagnostic ultrasound transducer array is widely performed and has been adapted for phased arrays. The aim of this study was to adapt the test further for multi-row transducer arrays.
Methods: An embossing tool was used in place of the usual paperclip or metal rod and was slowly moved along the transducer array, attempting to isolate the signal from each row in turn. Phased array transducers were operated in M-mode. Non-functioning elements were identified by a reduction in amplitude of the reverberation line. The test was repeated several times for each transducer, ensuring that all non-functioning elements were identified and looking for consistency of results. 28 phased arrays and 5 linear/curvi-linear arrays in clinical use and 1 phased array and 1 linear array already identified as faulty by electronic transducer testing were available for testing.
Results: 8 of the clinical phased arrays were found to have 1 or more faulty elements; 3 had only minor defects and 5 were replaced under warranty or service contract. The linear/curvi-linear arrays showed no fault. The adapted test showed the failed elements in the known faulty phased array, except at the end of the array, but weak elements were not detected. The faulty linear array had a block of failed outer elements which was identified by the test.
Conclusions: The adapted test is capable of detecting non-functioning elements in multi-row arrays, but weak elements were not detected.

Key references

[1] Goldstein A, Ranney D, McLeary RD. Linear array test tool. J Ultrasound Med 1989; 8:385-97.
[2] Dudley NJ, Woolley DJ. A simple uniformity test for ultrasound phased arrays. Physica Medica 2016; 32:1162-1166.

Novel in-house string-phantom – a viable alternative to a commercial string-phantom for Doppler velocity measurements?

Aleksandra Kraska, Vascular Studies Unit, Oxford University Hospitals NHS Foundation Trust, UK.

Background. Accurate flow velocity estimation is crucial for correct vascular disease diagnosis [1,2]. Even slight under- or overestimation of velocity can influence final results and mask or mimic stenoses, leading to adverse outcomes such as misdiagnosis or unnecessary interventions. String-phantoms can be used in quality assurance (QA) programmes to test the accuracy of blood flow velocity measurements made using Doppler ultrasound. However, commercial string-phantoms (CSP) are not widely used, partly due to high cost. This study aimed to assess the suitability of a newly developed novel in-house string-phantom (NSP) for use as an alternative to a CSP for a local QA.

Methods. The NSP was designed and built to include novel solutions such as self-calibration system and novel probe holder. Velocities in a range of 30-150 cm/s were produced by both phantoms and detected by the same ultrasound system under consistent conditions. Velocity measurements were obtained and maximum velocity accuracy (MVA) and intrinsic spectral broadening (ISB) were calculated before differences and agreements between measurements were statistically analysed.

Results. Significant differences ($p<0.001$) were found when comparing measured velocities between the two phantoms. However, there was no difference between the detected mean velocity and string velocity of the NSP ($p=0.980$). Limits of agreement between commercial and novel phantom were -4.48% and 3.09% for MVA and -2.62% and 0.91% for ISB comparison.

Discussion. Differences found between phantoms could be attributed to limitations such as differences in generated velocity values, fluctuation of waveform shape due to the novel self-calibration system, learning-curve in device setup and the string material used. Comparing limits of acceptability suggested in previous studies, established between ± 5 – 20% difference [2,3], it appears that reasonable agreement was found between ISB and MVA generated by both phantoms.

Conclusion. Overall, use of the NSP in a local QA programme appears feasible. With some technical improvement and more extensive testing, this phantom could become an inexpensive alternative to commercial devices.

Key references.

1. Oates CP et al. Joint recommendations for reporting carotid ultrasound investigations in the United Kingdom. Eur J Vasc Endovasc Surg. 2009 Mar; 37(3):251-61. DOI: 10.1016/j.ejvs.2008.10.015.
2. Cournane S et al. An audit of a hospital-based Doppler ultrasound quality control protocol using a commercial string Doppler phantom. Phys Med. 2014 May; 30(3):380-84. DOI: 10.1016/j.ejmp.2013.10.001.
3. Walker A et al. Accuracy of spectral Doppler flow and tissue velocity measurements in ultrasound systems. Ultrasound Med Biol. 2004 Jan; 30(1):127-32. DOI: 10.1016/j.ultrasmedbio.2003.08.020.

The role of anthropomorphic phantoms in Diagnostic ultrasound for training and performance evaluation

Jacinta Browne, TU Dublin

The role of anthropomorphic phantoms in Diagnostic ultrasound for training and performance evaluation

Purpose:

A range of anthropomorphic and anatomical breast ultrasound phantoms were developed for training and image quality evaluation. The training breast phantoms simulated both the anthropomorphic and sonographic characteristics of the different breast tissues and their use as training tools was evaluated in a group of radiology residents. Image Quality task-specific phantoms were developed to carry out an objective evaluation of different ultrasound systems.

Materials and Methods:

In the first part of this study, two similar devices (Phantom 1-P1 and Phantom 2-P2) were designed to produce realistic sonographic images of breast morphology and each contained similar pathologies embedded in different locations. A pre-training assessment of nine radiology residents' (2nd–4th year) ability to detect and characterize all lesions in P1 was completed, followed by a two hour training session on the same phantom, which included a map detailing each lesion location and characteristics. All residents underwent a post-training assessment on P2; rates of lesion detection and correct lesion characterization were determined. Residents were surveyed about their views of the phantoms following the post-training assessment. In the second part of this study, anthropomorphic breast phantom were developed through consultation with Radiologists, breast US sonographers and Medical Physicists f to represent both easy and challenging patients. The specification and design included thickness and acoustic characteristics of the skin, fat and fibroglandular tissues as well as the number, location, size, echogenicity, margin characteristics, and associated artifacts of "must see" lesions. These lesions included cancers with spiculations and angular margins; lipid, sebaceous and acorn cysts; fibroadenomas; lymph nodes; Mondor's disease; and papillary lesions.

Results:

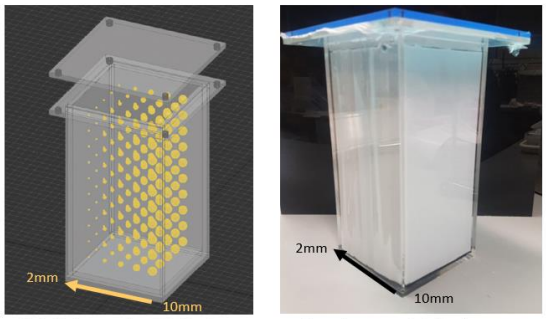
This study demonstrated a significant increase in the radiology residents' detection and correct characterization scores between pre- and post-training, with a pooled increase of 26±14%, $p<0.003$ and of 17±8%, $p<0.0003$, respectively. A range of anatomical phantoms were constructed which included the different breast tissue types and 10 lesions with the specified anthropomorphic and acoustic characteristics. An acoustic macroscope verified that the target acoustic properties were achieved for the different breast tissue types and lesions. Initial US scanning of these phantoms showed very good resemblance between the model lesions and the corresponding "must see" findings. Also, these anatomical phantoms were capable for differentiating between different types of ultrasound systems.

Conclusion:

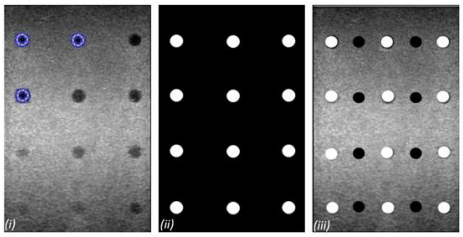
The anthropomorphic breast phantoms were found to be successful for training and assessment. Furthermore, they provided a "life-like simulation" of breast tissue for ultrasound imaging in a non-pressurized environment which allowed residents to practice and refine ultrasound imaging skills without direct exposure to patients. The developed anatomical phantoms were successful in replicating the anatomical, morphological and sonographic appearance of "must see" lesions and were found to be suitable for assessing image optimization through identification of individual lesion features.

Survey of a Range of Ultrasound Systems used in Trans-rectal Ultrasound Guided Prostate Brachytherapy using task-specific Contrast Detail Phantoms for the determination of Contrast Detectability Performance

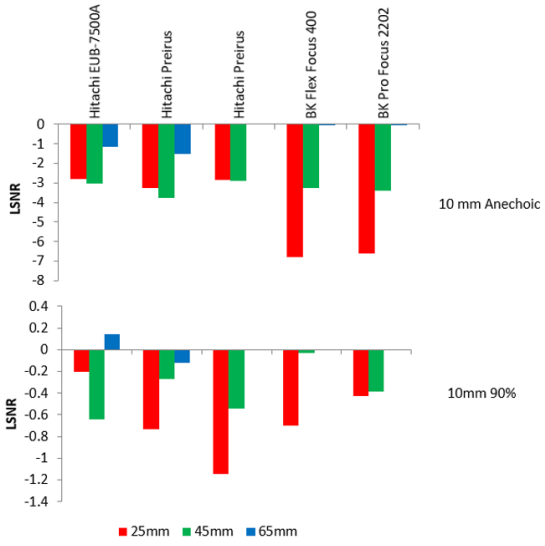
A J Doyle, Dublin Institute of Technology, Ireland



(a): Schematic of C-D phantom and an Image of C-D phantom



(b): (i) Selection of input targets (ii) ROI mask generated at target locations (iii)Target ROIs and corresponding background ROIs at depths



(c): Lesion-Signal-to-Noise ratios for five TRUS systems as a function of depth for anechoic and 90% relative contrasts

Background in Trans-rectal ultrasound (TRUS) guided prostate brachytherapy for prostate cancer has become a popular treatment option largely due to its benefits for patient recovery, dose localisation and conformity [1]. Contrast detectability is vital during the TRUS PBT procedure, as delineating and contouring the prostate from the pelvic parenchyma, is intrinsic to determine the volume of the gland. The aim of this study was to determine contrast detectability performance of a range of TRUS systems using novel contrast-detail phantoms, with task-specific and clinically relevant contrasts and targets.

Methods Four purpose built C-D phantoms were used in the investigation, containing (5x10) arrays of small spherical targets at clinically relevant contrasts ranging from 2-10mm diameter, figure (a). Images were acquired on both probe arrays, of each of the target sizes at each contrast, on the clinical pre-set and on a pre-set THI setting for each of the five TRUS systems evaluated. A program was developed in Matlab (R2017a) to objectively measure the contrast-detectability in terms of the lesion-signal-to-noise ratio (LSNR) over a range of depths for each contrast level, figure (b).

Results The preliminary results indicate that for the five TRUS systems evaluated there is a decrease in contrast detectability at depth in the phantom with a decrease in target size. The BK systems performed well with superficial anechoic large targets, but was challenged at depth. As the target diameter decreased and contrast became more challenging, analogous to the clinical contrast of the prostate, the Hitachi Preius performed best, figure (c). With further data collection and data analysis the objective comparison of these systems may indicate optimum settings for TRUS imaging.

Conclusion Preliminary data from TRUS systems evaluated, demonstrated the efficacy of the device as an image quality evaluation tool. The Matlab program allows for objective comparison of these systems which has the potential to determine optimised imaging parameters that could be as part of a standard imagining protocol for this application. Objective comparison of the TRUS systems used in PBT has the potential to identify the most suitable system for the task, and to determine optimised imaging parameters for a standard imaging protocol.

Introducing automated and objective methods to routine diagnostic ultrasound quality assurance

Dr Tom Lister, Royal Berkshire Hospital.

National guidance for diagnostic ultrasound services, including national screening programmes, recommend a quality assurance programme inclusive of acceptance testing and baseline measurements performed by an expert medical physicist, followed by frequent user checks and regular (6-12 monthly) assessments of equipment performance by a medical physicist.

IPEM report 102 provides details of quality assurance tests and appropriate phantoms to use. Many of these tests, including both user and medical physicist checks, have subjective elements and may vary between users, with a single user over time or with ambient lighting conditions, for example.

This talk discusses the benefits and challenges faced with the introduction of automated 'user QA' to detect faulty probes, inspired by the work of van Horssen et al[1] as well as objective methods to support routine medical physics QA. Objective methods include a system for the automatic detection of test objects, measurements of image contrast and an attempt to highlight variations in element sensitivity.

It is recognised that medical physics expertise plays an important part of the QA process but it is hoped the potential of the approaches desctibed can help to improve the objectivity and frequency of diagnostic ultrasound QA.

Reference: 1. *Ultrasound* 2017, **25**(4): 229-238

An investigation of machine learning techniques to classify ultrasound QA images by test type.

Nick Gibson, Nottingham University Hospitals NHS Trust, UK.

Background.

Quality assurance (QA) testing systems based on computerised image analysis have been in use for some years. Such a system in use locally for ultrasound imaging is based on analysing phantom images containing various targets for each of the 6 tests covered (resolution, slice thickness, penetration depth, low and high contrast sensitivities, in air)[1]. One barrier to full automation of such systems is the lack of ease of assessing DICOM images to identify the test type to which they pertain, for example by encoding this into a DICOM data element, in order for an automated processing system to determine which processing apply. An automated method of determining this from the pixel data alone would overcome this. Machine Learning methods have been applied successfully to many different image classification tasks in recent years including widely in medical imaging[2,3,4,5]. It is the objective of this study to investigate the capability of such methods to classify ultrasound QA images.

Methods.

Over 1500 images from over 50 transducers, including a range of curved, linear and phased array types, across more than 25 scanner units were used for this study. These were manually classified by test type to provide a 'ground truth' data set. Software was developed in Matlab to classify the images using two methods. In the first, features were extracted from the images using a KAZE feature extraction algorithm and from these a visual 'bag of features' compiled and which was then fed into a K-nearest neighbour classifier. In the second method, a convolutional neural network was trained to classify the images. The performance of each of these methods was assessed by holding a proportion of the images, selected at random, out of the training process and then applying the methods to those images held out, calculating the classification accuracy.

Results.

The method based on feature extraction yielded an accuracy of just over 95 % whereas the convolutional neural network method yielded and accuracy of over 98 %.

Discussion.

The accuracy of the feature extraction method was good and whilst perhaps not sufficient for deploying in a fully automated QA system would be sufficient for renaming files for ease of identification for a semi-automated system where files are manually selected for processing one by one, as is current practise locally. The accuracy obtained using the neural network was significantly better and would be suitable for deployment in a fully automated QA system. It should be borne in mind that the accuracies obtained by this experiment are only applicable to the data used in the experiment and give only an indication of generalised accuracy.

Conclusion.

A method of classifying ultrasound QA image by test type using a convolutional neural network was developed and found to have very good accuracy (98%), outperforming a feature extraction based method, and is suggested suitable for use in a fully automated QA system.

Key references.

1. Gibson NM et al, Ultrasound in Med. & Biol., Vol. 27, No. 12, pp. 1697–1711, 2001
2. Rancheart ER et al, AI in Medical Imaging, Springer 2019
3. Alcantarilla PF et al, ECCV 2012, Part VI, LNCS 7577. 2012, p. 214
4. Csurka GCR. et al, ECCV 1 (1–22), 1–2

Krizhevsky A, in: Pereira F et al, Advances in neural information processing systems 25. Red Hook:

Curran Associates Inc.; 2012. p. 1097–105.

TBC

Sander Dekker of Cablon