Workshop of the Consultative Committee for Acoustics, Ultrasound and Vibration

"Diagnosis and inspection by AUV measurement"

Venue : Pavillon du Mail, BIPM, Sèvres, France
Start : Wensday25 September 2019 14:00

14:00 – 14:05 Introduction: Aim of the workshop

[Takashi Usuda, CCAUV President, NMIJ (Japan)]

14:05 – 14:50 Probing biological systems with ultrasound

[Dr. S. Lori Bridal – Laboratoire d'Imagerie Biomédicale (LIB), Sorbonne Université (Paris, France)]

Ultrasound can be used to both to precisely evaluate the physical properties of biological materials and to safely probe living systems in real-time. For example, resonant ultrasound spectroscopy has recently been adapted to measure anisotropic elasticity in the highly damped material of bone specimens. Characterization of low-level blood flow in vivo is another challenge for which ultrasound has demonstrated a plethora of creative and powerful solutions. The state-of-the art for these emerging techniques and current criteria used to assess their safety and precision will be considered.

Selected topics from CCAUV member institutes

14:50-15:10 Quantitative Ultrasonic Attenuation Imaging of Breast Phantoms

[Christian Baker, NPL (United Kindom)]

Ultrasound Computed Tomography (UCT) has been suggested as a potential adjunct and replacement for X-ray mammography due to its quantitative, non-ionising and non-invasive nature. However, measurement of attenuation – a diagnostically important property - is metrologically challenging. Images suffer from artefacts, partly due to the phase-sensitive nature of the detectors traditionally employed. It was suggested early in the development of UCT that use of phase-insensitive detectors could improve attenuation imaging. A new UCT system employing a novel phase-insensitive pyroelectric sensor has been developed at NPL and 2D attenuation maps of two commercial multi-modality anatomical breast phantoms (CIRS, Norfolk, VA, USA) generated. Early images obtained using the piUCT system compare well with X-ray computed tomography images of the same phantoms, qualitatively and quantitatively. The system was able to detect inserts representing malignant masses with absolute attenuation values derived at 3.2 MHz agreeing with ground-truth values to within 10%. Future work will systematically evaluate the performance of the system and its ability to differentiate inclusions of known sizes and acoustic properties relevant to clinical breast imaging.

15:10-15:30 Non-destructive inspection by visualization of laser-induced ultrasonic waves

[Nobuyuki Toyama, NMIJ (Japan)]

A new NDT technique to detect damage quickly, reliably, and automatically has been required by industry. We have first developed an ultrasonic inspection technique that visualize the propagation of ultrasonic waves in arbitrary shaped objects. This technique provides a movie of traveling waves

through the use of a laser ultrasonic imaging system, which consists of a rapid pulsed laser scanning unit for ultrasonic generation and a fixed receiver unit for ultrasonic reception. We applied this technique to the inspection of various metal and CFRP structural components and successfully demonstrated the efficiency and the feasibility of the technique. We also introduce our cutting-edge techniques, a “fully” non-contact ultrasonic inspection system and an automatic diagnosis system using machine learning.

15:30-16:00 Coffee/Tea breaks

16:00 -16:20 Environmental vibration measurements in order to protect the premises and work of a national metrology institute

[Thomas Bruns, PTB (Germany)]

Environmental vibration and its influence on humans is a persistent topic inside highly populated areas like cities. Here, the vibrations are known to be generated by permanent sources like road or railway traffic or non-permanent sources like construction sites. Even in areas of rather quiet environments new sources of vibration may threaten existing work places with national and international importance. Such a situation was the trigger for some serious vibration monitoring and measurement activities at the PTB (Germany), which were aimed at the question in how far the recommissioning of a railway-track was a threat to its metrological obligations. The contribution will describe the situation, the performed measurements, test runs and the outcome, which was a surprise for many parties involved

16:20-16:40 Vibration Measurement and Analysis Experience on Rail Transporting in TAIWAN

[Tsung-Hsien Tu, CMS/ITRI (Chinese Taipei)]

At present, the inter-city railway commuter rail and high-speed rail have a total mileage of more than 1405 km in Taiwan. Meanwhile, Taiwan is an area with frequent earthquakes, about 60 % of this island located in the high-intensity region with the intensity above level 7. The rail-track configuration and design were import to ensure the safety and customer satisfaction for every route journey. With the rise of train speed, the environmental vibrations along railway lines become a major concern. Rail transportation system, especially high-speed rail, invest lots of resource at vibration investigation along the railway line for preventing the error of operation and reducing the negative vibration impact on the surrounding area. This presentation intends to provide some experimental activities performed on the ground borne vibration and rail infrastructure vibration excited by high speed trains passing by. The outcome of these results help the railway operation engineers improve the rail operation safety and comfortable issues both for the passengers and resident along the railway line.

16:40-17:00 Quantification of hardened layer thickness in steels using ultrasound metrology

[Andres Esteban Perez Matzumoto, CENAM (Mexico)]

A widespread application within the automotive industry is the measurement of hardened layer thickness in heat treated steels by induction. In general, destructive tests are performed and that may require too much time to carry them out in order to ensure that a production line indeed manufactures components with the hardness depth profile required. A viable ultrasound alternative has been studied and implemented at laboratory level at the National Metrology Center (CENAM) in Mexico. Basically,

a non-destructive ultrasonic method was developed to measure hardening depth in steels after being heat treated by induction. Ultrasonic immersion techniques were tested and optimized at laboratory workbench. A high frequency ultrasonic transducer at a fix angular orientation was used to propagate ultrasonic shear waves inside the hardened steel component. The interaction of the ultrasound in the transition zone (hardened material - soft material) generates ultrasonic indications, that after several stages of signal de-noising and smoothing, making use of the wavelet transform, Hilbert transform and smoothing filters; allow us to determine the depth of the hardened layer through the measurement of the time-of-flight between the indication of the surface of the piece under study and the indication of the transition zone. The methodology developed has proved to be successful at laboratory level; results obtained show measurement errors < 0.2 mm compared to micro-hardness methods, but being much faster and feasible for an on-line implementation in production lines.

17:00-17:20 Calculation of acoustic transfer impedance in couplers for reciprocity calibration

[Erling Sandermann Olsen, BKSV-DPLA (Denmark)]

For many years, the most accurate method to establish primary sound pressure standards at medium and low frequencies has been pressure sensitivity reciprocity calibration of Laboratory Standard, LS, microphones. In recent time, it has been increasingly clear that the calculation of the acoustic transfer impedance of couplers used in the calibrations is inaccurate. Focus has been on heat exchange with the coupler walls leading to a transition from adiabatic to isothermal conditions at low frequencies, and recently Vincent et. al. published a suggested solution reconsidering the background of the full low frequency solution in international standard IEC 61094-2. In this presentation, the suggested solution is compared to alternative calculations and the influence of the acoustic impedance of the microphones is discussed. Consistence between calibrations of different microphone types and between different independent measurement methods will be discussed. The alternative calculations seem to give more consistent results than the solution suggested by Vincent et.al.

17:20-17:40 Acoustic transfer admittance of cylindrical cavities in infrasonic frequency range

[Dominique RODRIGUES, LNE (France)]

Demand for calibration at infrasonic frequencies has emerged in response to earth monitoring problems. The primary standard for sound pressure is defined through the reciprocity calibration method specified in the International Electrotechnical Commission (IEC) Standard 61094-2:2009. This method is based on the use of closed couplers and is routinely applied by the National Metrology Institutes for a large frequency range; however, infrasonic frequencies below 2 Hz have not been explored until recently. The acoustic transfer admittance of the coupler, including the heat conduction effects of the fluid, must be modelled precisely to obtain accurate microphone sensitivity. IEC 61094-2:2009 provides two standardised solutions for the correction of heat conduction. However, researchers have noted significant deviations between these corrections at low frequencies in plane wave couplers, indicating that one or both techniques incorrectly calculate the influence of heat conduction. In this paper, the limitations of the standardised formulations at infrasonic frequencies are identified and two alternative solutions are proposed. An experiment is also reported, which highlights the discussed limitations of the standardised formulations for acoustic transfer admittance, while also demonstrating the validity of the proposed alternative formulations at frequencies down to 0.04 Hz.

Finished by 6 pm