National Nuclear Laboratory

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NNL RCNDE Newsletter

Introduction

Welcome to the 2nd issue of NNL's RCNDE Newsletter. The NNL is a member of the Research Centre for Non Destructive Evaluation (RCNDE) on behalf of the NDA. The RCNDE, formed in 2003, is an EPSRC (Engineering and Physical Sciences Research Council) sponsored collaboration between industry and academia to coordinate research into NDE technologies and to ensure research topics are relevant for the medium to longer term needs of industry.

More information is available on the RCNDE website: www.rcnde.ac.uk

RCNDE Universities and their areas of expertise

Bath

Thermographic NDE methods

Bristol

Ultrasonic (US) arrays, Non-linear US method for precursor detection

Imperial

Guided US waves, Electromagnetic methods

Nottingham

US hardware, Optical NDE methods

Strathclyde

US transducers, Robotics for remote deployment

Warwick

Electromagnetic Acoustic Transducers (EMATs), Non-contact US

The Six RCNDE Universities

Imperial College London

University of Strathclyde Glasgow

The University of Warwick

The University of Nottingham

University of Bath

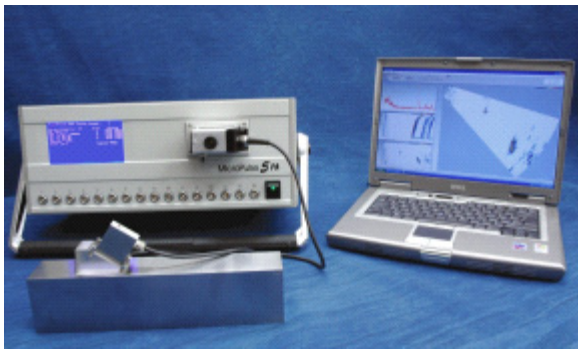
University of Bristol

There are 6 academic members of the RCNDE, offering a wide range of techniques and expertise. These include ultrasonic bulk and guided waves, thermographic, electromagnetic, advanced optical and non-contact methods (see table, left). One of the benefits of RCNDE membership is access to this expertise across the academic partners. The group of academics have long-standing collaborations with a range of industry sectors and are focused on solving industrially relevant problems. If you would like to speak with someone on any of these topic areas, please contact Gary Bolton at NNL. 01925 289856 or gary.bolton@nnl.co.uk.

Focus on Bristol University

The Non-Destructive Testing and Ultrasonics Group at Bristol are founding members of the RCNDE. They are led by Professors Bruce Drinkwater and Paul Wilcox and perform research on both the fundamental science and practical applications of ultrasound. The group is particularly well known for the development of Ultrasonic (US) phased arrays. Conventional US transducers for NDT commonly consist of either a single active element that both generates and receives high frequency sound waves, or two paired elements, one for transmitting and one for receiving. Phased arrays were initially developed for medical applications where they provide highly detailed cross-sectional pictures of internal organs. They comprise multi-element transducers and accompanying hardware and software for driving the multi-element probe and receiving and analysing the signals. Phased array probes typically consist of a transducer assembly with 16 to 128 small individual elements that can each be pulsed separately. These may be arranged in a range of geometries including a strip, a ring, a circular matrix or a bespoke shape to complement a particular component geometry. Phased array systems can

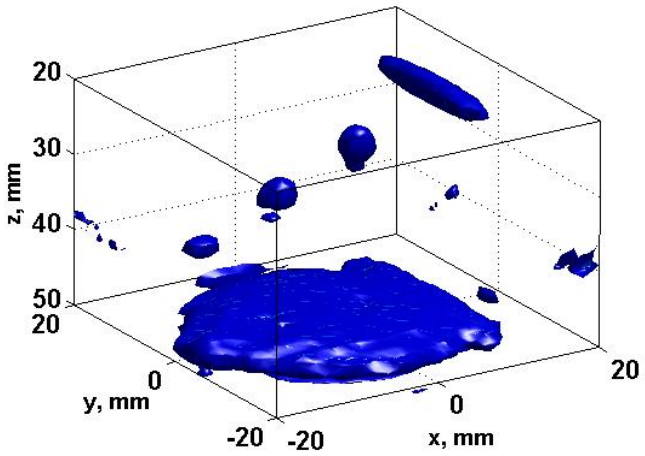
sweep a sound beam through a range of angles or along a linear path, or dynamically focus at a number of different depths, thus increasing both flexibility and capability in inspection setups.



US phased array controller, array on a test block and the PC for post-processing of data

The array research at Bristol started in 2001 when the group were involved in the development of a wheel probe containing an US array (which eventually became the Rapidscan system, now available from Sonatest). This wheel-array probe is used much like a paint roller to dramatically increase inspection speeds. With the start of the RCNDE in 2003 the group started to research the post-processing of array data. The concept, which is termed Full Matrix Capture (FMC), was to record the signals from every possible transmit-receive combination for off-line post processing. This provides significant flexibility (and auditability as the data is stored) as the same data can be used in conjunction with a range of imaging algorithms. For example, the same data-set can be used to produce focused, beam steered, mode converted or full-skip images. Post-processing also allows the simple implementation of algorithms such as the Total Focusing Methods (TFM), where the beam is focused at every imaging point. A critical breakthrough came in 2005 when it was demonstrated that images could be produced which were identical to the traditional B-scan images using this post-processing approach and that the TFM gave superior resolution to existing techniques. Since this time, the Bristol NDT group have been working on using post-processing approaches for defect characterisation and on developing better models of the data itself. In defect characterisation it has been possible to extract crack orientation from defects below an ultrasonic wavelength in size (approx. 1-2mm) as well as distinguishing between crack-like and volumetric type defects. The current RCNDE work on array data modelling is investigating the resolution limits of arrays.

NNL have recently supported the University of Bristol NDT Group as an industrial partner on the RCNDE targeted research project 'Two-dimensional arrays for the quantitative characterisation of complex defects' (EPSRC Reference EP/F005032/1). This project, in collaboration with Strathclyde University, also had industrial support from Airbus, Rolls-Royce, Serco Assurance and Shell. The final project report is due in March 2011. Key outputs to date have included the experimental demonstration of a 2D array with Poisson disk distribution, which leads to a three-fold resolution improvement over the traditional grid layout of elements. The work has also extended characterisation and sizing methods to the three-dimensional images that 2D arrays produce. Small (wavelength order) defects have been sized using the so called S-matrix approach which has been successfully demonstrated experimentally.



3-D image (FMC and TFM) of three flat bottomed holes and a slot taken using a 2MHz Poisson's Disk 2-D ultrasonic array

Projects Needed for EngD Students

The Engineering Doctorate (EngD) Centre in Non Destructive Evaluation is part of the RCNDE and is administered from the Department of Mechanical Engineering, Imperial College London. The four-year doctorate combines advanced knowledge and professional development training modules with company-based research. The Research Engineers spend a significant proportion of their time (60-80%) at the sponsor company and the balance at one of the six RCNDE Universities at which they are registered. The EngD centre in NDE is currently looking for industrial partner companies to host EngD students for the September 2011 intake with funding available for a total of 6-7 positions. The posts are fully funded by the EPSRC with the industrial company expected to contribute a top-up thereby offering excellent gearing. If you are interested in the EngD scheme please contact Gary Bolton at the NNL.

Rolls-Royce Aerospace Develop Remote Dye Penetrant Technique

Rolls-Royce is a founding industrial member of the RCNDE. NDT plays a critical role in the aerospace sector as aircraft components are inspected before they are assembled into aircraft and then are periodically inspected throughout their useful life. Visual techniques play an important role in aircraft inspection with remote videoprobes being an important tool for inspection of complex geometries such as jet engines. Rolls-Royce, in collaboration with GE Inspection, have developed a combined remote videoprobe and fluorescent dye penetrant inspection system over the past 3 years for improved defect detection in complex mechanical structures. The system has undergone Aviation Authority validation and Probability of Detection (POD) trials allowing its generic use across the Rolls Royce fleet. The main benefits of the system to Rolls Royce are a reduction in false calls which would otherwise lead to costly removal from service of engines ($0.5m to strip and inspect an engine) and improved defect detection with the potential to avoid catastrophic failure. This development fits well with the current Rolls Royce business model where engines are often leased to airline companies with Rolls Royce providing long-term inspection and maintenance services. The inspection system has been developed for aerospace use but is available to the wider engineering industry through agreement with Rolls Royce. A demonstration facility is available at a Rolls-Royce facility in the UK.

Strathclyde Seeks Undergraduate Projects

NDE research at the University of Strathclyde is performed in the Centre for Ultrasonic Engineering (CUE), a centre of excellence in the field of ultrasonic transducers and transducer systems within the Department of Electronic and Electrical Engineering. It has expertise in ultrasonic transducer manufacture, system prototyping, instrumentation hardware, system simulation and data processing software.

The four-year MEng degree in Electronic and Electrical Engineering degree includes a final year research project which runs from October to April. The aim is to give students "real-world" experience in team working and group project management. Working in project teams of 3 or 4, students are expected to convert a given specification into an appropriate deliverable. Following initial liaison with the supervisors, the student team is primarily responsible for all aspects of the project development including initial research, planning, designing, implementation and reporting to supervisors. This has proved to be an excellent way to pose new and challenging research topics. If you have a suitable topic for a final year undergraduate group research project at Strathclyde please contact Gary Bolton at NNL.

Future Meetings

10-12th May 2011 - RCNDE Annual Review & Board Meeting, Stratford on Avon
12th September 2011 - RCNDE Board Meeting, Telford
13-15th September 2011 - NDT 2011 Conference, The International Centre, Telford

Further Information

If you require further information on any of the articles in this newsletter or any aspect of the RCNDE please contact:
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Winner
RESEARCH & DEVELOPMENT
Sector Award

Winner 2004 - 2008, 2010
Highly Commended 2009

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