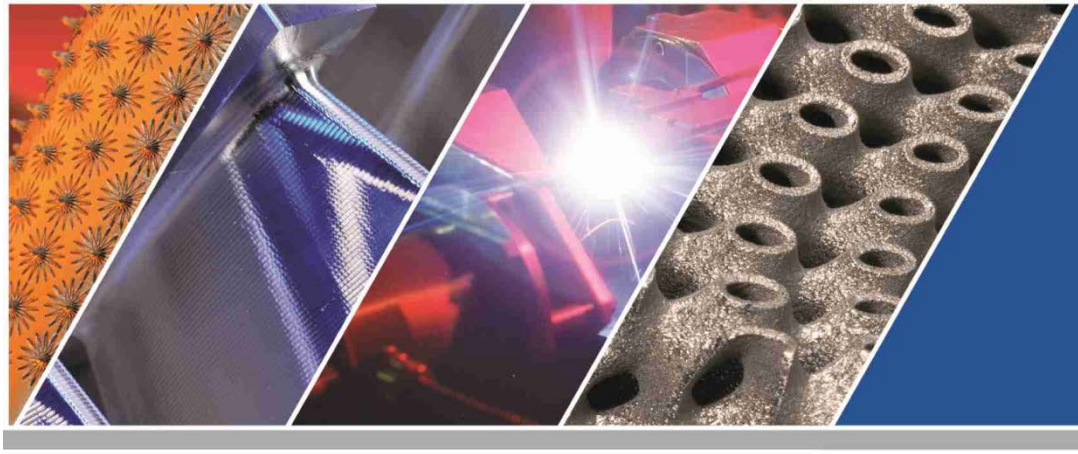
IntACom 4.0 – Advanced Non-Destructive Inspection



JOINT INDUSTRY PROJECT OUTLINE

PROP311638

Summary

IntACom 4.0 aims to revolutionise inspection methods, particularly for composites and thin metals. The aim of this project is to build on the achievements of the previous IntACom programme by adding new inspection methods e.g. microwave and Ultrasonic non-contact methods, to the robotic inspection cells and to deploy advanced digital radiography (X-ray Computed Tomography (XCT) and Laminography using robot solutions). Moreover, IntACom 4.0 will tackle new challenges posed by Industry 4.0. These involve the creation of artificial intelligence (AI) and machine learning (ML) systems for robot navigation and path planning (for both static based and mobile based robots) to facilitate automated NDT inspection, the use of digital twins to assist with NDT inspection and the use of collaborative robots (Cobots) to work with human NDT operators without special safety cells, and ultimately the collection and handling of very large data sets on-site using mobile robotic manipulators connected to metrology systems.

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IntACom 4 – Advanced Non-Destructive Inspection

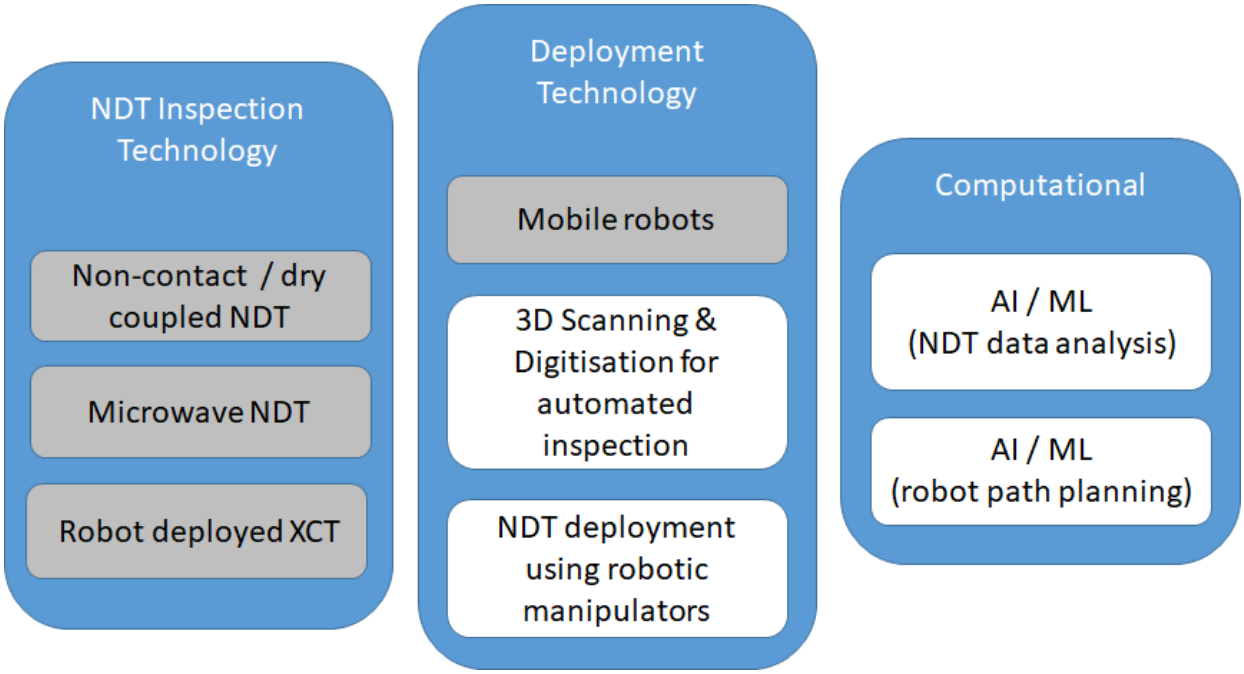
Objectives

The objectives of the IntACom 4.0 project can be summarised below:

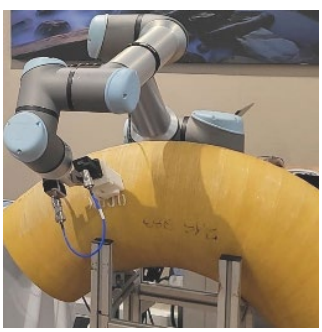
- Development of Dry and non-contact Ultrasonic Testing
- Development og Microwave NDT
- Development of Robot deployed X-ray Computed Tomography
- Development of In-process UT inspection for welds
- Development of Mobile Robots for NDT
- Development of 3D Scanning & Digitisation

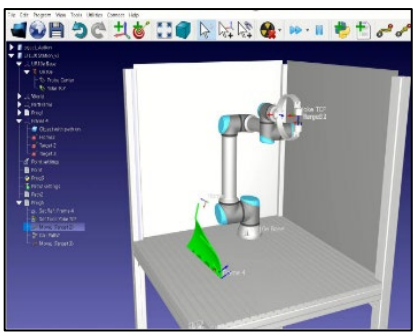
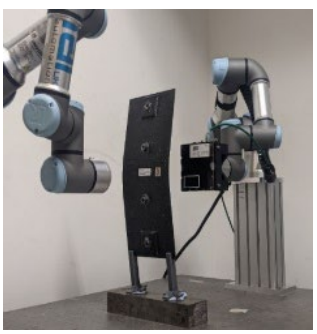
Benefits

- Reduced manufacturing and maintenance costs
- Faster lead times on inspection of complex components
- Component life extension
- Share and develop state-of-the-art knowledge with like-minded companies
- Sponsors receive substantially more results for their funding than could be obtained by single-company project
- Project takes advantage of existing leverage, including £1.1M SMART Funding equipment received in 2023, as well as strong equipment and expertise legacy from AEMRI



Scope and technology aspirations to be undertaken in IntACom 4.0



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Approach

Non-contact / dry coupled NDT

With the recent advancements in Arbitrary Waveform Generation (AWG), there is a real opportunity to explore the use of AWG in both dry coupled and non-contact (air coupled) UT, for solving real world challenges within industry. Successful deployment of AWG through development of software processing techniques could leverage better quality data (improve the SNR associated with air coupled NDT) and make Non-contact / dry coupled NDT techniques a practical method at low (0.5MHz) and high frequencies (1MHz+).
The objectives of this work are:

- Development of AWG dry coupled UT for use on flat and curved surfaces.
- Development of AWG air coupled UT for use on complex structures such as honeycomb.

Microwave NDT

Although Microwave inspection equipment is commercially available, the understanding of Vector Network Analyser (VNA) based microwave inspection technology and data analysis techniques is currently estimated to be at TRL 6. A VNA based RF and microwave measurement allows the phase and amplitude of the acquired signal to be analysed and compared to the originating microwave signal as it passes through the material under test. VNA is able to eliminate errors due to multiple reflections.
This work package will have the following objectives:

- Investigation and development of data processing and visualization techniques to provide a robust method of data analysis, flaw characterization and sizing, whichis essential for a reliable non-destructive testing process.
- Investigation of the use of AI / machine learning algorithms for data processing and assisted or automated flaw detection.
- Demonstration of the capability of the Microwave inspection equipment on real industrial components and incorporation within the TWI Crystal software solution. A Crystal software licence will be made available to each sponsor.

Robot deployed XCT

Robotic deployed X-ray Computed Tomography (XCT) acquisition has the potential to overcome limitations of cabinet-based XCT systems, allowing scanning of complex and large structures. TWI has already developed a Cobot deployed 2D Digital Radiography setup.Challenges for XCT include path planning, coordination of the robotic system, and developing algorithms for image reconstruction from arbitrary scan paths, resulting in 3D volumetric data sets similar to typical XCT. IntACom 4.0 aims to implement and test a physical robot deployed XCT setup in TWI's radiography bunker. The objectives of this work package are the following:

- Development of robotic code to support synchronisation of the robotic/manipulator system (where two axes of motion move in tandem with each other).
- Development of XCT reconstruction algorithms to allow for robotically acquired data.
- Implementation of algorithms and code into the Crystal SDK to improve current operational capability.
- Implementation and test of physical setup in TWI's radiography bunker.

Mobile Robots for NDT

Mobile robots offer a dynamic and versatile approach to non-destructive testing (NDT). By deploying robotic systems on mobile platforms, it is possible to unlock unique advantages that can significantly enhance inspection capabilities. For example applying NDT in a repeatable and accurate fashion for large components on-site. Unlike fixed systems, mobile robots need to adapt to their surroundings and autonomously navigate through complex layouts, adjusting their paths based on real-time data and ultimately producing a digital twin of the environment.

TWI will carry out its research on a number of mobile robot platforms using different propulsion systems and any loan systems from the sponsors. Three levels of autonomy are to be considered, pure teleoperation, safeguarded teleoperation and autonomous navigation.

3D Scanning & Digitisation

To explore AI / ML methods for autonomous robotic path scanning, using low cost sensors to provide feedback and data for pre, during and post manufacturing process to extend well beyond current capability.
In the case of unknown or ill-defined geometry (where the CAD model does not match the component), a highly skilled operator is required to determine and measure variations in the CAD in an effort to define an appropriate robotic scanning path. This is often iterative taking several hours to days to resolve. The objectives of this work package are the following:

- Development of sensor driven robotics (such as the technology found in self-driving vehicles – LIDAR and 3D camera systems), and AI / ML to allow for the creation and validation of the digital twin in real-time.
- Development of a robot scanning system that can inspect a component through learning its environment to generate a digital twin.
- Development of AI / ML to make decisions and fully automate the robotic scanning process.

Deliverables

The JIP will provide knowledge, equipment specification, prototype inspection equipment available for sponsor sample validation, and one Crystal software licence per sponsor.

Price and Duration

The overall estimated price for the work is £720,000 (excluding VAT). Based on four sponsors participating over a three year duration, the ticket price for each sponsor to take part is anticipated to be £180,000 excluding VAT.

Further Information

For further information on how a Joint Industry Project (JIP) runs please visit:

http://www.twi-global.com/services/research-and-consultancy/joint-industry-projects/

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