Viewpoint on Robotic Non Destructive Testing

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Reliable Non Destructive Testing (NDT) is vital to the integrity and performance management of capital assets in safety critical industries such as aerospace, transportation, pipelines, petro-chemical processing, and power generation. The NDT system is required to be capable of finding and characterizing component and structural defects to a high probability of detection thereby decreasing the probability of failure.

Advances in engineering design and new materials such as composites have resulted in components and structures with complex geometries that need to be inspected with more robust NDT techniques. Radiography and ultrasonic NDT have become established as the most flexible methods being applicable to metals and non metals.

Advanced radiography systems are very expensive and have to be operated in shielded bays but they provide the best NDT with X-ray Computed Tomography producing high-resolution 3D images of samples that can be viewed from any angle, sliced in any direction, measured and even animated in a virtual workspace. This enables detailed analysis of the internal structure of a wide range of components.

Manual Ultrasonic Testing (0.5MHz - 50MHz) is much cheaper and is widely used for inspection of most materials and especially of composite structures. It enables the inspection of critical areas that would otherwise be inaccessible and is used extensively to locate tiny cracks that would are undetectable by other methods. It is subject to the influence of 'human factors' and it is now widely recognised that despite intrinsic sensitivity advantages over other competing technologies it is not sufficiently reliable to assure the safety and integrity of components of complex geometry.

To improve the reliability of ultrasonic NDT automated and semi-automated ultrasonic scanners have been developed but they are generally only suitable for application on components with simple and consistent geometries, for example pipe welds. Automated systems for components with complex geometries must be tailored for each item and the costs become prohibitive when faced with a large range of component designs, as is the case in the aerospace industry.

Robotics offers a better solution by providing flexible reprogrammable scanners that can scan components of complex geometries and multiple shapes with accuracy and repeatability.

Recent developments in mobile wall climbing, swimming and pipe crawling robots have provided the means to perform NDT on very large structures and remote test sites. These may be located in remote and hazardous environments that are otherwise very expensive to access, requiring the erection of scaffolding and lengthy preparation before NDT can start. They provide the possibility of carrying out the NDT in-service thus preventing costly outages. In confined and hazardous environments they are the only means to reach a test site and perform the NDT.

Current research is developing mobile NDT Robots to go inside petro-chemical storage tanks (while full of product) to inspect floors for pitting and corrosion, to climb on the hulls of steel ships to inspect hundreds of kilometres of weld, to inspect the walls of petro-chemical storage tanks for corrosion and weld integrity, to inspect nozzle welds inside nuclear pressure vessels, to inspect structures such as dams and bridges for cracks, to inspect overhead power cables, to internally inspect buried pipelines that are currently not

reachable by intelligent pigs, to climb up off-shore wind turbine towers to inspect the blades, and to climb on aircraft wings and fuselage to detect for cracks and loose rivets.

Recent developments in cheap wireless control, mobile communications and improved battery technology now offers the means to build small umbilical-free mobile robots that can be deployed cheaply and quickly to go to a remote test site, gather NDT data and have it analyzed in real-time by an operator sitting safely some distance away. If they could be made cheap enough to be expendable then the costs and effort of robot recovery would be eliminated. A revolution in NDT!