Robot-based Ultrasonic Examination and 3D imaging of Complex-shape Components

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The state of the art of ultrasonic testing raises expectations on quantitative imaging of material flaws with automatic on-line evaluation of inspection results, whereby a rapid inspection procedure may provide a differentiated predication of the flaw type, size, and location. Modern signal processing and image reconstruction techniques for phased array generated data such as 'Total Focusing Method' allow tomographic representation of the inspection volume and thus accurate flaw evaluation. The geometric complexity of the inspection parts significantly complicates tomographic imaging approach and requires more advanced technological solutions in inspection systems as well as the image processing methodology. In the current contribution, an inspection technique and system solution for complex shape component testing during production will be presented that combines fast optical profile measurement, automated data acquisition by a robotic inspection manipulator with real-time tomographic reconstruction of inspection volume alone with a novel 3D image analysis approach for complex-shape parts. Novel techniques for automated analysis of ultrasonic images and evaluation of inspection results are discussed. Application oriented approach for implementation of pragmatic and cost-effective inspection solutions is exemplified by several practical examples on production testing of CFRP and metallic components, where combination of adaptive TMF and robotics provide unprecedented flexibility of UT with truly quantitative evaluation of inspection results.