Automated self-adjustment of array probe with a robotic ultrasonic test system

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Ultrasonic testing (UT) of objects with complex geometries often requires the use of a robotic arm to position the probe perpendicular to the local surface. Using immersion makes it possible to test these objects with standard ultrasonic linear array probes. Here, the probe positions and orientations provided by the robot are used for merging the locally acquired image data into a 3D-reconstruction. The quality of this reconstruction is highly dependent on the alignment of the tool center point (TCP) of the physical probe with the TCP used in the digital model. For common industrial tools, the TCP is usually acquired using geometric features of the tools. However, for ultrasonic arrays in immersion, there is a water standoff between the probe and the test object, therefore the TCP is in free space in front of the array and cannot be acquired with the common method. To overcome this challenge, we propose a method that allows the robotic ultrasonic system to automatically self-adjust the positioning of the UT probe using a test block made of steel with defined geometric features as a target for referencing. For each of the six degrees of freedom, a scan and adjustment routine are established using the data acquired by the UT probe to update the TCP's position and orientation in the robot control. Given a coarse pre-definition of the TCP and the known target test block, no human interaction is required while the system determines the optimum tool position and orientation. Part of this work will be used to improve and extend standards for robotic ultrasonic test systems, e.g. ISO 24647.