Design and application of automatic ultrasonic phased array testing system for welding seam of large component robot

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In recent years, with the advancement of robotics technology, there has been a growing interest in the application of robots with high speed, precision, and a high payload-to-weight ratio in the industrial and aerospace sectors. This paper introduces a method for ultrasonic phased array inspection of fully-penetrated welds in H-shaped steel, U-rib web plates, and flange plates in building and bridge steel structures. Additionally, a detection system, developed in conjunction with a robot, capable of automatically inspecting weld seams is presented. The paper elaborates on the system's equipment composition, key process parameters, operational processes, and applications. A comparison with conventional ultrasonic testing underscores the significantly enhanced detection sensitivity and efficiency achieved with the robot in phased array inspection, highlighting the superiority of robotics in ultrasonic phased array detection. Through research, we have successfully implemented key technologies including force feedback scanning, rapid scanning path planning algorithms, tracking of irregular workpiece surfaces, fusion of robot and inspection data, adaptive coupling, human-machine safety protection, and intelligent robot inspection. The integration of robot and ultrasonic equipment not only reduces the labor intensity of inspection personnel, thus avoiding issues arising from fatigue, but also improves inspection efficiency and effectiveness. Moreover, it provides a more intuitive display of the internal conditions of the workpiece, introducing novel approaches to non-destructive testing technology.