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Design and optimization of a mobile parallel robotic system for fusion reactor vacuum vessel assembly

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ABSTRACT

Fusion is the energy source of the sun and stars; fusion reactor is a machine to harness the fusion energy. The heat generated during the operation is used to produce electricity just like a conventional power plant. Different fusion power plant is under design and construction worldwide. In recent years, with the development of different configurations of the fusion reactor, such as the divertor, breeding blanket, vacuum vessel, as well as the size of the machine, the robotic systems start attracting researcher's and business attention. A mobile parallel robotic system for vacuum vessel assembly is designed, manufactured, and tested in the laboratory, the milling and welding results reveal the robust of the proposed robotic system. The robot is designed to have a load capacity of 200 kg, and milling accuracy of 0.1 mm. The robotic system is able to move along the designed single-track rail, which is mounted on the surface of the fusion reactor vacuum vessel. The parallel mechanism in the robotic system can carry out different tasks even during the movement of the mobile robot, in addition, to perform different tasks, series robot or other machines can be carried by the mobile robot, to perform other required tasks. Multi-objective optimization of the Stewart-based parallel mechanism is carried out. The design variables are chosen to be the four parameters that decide the overall shape of the parallel mechanism, the goal of the optimization is to minimize the value of cost function, which is derived from the parallel mechanism performance, such as dynamic force, workspace, stiffness. The results show the effectiveness of the model, the model can be seen as guide book for future designer who is interested at designing the parallel mechanism.

Keywords: mobile robot, parallel robot, optimization, fusion reactor