DESIGN AND FEASIBILITY ANALYSIS OF THE ROBOTIC SYSTEM

FOR EAST TOKAMAK FLEXIBLE IN-VESSEL INSPECTION

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Abstract: EAST is a full superconducting tokamak with 'D' shape vacuum vessel and toroidal coils and actively cooled plasma facing components (PFCs), which aims at studying the scientific and engineering issues under steady state operation. It is difficult but very important to know well the operating state of the components in the vacuum vessel during plasma operation campaign for the help of guiding the operation plan and understanding physical phenomena. A robotic system (called flexible in-vessel inspection robot, FIVIR) is proposed to inspect the surface of plasma facing components to know the performance, such as erosion and desquamation, of first wall. Because of the geometric requirement and the intensity of ports usage arrangement, two FIVIRs are planned installing toroidal symmetry on EAST. Each FIVIR is a series-wound robot with ten degrees of freedom consisting of main robot and end-effector. The main robot has the primary function that transports the end-effector and associated process tools into the vacuum chamber in the equatorial plane at R=1.94m and back to the storage port, which has the benefit that easy control of the FIVIR and easy position calculation of the end-effector. All the joints in the FIVR are driven by actuators. In this paper, the working space for the robot was analyzed to see whether it can reach any point of the plasma facing surface in the distance of 15mm and the range of $\pm 90^{\circ}$ along toroidal direction. The advantages and disadvantages of the robot were studied to address the adaptability under the special working environment in tokamak vacuum vessel, vacuum and high temperature. And some mechanical analysis done by ANSYS for some key components also introduced here for the mechanical design requirements.

[1] X.B. Peng, etc. Conceptual design of EAST flexible in-vessel inspection system, ISFNT-9, 2009, Dalian, China, to be published in Fusion Engineering and Design.