

Development of a 15 kg servo manipulator for remote handling applications

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Remote Handling is one of the prominent areas of research and development for the nuclear sector for the remote manipulation of irradiated nuclear fuels and structural materials. The standard coding for the Remote handling devices for radioactive materials is covered as part 1: General requirements under ISO: 17874-1:2004 & part 3: Electrical master-slave manipulators (Servo Manipulator) under ISO:17874-3:2019. Though the master-slave mechanical manipulators have found wide applications in the nuclear domain especially in the hot cells, but recently the electric manipulators find its application in both nuclear fuel fabrication and in carrying out complex tasks inside the hot cells. This also finds its application in the decommissioning operations of nuclear reactors. Under the mobile manipulators it is further classified into power manipulator and servo manipulator. The servo manipulators are closed-loop feedback system, which enable the sensing of slave side forces and reflect it on the master end. This makes the operator feel the slave environment remotely as tangible forces on the slave end-effector are directly sensible. The dual arm design makes it further more easy to perform complex tasks with delicate handling of the slave objects. A 15 kg payload capacity servo manipulator was designed, developed and qualified at IGCAR. The real time force synthesis is done using the Jacobian matrix linearizing method for the inverse kinematic and force synthesis and the Jacobian matrix is constructed from the Jacobian generating vectors by the slave side manipulator pose/orientation. This is done by directly networking all the servo drive controllers and reading the slave motor encoder positions. Further, the motor torque is evaluated from the motor currents from all the slave joints and the torque vector is constructed. By calculating the work done by the manipulator the end effector Cartesian forces and the direction vectors are computed and the same is applied on the master end thereby simulating the slave environment. This paper deals with the design of the servo manipulator for the remote handling application.

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