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Development of a Prototype Collaborative Robot for Fusion Remote Handling Applications

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Remote handling (RH) systems are highly challenging for application in the maintenance of fusion devices. The challenges include accurate handling of very heavy payloads using long cantilevered robotic arms with a dexterous manipulator. For the flexibility to execute dynamic tasks safely, these manipulators are typically controlled using a 'man in the loop'architecture. Haptic systems with real-time force feedback integrated to full 3D virtual reality environment can enable the RH operators to have the sense of virtual presence. These are highly complex systems requiring integration of several technologies with a closed loop control system. One modern approach for handling such application can be by the development of collaborative robot mechanisms. A collaborative robot is a robotic device designed to assist human beings as a guide or assistor in a specific task. It can assist a human operator semi-autonomously during the task as if it were a real mechanical tool and improves the manoeuvrability and the efficiency in the teleoperation. The collaborative robot mechanism with human-robot interactions in a shared workspace can be used as a training platform for the operators to check the feasibility and optimize the operation sequences for planning the RH tasks. This can be extremely beneficial to reduce the duration of maintenance cycles and to maximize the availability of the fusion device for plasma operations.

In this work, a concept is developed for a tokamak relevant collaborative robot mechanism followed by implementation of a prototype system. The system uses back-drivable actuators with force feedback in the closed loop control system. High precision encoders are used to measure the joint movements and mapped in the control system. The system aims for the development of a low friction, efficient system for fusion RH requirements and can act as a training platform for the RH operators.

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