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Visual Servo of Tokamak Relevant Remote Handling Systems using Neural Network Architecture

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Tokamak inspection and maintenance requires different Remote Handling (RH) systems such as long reach planar manipulators, multi-DOF hyper-redundant arms etc. As no structural support can be provided inside the tokamak, these RH systems are usually cantilevered and have a number of articulations to traverse the toroidal geometry of the tokamak. The kinematic configuration is thus different for conventional manipulators. Due to long cantilevered length, heavy payload handling, structural deformations, gearbox backlash and control system inaccuracies the final pose of the end effector may vary from the desired pose when only a servo feedback loop is used. Such inaccuracies can only be eliminated by using Visual Servo (VS) technique, where the inverse kinematics and trajectory planning are done based on visual feedback from cameras mounted on the RH system.
The paper gives a fresh approach to visual servo for tokamak RH systems using artificial neural networks (NN) architecture. A multi-layered feed-forward NN is trained using the joint angle vector as input and the corresponding feature vector(s) of markers in a sample tile as output. The trained NN can thus predict the joint configurations for given features vectors. This eliminates the requirement of closed-form inverse kinematic solution of the manipulator and camera calibration. The NN architecture and proposed controller are validated and presented using simulation on 5DOF remote handling manipulator. Real time implementation methodology for NN based controller are also discussed.

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