## Dynamic Modelling and Robust Control of Cassette Multi-functional Mover for ITER

## **Remote Handing Tasks**

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The Cassette Multi-functional Mover (CMM) is a multi-degree-of-freedom hydraulic robot, which is design for the International Thermonuclear Experimental Reactor (ITER) remote handing tasks. However, the multivariable tracking control of CMM poses many challenges, such as the highly nonlinear actuator dynamics and varying loading conditions. In this paper, the dynamic model of CMM is first derived, characterizing both nominal model and model uncertainties. Secondly, an  $H_{\infty}$  - based robust controller is designed which ensures both robust stability and robust performance. The presented method is well supported by Computer Aided Control System Design (CACSD) software tools, yielding a fast design. The designed controller is validated by both robustness analysis and experimental tests.



Figure 1: The Cassette Multi-functional Mover with 10 tonnes load



Figure 2: The control configuration with model uncertainty

The state space model:

$$\begin{bmatrix} \Delta \dot{\theta} \\ \Delta \ddot{\theta} \\ \Delta \dot{F} \end{bmatrix} = \begin{bmatrix} \mathbf{O} & \mathbf{I} & \mathbf{O} \\ \mathbf{O} & -\mathbf{M}_{0}^{-1}(\mathbf{A}_{h0}^{T} diag(\boldsymbol{b}_{i}^{*})\mathbf{A}_{h0} + D) & \mathbf{M}_{0}^{-1}\mathbf{A}_{h0}^{T} \\ \mathbf{O} & \mathbf{B}_{C2}\mathbf{A}_{h0} & \mathbf{A}_{C} \end{bmatrix} \begin{bmatrix} \Delta \theta \\ \Delta \dot{\theta} \\ \Delta F \end{bmatrix} + \begin{bmatrix} \mathbf{O} \\ \mathbf{O} \\ \mathbf{B}_{C1} \end{bmatrix} \widetilde{u}$$