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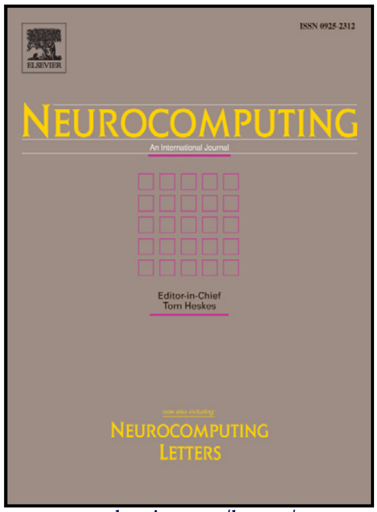

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Neural Network Based Dynamic Surface Control of Hypersonic Flight Dynamics Using Small-gain Theorem

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Abstract: This paper analyzed the neural control for longitudinal dynamics of a generic hypersonic aircraft in presence of unknown dynamics and actuator fault. For the attitude subsystem, direct adaptive design is presented with the dynamic surface design and the singularity problem is removed. For actuator fault, the unknown dynamics caused by fault is approximated by neural networks. The highlight is that the minimal-learning-parameter technique is applied on the dynamics and the simpler adaptive algorithm is easy to implement since the online updating computation burden is greatly reduced. The uniform ultimate boundedness stability is guaranteed via Small-gain Theorem. Simulation result shows that the controller could achieve good tracking performance with minimal learning parameter in case of actuator fault.

Index Terms – hypersonic flight vehicle, dynamic surface control, small-gain theorem, neural network, minimal learning parameter

Nomenclature

$C_D(\alpha)$ = drag coefficient

$C_D^{\alpha^i}$= ith order coefficient of α contribution to $C_D(\alpha)$

C_D^0 = constant term in $C_D(\alpha)$

$C_L(\alpha)$ = lift coefficient

$C_L^{\alpha^i}$ = ith order coefficient of α contribution to $C_L(\alpha)$

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