

Generalization of Cluster Treatment of Characteristic Roots for Robust Stability of Multiple Time Delayed Systems

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Abstract

A new perspective is presented for studying the stability robustness of n^{th} order systems with p rationally independent delays. It deploys a holographic mapping procedure over the delays into a new coordinate system, in order to achieve the objective. This mapping collapses the entire set of potential stability switching points on a manageably small number of *hypersurfaces*, which are explicitly defined in the new domain. This property considerably alleviates the problem, which is otherwise infinite dimensional, and therefore notoriously complex to handle. We further declare some unrecognized features of these switching *hypersurfaces*, that they are (a) encapsulated within a *higher dimensional cube* with edges of length 2π ; which we name the “**building block**”, (b) the “*offspring*” of this *building block*, which represent the secondary stability switchings, appear within the adjacent and identical building blocks (*cubes*) stacked up next to each other. The final outlook is an exclusive representation of stability for this general class of systems at any arbitrary point in the delay space. Two example case studies are also provided, which are not possible to analyze using any other methodology known to the authors.

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