J Aeronaut Aerospace Eng 2018, Volume 7
DOI: 10.4172/2168-9792-C3-029

6th International Conference and Exhibition on
Mechanical & Aerospace Engineering
November 07-08, 2018 | Atlanta, USA

New directions in infinite dimensional direct adaptive control of quantum information systems

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Many control systems are inherently infinite dimensional when they are described by partial differential equations. Currently, there is renewed interest in the control of these kinds of systems especially in flexible aerospace structures and the quantum information field. Since the dynamics of these systems will not be perfectly known, it is especially of interest to control these systems adaptively via low-order finite-dimensional controllers. When systems are subjected to unknown internal delays, they are also fundamentally infinite-dimensional in nature. In our work, we have developed direct model reference adaptive control and disturbance rejection with very-low-order adaptive gain laws for as infinite-dimensional systems on Hilbert spaces. Quantum information systems are fundamentally infinite dimensional and the basic operations that can be performed on quantum systems to manipulate information are unitary quantum gates. Because of the nature of entanglement at the quantum level, these gates suffer from decoherence and cannot operate in a fully unitary way. It is also quite difficult to perform experiments that would identify all the parametric data needed to create precise models of a particular quantum system. Instead of direct adaptive control that is suited to infinite dimensional systems could provide a reduction in the decoherence and allow the quantum gates to function in a more idealized unitary way. This talk will focus on the use of direct adaptive control in the reduction of decoherence in quantum information systems. In particular the control of the quantum master equation and the adaptive attraction to DE coherence-free subspaces. Although the topics here may sound highly technical and to some extent they are, I hope to present a version of them that will be reasonably accessible and will still remain as exciting and attractive to you as they are to me.

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