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New Results for Quantum Control Problems

Non-commutative least mean squares estimators and coherent observers for linear quantum systems

Nina H. Amini

CNRS, Team L2S, Supélec

nina.amini@lss.supelec.fr

Abstract: In quantum control, we can apply different strategies to design a feedback. Coherent feedback is one of the most common strategies. For coherent feedback, a quantum controller is connected to the original quantum system to form a closed-loop system. This type of feedback could lead to new proposals for quantum memories and quantum error correction. However, quantum versions of control problems are often more difficult than their classical counterparts because of the additional constraints imposed by quantum mechanics. To make further progress, new methods need to be developed to estimate the internal state of plants.

In this talk, we consider a class of plants whose internal states are governed by general non-commutative linear quantum stochastic differential equations (QSDEs). The state variables of such plants are supposed to be physically realizable. As a result of physical realizability, the commutation relations are preserved for such systems. We assume that the output signal of plant satisfies a non-commutative linear QSDE. We obtain non-commutative linear least mean squares estimators of the plant's state which are supposed, given as a linear combination of innovation processes similar to Belavkin-Kalman (commutative output) and classical Kalman filtering. Also, we give conditions which make these estimators physically realizable. Finally, some algorithms for designing coherent quantum observers will be presented.