International Journal of Innovative Computing, Information and Control
Volume **6**, Number **2**, February **2010**

ICIC International ©2010 ISSN 1349-4198
pp. 529–540

A UNIFIED ALGEBRAIC APPROACH TO STABILIZING RISK-SENSITIVE CONTROL DESIGN

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Received September 2008; revised February 2009

Abstract. *An extended formulation to the risk-sensitive control of discrete-time linear stochastic systems is presented in the paper. The problem considered is formulated as a convex optimization problem where the design procedure relies on a unified algebraic approach. A possible singular task of risk-sensitive minimum variance control is regularized by defining a quadratic constraint on input variables and linear matrix inequalities are outlined to pose a feasible solution. The resulting formulation gives a necessary and sufficient condition for constrained risk-sensitive minimal variance control. An example is presented along with a discussion to illustrate basic characteristics of the proposed method.*
Keywords: Discrete-time stochastic systems, Risk-sensitive control, Convex optimization, Linear matrix inequality

1. **Introduction.** Many real systems operate in a stochastic environment where they are subject to unknown disturbances and in addition, the controller has to rely in practice on imperfect measurements. One of the principal reasons for introducing feedback into a control system is to obtain relative insensibility to changes in plant parameters and to disturbances.

The majority of optimal control applications use the risk-neutral deterministic and/or stochastic formulation, and more conservative controllers such as risk-sensitive controllers do not frequently occur though risk-sensitive filtering and control is an exciting area of research in stochastic systems and is well studied in literature as an extension of classical linear quadratic gaussian control. Pioneering work was done by Jacobson in [8], [18] where Linear-Exponential-Gaussian (LEG) control was introduced for discrete-time systems with perfect and partial state observation, respectively. Subsequently, Whittle [20], [21] completed these results and characterized the solution in terms of the certainty equivalence principle. Whittle introduced risk-seeking ($\theta > 0$), risk-averse ($\theta < 0$) and risk-neutral ($\theta = 0$) optimization in dependency on a risk-sensitivity (scalar) parameter θ, as well as pointed out that the features of risk-sensitive Linear-Quadratic-Gaussian (LQG) case had a version for the risk-sensitive LEQD. The operation used is maximization when ($\theta < 0$) and minimization when ($\theta \geq 0$) and is defined using information matrices rather then covariance matrices. The conclusions of those papers were transformed to the case of continuous time by Bensoussan and van Schuppen [1] and subsequently a solution to the output feedback risk-sensitive control problem for linear and nonlinear discrete-time stochastic systems was proposed in [3], [12] by Moore and co-workers. Also, risk-sensitive filtering and smoothing as well as the tracking control problem have been solved for a class