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A MULTIPLE-DERIVATIVE AND MULTIPLE-DELAY PARADIGM FOR DECENTRALIZED CONTROLLER DESIGN: UNIFORM-RANK SYSTEMS

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Abstract. The work presented here is motivated by the need for new control schemes for modern dynamical networks, that can exploit a network's topological structure in shaping its dynamics. To this end, we introduce a new philosophy for decentralized controller design, that is based on first postulating and designing multiple output-derivative feedbacks at each control channel, and then using lead-compensator or multiple-delay-based implementations of the derivative feedback. The proposed design methodology is shown to achieve both stabilization and a certain group pole placement for a broad class of uniform-rank plants. The benefit of the new design methodology with regard to actuation requirements and complexity is demonstrated, and applications in both autonomous-agent-network and infrastructural control problems is discussed.

Keywords. Decentralized Control, Lead Compensator, Uniform Rank Systems, Special Coordinate Basis, Delay Systems.

1 Introduction

Decentralized feedback systems have long been of interest to the controls community [3, 28, 40]. In recent years, research in decentralized control has been re-invigorated by interest in such applications as cooperative control of autonomous vehicle teams, data fusion in sensor networks, air traffic management, and virus-spreading control, among many others, see the overviews [2, 11, 12, 16] and also e.g. the articles [13, 14, 32]. These numerous network-control applications are widely varied in scale, structure, and control needs/capabilities. What these vastly different applications make clear, however, is that new tools for *designing* decentralized controllers are badly needed: *ones that permit highly limited components subject to delay and variation to complete intricate tasks by exploiting the network's topological structure.* As the need for topology-exploiting decentralized controllers