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CONSENSUS FILTERS ON SMALL WORLD NETWORKS

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Abstract. In recent years, the broad applications of multi-agent systems in many areas have stimulated a great deal of interests in studying consensus or agreement problems. In this paper we investigate consensus update schemes motivated by the Kalman filter, which take into account the communication noise and the reliability of information states from each agent in the group. We study the consensus update schemes on a small-world network model, which describes a transition from a completely regular lattice to a completely random graph as the rewiring probability increases from zero to one. We found that the convergence speed of the consensus algorithm on a completely regular lattice can be greatly enhanced by just randomly rewiring a very small number of links in the network. We further analyze the relationship between the convergence speed of the consensus algorithm and the second smallest eigenvalue of the graph Laplacian.

Keywords. Complex network, Cooperative control, Consensus problem, Kalman filter, Small world network.

1 Introduction

In recent years, consensus problems have attracted much attention among researchers studying distributed and decentralized automated systems [1]-[8]. This is partly due to the broad applications of multi-agent systems in many areas including formation cooperative control of mobile robots, unmanned air vehicles (UAVs), satellites, search, flocking, swarming, and air traffic control.

In many applications involving multi-agent systems, groups of agents need to agree upon certain quantities of interest, i.e., to reach consensus. Generally speaking, a consensus problem or an agreement problem is one that many spatially distributed agents or processors converge to a common value, and consensus problems have a long history in the field of computer science [9]. Consensus problems for networked dynamic systems have been extensively studied in the last few years [10]-[15]. However, many previous works assumed that each agent in the networks has identical certainty about their instantiation of the state value and didn't take into account the communication noise. In practice, some agents may get more or better information than the others. For instance, if a team of robots is assigned with a tracking