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Distributed robust stabilization of linear multi-agent systems with intermittent control.
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Summary: The distributed robust stabilization control problem of multi-agent systems with general linear dynamics is investigated in this paper. The topology of the network is directed and the dynamics of each agent are subject to unknown uncertainties. The control input of the root agent in a spanning tree can utilize its own absolute state intermittently and its neighbors' relative states continuously, while only relative state feedback control inputs are implemented for other nodes. In order to stabilize the whole network, an algorithm to choose systems' parameters is provided and the required length of the intermittent control intervals is also derived by using directed graph theory and Lyapunov stability analysis. Finally, a numerical example is simulated to verify the theoretical results.

MSC:

93D09	Robust stability
93A14	Decentralized systems
68T42	Agent technology and artificial intelligence
93C15	Control/observation systems governed by ordinary differential equations
93C05	Linear systems in control theory
93C41	Control/observation systems with incomplete information
93B52	Feedback control
05C90	Applications of graph theory

Keywords:

distributed robust stabilization; linear multi-agent systems; uncertain agent dynamics; directed network topology

Full Text: DOI

References:

[1] Jadbabaie, A.; Lin, J.; Morse, A. S., Coordination of groups of mobile autonomous agents using nearest neighbor rules, IEEE Trans. Autom. Control, 48, 6, 988-1001, (2003) · Zbl 1364.93514

[2] Ren, W.; Beard, R.; Atkins, E., Information consensus in multivehicle cooperative control, IEEE Control Syst. Mag., 27, 2, 71-82, (2007)

[3] R. Olfati-Saber, J.A. Fax, R.M. Murray, Consensus and cooperation in networked multi-agent systems, Proc. IEEE 95 (1) (2007) 215-233. · Zbl 1376.68138

[4] Ren, W.; Beard, R. W., Consensus seeking in multiagent systems under dynamically changing interaction topologies, IEEE Trans. Autom. Control, 50, 5, 655-661, (2005) · Zbl 1365.93302

[5] Li, Z.; Duan, Z.; Chen, G.; Huang, L., Consensus of multiagent systems and synchronization of complex networksa unified viewpoint, IEEE Trans. Circuits Syst. I: Regul. Pap., 57, 1, 213-224, (2010)

[6] Hu, G., Robust consensus tracking of a class of second-order multi-agent dynamic systems, Syst. Control Lett., 61, 1, 134-142, (2012) · Zbl 1250.93009

[7] Su, H.; Chen, M.; Lam, J.; Lin, Z., Semi-global leader-following consensus of linear multi-agent systems with input saturation via low gain feedback, IEEE Trans. Circuits Syst. I: Regul. Pap., 60, 7, 1881-1889, (2013)

[8] Hu, G., Robust consensus tracking for an integrator-type multi-agent system with disturbances and unmodelled dynamics, Int. J. Control, 84, 1, 1-8, (2011) · Zbl 1221.93012

[9] Yu, W.; Chen, G.; Lü, J., On pinning synchronization of complex dynamical networks, Automatica, 45, 2, 429-435, (2009) · Zbl 1158.93308

[10] Cao, J.; Wan, Y., Matrix measure strategies for stability and synchronization of inertial BAM neural network with time delays, Neural Netw., 53, 165-172, (2014) · Zbl 1322.93087

[11] Su, H.; Rong, Z.; Chen, M.; Wang, X.; Chen, G., Decentralized adaptive pinning control for cluster synchronization of complex

dynamical networks, IEEE Trans. Cybern., 43, 1, 394-399, (2013)

[12] Song, Q.; Liu, F.; Cao, J.; Yu, W., Pinning-controllability analysis of complex networksan M-matrix approach, IEEE Trans. Circuits Syst. I, Regul. Pap., 59, 11, 2692-2701, (2012)

[13] Vicsek, T.; Cziok, A.; Jacob, E. B.; Cohen, I.; Shochet, O., Novel type of phase transition in a system of self-driven particles, Phys. Rev. Lett., 75, 6, 1226-1229, (1995)

[14] Olfati-Saber, R.; Murray, R. M., Consensus problems in networks of agents with switching topology and time-delays, IEEE Trans. Autom. Control, 49, 9, 1520-1533, (2004) · Zbl 1365.93301

[15] Wang, J.; Cheng, D.; Hu, X., Consensus of multi-agent linear dynamic systems, Asian J. Control, 10, 2, 144-155, (2008)

[16] Xiong, J.; Lam, J., Stabilization of linear systems over networks with bounded packet loss, Automatica, 43, 1, 80-87, (2007) · Zbl 1140.93383

[17] L. Huang, Linear Algebra in System and Control Theory, Science Press, Beijing, China, 1984.

[18] Wen, G.; Duan, Z.; Li, Z.; Chen, G., Consensus and its L_2-gain performance of multi-agent systems with intermittent information transmissions, Int. J. Control, 85, 4, 384-396, (2012) · Zbl 1256.93016

[19] Li, C.; Feng, G.; Liao, X., Stabilization of nonlinear systems via periodically intermittent control, IEEE Trans. Circuits Syst. II: Express Briefs, 54, 11, 1019-1023, (2007)

[20] Wen, G.; Duan, Z.; Ren, W.; Chen, G., Distributed consensus of multi-agent systems with general linear node dynamics and intermittent communications, Int. J. Robust Nonlinear Control, 24, 16, 2438-2457, (2013) · Zbl 1302.93018

[21] Xia, W.; Cao, J., Pinning synchronization of delayed dynamical networks via periodically intermittent control, Chaos, 19, 1, 013120, (2009) · Zbl 1311.93061

[22] Wang, X.; Hong, Y.; Huang, J.; Jiang, Z., A distributed control approach to a robust output regulation problem for multi-agent linear systems, IEEE Trans. Autom. Control, 55, 12, 2891-2895, (2010) · Zbl 1368.93577

[23] Cao, J.; Wang, J., Global asymptotic and robust stability of recurrent neural networks with time delays, IEEE Trans. Circuits Syst. I: Regul. Pap., 52, 2, 417-426, (2005) · Zbl 1374.93285

[24] Yue, D.; Han, Q.; Lam, J., Network-based robust H_∞ control of systems with uncertainty, Automatica, 41, 6, 999-1007, (2005) · Zbl 1091.93007

[25] Li, Z.; Duan, Z.; Xie, L.; Liu, X., Distributed robust control of linear multi-agent systems with parameter uncertainties, Int. J. Control, 85, 8, 1039-1050, (2012) · Zbl 1282.93096

[26] Berman, A.; Plemmons, R. J., Nonnegative matrices in the mathematical sciences, (1994), SIAM Philadelphia · Zbl 0815.15016

[27] Li, Z.; Wen, G.; Duan, Z.; Ren, W., Designing fully distributed consensus protocols for linear multi-agent systems with directed graphs, IEEE Trans. Autom. Control, 60, 4, 1152-1157, (2015) · Zbl 1360.93035

[28] Horn, R.; Johnson, C., Matrix analysis, (1990), Cambridge University Press New York · Zbl 0704.15002

[29] Tang, Y.; Qian, F.; Gao, H.; Kurths, J., Synchronization in complex networks and its application—a survey of recent advances and challenges, Annu. Rev. Control, 38, 2, 184-198, (2014)

[30] Tang, Y.; Gao, H.; Kurths, J., Distributed robust synchronization of dynamical networks with stochastic coupling, IEEE Trans. Circuits Syst. I: Regul. Pap., 61, 5, 1508-1519, (2014)

[31] Tang, Y.; Gao, H.; Kurths, J., Multiobjective identification of controlling areas in neuronal networks, IEEE/ACM Trans. Comput. Biol. Bioinform., 10, 3, 708-720, (2013)

[32] Edwards, C.; Spurgeon, S. K.; Patton, R. J., Sliding mode observers for fault detection and isolation, Automatica, 36, 4, 541-553, (2000) · Zbl 0968.93502