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Event-triggered average consensus for multiagent systems with time-varying delay. (English)

Zbl 1407.93040

Math. Probl. Eng. 2014, Article ID 131586, 14 p. (2014).

Summary: The paper investigates average consensus for multiagent systems with time-varying delay. A reducing dimension multiagent systems model is presented firstly. Using event-triggered mechanism to reduce network load, a comprehensive model is then proposed, which considers communication delay and triggered issue. Furthermore, the event-triggered average consensus stability of multiagent systems with fixed directed/undirected graph is analyzed, and sufficient conditions are provided. Moreover, the upper bound of time-varying delay can be obtained conveniently. Finally, simulation results confirm the feasibility and effectiveness of the proposed method.

MSC:

93A14 Decentralized systems

90B10 Deterministic network models in operations research

93D20 Asymptotic stability in control theory

68T42 Agent technology and artificial intelligence

Full Text: [DOI](#)

References:

- [1] Ren, W.; Beard, R. W.; Atkins, E. M., Information consensus in multivehicle cooperative control, *IEEE Control Systems Magazine*, 27, 2, 71-82, (2007) · [doi:10.1109/MCS.2007.338264](#)
- [2] Maréchal, N.; Gorce, J.-M.; Pierrot, J.-B., Joint estimation and gossip averaging for sensor network applications, *IEEE Transactions on Automatic Control*, 55, 5, 1208-1213, (2010) · [Zbl 1368.93688](#) · [doi:10.1109/TAC.2010.2042233](#)
- [3] Hu, J.; Feng, G., Distributed tracking control of leader-follower multi-agent systems under noisy measurement, *Automatica*, 46, 8, 1382-1387, (2010) · [Zbl 1204.93011](#) · [doi:10.1016/j.automatica.2010.05.020](#)
- [4] Luo, X. Y.; Han, N. N.; Guan, X. P., Leader-following consensus protocols for formation control of multi-agent network, *Journal of Systems Engineering and Electronics*, 22, 6, 991-997, (2011) · [doi:10.3969/j.issn.1004-4132.2011.06.016](#)
- [5] Cao, Y.; Ren, W., Distributed coordinated tracking with reduced interaction via a variable structure approach, *IEEE Transactions on Automatic Control*, 57, 1, 33-48, (2012) · [Zbl 1369.93012](#) · [doi:10.1109/TAC.2011.2146830](#)
- [6] Cheng, L.; Wang, Y.; Hou, Z.-G.; Tan, M.; Cao, Z., Sampled-data based average consensus of second-order integral multi-agent systems: switching topologies and communication noises, *Automatica*, 49, 5, 1458-1464, (2013) · [Zbl 1319.93050](#) · [doi:10.1016/j.automatica.2013.02.004](#)
- [7] Münz, U.; Papachristodoulou, A.; Allgöwer, F., Consensus in multi-agent systems with coupling delays and switching topology, *IEEE Transactions on Automatic Control*, 56, 12, 2976-2982, (2011) · [Zbl 1368.93010](#) · [doi:10.1109/TAC.2011.2161052](#)
- [8] Nuño, E.; Ortega, R.; Basañez, L.; Hill, D., Synchronization of networks of nonidentical Euler-Lagrange systems with uncertain parameters and communication delays, *IEEE Transactions on Automatic Control*, 56, 4, 935-941, (2011) · [Zbl 1368.93308](#) · [doi:10.1109/TAC.2010.2103415](#)
- [9] Sakurama, K.; Nakano, K., Necessary and sufficient condition for average consensus of networked multi-agent systems with heterogeneous time delays, *International Journal of Systems Science*, (2013) · [Zbl 1312.93012](#) · [doi:10.1080/00207721.2013.798442](#)
- [10] Garcia, E.; Cao, Y.; Yu, H.; Antsaklis, P.; Casbeer, D., Decentralised event-triggered cooperative control with limited communication, *International Journal of Control*, 86, 9, 1479-1488, (2013) · [Zbl 1278.93005](#) · [doi:10.1080/00207179.2013.787647](#)
- [11] Yan, H. C.; Shi, H. B.; Zhang, H.; Yang, F. W., Quantized \mathcal{H}_∞ control for networked systems with communication constraints, *Asian Journal of Control*, 15, 5, 1468-1476, (2013) · [Zbl 1286.93163](#)
- [12] Zhang, H.; Yan, H. C.; Liu, T.; Chen, Q. J., Fuzzy controller design for nonlinear impulsive fuzzy systems with time delay, *IEEE Transactions on Fuzzy Systems*, 19, 5, 844-856, (2011) · [doi:10.1109/TFUZZ.2011.2147793](#)
- [13] Fei, M. R.; Yi, J.; Hu, H. S., Robust stability analysis of an uncertain nonlinear networked control system category, *International Journal of Control, Automation and Systems*, 4, 2, 172-177, (2006)
- [14] Gao, H. J.; Chen, T. W.; Lam, J., A new delay system approach to network-based control, *Automatica*, 44, 1, 39-52, (2008) · [Zbl 1138.93375](#) · [doi:10.1016/j.automatica.2007.04.020](#)
- [15] Zhao, X. D.; Ling, M. X.; Zeng, Q. S., Delay-dependent robust control for uncertain stochastic systems with Markovian switching and multiple delays, *Journal of Systems Engineering and Electronics*, 21, 2, 287-295, (2010) · [doi:10.3969/j.issn.1004-4132.2010.02.019](#)

- [16] Deng, W. H.; Fei, M. R.; Hu, H. S., A linear matrix inequality approach to system stabilization over constrained channels, *Transactions of the Institute of Measurement and Control*, 35, 1, 83-91, (2013) · doi:10.1177/0142331211407958
- [17] Yan, H. C.; Su, Z. Z.; Zhang, H.; Yang, F. W., Observer-based H_∞ control for discrete-time stochastic systems with quantisation and random communication delays, *IET Control Theory & Applications*, 7, 3, 372-379, (2013) · doi:10.1049/iet-cta.2012.0600
- [18] Zhang, L. X.; Gao, H. J.; Kaynak, O., Network-induced constraints in networked control systems—a survey, *Transactions on Industrial Informatics*, 9, 1, 403-416, (2013) · doi:10.1109/TII.2012.2219540
- [19] Zhang, H.; Yan, H. C.; Yang, F. W.; Chen, Q. J., Quantized control design for impulsive fuzzy networked systems, *IEEE Transactions on Fuzzy Systems*, 19, 6, 1153-1162, (2011) · doi:10.1109/TFUZZ.2011.2162525
- [20] Olfati-Saber, R.; Murray, R. M., Consensus problems in networks of agents with switching topology and time-delays, *IEEE Transactions on Automatic Control*, 49, 9, 1520-1533, (2004) · Zbl 1365.93301 · doi:10.1109/TAC.2004.834113
- [21] Sun, Y. G.; Wang, L.; Xie, G. M., Average consensus in networks of dynamic agents with switching topologies and multiple time-varying delays, *Systems & Control Letters*, 57, 2, 175-183, (2008) · Zbl 1133.68412 · doi:10.1016/j.sysconle.2007.08.009
- [22] Lin, P.; Jia, Y., Average consensus in networks of multi-agents with both switching topology and coupling time-delay, *Physica A: Statistical Mechanics and its Applications*, 387, 1, 303-313, (2008) · doi:10.1016/j.physa.2007.08.040
- [23] Qin, J. H.; Gao, H. J.; Zheng, W. X., On average consensus in directed networks of agents with switching topology and time delay, *International Journal of Systems Science*, 42, 12, 1947-1956, (2011) · Zbl 1260.93003 · doi:10.1080/00207721003802271
- [24] Sun, Y. Z.; Li, W.; Ruan, J., Average consensus of multi-agent systems with communication time delays and noisy links, *Chinese Physics B*, 22, 3, (2013)
- [25] Proskurnikov, A. V., Average consensus in networks with nonlinearly delayed couplings and switching topology, *Automatica*, 49, 9, 2928-2932, (2013) · Zbl 1364.93030 · doi:10.1016/j.automatica.2013.06.007
- [26] Sun, F. L.; Guan, Z.-H.; Ding, L.; Wang, Y.-W., Mean square average-consensus for multi-agent systems with measurement noise and time delay, *International Journal of Systems Science*, 44, 6, 995-1005, (2013) · Zbl 1278.93015 · doi:10.1080/00207721.2011.652221
- [27] Rong, L.; Xu, S.; Zhang, B.; Zou, Y., Accelerating average consensus by using the information of second-order neighbours with communication delays, *International Journal of Systems Science*, 44, 6, 1181-1188, (2013) · Zbl 1278.93012 · doi:10.1080/00207721.2012.659691
- [28] Zhang, Q. J.; Niu, Y. F.; Wang, L.; Shen, L. C.; Zhu, H., Average consensus seeking of high-order continuous-time multi-agent systems with multiple time-varying communication delays, *International Journal of Control, Automation and Systems*, 9, 6, 1209-1218, (2011) · doi:10.1007/s12555-011-0623-3
- [29] Yan, H. C.; Shen, Y. C.; Zhang, H.; Shi, H. B., Decentralized event-triggered consensus control for second-order multi-agent system, *Neurocomputing*, 133, 1, 18-24, (2014) · doi:10.1016/j.neucom.2013.11.036
- [30] Zhu, H. Y.; Cong, Y. R.; Wang, X. K.; Zhang, D. B.; Zhang, Q., Consensusabilization for continuous-time high-order multiagent systems with time-varying delays, *Mathematical Problems in Engineering*, 2013, (2013) · doi:10.1155/2013/527039
- [31] Tipsuwan, Y.; Chow, M.-Y., Control methodologies in networked control systems, *Control Engineering Practice*, 11, 10, 1099-1111, (2003) · doi:10.1016/S0967-0661(03)00036-4
- [32] Thompson, H. A., Wireless and Internet communications technologies for monitoring and control, *Control Engineering Practice*, 12, 6, 781-791, (2004) · doi:10.1016/j.conengprac.2003.09.002
- [33] Tabuada, P., Event-triggered real-time scheduling of stabilizing control tasks, *IEEE Transactions on Automatic Control*, 52, 9, 1680-1685, (2007) · Zbl 1366.90104 · doi:10.1109/TAC.2007.904277
- [34] Heemels, W. P. M. H.; Sandee, J. H.; van den Bosch, P. P. J., Analysis of event-driven controllers for linear systems, *International Journal of Control*, 81, 4, 571-590, (2008) · Zbl 1152.93423 · doi:10.1080/00207170701506919
- [35] Loizou, S. G.; Kyriakopoulos, K. J., Navigation of multiple kinematically constrained robots, *IEEE Transactions on Robotics*, 24, 1, 221-231, (2008) · doi:10.1109/TRO.2007.912092
- [36] Dimarogonas, D. V.; Frazzoli, E.; Johansson, K. H., Distributed event-triggered control for multi-agent systems, *IEEE Transactions on Automatic Control*, 57, 5, 1291-1297, (2012) · Zbl 1369.93019 · doi:10.1109/TAC.2011.2174666
- [37] Seyboth, G. S.; Dimarogonas, D. V.; Johansson, K. H., Event-based broadcasting for multi-agent average consensus, *Automatica*, 49, 1, 245-252, (2013) · Zbl 1257.93066 · doi:10.1016/j.automatica.2012.08.042
- [38] Hu, J. P.; Chen, G. R.; Li, H.-X., Distributed event-triggered tracking control of leader-follower multi-agent systems with communication delays, *Kybernetika*, 47, 4, 630-643, (2011) · Zbl 1227.93008
- [39] Yin, X. X.; Yue, D., Event-triggered tracking control for heterogeneous multi-agent systems with Markov communication delays, *Journal of the Franklin Institute*, 350, 5, 1312-1334, (2013) · Zbl 1293.93066 · doi:10.1016/j.jfranklin.2013.02.017
- [40] Hu, S. L.; Yue, D., Event-triggered control design of linear networked systems with quantizations, *ISA Transactions*, 51, 1, 153-162, (2012) · doi:10.1016/j.isatra.2011.09.002
- [41] Peng, C.; Yang, T. C., Event-triggered communication and H_∞ control co-design for networked control systems, *Automatica*, 49, 5, 1326-1332, (2013) · Zbl 1319.93022 · doi:10.1016/j.automatica.2013.01.038
- [42] Godsil, C. D.; Royle, G., *Algebraic Graph Theory*, (2001), New York, NY, USA: Springer, New York, NY, USA · doi:10.1007/978-1-4613-0163-9
- [43] Park, P. G.; Ko, J. W.; Jeong, C., Reciprocally convex approach to stability of systems with time-varying delays, *Automatica*, 47, 1, 235-238, (2011) · Zbl 1209.93076 · doi:10.1016/j.automatica.2010.10.014
- [44] Gu, K.; Kharitonov, V. L.; Chen, J., *Stability of Time-Delay Systems*, (2003), Boston, Mass, USA: Birkhäuser, Boston, Mass, USA · Zbl 1039.34067 · doi:10.1007/978-1-4612-0039-0

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