The current study of multi-agent systems is pervading many scientific disciplines, ranging from physical to biological, even to economic sciences, suggesting that its impact on modern engineering and technology is prominent and will be far-reaching. Typical co-operative behaviors of multi-agent systems include consensus, flocking, swarming, rendezvous and so on. Research on co-operative multi-agent systems has become overwhelming, which not only helps to provide a better understanding of the mechanisms of natural collective phenomena, but also benefits various applications of networked cyber-physical systems, such as robot teams and unmanned autonomous vehicles.

This Special Issue focuses on theoretical and technological achievements in co-operative multi-agent systems, specifically within the following three areas: the coordinated control of multi-agent systems and the synchronisation of complex networks; distributed estimation and control for mobile sensor networks; and applications of coordinated control of complex networked systems. It contains twenty-four papers, the contents of which are summarised below.

In the area of the coordinated control of multi-agent systems and the synchronisation of complex networks, Zhao et al. investigate the distributed finite-time consensus problem of networked agents described by second-order integrators in their paper entitled ‘Finite-time consensus for second-order multi-agent systems with saturated control protocols’. A saturated protocol is proposed based on both relative position and relative velocity measurements to achieve finite-time consensus. A synchronised output regulation problem via exchanging information at sampled time is studied by Xiang et al. in their paper ‘Synchronised output regulation of heterogenous networks with delayed and sampled data communications’. A necessary and sufficient condition is presented in which the sampled period should satisfy synchronised output regulation with fixed digraph and time-delay. In ‘Fuzzy dynamic output-feedback control of nonlinear networked discrete-time system with missing measurements’, by Li et al., the challenge of $H_\infty$ dynamic output-feedback control of nonlinear networked discrete-time systems with data packet dropouts is reported, and an approach based on fuzzy Lyapunov function is developed to solve it. Wang and Yi examine the consensus problem of second-order multi-agent systems via impulsive control in their paper entitled ‘Consensus in second-order multi-agent systems via impulsive control using position-only information with heterogeneous delays’, using position-only information with different communication delays. A distributed impulsive consensus protocol is designed, in which only the delayed sampled relative positions to neighbors and the relative position to the last sampling state are utilised.


Regarding the area of distributed estimation and control for mobile sensor networks, a paper by Yang and Shi, titled ‘Power allocation scheme for distributed filtering over wireless sensor networks’, explores distributed filtering
over wireless sensor networks with limited energy. Several offline power scheduling strategies are introduced to distribute the power of sensors, and a sufficient condition is provided to guarantee the convergence of network estimation error covariance. In ‘Distributed estimation using online semi-supervised particle filter for mobile sensor networks’, Yoo et al. presents an improved particle filter by incorporating semi-supervised machine learning for localization estimation in mobile sensor networks. In ‘Periodic event/self-triggered consensus for general continuous-time linear multi-agent systems under general directed graphs’, Yang et al. study the distributed periodic event-triggered consensus for continuous-time general linear multi-agent systems with the control cost reduced.

The final area, applications of coordinated control of complex networked systems, begins with Wang et al. addressing the co-operative control problem of multi-missile systems in their paper ‘Cooperative control of multi-missile systems’. A two-stage control strategy, aiming at simultaneous attacks from a group of missiles on a static target is proposed for the multi-missile systems. Zhou et al. investigate the emergency decision-making problem in a multi-agent system in ‘Multi-agent coordinated planning approach for deadline required emergency response tasks’. A novel multi-agent planning approach is proposed to coordinate for the solution among agents in the system. In the paper entitled ‘Virtual line shafting control for permanent magnet synchronous motor system using sliding-mode observer’, a novel observer-based electronic line-shafting control strategy, by Zhang et al., is presented for permanent magnet synchronous motor systems. Fu et al. examine the equilibrium behavior and negotiation protocol design for a class of systems composed of multiple, non-cooperative agents in ‘Concurrent multi-agent systems with temporal logic objectives: game theoretic analysis and planning through negotiation’. This work develops a negotiation protocol which ensures that, under a proper design of preferences and tasks, the mutually accepted plan is a Pareto optimal pure Nash equilibrium. A multi-agent control approach is proposed by Zhou et al. in ‘Multi-agent model-based predictive control for large-scale urban traffic networks using a serial scheme’, using a congestion-degree-based serial scheme for large-scale urban traffic networks. Liu et al. explore the opinion dynamics with group polarisation in their paper entitled ‘Multi-agent model of group polarisation with biased assimilation of arguments’. Integrated target search, tracking and tracking using multiple fixed-wing UAVs is studied by Meng et al. in ‘Integrated multi-agent system framework: decentralised search, tracking and tracking’, in which control logic and optimise flight paths are designed for the UAVs. Finally, Wang et al. consider the large population dynamic games where each agent evolves according to a dynamic equation containing the input average of all agents in ‘Decentralised dynamic games for large population stochastic multi-agent systems’. The Nash certainty equivalence is introduced to design decentralised controls.

Note that, although the selected topics and papers are not a comprehensive representation of the area covered by this Special Issue, they do provide some recent advances in the field of complex networked systems which could benefit current research in some way.

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