Guest Editorial
Special Section on Cyber-Physical Systems and Cooperating Objects

ALTHOUGH the IT transformation in the 20th century appeared revolutionary, a bigger change is probably yet to come. The terms *cyber-physical systems* and *cooperating objects* have come to describe research and engineering efforts that tightly conjoin real-world physical processes and computing systems. The integration of physical processes and computing is not new. Embedded systems have been in place for a long time to denote systems that combine physical processes with computing. The revolution will stem from extensive networking of embedded computing devices and holistic *cyber-physical co-design* of systems that integrate sensing, actuation, computation, networking and physical processes. Such systems pose many broad technical challenges, ranging from distributed programming paradigms to networking protocols, as well as systems theory that combines physical models and networked embedded systems. Applications of cyber-physical systems and cooperating objects include, among others, critical infrastructure monitoring and control, process control and manufacturing, highly dependable medical devices, intelligent transportation and vehicles, and energy management and conservation.

This Special Section presents examples of recent advances in the state-of-the-art of cyber-physical systems and cooperating objects. Pascal A. Vicaire, Enamul Hoque, Zhiheng Xie, and John A. Stankovic present a group-based programming abstraction for complex cyber-physical systems consisting of multiple systems and heterogeneous devices. Woochul Kang, Krasimira Kapitanova, and Sang Son introduce a real-time data distribution service for cyber-physical systems operating in unpredictable environments. Hahnsang Kim and Kang G. Shin propose a battery management architecture to monitor and control large-scale battery packs for electric cars. Xiaorong Zhang, Yuhong Liu, Fan Zhang, Jin Ren, Yan Lindsay Sun, Qing Yang, and He Huang describe the design and implementation of a cyber-physical system that controls artificial legs through a neural machine interface.

This Special Section is the result of the outstanding effort by the reviewers and the authors. We hope this Special Section provides a representative sample of the cutting-edge research on cyber-physical systems and cooperating objects.

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Raj Rajkumar is the George Westinghouse Professor of Electrical and Computer Engineering and the Robotics Institute at Carnegie Mellon University, Pittsburgh, PA. At Carnegie Mellon University, he directs the Real-Time and Multimedia Systems Laboratory (RTML), and co-directs the General Motors-Carnegie Mellon Vehicular Information Technology Collaborative Research Laboratory (VIT-CRL) as well as the General Motors-Carnegie Mellon Autonomous Driving Collaborative Research Laboratory (AD-CRL). He has authored one book, edited another book, holds one US patent, and has more than 150 publications in peer-reviewed forums. His work has influenced many commercial operating systems. He is the primary founder of Pittsburgh-based TimeSys Corporation, a vendor of embedded real-time Linux products and services. His research interests include all aspects of cyber-physical systems.

Prof. Rajkumar was selected as a Distinguished Engineer by ACM in 2007, and given an Outstanding Technical Achievement and Leadership Award by the IEEE Technical Committee on Real-Time Systems. He as served as the Program Chair and General Chair of six international ACM/IEEE conferences on real-time systems, wireless sensor networks, cyber-physical systems and multimedia computing/networking.

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