

**SPECIAL ISSUE**

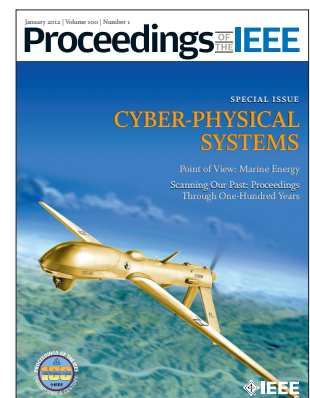
**CYBER-PHYSICAL SYSTEMS**

*Edited by R. Poovendran, K. Sampigethaya, S. K. S. Gupta, I. Lee, K. V. Prasad, D. Corman, and J. L. Paunicka*

- 13 Modeling Cyber-Physical Systems**  
By P. Derler, E. A. Lee, and A. S. Vincentelli  
| INVITED PAPER | Developing cyber-physical systems (CPS) models is the main concern of this paper which provides a comprehensive overview of their current state and future directions.
- 29 Toward a Science of Cyber-Physical System Integration**  
By J. Sztipanovits, X. Koutsoukos, G. Karsai, N. Kottenstette, P. Antsaklis, V. Gupta, B. Goodwine, J. Baras, and S. Wang  
| INVITED PAPER | This paper focuses on the design phase of the system lifecycle and proposes a passivity-based approach to decouple system stability from cyber timing uncertainties.
- 45 Distributed Real-Time Software for Cyber-Physical Systems**  
By J. C. Eidson, E. A. Lee, S. Matic, S. A. Seshia, and J. Zou  
| INVITED PAPER | New programming abstractions and modeling tools are presented in this paper to precisely capture the physical notion of time in these systems.
- 60 Toward Continuous State-Space Regulation of Coupled Cyber-Physical Systems**  
By Justin M. Bradley and E. M. Atkins  
| INVITED PAPER | The authors abstract the software execution rate of a controller program into a continuous-state framework to allow the application of modern control techniques.
- 75 Challenges and Research Directions in Medical Cyber-Physical Systems**  
By I. Lee, O. Sokolsky, S. Chen, J. Hatcliff, E. Jee, B. Kim, A. King, M. Mullen-Fortino, S. Park, A. Roederer, and K. K. Venkatasubramanian  
| INVITED PAPER | A broad overview of emerging applications for these systems is provided in this paper; challenges, promising solutions, and open problems are presented.
- 91 Body Sensor Networks: A Holistic Approach From Silicon to Users**  
By B. H. Calhoun, J. Lach, J. Stankovic, D. D. Wentzloff, K. Whitehouse, A. T. Barth, J. K. Brown, Q. Li, S. Oh, N. E. Roberts, and Y. Zhang  
| INVITED PAPER | This survey presents a vision that incorporates principles and novel ideas for enabling adaptive operation in dynamic physical environments using energy-constrained miniaturized sensor devices.
- 107 A Mining Technique Using n-Grams and Motion Transcripts for Body Sensor Network Data Repository**  
By V. Loseu, H. Ghasemzadeh, and R. Jafari  
| INVITED PAPER | To get efficient use of large amounts of body sensor data, the authors represent human movement data using clustering, and they propose a technique to analyze sensed physiological signals.
- 122 Cyber-Physical Modeling of Implantable Cardiac Medical Devices**  
By Z. Jiang, M. Pajic, and R. Mangharam  
| INVITED PAPER | The authors present an approach for verification of heart pacemaker device software, and a heart model that is effective when a pacemaker drives the heart into a harmful condition.
- 138 Powering a Ventricular Assist Device (VAD) With the Free-Range Resonant Electrical Energy Delivery (FREE-D) System**  
By B. H. Waters, A. P. Sample, P. Bonde, and J. R. Smith  
| INVITED PAPER | This paper discusses wireless delivery of power from a distant source to an implanted cardiac device, and it proposes recharging implanted batteries using magnetically coupled resonators.

**DEPARTMENTS**

- 3 POINT OF VIEW**  
Marine Energy: The Key for the Development of Sustainable Energy Supply  
By X.-P. Zhang
- 6 SCANNING THE ISSUE**  
Special Issue on Cyber-Physical Systems  
By R. Poovendran, K. Sampigethaya, S. K. S. Gupta, I. Lee, K. V. Prasad, D. Corman, and J. L. Paunicka
- 300 SCANNING OUR PAST**  
Proceeding Through 100 Years
- 304 FUTURE SPECIAL ISSUES/SPECIAL SECTIONS**



**On the Cover:** This month's special issue topic, cyber-physical systems, has numerous applications ranging from emerging smart technologies such as the smart grid, national security strategies, medicine, and "green" initiatives, and this month's cover illustrates a surveillance application using an autonomous vehicle.

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## SPECIAL ISSUE: Cyber-Physical Systems

- 150 Real-Time Feedback-Controlled Robotic Fish for Behavioral Experiments With Fish Schools**  
By *D. T. Swain, I. D. Couzin, and N. Ehrlich Leonard*  
| INVITED PAPER | Use of cyber-physical robotic fish to study fish-school behavior is proposed in this paper; each robotic fish gets video feedback from the fish group and its environment.
- 164 Robust Control for Mobility and Wireless Communication in Cyber-Physical Systems With Application to Robot Teams**  
By *J. Fink, A. Ribeiro, and V. Kumar*  
| INVITED PAPER | Control of an autonomous robot team with the aim of optimizing network performance is discussed in this paper; the authors design a controller to ensure availability of communication resources.
- 179 A Hierarchical Flight Planning Framework for Air Traffic Management**  
By *W. Zhang, M. Kamgarpour, D. Sun, and C. J. Tomlin*  
| INVITED PAPER | This paper aims to manage high-altitude air traffic flows by incorporating each flight operator's preferences and aircraft type while considering weather risks and airspace capacity constraints.
- 195 Cyber-Physical Security of a Smart Grid Infrastructure**  
By *Y. Mo, T. H.-J. Kim, K. Brancik, D. Dickinson, H. Lee, A. Perrig, and B. Sinopoli*  
| INVITED PAPER | The authors of this paper discuss the limitations of advances, measures to make the smart grid secure, and also to assure continuous power flows and dynamic power pricing.
- 210 Cyber-Physical System Security for the Electric Power Grid**  
By *S. Sridhar, A. Hahn, and M. Govindarasu*  
| INVITED PAPER | Control in power systems that may be vulnerable to security attacks is discussed in this paper as are control loop vulnerabilities, potential impact of disturbances, and several mitigations.
- 225 A Hybrid System Approach to the Analysis and Design of Power Grid Dynamic Performance**  
By *Y. Susuki, T. J. Koo, H. Ebina, T. Yamazaki, T. Ochi, T. Uemura, and T. Hikihara*  
| INVITED PAPER | This paper develops a hybrid model-based theory and methods for managing the joint dynamics of cyber elements and physical processes in the smart grid and ensuring grid stability.
- 240 Reducing Transient and Steady State Electricity Consumption in HVAC Using Learning-Based Model-Predictive Control**  
By *A. Aswani, N. Master, J. Taneja, D. Culler, and C. Tomlin*  
| INVITED PAPER | Energy efficiency improvement in HVAC systems is investigated in this paper; a model-predictive control strategy is proposed to maintain comfortable temperature.
- 254 A Cyber-Physical Systems Approach to Data Center Modeling and Control for Energy Efficiency**  
By *L. Parolini, B. Sinopoli, B. H. Krogh, and Z. Wang*  
| INVITED PAPER | The authors of this paper investigate the interplay of information technology, power, and cooling systems in a data center, and they develop a control strategy.
- 269 Distributed Coordination of Internet Data Centers Under Multiregional Electricity Markets**  
By *L. Rao, X. Liu, M. D. Ilic, and J. Liu*  
| INVITED PAPER | The problem of minimizing total energy costs for several data centers in a market environment is discussed in this paper, and a suitable control strategy is proposed.
- 283 Ensuring Safety, Security, and Sustainability of Mission-Critical Cyber-Physical Systems**  
By *A. Banerjee, K. K. Venkatasubramanian, T. Mukherjee, and S. K. S. Gupta*  
| INVITED PAPER | Insights into how to ensure performance of applications in these systems are offered in this paper; a framework is proposed to study interactions of applications and design of solutions.

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