# Intelligent Control

The increasing complexity and sophistication of modern-day systems require intelligent control techniques to ensure improved performance in diverse operating conditions, some of which may fall outside of the scope of conventional control. These intelligent control systems, modeled after biological systems and human cognitive abilities, possess learning, adaptation, and classification capabilities. Intelligent control involves the seamless fusion of systems and control, computational intelligence, and operational research to address the challenging problems of complex systems. Intelligent control systems are able to perform advanced functions such as planning under uncertainty; emulation of biological systems; learning from past experience; integration of sensor information; fault detection, prediction, and mitigation; and adaptation to environmental conditions.

The mission of the IEEE Control Systems Society (CSS) Technical Committee on Intelligent Control (TCIC) is to foster a community of members who advance the theoretical and practical considerations of intelligent control techniques and their application to devices and systems. The objectives of the TCIC are to make fundamental research contributions in intelligent control, to promote intelligent system design and development in providing solutions for complex systems, and to facilitate research and exchange in a vibrant and collegial environment. To achieve these objectives, the TCIC is dedicated to addressing the fundamental issues of the present and future aspects in intelligent control.

*Digital Object Identifier 10.1109/MCS.2015.2471038*
*Date of publication: 11 November 2015*

**The TCIC is dedicated to addressing the fundamental issues of the present and future aspects in intelligent control.**

The TCIC is organized into several working groups, including adaptive systems, distributed control systems, fuzzy systems, neural networks, machine learning, fault diagnosis and prognosis, soft computing, architectures of intelligent control systems, and applications of intelligent control. The groups meet at the TC meeting, which occurs twice a year. The TC meetings are normally held at the American Control Conference (ACC) and Conference on Decision and Control (CDC) and, on a few occasions, at the Multiconference on Systems and Control (MSC).

These working groups propose invited and tutorial sessions in conferences such as ACC, CDC, and, in addition, regular papers to the IEEE International Symposium on Intelligent Control (ISIC), which is held now as part of the MSC. Members of TCIC organized the first IEEE ISIC in 1985, and the committee has a 29-year history of successful organization. For many years, this symposium has been held jointly with the Conference on Control Applications (CCA) and/or the Symposium on Computer Aided Control System Design. In 2000 and 2005, ISIC was held jointly with the Mediterranean Conference on Control and Automation. Since 2007, it has been organized under the umbrella of the MSC. ISIC has occasionally been jointly organized with IFAC and one, or more, of the other IEEE Societies. TCIC members also participate in the IFAC computational intelligence committee.

In addition to organizing ISIC, TCIC members are active in the control research community and disseminate their research activities through monographs, *IEEE Transactions on Automatic Control*, *Automatica*, and IEEE Computational Intelligence Society (CIS) journals such *IEEE Transactions on Neural Networks* and *IEEE Transactions on Fuzzy Systems*. TCIC members also contribute to the control community by serving on ISIC, ACC, and CDC conference committees as editors and associate editors of the control- and computational-intelligence-related journals mentioned above and in leadership positions within CSS and CIS. For example, a couple of recent past CSS and CIS presidents were from the TCIC.

TCIC members continue to play an active role in organizing workshops at CDC and ACC, symposia with international academic organizations, participating in IEEE conferences in areas pertaining to intelligent control system research and design, and coordinating research and educational activities. Recently at the 2015 ACC in Chicago, a workshop on recent advances and future directions on learning, adaptation, and control was held in conjunction with an event to honor the contributions of Frank Lewis. Prof.

Lewis is one of the researchers who made outstanding contributions in the area of neural-network control in the past couple of decades. A total of 35 TC members from various countries attended this workshop.

The TCIC is dedicated to providing conferences for technical discussion and information over the web to CSS researchers interested in the field of intelligent control and its applications. Applications of the technologies developed by TCIC members include fuzzy-logic-controlled washing machines, neural-network-based navigation and control of missiles, adaptive-critic-dynamic-programming-based navigation and control schemes for the space shuttle, neural-network-online-approximator-based HVAC system and engine diagnosis, autonomous trucks and loaders, and many others. CSS members who are interested in participating in TCIC activities are welcome to contact the TCIC chair. The TC website can be found at http://www.ieeecss.org/technical-activities/intelligent-control, which provides a listing of the TCIC members and their activities.

**Sarangapani Jagannathan**

## Smart Cities and Control

The IEEE Control Systems Society, through its Technical Committee (TC) on Smart Cities, has launched an energetic initiative seeding new control sciences at urban and semi-urban scales. The story of city engineering, as old as cities themselves, has historically been one of concentration. Engineers have created water, transportation, and energy networks to concentrate food and the natural resources of a vast hinterland into a dense urban population center. However, neither the concentration capacity of the great aqueducts of Rome nor the vast expressways of modernity define the cities of the future any longer.

The CSS Smart Cities Initiative is tuned to our age of global warming, urban heat islands, and ocean acidification. The most virtuous water network might well be the one bringing in only 2% of consumption because the smart city would be efficiently reconverting and recycling the other 98% (see direct potable reuse [1]). In-situ microenergy generation via wind or solar may be preferable to energy sourced from distant coal mines or natural gas fields. The urban food network is now castigated for consuming an unacceptable nine calories to put one calorie on an urban plate [2]. Even the highway network transporting us is under pressure as drivers license acquisition rates fall for the first time since the birth of the automobile [3], the rise of automated cars fundamentally enhances the economics of car-sharing [4], and cities experiment with drones and personalized rapid transit like Lyft or Uber.

**The CSS Smart Cities Initiative is tuned to our age of global warming, urban heat islands, and ocean acidification.**

The old urban engineering of concentration is giving way to a new smart engineering of conservation and local production. The CSS Smart Cities Initiative is geared to build its control sciences. The smart cities style is having feedback move shared automated cars in real time to meet mobility demands or to modulate demand itself by dynamic pricing [5]. Smart cities should escape a personal car ownership model filling streets with cars, 96% of which are parked at any given time. Smart cities seek 1) control in the mobility and energy nexus to realize vehicle-to-grid and 2) control to break the wasteful positive feedback between air-conditioning and urban temperature [6]. Building HVACs regulate a set interior temperature. Might it be possible to cut the temperature of an urban heat island by 1 °C through the coordinated control of a city's water, transportation, and energy systems? Given that 50% of the world's population lives in urban regions, critical infrastructures of transportation, energy, health care, and food, as well as their growing interdependencies, have to be collectively analyzed and controlled for smarter cities.

We conclude with three programmatic thrusts already underway: transactive control for transportation, sustainable and resilient urban water systems, and control in the transportation-electricity nexus. The TC warmly and urgently seeks members working in these areas or motivated to start new thrusts.

### TRANSACTIVE CONTROL FOR TRANSPORTATION

The central entity in a Smart City, the human, enables myriad interconnections and interdependence through

*Digital Object Identifier 10.1109/MCS.2015.2471040*
*Date of publication: 11 November 2015*


1066-033X/15©2015IEEE