Title
Control Ambassadors [President's Message]

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Control Ambassadors

It is not often that the future of control is discussed in the mainstream media, but it occurred in the March 17, 2014, Barron's Technology Week column [1]. The author, impressed with the advances in sensor technology displayed at the 2014 South by Southwest show in Austin, Texas, concludes the article with conjectures about future *smart* control devices that new sensors will enable. I was reminded of this article by conversations at the American Control Conference (ACC) in Portland, Oregon.

Many types of sensors are becoming cheap and ubiquitous. An apt example is the typical smart phone, which contains an inertial measurement unit (IMU), camera, computer, satellite navigation, and communications devices sufficient to navigate and control autonomous vehicles. Sensor-stabilized quadrotors rapidly went from the research laboratory to commercially available toys. Vision-based intelligent cruise control and lane departure warning, enabled by cheap cameras, are now commercially available.

The Barron's column follows the ubiquitous sensor theme of [2], but neglects the huge advances that have occurred in computational hardware and algorithms; the speed, ubiquity, and reliability of communications; and advances in control and online data processing that have occurred in the last decades. Together, these advances enable a new era of control applications, including to large-scale, geographically distributed, dynamic systems. Discussions after the ACC special sessions identified some of the missing theoretical and practical tools needed to automatically organize and extract the essential information from the huge quantities of data, and manipulate the many control variables effectively, reliably, and automatically. Cyber-physical systems research has actively considered related issues for such applications as smart grid and smart cities, but many of the potential applications may be beyond our current imaginations.

Sensing and communication ubiquity are affecting observability and controllability in fundamental ways for applications where performance is currently limited either by lack of distributed sensing or actuation. How will cell phones, as ubiquitous mobile traffic sensors, alter the field of transportation flow control? Privacy concerns may limit the use of such data for ramp metering; however, the accumulated data is already providing drivers with the travel time distribution data necessary for (manual) real-time route planning. What will ultimately emerge in the areas of smart grids and smart cities? On a smaller scale, but with similar issues, if a battery stack is modeled as a spatially separated array of chemical reaction cells, each with slightly different chemical compositions, what are the sensor and actuator requirements for the effective battery management systems required for electrified transportation and smart-grid energy storage?

In addition to sound control-theoretic research, effective contributions in such application domains requires investigators to become control ambassadors. These people are willing to invest sufficient time to learn the fundamental domain knowledge in these application areas, just as we desire the professionals in such applications to learn the fundamentals behind control design and analysis.

Impact of Control. The second edition of the Impact of Control Technology provides several interesting examples of increasingly capable control systems enable by growing computational, communication, algorithmic, and analysis capabilities [3]. While most users are unaware that mobile phones contain controllers, in fact they contain several. For example, base stations and mobile phones cooperate over their network to control

transmission power by all units in a cell. The Kiva system includes learning and adaptation, world models, coordination through a hierarchical scheme, and novel robotic vehicles to achieve warehouse automation [4]. Model predictive control – even with nonlinear models, Boolean variables, and logical constraints – is expanding its realm of impact. The report documents award-winning applications in the cement and ethylene industries.

This message allows space for only these very few highlights. Please see the second edition for full details on approximately sixty different applications [3].

News. A related information item is that at the CSS Board of Governors approved a new Technical Committee on Smart Cities at its June 2014 meeting. Raja Sengupta is the founding Chair.

Trivia. Conversations with fellow members of the CSS Executive Committee (ExComm) provided me with the answers to the following two trivia questions. Who has hoboed their way, via train, across the United States? Who had an early career as a professional magician? These two individuals are both current members of ExComm. If you think you know the answers, I will be happy to confirm or deny.

Closing. Ideally, enhanced sensing, actuation, communication, and computational capabilities enable increasing utilization of control theory research results, improving performance and reliability, giving rise to new realms of control applications, and motivating new directions of control research. The potential applications keep the value and impact of control theory research in the minds of funding agencies.

I hope to see you at the IEEE Multi-conference on Systems and Control (MSC) in Antibes this month. I can be reached in person at the MSC or by email anytime at farrell@ee.ucr.edu.

– Jay A. Farrell

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2. Paul Saffo, “Sensors: The Next Wave of Infotech Innovation,” 1997. Available at http://www.saffo.com/essays/sensors-the-next-wave-of-infotech-innovation/.
3. T. Samad and A. M. Annaswamy, editors, *The Impact of Control Technology*, IEEE Control Systems Society, 2011, available at http://www.ieeecss.org.
4. Kiva Systems LLC, North Reading, Massachusetts, http://www.kivasystems.com/

Image: (1)20140509_190154.jpg
Caption: IEEE CSS executive committee and editors.

Image: (2)DSC00540.jpg
Caption: Maria Prandini, Elisabetta Astolfi, Elena Valcher, Kirsten Morris, and Anuradha Annaswamy.

Image: (3)IMG_20140510_082023.jpg
Caption: Thomas Parisini and Ed Chong finding their way to the executive committee meeting.