

About Face

If you're an aerospace control engineer, your job is to *point* things. Compared to some activities of aerospace engineers, such as aircraft and

rocket engine design, pointing may not sound especially exciting. But aerospace vehicles are useless without the ability to point in the desired direction. Spacecraft must aim their imaging sensors at objects of interest and their

communications antennas at other antennas; likewise, weapon systems must track their targets. Pointing is a lot more important than it sounds.

Suppose, then, that your job is to simply rotate the International Space

Digital Object Identifier 10.1109/MCS.2009.934094

Contributors



Alan Lynch and sons Ryan (left) and Aidan. Not shown is mom and photographer Christine Lynch.



Sagar Bhatt performing a dynamics experiment.



Jens C. Kalkkuhl horseback riding in Saxony.



Wei Kang with his wife Lisheng and their daughter Doreene.



Lars Imsland with his son Torjus and daughter Emma.



Tom and Rachel Grochmal and their children Jack and Orlagh ("Orla") on the shore of Lake Erie.

Station (ISS) by 90°. This sounds easy enough until you realize that the ISS is a huge structure, costs billions of dollars, has people living in it, is subjected to various types of disturbances, and has control hardware with complicated constraints. If something goes wrong during a maneuver, the ISS can't grab on to something to stabilize itself. A spacecraft can tumble out of control with embarrassing and dire consequences.



The authors of the cover article of this issue of *IEEE Control Systems Magazine*, Naz Bedrossian, Sagar Bhatt, Wei Kang, and Michael Ross, were given the responsibility of reorienting the ISS. What made their task somewhat unconventional was the goal of using only control moment gyros (CMGs). Thrusters and their precious fuel could not be used. A CMG is a wheel that spins at a constant rate. The control input

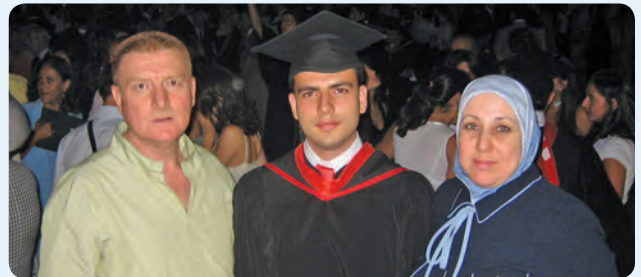
is the torque applied to the gimbals that support the wheel. Torques are applied to the ISS by rotating the gimbals and therefore the direction of the spin axis of the wheel. The CMGs can saturate in torque—essentially how fast the gimbals can rotate—as well as in stored angular moment, which is the vector sum of the angular momenta of all wheels. When no thrusters are used, the control strategy uses zero propellant. Since onboard fuel is limited and expensive, a successful zero-propellant maneuver can save a huge amount of money and increase the usable life of the ISS.



Xavier Litrico and his wife Gabi Bouleau singing some of their French songs in a backyard in Oakland, California (photo by Kelleth Chinn).



Avshalom Suissa in Vilanovai la Geltrú, Spain.



Tarek Rabbani with his mother Maha and father Sami.



Håvard Fjær Grip with his wife Dana near Palouse Falls in Eastern Washington.



Tor A. Johansen with his wife Trude.



Abbas Emami-Naeni (far right) and his wife Malahat, daughter Sheila, and son Nima.



David Dorchie in Tali, China.

This is an excellent example of the added value and enabling capability of control technology.

The feature by Tom Grochmal and Alan Lynch describes the challenges that arise in controlling self-bearing motors, that is, motors that magnetically levitate the rotating shaft. The challenging aspect of these systems is to allocate the available control effort between the desired torque and the required levitation force.

The feature by Håvard Grip, Lars Imsland, Tor Johansen, Jens Kalkkuhl, and Avshalom Suissa discusses the need to estimate sideslip angle for electronic stability control in automobiles. Sideslip angle is needed for control but is notoriously difficult to estimate. The authors describe techniques for estimating sideslip by using a combination of dynamic models and available sensors.

For “Applications of Control,” Tarek Rabbani, Simon Munier, David Dorchies, Pierre-Olivier Malaterre, Alexandre Bayen, and Xavier Litrico describe a control system implemented on an irrigation canal system in France to provide water more efficiently to vineyards.

In response to a casual comment from his son, Abbas Emami-Naeini found himself investigating the relationship between Nyquist plots and classical plane curves. You can read about these fascinating connections under Lecture Notes.

For “Focus on Education,” Ming-Tzu Ho, Yi-Wei Tu, and Hao-Shuan Lin describe a ball-on-a-wheel stabilization experiment that illustrates feedback linearization techniques.

For “People in Control,” we speak with yet more editors of control-

related journals. George Schmidt is the editor of *AIAA Journal of Guidance, Control, and Dynamics*, while Wolfgang Marquardt is the editor of the *Journal of Process Control*.

We report on a symposium in honor of Steve Marcus’s 60th birthday and, with sadness, remember Scottedward Hodel. We end this issue with a tribute to A.M. Lyapunov.

We welcome your letters on any aspect of *IEEE Control Systems Magazine*, and we especially welcome your contributions—short or long. If there is something you wish to write about, especially something tutorial that you wish to share, please contact me.

See you in December.

Dennis S. Bernstein



Naz Bedrossian playing chess with ISS GNC manager Susan Gomez in the Mission Evaluation Room during the 180° ZPM and at Draper headquarters in Cambridge, Massachusetts.



Pierre-Olivier Malaterre at Cemagref in Montpellier, France.



(From left) Nadia Bedjaoui (former Ph.D. student at Cemagref now at Melbourne University), Tarek Rabbani, Simon Munier, and Xavier Litrico at the Gignac canal control center.



Alexandre Bayen, a few minutes before the launch of the Mobile Century experiment, run jointly by Nokia and University of California, Berkeley, in Union Landing, California.