This *IEEE Control Systems Magazine* issue presents interviews with Bayu Jayawardhana, a tenured associate professor at the University of Groningen, The Netherlands, and the current chair of the IEEE Control Systems Society (CSS) Systems Biology Technical Committee (TC); Javad Lavaei, an assistant professor in the Department of Industrial Engineering and Operations Research at the University of California, Berkeley, and the 2016 winner of the American Automatic Control Council Donald P. Eckman Award; Simona Onori, an assistant professor at Clemson University and the chair of the CSS Automotive Controls TC; and Andrew G. Alleyne, who is the Ralph M. and Catherine V. Fisher Professor in the College of Engineering at the University of Illinois, Urbana–Champaign and was one of the semiplenary speakers at the 2016 Conference on Decision and Control.

Bayu Jayawardhana is a tenured associate professor at the University of Groningen, The Netherlands. He received the B.S. degree from the Institut Teknologi Bandung, Indonesia, in 2000, the M.Eng. degree from Nanyang Technological University, Singapore, in 2003, and the Ph.D. degree from Imperial College London, United Kingdom, in 2006, all in electrical and electronics engineering. He was with the Department of Mathematical Sciences, Bath University, United Kingdom, in 2006 and with Manchester Interdisciplinary Biocentre at the University of Manchester, United Kingdom, in 2007. He has been affiliated with the Engineering and Technology Institute Groningen, Faculty of Mathematics and Natural Sciences, the University of Groningen since 2008. He is a Senior Member of the IEEE, a subject editor of *International Journal of Robust and Nonlinear Control*, an associate editor of *European Journal of Control*, a member of the CSS Conference Editorial Board, and chair of the CSS TC on Systems Biology. He has consulted or collaborated with multinational companies including Philips, Photonis, and Fokker. His research interests are in nonlinear systems theory and its application to systems biology, mechatronics, micronanotechnology, and smart manufacturing processes.

Javad Lavaei is an assistant professor in the Department of Industrial Engineering and Operations Research at the University of California, Berkeley. He was an assistant professor in electrical engineering at Columbia University from 2012 to 2015. He received the Ph.D. degree in control and dynamical systems from the California Institute of Technology under the supervision of Prof. John C. Doyle and Prof. Richard Murray in 2011 and was a postdoctoral scholar at Stanford University working with Prof. Stephen Boyd and Prof. Abbas El Gamal for one year. He received the Milton and Francis Clauser Doctoral Prize for the best university-wide Ph.D. dissertation, "Large-Scale Complex Systems: From Antenna Circuits to Power Grids." His research focuses on optimization theory, control theory, and power systems. He has won several awards, including the DARPA Young Faculty Award, the Office of Naval Research Young Investigator Award, the National Science Foundation (NSF) CAREER Award, the Resonate Award, the Google Faculty Research Award, the Governor General of Canada Academic Gold Medal, the Northeastern Association of Graduate Schools Master's Thesis Award, and a Silver Medal in the 1999 International Mathematical Olympiad. He is an associate editor of *IEEE Transactions on Smart Grid* and serves on the conference editorial boards of the CSS and the European Control Association. His journal paper "Zero Duality Gap in Optimal Power Flow Problem" received a prize paper award from the IEEE Power Energy Society Power System Analysis Computing and Economics Committee in 2015. He is a corecipient of the 2015 INFORMS Optimization Society Prize for Young Researchers and the recipient of the 2016 Donald P. Eckman Award.

Simona Onori is an assistant professor at Clemson University. She received the laurea degree from the University of Rome, "Tor Vergata," in 2003, the M.S. degree from the University of New Mexico, Albuquerque, in 2005, and the Ph.D. degree from the University of Rome, "Tor Vergata," in 2007. She began as a control engineer at Thales-Alenia Space in Rome. Subsequently, she transitioned from a postdoctoral fellow, to a lecturer, and then to a research scientist, all at the Center for Automotive Research and Mechanical Engineering Department at The Ohio State University. Simona joined the Clemson University Automotive Engineering faculty in 2013, and she has held a joint appointment with the Electrical and Computer Engineering Department since 2014. She has held visiting research professor positions at the University of Trento, Italy, in 2014, and the University of Orleans, France, in 2016, and she was an invited lecturer at the Beijing Institute of Technology, China, in 2015. She is an IEEE Senior Member (2015), chair of the IEEE CSS TC on Automotive Controls (for the term 2015–2018), associate editor for the IEEE CSS Conference Editorial Board

(2015–present), vice-chair of the IFAC Technical Committee of Automotive Controls (2015–present), and an associate editor of *SAE International Journal of Alternative Powertrains* (2012–present). Since joining the Clemson faculty, her current research has been funded by Fiat-Chrysler Automobile, BorgWarner, Honda, Johnson Controls, and the NSF. She has coauthored a book and two book chapters and has published over 70 articles in archival journals and conference proceedings. Her research interests range from the area of dynamic systems to health monitoring, control and optimization for automotive propulsion systems with a focus on e-mobility, emission control, and waste-heat recovery.

Andrew G. Alleyne is the Ralph M. and Catherine V. Fisher Professor in the College of Engineering at the University of Illinois, Urbana–Champaign (UIUC). He received the B.S. degree (magna cum laude) from Princeton University in 1989 in mechanical and aerospace engineering. He received the M.S. and Ph.D. degrees in mechanical engineering in 1992 and 1994, respectively, from the University of California, Berkeley, while on leave from the Jet Propulsion Laboratory. He joined the UIUC Department of Mechanical Science and Engineering in 1994 and is also appointed in the Coordinated Science Laboratory, the Electrical and Computer Engineering Department, and the Institute for Genomic Biology. He currently leads the NSF Engineering Research Center on Power Optimization for Electro-Thermal Systems. He was awarded the ASME Dynamic Systems and Control Division's Outstanding Young Investigator Award, the Henry Paynter Award, and the Charles Stark Draper Award. He was a Fulbright fellow to The Netherlands, where he held a visiting professorship in vehicle mechatronics at TU Delft, and he has held other visiting professor positions the University of Colorado at Boulder, Johannes Kepler University, and ETH Zurich. He is the recipient of the ASME Gustus L. Larson Memorial Award, and he is a National Research Council fellow and a fellow of ASME. His research interests are a mix of theory and implementation with a broad application focus resulting in over 350 papers in journals and conferences. In addition to research, he has a keen interest in education and has earned the College of Engineering's Teaching Excellence Award, the UIUC Campus Award for Excellence in Undergraduate Education, and the UIUC Campus Award for Excellence in Graduate Student Mentoring. He has been active in the ASME, the IEEE, and several other societies. Additionally, he has been active on several boards including the Scientific Advisory Board for the U.S. Air Force.

Jonathan P. How

BAYU JAYAWARDHANA

Q. **How did your education and early career lead to your initial and continuing interest in the control field?**

Bayu: Throughout my education in electrical and electronics engineering

Bayu standing next to the coldest cryostat at the Dutch Space Research Institute in Groningen, The Netherlands, with an operating temperature of 50 mK.

(with bachelor's, master's, and doctorate degrees), I have always opted for the systems and control specialization. One of the main reasons is due to its proximity to mathematics discipline, which is one of the fields of science that I have loved since I was young. During my senior year at the Institut Teknologi Bandung, we won the grand prize of the Texas Instrument Asia Digital Signal Processing Competition as well as being a finalist for the Young Inventors Award organized by Hewlett-Packard and Far Eastern Economic Review, where our team worked on the application of a dynamic neural network algorithm in an active noise-control system for a cabin car. Two of the five team members (myself and Hendra Nurdin, now a senior lecturer at the University of New South Wales) are still active members of the IEEE Control Systems Society. After my bachelor's degree, I was very fortunate during my master's and doctoral studies to be supervised by two of the most influential figures in control, Prof. Xie Lihua, an IEEE Fellow at Nanyang Technological University, and Prof. George Weiss, at Imperial College London, who have shared their enthusiasm on systems and control theory. All of these positive experiences have compounded my determination to have an academic career in systems and control.

Q. **What are some of your research interests?**

Bayu: In general, my research interests cover broad topics related to nonlinear systems theory and applications. Let me present an overview of various research projects across different disciplines that I have worked on for the past five years.

The first one is on the development of a cryogenic mechatronic system that will be one of the essential systems inside a scientific instrument for the future European Extremely Large Telescope (E-ELT). The instrument is called the mid-infrared E-ELT imager and spectrograph (METIS), and it will be the third instrument commissioned for E-ELT around the year 2026. The
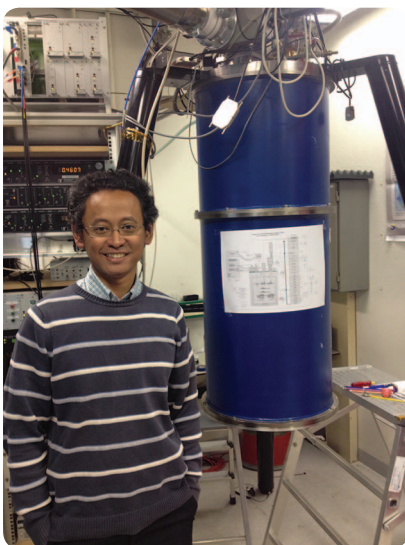
METIS is designed to measure basic chemical and physical properties of exoplanets. From a systems engineering perspective, the realization of such an ultrasensitive instrument imposes stringent requirements to all of its subsystems, including the two-dimensional chopping mechanism we worked on. This mechatronic system must be operational at cryogenic temperatures, have negligible heat dissipation, and be able to move very fast from one operating point or scanning profile to another. All of these requirements put a lot of constraints on the design space, including the control systems.

The demonstrator project was successfully completed in 2014, where we used a combination strategy of hybrid and repetitive control. I am looking forward to seeing its performance when the instrument will be commissioned in about ten years from now. As a continuation to this project, we are now working together with the Dutch Space Research Institute and the Kapteyn Astronomical Institute on a high-contrast optics project for future space missions aiming at enabling a wideband wavelength measurement of exoplanets in a habitable zone.

The second research project is on systems biology, where we have worked on a new model-order-reduction method applicable for general (bio)-chemical reaction networks. We believe that such tools will become indispensable in handling the complexity of future genome-scale kinetic models, in particular, when the use of models becomes crucial for the feedback loop in future model-based personalized medicine.

The third project is on the development of advanced process control for ultra-high-vacuum chemical vapor deposition batch reactors in collaboration with a multinational company. In contrast to the previous two projects, we must deal with ultra-low pressure in combination with high temperature. In all of these cases, our expertise on nonlinear control has enabled us to explore the unchartered nonlinear ter-

Bayu Jayawardhana during the Ph.D. defense of his first Ph.D. student, Ruiyue Ouyang, in 2013. From left: Prof. Kirsten Morris (University of Waterloo), Prof. Claudio de Persis (University of Groningen), Prof. Jacquelien Scherpen (University of Groningen), Prof. Harry Trentelmann (hidden behind, University of Groningen), Bayu, Dr. Shuo Zhang (now at Siemens, United Kingdom), Dr. Ruiyue Ouyang (now at ASML, The Netherlands), Prof. Arjan van der Schaft (University of Groningen), Dr. Matin Jafarian (University of Groningen), Prof. Paul van den Bosch (TU Eindhoven), Prof. Sophie Tarbouriech (LAAS, Toulouse), Prof. Ruth Curtain (University of Groningen), and Prof. Beatriz Noheda (University of Groningen).

Bayu standing on top of a saline wastewater-treatment plant in Delfzijl, The Netherlands.

ritories, beyond the comfort zone of linear domain.

The fourth project is on the dynamic planning and control of container-terminal operations, which was conducted with one of the Indonesian port authorities. Indonesia is an archi-

pelago country with more than 13,000 islands, and the current government has placed top priority on the optimization of its maritime transportation network. We developed a dynamic planning algorithm that is based on model predictive control, and I am

very satisfied to learn that our algorithm has been tested at an Indonesian seaport and has improved the quay-crane allocation ratio, which is one of the key performance indicators, by about 5%. We are now investigating the network case and will report our findings hopefully soon.

The fifth project is on distributed formation-motion control of mobile robots together with my colleague, Prof. Ming Cao, and our student, Hector Garcia de Marina. In this project, we worked on an open problem posed by Prof. Shaoshuai Mou (now at Purdue University) and coworkers, where a disagreement in the distance parameter in the gradient-based distributed control law of an undirected network leads to the distortion of the whole formation. We have proposed an elegant solution to this problem, which was published in *IEEE Transactions on Robotics* in 2014. Based on the insights that we have learned from solving this problem, we have proposed a simple modification to the standard gradient-based law that allows us to simultaneously achieve maneuvering and formation of robots, and it is reported in a recent paper in *IEEE Transactions on Robotics*.

Finally, we are also working on a novel wave-energy converter device, called the Ocean Grazer (http://www.oceangrazer.com). Its novelty lies in its adaptability to the full spectrum of ocean waves and on its large-scale energy-storage capability. It uses a floater-blanket technology, consisting of multiple coupled wave-energy converters, each of which is linked to a controllable multipiston pump system, that are able to pump working fluid from the lower basin to the upper basin. Electricity can thus be generated by converting the stored potential energy in the upper basin

Profile of Bayu Jayawardhana

- *Current position:* associate professor, University of Groningen.
- *Visiting and research positions:* Université Claude Bernard Lyon 1, France.
- *Contact information:* University of Groningen, Engineering and Technology Institute Groningen, Nijenborgh 4, Room 5117.0117, 9747AG Groningen, The Netherlands, b.jayawardhana@rug.nl, http://www.rug.nl/staff/b.jayawardhana.
- *IEEE Control Systems Society experience highlights:* chair, Technical Committee on Systems Biology (2015–2016); associate editor, IEEE CSS Conference Editorial Board; associate editor, *IEEE Transactions on Control Systems Technology* (2017–present).
- *Notable awards:* Senior Member, IEEE (2014); grand prize award, TI-Asia DSP Solution Challenge (1999).

via turbines. Due to the large number of distributed sensors and actuators in the full-scale system, there are many challenging control problems, which we are currently investigating within our Ocean Grazer group.

Q. **What courses do you teach relating to control? Do you have a favorite course? How would you describe your teaching style?**

Bayu: I teach a second-year bachelor's course on signals and systems, a first-year master's course on fitting dynamical models to data, and a graduate course on nonlinear control systems for the Dutch Institute for Systems and Control. I have also liked very much teaching nonlinear control systems, as well as signals and systems. I have always enjoyed the Massachusetts Institute of Technology's open course on electricity and magnetism, which was taught by Prof. Walter Lewin. Therefore, I try to emulate his teaching style in all of my courses.

Q. **What are some of the most promising opportunities you see in the control field?**

Bayu: I think that the systems and control field will experience another golden age when the concept of Industry 4.0 (as popularized in Germany) or of smart industry (as developed in The Netherlands) or of smart manufacturing (as it is known in the United States) takes off. I am currently involved in the formulation of the Dutch national road map in Smart Industry, and I see the opportunity that lies ahead with the reshoring trend of the high-tech manufacturing sector into Europe or the United States.

Q. **What are some of your interests and activities outside of your professional career?**

Bayu: One of my favorite pastime activities is doing origami with my daughter. I would recommend the book *Origami Design Secrets: Mathematical Methods for an Ancient Art* by Robert J. Lang, if you are interested in origami.

Q. **Thank you for your comments.**

Bayu: You are welcome. It is always nice to read your column and it is my pleasure to share my thoughts. Thank you.