The Future of Automation

By Eugenio Guglielmelli

In this issue, Eugenio Guglielmelli (EG), editor-in-chief of *IEEE Robotics and Automation Magazine* (*RAM*), interviews Henrik I. Christensen (HC).

Henrik is the KUKA chair of Robotics and the executive director of the Georgia Tech Institute for Robotics and Intelligent Machines. He does research on robotics and computer vision with an emphasis on estimation and systems engineering. He was the founder of the European Robotics Research Network and the editor of the U.S. National Robotics Roadmaps (2009, 2013). He is the chair of the IEEE Transactions on Automation Science and Engineering Advisory Board.

EG: From your perspective, what are the most important emerging application areas for automation?

HC: Automation has traditionally been focused on large-volume manufacturing. Products are increasingly becoming customized to the individual buyer. Even cars come in more than 1 million different configurations. The high degree of customization implies that we manufacture one-off products even on high-volume production lines. Through the use of model-based control, perception, and high-performance computing, we can provide customized manufacturing. This also implies that the same manufacturing techniques can be used outside of high-volume manufacturing by small- and medium-sized companies.

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EG: In one of my recent editorials of *RAM*, I speculated about the ongoing transition from the information society, driven by information and communications technology (ICT), to the automation society, driven by ICT in addition to robotics and automation technology. In the automation society, new products and services will be enabled not only by information exchange but also by action exchange, which will be possible ubiquitously and at a relatively low cost. Do you agree with this vision? What is your personal road map for the development of the automation society?

HC: There is no doubt that cloud computing will become ubiquitous as cloud robotics. We will see a higher degree of standard interfaces for robots as seen, for example, in ROS-I, which facilitates a higher degree of use of shared models, not only in terms of objects and mobiles for perception but also for planning and control. At the same time, we will see off-loading of processing to the cloud. In my mind, the sharing of knowledge and blurring the boundary between on- and off-board processing will generate a leap in performance and cost.

EG: Shall we expect an increasing convergence between automation and robotics research and industrial fields in the medium to long term, or will they develop more and more as separate fields with a clear independent scientific, technological, industrial, and social mission?

HC: Fixed automation has been the major driver for increased precision, quality, and robustness in manufacturing. Through the use of new sensors and advanced computing, it is possible to approach the same performance with robot technology. We can, in the true sense, move from fixed automation to flexible automation through the use of robot technology. We can take the fixed automation "monuments" and replace them with robot systems. This allows higher flexibility and better capitalization, and it feeds into the increased customization of technology.

EG: What are the most important ongoing research and industrial developments in the automation field in the United States?

HC: To me the main drivers are improved processing, perception, and networking. Just like Europe has embraced Industry 4.0, we are seeing the United States embrace the Industrial Internet in the same way. Recently, a number of national manufacturing institutes have been launched. One of

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13–16 October
ICCAS 2015: International Conference on Control, Automation and Systems. BEXCO, Busan, Korea. http://2015.iccas.org/

18–20 October
SSRR 2015: IEEE International Symposium on Safety, Security, and Rescue Robotics. Purdue University, Indiana, USA. https://robotics.purdue.edu/SSRR2015/index.html

3–5 November
Humanoids 2015. Seoul, South Korea. Call for Papers Deadline: 30 June 2015. http://www.humanoids2015.org/main/

6–9 December
ROBIO 2015: IEEE International Conference on Robotics and Biomimetics. Zhuhai, China. Call for Papers Deadline: 25 July 2015. http://ieee-robio.org/2015/

12–13 December
SII 2015: IEEE/SICE International Symposium on System Integration. Nagoya, Japan. Call for Papers Deadline: 31 August 2015. http://www.si-sice.org/SII2015/

2016

16–21 May
ICRA 2016: IEEE International Conference on Robotics and Automation. Stockholm, Sweden. Call for Papers Deadline: 31 August 2015. http://www.icra2016.org/

8–11 July
AIM 2016: IEEE/ASME International Conference on Advanced Intelligent Mechatronics. Ottawa, Ontario, Canada.

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them is focused on digital manufacturing. How do we streamline the tool chain from computer-aided design (CAD) to the factory floor? This will be a major push for integration of systems engineering, automation, and robotics.

EG: Since you worked for a long time in Europe before moving to the United States, what are the main differences in the way automation research and industry are developing in these two regions?

HC: The big difference is probably in how industry and academia collaborate. There are much more significant collaborations in the United States. A company based in the United States can sponsor university research and get a tax break, whereas that is much harder in Europe. The European Union (EU), on the other hand, has massive programs such as Horizon 2020, which fosters multi-institution collaborations and community integration. Such programs are sorely missing in the United States. However, we do see parallel programs in the EU and the United States, such as Industry 4.0 and the Industrial Internet. Through collaborations I think we could be even more successful.

EG: Based on your experience, why would you tell a young Ph.D. student to invest his/her professional, academic, or industrial career in automation?

HC: There are so many cool applications in industry, and I would encourage young researchers to actively engage with a few companies to make sure they work on problems that have a true long-term impact. So much research is never transitioned to the real world. If you can demonstrate a real-world impact, getting funding is easy. The same applies to industry. Results that show up on the bottom line make life much easier. We need to solve hard problems, but we also need to demonstrate that the new research makes a difference.

EG: What is the next important research development that we will hear from you and your research group in the near future?

HC: Right now we are working on methods for automated programming directly from CAD models without using traditional programming. We have a new model based on a vision system that allows control of robots with a global accuracy better than 0.1 mm, which will allow new types of automation. Finally, we are trying to embrace the cloud as a new paradigm for sharing and processing.

We live in a very exciting time for automation and manufacturing.