

Academic Corner

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In this issue, we are pleased to feature an interview with IEEE SMC member Dr.-Ing. Balint Varga. He received his B.Sc. in Mechatronics from the Technical University of Budapest, Hungary, in 2016. He earned an M.Sc. in Mechanical Engineering in 2017 and a Dr.-Ing. in Electrical Engineering and Information Technology in 2023, both from the Karlsruhe Institute of Technology (KIT), Germany. From 2017 to 2020, he worked as a research scientist at the FZI Research Center for Information Technology. Since 2020, he has been a research assistant at KIT, and in 2023 he became head of the research group on Cooperative Systems. His research interests include modeling human-machine interaction and designing shared-control concepts for applications such as autonomous vehicles, mobile manipulators, and healthcare systems. He is a member of the IEEE SMC Society and leads the Technical Committee on Shared Control. He also serves as an Associate Editor for the IEEE Transactions on Human-Machine Systems and the International Journal of Robotics and Automation.

(1) Please tell us a bit about yourself and your academic/professional background. How did your path from mechatronics and mechanical engineering lead you to cooperative systems and human-machine interaction?

To be honest, my path into this field was a natural evolution, starting from my background as an electrical and mechanical engineer and later moving into research on human-machine systems. When I started my Ph.D. with this topic, I immediately felt that it was both interesting and very relevant. After completing my Ph.D., I had the opportunity to apply for a research group leadership position, which I was fortunate to receive. This allowed me to continue developing my research interests and to contribute more actively to the field of human-machine systems.

(2) Could you tell us about your current research? What inspired you to work on cooperative control, shared control, haptic human-machine interaction, and human-in-the-loop automation?

What inspires me in my current research is the possibility of serving humanity by advancing human-machine systems that can help people in many different ways. In my current work, I focus mainly on the concept of teleoperation and try to answer the question of why, despite more than 30 years of research in this area, teleoperation systems are still not widely available or commonly used in practice.

This question motivates me to investigate not only the technical challenges, but also the usability, safety, and acceptance of such systems. For this reason, I am also planning to become more active in the Telepresence activities of our SMC Society.

(3) Your doctoral work focused on limited-information shared control and applications to large vehicle manipulators. What does "limited information" mean in practice, and why is it important for safe and intuitive cooperation between humans and machines?

"Limited information" means that certain measurements or state signals are not available to the controller. Instead, only the human operator can control or observe that part of the system. This topic was originally motivated by a problem in mobile machinery control, raised by a German OEM company. During my Ph.D., I transformed this industrial problem into a more theoretical research question. Over time, it turned out to be a rather niche topic; however, I believe that addressing the problem of "limited information" is still important for the development of safe, intuitive, and reliable human-machine systems.

(4) In many mobile machinery and robotic systems, the human operator remains part of the control loop. What are the main technical challenges in modeling human behavior, dynamically allocating authority, and keeping these systems trustworthy?

The main challenges are the complexity of unstructured environments and the need to understand human cognition and actions. Therefore, I would say that the technical challenge is no longer only the control itself, but rather the development of safe control algorithms that can understand human behavior, interpret human intentions, and interact reliably in complex environments, often with limited computational resources.

If a control algorithm is able to understand human actions and intentions, it can make the overall system more trustworthy, intuitive, and acceptable to users. In the end, people will only use such systems if they feel safe, confident, and comfortable interacting with them. Just think about the adaptive cruise control in your car: would you use it if it did not work the way you expected or wanted it to?

(5) Are there underexplored opportunities in cooperative or haptic human-machine systems that you find particularly exciting? Where do you see the field going in the next 5-10 years?

I believe that, in the future, areas involving human-machine systems will become especially relevant and interesting in situations where we do not want to give up full control, for example in medical procedures or in the care of our parents and grandparents. I do not know anyone who would be happy to simply hand over caregiving tasks or surgical intervention completely to an AI-controlled robot. Military applications will also require that a human being still makes the final decisions.

In such systems, there is always some form of interaction between humans and machines, whether it is haptic or physical interaction, or simply coordination and cooperation. This is exactly why I still consider research on human-machine systems to be important, relevant, and timely.

(6) What practical advice would you give to early-career researchers or PhD students who want to build impactful work at the interface of control, robotics, cybernetics, and human factors?

For younger researchers, I can only recommend that they start networking with the right people early enough, ask the right questions, and avoid positioning their research work too narrowly on a very small niche topic.

It is extremely important to attend conferences early on, to network with other people, and to exchange ideas. I believe the COVID period showed us that, without human-to-human interaction, research has much less to offer. Conferences are not only important because they allow us to present our scientific results, but also because they provide opportunities for active exchange. Through this exchange, we can return home with new research ideas, new proposal outlines, and renewed motivation to continue our research.

Therefore, ask your supervisors to allow you to attend conferences as early as possible, and network, network, network as much as you can. Do not be shy at conferences; talk to people and make connections.

(7) What role have IEEE and IEEE SMC played in your career so far? Looking ahead, what would you like to see the SMC community prioritize?

I believe that the SMC Society is one of the reasons why I am still in research and why I continue to enjoy it so much. There is nothing better than discussing ideas with my Ph.D. students or teaching students something new in lectures and seeing how they grow and learn.

What I find important is that our community should seek stronger connections with other societies, and that our Society should represent itself more actively so that SMCS becomes better known and more established within IEEE.

(8) Any last words of advice you would like to share with the SMC Society?

My final words to the SMC Society are that we should not hide. This Society may be smaller than others, but if we stand together and show our strengths and traditions, then we have an important role to play in the IEEE research landscape. I am proud and happy to be part of the SMC Society.