Academic Corner
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In this issue, we interview IEEE SMC senior member Dr. Yaoping Hu. Yaoping is a professor of Software Engineering, head of the Visualization and Interaction Laboratory, and the Schulich Momentum director of Hyperconnected World and Our Digital Future at the Schulich School of Engineering, the University of Calgary, Canada. In 2000, she received a PhD degree in robotics and neuroscience at the University of Western Ontario (now Western University), Canada. She joined the University of Calgary as assistant professor in 2004, and became associate professor in 2011 and full professor in 2015. She is a leading expert in human-computer interaction within virtual environments (i.e., XR = virtual reality – VR / augmented reality – AR / mixed reality – MR). Her current research interest lies in human cognitive ergonomics for XR systems.

(1) Tell us a bit about yourself and your academic/professional background
My journey has filled with encounters and opportunities, which guided me towards a researcher and leader. Educated in electrical and computer engineering, I was employed as a software developer at a research lab of neuroscience in the middle of 1990s. This employment allowed me to use my engineering knowledge/skills to design and implement various software for autonomous control of experimental procedures and semi-automatic analyses of empirical data. Importantly, my exchanges with neuroscience researchers injected a new perspective of similarity and difference between engineering and neuroscience. This perspective ignited my curiosity for research – i.e., asking questions and seeking answers – and sparked my passion for "cool" things – e.g., applying neuroscience discovery to create humanoid robots.

Hence, I pursued a PhD study to combine my interest in both engineering and neuroscience. The study not only shaped my understanding of human behavior and neural pathways for modelling, but also exposed me to use advanced VR technologies. Surprisingly, this VR usage enabled me to secure a researcher position at the first VR center in Canada (i.e., Virtual Environment Technologies Centre, National Research Council of Canada), while undergoing my JST-STA fellowship at the ATR Computational Neuroscience Laboratories in Japan. My working activities at this position provided me first-hand experience in recognizing challenges of human interaction with VR systems for engineering and medical applications. To addressing the challenges, I became a faculty member in academia to undertake fundamental and applied research in human-computer interaction with virtual environments.

Moving from an assistant professor to a full professor, I realized the importance of transdisciplinary collaboration and the impact of academic research on the world. Such realization elevated my passion from for "cool" things to for discovery and innovation; and propelled me to volunteer to the IEEE SMC Society and to take responsibility of the Schulich Momentum director for facilitating transdisciplinary research and innovation. Being a researcher and leader, I am glad to contribute to the world by educating undergraduates, training highly qualified personnel, innovating technologies, and advancing knowledge.

(2) Tell us a bit about your research? Are there any underexplored opportunities that you find particularly exciting in this field?
Relying dominantly on the visual sense, XR systems have been evolved to include other senses like haptics, auditory, smell, etc. for facilitating human interaction with objects. Over years, our research moves from creating XR systems to measure human cognitive states during multisensory interactive tasks – that is, how to achieve cognitive ergonomics. We identified that mental workload, in particular

the six factors of the NSAS task load index (NASA-TLX), is an important cognitive state. Then, we acquired brain activities as spatiotemporal signals during XR-based interactive tasks, extracted features and loci of the activities from the signals, and characterized each NASA-TLX factor with its unique features and loci. The outcomes of this pioneering work have been published in the IEEE Trans. on Human-Machine Systems.

The work opened opportunities of applying its outcomes for many applications: from designing user-friendly brain-machine interfaces to personalized effective training. Exploring the opportunities requires further intensive research to address issues such as brain signal security, computational efficiency, system trustworthiness, intuitive interfacing, etc. Efficient and robust solutions to these issues are paramount because the safety and comfort of human users are crucial prerequisites of practical XR systems.

(3) Where do you see your research field going in the next 5-10 years?
It is necessary to create XR systems to meet cognitive states, as humans are the linchpin of the systems in many applications. Depending on specific individuals and designated applications, the systems need to be tailored and adapted personally. This need demands researchers to investigate solutions of merging brain-machine interfaces with the systems to achieve such individualization and adaptation over time. A rethinking of multi-sensory integration and/or substitutions are also keys to future XR systems and their applications, especially when humans must interact with objects based on incomplete information for decision-making. Taking together, cognitive ergonomics for XR systems will be an emerging and exciting field in the next 5~10 years.

(4) What advice would you give young researchers entering your field?
Giving advice would be overstated, but some of my experience might be helpful. After many years in doing research, I realize that failures and opportunities are in the beholders' eyes and that curiosity, perseverance, and enjoyment are important for researchers. A failure is an opportunity for us to learn and improve. Being curious leads us to explore novel ideas and to keep up learning. Perseverance is essential because research often leads us to failures before succeeding. Finding enjoyment in what we do allows us to handle ups and downs in a research journey. The combination of the curiosity, perseverance, and enjoyment makes us full of passion and determination to enable success. Keeping these in mind would empower us to overcome difficulties and to find satisfaction in research.

(5) What role has IEEE played in your career?
IEEE is like light at the top of a lighthouse, guiding me to the best of knowledge and providing me a community of serving to the humanity. Its rigorous reviewing for publications warrants excellent quality of knowledge, which plays a positive and important role in my career. My exchanges with IEEE colleagues shape and aide me in every stage of my career path.