Embracing robots in our lives

by Weihua Sheng, Jindong Tan, and Shaikh Fattah

Robotics has the power to change our lives by transforming manual jobs to autonomous ones, with increased economic growth and productivity. You may recall the surprising appearance of Sophia, the most advanced humanoid robot, which fluently interacted with people in 2016. We are eagerly waiting for Elon Musk's Optimus to be available in 2027, a new humanoid robot that could be part of our everyday lives. NASA's Robonaut 2 (or R2) was flown to the space station as part of STS-133 mission. A robot cooker is capable of large-scale, fully automatic cooking. In fact, robots are coming to our lives with applications in space missions, underwater exploration, agriculture and the food industry, medicine and health care, industrial automation and manufacturing, security, entertainment, search and rescue, and education. Robotics is a multidisciplinary and exciting research field that crosscuts computer science, electrical engineering, mechanical engineering, material science, etc.

Robotics is a rapidly growing discipline with continuous innovation to meet real-life demand. In recent years, new forms of robots and new robotic technologies have been developed by robotics researchers and gradually deployed in real-world applications. This special issue aims to open a small window to the vast territory of robotics research, covering robotic technologies and their applications in education, robot manipulation, space exploration, and underwater exploration.

"A Summer Expedition to Robotics" [A1] focuses on the application of robots in science, technology, engineering and mathematics (STEM) education. It documents a recent robotics summer camp for K–12 students, which explores new ways of preparing and conducting summer camps. By integrating age-appropriate competitive games, the summer camp engaged students and stimulated their interest in robotics. A trivia game system, as one of the camp projects, was implemented to assess the student learning outcome in a highly entertaining and interactive fashion. The preparation of the summer camp involved a variety of students, including graduate, undergraduate, and high school students, to ensure that the program best fits the age groups without losing its rigorousness. As robotics and artificial intelligence (AI) technologies are rapidly changing the world, STEM summer camps focused on robotics will have long-term impacts on K–12 students.

"An Overview of Robotic Grippers" [A2] surveys the state of the art in robotic gripper design and identifies the future research directions in this area. The authors first reviewed existing grippers, which are divided into anthropomimetic and nonanthropomimetic. The former is further divided into underactuated and fully actuated, while the latter is further divided into biomimetic and nonbiomimetic. The article then discusses several critical issues in gripper design, including perception, level of autonomy, and the ethical considerations of using robotic grippers. Finally, the authors identify several future challenges that should be tackled in the application of robotic grippers. As robots are expected to replace human labor in many tasks, robotic grippers will continue to be an important and exciting area of research.

"Electroadhesive Robotics Experiment in Simulated Microgravity" [A3] reports the research effort by a group of young women who are leaning into Canadian robotics excellence through their investigation of how electroadhesive (EA) robots behave in reduced gravity while introducing a new testing procedure for rovers and adhesive space robotics. The proposed experiment consists of an automated robotic experiment conducted in a Pelican case that will be flown on a parabolic flight in 2023 as part of the Canadian Reduced Gravity Experiment Design Challenge competition hosted by Students for the Exploration and Development of Space Canada The objectives include investigating whether the testing setup for related enclosed rover and adhesive robotics experiments is feasible, the ability of an EA robot to adhere using simple EAs made of polyurethane and aluminum sheets, and the difference in adhesion in microgravity between conductive and nonconductive surfaces.

While space explorations bring exciting images and video from galaxies far away, the environment underneath deep oceans still remains largely unknown to humans due to its unique challenges of the dark, cold, unstable, and high-pressure water. Underwater explorations have inspired generations of roboticists to develop underwater vehicles and manipulators to unravel the secrets of the oceans. "An Underwater Explorer Remotely Operated Vehicle: Unraveling the Secrets of the Ocean" [A4] gives an overview of underwater applications ranging from

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coastal cruises to oceanographic 3D mapping. The article discusses underwater robots as an emerging way of exploring the oceans as well as the engineering challenges of the design, control, and operation of these robots. The article particularly addresses the use of underwater robots for the digital ocean collection of unknown marine creatures and ecological environments.

As the AI and machine learning technologies continue to advance rapidly, new robotics technologies and applications are expected to emerge at a fast pace. We hope more and more students will enter this exciting field, explore new research frontiers, and contribute to the development of next-generation robotic technologies. The IEEE Robotics and Automation Society (RAS) is a very vibrant technical society of IEEE that supports the development and exchange of scientific knowledge in the fields of robotics and automation, including applied and theoretical issues. The IEEE RAS runs some world-renowned journals and *IEEE Robotics and Automation Magazine* (*RAM*). In these journals and the magazine, various technical articles of interest to the international robotics and automation community are regularly published, with a readership of more than 12,000 worldwide. Students are encouraged to follow RAS social media and the *RAM* website for exciting new developments in robotics and automation.

Appendix: Related articles

[A1] W. Sheng et al., "A summer expedition to robotics," *IEEE Potentials*, vol. 42, no. 3, pp. 8–16, May/Jun. 2023, doi: 10.1109/MPOT.2023.3247909.

[A2] T. J. Cairnes, C. J. Ford, E. Psomopoulou, and N. Lepora, "An overview of robotic grippers," *IEEE Potentials*, vol. 42, no. 3, pp. 17–23, May/Jun. 2023, doi: 10.1109/MPOT.2023.3236143.

[A3] M. Kuzyk, J. Gebara, and J. Belisle, "Electroadhesive robotics experiment in simulated microgravity," *IEEE Potentials*, vol. 42, no. 3, pp. 24–30, May/Jun. 2023, doi: 10.1109/MPOT.2023.3241423.

[A4] X.-R. Huang and L.-B. Chen, "An underwater explorer remotely operated vehicle: Unraveling the secrets of the ocean," *IEEE Potentials*, vol. 42, no. 3, pp. 31–36, May/Jun. 2023, doi: 10.1109/MPOT.2022.3233713.

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