

An Introduction to Service Robots

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Abstract. A service robot is defined as the Internet of Things (IoT) consisting of a physical robot body that connects to one or more Cloud services to facilitate human-machine interaction activities to enhance the functionality of a traditional robot. Many studies found out that anthropomorphic designs in robots resulted in greater user engagement. Humanoid service robots usually behave like natural social interaction partners for human users, with emotional features such as speech, gestures, and eye-gaze, referring to the users' cultural and social background. During the COVID-19 pandemic, service robots play a much more critical role in helping to safeguard people in many countries nowadays. This tutorial covers the research issues from technical and social-technical perspectives, such as Human-Robot Interaction (HRI), spatial interaction, emotion, nonverbal and verbal interaction, ethical and moral, and cybersecurity issues with case studies.

1 Proposal

1.1 Requisite background of the target audience

This tutorial aims to bring together academics and practitioners to describe the use and synergy between the research issues in service robots. The target audience is those from Science, Technology, Engineering, and Mathematics (STEM), Business, Social Sciences, and Humanities.

1.2 The tutorial length

1 hour 45 minutes.

1.3 Content details: a bullet list of organization of the tutorial, in the order of presentation with estimated presentation time for each item

This tutorial encourages interactions between the presenters with multiple backgrounds on service robots with the audience who possess little or no prior experience in this area. The emphasis will be on generating a “collective learning process” that bridges gaps between the knowledge domains and applications. The audiences will be

encouraged to exchange knowledge and disciplinary perspectives in the context through unique approaches provided by the audience's background.

The tutorial consists of activities, including discussions based on literature review, problem definition, and use cases. In contrast, others include presentations and the development of a service robot application to apply the knowledge obtained during the tutorial. Table 1 gives a bullet list of the organization of the tutorial.

Table 1. Organization of the Tutorial.

Topic	Title	Duration
1	Service Robots and Examples - Introduce the fundamental concepts of service (social) robots, the Uncanny Valley, Robot Operating System (ROS), and related Service-Oriented Architecture (SOA) with illustrative examples by a robot and video clips.	10 mins
2	Human-Robot Interaction (HRI) - Explain the HRI models through robot embodiment features (e.g., microphone, speaker, camera, sensors, displays, etc.) and adapts its intelligence and behavior through the perception of specific social cues (e.g., voice commands, gestures, facial expressions, etc.).	10 mins
3	Spatial Interaction - Describe the importance of planning a robot's placement in space from the perspectives of people's preferences and the social norms regarding such placement to others.	10 mins
4	Emotion - Explain how a robot could mimic how people display emotions as an interaction strategy to recognize emotion in the human and then reflect the emotion in response by using gesture, motion, color, and sound to express emotion (e.g., happy, calm, sad, angry, etc.).	10 mins
5	Nonverbal and Verbal Interaction - Describe the role of nonverbal communication in interactions between people and how communication is enhanced by facial expressions, hand gestures, body posture, and sounds. The robot can also transcribe speech into words, understand words by coming up with appropriate responses, and generate spoken language.	10 mins
6	Cybersecurity - Discuss the integration of cyber and physical components in a robot that introduces new security threats beyond what a regular computing system may tackle. Cyber-physical systems (robots) do not operate in a stable environment, so they should adapt to failures and critical or emergencies.	15 mins
7	Case Study: Game, Robots and Digital World - Provide a case study to show how a service robot in gamification theory combined with the "Computers as Social Actors" paradigm and its impact in the digital world.	15 mins

8	<i>Ethical and Moral Issues:</i> Examine the ethical and moral issues related to technological advancements in service robots. A relationship exists between the emergence of robots and various ethical dilemmas that may affect services and humans.	10 mins
9	<i>Q&A</i>	15 mins

1.4 Importance of this proposed tutorial to the ICSOC audiences

A service robot is not a new concept in general. However, the concept may be still not well-established in the service computing community. This tutorial provides the fundamentals of service robots, covering their computational development, technical capabilities, and the roles of services, cloud, and edge computing in a cyber-physical space from a social-technical perspective. The tutorial will provide clear evidence that Web services play an ever-increasingly essential and critical role in supporting service robots, interdisciplinary research in business, information systems, and even social sciences. This tutorial will also further investigate new best practices and directions.

1.5 Short bios of the presenters including their expertise related to the tutorial

Patrick C. K. Hung is a Professor, Graduate Program Director of Computer Science Programs, and Director of International Programs at the Faculty of Business and Information Technology at the Ontario Tech University, Canada. He is currently working with Zayed University on social robots and related privacy issues. Patrick worked with Boeing Research and Technology at Seattle on aviation services-related research with two US patents on mobile network dynamic workflow systems. Before that, he was a Research Scientist with the Commonwealth Scientific and Industrial Research Organization in Australia. He is a founding member of the IEEE Technical Committee on Services Computing, the IEEE Services Congress, and IEEE Transactions on Services Computing. He published two peer-reviewed Springer books, *Mobile Services for Toy Computing* and *Computing in Smart Toys*. He is teaching a social robot course in Canada and Germany. He also chairs the Social Robots mini-track and Symposium in the Hawaii International Conference on System Sciences. He also edited several special journal issues related to social robots and HRI. He has a Ph.D. and Master in Computer Science from Hong Kong University of Science and Technology, a Master in Management Sciences from the University of Waterloo, Canada, and a Bachelor in Computer Science from the University of New South Wales, Australia.

Farkhund Iqbal holds the position of Associate Professor and Director of Advanced Cyber Forensics Research Laboratory in the College of Technological Innovation, Zayed University, United Arab Emirates. He uses machine learning and Big Data techniques for problem-solving in health care, cybersecurity, and cybercrime investigation in smart and safe city domains. He has published more than 80 papers in high-ranked journals and conferences. He has served as a chair and TPC member of several

IEEE/ACM conferences and reviews high-rank journals. He also chairs the Social Robots Symposium in the Hawaii International Conference on System Sciences.

Saiqa Aleem is an Assistant Professor at the College of Technological Innovation at Zayed University. She holds a Ph.D. in Electrical and Computer Engineering from the University of Western Ontario (Canada) and a master's degree in Computer Science & Master's in Information Technology. She had many years of academic and industrial experience holding various technical positions. She is Microsoft, CompTIA, and Cisco Certified Professional. Her current research interests include Service Engineering, Software Process Assessment, Software Product lines, IT governance, Data Analytics, and Cloud Computing. She has also authored peer-reviewed papers in these areas.

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