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Introduction

1.1 About this book

Since the 1950s, an everyday life with robots has always been about 10–20 years away. This is probably true at the moment in which you are reading this book. In the early 2020s, as we are writing, there’s a lot of talk about robots in the news, on the movie screen, and of course, in science-fiction literature. We now even see robots in our daily lives, on city streets and in classrooms, cafés and restaurants, and hotels. Have you ever interacted with a robot? A vacuum-cleaning robot? A robotic toy, pet, or companion? Chances are that if you haven’t, you will soon. Technology companies are eyeing the potential of personal robots, with start-ups as well as large multinationals readying themselves to create the kind of robot that everyone wants to own. But you may still not get a chance to be served breakfast in bed by your trusty robotic butler anytime soon. One of the reasons for this is that designing robots to participate in dynamically unfolding interactions with diverse users over long periods of time has turned out to be more difficult than anyone initially thought. Robust human–robot interaction—HRI—is difficult to design and implement.

So where is the field of robotics headed? What will, and should, our future with robots look like? How will robots find a place in our lives? These are still very open questions. A range of unknown but exciting futures awaits, in all of which robots support us, collaborate with us, transport us, or entertain us. If you’ve opened this book, you must be interested in seeing how this future might unfold. Perhaps you even want to get involved in shaping our future interactions with robots.

To get you started on this path, first of all, it is all about you: What kind of educational background do you have? Did you become interested in robots through your interest in engineering, psychology, art, or design? Or did you pick up this book because it rekindled a childhood fascination with robots? HRI is an endeavor that brings together ideas from a wide range of disciplines. Engineering, computer science, robotics, psychology, linguistics, sociology, and design all have something to contribute to how we interact with robots. HRI lies at the confluence of these disciplines. As a computer scientist, it pays to know about social psychology; as a designer, there’s value in dipping your toes in sociology.

If you have an engineering background, do you think you can build a robot that interacts with people, working only with other engineers? We,

unfortunately, think that you will not be able to do so. To design robots that people want to interact with, you need a good understanding of human social interaction. To reach such understanding, you need insight from people trained in the social sciences and humanities.

Are you a designer? Do you think you can design a socially interactive robot without working with engineers and psychologists? People's expectations about robots and their roles in everyday life are not just high, but they also vary a lot from person to person. Some people may tell you they want robots that will cook for them; others wish for a robot to do their homework, then have an intellectual conversation about the latest *Star Wars* movie. The prowess of robots as assistants, however, is still rather limited. Moravec's paradox, decades after being first expressed, still holds: anything that seems hard to people is relatively easy for machines, and anything a young child can do is almost impossible for a machine. As a designer, you would therefore need a good understanding of technological capabilities and of human psychology and sociology to create a design that is viable and realistic.

And last but not least, those of you who have training in psychology and sociology, do you want to just wait around for such robots to appear in our society? Wouldn't it be too late to start studying these technologies after they appear in our environment? Don't you want to have an impact on what they look like and how they interact? One thing you can do is start talking to friendly engineers and computer scientists, or have lunch with a designer. They will give your social science ideas some grounding in what is technically possible and help you find the areas in which your knowledge can have the most impact.

Just like the six of us writing this book, you will all need to work together. To do so in an effective way, you will need to understand the perspectives of HRI practitioners from different disciplines and be aware of the different kinds of expertise needed for developing successful HRI projects. In this book, we want to provide you with a broad overview of HRI topics central to the field and get you started on thinking about how you can contribute to them. We would like you to join us in expanding the boundaries of what is known and possible. Technology has progressed to a degree to which it is possible to build and program your own robot at little cost. Robots will be part of our future, so seize your chance to shape it. Go read (this book!), create, test, and learn!

We assembled a team of leading experts from the wide spectrum of disciplines that contribute to HRI. All of our hearts beat for improving how humans and robots interact and for ensuring that robots are used in ways that benefit our societies and the lives of individuals who use and are affected by them.

1.2 Christoph Bartneck

Christoph Bartneck is an associate professor in the Department of Computer Science and Software Engineering at the University of Canterbury. He has



Figure 1.1 The authors of this book got together in Westport, New Zealand, in January 2018 to start the manuscript during a weeklong “Book Sprint.” Writing and editing continued throughout the following year and a half through remote collaboration—many long Skype calls and emails.

a background in industrial design and human–computer interaction, and his projects and studies have been published in leading journals, newspapers, and conferences. His interests lie in the fields of human–computer interaction, science and technology studies, and visual design. More specifically, he focuses on the effect of anthropomorphism on HRI. As a secondary research interest, he works on projects in the area of sports technology and the critical review of scientific processes and policies. In the field of design, Christoph investigates the history of product design, tessellations, and photography.

1.3 Tony Belpaeme

Tony Belpaeme is a professor at Ghent University, Belgium, and prior to that was a professor of robotics and cognitive systems at Plymouth University, United Kingdom. He received his PhD in artificial intelligence from the Vrije Universiteit Brussel (VUB). Starting from the premise that intelligence is rooted in social interaction, Tony and his research team try to further the artificial intelligence of social robots. This approach leads to a spectrum of results, from theoretical insights to practical applications. He is involved in large-scale projects studying how robots can be used to support children in education, and he studies how brief interactions with robots can become long-term interactions and how robots can be used in therapy.

1.4 Friederike Eyssel

Friederike Eyssel is a professor of applied social psychology and gender research at the Center for Cognitive Interaction Technology at Bielefeld

University, Germany. Friederike is interested in various research topics ranging from social robotics, social agents, and ambient intelligence to attitude change, prejudice reduction, and the sexual objectification of women. Crossing disciplines, Friederike has published vastly in the fields of social psychology, HAI, and social robotics.

1.5 Takayuki Kanda

Takayuki Kanda is a professor in informatics at Kyoto University, Japan. He is also the visiting group leader at Advanced Telecommunications Research (ATR) Interaction Science Laboratories, Kyoto, Japan. He received his bachelor's degree in engineering, his master's degree in engineering, and his PhD in computer science from Kyoto University, Kyoto, Japan, in 1998, 2000, and 2003, respectively. He is one of the starting members of the Communication Robots project at the ATR in Kyoto. He has developed a communication robot, Robovie, and applied it in daily situations, such as peer tutoring at an elementary school and as a museum exhibit guide. His research interests include HAI, interactive humanoid robots, and field trials.

1.6 Merel Keijsers

Merel Keijsers is an assistant professor in psychology at John Cabot University in Rome, Italy. Her training is in social psychology and statistics, and she completed her PhD on the topic of robot bullying at the University of Canterbury, New Zealand. For her PhD, she studied what conscious and subconscious psychological processes drive people to abuse and bully robots; recently, she has gained an interest in how robots influence the way humans view themselves. More generally, having a background in social psychology, she is mainly interested in the similarities and differences in how people deal with robots versus other humans.

1.7 Selma Šabanović

Selma Šabanović is a professor of informatics and cognitive science at Indiana University, Bloomington, where she founded and directs the R-House Human-Robot Interaction Lab. Her research combines studies of the design, use, and consequences of socially interactive and assistive robots in different social and cultural contexts, including healthcare institutions, user homes, and various countries. She also engages in the critical study of the societal meaning and potential effects of developing and implementing robots in everyday contexts. She received her PhD in science and technology studies from Rensselaer Polytechnic Institute in 2007, with a dissertation on the cross-cultural study of social robotics in Japan and the United States. She served as the editor in chief of the journal *ACM Transactions on Human-Robot Interaction* from 2017 to 2023.

1.8 Notes on second edition

The field of HRI, like many fields relating to emerging technology, changes and develops as new technological capabilities become available for the design and implementation of robots and the study of people who interact with them. To ensure that this text maintains its relevance, we updated it in 2023 to cover new technical capabilities as well as new theoretical and methodological developments in the field. We also wanted to add more discussion of conversations about inclusion, societal relevance and impact, and ethical considerations regarding HRI to the original text. Finally, we recognized that our first edition focused largely on social robotics as the main domain of HRI, obscuring human–robot interactions in domains like factories, where people and robots collaborate to work on different tasks; disaster assistance, where people interact with mobile and flying robots to put out fires or save human lives; and even in autonomous driving, where interactions between people and robots may not be focusing on social engagement. In this edition of the book, we reframe our understanding of the social nature of HRI to include HRI and collaboration whose social nature is more broadly construed—in some sense, all robots operating alongside and with humans can be understood as social, and all human–robot interactions can be the purview of HRI research. In late 2022/early 2023, we worked both in person and remotely to update the text and teaching activities provided in the book. We hope you enjoy the new materials!