BOOK REVIEW

Human–Robot Interaction: An Introduction, Christoph Bartneck, Tony Belpaeme, Friederike Eyssel, Takayuki Kanda, Merel Keijsers, Selma Sabanovic (2020) 251pp., £44.50 paperback, Cambridge University Press, Cambridge, ISBN 9781108735407

Although the ideas that underpin *Human–Robot Interaction* (HRI) are not new, the concepts and organizing principles of this field have recently coalesced into a standalone, experimentally verifiable line of inquiry. The field of human–robot interaction is an amalgam of concepts and methods from psychology, cognitive science, artificial intelligence, engineering and even more remote fields, such as ethology. There are few interconnecting conceptual threads binding the different portions of the field, and even fewer threads that run through the field as a whole. So, encapsulating the ideas that comprise HRI with a single title is not easy. Nevertheless, Bartneck, Belpaeme, Eyssel, Kanda, Keijsers and Sabanovic's recently published work does an admirable job of serving up HRI in digestible pieces.

As the title states, the book is an introduction, designed for undergraduates. It contains none of the math that underpins artificial intelligence, computer vision and machine learning, some of the fields that support HRI. Rather, the book focuses on HRI's concepts and research methodology, areas useful for undergraduates considering graduate studies in HRI and for professionals already working in the area. The first three chapters introduce the reader to the authors, the field itself (including the history of HRI) and provide short summary of how robots operate. These chapters are filled with images and diagrams to help build common understanding with readers of what a robot is and how it works, and to help modify the notion of a robot inculcated upon most readers by science fiction. Each chapter begins with what might be described as learning objectives for the chapter and concludes with a series of questions for reflection and further reading.

Background material covered, the remainder of the book delves into what might be considered the core ingredients of HRI. Chapter 4 takes a lengthy look at the design of interactive robots, covering key aspects and key researchers in HRI design. Throughout this book, chapter topics often seem to take a detour, covering material which is not a natural fit for the chapter, but which might not be a natural fit elsewhere. For instance, the design chapter presents some of the theory underlying anthropomorphism and the 'uncanny valley'. Anthropomorphism is the natural tendency of human beings to perceive and reason about non-living things as if they were living (Heider and Simmel, 1944). The uncanny valley is the observation that, as the human likeness of an object increases, likability increases to a point, but then sharply decreases, before rising again (Mori, 1970). This sharp dip is the uncanny valley, where the human likeness of an object is enough to foster anthropmorphism but may also foster a sense of uneasiness. The inclusion of the psychological basis for anthropomorphism and the uncanny valley in the design chapter highlights one of the challenges of writing an introduction to HRI – the fact that some topics may not have a natural home.

We then pivot through a series of three chapters, briefly exploring different methods for interacting with a robot. In fewer than 15 pages, each chapter summarizes expansive fields of research, focusing on the facets that relate most to HRI. The spatial interaction chapter describes how a robot's proximity to a person can impact interaction. The non-verbal interaction chapter examines the use of gaze, gestures, touch and posture as methods for a robot to communicate with a person. The verbal interaction chapter, after succinctly introducing the components of human–human verbal interaction, very briefly outlines methods of speech recognition, dialogue management and speech production. Each of these chapters barely skims the surface of the topics it covers which

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would have benefited from a somewhat longer treatment, especially considering that verbal interaction, non-verbal interaction and spatial movements are not only the primary ways, but the only ways that robots communicate with people. These chapters also seem to favor one side of the human–robot interaction coin. Much greater emphasis is paid to how a robot communicates with a person (verbally, non-verbally and spatially) than to how a robot recognizes communication from a person. Practically speaking, HRI is a two-way street of communication: the robot must not only be capable of generating communicative actions that can be recognized and understood by a human, it must also recognize the communicative actions of a human being. The author's focus on robot-generated actions rather than robot recognition reflects both the author's natural inclinations and the inclinations of the field as a whole. HRI often focuses on creating interactive robots and assumes that other fields (computer vision, natural language understanding, etc.) will provide tools for recognition. The eighth chapter briefly surveys the use of emotion in HRI. It first provides a short background of the psychology underlying human emotion before concisely describing methods allowing a robot to recognize emotion and use emotion models to express emotions.

The ninth chapter explores the various research methods used by HRI and shared by psychology and other fields. Although probably unexciting for the casual reader, this chapter offers excellent, in-depth guidance for students interested in studying HRI in graduate school. The chapter also demonstrates some of the challenges of conducting HRI research, including the many different techniques (some borrowed from other fields, others developed within the field) employed by HRI researchers. The reader comes to recognize a bewildering array of different HRI study types and study characteristics. He might also come to recognize that there are few hard rules or agreed best practices relating to how human–robot interaction experiments are conducted. The field has grown organically with researchers often inventing their own methods for testing research questions. Many HRI experiments are one-off and little experimental replication occurs. Moreover, unlike fields such as machine learning, which have greatly benefited from comparing the results of different research methods, HRI rarely compares experimental results from one study with those from other studies. This is, in part, because the use of human subjects makes it difficult to repeat experiments and the results from these experiments are difficult to compare. The chapter concludes by noting that HRI struggles with the same experimentation issues that have long plagued the social sciences.

A wide variety of applications for interactive robots is described in the tenth chapter. The applications range from service to sex. In contrast to the prior chapter, this chapter is filled with images of robots and applications. Yet the chapter does a poor job of fully explaining some applications (i.e., security and sex robots) and misses some application areas entirely (e.g., surgery and military applications). The chapter concludes with a brief but important section describing potential problems resulting from the use of interactive social robots. Overall, readers may find this chapter too terse and lacking in detail, despite its broad coverage of HRI applications. The final chapter, 'Robots in society', is a rather uneven examination of robots in the popular media and in HRI ethics. Robots, especially interactive robots, may one day play a significant role in society beyond their portrayal in movies and books. Moreover, HRI ethics is itself a significant topic of discussion and inquiry.

Overall, this book serves as an excellent introduction for interested undergraduates and graduate students. The book is rather uneven in the sense that there is a focus on research methods and comparatively little consideration of HRI's grand challenges, most important roadblocks or how robots might affect society and its citizens. At times, the book's organization feels odd and disengaging, with 32 pages describing HRI research methodology situated in the middle of the book. The depth of treatment of this one chapter feels out of place. This variation in chapter treatment might simply reflect the state of the field – to date, researchers have developed more research methods than real-life applications. As a nascent field of study, the reader is reminded that human–robot interaction poses a number of important questions yet to be answered.

References

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