# Benefits of Human–Robot Interaction

By Pericle Salvini (p.salvini@sssup.it), Monica Nicolescu (monica@cse.unr.edu), and Hiroshi Ishiguro (ishiguro@sys.es.osaka-u.ac.jp)


Human–robot interaction (HRI) is an interdisciplinary research field aimed at improving the interaction between human beings and robots and to develop robots that are capable of functioning effectively in real-world domains, working and collaborating with humans in their daily activities. HRI has its roots in the more general field of human–machine interaction and the more specific field of human–computer interaction. However, its origin can be traced back to 1980s with the diffusion of service robots. Contrary to traditional applications of robots in industrial settings, where robots worked in isolation from human beings and only trained operators were allowed to interact with them, service robots are designed for applications in several nonindustrial settings, such as home, urban areas, and schools, and the interaction is with nonexpert users. In particular, HRI could benefit our society in multiple ways. Assistive and health-care robotics can improve the quality of life of the elderly or physically impaired people, as our aging population is growing and there is a limited human health-care workforce available. Robots can be used in search and rescue operations to spare the lives of rescue workers in the event of natural or man-made disasters. For applications such as service robotics, the use of robots in homes, offices, museums, schools, or stores can increase the efficiency of people's work, providing new services and improving the quality of life. Education would also benefit from HRI, as robotic teacher aides could assist students and provide an enhanced learning experience for the children, leading to better results later in life. As the challenges of HRI would be solved, the market for robotic entertainment will grow and benefit significantly.

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To succeed with the above applications, the purpose of research in HRI is to facilitate the communication, coexistence, and mutual adaptation between robots and users by providing robots with natural ways of interfacing with humans (e.g., via normal communicative channels used during interpersonal relations, such as speaking, hearing, and gesturing) and removing the barriers that may prevent robots' acceptance from users, such as appearance, behavior, usability, and so on.

## Major Challenges

Owing to the nature of the intrinsic problems posed by HRI, as indicated by the large span of application areas, solving the major challenges in the field requires concerted effort not only from experts in robotics but also from cognitive scientists, linguists, sociologists, psychologists, ethicists, lawyers, and artists.

Robots that can successfully operate alongside with humans should be endowed with multimodal perception, cognition, and interaction capabilities that enable them to fuse sensory perception from multiple sensors (such as vision, audition, touch, smell, and others), assimilate these multimodal data in real time, and then respond at the timescale of the interaction.

Learning and adaptation in a social context are also necessary for systems that share the same environment with people. Such learning methods need to take into consideration the human


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**Figure 1.** Geminoid F acting on stage by Hiroshi Ishiguro and Oriza Hirata.

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factor and enable robots to learn in a social context, either through tutelage, demonstration, observation, or as a lifelong learning experience. Robots would need to learn independent of the physical platform, in real-world domains, from a broad range of real users through natural communication mechanisms.

Scientific and technological challenges are still to be solved for obtaining robust, reliable, and safe interfaces, which will allow mutual communication and adaptation between human beings and robots in natural and smart ways. The design and evaluation of interfaces is also a challenge that needs to be addressed to determine the best designs that can assist the human operators using the robots. Such interfaces need to be intuitive and ergonomic, and exhibit safety and redundancy to cover the key modes of interaction with the robots. Research in this area would need to leverage our knowledge in human-to-human multimodal interfaces as well as an understanding of the human task with enough fidelity to identify potential areas in which a robot and a human can perform better than the human alone.

In addition to the above challenges, research in HRI needs to address issues related to reliable identification and tracking of human partners, human behavior modeling, robot awareness of the environment, HRI group dynamics and teamwork, the performance evaluation and benchmarking of interactive systems in user studies performed in real-world domains, and the societal, ethical, and legal implications of extensive and pervasive interactions with robots that show cognitive as well as emotion capabilities.

## Recent Developments

Numerous advances have been achieved in recent years on research topics that address the above challenges. Social intelligence and models of HRI have been successfully demonstrated in human robot teams. Assistive robots can now provide significant support to the elderly or physically impaired people. The use of nonverbal, multimodal, or haptic interfaces enables robots to interact more naturally with people around them. Sensing and perception have been significantly improved providing robots with better mechanisms for perceiving the world, thus increasing the range of applications where they can be used. The development of a wide range of affordable humanoid robotic platforms had a positive impact on research in motion and action planning, language, communication, and modeling of human behavior. As a result, HRI has developed into a strong field of research with impressive examples of robots working alongside with people in real-world domains (Figures 1–3).


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**Figure 2.** DustCart robot for rubbish collection.

## Recent and Upcoming Activities of the Technical Committee

The Technical Committee (TC) on HRI will organize workshops and special sessions related to the major challenges and research directions of HRI in relevant robotics conferences in the following years. A workshop is already proposed for IEEE International Conference on Robotics and Automation (ICRA 2012) and others are planned for IEEE International Conference on Intelligent Robots and Systems, IEEE International Symposium on Robot and Human Interactive Communication, International Robotics Science and Systems Conference, and Humanoids in 2012 and 2013. The committee will also report advances in the field of HRI in journal articles of *IEEE Transactions in Robotics* and *International Journal of Social Robotics*.

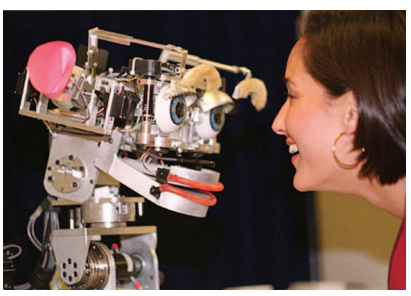
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**Figure 3.** Kismet by Cynthia Breazeal.

The TC on HRI is 12 years old. The next ICRA in St. Paul, Minnesota, United States, on 14–18 May 2012 will be the time for the TC triennial review. We propose that notwithstanding the many results achieved during the past years, the TC in HRI will continue to play an important role in coordinating activities related to HRI, consolidating HRI communities, and pushing research toward new and underexplored areas. We envision several possible directions for future research:

1) new research for developing smart and natural human–robot interfaces
2) increasing the interdisciplinary nature of research in HRI by enlarging the HRI community, especially by linking and coordinating activities with sister groups such as human–computer interaction or human–machine interaction
3) investigating further the social impact of HRI
4) promoting field tests on HRI
5) new knowledge on performance evaluation and benchmarking.

We invite all people with an interest in HRI to send us their ideas about future directions, activities, and proposals for renewing this TC. Please feel free to e-mail us at p.salvini@sssup.it, monica@cse.unr.edu, or ishiguro@sys.es.osaka-u.ac.jp.