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Synonyms

Interaction Studies, Human-Robot Communication

Definition

"Human-Robot Interaction (HRI) is a challenging research field at the intersection of psychology, cognitive science, the social sciences, artificial intelligence, computer science, robotics, engineering and human-computer interaction (Dautenhahn, 2007)." This broad field encompasses almost all situations where humans and robots are co-located and many methodologies and approaches are borrowed from other disciplines. The main goal of HRI is to endow robots with various competencies that will facilitate their interaction with humans. To drive the design of such skills, HRI studies humans in interaction with robots and attempts to make it more effective or *intuitive*.

The relevance of HRI has increased as robots themselves become more common. When they were rare, a lack of effective interactions could be compensated for by increased user training. However, as robots are encountered by more people during everyday life, it has become more important that untrained users be able to effectively interact with and use these robots.

As the focus in HRI is on the interaction of the human and the robot, work in HRI does not require a fully autonomous robot. Often, interactions are "mocked-up" by using a so-called 'Wizard of Oz' scenario, where a hidden researcher controls a robot to have a desired interaction with an unsuspecting human. Alternatively, experiments may involve prerecorded videos of humans and robots interacting that are shown to external observers. But, of course, if an actual autonomous robot exists, the direct interaction of it and lay users can be studied.

Theoretical Background

The motivation for the field comes from the belief that as robots become more capable, they will move out of the highly controlled and constrained environments in which we now find them such as factories or hospitals and into less ordered locations such as people's homes and busy streets. Further, as robots are encountered and used more often, the humans with which they interact will no longer be trained specifically in how to interact with the robot.

To bootstrap work on Human-Robot Interaction, HRI draws heavily on current knowledge of Human-Human (and to a lesser extent Human-Animal) Interaction from the fields of Psychology

and Cognitive Science. For instance, work on imitation learning in robots is informed by developmental psychology and uses concepts such as tutelage and scaffolding to help the robot learn more effectively from human guidance. Work on designing effective verbal communicative capabilities on the robot are inspired by psycho-linguistics and exploit verbal deixis and prosody in both robot's production and understanding of speech. Robot controllers are designed to reproduce humans ability to pick on social cues, such as following the other's gaze and interpreting facial expression of emotion (Breazeal, 2002). Analysis of experiments also follows protocols established in those fields, with interaction scenarios being evaluated via questionnaire or objective coding of specific occurrences (such as physical contact).

Important Scientific Research and Open Questions

Some robot competencies sought by the field of HRI are the ability to detect and recognize humans, to respond adequately to humans' actions or even emotions (conveyed perhaps by facial expression), and the ability to learn from interacting with a human. Individual studies of humans in interaction with robots may also aim at deciphering which social rules and social apriori the robot should be endowed with to facilitate the interaction, or even if it is necessary for the robot to be social at all (Kahn et al., 2007). Social apriori range from social cues, such as responding to pointing gestures or other verbal and non verbal deixis to keeping a socially acceptable distance between robot and human. A body of work is also devoted to understanding how the robot's appearance may affect the interaction. While some seek perfect mimicry of the human form in order to integrate the robot more fully into human society (Figure 1a), others consider alternate embodiments, in order to elicit different emotional and social responses (such as empathy or fear).

Along these lines, some work in HRI focuses directly on the effects robots can have on particular individuals (Fong et al., 2003). In particular, there is growing interest in using robots for therapeutic purposes, such as companions for the elderly (seen in Figure 1b) or for the diagnoses of Autism in children. However, because individual humans and their environments are changing and unpredictable, a different branch of HRI seeks to enable robots to learn from the humans around them. This work views humans as information sources, who can demonstrate to the robot how to perform novel actions, and even indicate when it is appropriate to do so. By allowing all users to adapt the robot's behavior, users can have truly personalized interactions, without the robot developers having to program every conceivable possibility.

There is also work in HRI that views the human and robot as a team, and asks what can they do together. An example domain is urban search and rescue, where robots are sent into territory unsafe for humans, allowing recovery operations to take place when they might otherwise not. HRI is here important in two manners, first to the remote operators (who want the robot to be predictable and easy to use) and secondly to the potential victims (who should not be scared by the robot).

Despite the wide array of work in HRI, there are some common concerns (Sharkey, 2008). One

(a) Geminoid

(b) Paro

Figure 1: Some aspects of work in Human-Robot Interaction. One the left, geminoid robots attempt to mimic humans exactly to allow for more natural interactions. On the right, therapeutic robots elicit emotional responses. Both are designed to interact socially with humans.

is human safety, which was addressed in industrial robotics by physically segregating the humans and the robots. However, in HRI that is not an option, and in addition to safe behavior, there is work in making the robots physically more safe, by perhaps being compliant or soft. Another concern has to do with ethics. Not just whether or not robots can be made to act ethically (even in war), but also if it is ethical to build robots that put people out of work, or that 'trick' humans into thinking robots are more or less capable than they are by eliciting certain psychological responses .

Because of the diversity of the background of HRI researchers, work in HRI is published in various scientific venues with differing foci. For instance, the Interaction Studies journal (John Benjamin Publ.), the International Journal of Social Robotics (Springer Publ.) and the IEEE Transactions in Mental Development publish work pertaining to HRI at large. The IEEE-ACM international conference on HRI covers primarily studies of human in interaction with robots, whereas the IEEE International Workshop on Robots and Human Interactive Communications, has a more technical/robotics perspective.

Cross-References

- Imitative Learning of Robots

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Glossary

deixis: something where the meaning has to be understood from context. Example: A pointing gesture changes meaning based on what is being pointed at.