Paper from Proceeding of the National Conference "Science in Media 2012" Organized by YMCA University of Science and Technology, Faridabad, Haryana (India) December 3rd -4th 2012 Published by IJMRS's International Journal of Engineering Sciences, ISSN (Online): 2277-9698
www.ijmrs.com

Human-Robot interaction - Emerging opportunities

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***Abstract*—Human-Computer Interaction (HCI), as a field, has made great strides toward understanding and improving our interactions with computer-based technologies. From the early explorations of direct interaction with computers, we have reached a point where usability, usefulness and an appreciation of social impact of technology, including its risks, are widely accepted goals in computing. Advances in computer technology, artificial intelligence, speech simulation and understanding, and remote controls have led to breakthroughs in robotic technology that offer significant implications for the human computer interaction community. Human Robot Interaction (HRI) which is defined as the study of humans and robots and the ways in which they influence each other, though is a sister discipline of HCI, is a distinctive case of HCI. A very important aspect in developing robots capable of human robot interaction is the research in natural, human-like communication, and subsequently, the development of a research platform with multiple HRI capabilities for evaluation. Design explorations and research in human robot interaction in the field of robotics existed since at least the mid 1990s. Today, many such developments are taking place in Europe and in Japan. Over the last few years, research on human-robot interaction has gained increasing attention and funding. With the help of the present review we would like to discuss the need and benefits of natural and intuitive Human Robot Communication.**

***Index Terms*—HCI, HCI**

I. INTRODUCTION

Human-robot interaction (HRI) is the interdisciplinary study of interaction dynamics between humans and robots. Researchers and practitioners specializing in HRI come from a variety of fields, including engineering (electrical, mechanical, industrial, and design), computer science (human-computer interaction, artificial intelligence, robotics, natural language understanding, and computer vision), social sciences (psychology, cognitive science, communications, anthropology, and human factors), and humanities (ethics and philosophy).

Robots are poised to fill a growing number of roles in today's society, from factory automation to service applications to medical care and entertainment. While robots were initially used in repetitive tasks where all human direction is given a priori, they are becoming involved in increasingly more complex and less structured tasks and activities, including interaction with people required to complete those tasks. This complexity has prompted the entirely new endeavour of Human-Robot Interaction (HRI), the study of how humans interact with robots, and how best to design and implement robot systems capable of accomplishing interactive tasks in human environments. The fundamental goal of HRI is to develop the principles and algorithms for robot systems that make them capable of direct, safe and effective interaction with humans.

II ORIGIN

Robots got their name in Capek's play R.U.R. (Rossum's Universal Robots, 1921) [1]. In R.U.R., robots were man-made beings created to work for people and, as in many fictional stories thereafter, they went on to rebel and destroy the human race. In the 1950s, Isaac Asimov coined the term "robotics" and first examined the fundamental concepts of HRI [2]. He proposed famous three laws of robotics:

1. A robot may not injure a human being or, through inaction, allow a human being to come to harm.
2. A robot must obey orders given it by human beings except where such orders would conflict with the First Law.
3. A robot must protect its own existence as long as such protection does not conflict with the First or Second Law.

The theoretical implications of how the three laws are designed to work has impacted the way that robot and agent systems operate today [3], even though the type of autonomous reasoning needed for implementing a system that obeys the three laws does not exist yet.

With the advances of artificial intelligence, the autonomous robots could eventually have more proactive behaviors, planning their motion in complex unknown environments. These new capabilities would have to keep safety as a primer issue and as second efficiency. Research ranges from how humans work with remote, tele-operated unmanned vehicles to peer-to-peer collaboration with anthropomorphic robots. Design explorations and research in human robot interaction in the field of robotics existed since at least the mid 1990s. Today, many such developments are taking place in Europe and in Japan. Over the last few years, research on human-robot interaction has gained increasing attention and funding.

2. DESIGN & HUMAN FACTORS

The design of the robot, particularly the human factor concerns, is a key aspect of HRI. Research in these areas draws from similar research in human-computer interaction (HCI) but features a number of significant differences related to the robot's physical real-world embodiment. The robot's physical embodiment, form and level of anthropomorphism and simplicity or complexity of design are some of the key research areas being explored.

2.1 EMBODIMENT

The most obvious and unique attribute of a robot is its physical embodiment. By studying the impact of physical embodiment on social interaction, HRI researchers hope to find measurable distinctions and trade-offs between robots and non-embodied systems (e.g., virtual companion agents, personal digital assistants, intelligent environments, etc.). Recent findings [4, 5] suggest that there are several key differences between a robot and virtual agent in the context of human-machine interaction. The three conditions explored in that work (a physical robot body, a physical robot located elsewhere through a video link, and a simulation of a robot) were an attempt to control variables in order to isolate the effects of embodiment from realism. The researchers surveyed the participants regarding various properties related to the interaction. The results showed that the embodied robot was viewed by participants as more watchful, helpful, and appealing than either the realistic or non-realistic simulation.

2.2 ANTHROPOMORPHISM

The availability and sophistication of humanoid robots has recently soared. The humanoid form allows for exploring the use of robots for a vast variety of general tasks in human environments. This propels forward the various questions involved in studying the role of anthropomorphism in HRI. Evidence from communications research shows that people anthropomorphize computers and other objects, and that anthropomorphism affects the nature of participant behavior during experiments [6]. HRI studies have verified that there are differences in interaction between anthropomorphic and non-anthropomorphic robots. Biomimetic, and more specifically, anthropomorphic form allows human-like gestures and direct imitation movements, while non-biomimetic form preserves the appeal of computers and mechanical objects.

Several examinations have been performed of the effects of anthropomorphic form on HRI [7]. These include studies of how people perceive humanoid robots compared to people and non-humanoid robots [8], possible benchmarks for evaluating the role of humanoid robots and their performance [9], and how the design of humanoid robots can be altered to affect user interacts with robots [10].

2.3 SIMPLICITY/COMPLEXITY OF ROBOT DESIGN

The simplicity/complexity of the robot's expressive behaviour is related to the biomimetic/anthropomorphic property. Researchers are working to identify the effect that simple/complex robot behaviour has on people interacting with robots. It has been observed that the more realistic or complex a robot was, the more watchful it seemed. However, it was also found that participants were less likely to share personal information with a realistic or complex robot.

2.4 OTHER ATTRIBUTES

As researchers work to better understand human-robot interaction, human factors insights from HCI can be valuable, but may not always be relevant. The users experienced a stronger sense of social presence from the agent when the voice type and personality matched, than when they did not. An HRI study showed that when a robot's expressive personality matched the user's personality, task performance was better than when the personalities were mismatched [11]. Ongoing research is also exploring how cultural norms and customs can affect the use of computer agent and robot systems.

3. ROBOT TEACH PROGRAMMING

Robot-Teach Programming is one of the most frequent human-robot interactions, thus an in-depth understanding of these methods is essential. The most important human elements in robot programming are safety, productivity and required human skills. Almost all modern robots are computer based systems, and as such, they always have human elements within their task performance cycles. A person may interact directly with the hardware and software, conducting a dialogue that drives the function of the system; in all cases people are responsible for the development, support and maintenance of the system.

There are two different classes of robot teaching: teach by "showing" teach by "telling". "Showing" includes methods that guide the robot step by step through the task. "Telling" exploits high-level language structures for efficient programming, providing the ability to deal with real-time decision making in response to sensor – based information. Of the two teaching methods, the use of high-level robot programming languages and covers a wider range of applications. Human factors are important since they influence the selection of the appropriate teaching method for a given robotics application.

Teaching a robot is in fact programming it to perform a specific task. A larger part of robot programming involves

defining a path for the robot to take. There are two main approaches considered in robot teaching – online programming and offline programming. When using online methods, the robot itself is used during programming. It provides direct interaction between human and robot and appears to be the most natural method of robot teaching. The off-line approach allows the user to program the task on a different computer system and download the task application program into the robot's control system.

Depending on the particular application of robot, different teaching methods may be used. The basic goal in modern robot design is to make the teaching process as user friendly as possible considering the safety issues.

4. EHICAL ISSUES FOR HRI

As HRI systems are being developed, their impact on users and society at large are increasingly being considered. Currently, it is difficult to compare robotic systems designed for different problem domains, yet it is important to do so in order to establish benchmarks for effective and ethical HRI design.

One of the most challenging aspects of establishing such benchmarks is that many aspects of HRI are difficult to measure. Establishing whether or not a robot can make eye contact with a person is comparatively simple (if not always easy to implement), but evaluating how the person reacts to and is affected by the robot's gaze and behaviour is much more difficult. Does the user get bored or frustrated? Does the user consider the robot helpful and effective? Is the robot perceived as competent? Is it trusted to perform its intended tasks? These and related questions lead to ethical considerations and legal guidelines that need to be addressed when developing HRI systems. Not only do roboticists need to act ethically, the robots themselves must do so as well.

Challenges to be considered include unintended uses of the robot, allowable tasks, and unintended situations that might be encountered. For example, if the user needs emergency attention, what is the robot's responsibility? Furthermore, the issue of control has important implications. While it is assumed the user is in control, in a variety of situations (dispensing medicine, dealing with cognitively incapacitated users) the control responsibility must rest with the machine. The issue of control and authority thus extends to all involved with the machine, including caretakers, and even designers and programmers. Well-studied ethical challenges are gradually making their way into HRI as the systems are growing in complexity and usefulness, and as their likelihood of entering human daily life increases.

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