Interdisciplinary Studies of Interaction Dynamics between Humans and Robots

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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 endeavor 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. Many facets of HRI research relate to and draw from insights and principles from psychology, communication, anthropology, philosophy, and ethics, making HRI an inherently interdisciplinary endeavor. Human–robot interaction has been a topic of both science fiction and academic speculation even before any robots existed. Because much of active HRI development depends on natural-language processing, many aspects of HRI are continuations of human communications, a field of research which is much older than robotics. The origin of HRI as a discrete problem was stated by 20th century author Isaac Asimov in 1941, in his novel I, Robot. He states the Three Laws of Robotics as:

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 the 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.

These three laws provide an overview of the goals engineers and researchers hold for safety in the HRI field, although the fields of robot ethics and machine ethics are more complex than these three principles. However, generally human–robot interaction prioritizes the safety of humans that interact with potentially dangerous robotics equipment. Solutions to this problem range from the philosophical approach of treating robots as ethical agents (individuals with moral agency), to the practical approach of creating safety zones. These safety zones use technologies such as LIDAR to detect human presence or physical barriers to protect humans by preventing any contact between machine and operator. Although initially robots in the human–robot interaction field required some human intervention to function, research has expanded this to the extent that fully autonomous systems are now far more common than in the early 2000s. Autonomous systems include from simultaneous localization and mapping systems which provide intelligent robot movement to natural-language processing and natural-language generation systems which allow for natural, human-esque interaction which meet well-defined psychological benchmarks. Anthropomorphic robots (machines which imitate human body structure) are better described by the biomimetics field, but overlap with HRI in many research applications. Examples of robots which demonstrate this trend include Willow Garage's PR2 robot, the NASA Robonaut, and Honda ASIMO. However, robots in the human–robot interaction field are not limited to human-like robots: Paro and Kismet are both robots designed to elicit emotional response from humans, and so fall into the category of human–robot interaction. Goals in HRI range from industrial manufacturing through Cobots, medical technology through rehabilitation, autism intervention, and elder care devices, entertainment, human augmentation, and human convenience. Future research therefore covers a wide range of fields, much of which focuses on assistive robotics, robot-assisted search-and-rescue, and space exploration.

FIGURE 1: A HUMANOID ROBOT HAS BEEN DEVELOPED FOR THE ADVANCEMENT OF THE INSTITUTE. THE ROBOT WILL TELL THE ASKED INFORMATION ABOUT THE INSTITUTE IN VOICE. THE ROBOT WILL BE SELF-DRIVEN; IT WILL FIND ITS PATH BY ITSELF.

THE GOAL OF FRIENDLY HUMAN–ROBOT INTERACTIONS: Robots are artificial agents with capacities of perception and action in the physical world often referred by researchers as workspace. Their use has been generalized in factories but nowadays they tend to be found in the most technologically advanced societies in such critical domains as search and rescue, military battle, mine and bomb detection, scientific exploration, law enforcement, entertainment and hospital care. These new domains of applications imply a closer interaction with the user. The concept of closeness is to be taken in its full meaning, robots and humans share the workspace but also share goals in terms of task achievement. This close interaction needs new theoretical models, on one hand for the robotics scientists who work to improve the robots utility and on the other hand to evaluate the risks and benefits of this new "friend" for our modern society. With the advance in AI, the research is focusing on one part towards the safest physical interaction but also on a socially correct interaction, dependent on cultural criteria. The goal is to build an intuitive, and easy communication with the robot through speech, gestures, and facial expressions. Kerstin Dautenhahn refers to friendly Human–robot interaction as "Robotiquette" defining it as the "social rules for robot behaviour (a 'robotiquette') that is comfortable and acceptable to humans". The robot has to adapt itself to our way of expressing desires and orders and not the contrary. But every day environments such as homes have much more complex social rules than those implied by factories or even military environments. Thus, the robot needs perceiving and understanding capacities to build dynamic models of its surroundings. It needs to categorize objects, recognize and locate humans and further recognize their emotions. The need for dynamic capacities pushes forward every sub-field of robotics. Furthermore, by understanding and perceiving social cues, robots can enable collaborative scenarios with humans. For example, with the rapid rise of personal fabrication machines such as desktop 3d printers, laser cutters, etc., entering our homes, scenarios may arise where robots can collaboratively share control, co-ordinate and achieve tasks together. Industrial robots have already been integrated into industrial assembly lines and are collaboratively working with humans. The social impact of such robots have been studied and has indicated that workers still treat robots and social entities, rely on social cues to understand and work together. On the other end of HRI research the cognitive modelling of the "relationship" between human and the robots benefits the psychologists and robotic researchers the user study are often of interests on both sides. This research endeavours part of human society. For effective human – humanoid robot interaction numerous communication skills and related features should be implemented in the design of such artificial agents / systems.

GENERAL HRI RESEARCH: HRI research spans a wide range of fields, some general to the nature of HRI.

1. METHODS FOR PERCEIVING HUMANS
2. METHODS FOR MOTION PLANNING
3. COGNITIVE MODELS AND THEORY OF MIND
4. METHODS FOR HUMAN–ROBOT COORDINATION

APPLICATION AREAS: The application areas of human–robot interaction include robotic technologies that are used by humans for industry, medicine, and companionship, among other purposes.

1. INDUSTRIAL ROBOTS
2. MEDICAL ROBOTS
3. SOCIAL ROBOTS
4. AUTOMATIC DRIVING
5. SEARCH AND RESCUE
6. SPACE EXPLORATION

TECHNOLOGY: The robotic technologies that are used by humans for industry, medicine, and companionship, among other purposes have been mentioned below.

1. **ARTIFICIAL INTELLIGENCE:** Artificial intelligence (AI) is intelligence demonstrated by machines, as opposed to the natural intelligence displayed by animals including humans. AI research has been defined as the field of study of intelligent agents, which refers to any system that perceives its environment and takes actions that maximize its chance of achieving its goals.

2. **DIALOG MANAGEMENT:** A dialog manager (DM) is a component of a dialog system (DS), responsible for the state and flow of the conversation.

3. **HUMAN–COMPUTER INTERACTION:** Human–computer interaction (HCI) is research in the design and the use of computer technology, which focuses on the interfaces between people (users)

and computers. HCI researchers observe the ways humans interact with computers and design technologies that allow humans to interact with computers in novel ways.

4. **NATURAL-LANGUAGE UNDERSTANDING:** Natural-language understanding (NLU) or natural-language interpretation (NLI) is a subtopic of natural-language processing in artificial intelligence that deals with machine reading comprehension. Natural-language understanding is considered an AI-hard problem.

5. **HUMAN SENSING:** Human sensing (also called human detection or human presence detection) encompasses a range of technologies for detecting the presence of a human body in an area of space, typically without the intentional participation of the detected person. Common applications include search and rescue, surveillance, and customer analytics (for example, people counters).

6. **CAPTCHA:** A CAPTCHA for "Completely Automated Public Turing test to tell Computers and Humans Apart" is a type of challenge–response test used in computing to determine whether the user is human.

7. **FACE DETECTION:** Face detection is a computer technology being used in a variety of applications that identifies human faces in digital images. Face detection also refers to the psychological process by which humans locate and attend to faces in a visual scene.

8. **INTERACTIVE SYSTEMS ENGINEERING:** Systems engineering is an interdisciplinary field of engineering and engineering management that focuses on how to design, integrate, and manage complex systems over their life cycles. At its core, systems engineering utilizes systems thinking principles to organize this body of knowledge. The individual outcome of such efforts, an engineered system, can be defined as a combination of components that work in synergy to collectively perform a useful function.

TYPES OF ROBOTS: There are various types of robots and have been discussed below.

1. **AUTONOMOUS ROBOTS:** An autonomous robot is a robot that acts without recourse to human control. The first autonomous robots environment was known as Elmer and Elsie, which were constructed in the late 1940s by W. Grey Walter. They were the first robots in history that were programmed to "think" the way biological brains do and meant to have free will. Elmer and Elsie were often labeled as tortoises because of how they were shaped and the manner in which they moved. They were capable of phototaxis which is the movement that occurs in response to light stimulus.

2. **GESTURE RECOGNITION:** Gesture recognition is a topic in computer science and language technology with the goal of interpreting human gestures via mathematical algorithms. It is a subdiscipline of computer vision. Gestures can originate from any bodily motion or state but commonly originate from the face or hand. Current focuses in the field include emotion recognition from face and hand gesture recognition. Users can use simple gestures to control or interact with devices without physically touching

them. Many approaches have been made using cameras and computer vision algorithms to interpret sign language. However, the identification and recognition of posture, gait, proxemics, and human behaviors is also the subject of gesture recognition techniques. Gesture recognition can be seen as a way for computers to begin to understand human body language, thus building a richer bridge between machines and humans than primitive text user interfaces or even GUIs (graphical user interfaces), which still limit the majority of input to keyboard and mouse and interact naturally without any mechanical devices.

3. **HUMAN–ROBOT COLLABORATION:** Human-Robot Collaboration is the study of collaborative processes in human and robot agents work together to achieve shared goals. Many new applications for robots require them to work alongside people as capable members of human-robot teams. These include robots for homes, hospitals, and offices, space exploration and manufacturing. Human-Robot Collaboration (HRC) is an interdisciplinary research area comprising classical robotics, human-computer interaction, artificial intelligence, process design, layout planning, ergonomics, cognitive sciences, and psychology.

4. **MOTION PLANNING:** Motion planning, also path planning (also known as the navigation problem or the piano mover's problem) is a computational problem to find a sequence of valid configurations that moves the object from the source to destination. The term is used in computational geometry, computer animation, robotics and computer games.

5. **ROBOT SIMULATIONS:** A robotics simulator is a simulator used to create application for a physical robot without depending on the actual machine, thus saving cost and time. In some case, these applications can be transferred onto the physical robot (or rebuilt) without modifications. The term robotics simulator can refer to several different robotics simulation applications. For example, in mobile robotics applications, behavior-based robotics simulators allow users to create simple worlds of rigid objects and light sources and to program robots to interact with these worlds. Behavior-based simulation allows for actions that are more biological in nature when compared to simulators that are more binary, or computational. In addition, behavior-based simulators may "learn" from mistakes and are capable of demonstrating the anthropomorphic quality of tenacity.

6. **SOCIAL ROBOT:** A social robot is an autonomous robot that interacts and communicates with humans or other autonomous physical agents by following social behaviors and rules attached to its role. Like other robots, a social robot is physically embodied (avatars or on-screen synthetic social characters are not embodied and thus distinct). Some synthetic social agents are designed with a screen to represent the head or 'face' to dynamically communicate with users. In these cases, the status as a social robot depends on the form of the 'body' of the social agent; if the body has and uses some physical motors and sensor abilities, then the system could be considered a robot.

7. **COBOTS:** A cobot, or collaborative robot, are a robot intended for direct human robot interaction within a shared space, or where humans and robots are in close proximity. Cobot applications contrast with traditional industrial robot applications in which robots are isolated from human contact. Cobot safety may rely on lightweight construction materials, rounded edges, and inherent limitation of speed and force, or on sensors and software that ensure safe behavior.

8. **HUMANOID ROBOTS:** A humanoid robot is a robot resembling the human body in shape. The design may be for functional purposes, such as interacting with human tools and environments, for experimental purposes, such as the study of bipedal locomotion, or for other purposes. In general, humanoid robots have a torso, a head, two arms, and two legs, though some humanoid robots may replicate only part of the body, for example, from the waist up. Some humanoid robots also have heads designed to replicate human facial features such as eyes and mouths. Androids are humanoid robots built to aesthetically resemble humans.

9. **MOBILE ROBOTS:** A mobile robot is a robot that is capable of moving in the surrounding (locomotion). Mobile robotics is usually considered to be a subfield of robotics and information engineering.

10. **PERSONAL ROBOT:** A personal robot is one whose human interface and design make it useful for individuals. This is by contrast to industrial robots which are generally configured and operated by robotics specialists. A personal robot is one that enables an individual to automate the repetitive or menial part of home or work life making them more productive.

11. **ROBOT TEAMS:** Swarm robotics is an approach to the coordination of multiple robots as a system which consists of large numbers of mostly simple physical robots. It is supposed that a desired collective behavior emerges from the interactions between the robots and interactions of robots with the environment. This approach emerged on the field of artificial swarm intelligence, as well as the biological studies of insects, ants and other fields in nature, where swarm behavior occurs.

CONCLUSION: This was enough detail about robot devices and systems. As the world is getting converted into technology oriented with robot other top most in demand. All engineers in many companies work day and night to make robots as fast as possible. High demand and high cost give rise to an economy very fast. So we should keep searching on robots and its other devices which can give us help in making the world full of Technology where manpower is less.

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