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Artificial Cognition for Social Human-Robot Interaction

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Abstract: *Human–Robot Interaction (HRI) has lately gotten a lot of press in the academic community, in labs, in IT firms, and in the media. It is desirable as a result of this focus. to deliver an HRI survey as a lesson to individuals outside of HRI throughout the field, and to encourage debate on a united vision of HRI. The playing field The purpose of this article is to offer a comprehensive overview of difficulties relating to HRI, to identify significant themes, and to explore the topic issues that are expected to reshape the sector in the not-too-distant future. Although The review is structured like a survey. Because the purpose is to give a cohesive "narrative" of HRI, several well-written, fascinating, and impactful studies will inevitably be left out. We recount the HRI tale from many viewpoints with the goal of discovering trends that span applications, rather than trying to survey every publication. The survey aims to include articles from a diverse range of institutions, government initiatives, corporate laboratories, and nations that contribute to HRI, as well as a diverse range of disciplines that contribute to the area, such as human factors, robotics, cognitive psychology, and design.*

Keywords: Human–Robot Interaction

I. INTRODUCTION

From factory automation to service applications to medical care and entertainment, robots are ready to perform a rising range of roles in today's society. While robots were first utilised in repetitive work where all human guidance is supplied a priori, they are rapidly being used in more complicated and less organised tasks and activities, which include interaction with people [1]. This intricacy has driven the creation of a brand-new field called Human-Robot Interaction (HRI), which studies how people interact with robots and how to best design and operate robot systems capable of doing so. [2]

1.1 Definition

Human-robot interaction (HRI) is the multidisciplinary study of human-robot interaction dynamics. HRI researchers and practitioners come from a wide range of backgrounds, including engineering (electrical, 1computer science (human-computer interface, artificial intelligence, robotics, etc.), mechanical, industrial, and design social sciences (psychology, cognitive science, communications, anthropology, and human factors), and humanities (natural language comprehension and computer vision) (ethics and philosophy).

II. HISTORY OF ROBOTICS AND HUMAN–MACHINE-INTERACTION

In this part, we take a quick look at the events and efforts that have paved the way for current HRI. Clearly, developing robots was the first and most important step. Although robot technology was predominantly created in the mid- and late-twentieth century, it is crucial to highlight that the technology has been around for a long time. The concept of robot-like behavior and its ramifications for humans have received a lot of attention recently.Religion, mythology, philosophy, and literature have all used it for millennia. The term "robot" comes from the Czechoslovak word "robota," which means "labor." The term "robot" appears to have been coined first. Though this is not the case in Karel Chapek's 1920 drama Rossum's Universal Robots, was far from the first example of a machine that resembled a person. Indeed,Around 1495, Leonardo da Vinci drew a mechanical man. In contemporary times, it has been assessed for viability.The first robots were remote-controlled machines with little or no autonomy (Figure 2.1). Nicola Tesla exhibited a radio-controlled watercraft in 1898, claiming it to be the first of its kind.``a borrowed intellect," says the author. Tesla, in reality, had remote control over the boat. His invention, which he applied to a wide range of vehicles, was "Method and Apparatus for Controlling" is detailed in patent 613,809, "Method and Apparatus for Controlling." "Moving Vessels Mechanism." "... you see there," Tesla speculated. Tesla's boat is seen in Fig. 2.1.208 Robotics and Human–Machine Interaction in the Early Years, the first of a new breed of robots, mechanical men who will carry out the grunt work. He even envisioned one or more operators simultaneously directing 50 or 100 vehicles.

III. HUMAN-ROBOT SOCIAL INTERACTION

According to researcher reports, MIT's Kismet is an expressive robot head with "social intelligence" (Breazeal, 2000; Adolphs, 2005). Kismet responds with appropriate motions based on computer analysis of another person's face and speech. It's debatable if this is actually social intelligence, but it certainly raises philosophical issues. Evidence shows that such gadgets can help young toddlers engage in "normal" social contact. However, one can ask whether such gadgets impede rather than stimulate healthy imagination (as seen by youngsters playing with inert dolls) (Turkle, 2011).Computer-based speech, voice recognition, and decision-making software are included in a number of toys and therapeutic animal or human figurines that are now on the market. For example, the Mattel Company has created a new Barbie doll with a large speech and language recognition
vocabulary that is connected to the company's server through the internet (Vlahos, 2015). The doll is made to have a long chat with young girls about topics that interest them. [1]

IV. MAJOR HRI INFLUENCES IN POPULAR CULTURE

Capek's play R.U.R. (Rossum's Universal Robots, 1921) gave robots their moniker. Robots were man-made entities developed to labor for humanity in R.U.R., and they went on to rebel and kill the human species, as they did in many fictitious novels afterward. Isaac Asimov created the word "robotics" in the 1950s and was the first to study the core principles of HRI, most notably in his novel I, Robot .HRI has been a focus of scholarly and popular culture attention in recent years. In truth, real-world robots have existed for a long time, long after plays, books, and films formed them as concepts and began to explore questions about how humans and robots may interact and what their roles in society might be. While not all of those well-known Isaac Asimov proposed the first HRI standards in his now-famous three laws of robotics: [2]

1. A robot may not damage a human being or enable a human being to come to danger as a result of its inactivity.
2. Except when such directions contradict with the First Law, a robot shall obey orders provided by humans.
3. A robot must defend its own life as long as it does not interfere with the First or Second Laws.

Data, a vital crew member on the television programme Star Trek: The Next Generation (1987-1994), is an artificial with superhuman intelligence but no emotions. Data's major ambition was to grow up and become more human.emotion. Data evolved into an actor, a poet, a friend, and frequently a hero, showing robots in a variety of potentially beneficial positions.

Figure 1: An example of an HRI testbed: a humanoid torso on a mobile platform, and a simulation of the same system

V. DESIGN AND HUMAN FACTORS

The robot's design, particularly human factor considerations, is an important feature of HRI. The study in these areas is based on comparable research in human-computer interaction (HCI), but there are a few key differences linked to the robot's physical embodiment in the actual world. Some of the primary study themes being examined include the robot's physical embodiment, shape and amount of anthropomorphism, and design simplicity or complexity. [3]

5.1 Embodiment

The physical manifestation of a robot is its most evident and distinguishing feature. HRI researchers want to uncover measurable differences and trade-offs between robots and non-embodied systems by examining the influence of physical embodiment on social interaction.

Anthropomorphism Humanoid robots have lately become more accessible and sophisticated. The humanoid shape allows researchers to investigate the usage of robots in human surroundings for a wide range of common functions. This advances the different concerns around the use of anthropomorphism in HRI research. People anthropomorphize computers and other objects, according to communications study, and this anthropomorphism impacts the nature of participant behaviour during tests.

5.2 Robot Design Simplicity/Complexity

The biomimetic/anthropomorphic feature is connected to the robot's expressive behavior's simplicity/complexity. Researchers are attempting to determine the impact of simple vs. complicated robot behavior on human-robot interactions. For example, I looked at the impact of life-like entities on task-oriented behavior. Powers and Kiesler investigated how two types of agent embodiment and realism affect HRI for medical question response. Wainer et al. [2] investigated the impact of realism on task performance using a similar experimental approach. The more lifelike or intricate a robot was in those experiments, the more wary it appeared. Participants, on the other hand, were shown to be less willing to exchange personal information with a realistic or complicated robot.

5.3 Developmental/Epigenetic Robotics

While developmental/epigenetic robotics is not a direct subset of HRI research, the two fields' aims are rather similar. Multi-modal perception and developmental strategies for information acquisition have a lot in common. Pronoun learning epigenetic research intersects with social robotics. Finally, strategies for automating skill teaching and learning have direct applications in the creation of algorithms for education robots . This research entails predicting behavior based on human activities. A number of approaches for robot training are being developed in the larger subject of robot learning, including human demonstration, reinforcement learning , and genetic programming, among others.

5.4 Training Robots

It may be tempting to limit training to the human aspect of HRI, but given current HRI research, this would be a mistake. Robots learn in HRI, both offline and online, as part of the design process and interaction, particularly long-term interaction . Perceptual capabilities can be improved by efficient communication between people and robots [3], reasoning and planning capabilities may be improved through interaction, and autonomous capabilities can be improved through interaction. Teaching or programming via example. task learning, and skill learning are all approaches to robot learning as well as locomotor abilities. Some academics are investigating biologically inspired learning models, such as how education among children might be improved.

A robot can be taught by humans or social animalsOthers are looking at how learning may be made more efficient.in a few words, uses information on how the human brain learns trials Surprisingly, providing assistance for efficient programming or knowledge management systems might be argued to be a significant part of robot training in HRI. It also has the potential to It may be argued that teaching a robot about culture and manners is a good idea. enables them to adapt to changing human behavior standards

VI. SOCIAL, SERVICE, AND ASSISTIVE ROBOTICS

Social interaction, laying the groundwork for the emerging discipline of socially assistive robots (SAR).SAR (socially assistive robotics) is a rapidly expanding field of study with potential applications in elder care, education, persons with social and cognitive problems, and rehabilitation, among other things. SAR is the junction between assistive robotics, which focuses on robots whose major objective is to help, and socially interactive robotics, which focuses on robots whose primary characteristic is to engage socially. SAR developed from a growing collection of problem domains that are ideal for robot aid but entail social rather than physical contact [4]. Non-contact assistive robots are currently being created and assessed in the field of rehabilitation robotics, which has traditionally focused on physically-assistive robots. In order to inspire and supervise the user during the rehabilitation therapy process, these robots combine the roles of coach, nurse, and companion. The robots give tailored encouragement and coaching based on the user's success. Applications have been investigated for postoperative heart surgery recovery and post-stroke rehabilitation. Other rehabilitation efforts have looked into utilising a robot to motivate rehabilitation through mutual storytelling. In these trials, a robot and a user create a tale that requires the user to undertake physical therapy exercises when it is performed.

VII. ROLE OF ROBOTS IN EDUCATION

Learning via books and recorded lectures is feasible, but it may be tough and tedious, and it won't help youngsters who don't read or people with cognitive problems. Interacting with a real human teacher or co-learner improves the learning process virtually every time. Since Papert's early experiments on children teaching a mechanical "turtle" cited above, robots have been a part of discussions about the future of education: to add fun, to serve as an avatar to be taught or to speak, to demonstrate a physical relationship (as in physics), or to react to student responses (with criticism or reinforcement). The idea of robots learning from other robots as well as humans is a hot topic at the workshop (see IEEE Robots and Automation Society, 2015). Understanding how people of various ages interact

VIII. LIFESTYLE, FEARS AND HUMAN VALUES

Naturally, there are trade-offs to consider: robots providing jobs versus eliminating jobs, robots as useful assistants enhancing human sense of self-worth versus diminishing human sense of self-worth, robots improving human security versus becoming spies (e.g., miniature UAVs), saboteurs, and killers. Human factors researchers, in my opinion, are more aware of the reality of living and working with robots than the general people. As a result, HF professionals have a responsibility to participate in conversations and policy development on these topics, including public education. [3]

IX. CHALLENGES

Creating a new course is difficult enough, but the field of HRI adds three further hurdles to the mix.First, HRI is interdisciplinary, including contributions from communications, computer science, engineering, psychology, and theater, posing issues in developing course content that sufficiently covers the area without having a significant number of prerequisites. Because the backdrop between the engineering sciences and the human sciences was considered to be extensive, balancing coverage breadth while limiting requirements was particularly difficult. As a result, the workshop participants rapidly limited their discussion to educating engineering students; even within that confinement, however, the disparities between specific engineering fields and computer science were substantial. [6] Second, the diversity of the HRI field also extends to resources, and as a result, there are no dedicated HRI resources, although possible materials can be extracted from mature fields Finally, there is a scarcity of low-cost, pedagogically acceptable robots and rich interfaces. Hands-on projects in HRI are extremely desirable, as stated below. Robots like Lego Mindstorms are affordable and do not require substantial programming knowledge, but they may not be capable enough to handle major HRI issues, according to the students. Humanoid robots come in a variety of pricing ranges, however they frequently have considerable limits when it comes to HRI in general.

X. COGNITIVE SKILLS

The integration model of our architecture, as well as the corresponding knowledge model, were discussed in the preceding section. In this part, we'll go through each of the sections that make up the whole. Figure 2 depicts them, as well as their relationships to the other components. We refer to cognitive skills as deliberative behaviors that are: 1

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stateful, i.e. keeping track of previous states is typically required for the component to perform appropriately; 2 amodal, i.e. the skill is not inherently bound to a specific perception or actuation modality; 3 manipulate explicit semantics, typically through symbolic reasoning; 4 operate at the human-level, i.e. are eligible to humans, typically by acting at similar levels of abstraction.

10.1. Internal Cognitive Skills

Those cognitive capabilities that are strongly tied to the knowledge model and so implemented directly within the Oro server are referred to as internal. We present three of these here: reasoning, theory of mind modeling, and our (naive) memory management strategy.

10.2 Working Memory

Memory has been extensively studied in the fields of cognitive psychology and neuropsychology: Atkinson and Shiffrin proposed the concept of short-term and long-term memory; Anderson Proposes the division of memory into declarative (explicit) and procedural (implicit) memories; and Tulving [4] organizes the concepts of procedural, semantic, and episodic memories into a hierarchy.

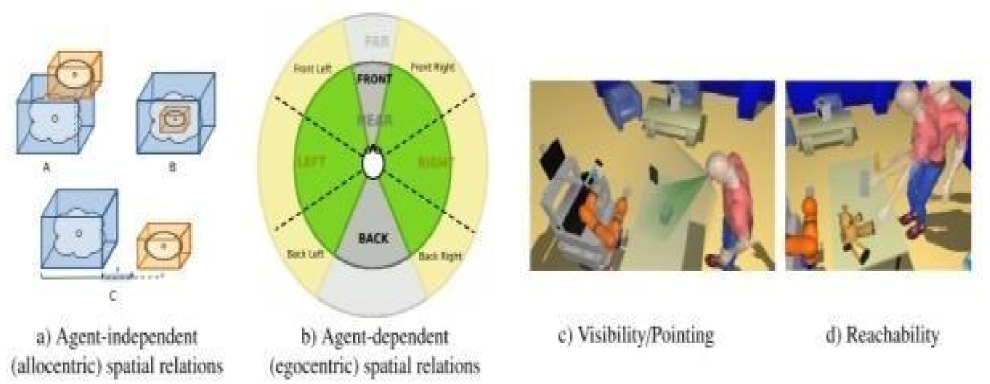

Fig. 5. Functional overview of the geometric situation assessment module SPARK. SPARK computes symbolic relationships between objects and agents, and exports them to the knowledge base. (For interpretation of the references to colour in this figure legend, the reader is referred to the web version of this article.)

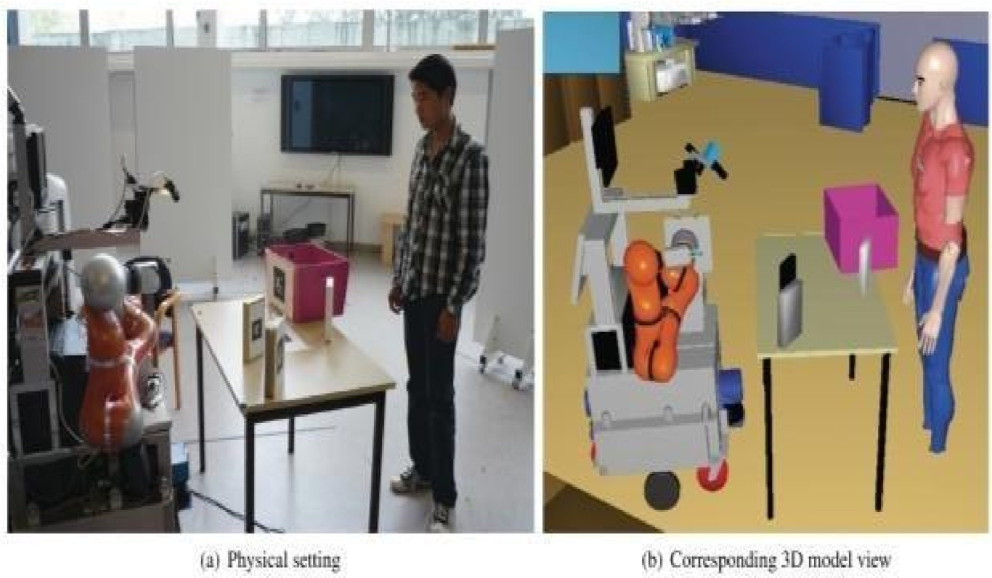

Fig. 6. Test setup involving videotapes boxes that are manipulated, with other objects acting as supports or containers. After identification and localisation of the set of objects (using fiducial markers) and acquisition of the position and posture of the human partner (using skeleton tracking), the robot is able to compute that two tapes only are reachable by itself: the black and grey (in the 3D model) tapes. The third tape and the container box are only reachable by the human. This physical situation is transformed by SPARK into the set of facts presented in Table 1.

Baddeley refines short-term memory by introducing the idea of working memory. The Soar architecture is one of the cognitive architectures that attempts to replicate a human-like memory organization. Long term/short term and episodic/semantic memories are also concepts in the GLAIR cognitive architecture. While memory is typically linked with the process of forgetting data after a certain length of time, it really encompasses a broader range of mechanisms important to robotics, such as priming (idea pre-activation induced by a specific environment and reinforcement learning). [7] The Oro server has a system for simulating only the most basic memory families. When new statements are added to the knowledge base, they are given a memory profile. Short-term, episodic, and long-term profiles are all available. For the assertions, they are currently tied to various lifetimes (respectively 10 seconds, 5 minutes and no time limit). The remarks are automatically deleted when this time period has passed. This method has certain limitations. The term "episodic memory" should be used to refer to episodic memory in particular.

XI. CONCLUSION

Human–robot interaction is a rapidly expanding area of study and application. There are many difficult challenges in this subject, and it has the capacity to solve them.to develop solutions that have a beneficial societal effect Its multidisciplinary nature necessitates that field researchers comprehend their work. within the framework of a larger context We attempted to offer a balanced picture in this poll. a cohesive approach to HRI-related issues, the identification of essential themes, and Except in particular situations, such as commercial aviation and military systems, where human factors specialists have long contributed, research and design in human-robot interaction requires far more engagement from the human factors community than has previously been the case. Current "self-driving" automobile and drone technology present significant problems in terms of safety and acceptance. Techniques that are likely to shape the field in the near future. A language problem involves teaching (instructing, programming) a robot. [5] The variety and developing elements of human-robot interaction discussed above imply that human factors engagement in symbolic education research and design has a lot of potential. With regard to Mental Models, i.e What operators are thinking, what they know, whether they misunderstand, etc. is critical as systems get more complex and the stakes get higher In this study, we offer an example of a comprehensive deliberative architecture for social robots. While most of its sub-components have been published separately, we give here for the first time a perspective on the model of integration of these components into a coherent and consistent system for social human–robot interaction. We've shared our underlying knowledge model, which is based on Description Logics, as well as some of the reasoning capabilities that result from it, such as disambiguation and mental modeling], which have been shown to effectively scaffold interaction using human-level semantics and cognitive skills. Then, based on an a modal scenario evaluation environment that enables viewpoint taking , we presented our method to symbol grounding.

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