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Designing Humanoid Robots with Novel Roles and Social Abilities

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Abstract

This mini-review describes aspects of human-robot interaction to be taken into account when designing humanoid robots with novel roles and social abilities. The review accentuates the psychological complexity that is necessary to be made inherent in the design of humanoid robotic technology. Some recent studies of robot acceptance are summarized leading to the proposal for more complex synthetic sensors being needed in novel humanoid robots.

The perspective is designing based on modeling attitude (the social level of human robot interaction), but not opinion (psychological level), which can be a valuable aim for humanoid robotics.

Keywords: Humanoid robots; Synthetic sensors; Uncanny valley; Psychology; Behavior; Attitude; Modeling

Introduction

The interest in humanoid robotics is constantly increasing and is motivating novel solutions for personal assistance, elderly care, child education or even for "designing robots for well-being" [1]. In building humanoid robots with novel roles in our society more social and psychological factors will be of major concern in addition to the safety and acceptability issues of having robots performing close to the human and engaging them in joint tasks [2-4]. The aim of the present mini-review is to outline some possible novel roles of humanoid robots accentuating on the psychological complexity that is necessary to be made inherent in the design of humanoid robotic technology.

An especially designed study has revealed that, unlike the common view "that robots should do dangerous, dirty or dull jobs; public opinion favors the view that robots should perform tasks requiring memorization, keen perceptual skills and service orientation. People are preferred for occupations that require artistry, evaluation, judgment and diplomacy" [5]. The factor levels of the study were: jobs "performed either by robots or people" vs. "performed by both robots and people" and what people think robots "could do" or "should do". The participants in the experiment, who were not expert with robots, filled in a web-based survey with questions like the following: "If, hypothetically, robots and people could be fire inspectors, who would you prefer?" with possible answers: "Robots either\or people" or Robots\both\people". The study demonstrated that people accepted with little surprise the possibility to be asked questions about the utility of having humans or robots performing as professionals. Therefore new roles for humanoid robots can be formulated, like being teachers, driving instructors, medical care advisors or counselors, even friends and fashion experts. In this future social medium, densely populated with humanoid robots with different professional roles, what type of human-robot sameness, closeness, or "bond" has to be established, is one of the crucial questions to be asked, as stated in [2].

Synthetic Sensor Design for Improved Human-Robot 'Mutual' Understanding

One aspect of the area of synthetic sensor design for humanoid robots will have to deal with much more complex sensations being function of integrative 'brain-like' analyzers, such as a "gaze sensor" as it is proposed in [6]. A gaze sensor is a complex algorithm, providing robots with understanding of the attention attracted to others or their communicative intentions similarly to the way people perceive them at some subtle level of awareness. The term 'affection' is becoming more and more characteristic of the process of natural and intuitive human-robot interaction, when the anthropomorphism is the underlying notion of this process according to [7], calling for the design of an 'affection sensor', i.e. for modeling of complex multidimensional aspects of the psychological side of the human-robot interaction process. Designing social sensors as integrative 'brain-like' analyzers is a next step in the development of humanoid robots with novel roles, which can be possibly comprised of infinite number of dimension combinations of features underlying the process of communicating with a humanoid robot. For example, methods for defining the characteristics of a human communicating with an intelligent computer interface, for adapting to personality dimensions like generosity, sociability and cautiousness/risk taking, i.e. in the design of the relevant synthetic sensors are described in [8]. Examples from experimental studies have provided evidence that the similarity of humans and robots is defined by people in terms of deep, essential, rather than shallow, characteristic features, according to the classical taxonomy formulated by Rosch to explain concept formation based on the 'family resemblance' principle [9]. Actually, people (not being experts with robot design) do not implicitly assume the android a robot – on the contrary – the mechanical outlook is usually combined with human-like intelligence or sensitivity - at the level of human intuitive assumptions. This is confirmed by a study on "reported characteristics for home computers, robots and human beings" [10]. In the condition Human-Computer, participants were asked to list features of humans and subsequently to indicate which features were shared with computers. The labels Human-Robot, Robot-Human, and Computer-Human denote the respective other conditions in the study. In the Human-Computer condition the proportion of shared features between a computer and a human is 0.06, in Human-Robot - 0.42, in Robot-Human - 0.31 and in Computer-Human - 0.11.

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Users tend to report more features shared between humans and robots than with other intelligent devices like computers, on the one hand. On the other – this is rather characteristic, than essential – i.e. below 50% of the reported features. Even more interesting is the result on attributing facial characteristics to robots, humans and computers. Given that only 8% of robot features are facial features, whereas the comparable percentage for human beings is about 30%, robots are "not stereotypically defined by their face" [10]. At the same time, face features are often reported in a form like: "Scary face", "Imitation of human face", "Pair of eyes" or "Rectangle mouth". Therefore, based on the deep, essential features shared between humans and robots, it is logical to assume that a humanoid robot has to be able to display empathy – as one of the deepest humane features guiding our social life [11], to keep memories of our autobiographical experiences [12] and be able to anticipate future events based on one-time experiences [13]. We can imagine iFoxy, a humanoid robot like the Fox in the book of Antoine de Saint Exupéry, saying to the Little Prince: "It is only with the heart that one can see rightly; what is essential is invisible to the eye" [14] in a therapeutic session to reduce the anxiety of a human patient.

Overcoming the 'Visceral Uneasiness' of Human-Robot Interaction

Recent studies reveal that people perceive simultaneously multiple aspects of the agency attributed to the robot like, for example, "visceral factors of interaction", "social mechanics" and "social structures" [15]. The authors relate the "visceral factors" to the 'uncanny valley' phenomenon, defined first by Mori [16] – whenever the surface, physical attributes of the robot exceed a certain degree of resemblance to the human – feelings of unpleasantness and fear emerge in people communicating with the robots. One of the hypotheses explaining it is that on a subtle discriminative, i.e. 'visceral', level, sensing of 'strangeness' of robot behavior emerges provoking negative reaction and thus presenting an obstacle to the flawless human-robot communication [16-18].

A novel hypothesis of the categorical nature of the 'uncanny valley' phenomenon has been recently proposed by Moore [19]. The advantage of his model is the mathematical description of the observed discrepancy between the subjective comfort of the interaction with the robot and the sudden repulsion by the realization that the creature we are communicating with is a non-human. His model represents 'the human' as a normal distribution of 'objects' possessing features, defining the human as a conceptual category. This distribution is characterized by its mean, standard deviation and mathematical function that is descriptive of the form of the distribution and delimits the category boundaries. Representatives of the category "human", sharing very typical or essential for the category features, in the abstract perceptual (i.e. internal) space are nearer the center of the distribution, whereas the representatives with less typical (i.e. surface or characteristic) features are at the distribution outskirts – i.e. near the category boundaries. Inside the distribution, the probability of occurrence of a 'target' category – a human with typical 'human' features is higher; therefore there is better 'predictability' (as subjective anticipation) to encounter a typical human 'target'.

This distribution is combined by Moore with the distribution of the category 'non-human', which has bigger variance, hence broader span below the distribution function. The mean of the second - "background" - distribution does not typically coincide with the mean of the 'target' distribution in terms of the amount of features, describing essentially a 'human' in a categorical sense. However, if these coinciding features make the distribution means close enough, at some moment the forms of the overlapping functions, denoting category boundaries, form a 'function' with two optimums in Mori's sense – one positive when a humanoid robot resembles a stuffed animal - and one negative – when the interaction with the robot generates the feeling of communicating with a zombie. This form of the function was plotted in 3D by Duffy with dimensions - acceptance, efficiency and emotion. Acceptance and efficiency are of positive sign, but emotion follows Mori's function separating two 3D 'hills' – of the so called "economic ideal" and the "ultimate ideal", the latter representing the "perfect artificial human" in Duffy's words [20].

The model of Moore plots 'affinity' in Mori's sense as familiarity plus 'perceptual tension'. The subtracting of the perceptual tension, playing the role of internal weighting factor, from the familiarity, will predict the observed phenomenon well. "If the weighting factor is small or zero, then the implication is that the observer does not notice (or does not care), if perceptual cues are in conflict. If the weighting factor is large, then it indicates a strong sensitivity to differential cues on the part of an observer. The weighting is thus a key property of an observer, not of a stimulus" [19]. The model of the 'visceral' uneasiness of the human-robot interaction process, proposed by Moore, aims at explaining a variety of psychological phenomena when perceiving conflicting cues in an observed scene can invoke repulsion, anger or aggression and as such has deep societal validity. As guiding principle for humanoid robot design for fulfilling novel professional roles, based on the current mini-review, the following conceptualization of the process of human-robot interaction is proposed: People perceive other people (or humanoid robots) simultaneously at three levels of abstraction - physical, social and psychological - and form anticipation of the actions of the others depending on the respective level. The physical level is the case of 'predicting behavior in response to behavior' – as physical objects clashing or avoiding each other. The social level is similar to the "social mechanics" proposal of [15] – when people play teams with people/robots and display attitudes of tolerance and affection towards people/robots. We call this case 'predicting behavior in response to attitude'. This social level of communication is when people perceive the attitudes of the agent – human or robot – positive, empathic, friendly, assistive, negative, rude, hostile - which current robotics is completely capable of reinstating and where most effort is to be devoted in humanoid robot design.

The psychological level of 'predicting behavior in response to opinion', in our view, is the "uncanny" case. Whenever people react as if they feel that the behavior of the robot is guided not just by attitude (social level), but by opinion (psychological level), by some kind of awareness like the one produced by a 'gaze sensor', we expect to observe the 'uncanny valley' phenomenon. Robots need synthetic sensors like the 'gaze sensor' but they need not reinstate situations where the human 'gaze sensor' is on. They can rather reinstate feelings of positive attitude, friendliness, trust and compassion. Special questionnaires, distinguishing feelings close to perception of attitude from perception of opinion in human-robot interaction need to be designed to explore the validity of this hypothesis.

Conclusion

Humanoid robotics is gradually taking novel roles and is performing tasks usually referred to by people as "professional". This will require the design of novel synthetic sensors, capable of capturing complex psychological phenomena in a human-like manner, as the present mini- review has revealed. We propose to keep in mind the tendency of people to animate creatures (cartoons, animation, fairy tales and fantasy) as part of their internal confidence with the external living and nonliving world. This confidence is the result of concentrating primarily on the social level of interaction with inanimate creatures. The perspective is designing based on the social level of human-robot interaction process or on modeling attitude - friendly, supportive and empathic - which can be a valuable aim for humanoid robotics.

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References

1. Cooney MD, Nishio S, Ishiguro H (2015) Designing robots for well-being: Theoretical background and visual scenes of affectionate play with a small humanoid robot. Lovotics 1: 1-9.
2. Pandey AK (2015) The Uncanny Valley and the Grand Challenges. Lovotics 1: 1-3.
3. Wada K, Shibata T, Sakamoto K, Tanie K (2006) Long-term interaction between seal robots and elderly people — Robot assisted activity at a health service facility for the aged. Proceedings of the 3rd International Symposium on Autonomous Minirobots for Research and Edutainment, Japan.
4. Dimitrova M, Lekova A (2013) Security analysis and user acceptance of socially competent robotic systems. International Journal on Information Technologies and Security 4: 37-46.
5. Takayama L, Ju W, Nass C (2008) Beyond dirty, dangerous and dull: What everyday people think robots should do. Proc. Human-Robot Interaction Conference HRI´2008 NL 25-32, Amsterdam, Netherland.
6. Jamisola RS (2015) Of Love and Affection and the Gaze Sensor. Lovotics 1: 10000e102.
7. Duffy BR (2003) Anthropomorphism and the social robot. Robotics and Autonomous Systems 42: 177-190.
8. Dimitrova M (2012) Socially-competent computing implementing social sensor design. International Journal of Web-Based Learning and Teaching Technologies (IJWLTT) 7: 61-70.
9. Rosch EH, Mervis CB (1975) Family resemblances: Studies in the internal structure of categories. Cognitive Psychology 7: 573-605.
10. Ramey CH (2006) An inventory of reported characteristics for home computers, robots, and human beings: Applications for android science and the uncanny valley. Proc ICCS/CogSci-2006 Long Symposium: Toward Social Mechanisms of Android Science Vancouver Canada 21-25.
11. Tapus A, Matarić MJ (2004) Emulating empathy in socially assistive robotics. Proceedings of the American Association of Artificial Intelligence (AAAI) Spring Symposium on - Multidisciplinary Collaboration for Socially Assistive Robotics Palo Alto USA.
12. Dimitrova M, Wagatsuma H (2011) Web agent design based on computational memory and brain research. N. Tang (Ed.) Information Extraction from the Internet iConcept Press Ltd. 35-56.
13. Wagatsuma H, Yamaguchi Y (2007) Neural dynamics of the cognitive map in the hippocampus. Cognitive Neurodynamics 1: 119-141.
14. http://www.goodreads.com/quotes/tag/the-little-prince (accessed January 2015).
15. Young JE, Sung JY, Voida A, Igarashi T, Christensen HI, et al. (2011) Evaluating human-robot interaction. Focusing on the holistic interaction experience. International Journal of Social Robotics 3: 53-67.
16. Mori M (1970) Bukimi no Tani Genshō. The Uncanny Valley (K. F. MacDorman and T. Minato, Trans.) Energy 7: 33-35.
17. MacDorman F (2006) Subjective ratings of robot video clips for human likeness, familiarity, and eeriness: An exploration of the uncanny valley. Proc. ICCS/CogSci Long Symposium: Toward Social Mechanisms of Android Science Vancouver Canada.
18. Walters ML, Syrdal DS, Dautenhahn K, Boekhorst R, Koay KL (2008) Avoiding the uncanny valley: robot appearance, personality and consistency of behavior in an attention-seeking home scenario for a robot companion. Autonomous Robots 24: 159-178.
19. Moore RK (2012) A Bayesian explanation of the 'Uncanny Valley' effect and related psychological phenomena. Sci Rep, Nature.com.
20. Duffy BR (2008) Fundamental issues in affective intelligent social machines. The Open Artificial Intelligence Journal 2: 21-34.