Intuitive Interfaces? Interface Design and its Impact on Human-Robot Interaction

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ABSTRACT
One goal of developing humanoid robots and virtual agents is to allow for intuitive and natural interaction with technical systems. However, up to now existing robotic systems do not live up to this promise. Based on an empirical approach that combines the analysis of the interface design of three different robot/agent systems with the micro-analysis of empirical encounters between humans and respective systems, we show that and how the systems provide contradictory 'affordances', which make it systematically difficult to start and continue satisfying interactions with them.

KEYWORDS
Human-Humanoid-Interaction, Interface Design, Conversation Analysis, Social Robots, Embodied Agents, Affordances

1 INTRODUCTION
One of the goals of developing technical systems with human-like appearance and interactive capabilities is to allow people to interact with machines in a natural manner. The simple idea behind this is that "building conversational machines is expected to help make communication between humans and machines more intuitive" [5]. The shift from human-computer interaction (HCI) to human-humanoid interaction [6] (HHI) thus reflects a paradigm shift in the development of technical interfaces. While traditional computers force their users to adapt to the constraints of the GUI and often are used for technical operations, humanoid technical systems are considered as systems that not only adapt to the users needs and interactive capabilities, but also act as interaction partners [2, 6]. However, in our contribution, we aim at investigating if and to what extent existing robot/agent systems really live up to this promise. Therefore, we explore the interface design of three different robot/agent systems as well as empirical encounters between humans and respective systems in order to answer the following research questions: (1) What are the interactional "affordances" [3, 4], i.e. possibilities and constraints for interaction, provided by the robots/agents? (2) How do humans relate to these possibilities and constraints in empirical human-machine encounters?

2 STUDY SETUP AND ANALYTIC METHODOLOGY
The three robot/agent systems under investigation already have left the laboratories of the information sciences and serve as interactive exhibits in the Heinz Nixdorf MuseumsForum in Paderborn, which is the world's largest computer museum. These systems are the humanoid robot 'Nadine', the embodied agent 'Max' and the social robot 'Pepper' (see figure 1). They all are part of the permanent exhibition and allow visitors to talk and interact with them. In our analysis we draw on the analytical concept of "affordances" as provided by conversation analyst Ian Hutchby [3, 4]. According to this understanding, affordances are not simply 'objective' properties of artefacts but emerge in the interplay between material properties of objects, conventionalized forms of their use and their actual use in concrete situations [1, 4]. Thus, we do not just consider with the interface design of the three robotic systems to explore their objective properties, but also investigate their affordances in terms of a relation between the possibilities for (inter-)action provided by these properties, existing social conventions of HHI and the ways in which human visitors of the museum 'actualize' or 'shift' these possibilities and conventions in situ. This allows for gaining insights into both the "[im-]possibilities for agentic action" [4] provided by the robots/agents on the one hand and the realization of these (im-)possibilities by actual users on the other hand.

In order to implement this approach empirically we both took photos of the robot/agent systems and their interface design and video-taped more than 200 encounters between the systems and visitors of the museum. By drawing on these data, we first examined the interface design on the basis of the photos, and then reconstructed on the basis of the video
recordings how this supports or restricts opportunities for beginning and continuing interaction.

3 RESULTS

Our results show that up to now existing humanoid robots and embodied agents do not allow for intuitive and natural interaction. Instead, encounters between humans and robotic systems often do not go satisfactorily and thus frequently lead to interaction breakdowns after a short time.

The first reason for this is that the interface design of the robots/agents calls up expectations regarding the operability of the systems that are not met by their factual mode of operation. For example, Nadine in her human-like form at a first glance appears present and intuitively addressable. On closer inspection however, it becomes clear that the interaction with her is mediated, since she does not perceive her environment directly, but via an external camera and a microphone. This systematically leads to confusion when visitors try to address her. In a similar manner, some visitors seem surprised when they realize that Max is talking to them, but is not able to listen. Instead visitors must write their messages on a keyboard to get access to him, which again creates confusion.

The second reason for unsatisfactory encounters is that the conversational skills of existing robots and agents still are not yet mature, while at the same time the humanoid appearance of the robots/agents raises expectations of human-like interaction capabilities. Consequently, expectations regarding the interactional capabilities of the robots/agents are systematically disappointed, which leads to breakdowns of interaction. Interestingly, the biggest problems seem to arise with Nadine, the most human-like and thus most ambitious system, while encounters with Pepper seem to be most satisfactory for museum visitors. We assume that this has to do with Pepper’s childish appearance and the fact that a screen on his body explicitly shows what people can say to the robot.

4 DISCUSSION

Our results show that and how the interaction design and the limited conversational skills of the robots/agents provide ‘contradictory affordances’ in a sense that the interface design first raises expectations regarding possibilities of intuitive and natural interaction, which can not be maintained in the course of encounters with museum visitors. This does not only make visible the current state of development of robotic systems. At the same time, hints for an optimization of the systems can be given. The results in particular make it clear that the shape of ‘social robots’ should not be too humanoid at this stage of development in order not to raise false expectations about the capabilities and characteristics of respective systems. At the same time, in our opinion, robotic systems should also make explicitly accountable how, for which purposes and about which topics one can interact with them. Probably, this would question the paradigm shift from HCI to HHI to a certain extent, but could help to improve the user experience in encounters with robots and agents.

5 FIGURES

![Figure 1: Embodied agent Max, humanoid robot Nadine and social robot Pepper](image)

6 ACKNOWLEDGMENTS

The authors would like to thank the Heinz Nixdorf MuseumsForum and especially Dr. Stefan Stein for their continuous support of the research project “Communication at the boundaries of the social world. Towards a theory of the personal addressability of new Interaction Technologies”. They also gratefully acknowledge financial support by the DFG.

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