Designing Robots with Personality

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Let's imagine a time when cleaning robots have become very popular, and every household has its own. Whether this cleaning robot is humorous, sociable, and sometimes makes cocky jokes, or is rather depressed and sarcastic and avoids actively seeking interaction with humans, has different implications for users. It would certainly affect users' mood and behavior in different ways, just like the different personalities of our human interaction partners affect us, each in a different but characteristic way. To foster responsible robot design, such effects on users need to be considered as part of the overall intended impression a robot should leave. This goal has been developed in many of the robotics projects with which we have cooperated during the last two years.

WHY SHOULD A ROBOT HAVE A PERSONALITY?

First of all, the question arises as to why a robot should have a particular type of personality, and what benefits this could provide. In current human-robot interaction (HRI) research, the definition and operationalization of personality in robots is the subject of much research and ongoing debate. On the one hand, many researchers argue that designing a robot with a personality, and thus mimicking qualities known from humans or animals, might not always be ideal. For example, Laschke et al. (2020) suggest that mimicking humans in robot design could reinforce inappropriate gender stereotypes (Brahnam & De Angeli, 2012), or affect children's behavior in as-yet unknown ways (Sciuto et al., 2018). Moreover, in the private home context companion technologies are typically involved in intimate situations, including interactions with household members. With regards to data protection and the desire for privacy, some users might prefer a technology with less social cues (see e.g. Ha et al., 2020), i.e., one that does not have a personality and does not resemble any human counterpart.

On the other hand, robots are increasingly being applied to address users' social needs. For example, within the domain of mental health or elderly care, social robots are often implemented to support users' wellbeing by enhancing social interaction. In these cases, it may be a reasonable or even necessary goal to design robots that mimic human qualities, e.g., with certain personality traits. This could come with the advantage of reinforcing intuitive interactions known from human-human interactions (see e.g. Laschke et al., 2020). Moreover, for innovative visions of robots as roommates, it can foster user acceptance to design robots that behave in a more unpredictable and independent manner rather than submissive robots that depend solely on their users' commands (c.f., Auger, 2014). As a result, robots are designed with certain personality traits.

WHAT TYPE OF PERSONALITY SHOULD A ROBOT HAVE, AND HOW CAN THIS BE IMPLEMENTED?

Having decided to equip a robot with a certain personality, the next question concerns what type of personality a robot should have, and how this can be expressed through design. Specifically, practitioners have to reflect on how the robot will interact with users.Should it be supportive and understanding, or demanding and rather strict? Often, practitioners also express the goal of developing an adaptive personality suitable for various users and situations. This goal was part of several of the robotics projects presented and discussed in this book. This in turn brings up the question of how the robot's personality should be designed depending on the user and specific interaction situation.

To date, universal approaches for implementing a desired robot personality do not exist. In general, previous research on social robot personality highlights challenges in the definition of robot personality rather than obvious solutions. For example, attempts to systematically conceptualize robot personality based on approaches from →personality psychology reveal many inconsistencies and barriers involved in transferring models of interpersonal interaction to the domain of robots (for a comprehensive overview, see Diefenbach et al., forthcoming). Moreover, after discussions and consideration of various design solutions within many of the projects we cooperated with, focusing on the overall human-robot relationship and the respective role of robots within specific contextualized interactions appears more practicable than focusing solely on the design and implementation of a robot's personality in isolation. In parallel to most of the abovementioned projects, social robots are often applied in the

Personality psychology is a central field in psychology. It involves research on the psychological concept of personality and how this varies among individuals (see e.g. Costa & McCrae, 2011).

context of healthcare or private homes. In different situations, such as interactions with various users such as patients and nursing staff, different robot behaviors or styles of communication were shown to be beneficial (c.f., Niess and Diefenbach, 2016). For example, while rehabilitation patients might benefit from a motivational robotic counterpart which is highly present and proposes many activities, nursing staff might need a more neutral counterpart or supportive assistant. Therefore, an isolated consideration of robot personality appears to be less expedient, as the robot typically acts in interaction with its user. Consequently, it seems more appropriate to focus comprehensively on the human-robot relationship and the specific roles of robots and humans in interactions.

Examples of different roles of robots and humans in interaction can be found in preliminary frameworks in the HRI literature. In their review of HRI frameworks, for example, Onnasch and Roesler (2020) have developed a new HRI taxonomy that considers the human, the robot, the interaction, and the HRI context. Within this framework, the authors also specify human roles that the robot can adapt in specific HRIs. These roles involve the supervisor, the operator, the collaborator, the cooperator, and the bystander.

Furthermore, specifically considering →companion technologies as a form of technological counterpart in business contexts, Niess et al. (2018) have identified two basic types of companions: active and passive. When reflecting on their personal experience of companion technologies, study participants typically characterized an active companion as innovative, dominant, proactive, and independent; some also reported a feeling of being under surveillance and limited in their autonomy. A passive companion was described as caring, empathetic, cautious, subdominant, and only acting on direct request (Niess et al., 2018). Furthermore, beyond the active-passive distinction, the authors also found a variety of possible roles and character traits associated with the image of a companion. According to their results, a (digital) companion can take the role of a friend, an advisor, a teacher, or a coach, while each of these roles was connected to different expectations, as well as requirements for interaction qualities towards the product. The authors give detailed examples for patterns of interaction qualities related to different companion roles resulting from the workshops conducted (c.f., Niess et al., 2018). For example, a participant seeking motivation to train in order to look good on a beach vacation deliberately decided in favor of a tough communication style of the digital companion in the used fitness app to achieve this goal as fast as possible.

Companion technologies can be described as interactive technological artefacts that evoke empathy (Niess & Woźniak, 2020).

Moreover, considering embedded technologies in the smart home context, Diefenbach et al. (2020) propose possible roles for what they call a “room intelligence” each displaying certain characteristics (see →Fig. 1). The authors propose an overarching interaction concept for a whole environment, which conveys the mental model of a central, omnipresent, and embodied room intelligence. Although such technologies are described as having “personalities” (c.f., Diefenbach, 2020), they are designed to adopt specific roles in interactions with users or their environment rather than to express an isolated, consistent personality based on dimensions from personality psychology.

Fig. 1 Possible personalities for a “room intelligence” (Diefenbach et al.,2020).

In general, it appears to be common and practicable in HCI and HRI research to consider specific roles for certain interactions between humans and technology. The frameworks and specific roles mentioned above can serve as a basis for the design of robots as social counterparts, as well as for choices regarding their roles within a specific HRI. In line with this, some of the projects presented in this book describe successful examples of robot design achieved through focusing on a specific role in HRI, e.g., a friend or a coach, depending on the specific interactions required within a given household.

HOW CAN A ROBOT PERSONALITY BE EVALUATED?

Finally, it is essential to evaluate how users perceive the robot. While the designer may have intended to apply a very supportive and service-oriented robot personality, users might perceive the personality to be, for example, ignorant and distant. This, in turn, could affect the user experience in an unintended way. Therefore, potential prototypes should be evaluated in terms of perceived robot personality, among other considerations.

In current research, assessment methods for personality perception are diverse, but are not necessarily appropriate for certain contexts or robots. Additionally, the selection of evaluated user perceptions does not follow a particular theoretical approach due to a lack of comparability (for a comprehensive overview, see Diefenbach et al., forthcoming). In this regard, in our latest research, we have

developed a tool, the so-called Robot Impression Inventory (RII). The inventory consists of a set of dimensions (e.g., appearance, movement, personality) of users' impressions of robots, each consisting of various facets (e.g., emotional stability, emotional vulnerability, openness of the personality dimension) (Ullrich et al., 2020).

The RII can be used as a source of design inspiration, for example, by exploring different facets of a dimension that could be addressed through design. The inventory could also be applied as a questionnaire and evaluation tool, for example, to test whether an intended robot personality is perceived accordingly by potential users. Furthermore, as the inventory involves different dimensions, empirical interrelations between dimensions could be explored. Results could, for example, indicate how visual design cues, primarily affecting the perceived appearance on the robot, could be interrelated with the perception of various personality facets. The RII was validated within a set of studies and applied in preliminary evaluation studies of the eight robotic projects discussed in this book.

WHAT REMAINS TO BE EXPLORED IN ROBOT PERSONALITY DESIGN?

Future research could aim at a more systematic categorization and definition of roles for robotic counterparts regarding various forms of human-robot relationships, e.g., companion robots and human-robot teaming, as well as automation. In addition, future studies could explore how the defined roles affect various user experience variables of interest, such as acceptance, trust, and overall evaluation of the robots, as initial studies have done for single role comparisons (see, e.g. De Graaf & Alouch, 2015; Griffiths et al., 2021; Groom et al., 2008). The robot's specific operational context should be considered, as this could have an impact on such evaluations, for example, users might have different expectations of a cleaning robot versus a robot coworker in the office. Based on such results, suggestions for appropriate robot roles within specific HRIs could be compiled, and design ideas to facilitate the incorporation of appropriate roles could be developed and evaluated.

More research is also needed on the interrelation between robot roles and user personalities, as well as how robots can adapt to users depending on their individual preferences and personalities — the idea of adaptable robot roles implies that a robot will act differently depending on context and their interaction counterpart. In many contexts where social robots are used, such as care homes or private households, this could imply that one user might observe the robot behaving in a completely different way while interacting with another user. This raises the question of whether and how this could affect robot authenticity and thus the overall user experience.

In summary, especially within the field of social robots, the idea of designing robots with personalities has gained increasing interest, and this can be beneficial when a robot's main purpose is social interaction with its users. The systematic conceptualization and implementation of a coherent robot personality relying on theoretical approaches from personality psychology appears rather challenging. Instead, our cooperation with robot designers in different contexts suggest focusing on robot roles in terms of specific interactions between humans and robots. The abovementioned frameworks offer preliminary ideas for orientation in this regard. Thus, tools such as the RII can support a systematic process of robot personality design through an assessment of users' impressions. Future work should address an overarching classification of robot roles, further considering specific tasks and interaction contexts. Such studies could then serve as a basis to advance research and development of appropriate robot roles for specific HRIs, and to develop concrete design solutions.

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