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Preface to the special issue on personalization and adaptation in human–robot interactive communication

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1 Introduction

The role of user-adaptive interfaces and interaction is widely recognized in the human–computer interaction (HCI) community to improve the acceptance and naturalness in comparison with non-adaptive ones (Martins et al. 2017). However, when dealing with robots, to make the interaction socially acceptable, legible, and natural from the user's point of view additional challenges arise due to the physical presence of the robot and the required multi-modal interaction and perception capabilities (Rossi et al. 2017). A lack of perceived adaptability and sociability are the two main reasons why people discontinue the use of a robot, even after initial adoption (de Graaf et al. 2017). Indeed, creating robotic systems capable of correctly acquiring, recognizing, and consequently, modeling human behavior is still a challenging task for robots (Lee et al. 2012). Moreover, the need to correctly infer and model the users' preferences, needs, and motivations (Churamani et al. 2017) become very critical, especially in the domain of socially assistive robotics and when working with vulnerable user populations (Cao et al. 2019). A robot should be able to cope with local uncertainties of the environment, variations of human desires and motivations, and volatilities of the interaction itself. In addition, the embodiment condition of a robot requires the ability to extract such

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relevant information from the interaction history but also from the indirect observation of the user (Rossi et al. 2020; Botta et al. 2022). Thus, a user modeling component should cope with these challenging and evolving requirements.

With respect to software agents and vocal assistants, a robot requires also to consider the physical characteristics of the interaction, such as the user preferences regarding the robot's physical movements in the space (e.g., proxemics, speed, and trajectories) (Syrdal et al. 2007). A personalized and adaptive interaction, different from pure reactive strategies, strongly relies on the learning of such computational models of human behavior and the integration of these into the decision-making algorithms of the robot (Martins et al. 2019). This includes also the possibility of endowing the robot with meta-cognition capabilities such as the capability of reasoning on the other individuals' intentions, desires, and beliefs, as well as their internal states, personality, and emotions (Gordon et al. 2016; Karpouzis et al. 2013; Leite et al. 2012). Finally, since human–robot interaction (HRI) may rely on a complex set of multi-modal interaction modalities (Caccavale et al. 2014), the ability of a robot to adapt its multi-modal behavior according to social expectations, specific cultural norms, and possible individual preferences, will determine the success and large-scale use of such robotics applications.

This special issue aims at examining and promoting recent developments in personalized and adaptive interactive communication in robotics, providing the UMUAI journal with a different perspective related to the specific characteristics of the interaction with a physical robot. The SI is composed of 11 articles addressing different challenges for user-adapted interaction in HRI.

2 Papers in this issue

Adaptation of the robot's physical behavior is addressed in the paper from Samarakoon et al.: "Adapting approaching proxemics of a service robot based on physical user behavior and user feedback". The manuscript proposes an approach that combines on-the-fly adaptation of the robot's proxemics, evaluated by considering the current physical user behavior, with personal factors that are learned by a fuzzy neural network via user feedback. The fuzzy neural network perceives user behavior through dynamic parameters of skeletal joints to determine the appropriate termination position of an approach. This determination can be adapted toward the preferences of a user by modifying the internal parameters of the neural network based on user feedback.

In the paper from García-Corretjer et al. "Empathy as an engaging strategy in social robotics: a pilot study", adaptation is achieved by means of empathy which plays a fundamental role in building relationships. Here empathy is not modeled through passive observation of a situation, but intended as the result of an active process where the actors actively collaborate to resolve a task by deciding together at each step while exchanging their points of view. In this study, quantitative way indicators of early empathy realization between a human and a robot are evaluated using expectations, trust, and affective attachment toward the robot.

Monitoring of the user's state and reactions is also addressed in the paper from Almousa et al. "Conceptualization and development of an autonomous and personalized early literacy content and robot tutor behavior for preschool children". The manuscript analyzes personalization in learning and in particular the development of an autonomous robot tutor with a personalization policy for preschool children. Personalization is performed by automatically adjusting the difficulty level of the lesson delivery and assessment, as well as adjusting the feedback based on the reaction of children. Results are evaluated in terms of the correctness of the answer, attention, and hesitation. The findings of the study reveal that the personalized interaction with the robot showed a positive potential in increasing the children's learning gains and attracting their engagement.

On the same line, the work of Umbrico et al. "A dichotomic approach to adaptive interaction for socially assistive robots" proposes a solution based on a user model grounded on the international classification of functioning, disability, and health (ICF) and a novel control architecture inspired by the dual-process theory. In this paper, the authors focus on a social robot in charge of the synthesis of personalized training sessions for the cognitive stimulation of older adults, customizing the adaptive verbal behavior according to the characteristics of the users and their dynamic reactions when interacting. Given a user profile and a set of inferred situation opportunities, a personalized assistive plan can be provided taking into account the set of stimuli that "best" address the impairments of a person, while a policy-based approach is used for managing the interaction.

How to include preferences in the decision-making system of the robot is also addressed in the contribution from Canal et al. "Generating predicate suggestions based on the space of plans: an example of planning with preferences". The paper deals with the role of user preferences in task planning for human–robot environments which are usually hard to obtain. To deal with this issue, the authors present a space-of-plan-based suggestion approach which provides suggestions for some planning predicates (e.g., the robot speed) to the users taking into account the configuration values that have already been set.

The paper from Maroto-Gómez et al. "An adaptive decision-making system supported on user preference predictions for human–robot interactive communication" also deals with the decision-making system of a social robot to produce a personalized interactive communication experience by considering the preferences of the user. The main contribution is the development of a preference learning framework, using the label ranking (LR) method, that allows a social robot to suggest their preferred activities to each user balancing activity exploration with the selection of the favorite entertaining activities.

Personalization and adaptation play a fundamental role when dealing with assistive applications. The paper from Di Napoli et al. "Personalized home-care support for the elderly: a field experience with a social robot at home" deals with personalization and adaptation for socially assistive robotics applications for people with mild cognitive impairments in home environments. Personalization is based on the user's characteristics such as clinical needs, personality, and cognitive profile, but also on environmental conditions, while an adaptation process takes into account dynamic changes. Functional and non-functional aspects of personalization are modeled through a service-oriented approach. Acceptability and reliability results of into-the-wild experimentations with seven patients are reported showing the feasibility and a positive evaluation for such robotic application in a not controlled domestic environment.

Short-term adaptivity and personalization of robot socially assistive behavior are explored also in the paper from Andriella et al. "Introducing CARESSER: A framework for in situ learning robot social assistance from expert knowledge and demonstrations". The manuscript introduces a framework for actively learning robotic assistive behavior by leveraging the therapist's expertise (knowledge-driven approach) and their demonstrations (data-driven approach) while providing cognitive exercises. To achieve that, a patient-specific simulator, which models the patient and the robot at a symbolic high level, was employed to generate data. The evaluation of the framework is conducted with two user studies in a daily care center in which older adults are affected by mild dementia and mild cognitive impairment.

The contribution of the paper from Irfan et al. "Personalized socially assistive robot for cardiac rehabilitation: Critical reflections on long-term interactions in the real world" is a better understanding of whether and to what extent personalization of a social robot in a robot-based rehabilitation program may considerably improve therapeutic efficacy over traditional programs and programs supported by a less sociable robot. This paper presents a complete real-world study that lasted 2.5 years, drawing upon results from 26 patients that completed the program focusing on the benefits and challenges of personalization in long-term interactions in the real world.

While most prior work on social robot exercise coaching systems has utilized generic, predefined feedback, the work of Hun Lee et al. "Design, development, and evaluation of an interactive personalized social robot to monitor and coach post-stroke rehabilitation exercises" aims at iteratively engaging therapists and post-stroke survivors to design, develop, and evaluate a social robot exercise coaching system for personalized rehabilitation. The paper presents a social robot exercise coaching system that integrates a neural network model with a rule-based model to automatically monitor and assess patients' rehabilitation exercises and can be tuned with individual patients' data to generate real-time, personalized corrective feedback for improvement.

Finally, the study presented in the paper from Jeong et al. "Deploying a robotic positive psychology coach to improve college students' psychological well-being" investigates the influence of a robot coach, which is meant to give interactive psychological therapies to students in on-campus dorms, on students' mental health. The one-week study with 35 students found that robot interventions significantly increase students' well-being, mood, and readiness to modify their behavior to improve their well-being after the study. The researchers also discovered a link between participants' personality qualities and the intervention's outcome, as well as their working alliance with the robot and overall satisfaction.

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