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Introduction to special section “Bridging from user needs to deployed applications of social robots”

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Social robots have matured enormously in the last two decades, reaching high levels of reliability, robustness, and safety in performing basic perception, navigation, and manipulation tasks. This evolution has enabled the deployment of different robotics platforms in many everyday applications, and in close proximity to humans (Rajan and Saffiotti 2017). In the future, social robots are very likely to be designed and commercialized primarily to help persons of all ages in everyday activities at home and in various environments of the social sphere (Fortunati 2017; Taipale and Fortunati 2018). The social robotics market is predicted to reach \$23.9 billion by 2022 (MarketsandMarkets 2017).

As social robots need to work closely with humans, they are expected to operate autonomously with human-like social abilities (i.e., to interact and communicate with humans and other autonomous physical agents by embodying human social behaviors and rules). In this context, social robotics, the branch of robotics that designs and develops abilities of robot to act and interact physically, emotionally, socially, and safely with humans, has focused on development of solutions and support for improving the quality of life of elders, impaired persons, and others by augmenting mobility, manipulation, and cognitive capabilities of the users (Cavallo et al. 2014). With the rapid progress in computational power of small form-factor hardware and in digital data availability through Internet technologies, AI (artificial intelligence)-based techniques are being increasingly incorporated in social robotics (Bonaccorsi et al. 2016). In fact, today, social robotics involves a combination of hardware, AI, sensors, and mobility.

Despite the progress in the field of social robotics, a number of issues remain to be discussed and addressed for a wide deployment of social robots in the real world, and for the creation of a real market. These issues are both technical and social. On the one hand, product-related issues such as reliability, availability, adaptability, safety, security,

and maintainability need to be addressed and appropriately evaluated for complex environments within which such robots will be operating. On the other hand, user-related and social issues such as acceptability and usability of social robots and the economic, ethical, legal, and social implications, as well as standardization need to be considered.

These developments have been accompanied by a heated debate in the social sciences level. In the last few years several special issues of journals have addressed such issues and offered a substantial body of theoretical and empirical work (Sugiyama and Vincent 2013; Esposito, Fortunati, and Lugano 2014; Pfadenhauer, Sugiyama, and Ess 2015; Fortunati, Esposito, and Lugano 2015; Böhlen and Karppi 2017). Moreover, a key book, *Robots from a human perspective*, edited by Vincent et al. 2015, has articulated and advanced the social science debate on social robotics. This debate continues to unfold in forthcoming special issues of journals, such as “Digital interlocutors: Theory and practice of interactions between human and machines” in *Computers in Human Behavior* (Spence 2018) and “The mutual shaping of human-robot interaction” (Ben Allouch, De Graaf, Šabanović, and Eyssel 2018) in the *International Journal of Social Robotics*. Other relevant publications include a book on socialbots authored by Gehl and Bakardjieva (2017) and a forthcoming book edited by Guzman (2018).

Three years after the publication of the special issue “Beyond industrial robotics: Social robots entering public and domestic spheres” (Fortunati, Esposito, and Lugano 2015), *The Information Society* comes back to social robotics with this special section. The three articles included in this special section look at the legal and ethical issues related to social robotics, the social robot as a cultural object, and the usability and user experience evaluation of a care robot.

The first article “Robot companions: A legal and ethical analysis” by Bertolini and Aiello (2018) addresses

some of the most pressing legal and ethical issues raised by the use of robot companions.

First, it says that robots are to be deemed objects and, more precisely, products. The legal approach presented here, on the one hand, refutes the legitimacy of the very notion that robots are bearers of their own rights and obligations, and, on the other, suggests a functional approach. Second, pursuant to these theoretical considerations, it addresses a range of issues, including potential dehumanization of care, privacy, liability, and purchase and lease agreements and attendant financing. Solutions are briefly sketched to provide the reader with pointers on which strategies could and should be implemented, what solutions are already in the design phase, and what kind of policy interventions national and European legislators should make. A recent document by the European Parliament “Report with recommendations to the Commission on Civil Law Rules on Robotics” of January 24, 2017 is specifically covered.

The second article “Social robots as cultural objects: Is there room for dynamicity?” by Fortunati, Sarrica, Ferrin, Brondi and Honsell (2018) explores the role of robots in contemporary culture, which has largely not been examined in the literature on social robotics (one exception is Barile and Sugiyama 2015). It invites the readers to look at the robot as a cultural object coconstructed by producers and users, often drawing on the cultural repertoire of myths and archetypes settled in the most archaic structures of humankind imagination and reworked over the years in popular literature, films, and media. Moreover, it adopts and tests the theory of the potency of cultural objects proposed by Schudson in 1989 to investigate, 30 years later, to what extent robots can be considered cultural objects today (Schudson 1989). It explores the way in which youths conceptualize social robots by means of free-form essays and projects of students at the University of Udine, Italy. Analysis of these essays and projects shows that for these students social robots embody all five dimensions that characterize cultural objects—retrievability, rhetorical force, resonance, institutional retention, and resolution. Further, it suggests the need for an additional dimension—dynamicity—to capture the peculiarity of robots as cultural objects.

The third article “Exploiting ability for human adaptation to facilitate improved human-robot interaction and acceptance” by Caleb-Solly, Dogramadzia, Huijnen, and van den Heuvel (2018) brings to us the world of empirical research on a specific robot. It presents findings from user-based evaluation studies of the Kompaï robot from Robosoft. It proposes a more pragmatic approach for studying user interactions with social robots in real-life like contexts, with their attendant complexities, when long-term trials are not possible. This is a

crucial issue in the field of social robotics research. While long-term trials are needed to better design and develop dependable and acceptable care robots, such trials are difficult because developmental prototypes lack robustness to operate in real-life like contexts. Their evaluation studies of user interactions with the Kompaï robot were conducted in a robotic-assisted living studio in the United Kingdom, a residential care home in the United Kingdom, and in an older couple’s own home in the Netherlands over 2 days.

These contributions show three different facets of the increasingly multidisciplinary research on social robotics (Cavallo et al. 2011), which involves researchers and scientists from different disciplines such as engineering, computer science, medicine, sociology, psychology, law, economists, and also professional caregivers.

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