CIFMA 2022

The relationship between Social Robotics and Sustainability: thinking about the future of human-robot interaction

Author: Antonio Fleres Ph.D. Student Visual and Media Studies – IULM University, Milano (Italy)
antoniopietrougo.fleres@studenti.iulm.it

Keywords: Sustainability – Social Robotics – Human Robot Interaction – Sustainable development

Extended Abstract:

1. Introduction: technology and the need for sustainable development

This paper aims to analyze the relationship between social/domestic robotics and sustainability. It wants to propose strategies useful to develop a more sustainable social robotics. Recently, the debate on the unsustainability of technological development has become increasingly relevant in academia. The emergence of climate change (Alley et al., 2007) has raised concerns about the current global climate situation. At the same time, a technological revolution has taken place in computing, robotics and automation, which has materialized respectively with technologies that have emerged in recent years such as: Machine learning and Deep Learning, Internet of Things, Industry 4.0, and social robotics (Kagermann et al., 2013). In addition, robotics is also beginning to spread widely in domestic environments, implying the initiation of massive use of these new devices, as in the case of the Roomba service robot (Elara et al., 2014). These transformations have a significant effect on today's society and the environment, calling for a reconsideration of our impact on the global ecosystem from ecological, social, and political perspectives.

2. Robotics: a possible solution?

In recent years, research in robotics has focused on finding applications that can be useful in increasing sustainability of robotics. Some studies show how robotics can be used to increase environmental (Talib et al., 2020) and social (Román-Graván et al., 2020) sustainability. Further studies searched to apply social robots in educational settings for the purpose of educating students about eco-sustainable behaviors (Giuliani et al., 2010; Gra et al., 2019). Alongside these applications, which are still at the prototype stage, the academic community proposes studies on the role of robotics in reference to sustainability.

A study from Bugmann and colleagues questions the role of robotics in sustainable development, showing how robotics can be a solution to current environmental problems (Bugmann et al., 2011). Their study illustrates how robotics impacts on the environment. For example, they make a comparison between the consumption of energy between industrial robots and households in Europe and in Asia, and how robotics promotes over-production and unemployment. On the other hand, their study shows how robotics can promote sustainability. Robots can be employed in several tasks such as improving the access to new resources (under the sea, mining in dangerous zones), helping in recycling resources, reducing waste during industrial production processes, repairing products which at the present time are thrown out. Other studies focus on the role of automation and robotics in reference to public-private partnership projects, proposing new models of collaboration among the agents involved (Hoeft et al., 2021). Although these studies are very proactive and try to align robotics with the new needs that have emerged from recent events, the current situation of social robotics in reference to the impacts on society and the environment appears neglected. In one of her studies, Damiano opens the philosophical question regarding domestic robots and the phenomenon of their "domestication". She underlines that the currently ethics reflection on robotics is skeptical about use of social robot, but instead it should orientate social robotics towards sustainability. Her paper emphasizes the need to develop an ethics that can promote the sustainability of these new uses of robotics (Damiano, 2021).

3. The role of social robotics in sustainability: a new area to investigate

There are currently some studies on specific applications of robotics such as automation in industrial settings and the use of AI. These studies show how these technologies negatively impact, both on the environment - generating pollution, waste material and accelerating resource depletion (Joshi, 2018) - and socially, because they have a disruptive effect on the labor market (Khakurel et al., 2018). In contrast, the current scientific literature has a dearth of studies on the future impact of domestic and social robotics from a sustainability perspective. Recent studies attempt to predict what will be the future effects of technology on the environment. A study by the International Institute of Sustainable Development made a prediction of what the environmental impacts will be of some of the emerging technologies that will be most prevalent in the next decade (Dusik & Sadler, 2019). The industrial automation is among the technologies considered for the study of Dusik and Sadler, but domestic and social robotics are not taken in account.

One of the possible reasons because the issue of sustainability of social robotics is not considered may lie in the fact that these robots have not currently reached such widespread use among the population to have a significant impact on the environment. Considering that the trend of sales of service robots is growing, and a substantial enlargement of the target market is expected (*Robotic Vacuum Cleaner Market Size, Share Report, 2020-2027*, n.d.), it is appropriate to consider assessing the unsustainability character of new generations of robotic devices that will operate in domestic and social settings.

On this basis, this paper aims to produce an overview of this branch of robotics in relation to the unsustainability of technological development. In this regard, it is deemed necessary to illustrate the pair of concepts of "unsustainability/sustainability". Nowadays sustainability is a well-known concept. The roots of those two concepts are grounded in the document known as “The Future of Man and Society” (Grober & Ray, 2012)and the manifesto called “Manifesto for a Sustainable society” (*Green History UK - Doc.Archive - Ecology Party Manifesto for a Sustainable Society*, 1975). Moreover, in order to better explain sustainability Moir and Mowrer illustrated this concept in comparison with the concept of “unsustainability”. (Moir & Mowrer, 1995). As Gonzales illustrate the concept is in continuous evolution and it involves more and more aspects such as ethical, environmental, political, social, economic, cultural (González et al., 2021).

Purvis, Mao, and Robinson define sustainability as a three-pillars concepts, which is based on three fundamental aspects. Those aspects are economic, social, and environmental ones. Furthermore, they define sustainability as a “ubiquitous” concept which is developed in the intersection between the areas of those aspects illustrated above

(Purvis et al., 2019). In addition, this study wants to depict the relationship between unsustainability and robotics. Given the multitude of applications of robotics nowadays, it is appropriate to consider the differences in the impacts that various types of robotics may entail, focusing more on the impacts of social and domestic robotics. This paper is not intended to be a map of all applications of robotics and its impacts on the environment, but to focus on those areas of social and domestic robotics and their relationship to the environment, which specific literature is just beginning to explore.

4. A comparison with technologies already in use

Since the diffusion of such devices has not yet occurred, what we can currently assess is what has happened with the mass diffusion of smartphones. A comparison with the ambient impact of smartphones could be a starting point to understand the potential consequences that could follow a mass diffusion of robotic devices in social environments. Based on the analysis of the negative impacts on the environment and society by robotics, and comparison with the effects of other new technologies in everyday use, this paper aims to initiate a reflection on these issues. Moreover, a reflection on this topic can lead to find innovative solutions or new strategies to increase the sustainability in social robotics. For instance, studies about sustainability and smartphones can help research in robotics to develop a more sustainable robot. It is the case of study of Fairphone, the first modular smartphone (Akemu et al., 2016; Wernink & Strahl, 2015). Modular smartphones allow consumers to replace singles parts of their smartphones to increase the lifespan of smartphones and reduce the waste of technological devices and thus being more sustainable. On the other hand, this study wants to open the path to new and innovative strategies to sustainable, such as using emerging technology like augmented reality visors in human-robot interaction. In the last decades research in social robotics has opened a new niche of research about Mixed Reality Agents (MiRA) (Dragone et al., 2007, 2009; Makhataeva & Varol, 2020; Williams et al., 2020). The body of these agents is based on Mixed Reality; some parts of the body are physical, and some are digital. This kind of application could be used to reduce the impact of physical bodies of robots in human-robot interaction on the environment.

5. Conclusion

Using the current unsustainability of technological development as a starting point, it is intended to propose critical reflections and useful strategies to increase the level of sustainability of these technologies. The understand of unsustainability of human-robot interaction is crucial to lead the design of future generation of social and domestic robotics to a lighter impact on the environment. Also based on the current literature (Damiano, 2021). This reflection can be a good starting point to direct research toward the development of new generations of social robotics that have sustainable impacts on both the environment and society.

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