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Dear Robot, What Do You Know About Me? Enhancing Transparency in Presence of Robots

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***Abstract*—Robots are increasingly used in more and more application areas, ranging from industry to everyday life. Independently of the deployment context, robots collect sensor data about the users, when interacting with them. The collected data can include users' location, appearance, and voice. Nevertheless, users interacting with them are not always well informed about which data are recorded. Providing such information is, however, necessary. Any recorded data must be presented to the users "using clear and plain language", according to the *General Data Protection Regulation* (GDPR). Our goal is therefore to develop user interfaces, with which users will be efficiently informed about data recorded by the sensors embedded in the robot. In addition to increase the compliance with the GDPR requirements, these interfaces will empower users to make informed decisions when interacting with a robot.**

***Index Terms*—transparency, human-robot interaction, privacy, user study**

Fig. 1. Robots with different appearances and sensors. From left to right: CruzR [6], Car-O-Bot 4 [7], James [8], and Pepper [9].

I. Introduction

Digitalization is growing and more connected and sensor-based devices are coming onto the market to improve everyday life. Among these devices, robots are increasingly introduced in the industry for manufacturing, the healthcare sector to assist doctors, supermarkets for self-pay cash registers [1], and private environments as robotics mowers, vacuum cleaners, or connected to a smart home system [2]. To fulfill such tasks, robots are equipped with sensors, e.g. cameras or microphones, which record different data types. Among these sensors, some are often not identifiable by users. For example, each robot displayed in Fig. 1 is equipped with LiDAR sensors, which help the robot to orient in a room. By recording these data, insights about the users can be captured that may endanger their privacy. For example, cameras can capture medication plans, private conversations can be recorded by microphones, or LiDAR sensors can recognize the shape of a person. Users must be informed about which kind of data is recorded by robots according to the GDPR [3], so that they can make informed decisions when interacting with robots. However, there are currently no solutions designed for robots that address this requirement. While existing works describe the general importance of making such data transparent [4], [5], they do not offer a concrete solution.

We hence propose different contributions detailed in Sec. II to address the existing gap in the state-of-the-art. During the process, we will apply the methodology described in Sec. III, to ensure the quality of our contributions. We finally make concluding remarks in Sec. IV.

II. Planned Contributions

Our contributions are articulated around the following key question: How to efficiently inform users which data are recorded when interacting with robots? To answer it, the following two research questions should be considered and answered.

RQ1: Which privacy concerns do users have when interacting with a robot, and how can these concerns be influenced?
By answering this question, we will understand how privacy concerns influence human-robot interactions. The achieved knowledge will be used to enhance this relationship and help developing a user interface. Initial studies explored privacy concerns in the context of a human-robot interaction [10],

[11] but did not use real robots to explore privacy concerns. Instead, they used theoretical scenarios that included a robot. Therefore, it is important to explore privacy concerns of users who interact with real robots, to achieve more reliable results. One challenge is that the privacy concerns for each person may differ. For example, gender, age, and experience with robots may influence the human-robot relationship. Additionally, the kind of robot, the embedded sensors, and the context of the interaction may play an important role. For example, privacy concerns may be lower if users interact with a robot in shopping centers than if the interaction takes place in a private living room.

RQ2: Which kind of user interface is the most appropriate to make collected data transparent to users interacting with robots?

For users to understand which data are collected, we require a user interface that efficiently represents this information. The problem with creating this user interface is that robots have different appearances and sensors, as shown in Fig. 1. Therefore, the user interface needs to be customizable for different robots, based on the recorded data and induced privacy concerns.

III. Methodology

As a first step to answering *RQ1*, we will conduct a user study with the different robots shown in Fig. 1 to examine the influence of the robot's shape on the users' privacy concerns. We will conduct a field study, during which users will have a real interaction with a robot. By doing so, users may show more reliable concerns, that take into account the deployment context better than in lab studies. We will conduct follow-up studies to explore the influence of other variables on the perceived privacy concerns. For each planned study, we will select a combination of participants, robots, and human-robot interaction, in order to achieve a realistic scenario. This will allow us to obtain insights on factors that may impact users' concerns, as well as which collected data should be made transparent to the users.

After these studies will be conducted, we will analyse the users' feedback and implement user interfaces for comparison. These user interfaces will make the recorded data from a robot transparent to a user and easy to understand. Based on the results obtained in *RQ1*, we will prioritize the information related to the most severe concerns expressed by the participants. Additionally, the user interfaces will be developed with the possibility to customize them based on the used robot. This will allow us to create user interfaces that can be used to inform users about recorded data from any kind of robot. A first draft of a possible user interface is shown in Fig. 2.

To evaluate whether the created user interfaces are sufficient to inform a user about the recorded data, as well as to answer *RQ2*, several user studies will be conducted. Thereby, the studies have the same setting as the studies for *RQ1*. This will allow comparing if a user interface helps to make the human-robot interaction more transparent.

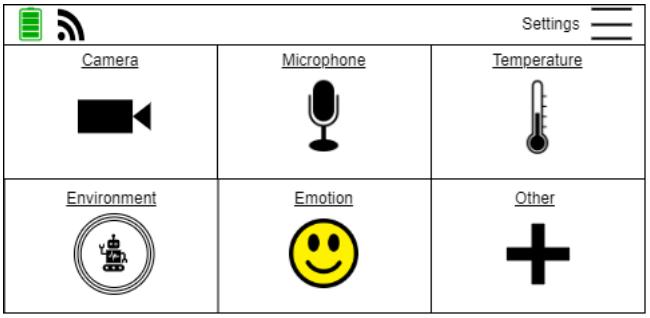

Fig. 2. First draft of a user interface, to inform users about recorded data by a robot. Each box can be customized based on the recorded data by the robot and the user's privacy concerns.

IV. Conclusion

Users are not always well informed about which kind of data is recorded when interacting with a robot. Such information is however necessary for users to make informed decisions. Until now, not much research in this area exists. Therefore, it is important to get insights into how users can be efficiently informed about these data. To get these insights, we will conduct several studies to better understand which privacy concerns users have in presence of robots. Next, we will design and implement user interfaces, to highlight recorded data with a focus on privacy-sensitive data. Finally, the user interfaces will be evaluated to assess if users are sufficiently informed. Consequently, the gained knowledge and proposed solution will not only be specific to one robot but cater for their diversity.

References

[1] R. Goel and P. Gupta, "Robotics and industry 4.0," in *A Roadmap to Industry 4.0: Smart Production, Sharp Business and Sustainable Development*, 2020.

[2] G. Wilson, C. Pereyda, N. Raghunath, G. de la Cruz, S. Goel, S. Nesaei, B. Minor, M. Schmitter-Edgecombe, M. E. Taylor, and D. J. Cook, "Robot-enabled support of daily activities in smart home environments," *Cognitive Systems Research*, 2019.

[3] "General data protection regulation (gdpr)," https://gdpr.eu/article-12-how-controllers-should-provide-personal-data-to-the-subject/, accessed: 2023-11.

[4] A. Chatzimichali, R. Harrison, and D. Chrysostomou, "Toward privacy-sensitive human–robot interaction: Privacy terms and human–data interaction in the personal robot era," *Paladyn, Journal of Behavioral Robotics*, 2020.

[5] M. Rueben, A. M. Aroyo, C. Lutz, J. Schmölz, P. Van Cleynenbreugel, A. Corti, S. Agrawal, and W. D. Smart, "Themes and research directions in privacy-sensitive robotics," in *IEEE Workshop on Advanced Robotics and Its Social Impacts (ARSO)*, 2018.

[6] "Cruzr," Online: https://zorabots.be/robots/cruzr, accessed: 2023-11.

[7] "Care-O-bot 4," Online: https://www.care-o-bot.de/de/care-o-bot-4.html, accessed: 2023-11.

[8] "James," Online: https://zorabots.be/robots/james, accessed: 2023-11.

[9] "Pepper," Online: https://www.aldebaran.com/de/pepper, accessed: 2023-11.

[10] M. Krupp, M. Rueben, C. Grimm, and W. Smart, "A focus group study of privacy concerns about telepresence robots," in *26th IEEE International Symposium on Robot and Human Interactive Communication (RO-MAN)*, 2017.

[11] P. Boissy, H. Corriveau, F. Michaud, D. Labonté, and M.-P. Royer, "A qualitative study of in-home robotic telepresence for home care of community-living elderly subjects," *Journal of Telemedicine and Telecare*, 2007.