ICRES 2018: International Conference on Robot
Ethics and Standards, New York, USA, 20-21 August 2018.
https://doi.org/10.13180/icres.2018.20-21.08.016

ROBOT COMPANIONS FOR OLDER PEOPLE – ETHICAL CONCERNS

JIM TORRESEN, TRENTON SCHULZ, ZIA UDDIN, WERIA KHAKSAR
Robotics and Intelligent Systems group, Department of Informatics, University of Oslo
Oslo, Norway

EDSON PRESTES
ϕ-Robotics Research Group, Informatics Institute, Federal University of Rio Grande do Sul (UFRGS),
Porto Alegre, Brazil

The proportion of older people in the population is increasing and correspondingly, the need for support in elderly care services. As the relative number of human resources would be diminishing, technological solutions and services need to be explored. However, many ethical concerns arise when exploring these solutions and services, which we have seen in an ongoing research project – multimodal elderly care systems (MECS) – for introducing robot companions for older people. The ethical concerns focused on in this paper include privacy, security, safety and the potential lack of contact with other humans. This paper will present these issues and discuss possible ways of addressing these concerns.

1. Introduction

Would we like to be surrounded by robots rather than humans? Most would answer no to this question. However, if the question is whether we would like – with some help from robots – to be *independent* with regards to our *key needs* like personal care, eating and transportation, the answer is not as obvious (although it will vary with cognitive degradation or mobility limitations). In contrast to most enjoying to help others, the feeling of being a burden to others can be unpleasant, and we derive a sense of dignity from handling our key needs by ourselves. Thus, if a machine can help us, we prefer it in some contexts. We see this today with the Internet where we rather than asking others about how to solve a problem, seek advice on the Internet. We probably achieve things with machines which we otherwise would not get done. Thus, in the same way as Google is helping us today with information needs, robots will in the future help us with our physical needs. Of course, we still need human contact and social interaction. Thus, it is important that technology can support our social needs rather than making us more isolated. Autonomous cars may be one such measure, by enabling the elderly to go out and about more independently. Thus, such cars would support a more active social life than today where a human operated car would have to be called for if public transportation is not an option.

The multimodal elderly care systems (MECS) project* aims to create and evaluate multimodal mobile human supportive systems that can sense, learn and predict future abnormal events of elderly. A part of this will be to demonstrate the benefits regarding both performance and privacy being improved by applying sensors like cameras on a robot companion rather than having them permanently mounted in a home. These would be used for detecting falls and other non-normal situations. Using new sensor technology, we would also like to explore if it is possible to remotely monitor medical states like pulse or breathing. Rather than having elderly themselves activating their personal security alarm in the case of an emergency situation, a target

*http://www.mn.uio.no/ifi/english/research/projects/mecs/

of this project is to demonstrate *automatic* activation. Many systems for elderly have been designed but few have been adopted on a large scale. We think a key reason for this – in addition to technical limitations – is limited user involvement and few iterations of user testing. Therefore, we focus specifically on developing our systems with a large degree of user participation. In this paper, the current findings with regards to how sensing, control and user participation can impact ethical issues will be presented. That includes how to address the ethical challenges of a robot in the home. E.g. sensors in the home can record lots of sensitive information that needs to be protected so that the elderly living at home can keep their dignity and not worry about the data being misused.

The remainder of this paper is organized as follows; the next section introduces a selection of earlier works on robots and elderly. In section 3, our proposals and findings we have made with regard to various ethical concerns will be outlined, including a discussion of relevant ways of addressing the concerns. Finally, conclusions are included in section 4.

2. Background

There are a number of larger funding schemes to support the development of technology for an active and assisted living [1,2. Thus, there have been several related projects about robot companions for elderly people. This includes the CompanionAble project (2008-2012) which applied an assistive companion robot called Hector to provide care support facilities including diary management, reminder services – for example, reminders for taking medicines on time – and perform fall detection. The ACCOMPANY project (2011-2014) used a robotic companion providing services to elderly users in a motivating and socially acceptable manner. The elderly was using a tablet to interact with the robot. CORBYS (Cognitive Control Framework for Robotic Systems, 2011-2015) has a goal of making a demonstrator which match the requirements of the user at different stages of rehabilitation in a wide range of gait disorders. ExCITE (Enabling SoCial Interaction Through Embodiment, 2010-2013) had a target to evaluate user requirements for robotic telepresence employing the *Giraff* robotic platform. GiraffPlus (2012-2014) focused on monitoring activities in the home using a network of sensors, both around in the home and on the body. The robot platform was the same as in the ExCITE project. This platform is also used in the VictoryaHome project (2013-2016) targeting a support system that monitors health and safety, and facilitates social contact. Work on addressing potential ethical issues with assistive robots has also been undertaken [5. 6. . Further, the term *roboethics* has been introduced to address ethical issues related to the development and use of robots [15. . There has in recent years been taken a number of initiatives to propose possible regulations for robots and AI in the real world [12. . There is a range of ethical concerns relating to robot care for the elderly with regards to human rights and to shared human values [11. , e.g. potential lack of human contact, loss of privacy and control to name a few. Below follows a presentation of various ethical considerations and countermeasures for robot companions for elderly that we have selected and addressed in the MECS project introduced in section 1.

3. Addressing Ethical Concerns with Robots and Elderly

Focus on user needs and preferences including how a person perceives a robot are essential when developing and applying robots for elderly. Thus, both size and shape, as well as how it moves around regarding motion pattern, speed and more are important [10.]. As a part of design with user participation, it is also important working with the elderly both with talking and observation to detect issues they may have where a robot can provide a solution.

In addition, we have in our work found the following methodological approach useful for the technical development: (i) survey current available sensor technologies relevant for robots (ii) obtain sensors relevant for studies and collect data from different environments and degrees of user interaction (iii) apply current state of the art methods in feature extraction (e.g. independent component analysis, local directional pattern and deep belief networks) and classification (e.g. convolutional neural networks, recurrent neural networks and deep reinforcement learning) and combining them into novel hybrid systems for robot sensing and control [14. . (iiii) Test and verify the different robot configurations starting in lab environment and gradually moving into real user environments like elderly homes.

Below follows a description of a set of different ethical issues that have appeared in our project including proposals on how to address them.

3.1. *Privacy*

It is important to balance the privacy of the elderly against the needs for data collection for having an efficiently functioning elderly care systems [3. . Privacy in this setting regards the protection of sensitive data to avoid unwanted distribution and misuse of such data. The choice of robot sensor technology and the way sensor data in processed and potentially stored can have a major impact on privacy and vulnerability for possible misuse of data. Thus, considering and comparing these, which we have undertaken in the MECS project, are important to make progress in feasible sensor technology and processing that would be relevant out of privacy concerns. RGB camera and microphone are the kinds of sensors revealing most privacy related information. Some sensor technologies are collecting less privacy related information but may on the other hand, result in the robot not having the most accurate and effective behaviour possible but can still be relevant [12. . The lack of performance from one sensor can to some extent be compensated with using multiple different complementary sensors in combination [4. . Such a hybrid multi-sensor system can also *adaptively adjust* which sensors a robot is using depending on the given context. Relevant sensors include e.g. depth camera, force and proximity sensors, ultra-wide band radar and ultrasound sensor. Depending on the current needs for a given setting, that may be more or less privacy revealing. This can be combined with some signalling or actuation by the robot indicating to its user what and how detailed sensing that is currently undertaken. E.g. one may think of an eyelid hiding a sensor when not in use. User studies – including design with *user participation*, would here be important to assess how the user perceives a robot companion with sensors equipped. The sensor technology will, however, potentially also impact the quality of the robot-human interaction. Thus, if sensors are simpler, potentially more instructions or follow up from the user would be needed to control the robot. Similarly, by not sending sensor data over the Internet for processing in cloud resources, privacy is strengthened but limits the quality that can be provided. This is due to the more limited on-board computing power on a robot. The focus on local processing puts attention on the power consumption rather than the processing speed only. Custom hardware realization in reconfigurable hardware has shown to be preferable compared to software running on a processor [9. . That is, FPGA (Field Programmable Gate Arrays) are more energy efficient than GPUs (Graphics Processing Units) and GPUs, in turn, are more energy efficient than CPUs (Central Processing Units). However, implementing and maintaining a custom hardware design is more time consuming than regular processor software. The need for collecting and storing data is also higher when *developing* systems than when *applying* them. For development, much sensor data would be helpful to determine – by using machine learning – what sensors and features that are most effective for solving the given task and then also train the system to

provide as high performance as possible. A trained system to be applied, on the other hand, can run the sensor data processing locally and only forward some high-level status information to the caregiver. However, if there is an alarm situation, it will once again be a compromise between the benefit of being able to remotely observe the elderly and proving privacy protection. There has appeared several guidelines and regulation with respect to handling data. One is the US *Health Insurance Portability and Accountability Act* (HIPAA)[†] from 1996 targeting to properly protect health information. Another recent one is the *General Data Protection Regulation* (GDPR)[‡] designed "to harmonize data privacy laws across Europe, to protect and empower all EU citizens data privacy and to reshape the way organizations across the region approach data privacy".

In conclusion, there will always be a trade-off for a robot in a home with regards to the *conflicting objectives* of performance and privacy protection. Thus, future work should address these together and try to come up with technological solutions which provide the best possible performance while at the same time provide privacy for its user.

3.2. *Security*

The are several concerns related to security. One is related to *privacy* and possible theft and unwanted distribution of sensor data from a robot. Another is related to risk of misbehaviour of the robot in similar ways as computers can be attacked with malware. Thus, security mechanisms should be designed by analysing where to insert a protective mechanism to both handle sensor data misuse and protecting a robot from being controlled by unauthorized people. There is probably today a larger vulnerability related to privacy than robot misbehaviour but precautions for both should still be taken. Beyond regular security measures with passwords and authentication, one may also add schemes within a robot sensing and control system assessing the given context when external requests occur. That is, a robot would often have a self-aware system that is continuously updated and adapted [8. that as a part of the motion planning and communication with the outside world would consider and take into account the potential security risks, as well as other ethical challenges [12. . That is, as a part of the reasoning engine, we would add a user assessment module that can consider the current context when a remote login is received and control or data access is requested.

3.3. *Safety*

The expected upcoming wide employment of robots in our society would result in robots getting physically much closer to humans than what we are used to from protected manufacturing settings. Thus, it would be of major importance that the new robot companions operate properly for us to want them *close by*. If they hit us unintentionally or work too slowly, few would accept them. Or worse, if someone through illegal access is able to take control of a robot companion and with intention targeting to hurt us or make other damage, our trust in them would be even less.

However, there are various solutions that aim at mitigating the safety risks associated with robots. In particular, research considers mechanisms for detecting and handling safety risks as introduced in the previous section. At the same time, the control and motion planning algorithms have to be robust and well tested. Still, a robot should be able to enter a new home without extensive training and testing before it can be applied, thus, we have seen that sampling based

[†] https://www.hhs.gov/hipaa/for-professionals/privacy/laws-regulations/index.html
[‡] https://www.eugdpr.org

motion planning algorithms are relevant to design and apply [7. . The research also looks into the potential trade-off between robot size, performance and safety. A small robot on the floor can be stumbled on while a bigger one may be regarded as more threatening and can also potentially represent a larger physically risk. That is, the physical design and size of a robot would impact safety issues that should be studied with user participation which is a part of our future work. Providing a robot with arm(s) and hands built from soft material would also contribute to reducing physical harm. Last, it would be important for a robot companion to contain a self-aware adaptable system that can learn about the user´s daily activities and preference and contribute in supporting these rather than introducing conflicts with them.

3.4. *Lack of Human Interaction*

As pointed out in the beginning of the paper, robots being introduced for taking care of people is a sensitive topic and often leading to many opposing the idea. Nobody likes the idea of especially elderly being left only with robots and no humans around to interact with them. However, robots can also have the opposite effect that caregivers can make robots take care of the manual work in a home to free time to talk and interact rather than doing practical work.

It is not only the robot engineers who determine how the future with robots is going to be. It will also be up to the politicians and society to decide, including on the *staffing* within elderly care when less physical work with elderly is needed. At the same time, if future robots take many of our current jobs, people in a family may, in general, have more free time, including *time* to spend together with elderly family members. And finally, today´s elderly should not worry about future robot technology. It is rather *us* who are younger, including those of us currently working with *developing* elderly care robots, that would be *confronted with* these close by robots when *we get old* in the future. Therefore, it's our own interest to make *user-friendly* robots.

4. Conclusion

The paper has introduced various ethical concerns that appear when robots are considered applied in the home care of older people. The main concerns relate to privacy, security and safety, as well as the potential lack of contact with other humans. However, there are some ways of mitigating the challenges but that may to some extent also limit the possible performance of a robot. Thus, it is important in future work to consider the different conflicting objectives being present.

Acknowledgments

This work is partially supported by the Research Council of Norway (RCN) and the Norwegian Centre for International Cooperation in Education (SIU) as a part of the Collaboration on Intelligent Machines (COINMAC) project, under grant agreement 261645 and Research Council of Norway as a part of the Multimodal Elderly Care Systems (MECS) project, under grant agreement 247697.

References

1. Active and Assisted Living Programme (2015). https://ec.europa.eu/digital-agenda/en/active-and-assisted-living-joint-programme-aal-jp
2. Ambient Assisted Living Programme (2015). http://www.aal-europe.eu/

3. A. Costa, F. Andrade, and P. Novais, Privacy and Data Protection towards Elderly Healthcare, Handbook of Research on ICTs for Human-Centered Healthcare and Social Care Services, pp. 330 – 346, 2013.
4. A. Danielsen, J. Torresen, "Recognizing Bedside Events using Thermal and Ultrasonic Readings", *Sensors*, Vol 17 (6), 1342, 2017
5. A. Ferreira M.I., J.S. Sequeira (2017) Robots in Ageing Societies. In: Aldinhas Ferreira M., Silva Sequeira J., Tokhi M., E. Kadar E., Virk G. (eds) A World with Robots. Intelligent Systems, Control and Automation: Science and Engineering, vol 84, pp 217 – 223, Springer.
6. R. Gelin (2017) The Domestic Robot: Ethical and Technical Concerns. In: Aldinhas Ferreira M., Silva Sequeira J., Tokhi M., E. Kadar E., Virk G. (eds) A World with Robots. Intelligent Systems, Control and Automation: Science and Engineering, vol 84. Springer
7. W. Khaksar, … and J. Torresen (2017). Sampling-based online motion planning for mobile robots: utilization of Tabu search and adaptive neuro-fuzzy inference system. *Neural computing & applications* (2017).
8. P. Lewis, A. Chandra, F. Faniyi, K. Glette, T. Chen, R. Bahsoon, J. Torresen and X. Yao, Architectural Aspects of Self-Aware and Self-Expressive Systems: From Psychology to Engineering, *Computer*, 48(7) (2015) IEEE Press, pp 62 – 70.
9. S. Mittal and J.S. Vetter. (2014). A Survey of Methods for Analyzing and Improving GPU Energy Efficiency. *ACM Comput. Surv*. 47, 2, Article 19 (August 2014).
10. T.W. Schulz; J. Herstad and J. Torresen (2018). Moving with Style: Classifying Human and Robot Movement at Home, In Christian Wögerer; Birgit Gersbeck-Schierholz & Steffen Gerhard Schulz (ed.), *ACHI 2018, The Eleventh International Conference on Advances in Computer-Human Interactions*. International Academy, Research and Industry Association (IARIA). ISBN 978-1-61208-616-3. 30. pp 188 – 193
11. A. Sharkey and N. Sharkey, Granny and the robots: Ethical issues in robot care for the elderly. In Ethics Inf Technol (2012) 14: 27.
12. J. Torresen, A Review of Future and Ethical Perspectives of Robotics and AI. (2018) *Frontiers in Robotics and AI*, vol. 4.
13. M. Uddin; W. Khaksar and J. Torresen, Human activity recognition using robust spatio-temporal features and convolutional neural network, In 2017 *IEEE Int. Conf. on Multisensor Fusion and Integr. for Intelligent Systems*.
14. M. Uddin; W. Khaksar and J. Torresen, Facial Expression Recognition Using Salient Features and Convolutional Neural Network. (2017) *IEEE Access*.
15. G. Veruggio and F. Operto (2008). Roboethics: Social and Ethical Implications. In Springer Handbook of Robotics (Siciliano, Bruno and Khatib, Oussama. eds). pp 1499 – 1524, Springer Berlin Heidelberg.