ICRES 2019: International Conference on Robot
Ethics and Standards, London, UK, 29-30 July 2019.
https://doi.org/10.13180/icres.2019.29-30.07.007

From traditional games to robotic games: ethical issues with elders

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This paper presents and discusses ethical issues related with the interaction of elderly people with robots while playing cognitive games. Four games were developed from classical nursing homes cognitive games, to incrementally increase its difficulty. The last one does include interaction with a robot. Several ethical issues were tackled to obtain a proper system with robots: those ethical issues were raised during the design phase and the interaction with the elders. As example of ethical issues tackled: beneficience - do not harm, and the deception and infantilisation of elderly. The games are based in objects with different shapes and colours to be positioned by the elder in pre-defined positions of a 3x3 arena, on the floor. The system then interacts with the elder given him/her the respective score, after performing image processing techniques to the image of the arena. The game with the robot consists to knock down objects in the arena, by pushing them outside the area using a car-like tele-operated robot, by the elders. The system was validated in two nursing homes, by performing experiments in the last months, and it is ethically proper.

1. Introduction

The future of the elderly in developed countries such as Portugal is connected with technological development, since there are many who now have and use smart mobile devices (smartphones). This trend will grow exponentially. As such, the solutions to propose for the welfare of the elderly will also have to go through this path.

Robots in the homes of humans are already a reality, for example the robot vacuum cleaner. The robots of assistance and supervision of elderly people at home and host institutions, residences of the elderly, are also having a growing development.

In this follow-up, the capabilities of these devices should be explored, not only to monitor the activity and safety of the elderly, but also to help improve the cognitive performance of the elderly. Leisure activities such as games aim to improve socialization among the elderly, for example in intra and / or inter-institutional games using robots.

The paper presents a technological framework to access ethical issues during the development and interaction of elders with robotic based cognitive games. Recent works proposed a methodology to evaluate the interactions between the elderly and the robot[1] in terms of initiative and involvement of the elderly with the proposed games and the comparison with the use of the robot, to verify if the introduction of the robot enhances social interactions.[2] However, no ethical issues were addressed.

The first contribution in this paper are the applications / games, based on objects and robots in real environment. With this solution, the robot will cease to be a mere element of monitoring the status of the elderly, to perform vacuum cleaning, etc, and will interact with the elderly in leisure activities, which stimulate the cognitive process. As such the proposed framework is suited to evaluate the tools proposed in.[1]

Four games were developed to stimulate the cognitive behaviours of the elderly and to provide active ageing in the cognitive component. In the first 3 games, a series of increasingly complex cognitive tasks are tested with the elderly. With the accomplishment of these tasks / games it is guaranteed that the 4th game is understood by the elderly and that the manipulation and commands given to the robot are not random. The interaction between the elderly and the robot is performed by a user friendly interface that allows the control and manipulation of the robot by the elderly.[3]

From the technological viewpoint, the first three are based on object shapes and colours that the elder must identify and place correctly in a 3x3 squared arena. In the first game a given layout of three objects from different colours (red, green, yellow) is shown to the elder in a computer/tablet, that she/he must replicate on a 3x3 squared arena. The second game relates to different object shapes (circle, square, triangle). The third game refers to a combination of different shapes and colours of the three objects that are shown to the elder, that he/she must replicate in the arena. The fourth game is based on a car-like robot, tele-operated by the elder, using a tablet, that he/she uses to push three objects outside the arena.

The second contribution of the paper is to present the ethical concerns that arise from the use of games and robots with elders. Those were based in the literature[4,5] and discussed in the text how those concerns were tackled during the games and robot development.

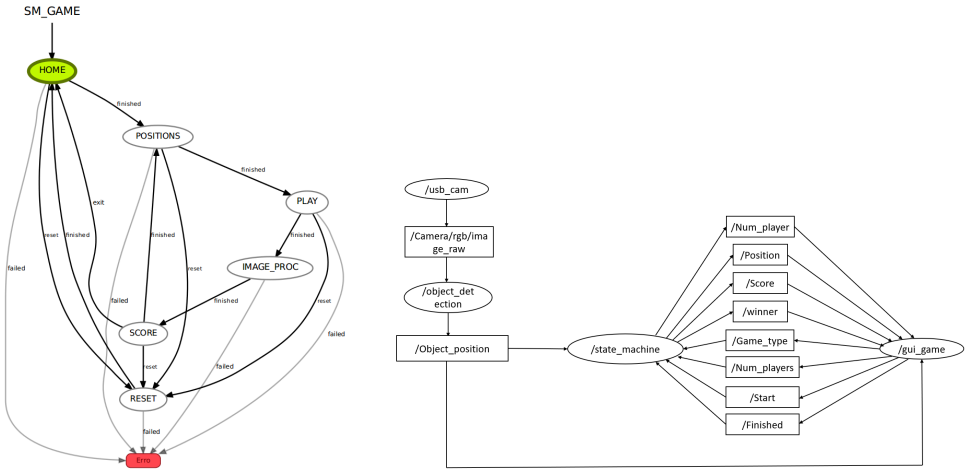
The experiments with the elders were conducted in two nursing homes. The 'Santa Casa da Misericórdia de Vila Velha de Ródão' and 'Santa Casa da Misericórdia de Castelo Branco'. The contact with elders was in July 2018, for the first experiments, and in January 2019, for the second round of experiments, in the second location. In total 50 elders have interacted with the games developed.

The paper presents in section 2, the games that were developed. In section 3, are presented and discussed the ethical issues that were discussed during the game development step and during the experiments with the elders. The paper ends with conclusions and future work directions in section 4.

Fig. 1. Game setup in the nursing home.

2. Game Development

In this section are presented the four games developed. In the first sub-section are presented all the hardware and software components used to implement the games. The three classical games with the inclusion of technology to verify the elders performance, are explained in the second sub-section. It follows the presentation of the game where the elder interacts with a robot.



(a) State Machine of the Game.

(b) ROS nodes and topics of the Game.

Fig. 2. Game implementation using ROS framework

2.1. *Hardware and Software components*

The physical components used in the four developed games, are depicted in figure 1. In this figure is present an usb camera (kinect in the middle of the image) to obtain a total view of the white arena in the floor. Also are depicted the coloured objects, with different shapes (above the arena and close to the elder). In the top left is depicted the screen of the game, where the pre-defined positions of the objects are shown to the elder, for him to place them in the arena. Moreover, at the end of the game the elder can verify his score in the screen. This verification procedure is performed automatically by the system, from the image captured by the usb camera, using image processing techniques to segment the colours and shape of each object in the 3x3 arena.

The software components were implement under the ROS[6] environment using the state machine framework SMACH.[7] Although this framework is a task-level architecture for rapidly creating complex robot behaviours, was used in this work because the experience of the authors with it and more importantly because the state-machine developed can evolve to a more complex one, when using a robot to play the games autonomously with the elders.

In figure 2(a) is presented the state machine of the game, where are depicted the six states of the machine and all the transitions. The states are: Home (start) ; Positions (to define the starting positions of the objects for the elderly to play) ; Play (the state were the elderly are playing) ; Image-Processing (where the image of the arena is captured and the current positions of the objects in the arena are calculated) ; Score (where the score of each play is calculated) ; Reset (to reset all the variables and prepare to start a new game).

The states and transitions depicted, allow a proper flow of information, from the start of the game, where the pre-set positions of the three objects are randomly defined. When the elder is ready, a start button is pressed to begin the timing until the elder finishes the task and the stop button is pressed. After this process is done, the image of the arena is captured and the positions of each placed object are obtained and matched to the pre-set positions. Using this information the score of the elderly play is calculated and shown to all the players. More players can have their turn next, and at the end of all plays, the system will show the winner of that batch of players. The winner will be the player with more accuracy. The time each player takes to complete the move is used to break the players with equal accuracy.

Another view of the system is presented by showing the ROS nodes and topics, that are running and sending information to each other, as depicted in figure 2(b). It can be clearly seen the source of information from the usb camera sensor (*/usb_cam* node) and object detection (*/object_detection* node), the state machine (*/state_machine* node), and the generated data to be shown in the graphical user interface (*/gui_game* node). In the rectangles are depicted the data messages that are sent within the nodes, as depicted in the directional arrows depicted in figure 2(b).

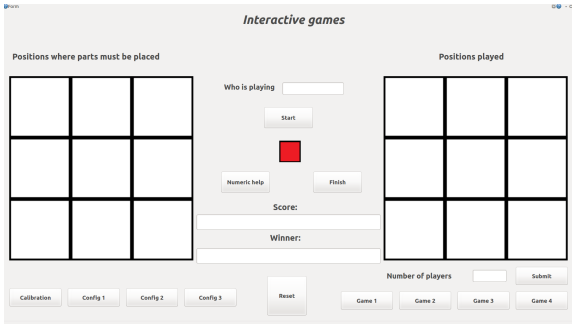


Fig. 3. Graphic User Interface (GUI) of the Game, english version.

This GUI, as depicted in figure 3, was developed under ROS, by using the QT-based framework for GUI development for ROS, RQT.[8] On the left side is depicted the desired positions of the objects to be placed in the 3x3 arena. On the right side are depicted the positions of the objects, obtained from the captured image when the elder finishes his play. In the middle is the start, stops buttons, the scoring information, along with a numerical help feature for the elders who get confused during the play (this help show, in the GUI, a number at each of the squares, which matches the number in the floor arena). In the bottom part of the GUI is the calibration of the system, possible choices for the configuration of the system (position of the camera relatively to the arena), and the choice of the type of game. This GUI is used for the four games, since the main difference is the type of objects that are used in each game.

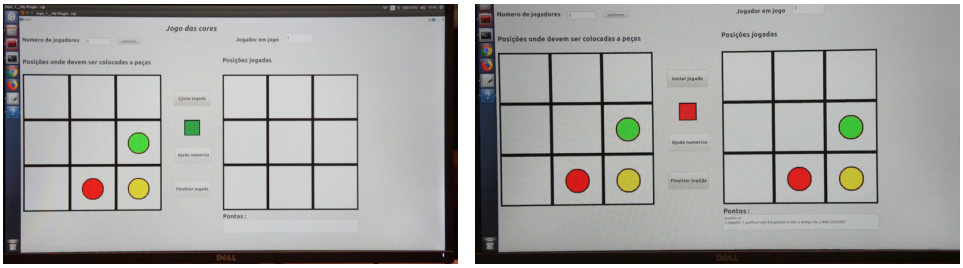
2.2. *Classical Games*

The classical games implemented are games that the elderly people often play in the nursing homes that are end-users of this work. The games are suitable to work the cognitive aspects of the elders.

In the first game (Colous game) the system chooses randomly three positions in the 3x3 squared arena, as depicted in figure 4(a). The shape of the object is a circle. The elder is invited to place the objects in the correct position of the 3x3 white arena that is on the floor, after a start button is pressed. When the task is done, a stop button is pressed, and the system evaluates the elder performance. When all the 3 objects are correctly performed, the elder gets 100 points. For each error the score is diminished by 20 points. If three errors occur the elder gets 40 points. The time to complete the task is used to obtain the winner of a group of players. In figure 5 is presented an elderly man playing the three colours game.

The remaining two classical games are similar to the three colours game, in the flow of the play and also in the scoring. The main difference is the type of objects at play.

In game 2, the three shapes game, the elder is invited to place the three different shapes (circle, square, triangle), shown in the GUI, in the 3x3 floor white arena. This game works other aspect of the cognitive process of the elderly.



(a) Start of the game. (b) End of the game.

Fig. 4. Three colours game, portuguese version.

Fig. 5. Elders playing the three colours game.

In game 3, the colours and shapes game, the elder is invited to place the three objects (chosen randomly from the nine variations of the three previous defined colours and shapes), shown in the GUI, in the 3x3 floor white arena. This game is more complex and challenging to the elders.

2.3. *Robot in the Game*

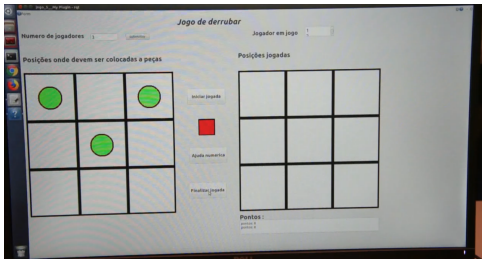
The game number four, includes a tele-operated robot, depicted in figure 6(b). The robot is an upgrade of a previous version presented in previous work.[9] It will be commanded by the elderly to knock down the objects. This is a complex challenge for the elders because the robot command is based on four buttons on a tablet screen. To go forward, backwards, left, or right. For that, they must train the fine motor skills in the fingers. Moreover, the hand-eye coordination must also be trained along with the depth perception. Although difficult, the elders loved to play with the robot.

The first step is to place the green circular objects in the 3x3 arena in the floor, as shown in the GUI. After all the objects were knock down, the vision system will capture the image and tries to find an object. If no object is found, the elder gets 100 points. For each object found, the score is diminished by 20 points.

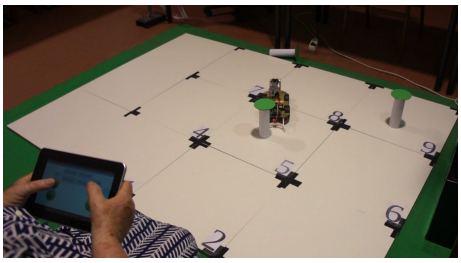
The control command of the robot can be sent using wi-fi or bluetooth, which allows communication even when there is no wi-fi in the nursing home. To knock down the object, and/or to push it outside the arena the car-like robot is equipped with a circular shape to help the elders tasks, and prevent the object to acquire undesired directions, when pushed.

3. Ethical Issues

In this section are presented the ethical issues that arise from the use of games and robots with elders. Those were based in the literature[4,5] and are discussed in the following sub-



(a) Start of the game.



(b) Elder playing the game.

Fig. 6. Game of knock down objects with robots, portuguese version.

sections. Those concerns were tackled during the games and robot development and also during the experiments with the elders in the nursing homes.

3.1. *Informed Consent*

Informed consent is one of the means by which a patient's right to autonomy is protected.[5] In the group of elders in this work, all of them do not have diminished autonomy, that can hampers the informed consent knowledge.

Instituto Politécnico de Castelo Branco, do have an ethics committee, based on the Health School, that suits the needs of the current research work. All the experiments performed in the nursing homes were approved by the ethics committee. As such, an informed consent document was prepared by the research team, read to the elders and signed by them. In conclusion, all the elders that are currently in the research programme gave his/her consent to the work developed with the four presented games.

3.2. *Beneficence- Do not harm*

According to Fouka[5] the ethical principle of beneficence refers to the Hippocratic "be of benefit, do not harm". This principle lead to the design of the game, i.e., the hardware and software parts. In fact, no physiological, emotional, social, or economic harm, was intended in the design.

Several measures were implemented in the games, to prevent physiological harm. For example, regarding safety issues: the arena is build in a material to prevent elders slippage and the consequent falls; the objects to be handled are very light to not harm the elder in case of falling; the robot stops if no command is given from the tablet; the robot stops if the elder gives the same command for 2 seconds (then he must wait half a second to receive a novel command). No emotional, social, or economic harm are present in the games because they are to be played in a controlled environment within the nursing homes. The potential impact of social harm, due to the fact that some elders could not complete the game was not verified. Moreover, it was observed that the elders helped each other to complete the games in a peaceful social environment.

3.3. *Respect for anonymity and confidentiality*

This is an important issue, that must be assured to the elders, an people in general, when performing research studies and work with machines. In the case of the games developed, they do not gather data of any kind, from any specific elder. All the scores recorded are not linked to any person/elder.

From the research performed in this work and the interaction with the elders, confidentiality was addressed and ensured by the research team on the elders behaviour during the

experiments.

3.4. *Respect for privacy*

Privacy[10] is the freedom an individual has to determine the time, extent, and general circumstances under which private information will be shared with or withheld from others. Moreover, in the nursing homes the research team strictly protect the privacy of the elders, while doing the everyday activities, for example in their bedrooms. The elders were asked to play the game in groups and the games were done, or not, according to their will.

3.5. *Reduction in human social contact*

The type of games developed and the use of the robot do not contribute to reduce the human social contact while, playing the games. In fact, interaction between them towards a winning spirit and help the other, was observed during the experimental sessions. The games are to be played in the central meeting room of the nursing home, which enhances human social interaction with other persons, elders or the nursing home professionals. Moreover, the games can/should be played by groups of elders, specially with heterogeneous capabilities. This was the case in the experiments performed during the past months, who helped the team to obtain a proper set of ethical robotic games.

3.6. *The insensitive use of robots*

The use of robots while interacting with humans in households is increasing, mainly service robots like the vacuum cleaner. Robots to interact with humans in public spaces, as tour guides are also in great demand. Recently, a large number of European Union (EU) research projects are ongoing to promote the EU leardership in Ambient Assisted Living, also using robots. Examples are the EU projects GrowmeUp (`http://www.growmeup.eu`) and EuroAGE (`http://www.euroage.eu`), that promote the use of robots for elderly care.

At this stage of the research, only one game of the four uses a robot, that is tele-operated, i.e., without autonomy. As such, the robot is introduced smoothly to the elders, where its use is not insensitive to the elders. This is because do not exist abuse in the use of the robot by the nursing homes professionals.

3.7. *The deception and infantilisation of elderly*

The deception and infantilisation of elderly was a major concern when developing the game, both the enhanced classical games and the one that used a robot.

The use of robot toys are commonly used by children in recent years, e.g., robot dogs, robot dolls, tele-operated cars. Elder care givers also use similar robotic devices to interact with elders, e.g., AIBO robot, PARO robot, or even dolls that have sensors and actuators, capable of some movement capabilities. The use of robots to promote relationships with elders is also a concern, specially if the elder can think that the robot is an animal or something similar. In fact, the elder could think that is something that he/she can have a relationship.

At this stage of the research, and to avoid these ethical concerns, the car-like robot that is tele-operated, i.e., with no autonomy, was a clear first step. In fact it does not look like an animal or doll. However is similar to some children toys. From several observations in the nursing homes, the car-like robot was not considered as a toy and was remembered as the car that some elders used to drive.

3.8. *Responsibility, if robots are placed under the control of elderly people*

This was the case in the experiments performed during the past months, who helped the team to obtain a proper set of ethical robotic games, where the robots and games have some issues covered, namely in the design stage (a car-like robot) and regarding safety issues. Moreover, the games can/should be played by groups of elders, who referee the control performed by the elders to the robot. In this case, the responsibility in the control of the robot lies within the nursing home, although the robots and objects to manipulate were built under safety concerns that raised during the experiments performed with the elders.

4. Conclusions and Future Work

The paper presented a system that implements cognitive games using robots. The system interacts with elders in groups within nursing homes. The system was developed in the framework of the EU project EuroAGE, aiming to provide robotic technologies to the elderly people. The system was developed using the ROS framework, to enable the interaction between the game, the robot, and a vision system, to obtain scores for each play.

During the development of the system, was performed an assessment of the concerns identified as major ethics risks when robots are in use with elderly people, while playing games to stimulate cognition. This study relied on in-loco qualitative observations done by the authors, which were discussed in section 3, while the elders were experiencing with the games. For the system developed the major ethical concerns were: beneficence - do not harm, the deception and infantilisation of elderly.

Ongoing work extends the robot interaction to the first presented games. Future works will develop quantification measures to the ethical issues raised in the paper. The games will be further developed by increasing the degree of autonomy of the robot. This will trigger novel ethical concerns that justifies the quantification of ethical issues for real-time reasoning on the robots and elderly interaction.

Acknowledgments

This work was partially supported by FCT, through IDMEC, under LAETA, project UID/EMS/50022/2019. This work was partially supported by project 0043- EUROAGE-4-E (POCTEP Programa Interreg V-A Spain-Portugal).

References

1. C. Pereira, V. Pinheira, M. Moreira, P. Gonçalves and S. Silva, *The European Journal of Social and Behavioral Sciences* **XXIII**, 2745 (2018).
2. S. Joshi and S. Sabanovic, A communal perspective on shared robots as social catalyst, in *26th International Symposium on Robot and Human Interactive Communication (RO-MAN)*, (Lisbon, Portugal., 2017).
3. S. Honig and T. Oron-Gilad, *Frontiers in Psychology* **9**, p. 861 (2018).
4. A. Sharkey and N. Sharkey, *Ethics and Information Technology* **14**, 27(Mar 2012).
5. G. Fouka and M. Mantzorou, *Health Science Journal* **5**, 3 (2011).
6. The robot operating system (ros) `http://www.ros.org/`, Accessed: 2019-03-11.
7. The task-level architecture smach `http://wiki.ros.org/smach`, Accessed: 2019-03-11.
8. Qt-based framework for gui development for ros `http://wiki.ros.org/rqt`, Accessed: 2019-03-11.
9. P. Gonçalves, P. Torres and R. A. A. Farinha, *Inovação Didática no Ensino Superior através do Projeto ROBOT@ESCOLA - Escola de Robótica*, in *EXPERIÊNCIAS DE INOVAÇÃO DIDÁTICA NO ENSINO SUPERIOR*, (Ministério da Educação e Ciência, 2015), pp. 181–191.
10. Levine, *Preliminary Papers prepared for the commission*, tech. rep., DHEW Publication, (Washington DC, 1976).