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EMOROBOT: AN OPEN-SOURCE ROBOT TO PROMOTE THE DEVELOPMENT OF SOCIAL SKILLS IN CHILDREN WITH AUTISM

EMOROBOT: UN ROBOT OPEN-SOURCE PER PROMUOVERE LO SVILUPPO DELLE SOCIAL SKILLS NEI BAMBINI CON AUTISMO

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Abstract

The aim of the following research work is to design and develop an open-source educational robot to promote the development of social skills in children with autism spectrum disorder (ASD). Recent studies have shown how the child-robot interaction can promote the implementation of new social behaviors in children with autism, creating predictable relational situations that help the child to relate, first with the robot and then with the human partner. Specifically, the aim of the project is to create an educational robot through the use of the 3D printer, which is customizable and programmable according to the specific needs of the child, so that it can be used by teachers. The project was born in the LAB-H of the Department of Human Sciences, Philosophical and Education (DISUFF) of the University of Salerno.

Lo scopo del seguente lavoro di ricerca è di progettare e sviluppare un robot didattico open-source per promuovere lo sviluppo delle social skills in bambini con Disturbo dello Spettro Autistico (ASD). Recenti studi hanno mostrato come l'interazione bambino-robot può favorire l'attuazione di nuovi comportamenti sociali nei bambini con autismo, creando situazioni relazionali prevedibili che aiutano il bambino a relazionarsi, prima con il robot e successivamente con il partner umano. Nello specifico, lo scopo del progetto è di realizzare un robot educativo attraverso l'utilizzo della stampante 3D,

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personalizzabile e programmabile in base alle specifiche esigenze del bambino, in modo da poter essere utilizzato da educatori e docenti delle scuole di ogni ordine e grado. Il progetto nasce nel LAB-H del Dipartimento di Scienze Umane, Filosofiche e della Formazione (DISUFF) dell'Università degli Studi di Salerno.

Key-words

social robotics, interaction, autism spectrum disorder.

robotica sociale, interazione, disturbo dello spettro autistico.

Introduction

Over the past decade, many studies have been conducted on the use of social robots as mediators in educational settings to foster the development of impaired skills in children with Autism Spectrum Disorder (Conti et al., 2015; Dunst et al., 2013) . There are two main categories of deficit in Autism Spectrum Disorder: the deficit in the area of social communication and the deficit of imagination. The main difficulties lie in verbal and non-verbal language, in social interaction and in the restricted repertoire of stereotyped behaviors (Cottini, Vivanti, Bonci, 2017). Recent studies (Conti et al., 2015; Pennazio, 2017) have demonstrated the effectiveness of social robots in interacting with children with autism, in which positive results have emerged regarding the child's imitation of observed behaviors. and performed by the robot (Duquette, Michaud, Mercier, 2008) and in increasing the maintenance of shared attention (Robins et al., 2005). Generally, the child with autism prefers to relate first with the robot and then with the human being, as the robotic mediator can be programmed to create reassuring situations, aimed at decreasing anxiety levels, allowing the child to establish an empathic relationship. (Marti, Iacono, Tittarelli, 2013). Social robots, while similar to humans, appear less complex to the child with autism and can help transfer learned skills into human interactions. In addition, the robot usually has a simple physical appearance, which gives the child confidence and control of the situation. When we refer to social robots, different types of robots must be kept in mind:

1) assistive robots (AR) that support people with physical disabilities;

2) socially interactive robots (SIR), which have social interactions as their main purpose; the term (SAR) refers to robots that are able to create effective interaction with individuals and promote learning (Rabbitt, 2015). SAR robots are different from other social robots, as they try to stimulate the user to change, ensuring specific assistance based on the different needs of the user; 3) companions of cognitive robots, who have the task of being at the service of users as "adaptive servants" (Pennazio, 2017), they must also continuously learn new skills to cooperate with humans, and also be adequate on an emotional and social level (Marti, Giusti, 2009).

Social robots can be used for different types of disabilities and must be chosen based on the user's problem, in the case of children with autism socially interactive robots (SAR) are more suitable, which stimulate the child to interact and implement new social behaviors through imitation. Robotic technologies are considered as “devices with which to think” (Harel and Papert, 1991) in which it is possible to favor sociality, cooperation and the co-construction of knowledge (Ackermann, 2002). Robotic systems can be used for different types of disabilities, as they are accessible, social and active. Therefore, the use of social robotics has proved useful

in environments with children with disabilities, as these robots have favored the development of social skills, imitation and communication in children with autism.

1. Emorobot Design

A social robot, to interact with children with autism, should appear: modular, social, configurable and adjustable on a sensory level, in this way the teacher could design individual activities with the robot and subsequently extend the activity with fellow students. class (Pennazio, 2019). Therefore the robot should not be understood as a substitute for the human being, it will not replace the teacher or the students, but if inserted in a school context the teacher will be able to gradually design activities based on the peculiarities of the robot. The robotic system will take on the role of social mediator to help the autistic child bridge the distance from the reassuring world that she constantly seeks and the complex world of human interaction (Ibidem). In this way, the robot can help the child develop social skills, stimulating social interaction and imitation, but also building a bond between children with disabilities and their peers.

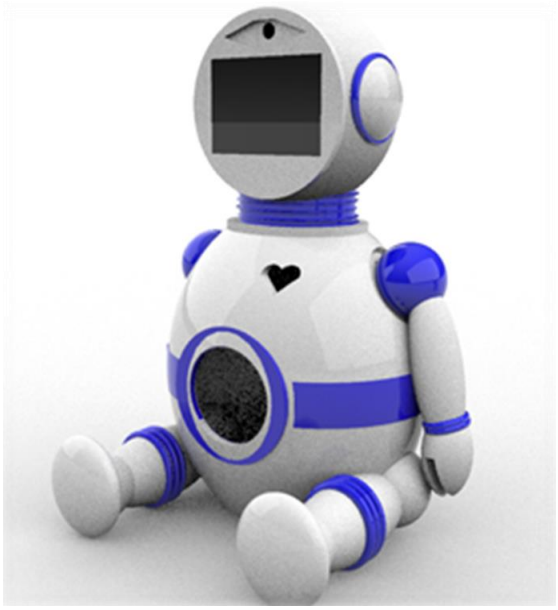

Figure 1: Emorobot Design

The following work aims to create an open-source educational robot, Emorobot, aimed at promoting the development of social skills in children with autism, in order to assume the role of learning companion or functional toy within activity sessions that include an interaction with the automaton. Emorobot was designed using Rhinoceros 3D modeling software and physically made with the Prusa MK3s printer, using PLA (Polylactic Acid) as the material. The use of the 3D printer has made it possible to reduce production costs and make the project customizable. The hardware part of the robot is equipped with the LattePanda board and the Arduino Uno microcontroller, used in a modular way. Specifically, the LattePanda board is used to manage the camera and the LCD display, while the Arduino Uno board is used to manage the various sensors and actuators, such as the robot neck servomotors (Campitiello, Todino & Di Tore, 2022) .

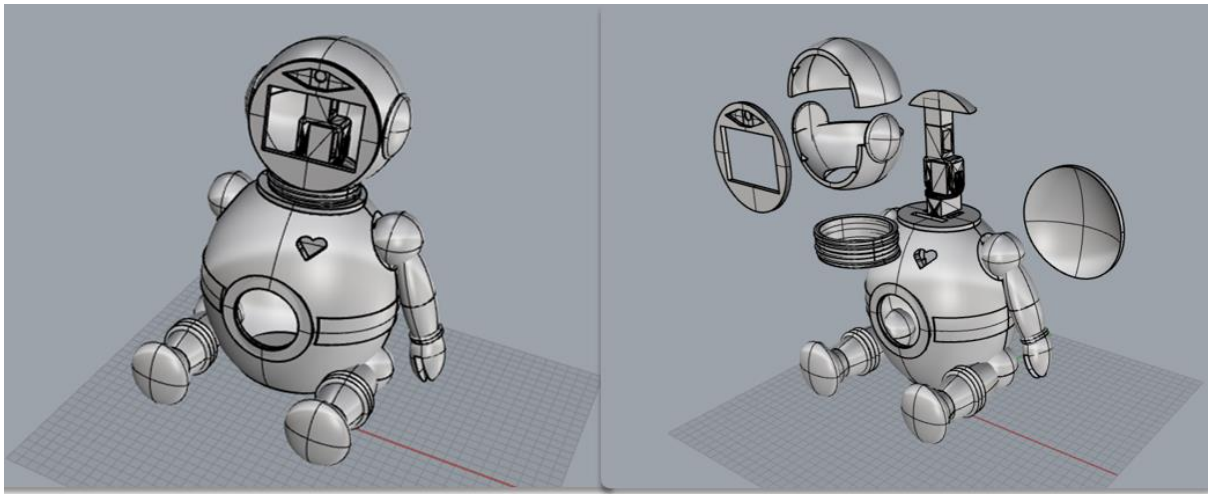

Figure 2: Design 3D modeling with Rhinoceros software

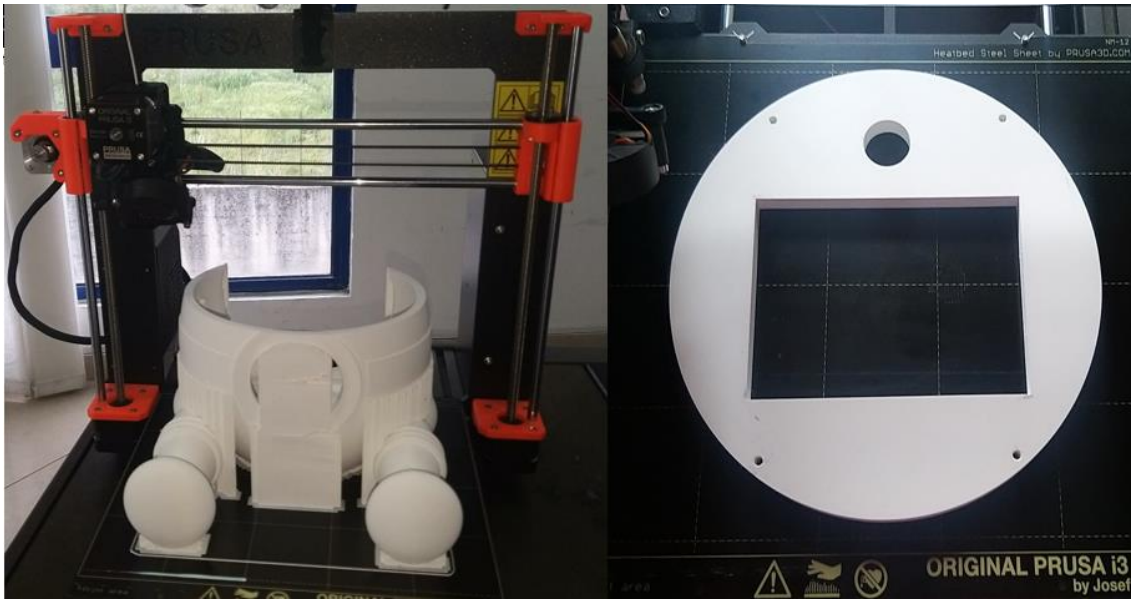

Figure 3: 3d printing of the robot

As regards the software part, the robot will be implemented with the "EmoTracker" software, still under development at the University of Cassino and Southern Lazio, which through an artificial intelligence algorithm is able to recognize the level of attention and the different emotions in users (Chiusaroli & Di Tore, 2020). In addition, the software, through the video stream of the webcam, is also able to detect the age and gender of the user. The goal is to make Emorobot interactive and customizable, so that it can be used to reduce social isolation, which is one of the main difficulties of this disorder, promoting motivation and the acquisition of relational skills.

3. Promote the development of social skills in children with autism

From the studies of Hobson (1993a; 1993b) it is highlighted how children with autism process emotional information differently and this creates difficulties in recognizing emotions, especially complex ones related to mental states (such as pride). In fact, the empathizing-second-systematizing theory (ES) developed by Baron-Cohen (2009), children with autism seem to prefer highly formal systems because they are made up of clear rules that are predictable and reassuring. For this reason it was decided to digitize part of Howlin's (1999) program, the theory of mind (TOM), which aims to develop the mentalization process and promote understanding of one's own mental state and that of others in children with Autistic Spectrum, across three dimensions:

- emotions;
- belief system and false beliefs;
- fiction and symbolic play.

The first part of Howlin's program is related to emotions, in fact, the goal is to help autistic children to identify the different emotions about themselves and others, through: 1) recognition of facial expressions in photographs; 2) recognition of emotions in schematic drawings (the use of schematic drawings, which appear on the robot's face, to facilitate the recognition of emotions; 3) identification of emotions caused by situations; 4) identification of emotions caused by desire; 5) identification of emotions provoked by opinions (Howlin, 1999).
In the first part of Howlin's program, the recognition of facial expressions through photographs, educators propose to children with autism to match photos of characters who display the same expression. As regards this first part of the program, the Mind-Reading software was used in Emorobot, with the aim of creating a free version of this software in order to design activities that teachers can carry out with the robot, imitating the expression that is represented in the various photographs. In this way, in the child with autism we try to create a greater bodily involvement, through the imitation of different emotions, which should help to memorize the emotions according to the coding reported by Ekman (1999).

Figure 4: Software for recognizing facial expressions in photographs

Regarding the recognition of emotions in schematic drawings, educators ask the child to identify the different emotions based on the physognomic conformations that characterize a given expression. For the first prototype of the robot, LED matrices were created that represented the different expressions, however, in the latest version of Emorobot, through the use of the PowerPoint software, the primary emotions were created, based on the coding reported by Ekman (1999), so that the robot can show different emotional states on its face.

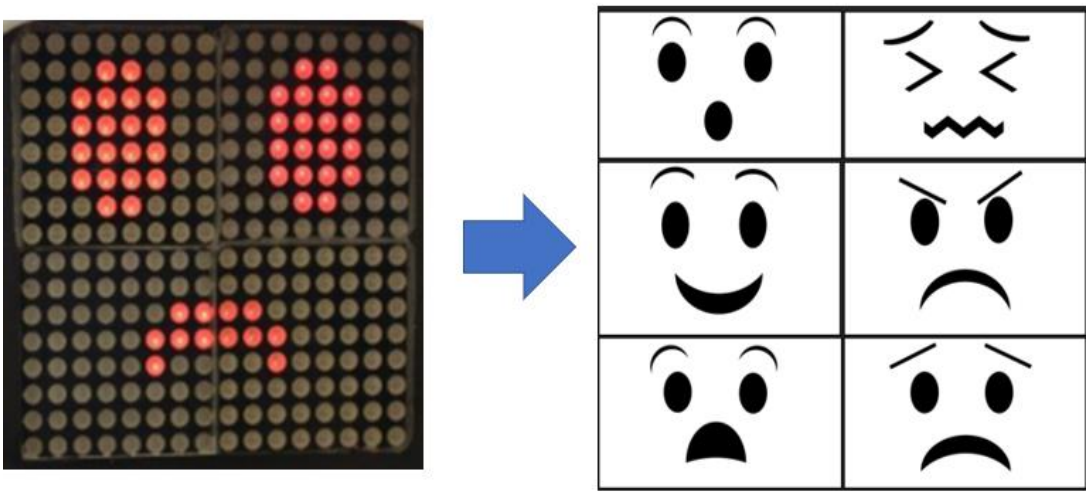

Figure 3: recognition of emotions in schematic drawings

In the last levels, however, educators ask children to identify the emotions caused by desires and opinions, through a sequence of figures in which the following are represented in the story: 1) the real image; 2) what the character wants; 3) how the story ends.

In this specific case, it is possible to design activities with the child, in which the Emorobot's face will be able to express the different emotions through schematic drawings and, to exercise the recognition of facial expressions in the photographs, the tablet will be able to show the different photos of the characters that they express different emotions. Furthermore, it is possible to use the robot in small groups of peers, proposing a simulation game of the emotions that the robot shows on the face, to give the child the opportunity to experience a state of mind with others. In this way the child interacts first with the robotic mediator, then with the teacher and the group of peers.

Robots represent "concrete objects" that can interact with children and move around the environment. Furthermore, the sensory stimuli of the robot can be adjusted and create a meaningful perceptual experience. The robot can play different roles, even that of a playmate, simulating human behavior to mediate during the cooperation activities between peers. In fact, planning activities with the robot in which classmates are present, can help the child to experiment with social skills and offers the possibility of working in a context where rules must

be followed. This is relevant for the good social development of children with autism, which will accompany them during complex social interactions (Pennazio, 2017).

4. I**mplementation with the Emotracker software**

The positive aspects, which can lead to the use of a robot for children with autism, reside in their ability to move in the environment, in carrying out actions and movements with the body, which inevitably lead to greater emotional involvement. Modularity and configurability are the main characteristics that a robot must possess, in order to perform actions autonomously and be programmed to implement complex behaviors based on the needs of children. In fact, just think that children with autism present various difficulties, for which they need specific and personalized interventions.
Emotions are also part of the design of humanoid robots, as they provide feedback during the interaction with the user and increase the level of credibility. The emotions that the robot manifests through the face offer information relating to the internal states and intentions of the automaton, in order to accustom the child to understanding the emotions and factors that can lead to a change in the robot's behavior. Robots can express emotional states in different ways, through LED lights or the movement of certain parts of the body, in order to give greater expressiveness.

In this specific case, to train children with autism to recognize emotions, a software, "EmoTracker", was used, which will be implemented in Emorobot. The Emotracker software is under development at the University of Cassino and Southern Lazio, and uses an artificial intelligence algorithm to recognize the emotions and level of attention in users (Chiusaroli & Di Tore, 2020); through the video stream of the webcam, it is able to detect the age and gender of the user. In Emorobot, the output that comes from the Emotracker software is used to animate a character that reproduces the same emotions intercepted by the software. An initial experimentation of the Emotracker software was also conducted, before implementing it in the robot, on a student of the University of Cassino and Southern Lazio, in which the software detected the emotions that the student felt when he was asked questions by of the teacher, noting peaks of happiness when interacting jokingly with classmates.

Figure 4: Software Emotracker

Therefore, in a context, the teacher could design educational activities with the robot, through which children with autism have to imitate the emotions that the robot represents through the character of the Emotrack software, in order to have a greater bodily involvement, the imitation of different emotions, which should help to memorize emotions according to the coding reported by Ekman.

Conclusions

The aim of this research is to create an open-source didactic robot, designed to be used within schools and which is programmable and customizable by all teachers. Social robots can be customized and adapted to the different needs of children, so they are considered useful intervention tools in educational environments. In fact, the attitude of the robot can be changed gradually, making small changes following the different activities. Furthermore, through the planning of these activities with the robot, it is possible to intervene in the social area, i.e. the ability to respond to social stimuli or to relate to others as well (Cottini, Vivanti & Bonci, 2017). Therefore, the approach is to hypothesize that social robots can serve as assistive technologies, promoting the development of social skills in children with autism through daily activities. The project was born in the LAB-H of the Department of Human, Philosophical and Education Sciences (DISUFF) of the University of Salerno.

References

Ackermann, E. (2002). Ambienti di gioco programmabili: cos'è possibile per un bambino di quattro anni. TD- Tecnologie Didattiche, 27, 48-55

Baron-Cohen, S. (2009). Autism: The empathizing-systemizing (E-S) theory. Ann N Y Acad Sci 1156:68–80.

Campitiello, L., Todino, M. D., & Di Tore, S. (2022). Lo sviluppo delle social skills in bambini con Disturbo dello Spettro Autistico: ASD-robot. Mizar. Costellazione di pensieri, 2021 (15), 15-20.

Chiusaroli, D., & Di Tore, P. A. (2020). EmoTracker: Emotion Recognition between Distance Learning and Special Educational Needs. Giornale Italiano di Educazione alla Salute, Sport e Didattica Inclusiva, 4(4_sup).

Conti, D., Di Nuovo, S., Buono, S., Trubia, G. & Di Nuovo, A. (2015). Use of robotics to stimulate imitation in children with Autism Spectrum Disorder: A pilot study in a clinical setting. Proceedings of the 24th IEEE International Symposium on Robot and Human Interactive Communication. Kobe. Japan.

Duquette, A., Michaud, F., & Mercier, H. (2008). Exploring the Use of a Mobile Robot as an Imitation Agent with Children with Low-Functioning Autism. Autonomous Robots, 24 (2): 147-157.

Dunst, C. J., Trivette, C. M., Prior, J., Hamby, D. W., & Embler, D. (2013). Parents' Judgments of the Acceptability and Importance of Socially Interactive Robots for Intervening with Young Children with Disabilities. Social Robots Research Reports, 1: 1-5.

Ekman, P. (1999). Basic emotions. Handbook of cognition and emotion, 98(45-60), 16.

Harel I. &Papert, S. (1991). Constructionism. New Jersey: Ablex Publishing Corporation.

Hobson, R.P. (1993a). Understanding persons: The role of affect. In S. Baron-Cohen, H. Tager-Flusberg e D. Cohen (a cura di), Understanding others minds. Oxford: Oxford University Press.

Hobson, R.P. (1993b). Autism and the development of mind. Hillsdale, N.J.: Erlbaum.

Howlin, P., Cohen, S. B., & Hadwin, J. (1999). Teoria della mente e autismo. Insegnare a comprendere gli stati psichici dell'altro. Trento: Edizioni Erickson.

Marti, P. & Giusti, L. (2009). A robot Companion for Inclusive Games: a user-centred design perspective. Proceedings of IEEE International Conference on Robotics and Automation, Anchorage, 3-8 maggio

Marti, P., Iacono, I., & Tittarelli, M. (2013). La relazione empatica con i robot. Rivista Italiana di Ergonomia, 9, 65-75.

Pennazio, V. (2017). Social robotics to help children with autism in their interactions through imitation. Research on Education and Media, 9(1), 10-16.

Pennazio, V. (2019). Robotica e sviluppo delle abilità sociali nell'autismo. Una review critica. Mondo Digitale, 2.

Rabbitt, S. M., Kazdin, A. E., & Scassellati, B. (2015). Integrating socially assistive robotics into mental healthcare interventions: Applications and recommendations for expanded use. Clinical psychology review, 35, 35-46.

Robins, B., Dautenhahn, K., Nehaniv, C. L., Mirza, F., Olsson, L. (2005). Sustaining interaction dynamics and engagement in dyadic childrobot interaction kinesics: Lessons learnt from an exploratory

study. In Proceedings of the 14th IEEE International Workshop on Robot and Human Interactive Communication, RO-MAN2005, Nashville, USA.