EmIR: An Emotional Intelligent Robot Assistant

Jaime A. Rincon, Alberto Martin, Angelo Costa, Paulo Novais, Vicente Julian, and Carlos Carrascosa

[1] Universitat Politècnica de València. D. Sistemas Informáticos y Computación
jrincon, vinglada, carrasco@dsic.upv.es
[2] Centro ALGORITMI, Escola de Engenharia, Universidade do Minho, Braga acosta, pjon@di.uminho.pt

Abstract. The development of robots that are truly sociable requires understanding how human interactions can be applied to the interaction between humans and robots. A sociable robot must be able to interact with people taking into account aspects like verbal and non-verbal communications (emotions, postures, gestures). This work presents a social robot which main goal is to provide assistance to older people in carrying out their daily activities (through suggestions or reminders). In addition, the robot presents non-verbal communications like perceiving emotions and displaying human identifiable emotions in order to express empathy. A prototype of the robot is being tested in a daycare centre in the northern area of Portugal.

Keywords: Social Robots, Emotional Models, Ambient Assisted Living

1 Introduction

Globally, the elderly population is increasing, according to demographic projections [1]. The OMS prdeicts that the amount of people aged over 60 is expected to double between 2000 and 2050 [2]. As less developed countries start to evolve, this trend is onset immediately [2]. A common societal issue that emerges from a rapid elderly population growth is the exponential demand or care (medical and otherwise).

The common human resources needed are healthcare professionals, including formal and informal caregivers. Which currently are in short supply, and there is no indication of increase of the caregivers numbers in the foreseeable future. The lack of these professionals represents a serious issue. One way of dealing with this issue is using technology that empowers people to overcome problems that they encounter on their daily lives. Various areas can be of help to the elderly, like Social Robotics [3], Virtual Assistants [4], Artificial Intelligence [5], etc.

These areas try to solve these problems by introducing new technologies that can help older people living alone or in nursing homes. Some of these solutions include voice assistants such as Amazon's Alexa, Google Voice Assitant and Apple's HomePod. However, other emerging technologies such as assistant robots and therapy robots are becoming increasingly popular. These devices integrate

speech recognition, artificial vision, text chat and gestural interactions. These mechanisms help users to interact with these devices. However, in human interaction the way that emotion is expressed plays an important role, mainly because emotions are themselves a communication channel.

In this paper we present a social robot, called *EmIR*, which main goal is to provide assistance to the elderly performing their daily activities, presenting human-like features like perceiving emotions of a group of people and displaying human identifiable emotions. Moreover, our social robot makes use of an e-Health platform (Cognitive Life Assistant - CLA) which integrates a persuasive module that makes use of argumentative techniques similar to reasoning procedures that physicians and caregivers use to recommend activities to patients.

The rest of the paper is structured as follows. Section 2 analyzes previous works in the area of assistants robots. Section 3 presents in detail the main functionalities of the robot with particular emphasis on the emotion detection and the user interaction. Section 4 describes the hardware employed to build the robot and it illustrates the functionalities of the robot through an example. Finally, the conclusions are presented in Section 5.

2 Related Work

Recently, it is observable the increase on interest in assistive robots and their development. Current sociological shift demands technological solutions that are able to interact with elderly people. Thus, the sudden increase of the number of robots available that have as goal solving this sociological issue. Furthermore, they are increasingly refined and advanced in terms of aspect and features, being more human-like in both fields.

In recent years, we have seen a growing interest in robots, many of which are available to people. These robots have nice looks, a powerful background of artificial intelligence, navigation in complex environments, artificial vision, etc. Some of them, such as Pepper [6] and Romeo [7] from *Aldebaran* or Aido [8] or Buddy [8] from *Frog Robotics*, are presented as a new generation of home robots. One of the main applications of these robots is to assist older people in their daily life. Usually, these robots are used as a form of therapy or health care. In therapy field, we can find the Paro robot [9]. The Paro robot is an advanced interactive robot developed by AIST, which offers the well-known benefits of animal therapy to be administered to patients in environments such as hospitals. This robot was built to be a companion to children and elderly, prompting a positive emotional response due to its visual aspect. In the healthcare field we can find the Mabu robot of Catalia Health, who learns over time about the personality, interests and therapeutic challenges of each patient. This allows Mabu to create conversations adapted to each patient. The structure of these conversations is based on well-known behavioral models of psychology to promote behavioral change.

From these projects we have observed that while the physical aspect, and its underlying impact (as displayed by PARO), is very advanced and the target of a

careful development, they lack in terms of functionality. The actions that makes one human and their emotions are not explored by these projects and we believe that after the initial impact of the visual aspect it is what makes them really human-like. We, as humans, strive for human empathy, and is what our project aims for.

3 Emotional Robot Assistant Description

In this section we describe the proposed social robot, called EmIR (Emotional Intelligent Robot). This robot has been developed in order to provide assistance to the elderly to perform their daily activities. To validate the proposed robot, a prototype is being tested in a real scenario, in a daycare institution in the north of Portugal.

The main features of the robot are the following: perceives the emotions of each individual and also calculates the social emotion of a group of people; displays human identifiable emotions according to the emotional states of the users; assists users recommending healthy activities and also, remembering when to do them; and finally, persuades users by giving them arguments to justify recommended actions. The robot was built using a lattepanda board[3] and an Arduino mega 2560 board[4]. These development boards are used to control the different engines and also to detect emotions and to identify people. Figure 1 shows a picture of the robot with its different elements.

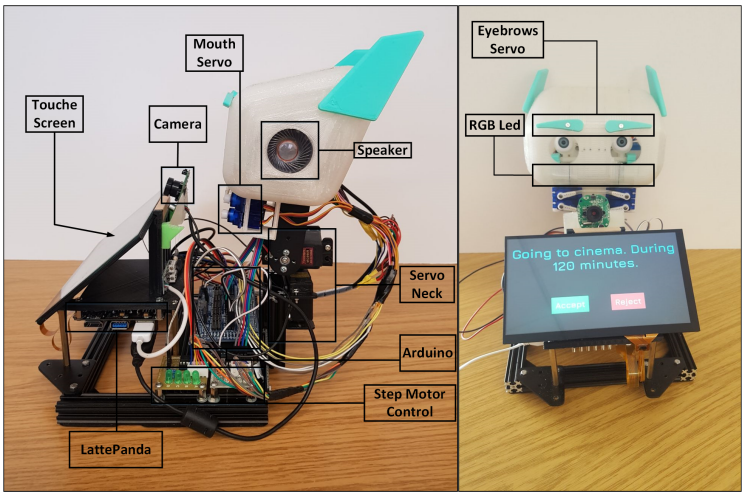

Fig. 1: Robot hardware.

[3] http://www.lattepanda.com/
[4] https://store.arduino.cc/arduino-mega-2560-rev3

The functionalities of the proposed robot are divided into three main modules which provides the services that our robot uses to perceive and interact with the environment. The first two modules are the Emotion Detection and the Emotion Display modules which are in charge of detecting, processing and displaying emotions. On the other hand, the other module is the User Interaction module which has been implemented using the CLA framework [10]. The CLA framework improves the user experience and gives a fluid visual interface to the robot.

4 Application Example

In order to illustrate the behavior of the robot, this section presents an example which describes the different processes made by the robot as an emotional-based persuasive recommender. In the proposed example, the robot will interact with humans by identifying them, detecting their emotions and suggesting activities.

Figure 2 shows the different processes followed by the robot for supporting the described interaction.

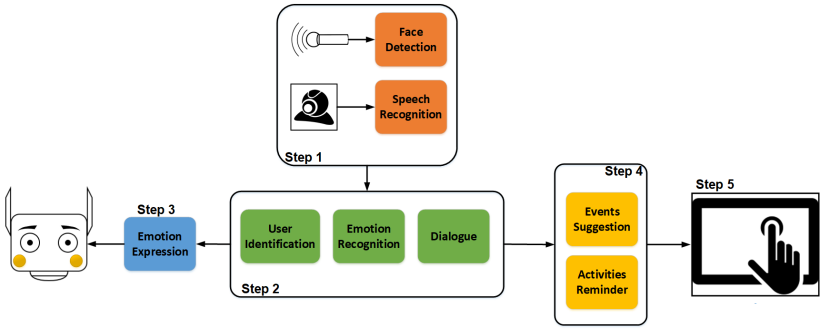

Fig. 2: A schema of the main processes followed by the robot

In a general view, the robot will follow the following steps:

1. The way to initiate the interaction with the robot consists of saying the name of the robot, which in our case is *EmIR (Emotional Interactive Robot)*.As soon as the robot hears its name it starts interacting with the caller(s).
2. The first step is to take a picture through its webcam. This image is used to identify the person and to track the face. If the robot does not know the person, the robot initiates the following dialogue (as an example):
   - **EmIR:** I'm sorry, but I don't know you.
   - **EmIR:** What's your name?.
   - **User:** Hi, my name is Jaime.

3. After this, the image is then introduced as input into a neural convolutional network that returns the emotional state. If the robot detects more than one face in the same image, the process is repeated for each face. Once the emotional state of all the users are obtained, the robot will adapt its emotion in an attempt to show empathy. To do this the robot can move its eyebrows and change the lights of its cheeks.
4. Next, the robot makes use of its persuasive recommender system. It can recommend the following items:
   - Events that promote active aging. The suggestion of events follows a set of configurations (age, likes, medical condition, etc.) that make them appropriate for each user.
   - Activities on the user calendar, e.g., medication reminders, medical appointments.

   During this recommendation process, a dialogue with the user is started where the user can accept or refuse the suggestions. If the user refuses a suggestion, the robot tries to suggest another activity or generates arguments in order to persuade the user. In parallel, it keeps identifying the user's emotion and producing visual cues (eyebrows, etc.) to enforce the information delivered.
5. After this process, the robot goes to a waiting state until it is requested again by the user. In the meanwhile the robot presents practical information like the current weather state or news, in an effort to interact with the user(s).

5 Conclusions and future work

This paper has presented the EmIR robot, a low cost desktop robot devised to interact with humans taking into account the emotion of the people it interacts with and even being able to express some emotion. The application area where is assistance to an elderly community.

In the interaction with people in this application area, the robot is able to talk with the persons it perceives and help those people by recommending new activities along with giving reminders about scheduled activities.

Although the robot is still in a prototype form, its design and abilities have been improved presenting human-like features like perceiving emotions of a group of people and displaying human identifiable emotions. The functionalities of the proposed robot are divided into three main aspects. The first one is the Emotion Detection that allows the robot to estimate the emotional state of the people that is in from of the robot. The second one is the Emotion Display, that allows the robot to express empathy with people according to the emotional states previously detected. The third and last one, is the User Interaction that allows the robot to enhance the user experience suggesting activities/events to the user based on his/her profile and medical condition and trying to persuade the users into accepting the suggested activities/events.

This work is being validated by workers and patients of a daycare centre in the northern area of Portugal. Specifically in the centre *Centro Social Irmandade de*

S. Torcato. The validation is being performed through simple interactions with the patients under the supervision of caregivers.

As future work, we want to improve the detection of emotions by introducing speech recognition as another input in the process of identifying emotional states. Another aspect to be introduced, and currently supported by CLA, is the direct connection with caregivers or doctors to share information on scheduled activities or events as well as the patient progress. Finally, we aim for the adaptation of the proposed system to people with disabilities who cannot use the touchscreen.

6 Acknowledgements

This work is partially supported by the MINECO/FEDER TIN2015-65515-C4-1-R and the FPI grant AP2013-01276 awarded to Jaime-Andres Rincon. Angelo Costa thanks the FCT - Fundacao para a Ciencia e Tecnologia for the Post-Doc grant SFRH/BPD/102696/2014. This work is supported by FCT within the projects UID/CEC/00319/2013 and COMPETE: POCI-01-0145-FEDER-007043.

References

1. United Nations, Department of Economic and Social Affairs, Population Division. World population ageing 2015. (ST/ESA/SER.A/390), 2015.
2. United Nations, Department of Economic and Social Affairs, Population Division. World population prospects: The 2017 revision, key findings and advance tables. (ESA/P/WP/248), 2017.
3. J. Broekens, M. Heerink, and H. Rosendal. Assistive social robots in elderly care: a review. *Grontechnology*, 8:94–103, 2009.
4. Nicole C. Krämer. Social effects of virtual assistants. a review of empirical results with regard to communication. In Helmut Prendinger, James Lester, and Mitsuru Ishizuka, editors, *Intelligent Virtual Agents*, pages 507–508, Berlin, Heidelberg, 2008. Springer Berlin Heidelberg.
5. Eduardo Lupiani, Jose M. Juarez, Jose Palma, and Roque Marin. Monitoring elderly people at home with temporal case-based reasoning. *Knowledge-Based Systems*, 134:116 – 134, 2017.
6. Fumihide Tanaka, Kyosuke Isshiki, Fumiki Takahashi, Manabu Uekusa, Rumiko Sei, and Kaname Hayashi. Pepper learns together with children: Development of an educational application. *IEEE-RAS International Conference on Humanoid Robots*, 2015-December:270–275, 2015.
7. Giovanni Claudio, Fabien Spindler, and Francois Chaumette. Vision-based manipulation with the humanoid robot Romeo. In *2016 IEEE-RAS 16th International Conference on Humanoid Robots (Humanoids)*, pages 286–293. IEEE, nov 2016.
8. Ester Martinez-Martin and Angel P. del Pobil. *Personal Robot Assistants for Elderly Care: An Overview*, pages 77–91. Springer International Publishing, Cham, 2018.
9. K. Wada, T. Shibata, T. Saito, and K. Tanie. Effects of robot assisted activity to elderly people who stay at a health service facility for the aged. In *3 IEEE/RSJ International Conference on Intelligent Robots and Systems (IROS)*, pages 2847–2852, 2003.

10. Angelo Costa, José Carlos Castillo, Paulo Novais, Antonio Fernández-Caballero, and Ricardo Simões. Sensor-driven agenda for intelligent home care of the elderly. *Expert Syst. Appl.*, 39(15):12192–12204, 2012.