Affective Robot for Elderly Assistance

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Abstract. Recently, several robotic solutions for the elderly have been proposed. However, to date, the diffusion of these devices has been limited: available robots are too cumbersome, awkward, and expensive to become widely adopted. Another key issue which reduces the appeal of assistive robots is the lack of socio-emotional interaction: affective interchanges represent key requirements to create sustainable relationships between elderly and robots. In this paper, we propose a new approach to enhance the acceptability of robotic systems, based on the introduction of affective dimensions in human-robot interaction. This strategy is aimed at designing a new generation of relational and cognitive robots fusing information from embodied unobtrusive sensory interfaces. The final objective is to develop embodied interfaces, which are able to learn and adapt their affective responses to the user’s behavior. User and robot will engage in natural interactions, involving verbal and non-verbal communication, improving empathic exchange of moods and feelings. Relevant independent living and quality of life related issues will be addressed: on-going monitoring of health parameters, assistance in everyday’s activities, social support and cognitive/physical exercises. We expect that the proposed strategy will enhance the user’s acceptance and adoption of the assistive robotic system.

Keywords. Elderly, independent living, affective interaction, relational robot, embodied sensory interfaces.

Introduction

The use of socially interactive robots for the elderly arises from two main trends, which portrays the current society. The first trend refers to social and health-related aspects, the second to technological ones.

The older population is growing at a considerably faster rate than that of the world's total population. This involves several issues to be considered, in particular the physical and psychological well being both of elderly and of caregivers.

Aging is a multidimensional process characterized by physical, psychological, and social change. However, many studies suggest that aging is not necessarily associated with negative evolution; actually, new abilities and skills can be developed, to compensate impairments caused by the physical decline. For example, reaction times

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become slower and more variable with age, while curiosity, creativity, and the wisdom gained from experience may expand. Research shows that even late in life potential exists for physical, mental, and social growth and development [1]. However, some clear impairments appear in perceptual, cognitive, and motor abilities.

The use of ITC and web-based communication work platforms is changing the society and is offering more and more solutions to everyday problems. Its integration in the new proposal addressing health and social activities is becoming less a suggestion and more a necessity.

As old populations continue to grow rapidly, the capacity of human caregivers is expected to be insufficient in the future. Nursing home care services do not represent a univocal solution, because of the social cost they involve: they are not only extremely expensive from an economic point of view, but also because they entail a forced relocation of elderly people.

A more supporting home environment has to be envisaged in order to reduce the individual and community burden.

The use of robotic systems, involving a physical proximity and an individualized service, provides a solution to main elderly and caregivers needs, related to everyday care and continuous monitoring.

1. Robotic solution for elderly assistance

Research on elderly emotional and social behaviors stresses that emotions and social relations play a key role for a healthy aging. When building social care and assistive robots, it is important to consider the desires, values, and needs of the elderly. Forlizzi et al. (2004) investigated the elderly expectations on assistive robotics. Seventeen elders aged 60 to 90 were interviewed. The authors of this study concluded that assistive robotics tools should support the elder’s values of identity, dignity, and independence. The elders have the desire to maintain their personal standard within their home or community.

Dorfman (1994) [2] conducted an extensive ethnography of elderly people in an upscale residential retirement facility (Quaker community). She identified five main values: remaining autonomous; sustaining personal growth; helping others; maintaining social ties; experiencing pleasure.

Two main categories of robots can be found for elderly:

1. Assisive: focused on providing everyday life assistance, mainly addressing mild cognitive impaired persons or healthy elderly living by their-selves (showing at least some motor impairment).
2. Social: focused on emotional activation/stimulation and on therapeutic effects of communication patterns and social interactions in subjects with cognitive deficits.

While the first kind of robot belongs to the category of assistive technology, social robots involve pet therapy principles transfer to technological applications (pet robots). Many studies on Animal Assisted Therapy demonstrated positive effects arising from the interactions of humans with real animals; some of these beneficial effects for interaction were confirmed also with a robotic animal.

However, a very small amount of examples exist of social robots that combine the
function of being a companion with other functionalities.

2. Psychological issues in human-robot interaction

Robots have the ability to serve not only as good companions, but also to assist elderly in attaining their goals through exchange of instrumental, emotional, and informational resources.

Elderly acceptability of an autonomous robotic agent in their home is a relevant issue when dealing with human-robot interaction applications.

User acceptance does not depend only on the practical benefits they can provide, but on complex relationship between the cognitive, affective, and emotional components of people’s image of robots.

Since now, only a small amount of studies have investigated the main aspects of these representations, surveying people at different stages of the lifespan and identifying their expectations and needs with respect to technology and in particular domestic robots.

The consideration of personal factors may help to clarify when robot can be perceived as mechanisms that facilitate regaining of independence, and when, on the contrary, they are seen as a threat to self-identity and autonomy.

Scopelliti, Giuliani and Fornari [3] interviewed several persons of different ages, aimed at identifying their actual representation of domestic robots, in particular how they should appear and work. The following results emerged:

1. People prefer direct speech to interact with the robot, usually through short and simple words (“as when speaking to my dog”)
2. People indicated the use of both acoustic and visual modality with respect to how the robot should communicate.
3. Respondents described the potential interaction with the robot by referring to “social dynamics”, typical of human beings. In particular this aspect involves: privacy regulation, unobtrusiveness, and equal relation instead of that between lord and slave
4. Finally, the robot should be small enough to be able to move everywhere inside the house.

When dealing with acceptance of robots, it is important to not only address acceptance in terms of the usefulness and ease of use of a system but also relational or social acceptance. This means that a user accepts the robot as a conversational partner, finds the robot’s social skills credible, sees the robot as an autonomous social being, and is more likely to exhibit natural verbal and non-verbal conversational behavior as well as feeling comfortable in interacting with the robot.

In addition to these described features, we must also consider that usually the elderly are not familiar with using new technologies involving complex interaction styles. As a consequence, elderly people can be fearful at the prospect of having a robot at home by experiencing negative feelings and general anxiety.
3. Our proposal: An affective interfaces to improve user acceptance in robotic applications

We propose an interesting solution to user acceptability issue through the developing of an Affective Robot.

The interaction with affective robots is based on social communication between humans. As a result of human evolution, humans are experts in using and understanding social communication principles. Therefore, this interaction style is expected to be very suitable, intuitive, and straightforward.

Our project will target the arising paradigm related to ambient intelligence and the use of relational and cognitive robots fusing information from embodied unobtrusive sensory interfaces and capturing the dynamic behavioral profile of the user (gesture, gait, body dynamics) and the physiological response of the user to events (analysis of ECG, respiration, electro-dermal response).

User emotional state recognition and user-robot interaction will arise from a three step process:

1) Emotional expressions produce different changes in autonomic activity. In particular, some main biological processes modify themselves according to emotional states valence and arousal level. For examples, anger is associated with increased heart rate and skin temperature; fear with increased heart rate and decreased skin temperature; happiness with decreased heart rate and no change in skin temperature.

Subjective physiological parameters will be recorded in a baseline condition, together with different emotional conditions (by presenting various stimuli, as images, videos and sounds), thanks to a new generation of biosensors [4].

In this first phase we will take into account only valence and arousal aspects. These measures will be useful in order to identify, in the next step, more complex emotional configurations.

2) Non-verbal and behavioral aspects (voice intonation, prosody and content, posture, gestures, movement, level and type of activities performed) are powerful indicators of different emotions experienced by subjects. In order to obtain a rich and coherent frame, both physiological and behavioral signals will be detected and interpreted as a whole.

Behavioral and speech parameters will help to identify the following states: Joy; Fear/Anger/Sadness/Apathy/Concern.

3) In addition to implicit emotional measures, some explicit measures will be considered, represented by self-evaluation questionnaires and semi-structured interviews. These will be identified and adjusted basing on some clinical tests.

According to the previous implicit evaluations it will be possible to identify the presence of some main clinical disease: Depression/Anxiety/Stress.

According to the supposed emotional state detected, the robot will try to obtain more information by asking the user about his/her emotional state.

The robot action and speech will be adjusted to previous phase results and will be aimed at two main goals:

1) to build a natural and affective user-robot relationship
2) to prevent or reduce some negative emotional states and unsafe behaviors.
An embodied affective-based human-robot is at the core of our proposal, in order to establish a proactive and emotional interaction with the elderly, encouraging and motivating him and becoming his intermediary with the external world.

This social and affective robot will be used to:

- stimulate mental activity, to prevent memory problems and compensate for memory problems by intelligently reminding its users;
- facilitate communication with external world, by avoiding the risk of loneliness;
- support the elderly in his daily activities;
- monitor his health status and coach him for a healthier lifestyle;
- identify critical situations and to activate emergency calls.

4. A possible scenario

John is a 73 year-old man, still in very good shape, with only some slight memory and hearing deterioration problems. He bought the affective robot, naming it “Digy”, and has the overall AI system in his home.

This day, the daily planner scheduled a medical visit at 2.00 P.M., to be performed by mean of the Digy video conferencing system.

John is quite upset about the doctor visit, since in the last visits some embarrassing situations occurred: when asked about his problems, he sometimes forgets to report some important things; it also happened that he was not able to remember the doctor’s prescriptions and suggestions at the end of the visit.

Daily planner and user profile knowledge allows Digy to predict that John will be very anxious this day. When John wakes up, the biosensors monitoring system detect a physiological activation; during a short conversation, speech prosody, and content analysis module indicates a clear “concern” state; Digy puts some pre-defined questions (as “Do you feel self-confident?”’, “Do you feel nervous and restless?”’, “Do you have negative thoughts’”) and, after having analyzed John answers, it classifies John state as “anxious”. Digy behaves as an expert consultant: he reminds John about some strategies to deal with the visit. It suggests him to summarize and write down what it is important for the doctor to know, about his health status and last day’s situation; John should also prepare a paper to record medical prescriptions. Digy also invites John to visit the “memory book”, identified by a specific icon on the monitor, containing some multimedia information about memory functioning and strategies, together with some exercises to train memory abilities.

Then, he suggests a relaxing and pleasant activity to John to be performed just before the visit (for example, to cook a good lunch, to phone to his grandchild).

Digy will also record John and doctor’s conversation, registering important information about healthy program and ongoing variations.
References


