Emulating Empathy in Socially Assistive Robotics

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Abstract

Evidence from psychology indicates that perceived empathy has a host of beneficial effects on attitudes and social behavior. Empathy plays a key role in patient-centered therapy, because it implies the apprehension of another's inner world and a joint understanding of emotions. This paper is a short survey of main issues relating to empathy that hold relevance to robotics. We focus on the existing literature on empathy in social psychology, and discuss its possible role of empathy in socially assistive robotics, along with possible methodologies for emulating and embodying empathy on robotic systems.

Introduction

While socially assistive robotics is a relatively new field, an important number of applications for the elderly (e.g., (Roy *et al.* 2000)), people in rehabilitation (e.g., (Eriksson, Matarić, & Winstein 2005), (Tapus & Matarić 2006)), and people with cognitive and developmental disorders (e.g., (Scassellatti 2005), (Michaud & Theberge-Turmel 2002), (Robins *et al.* 2005)) have been developed. Socially Assistive Robotics focuses on the social interaction rather than the physical interaction between the user and the robot (Feil-Seifer & Matarić 2005). In our research work, we believe that an adaptive, reliable, user-friendly and empathic *hands-off therapist robot* can establish a complex and productive human-robot relationship that provides an engaging and motivating customized therapy protocol to participants in laboratory, clinic, and ultimately, home environments.

Empathy is a provocative construct, evoking debate over its measurement in any context, and its potential applications in robotics. In human-computer interaction (HCI), there are very few research projects (e.g., (Bickmore 2003), (Paiva *et al.* 2004)) that attempt to emulate empathy in virtual agents. No work has yet tackeled the issue of empathy in the assistive physically embodied human-robot interaction.

One reason for our interest in empathy in socially assistive robotics is the findings of many psychologists showing that empathy plays a key role for therapeutic improvement (e.g., (Rogers 1975)) and their assumption that empathy mediates pro-social behavior (e.g., (Eisenberg 1986), (Hoffman 1981)). Rogers (Rogers 1975) showed that patients who have received empathy, genuineness, and unconditional positive regard from their therapist recovered faster. Therefore, we posit that empathy can ameliorate patient satisfaction and motivation to get better, and enhance adherence to therapy programs in the context of patient-therapist interaction.

Machines cannot feel and express empathy. However, it is possible to build robots that appear to show empathy. This paper is a short survey of main issues relating to empathy that hold relevance to robotics. We focus on the existing literature on empathy in social psychology, and discuss its possible role of empathy in socially assistive robotics, along with possible methodologies for emulating and embodying empathy on robotic systems.

Empathy in Socially Assistive Robotics

Empathy: Definition

The current concept of empathy originated as *Einfühlung* (i.e., feeling into somebody) in the late 19th century German aesthetics and was translated as empathy (i.e., from the Greek *empatheia*, meaning affection or passion) in the early 20th century American experimental psychology. Many definitions of empathy can be found in the literature. The definition we adopted in our work was given by (Davis 1983) and defines empathy as *the capacity to take the role of the other, to adopt alternative perspectives vis a vis oneself and to understand the other's emotional reactions in consort with the context to the point of executing bodily movements resembling the other's*. This definition implies that, first, empathy is expressed through perspective taking; second, that empathy is an internal state similar to emotion; and, third, that this emotional state can sometimes be recognized through imitative bodily movements.

Empathy: Model

The model of empathy adopted in our work is inspired by (Davis 1983). According to Davis, there are two main ways considering empathy: as the process and as the outcome. The process of empathy refers to something that happens when someone is exposed to another person (e.g., taking the other's perspective or unconsciously imitating the other's facial expression). The outcome of empathy is something that results from the processes of empathy, and can be affective or cognitive. The affective outcome of empathy is considered an important motivator of pro-social behavior. The feelings or condition of a person can generate strong vicarious emotion in others. The emotion is vicarious in that neither the conditions that affect the person who is the object of empathy nor his/her emotions have any direct effect on the empathizing person. The cognitive outcome of empathy relates to awareness, understanding, knowing of another's state or condition or consciousness, or how another might be affected by something that is happening to him/her. This is also referred to as role taking or perspective taking.

Empathy: Emulation in Robotics

According to (Feshbach 1987), empathy reaction can be postulated to be a function of three factors:

1. the cognitive ability to discriminate affective cues in others;
2. the more mature cognitive skills entailed in assuming the perspective and role of another person;
3. emotional responsiveness, the affective ability to experience emotions.

Taking into account all these elements and the previously given definition and model, we propose the following features that need to be embodied in an empathic robot:

- the robot should be capable of recognizing, understanding, and interpreting the other's emotional state (emotional expression and/or reaction created by a specific situation);
- the robot should be capable of processing and expressing its emotions by using different modalities (voice, facial expressions, and body movements and gestures);
- the robot should be capable of communicating with others (communication is considered part of any definition of empathy (Keefe 1976));
- the robot should be capable of perspective taking.

Our previous behavior control architecture, presented in (Tapus & Matarić 2006), takes into account different factors: proxemics, verbal and non-verbal communication, and robot activity. Two of those elements are also useful in emulating empathy: verbal and non-verbal communication. Proximity, i.e., the interpersonal distance, is another important element worthy of consideration, because it plays a key role in human interactions. It is well known that people have stronger empathic emotions and reactions when the interaction episodes are associated with others with whom they have a social relationship (e.g., friends, family) or a common background (e.g., a person who lived through a similar experience). To be able to use this factor, humans need to create strong bonds with robots of the nature similar to those formed with other humans. We posit that understanding human affect and reacting suitably to different social situations (e.g., so as to avoid misunderstandings and to permit natural interaction) will lead toward an improved emphatic appearance of the robot. Verbal and non-verbal communication provide social cues that make robots appear more intuitive and natural. As previously mentioned, there are two ways of mediating empathy: cognitive and affective. In the cognitive way, the robot should show empathy, in other words it should appear as if it understands others' emotions, can mimick others' emotions, and can behave as if the others' emotions affect it. In the affective way, the robot should manifest emotions through its facial expressions, voice, body postures, movements, and gestures so as to fit the situational context.

Some studies (Sterling & Gaertner 1984) have shown a positive correlation between empathy and physiological indices (e.g., heart rate accelaration, palm sweating). These physiological responses can also be used by the robot as a significant source of sensory information for real time interaction and emphatic response.

Importantly, the robot does not feel empathy in any real sense; instead, it is projecting empathy through the recognized means of expression overviewed above. As with any area of human-robot interaction, this involves a careful consideration and management of the user's expectations. The robot's empathy needs to be sufficiently believable, but not so realistic as to provoke expectations that cannot be met (Masahiro 2005).

Our first attempts towards emulating empathy with a socially interactive robot are based on the understanding and mimicking of the emotions of others (i.e., human users). We have developed a simple vision-based facial expression detection system capable of identifying a basic set of facial expressions including smiling, frowning, sadness, anger, etc. The list of facial expressions our system is capable of detecting is a subset of the Eckman's six basic emotions on human facial expression: joy, sadness, fear, anger, disgust and surprise (Eckman 1979). Our system will allow the robot to detect and recognize basic facial emotions, and then mimick them, thereby conveying the impression of knowing something about the user's inner state and empathizing with it. This can also be reinforced by appropriate verbal communication; the robot can express its understanding through empathetic voice and phrases that are appropriately matched to the emotional state of the user. Recent research work in linguistics (Cordella 2004) showed that a doctor's empathetic voice encourages the patient to adhere to the treatment regime and help building doctor-patient trust. Therefore, we believe that speech and language play important rols in expressing empathy in robotics, as does embodied expression through "body language."

Empathy: Measurement

Another important element in the empathy's description is the way empahty is measured. Here, we focus on two main methodologies: (1) Interpersonal Reactivity Index (IRI) (Davis 1983) and (2) the Barrett-Lennard Relationship Inventory(BLRI) (Barrett-Lennard 1986).

(Davis 1983) developed the Interpersonal Reactivity Index (IRI) as a measure of individual differences in empathy. The IRI consists of four scales, each composed of 7-item subscales, measuring a distinct components of empathy:

- **Empathic Concern**: feeling emotional concern for others (i.e., feeling sympathy, compassion, warmth, and concern).

Figure 1: Therapist Hands-Off Robot

- **Perspective Taking**: cognitively taking the perspective of another. It measures the tendency to spontaneously adopt the psychological point of view of others.
- **Fantasy**: emotional identification with characters in books, films etc.
- **Personal Distress**: negative feelings in response to the distress of others. It measures the feelings of personal anxiety and unease in tense interpersonal settings.

The rationale underlying IRI is that empathy is a multidimensional phenomenon that can be described as a set of distinct but related constructs that all involve reactions to other people. Davis found empirical support for this approach to empathy and demonstrated the validity of IRI by showing relationships among its subscales and between the subscales and other psychological measures.

The second approach for measuring empathy we are interested in is the Barrett-Lennard Relationship Inventory (BLRI) (Barrett-Lennard 1986), used to measure empathy, regard, and congruence. One of the main objective of this inventory was to explore the patient-physician relationship. The Barrett-Lennard Relationship Inventory (BLRI) was initially developed to assess qualities of the therapist-patient relationship and has been adapted for use in medical situations to assess the patient-physician relationship. Besides yielding a global measure of the relationship, it also assesses the warmth, honesty, and understanding experienced in the relationship by the patient. The subscale scores can range from 8 to 48.

We envision the users of empathetic socially assistive robots being able to quantify the therapist robot's empathy using appropriately presented versions of the measures above.

Conclusions

The goal of our research is not to substitute human with robotic care. Instead, the intention is to provide much-needed care where it is current lacking, and where the gap in available care will increase due to recognized demographic trends. In that context, creating robots capable of emulating empathy is a very important step towards having them be part of our daily lives.

This paper presented some of the elements needed for emulating empathy on embodied socially assistive robots. Our ongoing work continues to develop real-world experimental designs in which an empathy model can be tested on our therapist hands-off robot (see Figure 1) and other available testbeds. We will also address the relationship between personality and empathy, building on our prior results on robot-user personality matching (Tapus & Matarić 2006).

Acknowledgments

This work was supported by USC Women in Science and Engineering (WiSE) Program and the Okawa Foundation.

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