Closing the Loop: from Affect Recognition to Empathic Interaction

Iolanda Leite,
André Pereira,
Samuel Mascarenhas
INESC-ID and Instituto Superior Técnico
Porto Salvo, Portugal
iolanda.leite@inesc-id.pt

Ginevra Castellano
Dept. of Computer Science
School of EECS
Queen Mary Univ. of London
United Kingdom

Carlos Martinho,
Rui Prada, Ana Paiva
INESC-ID and Instituto Superior Técnico
Porto Salvo, Portugal

ABSTRACT

Empathy is a very important capability in human social relationships. If we aim to build artificial companions (agents or robots) capable of establishing long-term relationships with users, they should be able to understand the user's affective state and react accordingly, that is, behave in an empathic manner. Recent advances in affect recognition research show that it is possible to automatically analyse and interpret affective expressions displayed by humans. However, affect recognition in naturalistic environments is still a challenging issue and there are many unanswered questions related to how a virtual agent or a social robot should react to those states, and how that improves the interaction. We have developed a scenario in which a social robot recognises the user's affective state and displays empathic behaviours. In this paper, we present part of the results of a study assessing the influence of the robot's empathic behaviour on the user's understanding of the interaction.

Categories and Subject Descriptors

H.5.2 [**Information Interfaces and Presentation**]: User Interfaces; I.5.2 [**Pattern Recognition**]: Design Methodology; J.4 [**Computer Applications**]: Social and Behavioural Sciences

General Terms

Human Factors, Design, Theory.

Keywords

Affect recognition, empathy, artificial companions.

1. INTRODUCTION

Empathy plays an important role in human social interaction. Hoffman [8] defines empathy as "an affective response more appropriate to someone else's situation than to one's own". It includes perspective taking, the understanding of affective states of others and communication of a feeling of care [6]. Therefore, empathy is often related to helping behaviour and friendship: people tend to be more empathic towards friends than towards strangers [11].

Although no precise definition of the internal processes of empathy exists to date, most researchers agree that empathy has at least two phases. First, the assessment of the other's affective state and, in a second phase, a reaction (either by affective responses or "cognitive" actions) taking into account the other's state. Therefore, to endow social robots or virtual agents with empathic capabilities, we need to (1) recognise some of the user's affective states and (2) define a set of empathic behaviours to be expressed by the robot taking into account those states. These two phases are equally important. As discussed by Cramer et al. [5], the incorrect assessment of the user's affective states (and consequent inappropriate empathic behaviours) can have negative effects on user's attitudes towards robots.

Our goal is to develop an empathic robot companion capable of recognising some of the user's affective states and reacting in an appropriate manner. We hypothesise that with this social capability, users would be willing to continue the interaction and eventually establish a social relationship with the robot. To achieve this goal, we are developing an affect recognition system capable of detecting user's naturalistic affective states in a real world environment [3]. Once our companion is able to recognise some of the user's affective states, another important question arises: how can we use the knowledge about the user's state to actually improve the robot's behaviour? To evaluate the impact of empathic behaviours on people's perceptions of robotic companions, we developed a scenario in which an iCat robot observes a chess match between two players, and behaves in an empathic manner by commenting the game and disclosing its affective state. In this paper, we present part of the results of an experiment conducted within this scenario.

2. RELATED WORK

Previous studies have shown some of the benefits of modelling empathy in virtual agents [12, 13]. Empathic agents can better relieve user frustration [9, 10], foster empathic feelings on users [14], assist users in stressful situations [16], or even provide social support and comfort [1], when compared to agents without empathic capabilities.

AFFINE'10, October 29, 2010, Firenze, Italy.

In contrast to the extensive list of related work concerning empathy in virtual agents, only recently the first empathic robots started to appear. This may happen due to the required effort to recognise the user's affective state in human-robot interaction. While during the interaction with virtual agents the user is often in front of a computer and the affective state can be predicted, for example, by task-based information that the user provides to the agent or predefined dialogue utterances, the interaction with robots tends to be more open-ended and thus perceiving user activity becomes a more challenging task. Nevertheless, this is changing, considering the first working prototypes of automatic affect recognition using different modalities such as vision, speech or physiological signals [19].

Most of the research addressing empathy in human-robot interaction has focused on emotional contagion, which is a particular aspect of empathy. One of such examples can be found in [7], where an anthropomorphic robot that recognises a simple set of user's emotions (through speech) mirrors such emotions using facial expressions, while the user reads a fairy-tale in an "emotional" way.

In the same line of research, Riek and Robinson [17] conducted a study in which a robot with the form of a chimpanzee head mimics the user's mouth and head movements. The results of this study suggest that people interacting with the facial-mimicking robot considered the interaction more satisfactory than participants who interacted with a version of the robot without mimicking capabilities.

More recently, a study assessing the effects of empathic behaviours in people's attitudes towards robots was performed [5]. The experiment consisted of a video-based survey where participants saw a four-minute video with an iCat robot playing a cooperative game with an actor. The robot displayed inaccurate or accurate empathic behaviour towards the actor (depending on the control group). Results indicate that inaccurate empathic behaviours have significant negative effects on user's trust towards robots. Also, the relationship between the robot and the actor was perceived as closer by participants who watched the robot displaying accurate empathic behaviours. This study is similar to the one that will be presented in this paper, but with some key differences in the interaction. The evaluation in this earlier study was video-based, whereas in this paper's study subjects interacted directly with the robot and the interaction lasted at least one hour.

3. SCENARIO

We developed a scenario where the Philips' iCat robot [18] observes the chess game between two players, reacting emotionally and commenting the moves played on an electronic chessboard in an autonomous way (see Figure 1). The robot treats the two players differently, empathising with one of them - the "companion" - and behaving in a neutral way towards the other player - the "opponent".

To empathise with the companion, the iCat uses a role-taking approach. After every move played on the chessboard, the robot assesses the companion's affective state by appraising the contextual information obtained from the game. A previous study has shown that, in a game scenario context, the state of the game is relevant to discriminate the valence (positive or negative) of the player's affective state [2]. In the future, we intend to combine this information with the affect recognition system that we are developing, which also takes into account visual information such as smiles, head movements and other facial features [3].

Figure 1: Users interacting with the iCat.

After analysing the state of the game using a chess heuristic function in the perspective of the companion, the iCat predicts the companion's affective state and updates its own affective state accordingly. This way, the robot's facial expressions will be congruent to the companion's possible affective state, and the comments vary whether the move was played by the companion or by the opponent (for more details on the generation of the robot's empathic behaviours please see [15]).

When the iCat comments the companion's moves, the comments are much more empathic, in the attempt to motivate and encourage the companion (e.g. "you're doing great, carry on!", "don't worry, you didn't had better options", ...). When the iCat comments the opponent's moves, the utterances merely indicate the quality of the move in a very neutral way (e.g. "not a very good move", "you played well this time", ...). Also, during the game, the robot looks at the companion two times more than it does to the opponent and, while commenting the moves, it uses the companion's name more frequently (also two times more). The empathic and neutral behaviours displayed by the robot were inspired on characteristics of empathic teachers [4].

4. STUDY

The objective of this experiment was to evaluate people's perceptions of an empathic robot. Forty subjects took part in the experiment (36 male and 4 female, ages ranging between 18 and 28, mean age 21.5). All participants were undergraduate or graduate students recruited via email who knew how to play chess and had never interacted with the iCat before.

Participants were paired up based on their availability and, at the assigned schedule, they were asked to play an entire game against each other, having the iCat on their side commenting the moves. At the end of the game, subjects were guided to a different room where they answered a friendship questionnaire and filled in a set of open-ended questions to assess which goals and expectations participants had when interacting with the iCat ("I liked that iCat...", "When I played bad, iCat...", "When I played well, iCat...", "When I was feeling insecure about the game, iCat..." and "What would make me interact with iCat again is...").

Two different conditions concerning the iCat's behaviour were evaluated. Players towards whom the robot behaved in an empathic manner belong to the *empathic* condition, and

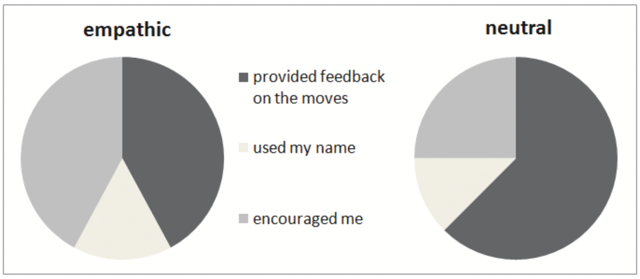

Figure 2: Most frequent answers to the open question "I liked that iCat...".

the remaining players belong to a control group (*neutral*). This means that we have 20 subjects in each condition.

4.1 Results

In this subsection we present the most interesting findings collected from the open questions that subjects were asked about their experience with the iCat. As we are working with qualitative data, the corpus was analysed manually. For each question, the similar responses were categorised and associated to a label. After that, the frequencies of these categories were analysed for each condition (neutral and empathic).

4.1.1 I liked that iCat...

Participants in both conditions, stated that they liked that the iCat provided feedback on their moves, and the fact that the robot used their names when speaking (for more details see Figure 2). In the empathic condition, almost half the subjects also mentioned that they liked the iCat because it encouraged them in the difficult moments of the game:

> *"iCat knew exactly the best moves I should play, and even when the game was almost lost it kept giving me hope to continue"*

Another participant in the empathic condition even mentioned that the robot elicited empathy feelings on him:

> *"I liked that the iCat used my name and commented my moves. Its facial expressions and movement made me feel empathy"*

4.1.2 When I played bad, iCat...

In both conditions most users acknowledged that the robot warned them about their bad moves. In addition, some of the subjects in the empathic condition answered that the iCat got sad when they played bad, and the opposite for the neutral condition (the iCat got happy). Four participants in the empathic condition also mentioned that when they played bad moves, the robot encouraged them to play better:

> *"The iCat got sad... but it was nice to me, saying that he was expecting more."*

4.1.3 When I played well, iCat...

Almost all subjects said that the iCat congratulated them when they played good moves. Some participants in the empathic condition stated that the robot got happy when they played good moves, and some subjects in the neutral condition said that the robot got sad. Like in the previous assertion, eight subjects from the empathic condition also added that the robot encouraged them to play better:

> *"When I played a good move, iCat demonstrated his support, and I felt good with myself."*

In some situations, participants in the neutral condition did not agree with the robot's evaluation of the game, yet they tried to took advantage of the situation:

> *"When I played well, sometimes the iCat said I didn't, but I was taking risks. In some situations I was trying to bluff and fool my opponent, and iCat's opposite comments were good for me because my opponent seemed to give lots of relevance to them."*

4.1.4 When I was feeling insecure about the game, iCat...

In this question, nearly one third of the subjects indicated that they did not feel insecure in any part of the game. For the other cases, the opinions differed among conditions. While around half the participants in the neutral group did not notice any differences in the iCat's behaviour, six subjects in the empathic group stated that the robot encouraged them when they felt insecure during the game.

> *"When I felt insecure during the game, the iCat tried to make me calm, so I could better play my next moves."*

On the other hand, some of the subjects in the neutral condition recognised that the iCat supported more their opponent:

> *"It didn't help much... I got the feeling that iCat was supporting my opponent the whole time and didn't care about me."*

4.1.5 What would make me interact with iCat again would be...

The answers to this question could be categorised in four different topics: (1) subjects who would like to interact with the robot again because they had fun during the interaction, (2) subjects who would like to play against the iCat, (3) those who wanted to improve their chess skills and (4) participants who would like to repeat the interaction as it is (playing another chess match with the iCat commenting the game). The frequencies of these categories for each condition are depicted in Figure 3. While in the neutral condition almost half the subjects would like to interact again with the iCat just for fun, participants in the empathic group would like to play another game in this same setting and improve their chess skills.

In addition to these motives, some of the participants also would like that the iCat could explain in more detail the reason for its comments. For instance, explain why a certain move was good or bad, or suggest other moves when users play a bad move. Furthermore, some users in both conditions claimed that they would like to perform other type of activities with the iCat.

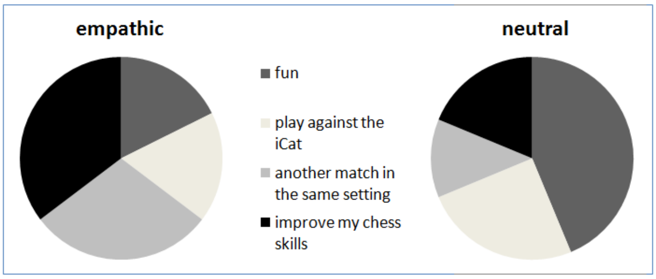

Figure 3: Most frequent answers to the open question "What would make me interact with iCat again...".

5. CONCLUSIONS AND FUTURE WORK

In the last few years, promising methods for affect recognition in real-world settings have been reported in the literature, some of which can be extremely useful in human-robot interaction. However, robots capable of recognising the user's affect in real-time and selecting appropriate responses taking into account the user's state are still not numerous. We believe that the latter capability is as important as the first: what is the advantage of having an accurate affect recognition system if, in the end, the robot behaves in the same way? Therefore, while working on an affect recognition system, we are also addressing aspects of empathy and how that may influence the possible relation established between the user and the robot.

This paper presented the results of a study about people's perceptions of a robot displaying empathic and neutral behaviours. By analysing the answers that users provided, we can conclude that the empathic behaviours of the robot were well recognised by users. Participants towards whom the iCat behaved in an empathic manner found the robot more encouraging and more sensible to their feelings. Also, more subjects from the empathic condition would like to interact again with the robot in this scenario.

This study has some limitations in terms of the sample. Ideally the sample should be gender-balanced, but only four women participated in this experiment, as it was performed at a computer science university where most students are male.

In the future, we intend to integrate in this scenario an affect recognition system that considers not only the context of the task but also visual information from the user, and perform an experiment with repeated interactions (the same users playing several games). With more accurate information on the user's affect, the robot should be able to respond to its companion even in a more sociable acceptable manner. Also, we are planning to improve the robot's responses by, in the long-term, adapting certain empathic behaviours to a particular user.

6. ACKNOWLEDGMENTS

This work was supported by the EU FP7 ICT-215554 project LIREC (LIving with Robots and intEractive Companions), FCT (INESC-ID multiannual funding) through the PIDDAC Program funds, and 3 scholarships (SFRH/BD 41358/2007, 41585/2007 and 62174/2009) granted by FCT.

7. REFERENCES

[1] T. Bickmore and D. Schulman. Practical approaches to comforting users with relational agents. In *CHI '07: CHI '07 extended abstracts on Human factors in computing systems*, pages 2291–2296, New York, NY, USA, 2007. ACM.

[2] G. Castellano, I. Leite, A. Pereira, C. Martinho, A. Paiva, and P. McOwan. It's all in the game: Towards an affect sensitive and context aware game companion. In *Affective Computing and Intelligent Interaction and Workshops, 2009. ACII 2009. 3rd International Conference on*, pages 1 –8, sept. 2009.

[3] G. Castellano, A. Pereira, I. Leite, A. Paiva, and P. W. McOwan. Detecting user engagement with a robot companion using task and social interaction-based features. In *ICMI-MLMI '09: Proceedings of the 2009 international conference on Multimodal interfaces*, pages 119–126, New York, NY, USA, 2009. ACM.

[4] B. Cooper, P. Brna, and A. Martins. Effective affective in intelligent systems - building on evidence of empathy in teaching and learning. In A. Paiva, editor, *IWAI*, volume 1814 of *Lecture Notes in Computer Science*, pages 21–34. Springer, 1999.

[5] H. Cramer, J. Goddijn, B. Wielinga, and V. Evers. Effects of (in)accurate empathy and situational valence on attitudes towards robots. In *HRI '10: Proceeding of the 5th ACM/IEEE international conference on Human-robot interaction*, pages 141–142, New York, NY, USA, 2010. ACM.

[6] A. P. Goldstein and G. Y. Michaels. *Empathy : development, training, and consequences / Arnold P. Goldstein, Gerald Y. Michaels*. New American Library, 1985.

[7] F. Hegel, T. Spexard, T. Vogt, G. Horstmann, and B. Wrede. Playing a different imitation game: Interaction with an Empathic Android Robot. In *Proc. 2006 IEEE-RAS International Conference on Humanoid Robots (Humanoids06)*, pages 56–61, 2006.

[8] M. Hoffman. *History of the concept of empathy.* Cambridge University Press, 2000.

[9] K. Hone. Empathic agents to reduce user frustration: The effects of varying agent characteristics. *Interact. Comput.*, 18(2):227–245, 2006.

[10] J. Klein, Y. Moon, and R. W. Picard. This computer responds to user frustration. In *CHI '99: CHI '99 extended abstracts on Human factors in computing systems*, pages 242–243, New York, NY, USA, 1999. ACM.

[11] D. L. Krebs. Altruism: An examination of the concept and a review of the literature. *Psychological Bulletin*, 73(4):258–302, 1970.

[12] S. W. McQuiggan and J. C. Lester. Modeling and evaluating empathy in embodied companion agents. *Int. J. Hum.-Comput. Stud.*, 65(4):348–360, 2007.

[13] M. Ochs, C. Pelachaud, and D. Sadek. An empathic virtual dialog agent to improve human-machine interaction. In *AAMAS '08: Proceedings of the 7th international joint conference on Autonomous agents and multiagent systems*, pages 89–96, Richland, SC, 2008. International Foundation for Autonomous Agents and Multiagent Systems.

[14] A. Paiva, J. Dias, D. Sobral, R. Aylett, P. Sobreperez,

S. Woods, C. Zoll, and L. Hall. Caring for agents and agents that care: Building empathic relations with synthetic agents. In *AAMAS '04: Proceedings of the Third International Joint Conference on Autonomous Agents and Multiagent Systems*, pages 194–201, Washington, DC, USA, 2004. IEEE Computer Society.

[15] A. Pereira, I. Leite, S. Mascarenhas, C. Martinho, and A. Paiva. Using empathy to improve human-robot relationships. In *Proceedings of the 3rd International Conference on Human-Robot Personal Relationships*. Springer, 2010.

[16] H. Prendinger and M. Ishizuka. the Empathic Companion: a Character-Based Interface That Addresses Users' Affective States. *Applied Artificial Intelligence*, 19(3-4):267–285, 2005.

[17] L. D. Riek, P. C. Paul, and P. Robinson. When my robot smiles at me: Enabling human-robot rapport via real-time head gesture mimicry. *Journal on Multimodal User Interfaces*, 3(1-2):99–108, 2010.

[18] A. van Breemen, X. Yan, and B. Meerbeek. icat: an animated user-interface robot with personality. In *AAMAS '05: Proceedings of the fourth international joint conference on Autonomous agents and multiagent systems*, pages 143–144, New York, NY, USA, 2005. ACM.

[19] Z. Zeng, M. Pantic, G. I. Roisman, and T. S. Huang. A survey of affect recognition methods: Audio, visual, and spontaneous expressions. *IEEE Transactions on Pattern Analysis and Machine Intelligence*, 31(1):39–58, January 2009.