Enhancing Affective Communication in Embodied Conversational Agents

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Abstract. *In this article, we present current work being developed in collaboration between UFRGS (Brazil) and LIG laboratory (France) inserted in the scope of PRAIA Project - international project of cooperation between UFRGS and LIG. We first motivate the use of Embodied Conversational Agents (ECAs) by showing and contextualizing research, in order to establish a foundation for understanding how these agents may be useful in human-computer interaction. We then give more details about the agent, its purpose and scenario, together with important characteristics of its development. Finally we conclude with more information about the cooperation and also demonstrating the importance of the research in this field.*

1. Introduction

One of the objectives of AI (Artificial Intelligence) is to provide formal tools for the development of computerized systems which express human beings' intellectual behavior when performing a certain activity [Russel and Norvig 1995]. Since early times, human beings have tried to develop natural communication among interlocutors. As technology has developed and consequently the access to personal computers and to the Internet, such concern has also focused on machines. Interface between machines and humans is getting more complex and better planned, moving towards more human-like ways of communication.

Embodied Conversational Agents (ECAs) can be defined as computer-generated characters that are able to demonstrate many of the same properties as humans in face-to-face conversation, including the ability to produce and respond to verbal and nonverbal communication [Cassell et al. 2000]. In order to emulate the experience of human face-to-face conversation, several verbal and nonverbal modalities of communication can be used: speech, intonation, gaze, facial display, gesture, among others. Because of the importance of nonverbal issues, ECAs must also be conversational in their behaviors, and human-like in the way they use their bodies in conversation, aiming to empower, facilitate, and enrich interaction between humans and machines [Bickmore 1999].

The goal of researchers in the field of ECAs is to create agents that can be more natural, believable and easy to use, including, in this expectation, several other specific

goals like: enrich conversational capabilities, deliberate in order to provide adequate feedback in different modalities of communication, consider social intelligence issues while developing conversational agents (trust, persuasion, personality...), use emotion as a form of improving deliberation, expression, and conversation [Cassell et al. 2000]. Due to the broad scope of research and the multidisciplinary of the field, many other investigations can arise in many different areas, leading researchers with the problem of choosing among different technologies and approaches, together with developing reasoning mechanisms to achieve the main goal.

Following the motivation presented above, the objective of this work is to present an ECA capable of communicating affectively with users. Actually we are strongly interested in an ECA capable of providing affective feedback considering an expressive communication language (briefly discussed in next section) and emotion as a tool for reasoning and behaving.

2. The agent

The role of our agent is to guide its own construction, as well as participate on it. We are developing a scenario where two participants must collaborate in order to define not only physical characteristics of the ECA, but also emotional ones (based on personality behaviors).

Initially, the role of the agent is to guide the user while deciding the appearance and personality of an agent for use as part of other systems (there are many possibilities in different applications: representing the student or the teacher inside educational environments, representing characters in games, interface web agents...). As far as the conversation goes and participants start to decide on aspects of the agent personality, the agent will go deep in conversation, reacting according to its characteristics (by means of language expression and other multimodalities of communication - i.e - if participants decide the agent will have soft personality, the conversation will be conducted accordingly). The idea behind the strong focus on emotion in our agent can be justified by the fact that emotions represent one important modality when communicating a message and latest scientific findings indicate that the use of emotions in ECAs may contribute to various domains of application. Also, the use of emotions in such agents can contribute to their credibility.

Emotional display can be a very complex phenomenon involving a wide range of verbal and nonverbal behavior, making the integration between different modalities of communication and textual exchange of messages (together with reasoning mechanisms that can take into consideration the beliefs and goals of the agent in specific environments) an interesting focus of research. By observing and participating in its own construction, our agent will consider the conditions of success and satisfaction present in each message exchanged. In this context, attitudes can affect their way of speaking and acting.

In order to achieve our goals, our agent is being developed considering a set of conversation acts formally defined in order to allow expressive communication between communities of mixed agents [Berger and Pesty 2005a, Berger and Pesty 2005b]. Mixed communities are those where agents and humans interact together. The idea behind the language is to allow expressive communication between not only software agents but also human agents. This language takes into consideration aspects such expectations, condi-

tions of success, among other characteristics that are present in human communication. The conditions of success and satisfaction are explicitly defined as well as the elements from the conversational background. The thirty two formalized conversation acts are:

- assertive $\rightarrowtriangle$ confirm, deny, think,say, remember, inform and contradict;
- commissives $\rightarrowtriangle$ commit oneself, promise, guarantee, accept, refuse, renounce and give; directives $\rightarrowtriangle$ request, ask a question, suggest, advise, require, command and forbid;
- declaratives $\rightarrowtriangle$ declare, approve, withdraw, cancel;
- expressives $\rightarrowtriangle$ thank, apologize, congratulate, compliment, complain, protest, greet.

The architecture of our agent will consist of three different modules: the understanding module, the processing module, and the generation module. The understanding module is responsible for understanding and treating the textual input received. It consists of two different phases: the input analysis and the act association. The input analysis is the process of verifying the textual input as a preparation for an act association. The act association is responsible for narrowing the analysis, choosing, through the use of knowledge base information, the different acts that can fit the input. The processing module is responsible for choosing and deciding the actions of the agent. The deliberation of the agent is based on the BDI approach [Rao and Georgeff 1991]. In this module, the action planner is responsible for generating the actions of the agent, considering the knowledge of the scenario, the point in conversation and agent emotional characteristics. Finally, The generation module is responsible for taking the actions generated by the response planner and adapt them to be expressed by the virtual agent.

3. Conclusion

We presented in this paper current research towards the development of an affective ECA. The importance of research in ECAs is evident. In recent years, many papers on the topic and related aspects can be found in leading AI scientific conferences like AAMAS and IJCAI (highlighting the workshops and special tracks focusing on the subject: special track on Virtual agents and Workshop on AI for Human Computing, respectively from AAMAS 2008 and IJCAI 2007). Another important conference on the topic is the International Conference on Intelligent Virtual Agents (IVA). IVA is the major annual meeting of the intelligent virtual agents community, attracting interdisciplinary minded researchers and practitioners from embodied cognitive modeling, artificial intelligence, computer graphics, animation, virtual worlds, games, natural language processing, and human-computer interaction.

This work is inserted in the Artificial Intelligence group of the Institute of Informatics - UFRGS (Brazil), and the research this group carries out on AI and its applications: intelligent tutoring systems, education, agents, among others. Additionally, it is being developed in collaboration with MAGMA team (Modélisation d'agents autonomes en univers multi-agents) at LIG laboratory (France). MAGMA team develops theoretical studies, computer tools and practical applications for the user in the field of MAS (multi-agent systems). This work is also inserted in the scope of PRAIA Project (Pedagogical Rational and Affective Intelligent Agents) - international project of cooperation between UFRGS and LIG, supported by Capes-Cofecub [Jaques et al. 2009]. The main goal of

the project is to develop methodologies, models, tools and solutions for handling student affect in the interaction between tutor and student.

Inside PRAIA project, a platform was defined in order to test and validate the research developed inside the scope of the project. It consists in a collaborative game, called "Collaborative Sudoku", and is a multi-user version of the popular logic-based number placement puzzle, which requires basically simple spatial reasoning. In the game, a team collaborates through a web-based interface. Supported by a game server, the partners interact, negotiating and coordinating actions in order to construct a shared solution to each proposed reasoning problem. The main goal of each team is to complete the task faster than an adversary team, matched by the server at random.

Although we are (initially) not focusing on this platform, the agent can be easily integrated inside it in the future, with the adaptation of the dialogue plan and knowledge base. The reason why this platform is not being used as the scenario for the development of the agent is that the conversation possibilities would be limited for test (helping users to solve the game by giving hints or stimulating users to perform tasks by sending supportive messages) and the agent would have a passive role in the environment.

International cooperation provides exchange of expert knowledge and collaboration of efforts in order to consolidate and deeply explore common interests of research. Some joint publications related to this work are [Leonhardt et al. 2008a, Leonhardt et al. 2008b].

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