Towards the Design of a Socio-Emotional Negotiator Agent as a Serious Games Character that Supports Learning Environments

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Abstract. Serious games are a type of video game used mainly for learning in various topics, in addition to entertaining. The design of characters for serious games requires great attention to detail, from the expression of the character to the intelligence built into its programming. This article presents a theoretical model of a negotiating socio-emotional agent architecture, which proposes a general design of behavior that a character in a serious game can execute. The behavior that is sought to generate tries to simulate the cognitive process in decision making and the process of communicating their responses through expressions and dialogues. The development of a character with these characteristics seeks to generate greater immersion on the part of the user due to the fact that it generates an interaction more attached to the reality, facilitating learning through the simulation environment of a serious game.

Keywords: Virtual agents' architectures, learning environments, serious games.

1   Introduction

The serious games are more than entertainment, they are a useful tool for training in virtual environments through simulations based on real world situations. Besides, serves to support to help people with psychological problems, for example, the game At Risk of Kognito [1], which aims to support university counsellors to treat psychological problems that affect the learning of young people who completed their military social service in the Iraq war, and return to study a university career.

One aspect to put attention in serious game development whatever the topic or implementation purpose is the credibility because it facilitates the process of transfer the knowledge learned in the virtual world to the real world To say that a serious game is credible, levels or scenarios presented are usually designed as real as possible, for example, the game Branches of power [2], which is an educational game that teaches legal processes in the government system of USA.

Likewise, characters should be credible too, therefore is important to endow characters with capabilities to emulate reasoning and expressions kinds like a human [3]. This contributes to increase interaction in users and therefore their learning; a way to reach this interaction is that the character shows personality and emotional aspects generated by its internal cognitive process programming, even implement negotiation skills on its programming, either with other characters or users.

2   Related Work

Nowadays exists serious games implemented in many topics with socio-emotional characters. An example of this games that use this kind of characters is TARDIS [4], this game shows a virtual training and advisory simulation scenario in the context of job interviews for people in job searching. This game stands out the design and modeling of characters which shows non-verbal expressions and behavior, this due to the affective module integrated on its architecture structured with the emotional approach OCC [5] and the decision module based on the approach of BDI agents (agents based on Beliefs, Desires, Intentions) [6].

Other simulation game is presented in Van-Mihn et al [7] work, that shows a virtual simulation of serious game in the context of forest fire, this work distinguish the internal modelling of decision process of the character, which also is based in BDI approach, but including Plans as element of the decision process, which give options to the character to solve activities in the game.

In addition to making decisions, characters in serious games may be able to display emotions. For example, Visschedijk et al [8], demonstrate in their work how the use of emotions in characters impacts users when playing; studies were carried out on different groups of people using humanoid animations with different expressions to measure the effect on users, all this process aiming to serve as a basis for the development of serious games in the context of the use of tactics.

Besides making decisions and showing emotions, serious game characters may have the ability to carry out negotiation processes. An interesting proposal to develop negotiation in a character is that of Villareal Hernandez [9], which, centered in the negotiation on the protocol of alternate multiple offers, demonstrates how emotions and personality alter the agent's decisions. However, this project has not yet been directed towards serious games.

In brief summary, from the aforementioned works, the use of intelligent agents as characters in serious games and the programming of their structure stand out. However, it is necessary to say that the game development of these projects does not follow a methodology or structure that delimits or formalizes in a more complete way the development of both the game and the characters that act in it.

To develop serious games there are different architectures and methodologies, such as the Crawford [10], Fullerton [11] and MTDA + N [12] (Mechanics, Technology, Dynamics, Aesthetics + Narratives). These works focus their design on the description of the mechanics and dynamics of the game, without giving details of the composition of the characters.
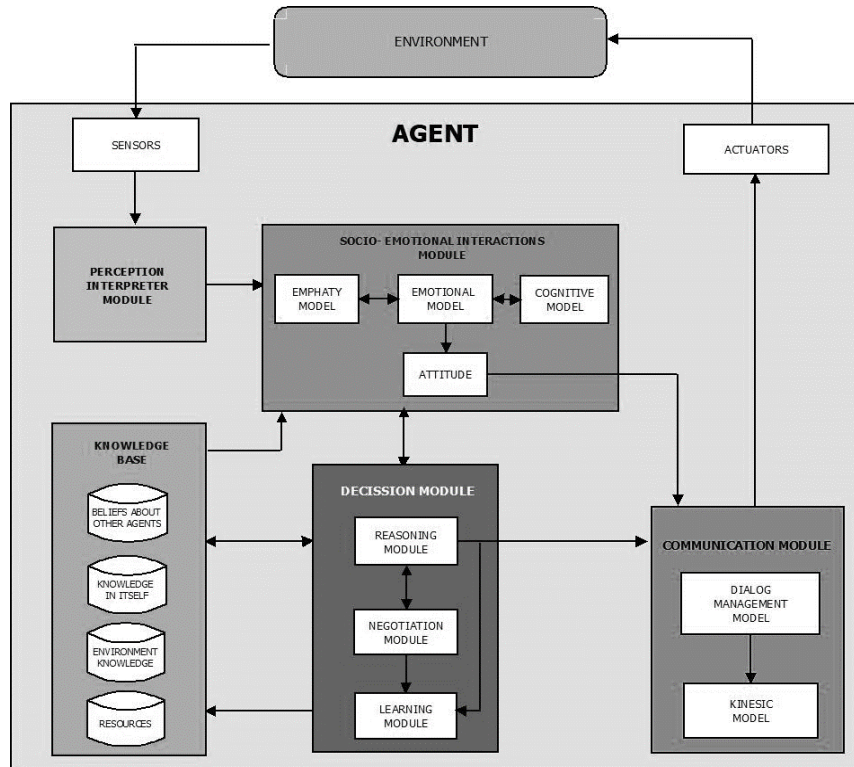
Fig. 1. Socio-emotional negotiator agent architecture.

An evolution of MTDA + N is the GAMENT framework [13], which does incorporate characters from serious games into its structure, unlike other works. GAMENT presents an architecture and methodology where the characters are associated with the components of the architecture. In general, GAMENT associates the elements of MTDA + N in its modules: Mechanics are the algorithms and bases of the game, Technology is the software to be used to develop the game, Dynamics are the interactions of the runtime mechanics, Aesthetics are the visual and auditory elements of the game and particularly interactive Storytelling (Narratives) as the main element of interaction with the user; however, it does not delve into their internal and external structure, as well as the role they must play in the game.

3   Proposal for Character Design in Serious Games

In games, two types of characters can usually be identified, either characters manipulated by the game's algorithms (NPC Non-Playable Character) or characters controlled by the user (Avatars). NPCs can be considered as intelligent virtual agents.

In order to extend the GAMENT architecture [13], a design of an intelligent socio-emotional negotiating agent is proposed considering characteristics and capabilities for

interaction with the user (see Fig. 1). Likewise, the proposal of the extension of the methodology of the same framework is made, describing internal and external aspects of the character.

The architecture is composed of four main modules: 1) the Communication module to express the character's responses, 2) Social and Emotional Interactions that structures the agent's behavior, 3) Knowledge Base for reviewing previous interactions and 4) Decision that carries out the agent's reasoning. The components of the proposed architecture are described below.

–   *Sensors:* these components receive information from elements of the environment.
–   *Actuators:* components of the agent used to execute the response obtained by its reasoning process in the environment.
–   *Perception interpreter:* it has a function of classify the information from sensors, comparing it with the knowledge bases and distributing it to the modules of social and emotional interactions and the decision module.
–   *Knowledge Base:* they are prior knowledge that the agent has stored. This knowledge deals with previous negotiations, emotional and personality aspects, agent preferences, agent resources, knowledge and behaviors about other agents according to previous interactions and actions of the alternate multiple offers protocol by which the agent is governed to negotiate.
–   *Social and emotional interactions:* Through this module the agent determines what response behavior to carry out in the interaction with the other agents. Its process is based on the result of the combination of three models: emotional, empathy and cognitive (according to Morales Rodríguez [14]). The result obtained is called attitude; This result is sent to the *Decision* and *Communication* modules for their influence and expression.
–   *Decision module:* determines the solution and/or response of the cognitive process. In addition, could implement a negotiation strategy in case the result of the attitude sent by the *Social and Emotional Interactions* module allows the formulation of an offer. The *Decision module* is made up of three internal parts: the *reasoning module*, the *negotiation module* and the *learning process.*

Through of the *reasoning module* the solution (action) is determined. The agent receives parameters of interpreter of perception and the module of *social and emotional interactions*, which are sent to the *negotiation module* to determine the best possible options to negotiate. With the offers obtained, the reasoning module is in charge of selecting the optimal one and sends it to the *communication module.*

The *negotiation module,* is based on the Villarreal Hernández [9] model, that has a function of develop the offers that the agent can accept to obtain benefits. It is made up of two sub-modules, interpreter and actions. Through the interpreter module, the agent evaluates the stimulus presented by his counterpart and with the actions module he develops the offers to present.

The *learning process* is responsible for updating the agent's knowledge bases; even though if the agent had not come to formulate an offer.

Communication module: It expresses the answers obtained from the *Decision module* and the *Social and Emotional Interactions Module*.

This module is based on the behavioral model of Morales Rodríguez [14], is made up of two parts, the dialogue management model and the kinesic model, which are combined to express the agent's behavior.

These elements are integrated into the methodology described. For example, the *Social and Emotional Interactions Module* is part of the *Mechanics* because the character generates their different behaviors through the internal structure of this module, which does not change when playing. The *Aesthetics* are shown through the *Communication* module, which is responsible for presenting the different expressions of the characters, in addition to their dialogues. So successively each module of the architecture is associated with the GAMENT framework.

The second part of the proposal is the extension of the GAMENT methodology, which center its attention on step 3 that aims to create ideas and diverse concepts of the game applied to the design of environments and characters. In particular, Step 3.5 describes the interactions of the architecture components, emphasizing the role that agents will have in *Interactive Storytelling* and in the learning process, as well as the definition of their *Mechanics*, *Dynamics* and *Aesthetics*.

The following describes the GAMENT methodology by integrating the detail of the elements of the character's architecture:

Step 1. Establish the content to be learned (goal) and the environment of the game (topic).

Step 2. Find and prepare the content to learn and the topic.

Step 3. Create diverse ideas or concepts for the game to be used, improved or discarded as appropriate.

Step 3.1. Propose game environments and visual and auditory elements that make it up.

Step 3.2. Establish the theoretical content, evaluation and feedback.

Step 3.3. Propose the idea of the Narrative that will be developed in the game.

Step 3.4. Get ideas of levels to present in the game and their respective elements: Mechanics, Dynamics, Aesthetics, Narratives and Content to learn.

Step 3.5. Design the virtual agents.

Step 3.5.1. Define the role they will have in Interactive Storytelling

It is necessary to identify the characters that will participate in the game and group them into the category they belong, be it narrator, actor or extra, which are described next.

- Narrator: describe the embedded narratives in which the character participates, through:

- Present their role or activities in the story.
- Describe the instructions to play according to the level where the player is.

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- Present the different levels or scenarios, in case the game contains different chapters of the game's history.

- Actor: being a participant in the game by presenting emerging narratives that appear during the game. Some functions that it can perform are:

- Provide clues to solve the different levels of the game.
- Support the user in the activities to be carried out in the game.
- Be the competition of the user in the game.
- Give feedback to the user.

Both can intervene in the game scenario or just be part of the game's interface.

- Extras: it is a character that, as such, does not provide help to the user, it is only a complement to the environment.

Step 3.5.2. Define the role they will have in learning

The agents present in the game, either narrator or actor, must be designed to carry out the following activities:

- Storyteller. The characters to be designed with the role of narrator must present the embedded narratives of the game.

- Actor: the character gives support to the user by presenting content from the topic of the game to solve the challenges of the level or scenario. Some activities that can be performed according to its role are:

- Present the story or theme of the game.
- Describes the elements and challenges of the current level to the user.

- Evaluator: at the end of the game, the character must evaluate the user's performance. This character can be designed to:

- Present the results obtained to the user.
- Give feedback to the user regarding the strategy implemented in the game challenge.

- Extras: they are part of the stage, they complement the design.

Step 3.5.3. Establish the mechanics according to the role of the character

The follows two types of Mechanics that can be applicable to all roles of character.

- **Character movements:** these are the movements that the character will be able to carry out. For example: walking, moving arms or fingers, head movements, etc.
- **Knowledge bases:** these are the different algorithms implicit in its programming to carry out the functions for which it will be designed.

Step 3.5.4. Structure the dynamics according to the role of the character

- **Character functions:** activities that the character performs in the game. Example: presentation of stage content, answering dialogues, feedback to the user, etc.
- **Processes of the character in the game:** implicit rational activities of the character, internal processes of its programming. Example: knowledge-based queries, definition of behavior according to behavioral models, etc.
- **Presentation of character dialogues:** narratives that the character mentions in the game, defined as a basis for the different messages that the user can make.

Step 3.5.5. Aesthetics according to the role of the character.

- **Internal structure of the character.** Design the internal parts of the character. Example: in case of being a humanoid character, structure the skeleton and movements of the skeleton.
- **Character design.** Design the visible parts of the character. For example, clothing, skin type, hairstyle, among others.
- **Design of the character's expressions.** Model the different expressions that denote the character's attitude, whether he is happy, sad, serious, asleep, etc.

Step 3.6. Create events to present game content during levels. Propose the desired dynamics and aesthetics.

Step 3.7. Propose objects which will have interaction with the player and their elements: Mechanics, Dynamics, Aesthetics.

Step 3.8. Create elements for evaluation and feedback to the player.

Step 4. Carry out the design phase: structure inputs / outputs, the game, the program and evaluate the design.

Step 5. Create physical prototypes to verify that the mechanics do their job.

Step 6. Create digital prototypes to verify that the core operation of the game systems is as desired.

Step 7. Perform the Playtesting.

Step 8. Test that the game is functional, internally complete and balanced.

Step 9. Verify that the game continues to provide the desired experience and usability.

4   Conclusions and Future Works

This document presents the architecture and methodology of the internal design of a socio-emotional agent capable of carrying out negotiation processes integrating into the GAMENT framework for the development of a serious game. It describes the different modules that the character contains and how they communicate with each other to develop the cognitive process of the character in the game. In addition, these modules

are associated with Mechanics, Dynamics, Aesthetics and Narratives to form the extended GAMENT methodology. Through this proposal, serious game developers, both experienced and novice, have a very complete guide to design the relevant characters of their applications, allowing to identify in a more graphic and direct way the functions of the characters and delve into their internal and external design according to the role to play in the game.

As future work, a module can be developed that details the character's negotiation skills, modifying the current protocol, to become independent of a specific negotiation strategy.

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