Playing with Agents - Agents in Social and Dramatic Games

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Summary. In this paper we describe the experiences we had at our group in building synthetic characters for virtual story telling and games applications. We provide an analysis framework useful to classify the autonomy of synthetic characters versus the control of the users over those characters. In this framework we distinguish between several types of autonomy of characters, in particular: scripted; partially scripted; influenced by role and autonomous. These types of autonomy can be found in some of the systems we have build at our group, namely Tristão and Isolda, Papous, Teatrix and FantasyA.

1 Introduction

When developing virtual story-telling environments, be them for entertainment or education, one of the major goals is to capture the interest and attention of the user, put him/her under the skin of the story characters and provide a narrative experience that he or she will remember and want to return to. Like films or games, virtual story-telling environments aim at providing the user with dramatic experiences, allowing the user's suspension of disbelief. Associated to a large extent to the story-telling environments, intelligent agents and synthetic characters are now being used as the way to build the characters in such environments. Their role is fundamental when we move from the traditional linear story to interactive stories or games where actions of the user affect the development of the story. Most specifically, work on intelligent agents and synthetic characters aims at providing autonomous characters with a rich personality and emotional states that are flexible enough to respond to the user's demands creating such suspension of disbelief. The great master of believability in animation, Walt Disney, once said: "I think that we must know these fellows (characters in the story) definitively before you can draw them" [22]. Their physical appearances, their personality, the way they behave, walk and talk, all are fundamental aspects to make the viewer engage in a truly captivating experience with the characters.

However, in stories and games, such emotional engagement also arises from believable "situations". The 7 dwarfs crying for Snow White in the Walt Disney film (see [22]) is an emotional experience, not only because of the characters personalities, behaviour and expressions, but fundamentally because of the situation and the function that such scene stands for the development of the story. The sequence of the story, the way it is told, its structure, its narrative elements are all components necessary for the engagement of the user. The actions of the characters in a play normally flow from a starting point where an initial complication is established, go through the climax point, and down to the conclusion of the story. In drama studies these three points are part of the Freytag's triangle, which was proposed as the structure of a dramatic incident. In fact, the functions of the actions of the characters and their causality, is according to many writers, one of the most important aspects of a story.

So, when building synthetic characters for virtual story telling or games we must generate intelligent and emotional behaviour in order to achieve interactivity and believability of the characters, and at the same time, guarantee some sequence and some structure in the character's actions to meet these dramatic incidents. This means that on one hand the characters must be autonomous, have personality and emotions to generate belivable situations, and on the other, the characters' actions must be restricted to follow a certain narrative structure. So, there are two opposing goals and a balance therefore must be found. Given the set of systems we have built so far, we believe that this balance is a result of two important factors: the type of virtual environment and interaction established with the user.

In this paperchapter we will therefore discuss these two aspects of intelligent agents and synthetic characters in virtual environments, which are: autonomy of the characters and interactivity/user control.

To do so, we will provide an initial discussion of the problems and then describe a set of systems developed at GAIPS in INESC-ID to illustrate some of the many the different approaches that can be taken to solve these problems.

2 Synthetic Characters in Interactive Storytelling

In general, work on synthetic characters in interactive story telling environments aims at providing characters in stories with a rich personality and emotional state, which will be used as the characters in the portrayed story. However, agents can play other roles in interactive storytelling or games. Among others, we can distinguish the following:

Story tellers. Embodied conversational characters can tell stories. Examples are Sam or Papous. In both cases, the character, an embodied conversational agent, is able to establish a story presentation with the user. In telling the story the character uses emotional expressions, speech and gestures to convey the message in the story.

Characters. Perhaps the type most used (see for example Teatrix [14], Marc Cavazza [6], Carmen's bright ideas [15]), characters play roles and act out their stories.

Actors. Whereas characters act as if they were in a situation (the story situation) according to their internal goals, dictated by their role, actors just follow a script (provided by a different entity) and act accordingly.

Director. Some systems, instead of creating characters that follow a certain behaviour, have a director that generates scripts for the synthetic actors. Such director can also be implemented using an agent oriented approach, thus with sensors that allows it to capture the state of the world, and with actuators that are indeed the scripts sent to the actors.

Camera agent. Similarly to the director, the camera can also be built as an agent that perceives the virtual world though its sensors and acts on it, by moving, focusing, zooming, etc.

2.1 Degrees of Autonomy of Characters

In general an agent can be seen as "a computer system that is situated in some environment and that is capable of autonomous actions in that environment in order to meet its design objectives" [24]. Although there are several different notions of what is an intelligent agent, in most of the definitions "autonomy" is central to the notion of agency. Plus, certain definitions entail pro-activeness of the agents, on top of their capability to act in an autonomous way. When we adopt this notion of agency in the context of interactive story telling, and considering the most common situation where agents act as characters in a story, the degrees of autonomy[1] can be quite diverse. We can distinguish the following possibilities:

Scripted. In this case, the characters do not have any autonomous behaviour; they simply follow a script provided by the programmer or the author. Such script is often embedded in the code of the character, which makes this approach obviously not very flexible. In fact, it requires a large amount of work to allow for interactivity, as all the possible actions of the user much be considered in the script. This type of approach is the one usually followed in computer games.

Partially Scripted. Although following a script, some systems do allow for the characters to have some independent autonomous behaviour (kind of improvisational actions)to guarantee the believability of the characters. For example, characters can improvise some idle movements, move as they like, etc. Obviously, the degree in which the character is controlled is a result of the type of scripting language used.

[1] See [5] for a discussion on different types of autonomy.

Directed. Characters follow a script given to them by a director, which can change and adapt it in real time. As with the previous cases, there can be different levels of scripting, ranging from completely controlled to only partially scripted. The difference is that the character (actor) must adapt in real time to the script sent by the director.

Constrained by role. Characters perform autonomously constrained by the role they play in the story/play. That is, the characters do not have available the whole possible range of actions, allowed for all characters, but only a few, related to their role in the story. This approach was followed in the system Teatrix [17], which will be described later.

Autonomous. Here the characters decide, according to their perception of the environment, which action to perform. If things change in the environment (perhaps by the actions of the user), characters are able to adapt to such changes and respond appropriately. The narrative structure in this situation is guaranteed by the way the characters perceive the environment, their goals and actions. Obviously there is not straightforward way of guaranteeing that the story will follow a certain path. The story will emerge from the actions of the characters.

Some applications may combine more than one type of autonomy in their characters, for example, having both autonomous and scripted characters.

2.2 Degrees of Control: the Role of the User

The other issue concerns the role of the user, which consequently affects the degree of autonomy of the agents in relation to that user. On one extreme, embodied social agents can be "fully" autonomous, and can interact with the user, through speech, facial expressions and gestures. They may recognize and respond to verbal and nonverbal input. They can exhibit verbal and non verbal output, combined with turn taking and feedback, necessary in social interactions [3]. They nod, glance, jump, point , explain, etc. in reaction to the user. Examples of such agents are Rea [4], Steve [11], Cosmo [10], and others. In general, these agents are not controlled by the user and interact with the users in a similar way that a human would. They are the ones to decide autonomously what and how to perform their tasks. The user is interacting with a third person in an interactive environment. On the other extreme, we have avatars, which are puppet-like characters, almost fully controlled by users that mimic, to the most detailed element, all the users' intended actions.

In the middle of these two extremes there are semi-autonomous avatars [19]. These combine some aspects related with the autonomy of the agents with some control of the avatars. Sengers [19] proposed the notion of semi-autonomous avatar as "agents/avatars that have their own behaviours and intentionality, but are intimately tied to the user's actions". However, there are different degrees of these ties, and we can distinguish at least the following types of control of the characters:

Puppet like control. In this type of control, characters are like puppets controlled by the user/player. The user decides where to move the character, how to move it, what to pick, etc. This includes both *motion control* and *behaviour control*. This is the most usual type of control found in avatars in computer games.

Guidance. In this type of control the user guides the character, giving it directives to where to go, but not deciding completely how to go.

Influence. In this type of control the user does not control the actions of the character but it influences certain aspects of its behaviour (for example, changing characteristics, power, emotional state, etc).

"God" like control. This type of control does not apply specifically to the characters but rather on the environment. For example, the user is able to change some characteristics in the story environment (like for example, add a prop) which will direct the storyline towards a certain path. This type of user interaction is used by Cavazza et al. [6].

No control. Finally, certain characters are not controllable by the user (thus autonomy in relation to the user) and the characters perform in an autonomous way in the system.

3 Some Applications

We will now describe some of the applications of synthetic characters in games and virtual story-telling environments developed by GAIPS (INESC-ID), focusing on the topics just discussed: autonomy of the characters and user's control.

3.1 Tristão and Isolda

S3A was a system developed for the EXPO'98 in Lisbon. Entering the S3A room of the Territory Pavilion, the visitor is driven to the beginning of Ages, "(...) to Atlantis, a place where humans and dolphins had a special way to communicate with each other. This communication was based on an apparatus that helped Humans to express their feelings to the dolphins." The apparatus is a porcelain sculpture of a dolphin, equipped with four pressure-button sensors, laid in the middle of the exhibition room, in front of a wide screen, as show in Fig. 1. The wide screen features two synthetic dolphins, Tristão and Isolda, swimming in the river Sado.

To communicate with Isolda and influence her emotional state, the visitor can, at any time, approach the sculpture and touch one of the buttons. The four types of emotions that the visitor can express to Isolda are represented in the four sensors of Fig. 1. Note that the user does not control the actions of the synthetic dolphin, but he/she only **influences** its emotional state, which in turn will then influence its behaviour.

Fig. 1. Interface and Sensors

To support the development of Tristão and Isolda, an architecture based on a theatrical metaphor was adopted. The developed system was instanced over a modular architectural framework composed by three functional units (or modules):

- The *dynamic script-writer* (or *mind module*) is responsible for the creation of the narrative. It manages all the agents at the narrative level and controls the emotional believability of the characters. It basically generates a set of directives to the cast of actors.
- The *theatrical company* (or *body module*), with its director and cast of actors, interprets the narrative and performs upon it. It manages the geometrical and audio-visual planning and controls the life-like believability of all characters.
- The *virtual stage manager* (or *world module*) controls all aspects related to audio-visual display of the character performance as well as handling the virtual camera and the stage special effects.

Fig. 2 shows the overall architecture. As we can see there, each agent is implemented by three distinct images: a mind image, a body image, and a world image. Each image is managed by its associated module. Hence, each module implements a specific part of *all* the agents. Whilst the mind of the agent, can be seen as generating its behaviour in an autonomous way, the body image is only following the improvisation directives provided by the

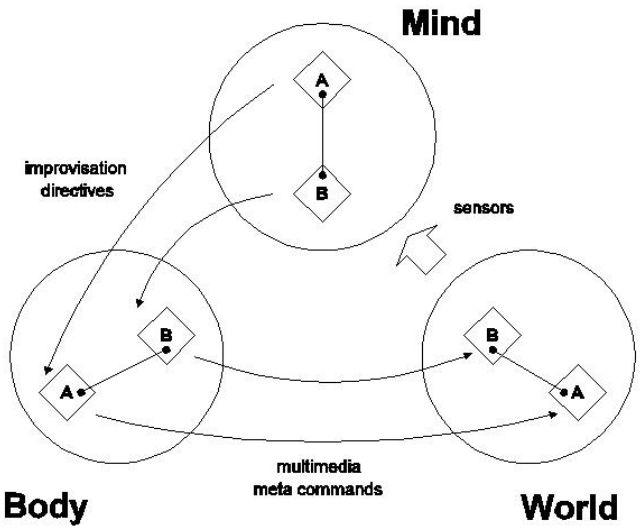

Fig. 2. Architecture Theatrical Metaphor

mind. This approach in a way follows the idea of a director (in here named dynamic script-writer) that provides directives to the characters (here the bodies of the characters).

3.2 Papous

Papous (see Fig. 3)) is a synthetic character that acts as a virtual storyteller. The ultimate goal is to obtain a synthetic character that tells stories in an expressive and believable way, just as a real human storyteller would do, and thus in an autonomous way.

Its first version, Papous (described in [20]) is a simplification of the storyteller idea and can be seen as a virtual narrator who reads a text enriched with control tags.

Papous is therefore controlled like a puppet by the story-writer, that not only writes the story but also provides a set of mark up elements that help the character to perform the story-telling. In fact, these tags allow the story-writer to script the behaviour of Papous. There are four types of tags: behaviour tags, where a specific action or gesture is scripted; scene tags, that allows for Papous to change the scene where he tells the story; illumination tags, to allow a new illumination pattern of the scene; and emotion tags, to change the emotional state of Papous. The texts, enriched with these tags, are then processed by

Fig. 3. Papous.

Papous' different modules, which contain an affective speech module and an affective body expression module.

The architecture of Papous has five components: the Input Manager, the Environment Control, the Deliberative Module, the Affective Speech and the Affective Body Expression. The Input Manager is the component responsible for processing the text file that contains the story, checking it for syntax and semantic errors, and taking the necessary actions to ensure that the data are correct and ready for the other components to process.

The Environment Control is responsible for managing the environment where the character is immersed. The Deliberative Module acts as the mind of the character and, therefore, contains its internal emotional state and is responsible for controlling the character's actions. The Affective Speech is responsible for the voice of the character. The Affective Body Expression is responsible for the appearance of the character. The Input Manager receives as input the annotated story file and a set of configuration files. This module parses the annotated text and generates tag-oriented information that is sent to the Environment Control and Deliberative Module components. Table 1 summarizes the four types of tags available and explains the function of each one. The list of available tags of each type is defined in a configuration file and depends solely on the available scenes and animations. We have defined a small set of tags for demonstration purposes.

Tag Type	Function
Behaviour	Indicate an action that the character should perform.
Scene	Specify a new scene where the character should be integrated.
Illumination	Specify a new illumination pattern
Emotion	Explicitly modify the emotional state of the character

Table 1 - Tag Types

The story-writer is free to use the tags as he/she wants, taking into consideration the context of the story. For example, if the writer wants to emphasize a particularly scary part of the story, he or she should specify the appropriate emotional state. The chosen emotional state will change the voice and the behaviour of the character and, therefore, suit the writer's intentions.

The Deliberative Module receives emotion and behaviour tags and sends commands to the Affective Speech and the Affective Body Expression components. In fact, the emotion tags update the internal emotional state indicating which emotion should be changed and the new value that it must have. Internally, the emotional state of the character is represented by a set of numerical discrete values, for each of the six emotions represented. The emotional state affects the voice and the behaviour of the character.

The Affective Speech component receives sentences and the current emotional state from the Deliberative Module, and synthesizes the sentences using the voice to express the current emotions. The precision with which we control the character's voice depends mostly on the underlying text-to-speech (TTS) system. The current TTS system allows the control of seven parameters to completely define the voice. To transmit emotions through the voice we established a series of relations between emotions and voice parameters based in theories of the interrelationship between speech and emotion. The Affective Body Expression component receives the current emotional state from the Deliberative Module and changes the character body in order to express the desired emotions. It can also receive commands to perform gestures explicitly indicated in the story (using behaviour tags). The body expression component is provided by the SAFIRA toolkit [23]. This component is able to perform real-time blending between animations and body postures to convey the desired emotions. However, at the current state of development, the emotions affect only the face of the character. For demonstration purposes we considered two facial animations (happy and sad) that are related with the happiness threshold .

We have also defined a set of iconic gestures (big, small, tall and short) that can be explicitly indicated in the story. The writer should be careful in using behaviour tags to perform explicit gestures, as they only benefit the story if the performed action is coherent with the current story context.

Although quite simple, Papous is an interesting example of how a user (writer) can control some of the actions of the character and how that control is transformed into behaviours that the character performs.

3.3 Teatrix

Teatrix is a collaborative virtual environment for story creation by young children (four to eight years old), which aims at providing effective support for children developing their notions of narrative through the dramatisation of different situations.

Children can create their stories by selecting the scenes, characters and props in the story, and then by performing the story through the control of the actions of their characters.

In Teatrix, we developed the concept of "virtual dramatis personae" which is a virtual actor with an associated role to play. A role, according to [9] is a class of individuals whose prototypical behaviours, relationships and interactions are known both to the actors and the audience. To develop such notion of a role in an interactive virtual environment, we relied on the work by Propp [18] on folk tales (similarly to the work by Spierling [21]). One of the most important developments of Propps theory was the description of functions for the characters in fairy tales. By function we mean "as an act of a character, defined from the point of view of its significance for the course of action". And, according to Propp: "functions of characters serve as stable, constant elements in a tale, independent of how and by whom they are fulfilled". That is, the functions constitute fundamental elements of a tale.

Based on this, we have created the following roles in Teatrix (see Fig. 4):

Villain - the role of the villain is to disturb the peace of the happy family, to cause misfortune, damage or harm. The villain may be a dragon, a devil, a witch, a stepmother, or even a little boy or a girl. One of the functions of the villain is the "villainy".

Hero/Heroine - introduced in the initial situation. Although Propp considers two types of heroes: the seekers, which go in search of a loved element; and the victimized heroes, whom are themselves the victim of the villainy, in Teatrix we do not make that distinction.

Magician (or magic element) - has special functions in the story and it can be represented in many forms. For example: (1) an animal (a horse; a bird; etc); or (2) objects out of which the magical helpers appear (a ring; a lantern; etc); (3) objects with magical properties (a ring; a sword; etc) or (4) qualities or capacities given directly to the hero/heroine.

Beloved one and Family - Usually described in the initial situation, and is often subject to harm by the villain.

Donor (or the provider) - It is from this personae that the hero obtains some agent (sometimes magical), which allows the hero to eliminate the misfortune.

Each role has a set of functions associated to it. For example one of the most important functions of the villain is the villainy– that is, the villain causes harm or injury to a member of the family. The dramatis personae in Teatrix's stories are implemented as agents inhabiting and interacting in 3D

Fig. 4. Roles of Characters in Teatrix

worlds scenes of the play), which result from the a backstage phase where the scenes, the actors, the props and the roles are chosen. Each of these dramatis personae is the conjunction of an actor and a role. An actor is the physical representation or appearance of a character in the 3D world. From this distinction between actor and role a set of combinations can be achieved, and a wide variety of possibilities can happen. The architecture to implement these personae is composed of five components: the mind, the body, the sensors, the effectors and the inventory. The main aspect of the agents in Teatrix is that their actions are constrained by the role they play (and thus the associated functions), and therefore their autonomy is restricted .

But in Teatrix we have two types of characters: the ones controlled by the system (as described above) and the ones controlled by the user. To control the characters Teatrix provides the children with a set of actions which they can select at acting time (see Fig. 5). These actions are associated not only with the character performing it but also with the props that the character owns at each instant. This defined set of actions provides the children with motion control (for example: each child can move her character along the scene by using the move action) and a type of behaviour control, achieved through assignment of a role to the characters and with the use of the props. She can pick objects, drop them, use props on other characters (like for example use a stick to hit another character), or even talk.

Additionally to the motion control, children have also the possibility to reflect upon their characters' behaviours at story creation time and control that behaviour. This meta level of control is implemented as a tool called the "hot-seating", which gives the children the possibility to freeze the story time, put themselves into their characters' shoes and explain the character's behaviours [2]. When a child enters the "hot-seating" he or she is reflect about the behaviour of the character. These reflection moments may happen at the child's demand or when the application detects that a character is not in character (see [13] for further details). With this tool we aimed at providing the children with more information about the story, which, we believed, would lead to a richer type of collaboration within the story world.

3.4 FantasyA and SenToy

FantasyA is a computer game that uses emotions as a way to engage the user in the game. In *FantasyA* two characters fight a duel where emotions are used

Fig. 5. Control of Characters in Teatrix

as the driving elements in the action tendencies of the characters. By playing the game, the user influences the emotional state of its character which in turn will act according to its internal emotional state. The characters in the game must cast different types of spells, either attack or defensive, in order to win the duels.

Characters in the game are able to express emotions by their behaviour (their spells) and, in parallel by their body movements and postures. Note that the emotional body movements and postures is extremely important for game mechanics, because the player must be able to recognize all the emotional states in order to discover the combinations that produce each action.

The characters themselves can be of two types: **influenced** by the user or fully controlled by the system (against whom the user will play with). In both cases, characters use their emotions to decide what action to take. This action selection is based on emotion theories by Lazarus [12], Darwin [7] and Ekman [8], which serve as inspiration for us to formulate the action tendencies of the six possible emotions in the game: Happiness, Sadness, Fear, Anger, Gloat and Surprise.

Each character decides what action to perform (what spell to cast) according to its internal emotional state and what it perceives from the opponent's emotion. So we defined for each character based on her/his personality a set

Fig. 6. FantasyA

of action tendencies taking into account their opponent emotions. When the decision is being made, the character compares both his action tendencies and the opponent's ones and decides what will be the best one for him (by performing a simple search). Although relatively simple, the characters in FantasyA are able to reason about the other's emotions and act taking that into account. This not only makes the characters more difficult to win, but it also makes them more believable, as they act as a player will do.

The user control of his/her character is achieved through SenToy, a tangible interface for affective control of a synthetic character. To play, the user must understand the emotional state of his opponent which is achieved through animations (featuring affective body expressions) of the character and influence the emotional state of his character by performing a set of gestures associated with each emotion.

SenToy (see Fig. 7) is an explicit sensorial interface equipped with three sets of sensors (see [1] for more details). The first and most important is the set of accelerometers, which measure the acceleration that the SenToy is subjected to. The second type of sensor is analog and these are used to determine the position of SenToy's limbs. The third set of sensors are digital, and are used to indicate whether the hands of the doll are placed over the eyes or not. Since the emotions/actions cannot be obtained directly from the rather complex data received from the SenToy sensors, a signal-processing module (Stimuli Acquisition module) was required. This module was build to capture

the patterns of each of the six chosen emotions: Happiness, Sadness, Fear, Anger, Gloat and Surprise. The emotions are inferred by the characteristics of these signals, mainly with the information given by the accelerometers, through which one can determine the SenToy's attitude (angle) and motion characteristics such as, the direction of the movement and its intensity. As an example, the emotion Sad is detected when the SenToy is bent forward (determined by the Sentoy's attitude), and the emotion Angry is identified when the doll is shaken (originating a fast and intense variation in the X-axis). The position of the limbs complements the information of the accelerometers. For example, the emotion Angry is only detected when the SenToy is shaken with the arms up.

Fig. 7. SenToy

Using these emotions, the player can **influence** the emotional state of the character on the screen. At each turn, the combination of the emotional states of the two characters (the one controlled by the player and the computer opponent) leads to actions, either offensive or defensive, that can damage the opponent or protect the character from future attacks. For example, if the computer opponent is gloating and the player uses the SenToy to influence his avatar to become angry, that will surely lead to an offensive action, probably a blast. Then, according to the results of the action, there is a reaction phase where both characters change their emotional state in response. In the previous example, if the blast succeeds then the computer opponent might

become fearful and the character controlled by the player will become happy. The game proceeds with the opponent's turn and so forth, until the end of the duel.

One interesting aspect of this game is that, although the players could not control their avatars completely (with both motion and behaviour control) they still very much liked the interaction, specially the use of SenToy (see [16] for more details on the results).

4 Conclusions

In this chapter we have discussed two central aspects in the development of synthetic characters for games or virtual storytelling environments: their autonomy and user control. Considering autonomy as a property of some synthetic characters,we have provided a taxomony which will allow us to classify some different types of autonomy we can find in these characters. To illustrate these issues, we have provided a review of some of the experiences we had at GAIPS (INESC-ID) with building synthetic characters during the past few years. For example, whilst the characters in Tristão and Isolda are fairly autonomous, the characters in Teatrix are constrained by the role they play in the story.

Indeed, different applications and different types of interaction with the user, leads to the different approaches to be taken in terms of the character's autonomy.

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