Is the Wolf Angry or... Just Hungry?

Inspecting, modifying and sharing characters' minds

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ABSTRACT

In this paper we will discuss different types of control over synthetic characters in interactive stories. We will argue that, to attain a deeper and more engaging control, in certain conditions, users should be able to inspect, disclose, and modify the characters minds. To illustrate this idea, we will present a collaborative virtual environment called *Teatrix*, designed for children to build their own stories - fairy tales. In *Teatrix*, virtual actors play roles (such as: villain, hero, etc.) and may be controlled either by children or by the system. *Teatrix* allows children to go into the minds of the characters through a special tool named *"Hot Seating"*. *Teatrix* is already in use by children ages between 7 and 9 in the context of a Computer integrated Classroom (CiC) scenario installed in a school. The initial evaluations show that the use of the "Hot Seating" tool is a fundamental element for children to feel in control of their characters and thus stay in character for their virtual performances.

Keywords

Believability, life-like qualities, synthetic agents.

1. INTRODUCTION

"Stories and storytelling are vital to children themselves and to their development"[5]. Stories are part of our lives and they shape what we experience and what we are. So, it is not surprising to see that recent research on virtual environments is now faced with the challenge of creating storytelling environments. Stories are now being told on virtual stages and users become part of the stories by controlling the virtual actors (see for example [4]). This new form of interactive story creation poses major challenges to the development of intelligent agents in virtual environments. One of these challenges concerns the degree of autonomy of the agents in relation to the user. In one hand, avatars can be seen as computational agents which represent the user in a virtual environment, and thus are assumed to be fully controlled by the user. On the other, autonomous intelligent agents are assumed to act without direct human or other intervention [16]. This distinction is becoming less and less precise as avatars acquire some intelligence and intelligent agents provide some degree of user control in the virtual environment. In fact, work by J. Cassell [3] has shown that users feel more in control when their avatars are able to exhibit a certain degree of autonomy and act not by direct command of the user. Recently, [13] proposed the concept of semi-autonomous avatars where the control can be seen as a combined task shared by the avatar/agent and the user. However, for this sharing of responsability to be possible at different levels (from motor control to emotional and motivational control), users must be able to understand what is happening in the "agent's minds".

In this paper, we propose a model for disclosing such agent's minds in the context of virtual environments. This model is inspired by the research of Dorothy Heathcote [2] on acting in classroom drama. The main idea is that, at some point in the interaction, the user controlling his character will be seated on a Hot Seating, freezing the character's actions. Stepping out of the characters' motor control, the user is able to inspect the character's role, goals, and previous actions, reflect upon them, and perform some changes if necessary. This approach is used in the context of *Teatrix*, a virtual environment that provides children with the means for collaboratively creating stories on a virtual stage.

This paper is organised as follows: first we will provide a brief description of *Teatrix*. Then we will describe the architecture of the characters in *Teatrix* providing some examples of interaction. Then we will explain how characters can both be controlled by the users/children and by the system, emphasizing the role of the Hot Seating tool. Finally we will describe some informal experiments performed with *Teatrix*, which suggest the importance of the Hot Seating. In the end some conclusions will be drawn.

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2. CONTEXT: *TEATRIX* APPLICATION

Teatrix is a system that provides the children with the means for collaboratively creating stories on a virtual stage. Inspired by dramatic games, *Teatrix*'s design (see [7], [8]) was grounded on a set of experiences run in the "dramatic

room" of the school "O Nosso Sonho[1]". During these experiences we observed children of several ages performing fairy tales in different settings: theatre and puppet scenarios. From there we designed *Teatrix*, in such a way that it follows a theatrical metaphor.

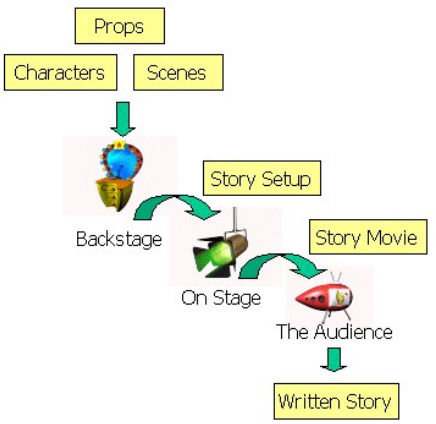

Figure 1: Phases in *Teatrix*

So, *Teatrix* is divided in three steps strongly related with children's dramatic games performances (see Figure 1):

- *Backstage Option* - in this first step, children can prepare the scenes, props and characters for each story (similar to what happens in the backstage of a theatre during the preparation of a play). They graphically select the scenes they want in their story, link them, and place within those scenes their chosen characters and props. The example in Figure 2 shows the setting of

Figure 2: *Backstage Option* **in** *Teatrix*

the story that includes two scenes *forest in the day* and *forest at night*. These two scenes are linked together, a *girl* character is placed in the *forest in the day* and a *wolf* in the *forest at night*. Some *mushrooms* are also placed in the *forest in the day* and a *stick* in the *forest at night*. Finally, each of the actors must have a role in the story. That is done by selecting from a list of possible roles (villain, hero, etc). In this case, the *girl* will be the *hero* and the *wolf* will be the villain of our story (figure 3).

Figure 3: Choice of characters in *Teatrix*

- *On Stage Option* - Once the setting up phase is done, the children may select one of the prepared stories to start the acting phase (on stage performance). The acting is done by means of each child's character, that she commands throughout the story creation process. Since *Teatrix* is a collaborative environment, each child participating in a play must select the character he/she wants to control. All characters that are not chosen by the group of children will automatically become system-controlled characters. After having chosen the characters, children are ready to start their performances, which will take place in a collaborative 3D world (see Figure 4). In general, children see this phase as a game. In this case virtual reality technology plays

Figure 4: *On Stage Option* **in** *Teatrix*

an important role because it provides the children with the means to explore the scenarios during the story creation [12]. The story creation only evolves if the children work together to achieve a common goal: their story. When the story finishes, children save the result in a kind of "movie", which they can analyze and even to reconstruct in future performances. According to

[1]In this school, there is an educational approach that divides the types of activities in rooms, giving the children with the possibility of choosing by their own their daily activities.

[10] children get much more from an interaction or experience if at the end they create a meaningful artifact that they can exhibit as a proof of their personal or collaborative work.

- *The Audience* - this third option is based on the movie produced from the story creation process. In this phase, children can be the audience of their own performances (see Figure 5). In this option the children have also

Figure 5: *The Audience Option - watching* **in** *Teatrix*

the possibility to write about the stories previously performed. The writing activity is done with the support of some snapshots taken from the story performance. These snapshots are organized in sequence and may also contain some vocabulary associated with the story, in order to encourage the children to write about it (see Figure 6).

Figure 6: *The Audience Option - writing* **in** *Teatrix*

3. CHARACTERS IN *TEATRIX*

The characters in *Teatrix* have a fundamental job since they are the ones that act out the story on behalf of the children. Based on the concept of *"virtual dramatis personae"*, which is a virtual actor with an associated role to play [9], many different stories can emerge using the same elements. To develop the notion of role in *Teatrix* we relied on the seminal work of Vladimir Propp on the analysis of russian folktales [11]. Propp defined a *function* of a character as: "an act of a character, defined form the point of view of its significance for the course of action". The set of functions established by Propp are distributed among seven different *roles*: villain, donor, helper, princess (and father), dispatcher, hero, false hero. In *Teatrix* we have used 6 different roles: the villain, the hero, the magician (donor), the beloved one, the parents and the helper (see Figure 3). Experiments done with *Teatrix* have shown that these selected roles are understood by the children.

Each one of these roles has a set of Propp's functions associated with it, and those functions are used for the generation of goals, behaviours and actions. For example, a villain must perform a villainy. This pre-definition of roles constrains the character's behaviour and is therefore a way for the system to control the characters, thus guaranteeing some structure in the dramatic incidents emerged. Indeed, as some of the characters may be controlled by the system, they must be capable of playing a determined role in the story and recognise the other characters' actions and behaviours in order to respond and react appropriately. On the other hand, if a character is being controlled by a child, then the role is only an indication of how the child's character should behave throughout the story. This opportunity to take different perspectives by assuming different roles, and explore different situations is beneficial for the children's cognitive development [14].

3.1 Architecture

The *Teatrix*'s characters were built as autonomous intelligent agents using the architecture shown in Figure 7. The same architecture is used for both child's controlled characters or system's controlled characters.

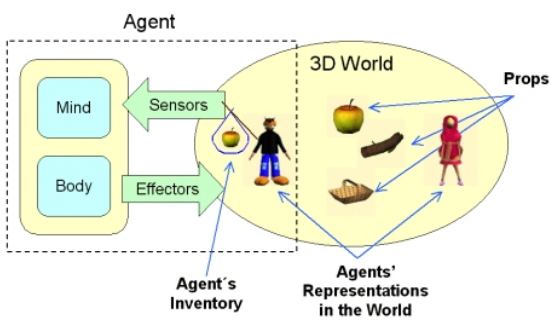

Figure 7: Character Architecture

These agents co-habit in a 3D virtual world where they can interact with each other and with story props. An agent has five distinct main components:

1. Sensors - are responsible for getting information from the world and translate it into perceptions given to the mind.

2. Effectors - allow the agent to take actions in the world. These actions include: walk, get item, drop item, use item and talk.

3. Body - controls the agent representation in the virtual world (e.g. what the agent looks like to the others, its position and movement).

4. Inventory - the set of items the agent has collected from the world so far. The agent may use any of them whenever needed.

5. Mind - responsible for the action planning of the agent, store information needed in the planning process. See next section for more details.

3.1.1 Mind

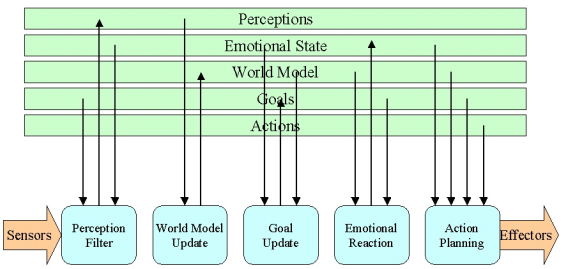

Figure 8: Mind Architecture

Figure 8 shows all the mind's sub-components, where the horizontal bars represent the knowledge stored and the boxes bellow represent the processes that manipulate that knowledge. The mind stores the last *perceptions* received by the sensors, the current *world model* (what the agent think the world is), the *actions* that it knows it can perform, its current *goals* and *emotional state*.
The only way the mind can communicate with the "outside" is through the sensors or the effectors. But not all information coming from the world is important to the agent: the *perception filter* checks the importance of a perception and accepts it (storing it on the perceptions' knowledge) or rejects it. This filtering process depends on the current *goals* and *emotional state* of the agent. For example, the agent may be too focused on accomplishing an important goal like "picking up the mushrooms" that doesn't care of anything else and therefore does not detect the presence of the wolf.

The *world model* must be updated if a perception of a world's change reaches the mind. It is the role of the *world model update* component to perform such update. Further, if the *emotional state* changes, the agent's *goals* may change with it (e.g. an agent that becomes sad may stop interacting with others). Note that the interaction between characters in the story is done in two ways: 1) by sending spoken messages (action speak) and 2) by using props against the others (like for example, using a stick against another character). *Goals* may also change if something in the world changes. For example, the agent wants to pick an item, so it must to be near it. However, if someone else picks it up before, the goal is not achievable anymore. All these *goal*'s changes are made by the *goal update* component.
The *emotional reaction* component changes the *emotional state* according to the changes in the world and in the current *goals* (e.g. the agent may become sad if a friend is hurt or become happy if it just achieved a desired *goal*).
Whenever the *goals* change re-planning is done to find appropriate actions to achieve them. Such planning uses knowledge of the *world model*, the *emotional state* and the *actions* the agent knows it can perform. Then, it decides what action to take and the corresponding effector is called to perform it. One should note that this architecture is used in the case of system controlled characters or child controlled characters. In the later case, some shortcuts are made and a call is done directly to execute an effector.

3.2 Controlling *Teatrix*'s Characters

When controlled by the children, the characters of *Teatrix*, can be seen as avatars. However, such notion of avatar does not confine to the concept of a mindless agent that acts on behalf of the children but it is enriched by a pre-defined role. That is, the character perceives the story world for the user and reacts to what happens in it, in accordance to its role. In [1] it is suggested that for integrating external control into characters that take part in interactive story systems, there is the need for 4 different levels of control: motor skill, behavioral, motivational and environmental. These different types of control are used by an external entity, the *director*.

Similarly when looking at the user control over the characters, we can also identify different levels. In general, agents/ avatars' inhabited VEs provide motor skill control as the major type of control. In *Teatrix* this control is achieved through a set of basic actions (see Figure 4). The child is able to give atomic and direct orders to the character like: *walk to <object or position>*, *use <object>*. Those actions are selected from a set of possible actions associated not only with the character but also with the props that the character has in its possession. For example, to achieve the behaviour "bewitch character **z**" any character must first have in its possession a magical object that allows such action, so it must first find it in the world. Furthermore, when a child gives an atomic order to her character, that order is always achieved even if against the character's role.

A different level of control of the characters is achieved when users demand certain complicated behaviour from their characters *behavioural* control. In *Teatrix* since the roles are pre-selected by the children when they prepare the story - some of the characters goals are already pre-defined. Thus, indirectly, such defined goals, done in the scope of a particular role, comprises complex orders or directives. For example: *<struggle with the hero>*, which would imply that the character *villain* should start to look for the character *hero* in the 3D world and fight with him (the action fight would only be achieved through the use of an object - like for example a sword).

However, this type of control was not easily done in real-time during a performance without some extra elements that we will describe bellow.

3.2.1 Inspecting Characters' Minds

Teatrix's first prototype, which included motor skill control and only implicit (offline) behavioural control of the characters by the children, was the target of a first empirical study. In this first empirical study we followed an informal evaluation approach, which was mainly based on direct observation of children using the system, and also on some data collected from children and teachers' diaries. The study group was small - only 12 children - and they interacted with the system for one month and a half. The interaction sessions did not have any limited duration, but usually lasted for about one hour each, three days a week. The results from such empirical study revealed positive and negative aspects

of *Teatrix*. On one hand, some of the positive comments from the children were as follows:

- "It's funny, instead of doing the drawings to use in the story we can pick them from a list of characters, things and scenes and in the end we build the story."
- "It's a fantasy of heroes and princesses. It's entertainment in the computer!"
- "*Teatrix* is a like a theatre, where we can play together. What I like most is the feeling of being inside the characters. In Teatrix we can do things that all others can watch, and that is very important because by this way everybody can participate in the stories."

However, some negative aspects also emerged:

1. the need of more freedom to elaborate on their characters' behaviour;
2. and also, the need of some way to fully express their creativity and not being limited by the resources provided.

Based on these results and in order to try to answer children's demands, we decided to include a reflection tool- *"Hot Seating"* which aims at giving the child a deeper control of the characters' minds.

The *"Hot Seating"* allows children to step out of the stage and reflect on their character's actions and performance, as well as changing their "minds". The "Hot Seating" method was based on the research of Dorothy Heathcote on acting in classroom drama [2]. The idea is that when a child is "seated" on the "Hot Seating", she is asked to freeze her character's actions. By stepping out of her characters motor skill control, she can explain and reflect upon the meaning of her character's current behaviour. At each reflection time we seek answers to the following questions:

Character **x** *has performed action* **z**
Because <motive>
Therefore <what are the expected outcomes>
Or
Character **x** *is* **sad**
Because <motive>
Therefore <what are the expected outcomes>

The tool gives the children information about the role, previous actions, emotional state and goals of the character. This approach has similarities with what is called "a window into the agent's mind" by B. Hayes Roth [6]. In *Teatrix* however, the Hot Seating not only allows changes in the mind but also provides a way for these the reflection statements to be shared among all the children involved in the story creation activity. This need of sharing arises from the fact that every child needs an audience during their pretend plays and also when acting as part of the audience of a play, children develop an empathic and close relation with the cast of the story [15]. To achieve this, we developed two different modes for the reflection tool:

- *for the child's own character*: in this mode the child has available the information about the character that is controlling in the story. Through this interface the child has the opportunity to: (1) introduce some motivation for her character's behaviour; (2) induce some change in the characters emotional state and justify such change; (3) or, consult her character's role in the story. This reflection mode can be explicitly invoked by the child that is controlling the character when she wants to introduce some motivation or induce some changes in her character's emotional state, or implicitly triggered by the system when the child orders or commands go against the character's role.
- *for others children character*: this mode is particularly, useful for the children to inspect other characters' minds, and get information about: the character's role; character's emotional state and also information about that character's reflection moments. This is particularly important to also understand the system controlled characters.

With this new type of control, children have the possibility to induce some changes in their characters' emotional state. For example, imagine the situation when a child controlling the *villain* character decides that she is not going to pursuit the *hero* character. In such situation the *villain*'s emotional state will go to a more negative value since he was unable to reach one of his goals. However, the child that is controlling that character has the freedom to change that and to induce a different emotional state for her character. When inducing any change in the character's emotional state the child also provides some motivation for such change.

4. INTERACTION EXAMPLE

To understand the role of the Hot Seating, let us return to our previous example, where two children (Ana and Maria) were controlling a girl (hero) and a wolf (villain).

The *girl* finds a path in the forest and decides to follow it. Meanwhile the *wolf* is just wandering in the *forest at night*. The path taken by the *girl* leads her to the same scene as the *wolf*. As the *girl* sees the *wolf* she walks towards him and asks: *"Hello! What's your name?"*. The *wolf* does nothing and the *Hot Seating* is activated. The window shown in

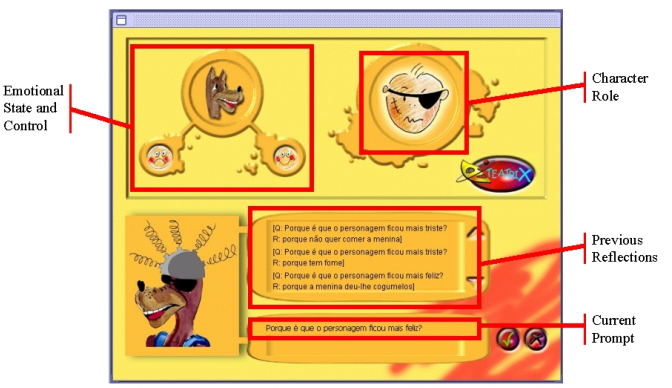

Figure 9: The reflection tool

figure 9 appears to Maria (the child controlling the *wolf*). On that window she can see her character's emotional state, currently normal, its role, the set of previous reflections, and the reflection currently prompted. In our example, the reflection prompted is: *"Why don't you pick up the stick and use it on Linda?"* (Linda is the name of the *girl* in the

story[2]. As Maria answers *"ok."* the control returns to the 3D world. There, the *wolf* picks the *stick* but does not use it on the other character. After a while, the *Hot Seating tool* becomes active again. A similar question is generated: *"Why don't you use the stick on Linda?"*, and now Maria answers: *"I don't want to hurt her. The wolf just wants to eat."*. At this stage, and due to fact that the goals of the villain are not being achieved, the emotional state of the *wolf* becomes sad. The system insists: *"You are a villain. You should harm Linda. Why don't you use the stick?"*. As the *girl-Linda* drops the *mushrooms* the Maria leads the *wolf* to pick them up and changes the emotional state of her character to happy.

In order to better understand how the system activates the Hot Seating, and the internal changes of the characters, let us now see the same example where the system controls the character *wolf*. When the *girl* named Linda goes to *forest at night*, the scene where the *wolf* is, the *wolf's sensors* will capture the information that another agent is in the same scene. Such information will be send to its *mind* since it is relevant for the agent because it concerns the *hero* (and the *wolf* is the *villain*!). The information is stored in the *perceptions* knowledge component. As the *perceptions* contents change, the *world model update* becomes active, a fact in the *world model* is introduced (stating the presence of the *girl* in the *forest at night*). The *emotional reaction* and the *goal update* will see this change in the *world model* (see Figure 8). Since the *wolf* has the *goal* of harming the *hero* a new *goal* "harm Linda" is produced by the goal update module. As a new *goal* emerges the *action planning* component will try to accomplish it. In the *world model* there is information about the presence of a *stick* in the *forest at night* (from a previous *perception*) and that the *stick* can harm another agent (this knowledge is associated with the *stick* and its use, and all agents have this global knowledge).

Note that all this process also happens in the previous example, when Maria was controlling the *wolf*, and it is the fact that the goal "harm Linda" is not pursued that is used for triggering the Hot Seating.

5. EVALUATION

After having introduced the *"Hot Seating"* in *Teatrix*, we conducted a new set of experiences in order to find answers about the influences of the new method in controlling the story characters. In this second set of experiences we had a different goal: - to evaluate the use of the reflection tool. The reflection tool should help the children to better understand what their character's roles are and how different the achieved story is when they direct them in-line with their roles, i.e., by *staying in character*. By this way, we expect that children start to understand how they can construct a well-formed story and at the same time enjoy doing it collaboratively way.

In this second period of evaluation, the target population was divided in two different groups: the control and test groups. The control group - composed by six children - was asked to perform and produce written stories that had the same themes and characters present in *Teatrix*. The test group - composed by 24 children - was asked to interact and use *Teatrix* to create new stories by acting and also to write about them in the end.

The test and control groups realised their story-telling activities (on paper or on *Teatrix*) on a daily basis and each session lasted for one hour. All children in both conditions were given equivalent guidelines. The control group was asked to write some stories and they were told that they had to include some of the *Teatrix*'s story elements - a table with pictures of such elements was provided. The control group could also bring their written stories into the *Dramatic Room* and perform them. The teacher of that room was asked to try to trigger some reflection moments when a child was not acting in character. These performances were recorded on video.

This experience started on middle September and finished by the end of December.

To analyze the data collected from both groups, we decided to conduct a qualitative assessment. This decision was based on two different reasons: (1) the experience conditions for both groups were not completely the same; (2) and, the lack of a method that could help us to evaluate in a quantitative way the reflection moments triggered in both evaluation conditions. In this qualitative assessment, we did not have a well-defined and measurable hypothesis but only a list of questions to analyze and study. Such questions were:

- *In what kind of situations do children reflect upon her characters' behaviour?*
- *Do children justify their characters behaviour when asked to do it?*
- *What type of justifications do they usually give?*

Although the results obtained were not very conclusive, due to the early stage of the experience, some situations revealed the importance of the *"Hot Seating"*. First, we realized that the control group used "reflection voices" mainly by some triggering from the teacher. Secondly, although during the first two weeks children tended to ignore the reflection tool, at the end of the experiment they started using it more often and more elaborated justifications of the character's actions started to appear. They also started to take those justifications into account in their future character's actions. Finally, there was no evidence that certain types of situations would trigger the reflection more than others. This results is perhaps due to the restricted set of scenes and characters that were available in *Teatrix*.

6. IMPLEMENTATION DETAILS

Most *Teatrix* modules were built in Java, namely the user interface and the core of the agent architecture. The 3D engine of the 'On Stage' and 'The Audience' modules was built using the Java 3D library from Sun MicroSystems. All 3D scenegraphs (e.g. story scenes and items) were modelled in 3DStudio Max and exported to VRML , our elected 3D data format. The mind modules of the agent architecture (see Figure 8) are in JESS, which is a Java implementation of CLIPS. The representation of the agents in the 3D world is accomplished by showing some animations on 3D sprites which were created using CharacterStudio. *Teatrix* data productions (e.g. story setups, plays and writings) are stored in XML format, VRML and JESS format.

[2]When choosing the *cast* children can also assign names to each character.

7. CONCLUSIONS

In this paper we presented a new type of control over synthetic characters in interactive virtual environments. This control relies on the disclosure of agent's minds. This model, inspired by the research of Dorothy Heathcote, is based on the idea that the user controlling his character will be seated on a "Hot Seating", freezing the character's actions. Stepping out of the characters' motor control, the user is able to inspect the character's role, goals, and previous actions, reflect upon them, and perform some changes if necessary. This approach was then presented in the context of *Teatrix*, a virtual environment that provides children with the means for collaboratively. The evaluations carried out on *Teatrix* show that this approach is well received.

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