From Chinese Shadows to Interactive Shadows: Building an storytelling application with *autonomous* shadows

ABSHLE: Agent-Based Systems for Human Learning and Entertainment

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Abstract: Creating Interactive Storytelling applications, where users can freely act out their roles in stories and, at the same time, be perceived by the application which adapts the story to these actions, is a challenge that many researchers are dealing with during the last few years. Perhaps the main problem lies in the balance that must to be reached between the author's need for control and the user's need for freedom. One of the approaches for addressing this problem is to adopt a multi-agent system as the base underlying simulation model for the Interactive Storytelling application. However, this approach is not only quite complex to develop but also extremely difficult to author. In this paper we describe the authoring process that took place for building autonomous characters in a storytelling application called I-shadows. I-Shadows is a Chinese shadows theatre with interactive characters that can be either autonomous or controlled by children. Stories in I-Shadows emerge from the collaboration between the children and the system. Children choose their shadows and act them out on the screen. The system collaborates with the children by controlling other characters that were created using an Emotional Agents Architecture (FAtiMA), allowing for the generation of believable behavior as the stories develop. In the paper we describe the creation of such characters, focusing on how they can embed in their behavior both elements of the story domain and at the same time, acting knowledge thus allowing them to really engage the user into the interactive experience.

Keywords: Interactive Drama, Autonomous Characters, Affective Characters

1. Introduction

Until recently, most of the interactive drama systems were developed using script-based or plot-based approaches. However, the use of autonomous characters, brought in by research such as the one developed by M. Cavazza [1], M. Mateas [2], and Aylett et.. al. [3], allowed new models of interactivity and flexibility, thus giving users eventually more freedom. Users in interactive drama may interact with characters and stories emerge from the characters and those interactions. It is the maturity achieved recently in the area of autonomous characters that allows them to be used to generate believable behavior to respond to users' expectations in interactive stories.

However, for the construction of these characters is not only quite complex to develop but also extremely difficult to author. In this paper we describe the authoring process that took place for building autonomous characters in a storytelling application called I-shadows. I-Shadows is a Chinese shadows theatre with interactive characters that can be either autonomous or controlled by children..

The paper is organised as follows. First we will present the main foundations that led to the approach taken in I-Shadows. Then, a brief description of the project, exploring some details of implementation , in particular the integration of the main ideas into the characters created using FAtiMA framework Finally, we will report of some preliminary results and provide some concluding remarks concerning I-shadows..

2. Foundations for Interactive Narrative and Autonomous Agents

In order to provide a fundamental mechanism to study interactivity and the role of users in an interactive story, we have adopted the well known model from Murray [4], who defined three aesthetic categories for evaluating the users experience in a interactive drama. The are: *Immersion*, *Agency* and *Transformation*. *Immersion* is achieved when the user totally accepts the logic of the environment. Furthermore, and according to Mateas this acceptance can be noticed when a player assumes the role of a first-person character in a dramatic story. Differently, *Agency* is defined as the users' freedom to take all the actions he or she wants. *Transformation* is achieved when the combination of *Immersion* and *Agency* provide a unique users' experience

each time he or she uses the system. [4] [5]

One should note that there is a conflict between *Agency* and the other two categories. This conflict can be related to the conflict between the author's need to guarantee a safe story development, thus following a drama structure, and the Characters and users' need to act autonomously.

Several approaches have been made in order to try to combine these three categories, either reinforcing the author's influence, or reinforcing the characters' autonomy (see for example Façade or Agent Stories).[6] [7]

In our approach (as already addressed by other researchers such as Aylett) the way to think about the combination of these two approaches would be to try to pass some of the structural knowledge of the play from the Author to the Characters. This approach is to some extent similar to what is followed by improv companies of theatre where the actors try to develop plays from an initial scene based only on pre-defined relations and their own creativity. The first major reference to his theatrical method goes back to Europe's Renaissance period when Comedia Dell'Arte trops travelled through all Europe presenting plays based upon open narratives with well defined characters, and narrative structure. More recently theatre teachers such as Viola Spolin and Keith Johnston created new techniques that launched the growth of several Improvisational Theatre companies, such as Compass. Most Improv directors agree on the following basic principles for an improve actor's actions on stage:

- Always accept information given from others.
  - Otherwise we say the actor is "Blocking" the scene
- Always add history to the scene
- Scene Beginnings should be short and objective
- Enter, stay and exit scene with purpose
- Maintain character's point of view

According to Spolin "Improvisational theatre requires very close group relationships because it is from group agreement and group playing that material evolves from scenes to plays". This suggests that in order to achieve a successful interactive drama, the user must take part in this group relation.[8][9]

Our research on Interactive Drama has taken this direction of integrating the user in an affective environment, where he or she can interact with emotional characters that act like real actors adapting the play to what is happening. Relations are established between the user and the characters according to their roles in the story and a consistent emotional behaviour. It is from the richness of these interactions, where the user is immersed, that we expect to bring to life real interactive drama, with surprising but structured story developments.

2. I-Shadows

2.1 Description

The I-Shadows' installation was inspired by one of the oldest forms of theatre: Chinese Shadows Theatre. There are however some important differences: (1) in I-shadows a user is a puppeteer in the play (thus manipulating physically his/her shadow puppets), and (2) some of the characters in the play are automatically controlled by a computer system. The play emerges as a collaborative process between the user (puppeteer) and the system (I-shadows). The system monitors the action on the screen using a vision component, and participates in it by projecting characters onto the screen. The drama emerges from the interaction between the projected characters and users that physically manipulate other characters, puppets.

Figure 1 – I-Shadows installation

One of the goals of I-shadows is to provide an environment where children learn how to create stories and act them out in character in front of an audience. So, we expect that the audience will be able to watch a play improvised by a child (or group of children) in cooperation with autonomous characters n.

To contextualize the I-shadows project we have developed a set of characters based on typical fairy tales stories, thus including fairies, goodies, a boy, a girl, a witch, a dragon (among other characters).

The challenges imposed by this project are numerous. Going back to the fundamentals of Interactive Drama, and in terms of Agency there are no severe restrictions over the actions of the user (a child can do whatever she likes) as long as he or she uses his/her puppet. Immersion will depend on the level of cooperation achieved between the user and the system. Transformation is achieved if the user feels that this cooperation does not monopolize his own decisions.

2.2 Designing Interactivity in I-Shadows

In general, and from the past few years, the theory of drama has been a good source of knowledge for interactive drama researchers. The challenge of placing the user in the process of creating and acting in a play, has taken researchers to try to adapt the theories of the classic theatre into new theories. A good example of this is the Neo-Aristotelian Theory of Interactive Drama, proposed by Mateas[5].

In 1863, Freytag defined the Freytag Pyramid and stated that drama (based on what he had studied) in general followed the same pattern of development along a variable that he called tension.[10]

Figure 2 - Freytag's Pyramid

Following the storyline from left to right, there are 5 acts. In *Exposition* provides the information about the environment, the characters and their relations. *Rising action* is the reaction to some negative events that are preventing the protagonist

from reaching his or her goals. In *Climax* is a turning point, usually into a positive solution. *Falling Action* brings everything back to normal. Finally, *Denouement* is the conclusion of the story. From an emotional point of view we can somehow associate the story start with a positive mood, which then suffered a negative impact and, reacted back with a positive conclusion. We call this process a *Valence Loop*. It is this valence loop that we will try to create in the I-shadow episodes.

Note that tension is a direct consequence of the emotional mood of the play. Emotions with a high arousal such as anger or surprise, will contribute positively to the increase of the tension. Using arousal and valence, we propose an emotional reaction model as a form to monitor an Interactive Drama emotional state, witch will somehow be the application of Freytag's storyline onto an emotional Valence vs. Arousal system (see Figure 3) .

Figure 3 – Emotional Model for Interactive Drama

As such, the storyline would start with a positive mood when all the characters live peacefully, in neutral arousal. As the story develops someone or something, is subtly unbalancing the peace (similar to the villainy function of Propp). Once the good and evil are identified, the villain will express his or her evil again but this time with enough impact to change the mood of the action into negative values. The hero's response (here we are assuming a hero is made known to the audience rising the arousal until the decisive moment of climax, when the valence of the story changes definitively and the villainy's defeat seems inevitable. Then we will achieve the falling action, and there will be a return to normality, ending with the denouement.

Using this model and trying to capture the emotional state of the scene, our system should be able to identify at which moment of a storyline the interactive drama is, and decide how to intervene in order to guarantee a story development around the proposed storyline. Since our goal is to let the story emerge from the relations between characters, the intervention in the action will include the ordering characters to enter or leave the scene (as well as sounds, and indications to the actors). To sum up, the proposed model adapts to the user's actions, not only by the interpretation of some patterns of behavior but also by adjusting the storyline as the emotional state of the story progresses.

2.3 The I-Shadows' Installation

The I-Shadows' installation merges the real world with the virtual world in the sense that the user, the real shadows and the screen exist in the real world, but what is projected is a result of a virtual world, where the characters' shadows are controlled by agents minds and decide upon the events of the

Drama. In this paper we will mainly focus on the aspects of mind in the virtual world although some aspects of the user interaction in the real world are essential for the whole mechanism.

The virtual world is modeled symbolically and has two main components. The *Virtual Set* which is a virtual representation of the real set that compounds all the active characters (all the characters in the scene, including an image of the real characters), and the *Cast* which aggregates all the inactive characters (characters that are ready to be used but are not on scene). In the Virtual Set, the user (controlling one or more characters) decides on the actions to do, and those actions are captured and symbolically represented. All the other agents acting in that virtual set perceive the actions of the others and act accordingly. Managing the transfers of characters between these two components is a Director Agent, that perceives the emotional parameters of the scene and decides which characters should enter the scene, moving from the cast to the virtual set, or letting the scene, moving from the virtual set to the cast.

Figure 4 - High level architecture for I-Shadows

2.3.2 The agents in I-shadows

Based on the proposed model, I-Shadows implements a very rich cast of characters, with appropriate actions and a rich emotional behavior. The characters are based on Fairy tales and were designed with the help of children. To achieve this rich emotional behavior we are using an OCC based architecture (FAtiMA) developed at GAIPS, for the minds of the characters and director (Agents).

Figure 5 – Shadow of a Physical puppet

2.3.2 Agent's Minds: FAtiMA

FAtiMA is an agent architecture designed to allow the generation of an emergent and unscripted narrative through believable agents. The plot is built by the interaction between

the several characters, which autonomously decide upon their own actions according to their beliefs and goals.

Each agent in the world (the character) perceives the environment through a set of sensors (allowing the perception of events, objects, etc. in the world) and acts on the environment though its effectors.

In order to achieve believable and expressive agents, their behavior is influenced by their emotional state and personality. FAtiMA models emotions based on the OCC cognitive theory of emotions, where emotions are defined as valanced (good or bad) reactions to events. The assessment of this relationship between events is called the appraisal process.

Whenever the agent receives a perception, the agent appraises its significance and triggers the appropriate emotions. Additionally, if a goal has become active, it will add a new intention to achieve the active goal.

FAtiMA provides two distinct levels in both appraisal and coping. The reactive level provides a fast mechanism to appraise and react to a given event, while the deliberative level takes longer to react but allows a more complex goal-driven behavior.

Figure 6 FAtiMA architecture

In order to build agents in FAtiMA one has to define the actions available for the domain (they will be used by the planner in the deliberative layer), and then to individually define each of the characters. The character's personality is strongly based in OCC and is defined by: a set of goals; a set of emotional reaction rules; the character's action tendencies; emotional thresholds and decay rates for each of the 22 emotion types defined in OCC.

The emotional reaction rules assess how generic events are appraised and represent the character's standards and attitudes. Since the appraisal process is clearly subjective, these rules must be very dependent on personality. The emotional rules are also important because they are used to influence interpersonal relations that are also modeled in FAtiMA. For instance, if an agent performs an action that triggers negative emotions in another agent, the relation of the latter with the former will deteriorate. These relations are stored explicitly in the agent's model of the world and can be used to activate goals and other type of behavior.

Action tendencies represent the character's impulsive and hardwired actions which he performs without thinking (reactive actions). Action tendencies correspond to simple action rules triggered by particular emotions. For example,

we may have a character crying when very distressed. Specifying action tendencies for characters is very important to convey the viewer a well defined personality. Loyall pointed out that in order to achieve believability, characters must have very particular details of movements, mannerisms and reactions. [12]

OCC specifies for each emotion type an emotional threshold and decay rate. An emotional threshold specifies a character's resistance towards an emotion type, and the decay rate assess how fast does the emotion decay over time. When an event is appraised, the created emotions are not necessarily "felt" by the character. The appraisal process determines the potential of emotions. However such emotions are added to the character's emotional state only if their potential surpasses the defined threshold

So, in addition to goals, standards and attitudes, these emotional thresholds and decay rates are used to complement a character's personality. For example, a peaceful character will have a high threshold and a strong decay for the emotion type of Anger, thus its anger emotions will be short and low. Thus, it is possible to have two characters with the same goals, standards and behaviors that react with different emotions to the same event (by having different thresholds).

Further information about FAtiMA can be found in [13]

2.3.3 Authoring Process: Defining Domain, Actions and Expressions

As explained earlier in the text, before jumping into the authoring of each character it was necessary to define their scope. Thus, we needed to know which emotions could be used in the context of I-Shadows. Although FAtiMA allows for a good range of emotions to be used in its appraisal system there was a gap in the communication with the user that had to be analyzed. Which emotion expressions could be used and identified, in the cooperation with children in this kind of interactive drama?

To answer these questions we have developed a non-functional prototype and tested it in a local school, using a fast prototyping user's centered approach. In the tests users were invited to several games that included, telling stories from scratch, from a suggested beginning, or simply playing mime games of emotions. These tests gave us some clear clues about the potential of the project, and most importantly the actions and the expressions that the characters should implement. At the end of the tests we have built and tested a prototype that generated and detected expressive movements. A detailed description of the methodology used and its results can be found in [14].

Figure 7 – First Prototype with Virtual Character with expressions

2.3.4 Characters

After deciding the domain of actions and expression of the characters, the authoring process had four main steps: Identify Characters and Goals, Define Relations, Define Action Tendencies, Define Multiple Emotional "Personality".

Figure 8 – Authoring Process with FAtiMA

The first step was to identify the characters and their goals. Assuming the children's preference for Fairy Tales the choice of adapting Propps' work that identified 9 roles and 31 functions in classical Fairy Tale literature seemed inevitable. Hero, Villain, Victim, Relative, Friend, Dispatcher, Donor, Helper and False Hero are all being implemented with the respective goals of performing "villainies" against an enemy or protecting his friends, inspired on the concept of Spheres of Action of the same author.[10]

The relations between the characters are established according to the roles. The following example shows the initial relations of a Hero with the other characters.

```
<Relation target="Villain" like="0"/>
<Relation target="Victim" like="3"/>
<Relation target="Donor" like="3"/>
<Relation target="Helper" like="3"/>
```

Figure 7 – Hero's interpersonal relations

For example, let's consider that we have John (a boy shadow) and he is a hero. As you can see in the example above the hero starts acting with a neutral relation towards the villain. However this relation is not static, and will evolve according to the emotional reactions of John to the actions of the Villain.

To do that, the character's minds include a set of action tendencies are the actions that are executed as an immediate reaction to a change in the environment. An author may give the John (the hero) an action tendency of running to his friends whenever he feels sad, or attacking a Villain whenever aVillain attacks him. By modelling these actions, it is possible to author different kinds of characters in the same role, which means that it is possible to define a more or less aggressive Hero.

Another way of authoring different personalities for the same role is by managing the emotional "personality" of each character. By manipulating the values of activation and decay of emotions, it is possible to build a hero that easily falls in love, or a Hero that likes to be a lone ranger.

2.3.5 Director

The Director agent controls the whole interactive process to keep the tension values are proposed in section 2.2. Although still being implemented this component is responsible for collecting all the affective information produced by the characters, specially focusing on the emotions of the hero and the victim. Based on this information and on its knowledge about characters relations it chooses between: sending a message to a character in the cast telling it to enter; sending a message to character on the scene to leave; or not to take any action for the moment.

Figure 9. General Architecture

3. Preliminary Results

The authoring process of I-shadows has combined elements of acting and fairy tales (by creating heros, victims, or villains) and on acting itself. As the system was designed as a close collaboration with children and teachers, some good results in terms of expression detection and emotion expression were achieved.

In terms of authoring the characters are interacting in small pieces of actions according to their roles, and more importantly, according to their relations with the other characters (taking into account their acting role).

Figure 10 - Hero Disappointed

Figure 10 shows the actual hero emotional state after failing to defend a Victim. The hero was in a very positive mood, because of the joy felt when the victim expressed her love for him. Suddenly the villain hits the victim. The hero appraised this event as a very negative action, and felt disappointed, this appraisal generated resentmet and reproach towards the action and towards his subject (Villain). As a consequence of these events his "Like" relation will decrease towards the villain and will increase toward the towards the victim. And because of this he will try to protect the victim the next time. The next figure shows the hero's emotional state after defending the victim.

Figure 2 - Hero Satisfied

This time the hero succeeded defending the victim and has a positive satisfaction feeling.

4. Conclusions

This paper presented gives a brief description on the development of I-shadows, an interactive storytelling where the user is free to act in the physical world by manipulating shadow puppets. The stories created are a result of the actions of the user and the actions of autonomous characters, controlled by an emotional architecture based on FATiMa. In the paper we tried to show the theorical groundings that supported the approach to interactive drama, and the role that the emotional model proposed has on achieving interactivity.

As with the authoring of FearNot! (also using FATiMA agents) the process is difficult to due to the lack of a real methodic authoring approaches for building agents. A character centered approach needs to be followed, and that is often difficult to do. Characters are acting according to their roles and and have dynamic relations, and it is these roles and relations that need to be captured in the agents minds. Although the results are so far positive, we believe however that, to really obtain a good play, the characters need to be further improved. Moreover, we expect to start evaluating the system with children very soon, thus providing us with enough feedback to improve our approach.

6. Acknowledgements

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