Towards Narrative-Driven Atmosphere for Virtual Classrooms

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ABSTRACT

In this paper, we propose the integration of audience atmosphere generation techniques into Interactive Storytelling (IS) engines to obtain more realistic and variable Virtual Reality (VR) training systems. We outline a number of advantages of this novel combination compared to current atmosphere generation techniques. The features of recent IS engines can be extended to automatically adapt the atmosphere produced by a group of virtual humans in response to user intervention while staying coherent with the unfolding story of the training scenario. This work is currently being developed in the context of a

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VR training for teachers, in which they learn to manage a difficult classroom under the guidance of an instructor.

KEYWORDS
Virtual Audiences; Interactive Storytelling; Virtual Reality; Training; Virtual Classroom

Figure 1: The Breaking Bad Behaviors (BBB) VR training for teachers to learn handle classroom discipline, while maintaining students' engagement and concentration on the lesson content and exercises [11].

INTRODUCTION

Numerous recent VR training systems use groups of virtual agents reacting to the user. For instance, VR training systems simulating different virtual audiences (e.g., attentive or bored) have been used to reduce public speaking anxiety [4, 8, 14]. A *virtual audience* is "a collection of virtual characters situated in an environment that mimics a public speaking situation" [14]. The term *atmosphere* is used in this context to describe how different types of audiences may be perceived. It corresponds to the collective impression generated by the whole virtual audience [6].

Recent work identified a set of critical non-verbal behaviors influencing virtual audience perceptions. They related combinations of virtual agent's bodily movements, gaze patterns, head nods, head shakes, facial expressions and users' emotional responses [14]. Further studies defined a precise set of virtual agent behaviors to simulate five distinguishable audience styles: *Interested and enthusiastic*, *critical and concerned*, *anxious and threatened*, *bored and impatient*, *indifferent and uninterested* [9].

In this paper, we propose the combination of recent developments on virtual audiences and Interactive Storytelling (IS) models and techniques. Therefore, we present an architecture under development that is using an IS approach to control a virtual classroom atmosphere in an open source VR training system for teachers, namely Breaking Bad Behaviors (BBB) [11] c.f. Figure 1. Our long-term objective is to provide more independent, interactive, coherent and believable virtual audiences for VR training or social applications.

POTENTIAL BENEFITS

The design of a social skill training system, including interactive virtual agents, presents several challenges. An important one is to control a virtual audience to follow a training plan, whilst allowing it to react to the user's behaviors and interactions. An important limitation of previous systems is the fact that they mostly relied on a *Wizard of Oz* approach to drive the audience in reaction to the user's performance [4, 8, 14, 17]. In recent work, different computational models of classroom atmospheres were compared and evaluated experimentally [10]. However, they still require a *human-in-the-loop* (i.e. an instructor) to adapt the classroom to the user's behaviors and interactions.

State of the art IS methods are good candidates to mitigate this issue: IS research, whether stemming from logical and rule-based perspectives [13] or more popular plan based perspectives [18], has addressed the issue of providing causally coherent narrative experiences, where user interaction is taken into account during the unfolding of a story. As such, various systems have provided interactive experiences where virtual agents are controlled by a narrative engine seeking to balance authorial

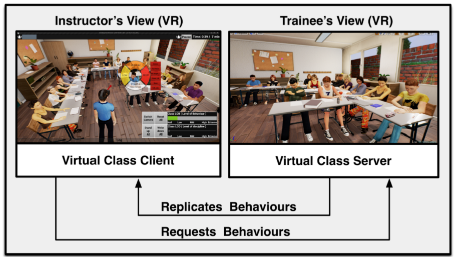

Figure 2: BBB Instructor's Interface (controlling virtual classroom) and Trainee Interface (immersed in classroom) [11].

Figure 3: BBB used in a classroom management seminar (trainee in the foreground, instructor in the background, other seminar students observing the session on the right). [12]

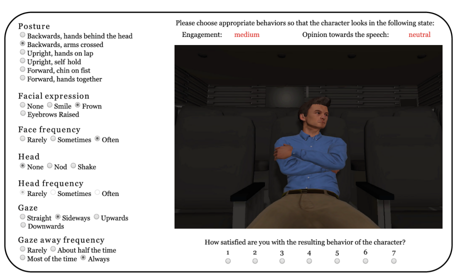

Figure 4: Interface used for the Audience Perception Model Creation [3].

intent, impact of user intervention, and narrative coherence. Previous work has, for instance, investigated how causally coherent stories can unfold from virtual agent interactions [1], how to control the unfolding of the story based on high level narrative goals [2, 15], means to take into account user intervention, including affective input [7], or how to patch up the narratives in systems where user intervention may break the causal coherence [16]. Another advantage of using an IS approach for educational systems lies in the fact that stories have the ability to influence attitudes and behavioral intentions of people [5].

METHOD

As a basis for our endeavour, we take the *Breaking Bad Behaviors* VR classroom training system [11], and a model of virtual audience perception (VAP) [3].

The BBB VR classroom management (CM) training system is based on low-cost portable hardware and software. BBB has been successfully deployed in seminars for teachers of primary and secondary schools (see Figure 3), and proven to be significantly better compared to traditional methods relying on video and role-play game [12]. BBB is capable of simulating up to 25 virtual students, semi-autonomous agents which can be controlled at any time by an instructor via a simple desktop interface (see Figure 2). The teacher in training is immersed within the virtual classroom using a VR headset and 3D controllers (see Figure 3). The instructor is an expert in CM, and evaluates the teacher's reactions to the bad or good behaviors of students. The instructor can either control the virtual student one by one, and/or the entire classroom by setting the wished level of class discipline (LOD). Instructor could choose between four main levels of LOD (*NONE, LOW, MEDIUM, HIGH and EXTREME*), going from very studious class room to highly agitated class.

The current system is simulating these levels by increasing the number of bad behaviours in the classroom and their intensities, based on pedagogic experts' descriptions. Consequently, the instructor is manipulating a lot of variables to create a specific atmosphere (e.g., bored or agitated class) and to change it according to a particular training scenario or trainee behaviour. We believe a interactive storytelling system using a generic audience atmosphere model will alleviate both, allowing the instructor to focus on the trainee evaluation, and create more convincing classroom simulation.

The VAP model [3] has demonstrated the capacity to express relevant audience states (i.e. low to high arousal, negative to positive valence), whereby the overall impression exhibited by the virtual audience can be controlled by manipulating the amount of individual audience members that display a target state. As shown in Figure 4, the state of an agent is represented by a set of different animation parameters: i) *Amount of time with averted gaze* (e.g., 0%, 25%, 50%), ii) *averted gaze direction* (e.g., sideways, down), iii) *posture* (e.g. backwards with arms crossed, upright with hand on lap), iv) *facial expression* (e.g., smile, frown, eyebrows raised), v) *facial expression frequency*(e.g., 25%, 50%, 75% of the time), vi) *head movements* (e.g., nod, shake) and, vii) *head movement frequency* (e.g., 3 times per 10 s).

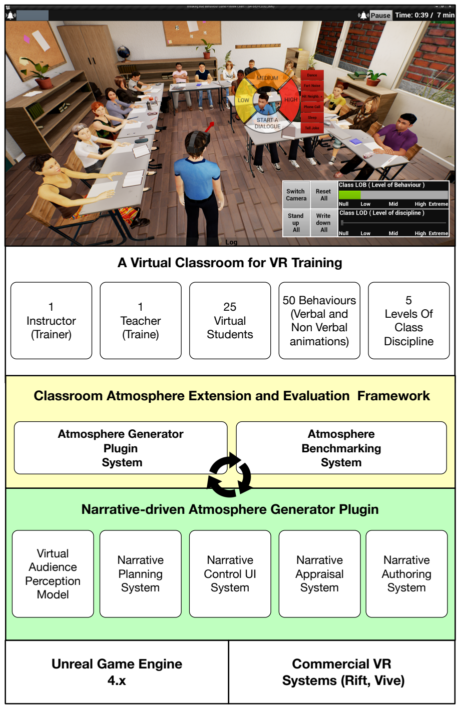

Figure 5: Architecture Overview: example of an instructor controlling a virtual student while the rest of the classroom is controlled by our narratively-driven atmosphere system.

The VAP model will be used by the IS engine to be able to replay variations of a training scenario within different classroom atmospheres (e.g., with *Interested and Enthusiastic* students against very *Indifferent and Uninterested* students). The IS engine will also allow the instructor to encode and replay many variations of typical bad classroom behaviours. For an example please imagine two students who are friends (*Social Model)* but are placed far away from each-other in the virtual classroom. Then one decides to communicate with the other, e.g., to badmouth a third student (*high level narrative action*). Depending on the atmosphere quality (*Interested and Enthusiastic* or *Indifferent and Uninterested*), the students' personalities (*Personality Model*) and the situational information (*distance*), the two friends may decide to use any of the available actions: i) pass the note labelled with the destination to a nearby student with whom they are in good terms ii) fly a paper plane with the note in it, iii) directly talk to their friend, or iv) even get up and go and talk to their friend, completely disturbing the course.

PROTOTYPE ARCHITECTURE

As illustrated in Figure 5, BBB has a **Classroom Atmosphere Extension and Evaluation Framework** (highlighted in yellow) which is an important advantage for our research. Its **Atmosphere Generator Plugin System** allows the fast integration of novel virtual student's behavior in the current training system and its **Atmosphere Benchmarking System** allows to compare different plugin performances on a scenario [10]. The architecture of the plugin under development, the **Narrative-driven Atmosphere Generator Plugin** (highlighted in green), is composed of the following modules:

- The **Virtual Audience Perception Model** defines the virtual students' non-verbal animations corresponding to a certain type of classroom atmosphere. We will initially use the model proposed by Chollet et al [3].
- The **Narrative Planning System** generates the next sequence of actions along with its associated atmosphere in real-time based on the interactive narrative model. We will initially build upon the approach from Martens et al. [13].
- The **Narrative Control UI System** is a user interface allowing the instructor to manipulate the narrative and its atmosphere in order to give feedback to the trainee or to adapt the difficulty level. The instructor will be able to change the atmosphere quality at any time, resulting in the narrative engine to automatically adapt the virtual students' behaviours. The UI System will also permit to replay or start new training scenarios, to confirm the successful resolution of the current bad behaviours, and let the narrative engine load the next training scenario.
- The **Narrative Appraisal System** keeps track of the current state of the narrative experience. It records past actions, corresponding atmospheres, and the narrative goals.

- The **Narrative Authoring System** defines the interactive narrative model: storylines, actions, characters, personality and social models as well as the goals set by the instructor, user interaction and atmosphere model and state manipulation. It is typically done using action language descriptions (e.g., planning languages [15], or logic programming [13]).

INTERDISCIPLINARY CHALLENGES

From an interdisciplinary perspective, the combination of VR, IS and virtual agents within a pedagogic application is raising three questions that we will address in our future work:

(1) **Is the generated audience atmosphere perceived as intended in immersive VR?**
The VAP model which we plan to use has so far been evaluated in a semi-immersive setting for a public speaking training software. After integrating this model into the BBB system, we need to verify whether the user's emotions triggered by the classroom match the intent of the model. The behavior models may have to be amended according to the findings.

(2) **Can classroom atmosphere successfully render narrative tension?**
Following the establishment of a reliable mapping between the classroom behavior model and the atmosphere perceived by the user, the next task will be to integrate a narrative engine into the system. This engine will be tailored to the requirements of the BBB system, and control the atmosphere as part of the unfolding story requirements. The narrative engine will use the atmosphere as a device to render intended scenarized effects for modulating the user experience by creating emotionally challenging situations.

(3) **Does the system lead to positive training outcomes?**
Provided the behavior models allow to control classroom atmosphere, the added value of the overall system in terms of improved engagement and learning will have to be assessed.

CONCLUSION

We have outlined the architecture, potential benefits and interdisciplinary challenges of a system under development, for controlling the atmosphere generated by an audience in a virtual training environment with a narrative engine. Delegating the task of coordinating virtual characters to the atmosphere generation engine may help to populate an interactive training scenario with a coherently behaving crowd of seemingly autonomous characters.

Our future work will evaluate the capacity of our system to produce more coherent and believable virtual audiences compared to a previously proposed *Wizard of Oz* approach. We believe our interactive, narrative-driven atmosphere generation approach and prototype, and its possible affordances, will interest the CHI community working on social or training applications in VR.

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