Developing an Immersive, Cultural Training System

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ABTRACT

CHI Systems, under contract to the U. S. Army Research Institute, is developing an immersive training system, called Virtual Environment Cultural Training for Operational Readiness (VECTOR), which applies highly experiential, scenario-based virtual environments to training in cultural familiarization. This paper describes the cultural-training application, the architectural design, and the associated implementation of the immersive environments and intelligent agent technology. This training system employs 1) a virtual environment/3D game engine, 2) cognitive and emotion modeling, and 3) intelligent tutoring/instructor agents. The virtual environment allows a trainee to explore the manner in which synthetic actors, or non-player characters (NPCs), respond to the actions of a trainee-led security force. An important determinant of the success of the training system is the representation of significant aspects of NPCs' cultural background and affective processes. One of the innovative features of the virtual environment is the use of executable cognitive models and emotion models, which play significant roles in the overall reactions and behaviors of NPCs toward the trainee. In addition to influencing the behavior of the active NPCs, the emotion models constrain interactions with NPCs encountered later in a scenario. In this way, the training system provides a means of modeling the overall cumulative emotional state of the simulated population and their impact on the simulated situation. The initial implementation of the virtual environment, focused on Iraqi Kurdish culture, is discussed.

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INTRODUCTION

The skill with which the members of our military forces interact with members of other cultures is often critical for their survival and mission success. Cultural familiarization and understanding of group differences are especially critical to security forces that are responsible for managing potentially dangerous situations in foreign settings. CHI Systems is currently developing an immersive environment training system for the U.S. Army Research Institute (ARI) that will help forces engaged in Operations Other Than War (OOTW) acquire the ability to accurately assess and effectively respond to the motives and tendencies of indigenous populations. Specifically, the Virtual Environment Cultural Training for Operational Readiness (VECTOR) system that is being developed uses highly experiential, scenario-based training in virtual environments to teach culturally adaptive interaction skills related to military police and military intelligence tasks.

The simulation-based training is an effective solution to the training problem of developing cultural sensitivity and understanding in trainees. Immersive training allows the trainee to learn and practice skills within the context of a game where the trainee's actions have a direct result on an evolving simulation. The virtual environment is designed to encourage a high degree of human interaction with the model, as the trainee encounters prototypical social contexts and military situations. The effects of trainee's actions, either positive or negative, are readily observable by the actions of characters within the game. The scenario reacts to these responses, and in the process, provides important information concerning the consequences of particular actions or omissions.

The outcome of the simulation is, thus, not predetermined, but instead depends on human participants interpreting and reacting to the evolving scenario. The scenario represents a collection of synthetic actors, or non-player characters (NPCs), in the cultural environment that have predefined roles, tasks, and motivations. Some external events happen at fixed times, while others happen on the basis of proximity or other contingencies. Essentially, however, the scenario plays out solely on the basis of the trainee's actions in the environment. In this respect, it has much in common with current game technology. At the heart of this immersive environment are executable cognitive models and emotion models, which influence the overall reactions and behaviors of the NPCs toward the trainee. The ultimate goal is to produce a highly interactive, realistic training environment for cultural training.

The first part of the paper describes how cultural elements are being integrated into the virtual environment to create effective, intensive instruction. The part that follows provides a brief overview of the specific training scenario that is being developed. The third part describes the mechanisms that allow the trainee to engage NPCs in a realistic way within the virtual environment. The final part of the paper addresses the significant role of cognitive and emotion models in informing and constraining the behavior of these NPCs.

CULTURAL FACTORS AND BEHAVIORS

Conducting Operations Other than War (OOTW) frequently require tact and an understanding of the motives and tendencies of indigenous populations in order to defuse tense situations peacefully, prevent civil disturbances from becoming violent, and obtain the cooperation of the population. The goal of the virtual environment is to provide trainees with the opportunity to explore the breadth of cultural behaviors related to a specific cultural group and to observe the effect of cultural behaviors (appropriate and inappropriate) within the context of a realistic military situation. The cultural focus is presently on the Kurd sub-culture of the Arabic culture.

Cultural Training Approach

The development of the immersive environment is in response to conventional forces, such as military police, being increasingly required to undertake

missions, such as peacekeeping, where cross-cultural interactions play a significant role in determining success or failure. These conventional forces do not, and will not have the benefit of intensive real-world experience, which is common in Special Forces, and may in fact need to be deployed with limited forewarning. A brief, intensive, effective, and rapidly-adapted training program in cultural interaction is what the virtual environment is intended to deliver, and will benefit conventional forces subject to time constraints and training needs on a large scale.

The specific training scenario is designed to make trainees more culturally sensitive, in general, rather than to instill in them specific rules of behavior in particular contexts. If a trainee comes away from the training with a list of rules (i.e., do's and don'ts) for a particular cultural situation, this would be valuable. But an even more valuable outcome of the training would be if that trainee were to begin to develop, or just become aware of the need for, adaptive strategies for dealing with difficult/ambiguous cultural contexts.

The development of the immersive environment, then, is premised on the idea that learning cultural knowledge requires more than merely inculcating a set of behavioral rules in trainees. In some sense, trainees need to internalize a mindset. Of course, a specific set of cultural encounters in a training scenario will never serve to cover all possible cases that a soldier may encounter in real life. It follows that the scenario needs to be designed to generalize into a broader understanding of cultural issues. In this sense, the training approach used in the simulation is consistent with constructivist, case-based learning – which encourages the exposure of trainees to a broad base of experience, in a compelling and memorable environment (see Riesbeck, 1996 for full discussion of this approach).

The essential lesson for trainees to learn from the virtual environment is that cultural situations – whether in Kurdistan, China, the Philippines, etc. – inevitably call for interpretations and conduct that diverge from their normal, taken-for-granted ways of acting or processing social cues. To accomplish this training goal, the scenario requires trainees to recognize that a particular situation calls for cultural sensitivity and then use their general knowledge of the culture to assess the most appropriate course of action. Remembering the correct "cultural rule" for the situation is important, but only to the extent that it helps trainees tap into and develop higher-level reasoning skills, which will serve them well regardless of the specific cultural context that they will be entering.

Major Cultural Dimensions

To construct a realistic immersive environment, the virtual-environment team gathered a large data set consisting of Arabic, as well as Kurd-specific, cultural information, as it applies to peace-keeping type missions. This information was synthesized from multiple sources, including books (e.g., Izady, 1992; Kreyenbroek & Allison, 1996), articles (e.g., Ruff, 1998), and military technical reports and pamphlets (e.g., Wise et al., 1998). Some of the major cultural dimensions that U.S. forces would be required to understand in Kurdistan, as well as many other cultures, include: gender; religion; status; perceptions of/attitudes toward American culture/individuals; interpersonal space (proxemics) and interaction; and emotion/personality tendencies or predispositions. A number of elements from each of these cultural dimensions are being integrated into the scenario.

The overarching pedagogical principle for all of these embedded cultural elements is to focus trainees on identifying and responding to divergences from American norms and expectations in a constructive way. Three short examples will serve to illustrate the kinds of cultural elements that we have in mind. Each of these elements is tied to a specific set of behaviors, along with related interpretations and understandings, that trainees are expected to recognize as different from, and in some cases contradictory to, those behaviors with which they are familiar.

One cultural element related to "gender" is that trainees, especially males, should not deal with, and should avoid all touching behaviors with, Iraqi/Kurdish women. A second cultural element, this one related to "religion," is the deference that should be given to mosque leaders (e.g., ask permission before entering) as well to those who are praying in or outside of mosques (e.g., do not talk to or walk in front of people praying). A cultural element related to "interpersonal interaction" is the shame associated with admitting that one "does not know" or admitting that one has made a mistake; an Iraqi/Kurd will not comfortably make either such admission – unless it can be done in a non-threatening way.

THE TRAINING SCENARIO

The training scenario immerses the Trainee, represented as Squad Leader, in a virtual village and requires them to interact with various Indigenous Entities. The main goal is gain information on the whereabouts of several Persons of Interest. The Trainee is free to move about the virtual village at will, as well as select the order of Locations he or she visits

and the Indigenous Entities that he or she will engage. While moving through the village, the Trainee gathers information from Indigenous Entities as to the whereabouts of the Persons of Interest. Success in acquiring this information depends on the degree to which the Trainee demonstrates appropriate cultural knowledge and skills.

The scenario begins at the Squad arrival point, where the Trainee and his/her fellow Squad Members, all of which are NPCs, are given the following mission briefing:

"There has been a car bombing at the UN outpost. We have received information that indicates another bomber may be in the area. Your job is to collect information, locate the bomber and stop him from reaching his next target. Because of a series of cultural mistakes there has been an increase in anti-American sentiment in the village. Any violation of cultural conduct may cause the city to turn violent and jeopardize your mission. Start your mission by visiting the local police station and getting any information they may have. Remember; time is of the essence. Dismissed."

From this point forward, Squad Members are under the direct command of the Trainee. These Members include several enlisted personnel who provide specific functions (e.g., communications, medical, security). There is also a Translator, a single synthetic entity, which will be represented as an Iraqi police or military official. The Translator functions as a trusted indigenous counterpart whose purpose is to facilitate the Trainee's mission by providing translations and offering cultural advice. The Translator is always within close proximity of the Trainee, and all communications are assumed to be made by the Translator. However, all audio communications are in English, so as to facilitate implementation of the initial scenario and increase interaction between the Trainee and Indigenous Entities (i.e., not mediated by Translator).

In most situations, the visual simulation has the first person perspective of the Trainee, and, thus, the Squad Leader is not visible in the visual scene. The Trainee moves through the virtual village using a mouse and keyboard. The Trainee can issue standing orders to the other Squad Members; however, the Squad Members behave in a semi-autonomous manner based on the Trainee's actions and according to a set of predefined military actions, behaviors, and rules of engagement. For example, when the Trainee moves forward, the Squad follows and maintains their formation and combat spacing.

Major interaction sequences and cultural training opportunities are based on Location – e.g., police station, a café, several households, a marketplace, and a mosque. As the Trainee moves from one Location to another, the development of the overarching plotline – and thus Trainee success – depends on him or her avoiding behaviors that contradict cultural rules and demonstrating behaviors that are consistent with these rules. The former behaviors reduce the cooperativeness/tension of the Indigenous Entities (e.g., willingness to provide useful information), whereas the latter behaviors increase the cooperativeness/tension of these NPCs. The Indigenous Entities have varying, pre-set levels of cooperativeness/tension, which makes the Trainee's task of eliciting information more or less difficult from one location to the next. There are also plans to have changes in the cooperativeness/tension of currently engaged Indigenous Entities affect the pre-set levels of Indigenous Entities at other locations. This representation of "emotion contagion" is based on the idea that Indigenous Entities communicate with one another about the conduct of the Trainee.

VECTOR TRAINEE INTERACTIONS

In order for interactions to take place three basic elements are necessary – a Location, an Indigenous Entity, and the Trainee Entity. The Trainee Entity is the visual representation of the simulation user's presence and position within the virtual environment. The Trainee Entity is under the direct control of the user in terms of locomotion, selection of dialog, selection of actions, and the choice to interact with all other simulation entities. To interact with NPCs, the user of the training system provides a GUI menu that allows the trainee to select dialog interactions through keyboard entry.

Interaction Dynamics

Interaction with Indigenous Entities can only occur in specific simulation Locations, which provide a stage for simulation events to unfold. This is necessary to provide predefined interaction opportunities, which contain variable outcomes and interaction evolutions based on user choices and the degree to which he or she can build trust in or otherwise negatively affect the Indigenous Entities present in the location. The two main types of locations are buildings and loiter points. Buildings can fall into several types of structures, including residences and specialized buildings (e.g., café, police station, and mosque). Interaction opportunities are based on the proximity of the Trainee Entity to Locations and Indigenous Entities.

The speech of NPCs is delivered by a WAV file output with concurrent text. An entity response (either an action or a dialog) is the direct result of an entity interaction, which evaluates the Trainee's actions and assesses its own internal and external state in order to generate a response from a set of possible responses. Only responses that are consistent with the entities' predisposition and allowable under the Location's present sub-plot position can be selected.

The Trainee can interact with both the Squad Members and the Translator for assistance in conducting the military mission. These interactions can occur anywhere in the virtual world and do not require a designated Location. To directly interact with other simulation entities, the Translator must be instructed to do so by the user. Autonomous behavior of the Translator would reduce the trial and error value of the simulation. The Translator can, however, offer preemptive advice to the user in the case where a blatantly inappropriate cultural action is about to be taken by the user. The Translator Entity can also be queried by the user and can serve as an instructor agent for cultural information.

Squad Member Entities and, to a lesser extent, the Translator Entity function in a semi-autonomous mode with respect to gross movements and actions. Squad Member Entities can, in effect, follow the Trainee Entity throughout the simulation and provide automatic context specific behaviors (e.g., forming a perimeter when the Trainee Entity approaches a door). Squad Members' actions are based on U.S. Army squad level movement doctrine.

Major processes underlying entity behaviors and memory include: *response generation* – what an entity will decide to do or say; *advice generation* – what the Translator may say in response to a query from the Trainee; *interactive evaluation* – how the Trainee's actions are scored; *psychological state propagation* – how interaction may affect the whole village; and *training evaluation* – how feedback is provided to the Trainee. Data stores consist mainly of actions and dialog alternatives, which represent all possible entity behaviors. Additional data stores include scenario related parameters and cultural rules. Transient data stores are used to represent behavioral state information for both individual entities and the overall village (i.e., the village mood).

Trainee's dialog options are limited to four pre-defined options at each critical interaction, or juncture in the scenario. Each of the dialog options varies from the others in terms of its consistency with one or more cultural rules. These dialog options appear on the bottom of the screen, and the Trainee is instructed to choose the most appropriate utterance for that interaction. Dialog selection across interactions plays an integral role in the success (or lack thereof) of the Trainee.

VECTOR Interface Constructs

Figure 1, on the next page, shows the VECTOR display interface and the five major GUI components, each marked with a numbered symbol, including a General Status Display, NPC Name Placard, Mission Objectives List, Dialog Interaction Display, and a Mission Map Each of these is explained below.

General Status Display: This is used to display Mission Objective (MO) information, including MO changes, additions, and completion status, as well as each instance of a cultural rule violation or adherence. Additionally, at the end of each mission, a summary of the mission is displayed with respect to a review of each cultural rule that was measured.

NPC Placard: Each NPC's name, and their overall emotional state, is displayed above their avatar and is always parallel to the player's field of view. By default, the NPC emotional state is not displayed until initial dialog interactions.

Mission Objectives Summary: This display toggle is used to view the current list of MOs and their status. Those MOs with a leading '_' character are not yet complete; those with a leading 'X' are completed. The Mission Objectives Summary can be viewed at any time by holding down the 'Tab' key.

Dialog Interactions: This display is used to present a text version of the utterances that an NPC generates (this is in parallel to the '.wav' file that is played as a companion modality to present the auditory version of the NPC utterance). Additionally, the user can 'speak' to an NPC by moving the dialog selection cursor, indicated by the '>' character and hitting return to send the utterance to the NPC that is being spoken to.

Scenario Map: This displays a static 2-D overhead map of the current scenario.

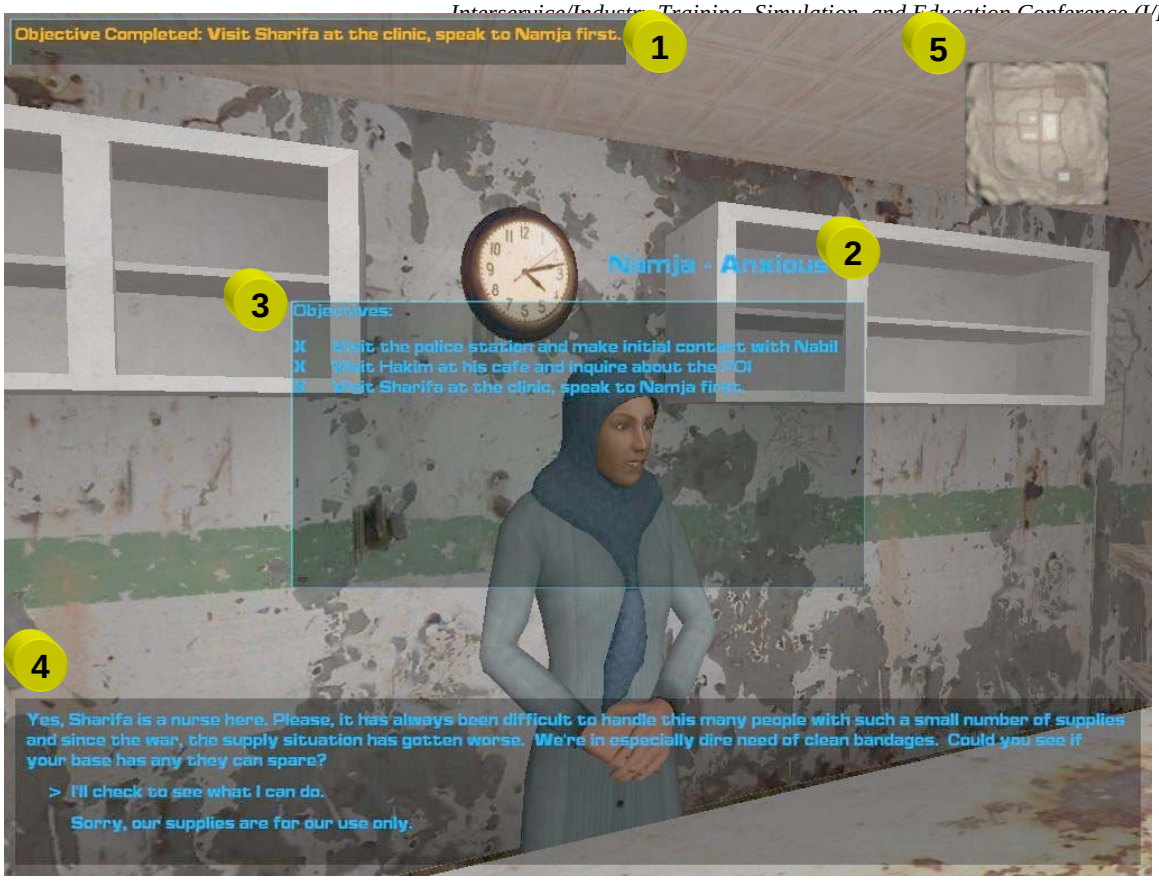

Figure 1. VECTOR Display Interface

NPC BEHAVIOR AND AFFECT

While the initial focus of the scenario is on the Arab and Kurdish culture and sub-culture in particular, a more generic model of culture was seen as an important requirement. To produce an interactive, realistic cultural world (whether it be Arabic or some other targeted domain), the virtual environment must incorporate synthetic actors that are capable of evaluating and responding, emotionally and behaviorally, to the cultural propriety of trainee's actions. An essential step in the creation of such synthetic actors is the representation of significant aspects of NPCs' affective processes, as well as their cultural background, in the scenario. This emphasis on the link between cognitive/emotion models, on the one hand, and culture, on the other, is consistent with our psychology-based ontology of culture (see Triandis, 1994; Strauss& Quinn, 1997).

According to our cultural ontology, the interactions between individuals are governed by implicit norms and procedures, which are organized in individuals' minds as shared cognitive schemas. These schemas provide members of a culture with a complex and interactive set of principles and procedures (e.g., "cultural rules") ranging from coherent verbal interactions to acceptable social behaviors. In this way, shared schemas provide individuals with a distinct lens through which to see the world. Culture, then, acquires its motivational force – its power to instigate and shape behavior – by activating emotions within individuals. Observing and performing culturally consistent behaviors trigger positive emotions within individuals, whereas observing and performing culturally inconsistent behaviors trigger negative emotions. It is this fundamental principle of culture/emotion that underlies all actions of synthetic actors toward the trainee. It follows that cognitive and emotion models serve as the linchpin in the integration of cultural factors into synthetic actors.

One of the innovative features of the immersive environment is the use of executable cognitive models that contain emotion models, which influence overall reactions and behaviors of NPCs toward the Trainee. Much research has been conducted on the development of more realistic emotional behaviors for intelligent virtual agents. The immersive environment leverages this experimental research in order to produce entities that respond to the Trainee in a realistic way during an evolving and variable plot sequence. Implementation of behavior and affect within the training system has required the adoption of three major constructs – an NPC cognitive model for behavioral interaction and dialog, an underlying emotion model within the NPC

cognitive model, and a scenario scripting language that allows for the specification of all aspects of NPC capability per scenario. We adopt a computational model of emotion based on the model proposed by Ortony, Clore, and Collins (1988), commonly referred to as the OCC model. They categorize over 20 emotional variables with respect to a valance mapping of reaction to objects, events, and actors.

The cognitive models that control the NPC behaviors are written using the commercially available version of CHI Systems' intelligent agent construction toolset. This toolset is based on a theoretical framework that includes a model of human information processing architecture, derived from multiple component theories, and a set of theoretically derived principles of operation.

NPC Behavioral Modeling

As has been described, a capability is desired that can adapt generic NPC models and enable them to support training content for specific cultures, as well as extend them to support "idiosyncratic" cultural features (ones that do not fit within the cultural template, but are still required for training) and instantiate them for individuals. The initial implementation takes the form of NPC profiles and scenario scripts. When the scenario script specifies instantiation of a specific actor (whose characteristics are drawn from a specific cultural profile), the model instance is created and reads the profile. The parameters of this profile are adjusted and extended by reading additional parameters specified with the actor definition within the scenario script. These additional parameters represent offsets from the norm represented by the cultural profile, as well as simple extensions that may be used by the cognitive model itself (such as name and gender of the actor). This scripting language allows for the construction of a canonical cognitive model of NPC interactions while allowing for infinite NPC character creation through the construction of new, or modifications of existing libraries, of NPC scenario scripts.

Based on our preliminary analysis, we have identified a candidate behavioral taxonomy. The taxonomy has two major components – emotion and behavioral mitigation factors. Figure 2 contains our preliminary behavioral taxonomy. The taxonomy contained in Figure 2 is rather large and could potentially produce hundreds of actions that interact with emotion and other mitigation factors. Although some efforts have attempted to develop mathematical models that account for large numbers of behavioral factors, these models cannot be easily integrated into the virtual environment to provide a realistic and predictable behavioral response, and thus may potentially confound the type of training the immersive environment seeks to deliver. The complexity of implementation, the refinement of avatar behaviors based on complex emotion models, and the assessment of the validity of the probabilistic output of the model are beyond the scope of this effort. We have developed an alternative initial approach to modeling emotion, which is presented below.

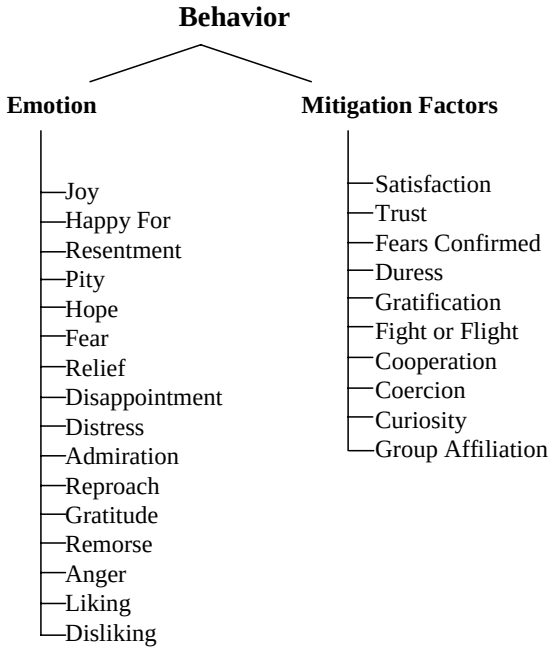

Figure 2. VECTOR NPC Behavior Taxonomy

Preliminary Emotion Model

To facilitate the implementation of the virtual environment, we are initially using a lower risk approach to attain a reasonable level of emotion model behavior. Our initial concept of the emotion model is to establish a set of variables that represent levels of each of six "basic" emotions. Commonly, this set includes happiness, sadness, anger, fear, disgust, and surprise (see Velasquez, 1997). For our purposes, we can choose to augment this set with other emotional variables (such as trust). Such additional variables can be chosen on the basis of their benefit to the realism of training, regardless of their actual theoretical validity.

The emotional variables are controlled by a set of (culture-specific) mappings that take output from the dialog manager, and from events in the environment and apply corresponding adjustments to one or more of these variables. The mechanism can be elaborated to

include excitatory and inhibitory effects between emotional variables, as well as saturation levels and a decay curve.

The emotional state (i.e., vector of emotional variables) influences the triggering, priority, and execution of cognitive tasks within the model. A combination of anger and fear, for example, in conjunction with an environmental stimulus (a gun being drawn) might trigger a self-defense task, involving a violent response. Instead of selecting anger or fear, the model might select a lesser reaction to the appearance of the weapon (such as a verbal response, or a decision to cooperate). All of the emotional factors have an ordinal scale from 0 to 10, with 5 being the median value. High values (i.e., 10) for the happiness and trust factors are good from the Trainee's perspective while low values (i.e., 0) are ideal for the sadness, anger, fear, disgust, and surprise factors.

Indigenous Entities do not start the simulation with the same emotional state. This variation is done to better model the anticipated differences between entities based on factors such as gender, age, social status, and political affiliation. The male Civilian Entity, for example, represents the most natural of all entities and has initial values of 5 for all emotional factors except trust. In the virtual environment, trust must be earned, and interactions with trusting Civilian men are the predominant way of collecting useful mission information. Trust has a significant impact on the degree to which an entity will supply useful information. For this reason the trust factor are set to 0 for male Civilian Entities.

Cultural rules are based on the appropriateness of the Trainee's action with respect to the current situation. For example, if the Trainee knocks on a door and a female answers the door, the Trainee will be penalized if he or she tries to engage the female in conversation (other than asking for the male of the household). More specifically, this cultural violation may cause the female's value for fear and surprise to increase. Entity action and dialog generation (i.e., what the entity decides to do or say) is governed by the entities' internal emotional state.

CONCLUSIONS

We have developed in VECTOR a virtual training environment incorporating cognitive-model-controlled NPCs that facilitates the delivery of cultural-familiarization training. Through the use of a canonical cognitive model of NPC behaviors using a cognitive architecture and a generic scripting language, cultural rules are encoded and mapped to scenario-specific NPC dialog and behaviors, thereby providing a set of virtual NPCs with which the Trainee can interact. Additionally, the NPC model contains an emotion model that modulates NPC dialog and actions based on underlying trainee actions and dialog. Future areas of VECTOR development will include use of NPC emotional state to drive real-time facial animation of NPC avatars, deepening the scenario to encode additional sets of cultural rule support, and adding additional features to the NPC emotion model. A beta-test version of VECTOR was released in May 2004. The final version of the software is due to be released in December 2004.

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REFERENCES

Card, S., Moran, T., and Newell, A. (1983). *The psychology of human-computer interaction*. Hillsdale, NJ: Erlbaum.

Hayes-Roth, B. (1985). A blackboard architecture for control. *Artificial Intelligence, 26*, 251-321.

Izady, M. R. (1992). *The Kurds: A concise handbook*. Philadelphia, PA: Crane Russak.

Kreyenbroek, P., & Allison, C. (1996). *Kurdish culture and identity*. New Jersey: Zed Books.

Ortony, A., Clore, G., Collins, A. (1988). *The cognitive structure of emotions*. Cambridge University Press.

Riesbeck, C.K. (1996). Case-based teaching and constructivism: Carpenters and tools. In B.G. Wilson (Ed.), *Constructivist learning environments: Case studies in instructional design*. Englewood Cliffs, NJ: Educational Technology Publishing.

Ruff, C. (1998). "Exploring Islam." *Washington Post*, 13 May.

Strauss, C., & Quinn, N. (1997). *A cognitive theory of cultural meaning*. Cambridge, England: Cambridge University Press.

Traindis, H.C. (1994). *Culture and social behavior*. New York, NY. McGraw-Hill.

Velasquez, J. D. (1997). Modeling emotions and other motivations in synthetic agents. *Proceedings of AAAI-97*. (pp 10-15). AAAI Press and The MIT Press.

Wise, C., Hannaman, D., Kozumplik, P., Ellen, F., & Leaver B. (1998). ARI Contract Report 98-06: *Methods to improve cultural communication skills in Special Operations forces*. United States Army Research Institute for the Behavioral and Social Sciences.