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Figure 1: Virtual advanced medical post

ABSTRACT

Health care delivery in military conflict, in peacekeeping missions or in the aftermath of disaster, implies high stress environments with danger exposures, life-threatening events and high levels of work demand. Crisis and emergency risk communication remains a real challenge. The rapid response of emergency medical teams has an important role to play in preventing serious adverse events.

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During critical events, medical errors can be related to human or system factors, including ineffective team leadership, non-standardized team communication, a lack of global situation awareness, poor use of resources and inappropriate triage and prioritization. The VICTEAMS project aims at building a virtual environment for training rescue team leaders to non-technical skills. Depending on the leader abilities, the virtual characters playing the subordinates (e.g. nurses) reproduce a variety of behaviors like erroneous actions, followership attitudes or stress-based behaviors. A pedagogical director tailors the difficulty according to the dynamic profile of the learner.

CCS CONCEPTS

• **Computing methodologies → Planning and scheduling**; **Cognitive science**; **Multi-agent systems**; **Intelligent agents**; **Virtual reality**; *Vagueness and fuzzy logic.*

KEYWORDS

Virtual Reality, Training, Autonomous Virtual Agents, Medical, Leader, Team, mass casualty management

1 INTRODUCTION

Rescue missions (conflict, peacekeeping, natural disasters) involve stressful environments where some decisions can make the difference between life and death. A quick response of the medical teams plays an important role in achieving optimal care and preventing serious adverse events. However, this time pressure can increase the level of stress, impacting the performance on tasks requiring information recovery and selection, shared attention, working memory capacity and decision making. This is why training in managing complex crisis situations is a challenge for trainers. Virtual environments for training provide useful complementary tools to existing training. Such existing training sessions train medics to physically perform technical gestures on tangible manikins (eg. SIM3G manikins). Life-size role-playing simulations also exist to train these teams to non-technical skills (leadership, teamwork, situational intelligence, communication and decision-making). But they are difficult to organize and are very costly. Finally, desktop non-immersive simulations (e.g. XVR) are available but do not support the training of non technical skills (eg. how to interact with expressive subordinates). The goal of VICTEAMS is to provide immersive virtual environments to easily create training situations for non-technical skills that include a strong collective dimension during a mass casualty management.

The VICTEAMS project aims to create a virtual environment for the training of medical leaders in non-technical skills, such as communication, stress management and leadership. The design of this type of immersive environment dedicated to medical simulation requires the work of a multidisciplinary team of experts, involving multiple skills (virtual reality, artificial intelligence, cognitive psychology, ergonomics, pedagogy, computer science, motion capture, military medicine and emergency medicine). In this interactive learning environment, the learner (medical leader) is immersed in a virtual environment and interacts with autonomous virtual characters. These characters play the role of the medical team members and must be able to have natural interactions with each other. Although the learner can act directly on the environment and on the victims, she has to learn to manage her team, to delegate actions, to manage her stress but also her team, to supervise and to collect information. In order to manage her team, she has to interpret the virtual characters behaviors (non-verbal, verbal, technical and non-technical behaviors). To produce unpredictability and stimulate the learner, depending on the training objectives, different type of errors must occur, both at the technical level (for example: poor material preparation) and at the non-technical level (for example:

poor communication, attentional focus). Errors need to be coherent with the skills and the behavioral profile of the virtual characters.

2 RESEARCH TOPICS

2.1 Ergonomic studies

As part of the VICTEAMS project, we sought to understand the role of non-technical skills in decision making during crisis management. The scope of the definition of non-technical skills was unclear and the question of their articulation with technical skills was little or not studied. VICTEAMS made it possible to define precisely the concept of non-technical skills, to model them, and to question how they are articulated with so-called technical skills [2].

2.2 Orchestration

The specification of possible unfoldings of events in a simulation is essential for human learning in a virtual environment. This allows both to propose and orchestrate personalized learning situations and also to bring the learner toward relevant and educative scenarios. We focused on the dynamic generation of scenarios and their execution in a virtual environment. For that, we aim at a set of objectives that are often contradictory: the **freedom of action of the user**, the generation of **various scenarios** that **respect the authorial intent**, the **narrative control** and the **capacity of the system to adapt to deviations from the learner**. The different approaches of interactive storytelling tackle more or less some of these objectives, but it is difficult to satisfy them all, and this is the challenge of our work. In addition to these objectives, we also aim at facilitating the **modeling of the narrative content**, which is still a real issue today when it comes to model complex environments such as the ones related to crisis management. We propose an **emergent** approach where the scenario experienced by the learner will emerge from the interactions between the learner and our narrative system MENTA [16], [13], [14], [15]. MENTA is in charge of the **narrative control** by proposing a set of adjustments (on the simulation) fulfilling the narrative objectives selected by the trainer (e.g. a list of specific skills). These adjustments take the form of a prescribed scenario generated by MENTA via a **planning** engine coupled with **fuzzy cognitive maps** through a macro-operator **FRAG**. FRAG is used to model FRAGment of the scenario in the form of scripted sequences of actions/events. The originality of our approach is due to a strong coupling between planning and graphical models. It preserves the exploration capability and the generative power of a planning engine (contributing to generate **various** and **adaptable** scenarios), while facilitating the **modeling of narrative content** and the **authorial intent**. To do so fragments of the scenario scripted by the author are used during the planning process.

2.3 Autonomous Virtual Characters

[6] states that "human errors are inevitable but it is possible to reduce, detect and mitigate them". It is therefore essential to learn how to detect errors as in many cases, human operators are able to control their consequences. [1] is interested in unforeseen situations and distinguishes two types: possible situations that can be anticipated as similar situations have happened before and unthought situations that will require more cognitive resources to

be resolved. This is why, within the VICTEAMS project, we have developed a virtual environment for the training of medical team leaders where the learner has to detect and correct her teammates errors. Teammates are represented by virtual characters in order to increase the proportion of possible situations related to unthought situations. The team leader must ensure the smooth conduct of the collective task as to facilitate the teamwork. In order to do so we wish her to identify behaviors which are representative of real behaviors. We have identified important characteristics as: type of communicators, stress resistance, type of followership (proactive vs passive). We propose to use, within a collective work situation of a virtual environment for training, an action selection engine to generate erroneous behaviors in order to recreate these learning situations [11], [10], [9], [8], [12] [7]. Errors may take the form of: poor communication, bad perception of the situation or non-compliance with the regulation in an emergency situation.

2.4 Non-verbal behaviors

Interactions in teamwork and their efficiency are based on a hierarchical system including vertical dyads. VICTEAMS studies leadership through the social roles linked to the hierarchical status of the vertical dyad (i.e., leader for the chief and follower for the subordinate). The influence of followers on leaders and leadership is more and more considered. However, the followerâĂŹs behaviors are still unexplored. This multidisciplinary work (i.e.,psychology and computer science) tries to highlight the influence of the follower´behavior on the leader, and the underlying process of this influence. To do so, we have used the follower´ s non-verbal behaviors (CNV) as the social clues that can influence the leader and her behaviors. We have applied here the principles of social cognition to study the cognitive evaluation made by the leader. We have worked on the implicit followership theories (IFTs), that is the activation of the characteristics used to categorize followers (eg. how a given leader believe that a follower should behave). Results from studies conducted during the project suggest that some characteristics displayed in CNV (i.e., dominance and support) can activate the leaders´ IFTs [17]. Moreover, the cognitive evaluation of the leader seems to influence her leadership behavior [4], [3], [5].

3 VIRTUAL ENVIRONMENT

The virtual environment in which the learner is immersed represents an advanced medical post with a HTC Vive Pro HMD. The area in which the wounded are taken when removed from the crisis zone. The figure 1 shows a visual of this medical post's interior. The learner has a menu of actions and communication to interact with her virtual team and to perform certain actions herself. This environment has been developed by REVIATECH. The space occupied by the demonstration is around 3mx3m. We need two electrical outlet (located 3 meter away), a table and a chair.

4 ACKNOWLEDGMENTS

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