ABSTRACT

The main goal of the ARLIST project is to qualify the traditional training environment currently used for Life Support training, introducing image and sound resources into the training manikins. Using these tools we can simulate some aspects such as facial expressions, skin color changes and scratches and skin injuries through image projection over the manikin body, and also play sounds like cries of pain or groans of an injured man.

Keywords: Medical Education, Augmented Reality, Emergency Training.

Index Terms: H.5.1 [Information Interfaces and Presentation]: Multimedia Information Systems—Artificial, Augmented, and Virtual Realities; I.3.6 [Computer Graphics]: Methodology and Techniques—Interaction Techniques

1 INTRODUCTION

In the Medical Education area, the qualifying process for Life Support (LS) training is based on simulations of emergency situations. During these simulations the students or physicians (hereafter called trainees) can repetitively practice patient care procedures in simulated scenarios using anatomical manikins, especially designed for this type of training [1].

Current manikins have several resources incorporated to allow and facilitate for qualified training, such as pulse, arrhythmia and auscultation simulator. However, some deficiencies have been detected in the existing LS training structure. For example: automatic feedback to the students as a consequence of their actions on the manikin, images such as facial expressions and body injuries, and their combination with sounds that represent the clinical state of the patient.

The main goal of the ARLIST project is to up date the traditional training environment currently used for LS training by introducing image and sound resources into the training manikins. Using these tools we can simulate some aspects such as facial expressions, skin color changes and various types of skin injuries through image projection over the manikin body, and also play recorded sounds like cries of pain or the groans of an injured person.

The instructors can manage the training simulation sequence using a control simulation tool that allows to easily define which one of the patient’s reactions should be presented to the trainee. In his turn, the trainee can autonomously hear cardiac and pulmonary sounds using an adapted stethoscope and is also able to easily see the images projected over the manikin and hear the patient’s speech through ordinary speakers installed near the mouth of the manikin. At the end of the simulation, the control simulation tool generates a log file reporting all configurations selected by the instructor and all the actions taken by the trainee. This feature is very important because it allows both the instructor and the trainee to evaluate the decisions taken and their consequence to the patient’s health.

2 TRAINING PROCESS FOR LIFE SUPPORT

LS training is developed all over the world and is divided into the following categories: cardiac (ACLS – Advanced Cardiac Life Support), pediatric (PALS – Pediatric Advanced Life Support) and trauma (ATLS – Advanced Trauma Life Support) [2].

These traditional training environments for LS, due to the fact that the instructor and the trainee need to imagine most of the situations because they are not actually represented by the traditional manikins, demand a high level of abstraction and significant cognitive effort from both. The most remarkable of these being the absence of automatic feedback to the trainee as a consequence of his/her actions on the manikin, a lack of images such as facial expressions and body injuries projected over the manikin body and the synchronization of images and sounds that represent the clinical state of the patient.

3 THE ARLIST PROJECT

The first step was to identify the important clinical responses that should be analyzed during emergency first aid and, among these, to select the most relevant ones and group them into two categories (visual and sound) to be developed.

In the sound category the developed aspects were:
- cardiac and pulmonary sounds;
- endotracheal and nasogastric tube sounds;
- some words or short sentences like the patient’s name, complaints such as lack of air and pain;
- responses to the evaluation of the alert state.

For this last kind of sound we follow the categorization found in the resuscitation manuals that classify the patient among Verbal and Pain Responsiveness.

In the visual signs category we developed the following issues:
- facial expressions, representing pain and the level of consciousness (unconscious or alert);
- body injuries;
- skin color changes;

The simulation is managed using a tailor-made software called Patient Simulation Control Tool (PSCT), in which the instructor is able to configure all the possible signs or feedbacks provided by the manikin and also to easily register all the trainee actions during the training session. Concerning this registration issue, actions like cardiac and pulmonary auscultation are automatically captured and saved by the PSCT. On the other hand, other registration aspects such as drugs administration, request for information and exams or cardiac massage or intubations can be easily registered on the PSCT’s user interface with one or two mouse clicks.

In order to allow a subsequent analysis of the medical care provided by the trainee, a log file is generated after finishing the

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simulation. More details of the log file are provided in section 4.2. The next section details the functionalities available in the system and the way we have implemented them.

3.1 Computational Features

One of the most relevant prerequisites for our project was the need to keep the original anatomical manikins currently used during the LS training sessions. So, no matter what kind of new resource is added, we still need to keep the manikin present during the simulation. In order to take care of this restriction and also to represent the most important sound signs, we have developed an instrumented waistcoat with push buttons and audio connectors (figure 1) that emit some physiological sound when pressed. These buttons, in total five, are divided as follows:

- two for cardiac auscultation;
- two for pulmonary auscultation;
- one for intubation checking.

![Figure 1. Waistcoat for Auscultation](image1)

They are connected to the computer through an analog-to-digital converter. When one of the buttons is pressed the signal is captured by the converter and transmitted to the computer using the parallel port. The PSCT receives the signal and plays the appropriate sound on the adapted stethoscope (figure 2) and on speakers installed in the back of the manikin neck.

![Figure 2. Adapted Stethoscope](image2)

The words and short sentences played by the system seek to represent autonomous manifestations from the patient, e.g. name, age, pain or dizziness. They are utilized by the instructor based on the clinical state of the patient. In this case, the sound is played only on the speakers in order to give the impression that the manikin is speaking with the trainee.

On the visual side, we implemented aspects such as facial expressions, skin color (visualized on the manikin face) and body injuries. These images are one of the main aspects that differentiate this project from the commercial training manikins. They allow the trainee to look at the patient and autonomously recognize the level of consciousness of the patient, evaluate the clinical state from the skin color (pale, cyanotic and normal) and perceive the presence of injuries like hematomas and ecchymosis on the manikin torso.

The image exhibition is made using a projector mounted on a metal structure especially designed for the project. It is very easy to assemble and take apart and also easy to transport. In figure 3 we present the physical setup for the simulation.

![Figure 3. The physical environment for ARLIST](image3)

The body injuries (ecchymosis. and hematomas) are projected on the waistcoat in two areas: on the bottom-left and on the top-right of the manikin chest. The presence of an injury on the chest inhibits the pulmonary auscultation on the corresponding side.

In this way the trainee can identify a possible fall or accident and take the proper steps, such as draining the chest using a needle.

The facial expressions are automatically synchronized with sounds of moaning and patient complaints in order to provide more realism to the simulation. The instructor can also control the opening and closing of the manikin’s eyes and mouth.

4 Final Remarks and Future Works

The ARLIST project can be considered innovative in the training area for LF. The preliminary results gathered from the tests performed with specialists and students have demonstrated that the implemented features are significantly relevant for emergency care training.

The apparatus used, such as the waistcoat, the projector and the adapted stethoscope allow the framework to be used in many different manikins, from the simple manikins used in clothing stores to the more specialized ones, available in recognized medical schools.

Considering the existing works, the ARLIST presents important improvements in the visual features because the images are projected directly over the manikin body. According to the instructors who have tested the system and also those who coordinated the sessions, the facial expressions and the body injuries stimulate the trainees in the direction of a more autonomous evaluation of the patient, which is very important for emergency care.

5 References