

AWARD NUMBER: H20B-001-0018

TITLE: CORE-Military: A Virtual Reality Platform for Emergency Care Training and Assessment in Austere Environments

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1. Introduction

The long-term goal of this project is to develop and validate a realistic mobile-based VR platform (CORE-Military) for frontline service members in austere environments, enabling effective just-in-time emergency care training and personalized assessment through AI-enabled learning analytics. In this proposal (phase 1), we focus on a proof-of-concept of a refresher tool for medical emergency recognition (e.g. early signs of deterioration) and initial response, as well as an embedded automated assessment engine to measure competency readiness and the need for educational remediation. We use existing state-of-the-art technologies.

2. Keywords

Extended Reality (XR); Emergency care; Medical Simulation; Military Medicine

3. Accomplishments

What were the major goals of the project?

SA-1: To design and develop high-fidelity simulated emergency scenarios based on the most recent Tactical Combat Casualty Care (TCCC) guidelines and employing publicly available detailed reports of real medical casualties from previous U.S. military operations. We will use the TCCC critical decision case studies to build branching narratives to immerse users in the virtual learning environment creating an engaging naturalistic decision-making tool that will enhance learning outcomes.

SA-2: To capture high-fidelity 3-D volumetric photorealistic scenes of professional actors performing emergency scenarios designed in SA-1. These scenarios will include branching narratives and assessment metrics presented on a screen-based VR platform.

SA-3: To demonstrate the **feasibility of the proof-of-concept** produced in SA-2 by creating a demonstration application for one TCCC scenario. The user will be able to navigate and interact with **3D emergency scenarios** on their mobile devices, identifying early signs of decompensation prompting clinical decisions.

What was accomplished under these goals?

Task 1. Design and develop a high-fidelity simulated emergency scenario based on recent Tactical Combat Casualty Care (TCCC) guidelines.

Task 1 (a) – Creation of a context-specific clinical case: we created a comprehensive clinical scenario (tension pneumothorax as a result of a gunshot) based on a real case from the Tactical Combat Casualty Care (TCCC) training material.

Task 1 (b) - Simulation design: we applied instructional design and simulation methods to design a high-fidelity medical simulation scenario that is engaging and aimed to achieve specific learning objectives relevant to service members.

Task 1 (c) - Branching narrative storytelling: we developed branching narratives and decision points to create a naturalistic training environment.

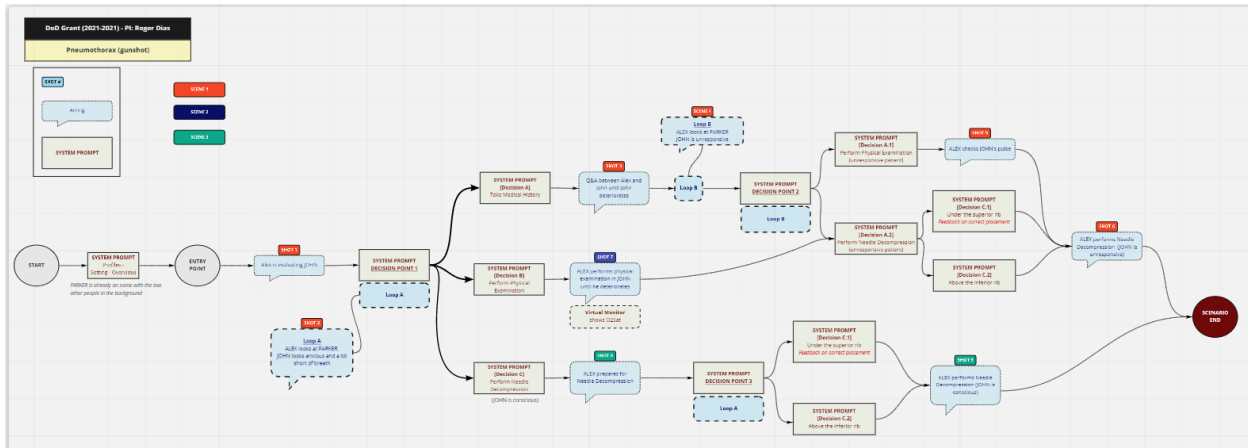


Figure 1. Branching narratives and interactive storytelling design of a simulated clinical scenario.

Task 2. To capture high-fidelity 3-D volumetric photorealistic scenes of professional actors performing emergency scenarios designed in SA-1. These scenarios will include branching narratives and assessment metrics presented on a screen-based VR platform.

Task 2 (a) – Video Volumetric Capture: we captured 3D video volumetric of two professional actors during a scripted medical scenario using state-of-the-art production techniques (Fig. 2).



Figure 2. Production and Video Volumetric Capture in 3D

Task 2 (b) – We edited the volumetric assets creating smaller clips tied to the branching narrative decision points. This 3D clips will be used in the system logic. See Figure 3.



Figure 3. Snapshots of the volumetric videos

Task 3. To demonstrate the feasibility of the proof-of-concept produced in SA-2 by creating a demonstration application for one TCCC scenario.

Task 3 (a) - We have also created the interactive functionalities that will allow the learners to select the certain course of actions and observe the clinical consequences of those decisions (Fig. 4).



Figure 4. Early version of the Interactive functionalities

Task 3 (b) - We have finalized the back and front-end development of the interactive storylines in the Unreal Engine and performed debugging. See Figure 1 for the Blueprint in Unreal and Figure 5-7 for the application.

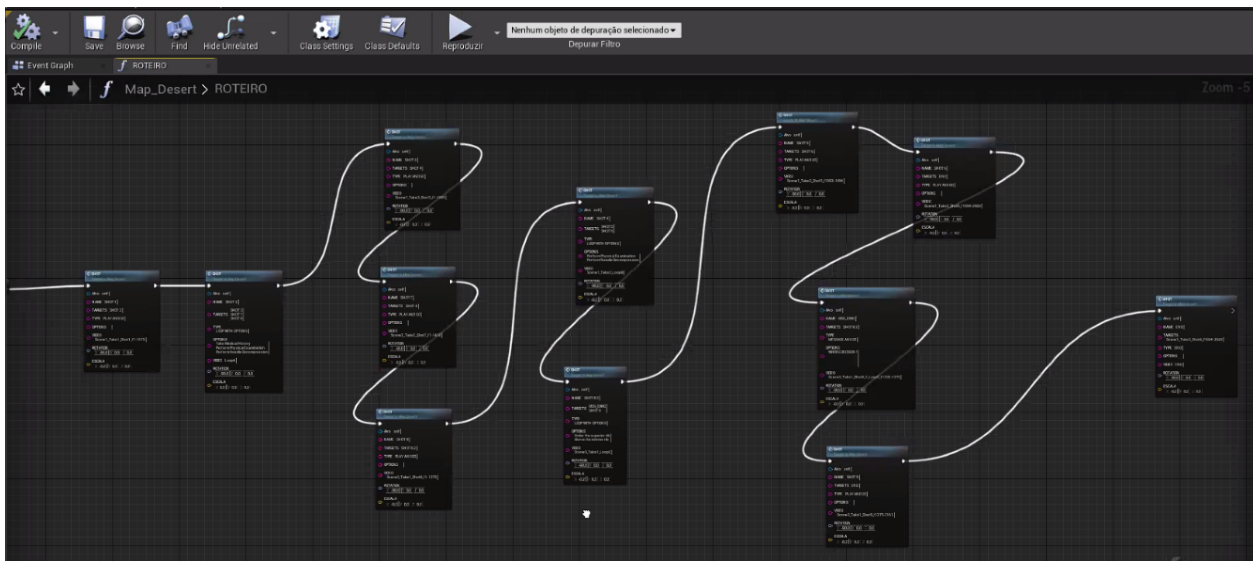


Figure 5. Blueprint of the software architecture in the Unreal Engine

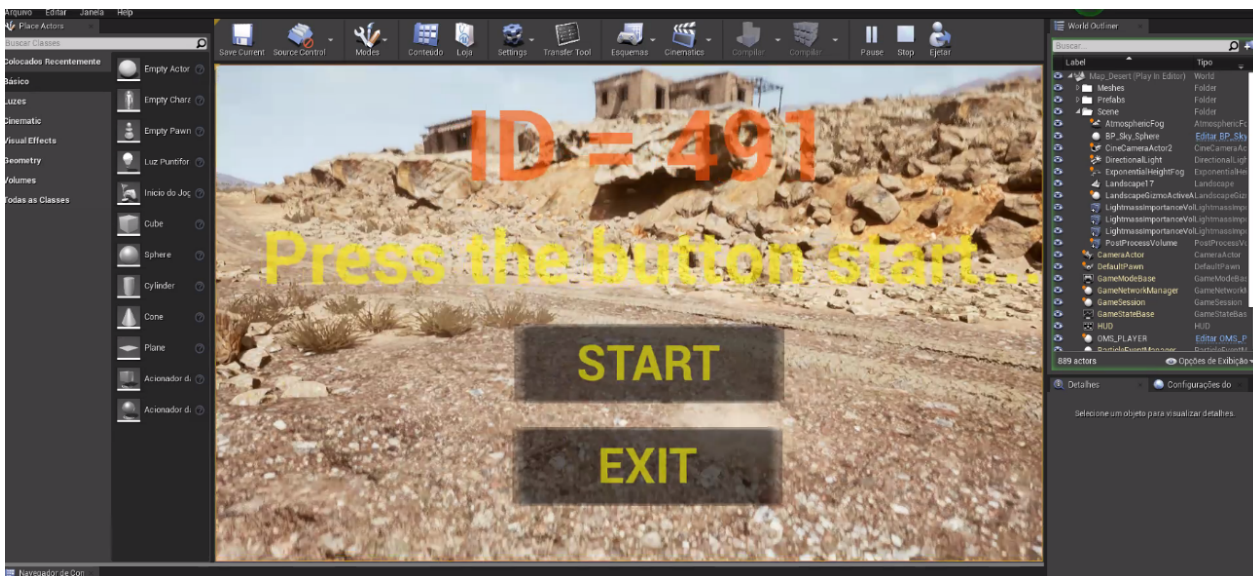


Figure 6. Start screen of the application generating an unique user ID that is linked to assessment data.

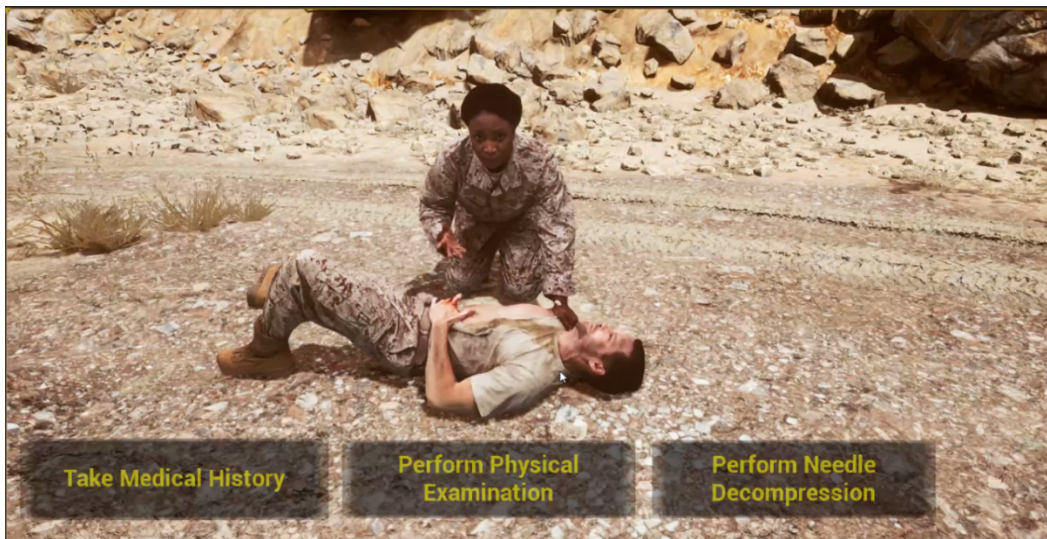


Figure 7. Improved version of the interface for better user experience.

Task 3 (c) - We have also completed the back-end development to generate log data (timestamp, events, accelerometer) to be used for performance assessment (Figure 8 and 9).

```
D: > OneDrive > Backups > 04_Arquivos_Especiais > Panogramma > DOD > 2021_10_03_OMS_Project_v06 > FILES > 20211008_171950_715_491.t
1 20211008_171950_715 0 START
2 20211008_171950_717 0,002 OPTIONS Take Medical History;Perform Physical Examination;Perfc
3 20211008_171952_310 1,595 PLAY SHOT 2
4 20211008_172037_476 46,761 CHOSE Perform Physical Examination
5 20211008_172046_408 55,693 PLAY SHOT 8
6 20211008_172128_980 98,265 OPTIONS Under the superior rib;Above the inferior rib;
7 20211008_172129_891 99,176 PLAY SHOT 8.2
8 20211008_172139_978 109,263 CHOSE Above the inferior rib
9 20211008_172148_256 117,541 PLAY SHOT 9
10 20211008_172217_848 147,133 END
11
```

Figure 8. Log data to be used for objective assessment

```
20211111_115104_710_632_ACE.txt - Notepad
File Edit Format View Help
0.017 -0.104 0.037 -0.312
0.06 0.408 -0.178 0.195
0.086 0.131 0.038 -0.064
8.253 -0.008 -0.041 0.079
8.396 0.023 0.366 -0.375
8.412 0.016 0.349 -0.318
8.449 0.021 0.087 -0.141
8.478 0.082 -0.203 -0.043
8.51 0.103 0.138 -0.224
8.55 0.140 -0.325 0.127
8.578 0.146 -0.305 -0.039
8.612 0.046 -0.144 -0.032
8.653 0.130 -0.145 0.165
8.677 -0.309 -0.113 -0.211
8.71 -0.180 0.110 -0.652
8.742 -0.039 -0.007 -0.245
```

Figure 9. Log data from mobile device accelerometer (time; x; y; z) to be used for objective assessment

Task 3 (d) – The final application was deployed on an Android OS and successfully used on a tablet in mobile augmented reality. Several optimization techniques were applied to volumetric video processing to improve the user experience by providing seamless scenario loading, transitions and interactions.

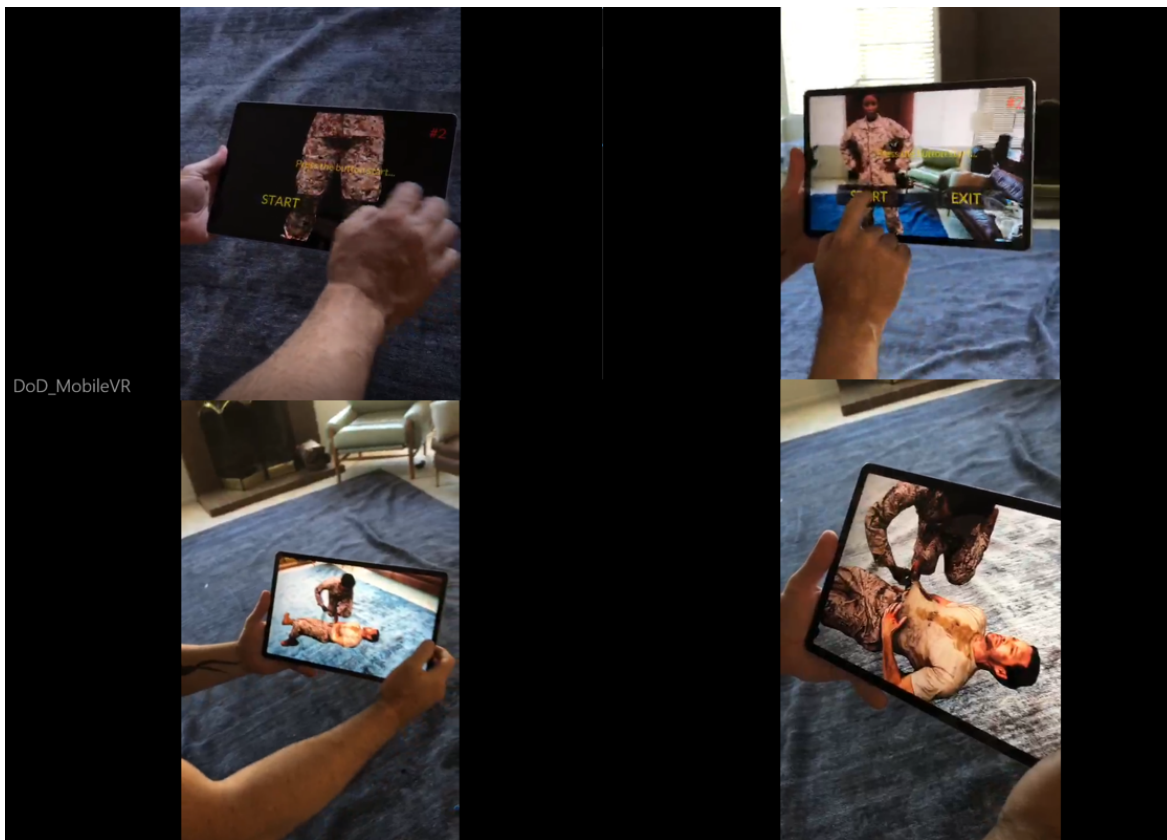


Figure 10. Demonstration of a user using a tablet to interact with the medical scenario in augmented reality (AR).

What opportunities for training and professional development has the project provided?

Nothing to report.

How were the results disseminated to communities of interest?

Nothing to report.

What do you plan to do during the next reporting period to accomplish the goals?

Nothing to report.

4. Impact

What was the impact on the development of the principal discipline(s) of the project?

This project demonstrated the feasibility of using highly realistic 3D volumetric video production for creating interactive medical scenarios for military medicine training.

What was the impact on other disciplines?

The findings from this project are applicable to other disciplines that could also benefit from having highly realistic virtual humans for training, research and human factors applications.

What was the impact on technology transfer?

Although feasible and able to produce high quality and engaging virtual scenarios to be used in off-the-shelf mobile devices (smartphones and tablets), without internet connection, this project showed that the current technology (video volumetric capture and processing) is still very expensive. The cost per minute of each 3D scenario is very high, making prohibitive the creation of multiple scenarios for a comprehensive medical training curriculum. Currently, this limits scalability and sustainability of a business model using current video technologies. However, we have been following the technology development in this field very closely, and we believe that in a few years (2-3 years) new video capture and 3D processing techniques will reach the market, allowing the mass production of highly realistic virtual medical scenarios like the one we have created.

What was the impact on society beyond science and technology?

With this work, our goal was to “bring to life” high-fidelity medical scenarios using cutting-edge video production and virtual reality technologies. We believe that this type of scenario facilitates human connection with other virtual humans and this aspect will certainly advance society through new ways by fostering human-human and human-virtual connections and limitedness possibilities to developing new virtual reality applications.

5. Changes/Problems

Changes in approach and reasons for change

No changes

Actual or anticipated problems or delays and actions or plans to resolve them

No problems or delays

Changes that had a significant impact on expenditures

No changes

Significant changes in use or care of human subjects, vertebrate animals, biohazards, and/or select agents

Not applicable

Significant changes in use or care of human subjects

Not applicable

Significant changes in use or care of vertebrate animals.

Not applicable

Significant changes in use of biohazards and/or select agents

Not applicable

6. Products

Publications, conference papers, and presentations

Nothing to report.

Website(s) or other Internet site(s)

Nothing to report.

Technologies or techniques

Nothing to report.

Inventions, patent applications, and/or licenses

Nothing to report.

Other Products

A functional Android application (.apk format) that allow the user to interact with a virtual reality realistic medical scenario on smartphone o tablets.

7. Participants & Other Collaborating Organizations

What individuals have worked on the project?

Michael Mansouri – No change

Roger D. Dias – No change

Rodrigo Cerqueira – No change

Charles Pozner – No change

Christian Miccile – No change

Has there been a change in the active other support of the PD/PI(s) or senior/key personnel since the last reporting period?

Nothing to report.

What other organizations were involved as partners?

Nothing to report.

8. Special Reporting Requirements

Nothing to report.

9. Appendices

Nothing to report.