

**DEPARTMENT OF COMPUTER SCIENCE & ENGINEERING
THE UNIVERSITY OF TEXAS AT ARLINGTON**

**SYSTEM REQUIREMENTS SPECIFICATION
CSE 4316: SENIOR DESIGN I
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**VR NURSING TEAM
CAREVR**

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1 PRODUCT CONCEPT

This section describes the purpose, use, and intended user audience for the CareVR application. CareVR is a virtual reality nursing simulator that allows users to participate in four scenarios relating to hospice patient care. Users of CareVR will be able to complete tasks that progress the user through patient care. The user will be exposed to realistic interactions with their surroundings, the patient, and the patient's family.

1.1 PURPOSE AND USE

CareVR will allow the user to simulate one of four scenarios that are not taught during the regular course load for nursing students. These scenarios are delivering a terminal diagnosis to a patient and their family, accessing a patient's home for hospice release, informing the patient and their caregiver of the proper way to sterilize equipment and maintain good hygiene, and finally how to deal with the patient's body following their death. The CareVR system will utilize the cross-platform technology OpenVR, which will allow the application to be compatible with the HTC Vive headset, the Oculus Quest II headset, and any other VR hardware that support OpenVR. Using virtual reality technologies allows the user to better interact with their surroundings and gain more from the learning process than traditional computer applications.

1.2 INTENDED AUDIENCE

The intended audience for the CareVR system is nursing students at the University of Texas at Arlington. The system will not be made publicly available unless the University of Texas at Arlington College of Nursing makes the system available to the public. CareVR is intended to be used as a supplemental instrument for instruction during the learning process for nursing students.

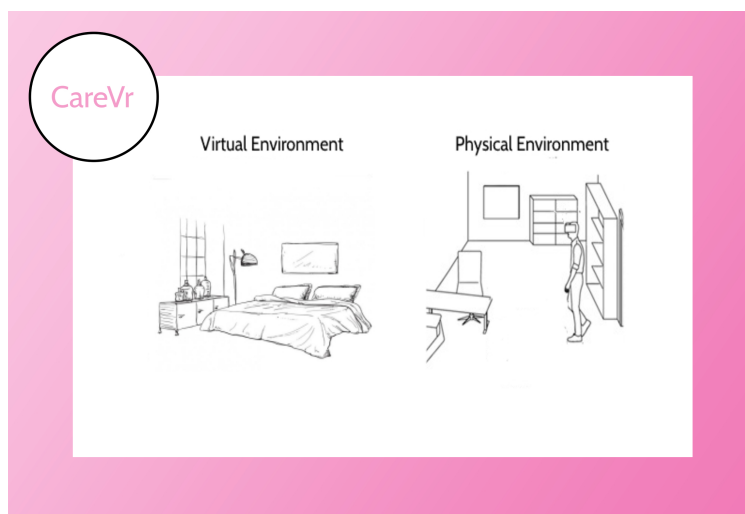


Figure 1: CareVR conceptual drawing

2 PRODUCT DESCRIPTION

This section provides the reader with an overview of the CareVR system. The primary operational aspects of the product, from the perspective of end users, maintainers and administrators, are defined here. The key features and functions found in the product, as well as critical user interactions and user interfaces are described in detail.

2.1 FEATURES & FUNCTIONS

The CareVR system utilizes the unity game engine for the software requirements and an virtual reality headset and controllers. The application is developed with OpenVR to ensure cross-platform capabilities so that various VR hardware can be used including HTC Vive and Oculus Quest II. The headset is used to project the simulation directly into the user's eyes. The handheld controllers are used to allow the user to move and interact with objects within the simulation. Oculus Quest II has complete wireless capabilities with the use of Wifi, but in order to remain functional for all platforms, the CareVR system will not rely upon use of an external element so it will not need to be connected to the internet.

2.2 EXTERNAL INPUTS & OUTPUTS

Name	Description	Use
Settings	Allows for changing to desired settings	Changes system environment to conform to user preferences
Controls	VR controller input	Allows user to interact with in-game environment
Movement	Motion tracking of hand-held controllers and headset	Tracks the user's motions and positions them accordingly in game
Dialog	Dialogue options with current NPC	Opens dialogue options that pertain to the current NPC and current scenario

Table 2: External Inputs and Outputs

2.3 PRODUCT INTERFACES

The product interface will have a home screen, login screen, level select screen, settings screen, main game screen, and results screen. All of these components have been completed by the previous teams with the exception of the level select screen. The home page will allow the user to choose between starting a new game, resuming an existing game, go to the settings page, or exit the application. The login/ resume game screen will prompt the user to log into the system with their UTA ID number. The level select screen will allow users to select which scenario to progress through (figure 2). The settings page will allow the user to change the volume and field of view. The main game screen will have a HUD displaying the tasks needing to be accomplished and the dialog system (figure 3). The results screen will appear at the end of each scenario and will show the user what actions were performed correctly and incorrectly.

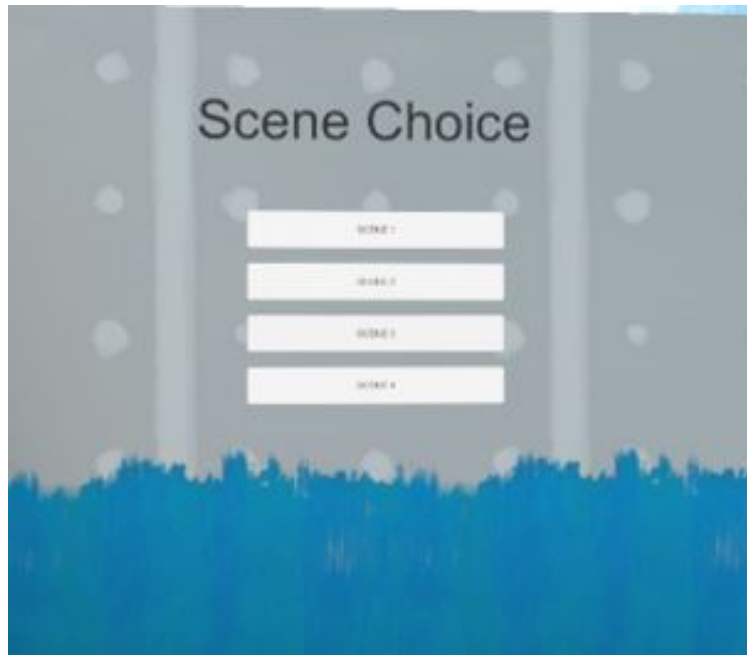


Figure 2: CareVR Level Select



Figure 3: CareVR Patient Viewing

3 CUSTOMER REQUIREMENTS

The customer requirements outline how CareVR is intended to educate nursing students in the methods used to monitor, diagnose, treat, or communicate with a patient. CareVR should be able to accurately replicate symptoms in a patient so that the nurse is able to properly practice diagnosing the patient. Various medical instruments will be implemented so that the nurse may practice their proper usage and handling. Our Customers need satisfaction in these areas:

3.1 GLASGOW COMA SCALE

3.1.1 DESCRIPTION

The Glasgow Coma Scale is a neurological scale which is used to assess the state of a patient's consciousness. The symptoms of the Glasgow Coma Scale will be accurately replicated in a way that will allow a nurse to properly observe these symptoms in a patient and record a corresponding score.

3.1.2 SOURCE

The source is the project sponsor.

3.1.3 CONSTRAINTS

- The user will assess the patient's consciousness
- The user attempt to solicit a pain response
- The user will monitor the patient's eyes, verbal skills, and motor skills to assess the patient

3.1.4 STANDARDS

Glasgow Coma Scale Assessment Standards:

- Eyes: The patient's eyes must open only in response to pain
- Verbal: The patient mumbling is reported as an inappropriate verbal response
- Motor: The patient should withdraw from painful stimulus

The Virtual Reality tool shall remain in compliance with the Texas Administrative Code Title 22, Part 11, Chapter 215. The Virtual Reality tool shall remain in compliance with The Regents' Rules and Regulations of the University of Texas at Arlington.

3.1.5 PRIORITY

High

3.2 PATIENT DOCUMENTATION

3.2.1 DESCRIPTION

User will access/modify patient's medical chart (EMR).

3.2.2 SOURCE

The source is the project sponsor.

3.2.3 CONSTRAINTS

Items on the EMR are as follows:

- Medication taken by patient
- Recorded vital sign data
- Personal ID info
- Patient's current symptoms

3.2.4 STANDARDS

The Virtual Reality tool shall remain in compliance with the Texas Administrative Code Title 22, Part 11, Chapter 215. The Virtual Reality tool shall remain in compliance with The Regents' Rules and Regulations of the University of Texas at Arlington.

3.2.5 PRIORITY

Critical

3.3 USER FEEDBACK

3.3.1 DESCRIPTION

The simulation logs and analyzes user actions and provides report at the end.

3.3.2 SOURCE

The source is the project sponsor.

3.3.3 CONSTRAINTS

The report will contain the following:

- Whether or not the user checked the patient's EMR documentation
- Whether or not the user assessed the condition of the patient
- Whether or not the user administered the wrong or correct dosage
- Whether or not the user selected the appropriate method of medication administration

3.3.4 STANDARDS

The Virtual Reality tool shall remain in compliance with the Texas Administrative Code Title 22, Part 11, Chapter 215. The Virtual Reality tool shall remain in compliance with The Regents' Rules and Regulations of the University of Texas at Arlington.

3.3.5 PRIORITY

Critical

3.4 COMMUNICATION

3.4.1 DESCRIPTION

The user will be subjected to dialog with a non-playable character, the patient's wife, throughout the simulation.

3.4.2 SOURCE

The source is the project sponsor.

3.4.3 CONSTRAINTS

Important dialog to be included:

- User will communicate with the patient's wife throughout the scenario
- The wife initiates a call to the user, concerning a change in the patient's status at the start of the simulation
- The dialog between the user and the wife should be therapeutic in nature
- User should confirm patient ID with the wife at the beginning of the scenario

3.4.4 STANDARDS

The Virtual Reality tool shall remain in compliance with the Texas Administrative Code Title 22, Part 11, Chapter 215. The Virtual Reality tool shall remain in compliance with The Regents' Rules and Regulations of the University of Texas at Arlington.

3.4.5 PRIORITY

Critical

3.5 VOICE ACTING

3.5.1 DESCRIPTION

Voice acting will be provided for the user and the patient's wife. Audio will be provided by the sponsor.

3.5.2 SOURCE

The source is the project sponsor.

3.5.3 CONSTRAINTS

Only the user and the patient's wife will have voices.

3.5.4 STANDARDS

The standards are determined by the sponsor.

3.5.5 PRIORITY

Low

4 PACKAGING REQUIREMENTS

CareVR will be loaded to hard drive or USB flash drive and given to the sponsor upon completion of the project. The software will be installed and run on school computer. Instructions will be given on how to import the files from the drive and how to set up the VR environment properly.

4.1 SOURCE CODE AVAILABILITY

4.1.1 DESCRIPTION

The source code will be available for continuation of project development to another team. The source code will need to be well documented and maintained for ease of use for any subsequent teams to work on.

4.1.2 SOURCE

VR Nursing Team

4.1.3 CONSTRAINTS

This is only applicable if the current team does not complete the project

4.1.4 STANDARDS

ISO

4.1.5 PRIORITY

Moderate

4.2 SOFTWARE

4.2.1 DESCRIPTION

The software will be transferred over external drive or USB hard drive and will be handed over to school of nursing. Instructions will be provided to allow smooth import of project files and VR environment setup.

4.2.2 SOURCE

VR Nursing Team

4.2.3 CONSTRAINTS

Project time limit

4.2.4 STANDARDS

ISO

4.2.5 PRIORITY

High

5 PERFORMANCE REQUIREMENTS

The CareVR system will immerse the user in a 360 virtual reality environment that will have a steady high frame rate and resolution.

5.1 FRAME RATE

5.1.1 DESCRIPTION

The simulation will be expected to have an average of 60 frames per second and a minimum of 30 frames per second when running on the sponsor computer

5.1.2 SOURCE

Sponsors

5.1.3 CONSTRAINTS

The computer that the simulation is developed on and the computer the sponsor will be using will have different graphics cards resulting in a possible difference in frame rate. The development machine has a NVIDIA GeForce RTX 2080 Ti whereas the sponsor machine has a NVIDIA GeForce GTX 1060 or lower. When developing the VRx system, these differences will need to be considered.

5.1.4 STANDARDS

- OHS
- P2048.1
- P2048.2
- P2048.4
- P2048.6

5.1.5 PRIORITY

Medium

5.2 RESOLUTION

5.2.1 DESCRIPTION

The simulation must run at a resolution of at least 1832x1920 in accordance with Oculus Quest 2 and the HTC Vive Pro.

5.2.2 SOURCE

Sponsors

5.2.3 CONSTRAINTS

A resolution of 1832x1920 is required to best use Oculus Quest 2 and the HTC Vive Pro.

5.2.4 STANDARDS

- IEEE-SA Standards Board Bylaws
- P2048.2 [1]

5.2.5 PRIORITY

Medium

6 SAFETY REQUIREMENTS

Because this project involves the use of VR equipment the following VR safety requirements should be considered. These safety requirements were created specifically with use of VR technology and our project in mind. Most of these requirements arise from safety from seizures, balance-loss, electrical shock, discomfort, and other general precautions.

6.1 LABORATORY EQUIPMENT LOCKOUT/TAGOUT (LOTO) PROCEDURES

6.1.1 DESCRIPTION

Any fabrication equipment provided used in the development of the project shall be used in accordance with OSHA standard LOTO procedures. Locks and tags are installed on all equipment items that present use hazards, and ONLY the course instructor or designated teaching assistants may remove a lock. All locks will be immediately replaced once the equipment is no longer in use.

6.1.2 SOURCE

CSE Senior Design laboratory policy

6.1.3 CONSTRAINTS

Equipment usage, due to lock removal policies, will be limited to availability of the course instructor and designed teaching assistants.

6.1.4 STANDARDS

Occupational Safety and Health Standards 1910.147 - The control of hazardous energy (lockout/tagout).

6.1.5 PRIORITY

Critical

6.2 NATIONAL ELECTRIC CODE (NEC) WIRING COMPLIANCE

6.2.1 DESCRIPTION

Any electrical wiring must be completed in compliance with all requirements specified in the National Electric Code. This includes wire runs, insulation, grounding, enclosures, over-current protection, and all other specifications.

6.2.2 SOURCE

CSE Senior Design laboratory policy

6.2.3 CONSTRAINTS

High voltage power sources, as defined in NFPA 70, will be avoided as much as possible in order to minimize potential hazards.

6.2.4 STANDARDS

NFPA 70

6.2.5 PRIORITY

Critical

6.3 VR SICKNESS SAFETY DISCLAIMER

6.3.1 DESCRIPTION

The simulation will start with a safety disclaimer warning the user about VR sickness and to wear the wrist straps for the controllers. This information will include a seizure warning, tripping hazard warning, loss of balance warning, and other helpful safety information for any user.

6.3.2 SOURCE

Sponsor

6.3.3 CONSTRAINTS

The safety disclaimer will be the first thing to appear upon launching the application. As well, the user must accept the safety warning by pressing any button when the warning comes up.

6.3.4 STANDARDS

ClassVR health and safety information.

6.3.5 PRIORITY

High

6.4 MAX SIMULATION TIME

6.4.1 DESCRIPTION

The simulation will have a max simulation time to prevent VR sickness. This time will be 30 minutes. If the user has still not completed the scenario in 30 minutes, the simulation will stop. The simulation will be able to be completed within 30 minutes and the proctors will gauge the students score based on how well they did during the examination.

6.4.2 SOURCE

Sponsor

6.4.3 CONSTRAINTS

The simulation will not take more than 30 minutes to complete.

6.4.4 STANDARDS

Sponsor standard

6.4.5 PRIORITY

High

6.5 WRIST STRAPS FOR VR CONTROLLERS

6.5.1 DESCRIPTION

Wrist straps will be attached to the Oculus/VIVE controllers to reduce the risk of the user dropping the controllers in use.

6.5.2 SOURCE

Sponsor

6.5.3 CONSTRAINTS

The wrist straps must be loose enough to fit all hands but tight enough that they will not come off.

6.5.4 STANDARDS

Sponsor standard

6.5.5 PRIORITY

High

6.6 DEDICATED SPACE FOR USING VR EQUIPMENT

6.6.1 DESCRIPTION

The VR equipment will need to be set up in a dedicated space for VR with no furniture (while the system is being actively used) to reduce the risk that the user trips, falls, or otherwise injures themselves while using the system.

6.6.2 SOURCE

Sponsor

6.6.3 CONSTRAINTS

This space will need to be on campus, and the space must be at least 2 meters by 1.5 meters. Explicit permission will be needed to use the space.

6.6.4 STANDARDS

Sponsor standard

6.6.5 PRIORITY

High

7 MAINTENANCE & SUPPORT REQUIREMENTS

Due to the nature of this project, the development will continue even after our team has delivered our finished product. Because of this, the CareVR team must implement methods that will allow future teams to continue development and perform maintenance. To accomplish this the CareVR team will provide a way for future teams to contact us to ask questions, and create documentation with instructions to perform common steps or fix common issues.

7.1 DOCUMENTATION

7.1.1 DESCRIPTION

For future teams to quickly learn the code base, code documentation is necessary. Each function shall have a quick description of what it does and is used for. The architecture of the code shall be described, as well. Other important resources may be provided, such as the Unity tutorials, documentation that were referenced to create the code, and possibly the teams' engineering notebooks.

7.1.2 SOURCE

CareVR Team

7.1.3 CONSTRAINTS

This will require our team to document code from previous teams which we are not familiar with.

7.1.4 STANDARDS

ISO

7.1.5 PRIORITY

High

7.2 COMMUNICATION WITH FUTURE TEAMS

7.2.1 DESCRIPTION

The VR Nursing sponsors and Dr. Gieser have created a group on Microsoft Teams. This will allow us to stay in contact with future team if they have any questions that specifically need to be directed towards us.

7.2.2 SOURCE

Sponsors, Gieser, CareVR team

7.2.3 CONSTRAINTS

We will be required to remain a part of group on Microsoft Teams until we are no longer needed and be able to check in regularly in order to answer any questions within a reasonable time.

7.2.4 STANDARDS

ISO

7.2.5 PRIORITY

High

8 OTHER REQUIREMENTS

Because this project has had so many teams working on it there are a lot of sponsors and thus there is a need to document extraneous requirements not specified by the project's main sponsors to accommodate the extended nature of this project.

8.1 EXISTING VRX CODE MUST BE ADAPTED TO VR

8.1.1 DESCRIPTION

Due to the extended nature of this project and issues with the pandemic there is a lot of code that needs to be converted to VR, faulty code, and different versions of unity which need to be standardized. Our goal is to covert that which has not been converted, fix the faulty code, and standardize the versions.

8.1.2 SOURCE

Dr. Geiser

8.1.3 CONSTRAINTS

VR input will be developed using the VR equipment in the Senior Design Lab. As such, the simulation will only work for this or similar types of equipment.

8.1.4 STANDARDS

- IEEE's Standard for Virtual Reality and Augmented Reality: Environment Safety [1]
- IEEE's Standard for Virtual Reality and Augmented Reality: Immersive User Interface [2]

8.1.5 PRIORITY

High

8.2 ALL CODE MUST RUN ON SAME VERSION OF UNITY

8.2.1 DESCRIPTION

As there were several previous teams that have worked on this project over the course of a year or two, and Unity has changed versions throughout this time, we must make sure that our and previous teams' codes run on the same version of Unity.

8.2.2 SOURCE

Dr. Geiser

8.2.3 CONSTRAINTS

Depending on which version of Unity we will be consolidating the code, make adjustments to previous teams' codes will be required to make it executable on that version of Unity.

8.2.4 STANDARDS

- Sponsor

8.2.5 PRIORITY

High

8.3 INTERACTIONS WITHIN THE SIMULATION MUST BE CONSISTENT

8.3.1 DESCRIPTION

Actions and interactions within the simulation should be adjusted across all teams' codes to be consistent. This includes the controls, physics, and simulation logic.

8.3.2 SOURCE

Dr. Geiser

8.3.3 CONSTRAINTS

The assets chosen will affect the required adjustments to the other teams' codes.

8.3.4 STANDARDS

- Sponsor Standard

8.3.5 PRIORITY

High

9 FUTURE ITEMS

9.1 MEDICATION ADMINISTRATION

9.1.1 DESCRIPTION

The simulation will require the user to properly administer medication to the patient in several quantities and in different manners. Medication will be held within a box to be opened in the simulation. The user will be able to access the box and medicate the patient through different processes.

9.1.2 SOURCE

Sponsor

9.1.3 CONSTRAINTS

- The medication will be limited to morphine
- The dosage will either be 4 mg or 8 mg
- The medication will be administered either sublingual or through the rectum
- If the medication is administered through the rectum, the user will need to move the patient into Sims' position

9.1.4 STANDARDS

The Virtual Reality tool shall remain in compliance with the Texas Administrative Code Title 22, Part 11, Chapter 215. The Virtual Reality tool shall remain in compliance with The Regents Rules and Regulations of the University of Texas at Arlington.

9.1.5 PRIORITY

Critical

9.2 VITAL SIGNS

9.2.1 DESCRIPTION

The user will need to check various vital signs on the patient when completing their examination. They will need to also document all vital signs as they take them

9.2.2 SOURCE

Sponsor

9.2.3 CONSTRAINTS

- The user will check the patient's blood pressure, pulse, breathing, and bowel sounds
- The user will use a blood pressure cuff for taking pressure
- The user will use a stethoscope for breathing and bowel sounds
- The pulse will be taken using the patient's wrist

9.2.4 STANDARDS

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9.2.5 PRIORITY

Critical

9.3 PATIENT DOCUMENTATION

9.3.1 DESCRIPTION

User will access/modify patient's medical chart (EMR).

9.3.2 SOURCE

Sponsor

9.3.3 CONSTRAINTS

Items on the EMR are as follows:

- Medication taken by patient
- Recorded vital sign data
- Personal ID info
- Patient's current symptoms

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The Virtual Reality tool shall remain in compliance with the Texas Administrative Code Title 22, Part 11, Chapter 215. The Virtual Reality tool shall remain in compliance with The Regents Rules and Regulations of the University of Texas at Arlington.

9.3.5 PRIORITY

Critical

9.4 USER FEEDBACK

9.4.1 DESCRIPTION

The simulation logs and analyzes user actions and provides report at the end

9.4.2 SOURCE

Sponsor

9.4.3 CONSTRAINTS

The report will contain:

- Whether or not the user checked the patient's EMR documentation
- Whether or not the user assessed the condition of the patient
- Whether or not the user administered the wrong or correct dosage
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9.4.5 PRIORITY

Critical

9.5 COMMUNICATION

9.5.1 DESCRIPTION

The user will be subjected to dialog with a non-playable character, the patient's wife, throughout the simulation.

9.5.2 SOURCE

Sponsor

9.5.3 CONSTRAINTS

Important dialogue to be included:

- User will communicate with the patient's wife throughout the scenario
- The wife initiates a call to the user, concerning a change in the patient's status at the start of the simulation
- The dialog between the user and the wife should be therapeutic in nature
- User should confirm patient ID with the wife at the beginning of the scenario

9.5.4 STANDARDS

The Virtual Reality tool shall remain in compliance with the Texas Administrative Code Title 22, Part 11, Chapter 215. The Virtual Reality tool shall remain in compliance with The Regents Rules and Regulations of the University of Texas at Arlington.

9.5.5 PRIORITY

Critical

REFERENCES

- [1] CES/VRARSC Virtual Reality and Augmented Reality Standards Committee. *P2048.5 - Standard for Virtual Reality and Augmented Reality: Environment Safety*. 2019.
- [2] CES/VRARSC Virtual Reality and Augmented Reality Standards Committee. *P2048.6 - Standard for Virtual Reality and Augmented Reality: Environment Safety*. 2019.