ÇANKAYA UNIVERSITY
FACULTY OF ENGINEERING
COMPUTER ENGINEERING DEPARTMENT

Project Report
Version 2

CENG 408
Innovative System Design and Development II

P201607
Simulacrum: Simulated Virtual Reality for Emergency Medical Intervention in Battle Field Conditions

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Abstract

Emergence of virtual reality in the form of developing technology, human computer interaction produced by head-mounted display (HMD) becomes more important to produce innovative software products. Using such a technology, a vast variety of projects can be developed that promotes simulation-based training much easier, especially in the fields of military, industry, education, medicine and entertainment. The goal of this study is to create a Virtual Reality-Based Framework that has the purpose of training military personnel who works in a battlefield for medical intervention techniques. Ultimately, a virtualized system should create the notion of presence and immersion. Simulacrum is a virtual reality training and simulation framework which is planned to operationalize on HTC Vive virtual reality system. Purpose of this project is to design "Immediate Medical Intervention During Combat" both as a standalone application and a VR system, which shall include realistic scenarios, by taking account of the experience gained by Turkish Armed Forces personnel and their inventories (e.g. tools, materials) that are used for medical intervention.

Key words:

Virtual Reality, HTC Vive, Training Simulation, Medical Intervention in Battle Field Conditions, 3 Dimensions Modelling, Dynamic Scenario Generator

Özet:

Sanal gerçeklik kaskı sayesinde oluşturulan bilgisayar insan etkileşimi olan ve gelişen teknoloji ile birlikte ortaya çıkan sanal gerçeklik, yenilikçi yazılım ürünlerinin üretilmesi konusunda daha önemli hale gelmektedir. Bu teknolojiyi kullanarak, özellikle askeri, endüstriyel, eğitim, sağlık ve eğlence alanlarında simülasyon bazlı eğitimlerin kullanılmasını kolaylaştıran çok çeşitli projeler geliştirilebilir. Bu araştırmanın amacı savaş ortamında, çalışan personellerin acil müdahale teknikleri üzerine eğitimini sağlayan sanal gerçeklik bazlı bir sistem oluşturmaktır. Sonuç olarak, sanal olarak üretilen bu sistem kullanıcı üzerinde bulunma ve gerçekçilik hissiyatı oluşturmalıdır. Simulacrum HTC Vive üzerinde çalışması planlanan bir sanal gerçeklik simülasyon eğitim sistemidir. Bu projenin amacı Türk Silahlı Kuvvetlerinin personel ve malzeme durumu dikkate alınarak hazırlanmış gerçekçi senaryoları içeren 'Savaş Koşullarında Acil Tıbbi Müdahale' eğitiminin verildiği 'Bilgisayar Oyunu Temelli Sanal Simülasyon Eğitimi Modülü" geliştirmektir.

Anahtar Kelimeler:

Sanal Gerçeklik, HTC Vive, Eğitim Simülasyonu, Savaş Ortamında Tıbbı Müdahele, 3 Boyutlu Modelleme, Dinamik Senaryo Üretimi

1. Introduction

1.1 Company Background

General Staff of the Republic of Turkey controls and leads the Turkish Armed Forces and it is comprised by other military departments such as Army, Navy, Air and Special Forces. In war, General Staff takes full control of the army and is allowed to operate all military functions. The Chief of General Staff is Commander of the Turkish Armed Forces and in war, the Chief behaves as Commander-in-Chief in the name of the President of Turkish Republic. General Staff is responsible for determining principles and programs for personnel, operation, training and education departments to make sure the Armed Forces are ready for any conditions especially for war. General Staff also is responsible for mutual military relations of the Turkish Armed Forces with NATO and other countries [1].

This project is given to us by Colonel Mustafa Dinç who works in Project Management Department that belongs to the General Staff of the Republic of Turkey. Due to the confidentiality agreement, this is all the information we can provide.

1.2 Motivation

We are a group of senior students in computer engineering department who are interested in virtual reality technologies and gaming. As a group, we have taken the course of innovative game design for a better understanding in gaming field. We aimed to combine the fields of education, gaming and virtual reality technologies in this project. We have chosen the game engine Unity 3D which all of the members of the group are already familiar to develop our project. Aside from scripting, our project includes visual arts but there are no classes about this field. So in order to increase our knowledge in this field, we have learnt Blender which is a 3D modelling environment and for complicated models that we could not able to design, we have taken help from professional designers. For including virtual reality technologies, we have acquired HTC Vive which is a Virtual Reality headset and we have read documents for how to use HTC Vive in Unity 3D.

1.3 Problem Statement

While the correct medical intervention that is applied within minutes to the injuries that are occurred during combat could be lifesaving, lateness of this active intervention could likely to result in death. It is essential that an intervention should be initialized by the person himself or the closest fellow soldier, continued by the medical personnel in the team until the

transportation of the wounded personnel to the base where this person receives the definite treatment is completed. Therefore, all soldiers must have first aid skills and medical personnel must be trained for medical interventions that will be performed by these personnel in order to continue this procedure effectively. In the current circumstances, this training is given to privates in boot camp, medical personnel in command post of medical field school and paramedic sergeants in health occupation academy. Case of number of employees that are currently being trained are much higher than the educational opportunities and case of these trainings are not repeated frequently are the important obstacles that prevent employees from gaining knowledge and skills at optimum level.

Virtual Reality technology can be considered as sufficiently developed in Turkey. One of the reasons why we used Virtual Reality Technologies in our project is to make a contribution to development of the VR Technology. Apart from this, this technology increases the level of immersion and interactions between human and computer. Goal of the project is educating military personnel about medical intervention techniques using VR Technologies. We will use HTC Vive as VR Display and its controller for allowing participant to interact in the simulation. Even though the HTC Vive is capable enough increasing the level of immersion, realism level of the simulation might still not be enough. In the simulation, it is planned to teach medical intervention techniques with various scenarios. One of the problems about engineering is to decide how to create these scenarios and how to generate a scenario randomly. Another problem is the behavior of the Non-Player Characters on the scenes. Since the simulation includes battlefield, these NPCs will act as a soldier and they should have the behaviors of moving around and aiming at enemy NPCs. Another problem is deciding how to implement these behaviors on NPCs.

1.4 Related Work

Upon our research, we have found Combat Medic Simulation. Combat Medic is an online virtual reality simulation that allows users to study on three of the injuries which are hemorrhage, airway management and tension pneumothorax in battlefield conditions. It is knows that the prevention of these injuries are lifesaving. A sample treatment from Combat Medic can be observed in *Figure 1* [2].

Figure 1 Combat Medic Simulation

Advantages of the Combat Medic [3] can be listed as:

- It is an effective alternative training method for medic units and soldiers who have limited resources.
- This simulation can be considered as a method to validate medical skills.
- Ability of collecting data can be a great asset to the army in order to understand the medical learning level of the soldiers who work in the army.
- Medic Combat can be beneficial to combat lifesavers as well as it can be beneficial to soldiers for practicing buddy aid.
- Combat Medic can be considered as cost effective since it does not need resources regularly every time a participant uses the system.

Although the project we are working on has similar functionalities with Combat Medic, both of these projects are not same since our project includes scenario based training, active combat and Virtual Reality Technologies.

1.5 Solution Statement

In this section, we will share our solutions to the problems that are mentioned in section of Problem Statement.

As we have stated before, we will integrate HTC Vive within our project to increase level of immersion. But using only HTC Vive in project for realism might not be enough. To solve

this problem, we have come to conclusion that we need to use more detailed 3D models which means 3D models with more polygons. Even though this is an effective way to increase realism in simulation, it also means larger memory in computer.

Scenarios will be categorized as two which are injury scenarios and battlefield condition scenarios. Each selected scenario from each category shall be merged and the scene shall be created according to merged scenarios. Scenarios can be chosen by the participant individually or a random scenario which will be created by the random scenario generator. Random scenario generator shall merge one injury scenario and one battlefield condition scenario randomly and present it to the participant. For example, if there are 5 different injury scenarios and 10 different battlefield condition scenario, random scenario generator shall check the compatibility between selected scenarios and merge if they are compatible.

As we have stated before, there will be Non-Player Characters that will move around in the scene and they will have certain positions in the scene which they will try to reach. Non-Player Characters in the simulation will be able to find the shortest path to reach their goal in the most efficient way which will be occurred by a Navigation script. Navigation script shall divide objects in the scene to 3 categorizes as WalkableArea, Obstacle and Agent. Agent shall represent the NPC. WalkableArea as it can be understood from its name will represent the areas that the Agent can move and Obstacle shall represent the objects that prevents agent from moving. WalkableAreas shall be divided into nodes. These nodes will be created from 3 vertices of the walkable object. Each node will have a neighbor node as in nodes from linked list. Shortest path from one place to another one will calculated by going through every neighbor node without encountering with any obstacle objects. Since the simulation shall include a battlefield, events which are related with war shall occur. For example, another script which includes basic Artificial Intelligence will help to decide the NPC to aim for any enemy NPC randomly.

2. Literature Search

2.1 Utilization of Virtual Reality in Training Simulations

This study aims to educate the military personnel for medical intervention techniques using virtual reality technology. The purpose is creating an immersive environment and preparing a possible dangerous scenario that the personnel might encounter in battlefield conditions.

Virtual Reality is a virtually created environment that has the resemblance of the real world's features like gravity to make the user feel like that person is actually in the real world. According to Zheng [4], the virtual reality can be explained as a realistic world with advanced human computer interaction (HCI). Virtual Reality includes many technologies such as the interaction technologies between human and computer, sense technology, etc. This technology offers a virtual environment that can be perceived with various senses [5]. Virtual Reality is a three-dimensional world that is created by computer that the user can interact with and walk around in as if in real world [6].

Virtual reality is a technology that its features are used in many training simulations in areas of military like simulation of battle training which named SIMNET [6], medicine like simulation that is designed for surgeons to participate in surgery scenarios which they might encounter in real life [6], etc. Lele [7] claims that many fields are already invested in this new technology such as information technology, structural designing and biomedical engineering. Elliman et al [8] report that Simulation Based Training (SBT) can be explained as "creating world that is similar to the real world which expects an individual to perform decision making and demonstrate critical thinking. Danilicheva et al. [9] claim that training simulations which are created in virtual reality can be as realistic as a real training. Also mentions that the real training usually is more expensive and more dangerous than the virtual one.

2.2 Virtual Reality Simulations for Medicine and Military

Medicine and military are the fields that use the virtual reality technology in projects. Medicine is one of the most important fields in human life. Trainings regarding this field are usually expensive such as working on cadavers and experiments on animals. Paiva et al. [10] claim while the traditional teaching methods costs more, training in virtual reality reduces the usage of laboratory animals and cadavers during laboratory practices and increases user's interaction. Buckley at al. [11] state that it is more effective to educate personnel using simulators rather than traditional techniques. Piedra at al. [12] support that synchronization of the hands and eyes is an important skill to have for surgeons. Since the virtual simulation decreases the learning time and helps the surgeons to improve their skills, it makes this virtual reality simulations a great asset to the surgeons. Allowing the trainees use the simulations repeatedly in order to gain experience causes increase in success rate [13], [14]. It is obvious that the immersion level of the simulation is directly proportionate to efficiency of the simulation. According to Lee et al. [15], realism level of the simulation is limited. For example, if error or weakness are identified during the simulation, it is not likely to re-run some parts of

the scenario. To increase the realism level, user of the system can use other equipment related to the topic such as protective clothing, gloves, etc. In addition to that, haptic technology can be used within virtual reality systems. McElhinney et al. [16] indicate that haptic is "tactile feedback system" that delivers vibrations to the user. Haptics are integrated within virtual reality simulators and it is obvious that this increases the level of realism of the training. Playing a prerecorded haptic stimulus back to the user can be considered as beneficial in medicine. To develop the motor skills of the user, user can receive the forces from the haptic device along on the predefined trajectory [17]. According to another study, to increase the level of immersion, the system should include high quality computer graphics, better sound effects, etc. Also, to increase human computer interaction, system should include advanced user interface [18].

Another usage area of virtual reality is military. Military industry which always adapts new technologies and ideas is one of the most important contributors of the virtual reality technology [7]. The types of virtual reality applications in this domain are flight, vehicle and battlefield simulations. According to Satava [19], pilots complete their virtual flight in simulations before the actual flight. One of the most important reasons why military is interested in virtual reality technology, is that there is not risk of injury or death even in lethal situations in the scenario such as explosions, accidents, etc. According to Lee et al. [15], smokes, explosions and fires are necessary for creating realistic environments. These realistic environments can be used to recreate combat situations for the soldiers who are dealing with posttraumatic stress disorder. Seitz et al. [20] claim that exposing the soldiers in these realistic combat situations, decreases their level of anxiety. Even though virtual reality technology is used frequently in both military and medicine, according to Rosen et al. [21], medical VR applications are prioritized differently rather than military VR applications. Objects which are in the medicine applications are smaller than the objects in the military applications but resolution of the data should be higher than the one in military applications.

Our work mostly focuses on medical intervention techniques in battlefield conditions rather than surgery in operating room. This medical intervention techniques include first aid steps. According to Dianty et al. [22], first aid is the first basic treatment that the accident victim receives before a professional medical treatment. They have developed a simulation game for Red Cross Youth. This game includes different accident scenarios which first aid can be applied in. Even though this game is similar to our work in respect to topic, this game doesn't include three-dimensional modelling, virtual reality elements and this project has not any relations with military field. Purpose of the project is teaching the basics of the first aid regarding the basic

situations like nose bleeding, broken arm, poisoning, etc. Our project has focused more on injuries that occur mostly during battlefields. Using HTC Vive and realistic three-dimensional models, we will be able to give more detailed information about injuries to the user rather than using images and videos. Stereoscopic rendering which is used in HTC Vive creates the notion of being in the virtual world rather than seeing through monitor. Using haptic controllers, immersion level of the simulations will be higher and user will be able to interact with the environment in a more realistic way. Haptic feedback will be given to user using vibrations with different intensity according to the hardness of the object which the user interacts with.

2.3 HTC Vive and Unity 3D

In today's technology, head mounted displays (HMD) are the most used virtual reality tools in order to increase the immersion level in the simulations. Stengel et al. [23] support that main concern of HMD is the level of immersion in virtual reality for creating a persuasive user experience. Kayabaşı [24] reports that the user equips a visor or a helmet. HMD is connected to the computer with cables. The equipped visor provides images for each eye differently to increase the level of immersion in virtual reality, besides user equips a headset in order to detect voices. Also there is another tool that receives the position of the user's head to synchronize the simulation and the real world.

There are multiple companies that produce head mount displays. Boland and McGill [25] claim that the Kickstarter project which is started by Oculus rift has caused a resurrection in Virtual Reality. After this, Oculus has been backed by Facebook, Samsung has created Gear VR, Sony has invented Morpheus, Valve has backed HTC Vive and Google has produced Cardboard.

According to our researches, Oculus Rift is most commonly used HMD tool in VR simulations. Oculus Rift Development Kit 2 (DK2) is the most preferred HMD product in VR world for the reasons it costs less than other HMD products, game developers tend to prefer it since there are already compatible drivers for integrating Oculus Rift easily within game engines [26]. Even though Oculus Rift looks more advantageous, we have decided to work with HTC Vive. Because HTC Vive has better haptic controller, gives more space to user to move around than Oculus Rift. Hamacher et al. [27] report that HTC Vive is better at tracking user's positions for the reason HTC Vive uses a system that is laser based in both front and behind the consumer whereas Oculus rift uses a system which is infrared tracking only in front of the

consumer. According to Heineman [28], HTC Vive requires a minimum space of 2 square meter. It uses 70 sensors and has 360-degree head-tracking system [29].

Procedures of creating the three-dimensional environment, programming and designing will be performed on Unity3D. Unity3D is a game engine [30] which is used by many game and simulation developers for it is practical. There are various programming languages that can be used within Unity3D such as C# and JavaScript. Xie [31] reports that Unity 3D includes packages like Unity Pro, Android, IOS, etc. It is a powerful cross platform and it is easy to extract to build of the project for Windows, Mac OS X, Linux, Android and IOS. Wang et al. [32] claim that when it comes to scripting, most programmers think that it is slow and limited. But in Unity 3D, script codes are compiled to native code and it is most likely to get a fast iteration time. This makes Unity 3D more attractive to programmers who likes scripting.

3. Summary

3.1 Technology Used

Unity 3D Game Engine is utilized to create scenes of the simulation and handling all the events in the simulation. Procedures of creating the three-dimensional environment, programming and designing will be performed on Unity3D. Unity3D is a game engine [27] which is used by many game and simulation developers for it is practical. There are various programming languages that can be used within Unity3D such as C# and JavaScript. Xie [31] reports that Unity 3D includes packages like Unity Pro, Android, IOS, etc. It is a powerful cross platform and it is easy to extract to build of the project for Windows, Mac OS X, Linux, Android and IOS. Wang et al. [32] claim that when it comes to scripting, most programmers think that it is slow and limited. But in Unity 3D, script codes are compiled to native code and it is most likely to get a fast iteration time. This makes Unity 3D more attractive to programmers who likes scripting. Because of these facts, we have chosen Unity3D as our development environment.

For designing 3D models, Blender 3D will be used. Blender 3D is an open source and free 3D modeling environment which completely supports processes such as modelling, rigging, simulation, animating, motion tracking and rendering [33]. The reasons why we have chosen Blender as our modelling environment are it is simple to use, User Interface of the program is easy to understand and there are a lot of documentation about possible problems that we could encounter using the Blender 3D.

Scripting part of the project is occurred using C# scripts. C# is a modern, simple and object-oriented programming language which unites features of rapid application development languages with the power of C and C++ [34]. The reasons why we have chosen C# as our programming language are all the members of the group have knowledge of C# programming language and C# is one of the three programming languages which can be used in Unity 3D.

4. Software Requirements Specification

4.1 Introduction

4.1.1 Purpose

The purpose of this document is describing the simulation which is called Simulacrum: Simulated Virtual Reality for Emergency Medical Intervention in Battle Field Conditions. This simulation aims to educate military personnel about principles of medical interventions in battlefield conditions. This document includes detailed information about requirements of the project. It reflects the identified constraints and proposed software functionalities. Moreover, the SRS document explains how participants interact with the simulation. This document explains how concerns of the stakeholders are met.

4.1.2 Scope of Project

Most of the military personnel do not have enough knowledge and experience about medical intervention techniques. In addition to this, the personnel, who has the knowledge about medical intervention techniques, might be ineffective because they are not familiar with the battlefield conditions and this causes increasing level of anxiety or stress. There are not enough efficient and low cost training programs that addresses this problem. The project has become necessary to develop due to lack of these training programs.

The purpose of Simulacrum project is to design “Immediate Medical Intervention During Combat” both as a standalone application and a VR system, which shall include realistic scenarios, by taking account of the experience gained by Turkish Armed Forces personnel and their inventories (e.g. tools, materials) that are used for medical intervention. To increase the level of immersion in this project, HTC Vive is going to be used. This technology allows the participants to interact with virtual environment. This interaction occurs by walking around in virtual world and touching the objects in the virtual world using controllers. Apart from having medical intervention situations in battlefield conditions, this simulation also includes first-aid

trainings. This project creates opportunities such as frequent repeating, easier access, efficient cost, etc.

There are two actors in the simulation which are participant and admin. NPCs (Nonplayer Character) have roles such as trainer, victim, etc. During the simulation, participant can interact with these NPCs and get specific information from NPCs related to situation. Training of the first-aid and medical intervention technique shall be divided into two different modes. First mode is Training Mode and traditional education technique is used in this mode. Participant will be debriefed about first-aid and medical intervention techniques. After the debriefing, participant shall take a quiz about these techniques. If the result of the test is satisfactory, the participant shall be able to practice the techniques. The other type of mode is Battlefield Mode and interactive education technique is used in this mode. Training of the firstaid or medical intervention technique shall be given to the participant in battlefield conditions. Second type of actor is admin and admins have the authority of making changes in simulation. Users will be able to enter the simulation as admin using password which are granted to admins.

4.1.3 Glossary

Table 1 Glossary of SRS

Term	**Definition**
Participant	The user who interacts with the simulation environment. Generally Medical Aid Man, Privates Sergeants, Militant Lifesaver, Commissioned Officer in Turkish Armed Forces.
Haptic Feedback	Creating sense of touch by applying vibrations and forces to the user.
HTC Vive	It is head-mounted virtual reality glasses which has gaze driven technology and provides haptic feedback through controllers.
Stakeholders	Any person who has contribution in the project.
Virtual Environment	Computer generated 3D modelled environment which has the resemblances of the real world.
Virtual Reality	It is computer-simulated environment which the user interacts with this environment.
NPC (Non-player Character)	Characters in the simulation who cannot be controlled by the participant [1].

4.1.4 References

[1] T. Petrenko and O. Tymchuk, "Adaptive Behavior Control Model of Non Player Character", 2013 UKSim 15th International Conference on Computer Modelling and Simulation, 2013.

4.1.5 Overview of Document

The second part of the document describes functionalities of the Simulacrum: Simulated Virtual Reality for Emergency Medical Intervention in Battle Field Conditions. Informal requirements are described and it is a context for technical requirement specification in the Requirement Specification chapter. Requirement Specification chapter is written for software developers and details of the functionality of the simulation are described in technical terms. Both of the sections describe the functionalities of the same product. However, it is described differently because they are intended for different audiences.

4.2 Overall Description

4.2.1 Product Perspective

Simulacrum: Simulated Virtual Reality for Emergency Medical Intervention in Battle Field Conditions is a virtual reality simulation project that has the purpose of training first aid and medical intervention techniques in battlefield conditions. The project divided into two parts: training mode and battlefield conditions mode.

Training mode includes three parts which are education about first-aid and medical intervention techniques, quiz about related topics and practice of the technique part. Battlefield condition mode has different scenarios about applying medical intervention techniques in battlefield conditions.

4.2.2 Development Methodology

For developing the project, we have planned to use Scrum which is an agile software development methodology. Scrum is incremental and iterative. In scrum, main work is divided into sprints which should be completed within a certain period of time which could be 30 days on average. Iteration length of every sprint must be equal, because scrum is an agile development methodology. Every Sprint includes tasks which has own story points and risk points. Development team should have a daily meeting every morning which should be maximum 15 minutes. Scrum has three main roles which are product owner, scrum master and

development team. Product owner is the person who delivers the requirements, scrum master is the person who manages the development team. Development team is the group of developers who work on the project according to schedule. There are some advantages of Scrum. First advantage is that it is easier to cope with changes because of short sprints and constant feedback. Another advantage is problems can be handled swiftly due to morning meetings. Also, it makes it possible to create quality products in scheduled time [35]. *Figure 2* represents four sprints of the project on the lab board. Sprint is one of the most important feature for Scrum methodology. At the end of each sprint, a part of project has been completed and it has been presented to customer for validation. By taking into consideration of these facts, Scrum is the most suitable methodology for the project.

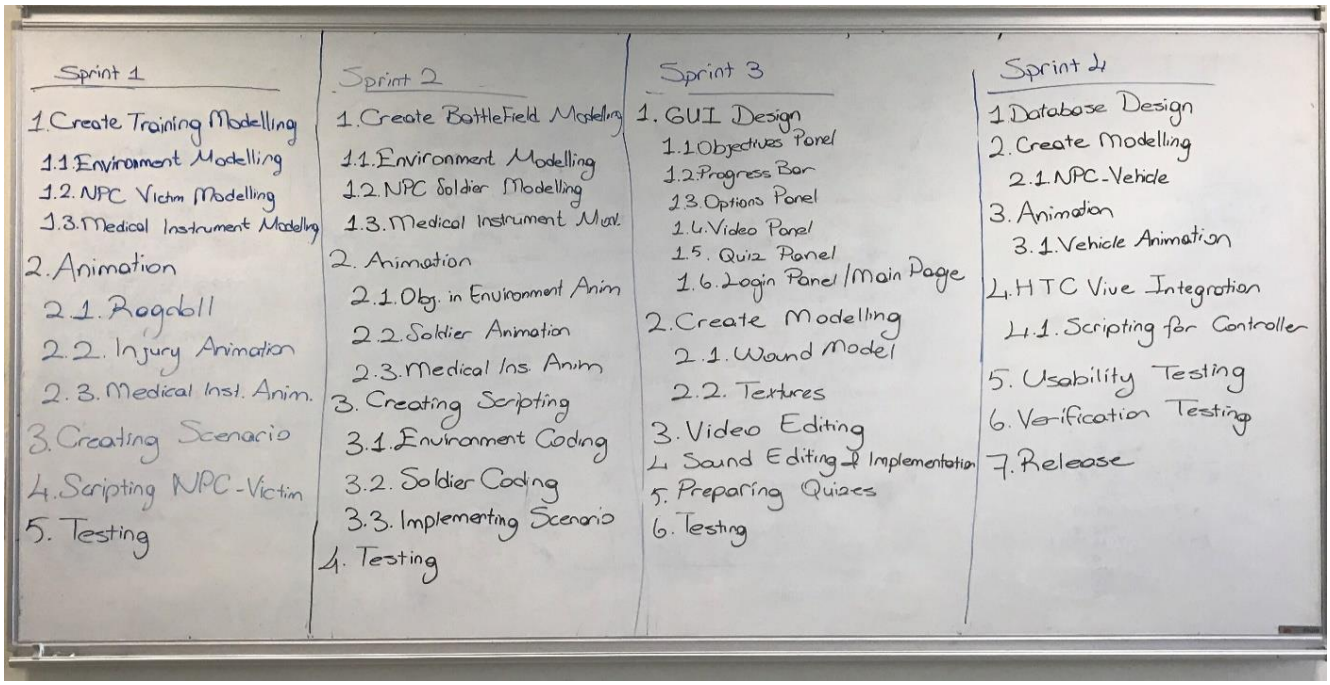

Figure 2 All Sprints of the Project on the Board

We have also used Scrum Board (see *Figure 3*) in order to complete tasks that are in the current sprint iteratively. Each tasks are written on the story cards which include their own risk points. Scrum board that includes six different phases. “Project Backlog” phase contains all processes within the sprint. “To Do” phase includes which is need to be done with priority. “In Progress” phase contains tasks that are currently being constructed. “In Review” phase represent processes that are being reviewed. “To Deploy” phase includes modules that are ready to be integrated within the main system. “Done” phase indicates processes that are successfully working within the system.

Figure 3 Scrum Board with Tasks

Gantt chart in *Figure 4* includes two parts which are research & documentation and sprints part. This Gantt chart explains the work to be done with using timeboxes. First approximately 60 days are spent using waterfall for research and documentation which include information regarding project. After documentation, there are 4 sprints which our group specified. Each sprint should be completed within 37 days and has unique tasks. After completing testing and release at the end of each sprint, if there are any tasks which are not completed, 4 extra working days have been reserved for the purpose of completing these tasks.

So technically these 4 days are for agile process technical debt. When all sprints are completed, next 10 days will be spent for usability tests.

Figure 4 Gantt Chart of Work Plan

4.2.3 User Characteristics

4.2.3.1 Participant

4.2.3.1.1 Participant must be an employee of Turkish Armed Forces.

4.2.3.1.2 Participant must read and understand Turkish language due to simulation language is Turkish.

4.2.3.1.3 Participant must have knowledge of first-aid and medical intervention techniques.

4.2.3.2 Admin

4.2.3.2.1 Admin must be an employee of Turkish Armed Forces.

4.2.3.2.2 Admin must read and understand Turkish language due to simulation language is Turkish.

4.2.3.2.3 Admin must know how to use a computer.

4.2.3.2.4 Admin must have knowledge of first-aid and medical intervention techniques.

4.3 Requirements Specification

4.3.1 External Interface Requirements

4.3.1.1 User interfaces

The user interface will be worked on Windows.

4.3.1.2 Hardware interfaces

The simulation requires HTC Vive. HTC Vive requires necessary drivers installed within the operating system. Also, it requires 1 USB and HDMI port on the PC.

4.3.1.3 Software interfaces

There are no external software interface requirements.

4.3.1.4 Communications interfaces

There are no external communications interface requirements.

4.3.2 Functional Requirements

4.3.2.1 Profile Management Use Case

Use Case:

- Start
- Login as Admin
- Exit

Diagram:

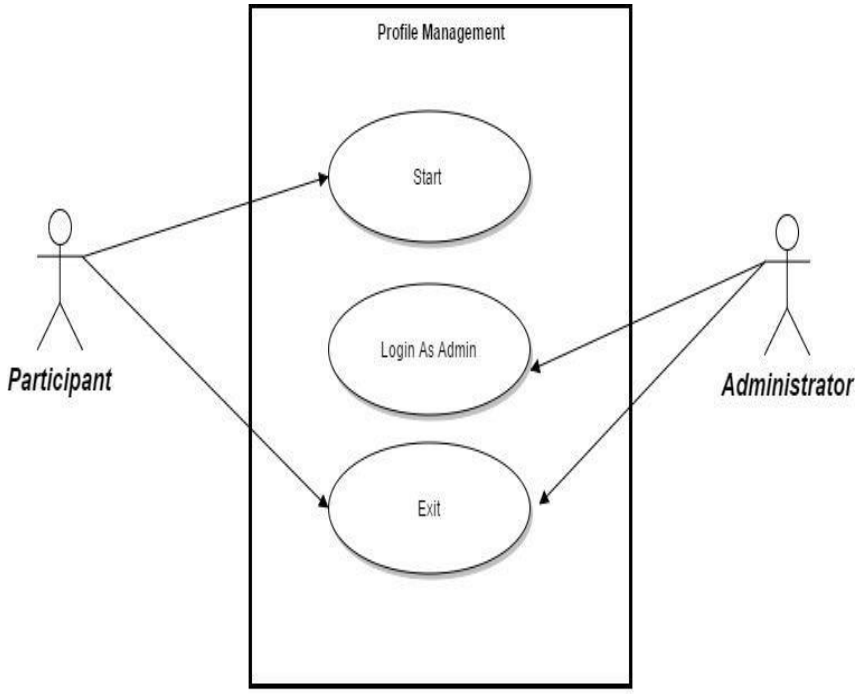

Figure 5 Profile Management Use Case

Brief Description:

In Profile Management diagram (*Figure 5*) explains the basic operations which is related to entering system of participant and admin. Participant and admin are able to use the following functions: Login, Update, and Exit. Apart from these, participant can also use the Register function and Admin can use the Delete, Approve and Add an Admin functions.

Initial Step by Step Description:

1. Participant shall start system without login.
2. Admin shall login to the system using password.
   2.1. If the password is invalid for the admin name, admin should re-login.
3. Admin and Participant can exit from the system.

4.3.2.2 **Options Menu Use Case for Settings**

Use Case:

- Pause
- Continue
- Change Volume Settings
- Display Instructions
- Exit

Diagram:

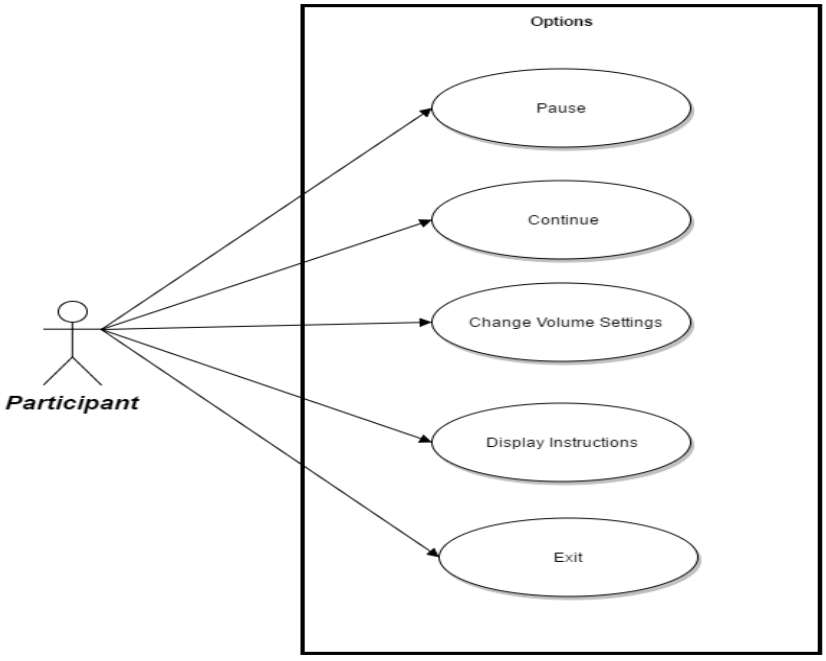

Figure 6 Participant Option Menu Use Case for Settings

Brief Description:

Figure 6 shows participant option menu use case diagram. When participant entered training and battlefield simulation within the system, he/she can display the options menu. Participant can execute functions of Pause, Continue, Change Volume Settings, Display Instructions and Exit in options menu.

Initial Step-By-Step Description:

1. If participant selects Pause button, the simulation stops.
2. If participant selects Continue button, the simulation continues from where it is left.
3. If participant selects Change Volume Settings button, a panel is displayed on the screen.

3.1. Participant can increase volume of the simulation by selecting “+” button.

3.2. Participant can decrease volume of the simulation by selecting “-” button.

4. If participant selects Display Instructions button, a panel which presents the instructions of the simulation is displayed.
5. If participant selects Exit button, simulation ends and main menu is displayed.

4.3.2.3 Training Mode Use Case

Use Case:

- Select Technique
- Display Result
- Display Options
- Take Quiz
- Answer Questions
- Attend Practice Technique
- Hold Object
- Drop Object
- Add Question
- Delete Question
- Update Question

Diagram:

Figure 7 Training Mode Use Case

Brief Description:

Figure 7 is a training mode use case diagram. In this use case diagram, when participant enters training mode, he/she can select a technique related to first-aid and medical intervention and he/she can display his/her result. After selecting a technique, the participant shall finish educating part of the simulation. Then, participant shall take a quiz related to the technique and he/she shall answer the questions which are multiple choices in the quiz. After quiz, participant shall be able to attend to practice part and he/she can hold and drop objects in the simulation. Admin is able to manage text files related to quizzes.

Initial Step by Step Description:

1. When participant selects a technique, a panel which includes a list of techniques which are related to first-aid shall be displayed.
2. During education part of training, participant shall take information from video.
3. When education part of training is completed, participant shall take a quiz related to the education.

   3.1. When quiz part of training occurs, a panel which includes list of questions which are multiple choices shall be displayed.

   3.2. Participant should answer questions by selecting one of the choices.

   3.3. At the end of the quiz, correct answers and result shall be displayed.

   3.4. If the participant has given correct answers to 80% of the questions, quiz part shall end and participant shall attend practice part.

   3.5. If the participant fails, participant shall return to education part.
4. When participant attends practice technique, participant shall be able to interact with objects.

   4.1. Participant shall interact with objects by holding and dropping them.

      4.1.1. If participant hold down the trigger button, participant hold the objects on the virtual environment.

      4.1.2. If participant stops holding down the trigger button, participant drop the objects on the virtual environment.
5. Admin can manage questions which are on the quizzes.

   5.1. When admin selects the add question button, a panel which admin can add multiple choice questions on will be displayed.

   5.2. When admin selects the delete question button, a panel which admin can delete multiple choice questions on will be displayed.

   5.3. When admin selects the update question button, a panel which admin can update multiple choice questions on will be displayed.
6. If participant selects options button, a panel which includes option properties shall be displayed.

4.3.2.4 **Battlefield Mode Use Case**

Use Case:

- Select Injury Scenario
- Select Medical Interventions Technique
- Display Option
- View Objective Panel
- View Inventory Panel
- Movement
- Hold Object
- Drop Object
- Display Result

Diagram:

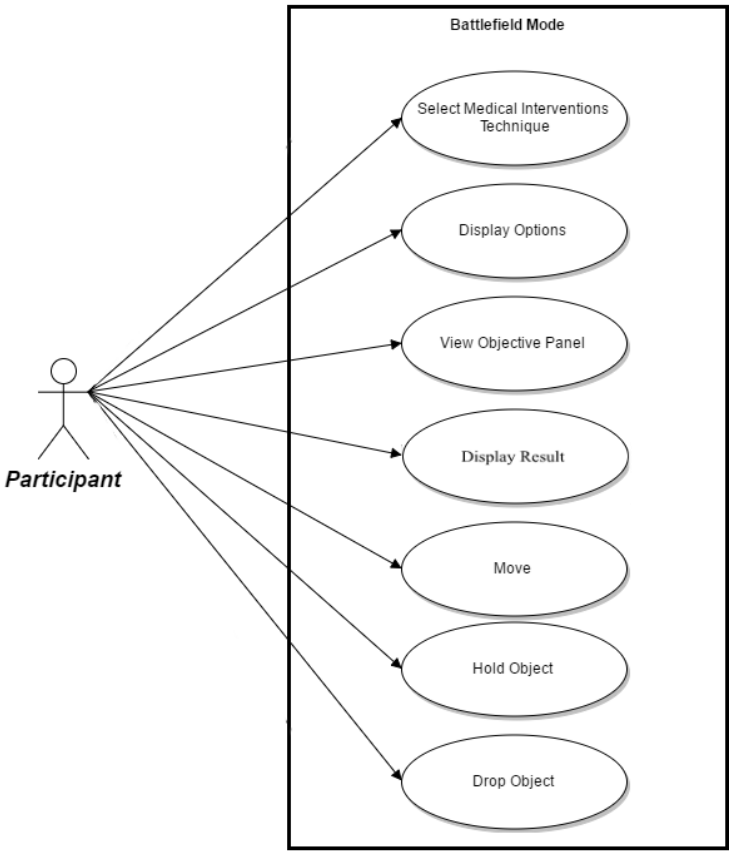

Figure 8 Battlefield Mode Use Case

Brief Description:

Figure 8 is a battlefield mode use case diagram. In this diagram, when participant enters battlefield mode. After that, participant shall select medical intervention technique. Then, participant shall finish his/her duty in specific time. Participant can display his/her progress in simulation. Moreover, participant can move on the virtual environment and interact with objects by holding and dropping objects. These objects will be selected by the participant from inventory panel. Also, Participant can display results on the battlefield environment.

Initial Step-By-Step Description:

1. Participant shall select a medical interventions technique related to the injury scenario.
2. Participant can select generate simulation button which chooses an injury scenario from the list of scenarios and a medical intervention technique which is related to the chosen scenario randomly.
3. Participant can move on the battlefield.

   3.1. When participant presses the trackpad up button on the HTC Vive controller, the participant shall move forward.

   3.2. When participant presses the trackpad down button on the HTC Vive controller, the participant shall move backward.

   3.3. When participant presses the trackpad right button on the HTC Vive controller, the participant shall move to the right side.

   3.4. When participant presses the trackpad left button on the HTC Vive controller, the participant shall move to the left side.

4. Participant shall interact with objects which are selected from objective panel by holding and dropping them.

   4.1. If participant hold down the trigger button, participant hold the objects on the virtual environment.

   4.2. If participant stops holding down the trigger button, participant drop the objects on the virtual environment.

5. If participant selects options button, a panel which includes option properties shall be displayed.

6. Participant can display objective panel to display the remaining tasks during the battlefield simulation.
7. When participant accomplishes or fails the given objectives, a new panel shall be displayed which includes the result of the simulation.

   7.1. If the participant accomplishes the given objectives in a certain amount of time, the displayed panel shall include the finish time and result of the participant.

   7.2. If the participant fails the given objectives, the displayed panel shall include the reason of failure and the result of the participant.

   7.3. The displayed panel shall also include two buttons which allows the participant to restart the current simulation and return to main menu.
8. Participant can display results on the battlefield environment.

4.3.3 Performance Requirements

Simulation's visual must run smoothly without any latency to keep the level of immersion high. This requirement is depended on many aspects of the user pc. Minimum requirements [36] for running HTC Vive are:

1. GPU: NVIDIA GeForce GTX 970, AMD Radeon R9 290 equivalent or better
2. CPU: Intel i5-4590/AMD FX 8350 equivalent or better
3. RAM: 4 GB or more
4. Video output: HDMI 1.4, DisplayPort 1.2 or newer
5. USB port: 1x USB 2.0 or better port
6. Operating system: Windows 7 SP1, Windows 8.1 or later, Windows 10

4.3.4 Software system attributes

4.3.4.1 Portability

- Simulacrum is designed for HTC Vive using Unity 3D.
- The project can mainly be used with HTC Vive but other virtual reality glasses like Oculus Rift, Sony PlayStation VR, Samsung Gear VR, etc. can be integrated into the project with basic adjustments since the project is developed by using unity 3D.

4.3.4.2 Performance

- Objects, which are not seen by participant, should not be rendered unless the participant sees the object.

- Animations of objects should not be played unless the participant sees the object.
- Level of detail of objects should be changed according to distance between object and the participant.
- Quizzes in training mode should be completed in 5 minutes.

4.3.4.3 Usability

- Each quiz in training mode has 5 questions.
- Each question in the quizzes has 4 choices.
- When the participant fails, an error message, which explains the reason that why the participant failed, should be displayed.

4.3.4.4 Adaptability

- Since no data is acquired and saved from the run time, there is no adaptability requirement.

4.3.4.5 Scalability

- Since only one participant uses the system at a time, there is no scalability requirement.

4.3.5 Safety Requirement

HTC Vive requires at least 2 meters square area. This area should not include any object which might be an obstacle to the user. These obstacles might cause the injury of the user or it could be harmful to the HTC Vive controller or the glasses.

Using HTC Vive for a long period of time and brain-body conflict might cause nausea and dizziness on the user. Brain-body conflict can be caused in simulation by changing position or rotation of the user in the simulation while the user stands still in real life.

5. Software Design Description

5.1 Introduction

5.1.1 Purpose

The purpose of this Software Design Document is providing the details of project titled as “Simulacrum: Simulated Virtual Reality for Emergency Medical Intervention in Battle Field Conditions”.

The target audience is military personnel in Turkish Armed Forces. Simulation will create opportunities to learn and practice the techniques of first-aid and medical intervention. We aim to provide an immersive environment which includes objects from the real world to make the participant familiar with the events of medical intervention techniques in battlefield conditions.

The purpose of Simulacrum project is to design “Immediate Medical Intervention During Combat” both as a standalone application and a VR system, which shall include realistic scenarios, by taking account of the experience gained by Turkish Armed Forces personnel and their inventories (e.g. tools, materials) that are used for medical intervention. Simulacrum simulation includes two main modes which are training and battlefield modes. In the training mode, participant can interact with these NPCs and get specific information from NPCs related to situation. Participant will be debriefed about first-aid and medical intervention techniques. After the debriefing, participant shall take a quiz about these techniques. If the result of the test is satisfactory, the participant shall be able to practice the techniques. Participant is always able to see his/her results in tests and practices. If the participant is successful in every technique in training mode, participant will be able to attend to practice medical intervention techniques in battlefield conditions. In battlefield mode, participant will start at combat environment. Participant is given ability of firing his/her gun in order to increase the level of immersion of the battle field. Thus, it is easier to give sensation of battle to the participant. When a fellow soldier in battle field gets wounded, a green indicator shall be displayed in front of the wounded soldier. When the participant reaches to this point, event of medical intervention practice shall be started. In this event, participant will try to apply necessary medical intervention technique properly before the given time is up.

HTC Vive is integrated within the simulation in order to increase the level of immersion. HTC Vive includes two controllers for each hand, two sensors for locating the position of the

participant and a laser based head mounted display which projects the frames on the computer screen to the participant.

Simulation is designed to be used with both HTC Vive and using keyboard and mouse. Using the simulation with HTC Vive is recommended, because of the fact that using HTC Vive increases the level of immersion of simulation. Head mounted display shall provide a more realistic view to the participant in the simulation and the controllers shall be used to provide interaction between objects in the simulation and the participant. Sensors of the HTC Vive creates a 2 meter-square of field for participant to move around. Participant is able to attend two different areas. One of them is a spatial area which includes only injured NPC and medical instruments. The other area is a battlefield environment which is designed for putting the participant in a difficult position to practice medical intervention techniques.

In order to provide a better comprehension, this SDD includes various diagrams such as UML diagram of the project, activity diagram and block diagram.

5.1.2 Scope

This document contains a complete description of the design of Simulacrum: Simulated Virtual Reality for Emergency Medical Intervention in Battle Field Conditions.

Unity 3D Game Engine is utilized to create scenes of the simulation and handling all the events in the simulation. Procedures of creating the three-dimensional environment, programming and designing will be performed on Unity3D. Unity3D is a game engine [30] which is used by many game and simulation developers for it is practical. There are various programming languages that can be used within Unity3D such as C# and JavaScript. Xie [31] reports that Unity 3D includes packages like Unity Pro, Android, IOS, etc. It is a powerful cross platform and it is easy to extract to build of the project for Windows, Mac OS X, Linux, Android and IOS. Wang et al. [32] claim that when it comes to scripting, most programmers think that it is slow and limited. But in Unity 3D, script codes are compiled to native code and it is most likely to get a fast iteration time. This makes Unity 3D more attractive to programmers who likes scripting. Because of these facts, we have chosen Unity3D as our development environment.

For designing 3D models, Blender 3D will be used. Blender 3D is an open source and free 3D modeling environment which completely supports processes such as modelling, rigging, simulation, animating, motion tracking and rendering [33]. The reasons why we have

chosen Blender as our modelling environment are it is simple to use, User Interface of the program is easy to understand and there are a lot of documentation about possible problems that we could encounter using the Blender 3D.

Scripting part of the project is occurred using C# scripts. C# is a modern, simple and object-oriented programming language which unites features of rapid application development languages with the power of C and C++ [34]. The reasons why we have chosen C# as our programming language are all the members of the group have knowledge of C# programming language and C# is one of the three programming languages which can be used in Unity 3D.

Participant shall navigate through virtual environment and shall interact with object using HTC Vive. Also, the participant is able to attend lectures, take quizzes and practice about first-aid and medical intervention techniques. In the first part of the system, participant shall select a first-aid technique. First part of the training includes non-interactive video. This video gives information about the selected first-aid technique. After participant obtains information from the video, a quiz panel, which includes questions regarding to selected first-aid technique, shall be displayed. This quiz will contain five questions. Every question has four different choices. These quizzes will be prepared with the professional help from Turkish Red Crescent. Purpose of these quizzes is to determine how much the participant learnt from the video. After completing the quiz, if the result is satisfactory, participant will be able to attend to practice training regarding to selected first-aid technique. The result of the quiz shall not be displayed to the participant yet. When the practice part has ended, the same quiz shall be displayed again in order to determine whether the practice part was helpful to participant or not.

5.1.3 Glossary

Table 2 Glossary of SDD

Term	Definition
BLOCK DIAGRAM	The type of schema which the components in the system are displayed in blocks.
HEAD MOUNTED DISPLAY (HMD)	It is a display device which is worn to the head.
HTC VIVE	It is virtual reality system with head-mounted virtual reality glasses which has gaze driven technology and provides haptic feedback through controllers.
NPC (Non-player Character)	Characters in the simulation who cannot be controlled by the participant [37].
PARTICIPANT	The user who interacts with the simulation environment. Generally Medical Aid Man, Privates Sergeants, Militant Lifesaver, Commissioned Officer in Turkish Armed Forces.
SDD	Software Design Document.
UML DIAGRAM	It is a modelling language which is used in Software Engineering.

5.1.4 Overview of document

The remaining chapters and their contents are listed below.

Section 2 is the Architectural Design which describes the project development phase. Also it contains class diagram of the system and architecture design of the simulation which describes actors, exceptions, basic sequences, priorities, pre-conditions and post conditions. Additionally, this section includes activity diagram of scenario generator.

Section 3 is Use Case Realization. In this section, a block diagram of the system, which is designed according to use cases in SRS document, is displayed and explained.

Section 4 is related to Environment. In this section, we have shown the sample frames of environment from the prototype and have described scenario.

5.2 Architecture design

5.2.1 Simulation Design Approach

5.2.1.1 Class Diagram

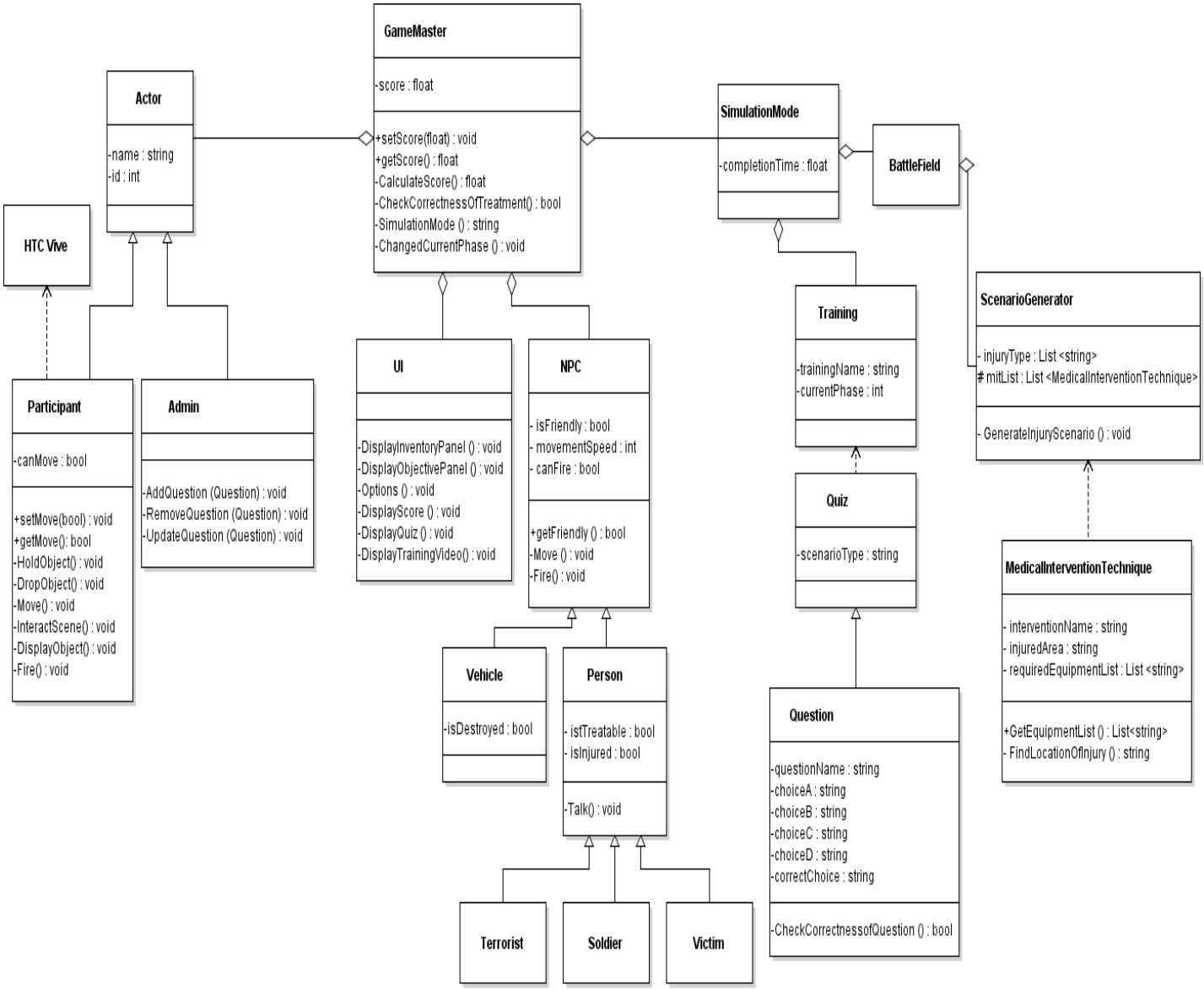

Figure 9 Class Diagram of Simulacrum project

Figure 9 displays information about connections between the systems within the simulation. GameMaster Class is the main system, which contains other systems. It is responsible for connections between other systems such as Actor, UI, NPC and Simulation Mode. Actor class represents all the users who use the system. Participant class is for users who will use the simulation for educational purposes with using HTC Vive. Admin class is for actor which manages the system. UI class represents the User Interface which the Actors of the

system will encounter. NPC class represents non playable characters which are used to increase the immersion level of the simulation. Vehicle class that is derived from NPC class represents information about vehicles which is used in battle field conditions whereas Person class represents the people that are in the battle field. Soldier, Victim and Terrorist classes are derived from Person class. Simulation Mode is the base class of Battlefield and Training classes and is used to represent the current mode of the simulation. Training class includes Quiz class which includes questions that are asked to the participant of the simulation. Battlefield class is a base class of ScenarioGenerator. ScenarioGenerator class, which is generating scenarios randomly, includes MedicalInterventionTechnique class.

5.3 Architecture Design of Simulation

5.3.1 Profile Management

Summary: This system is used by participant and admin. Participant can login, register, and update personal information and exit from the system. In addition to this, admin can delete an account, approve participant accounts and add a new admin.

Actor: Participant, admin

Precondition: User must run the program.

Basic Sequence:

1. User shall login to the system by entering admin password.
2. User can add, update and delete question from treatment quizzes.
3. User can exit from the system by selecting exit button.

Exception: None

Post Conditions: None

Priority: Low

5.3.2 Options Menu

Summary: Participant can pause and continue the simulation, change volume settings, display instructions and exit from the system.

Actor: Participant

Precondition: Participant must be logged in and selected options button.

Basic Sequence:

1. Participant can pause the simulation by selecting options button.
2. Participant can continue the simulation by selecting continue button from options menu.
3. Participant can change volume of the simulation by selecting change volume settings from options menu.
4. Participant can display instructions by selecting display objectives button from option menu.
5. Participant can exit from the system by selection exit button.

Exception: None

Post Conditions: None

Priority: Medium

5.3.3 Training Mode

Summary: This system is used by both participant and admin. Participant can select a first-aid technique, display result, display options, take quiz, answer questions, attend practice technique, hold and drop objects. Admin can add, delete and update questions of the quizzes in this system.

Actor: Participant, admin

Precondition: User must be logged in, chose a first-aid technique.

Basic Sequence:

1. Participant can select a first-aid technique from the list of techniques.
2. After selecting a technique an educational video regarding selected technique shall be displayed to the participant.
3. Quiz panel which includes questions about selected technique shall be displayed to the participant.
4. If the result of the quiz is satisfactory, a training environment shall be created for the user.
5. Participant can hold and drop object in training environment.
6. Participant can display options by selecting options button.
7. Admin can add, delete and update questions regarding selected technique.

8. Participant can display result regarding selected technique.

Exception: None

Post Conditions: None

Priority: High

5.3.4 Battlefield Mode

Summary: This system is used by participant and admin. Different from the training mode, this mode includes war ambiance, includes medical intervention techniques and injury scenario.

Actor: Participant, admin

Precondition: User must be logged in to system and selected battlefield mode.

Basic Sequence:

1. Participant can select an injury scenario from list of injuries.
2. After selecting an injury scenario, Participant shall select a medical intervention technique.
3. An environment is created depending on the selection of participant.
4. Participant can move around the environment with keyboard's w-a-s-d buttons and HTC Vive Controllers.
5. Participant can hold and drop objects which are in this environment.
6. Participant can fire a gun with mouse's right click or HTC Vive controller.
7. Participant can display Progress Bar by selecting progress bar button.
8. Participant can view items in his/her inventory by selecting inventory button.
9. Participant can display objectives panel by selecting objectives button.
10. Participant can display options by selecting options button.
11. Participant can display result regarding selected medical intervention techniques and injury scenario.

Exception: None

Post Conditions: None

Priority: High

5.4 Activity Diagram

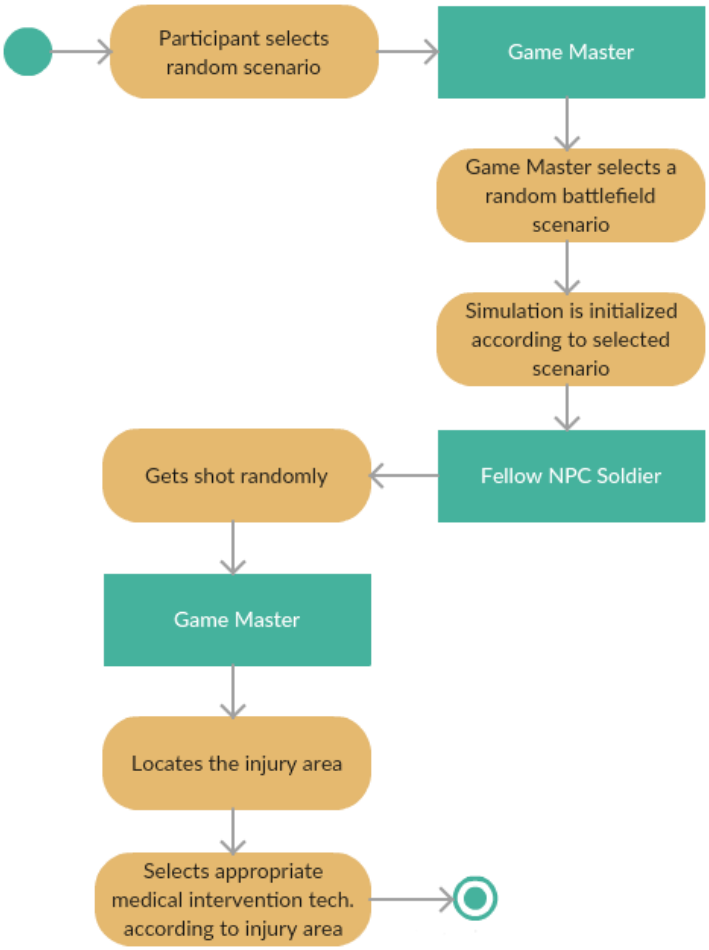

Figure 10 Activity Diagram of Scenario Generator

Figure 10 shows how the scenario generation works as an activity diagram. When the participant selects random scenario generation choice, Game Master Object will run random scenario generation function. First of all, in this function, a battlefield scenario shall be selected randomly according to the algorithm. After that, scene will be initialized according to selected battlefield scenario. When a fellow soldier gets injured randomly, Game Master Object will locate the injury area and shall select the appropriate medical intervention technique scenario. When the appropriate medical intervention technique scenario selected, practicing of that scenario will be started.

5.5 Use Case Realization

Simulacrum Project

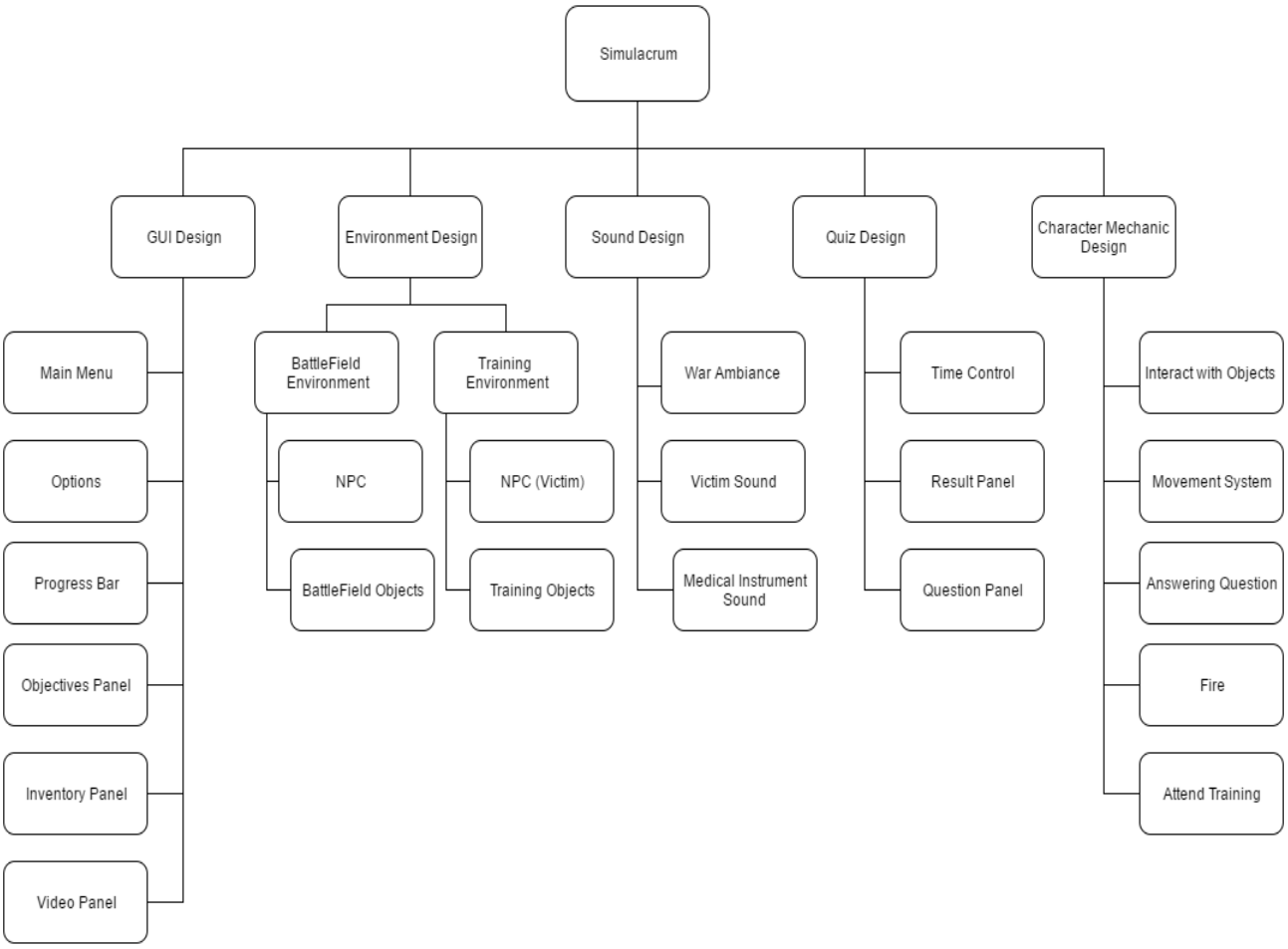

Figure 11 Project Components of Simulacrum

5.5.1 Brief Description of Figure 11

Components of the Simulacrum Project are shown in the *Figure 11*. All designed systems of the simulation are displayed in the block diagram in the figure. There are five main components of the system which have their own sub-systems.

5.5.1.1 GUI Design

GUI design is responsible for interaction between the actors and the system. There are six sub-systems in this design which are Main Menu, Options, Progress Bar, Objective Panel, Inventory Panel and Video Panel. Main Menu is a start page, participant can register, login, display the information about how to use the system, and logout from the system. There are two different ways to access the options menu. First of all, if HTC Vive is connected to the system,

participant shall access options menu by activating the panel on the tip of the index finger of left hand with using right hand. Secondly, if HTC Vive is not connected to the system, options menu can be accessed by clicking esc button from keyboard. Participant can reach the progress bar from both simulation modes. Progress bar indicates the achievement of the participant. Objective panel can be reached from both simulation modes by clicking “O” from keyboard or can be accessed by activating the panel on the tip of the middle finger of the left hand with using right hand. Objective panel displays current objectives. Inventory panel can be accessed from both simulations. This panel is located on top of the screen. Inventory panel indicates participant’s inventory that contains medical instruments. Video panel is shown from both of simulation modes. It will give information about first-aid and medical intervention techniques.

5.5.1.2 Environment Design

Environment Design is responsible for managing environment which the user interacts with objects. There are two types of environment in the system which are battle field and training environment. Training environment is more focused on education whereas battle field includes objects which are related to battle. Both of the environments includes NPC objects such as victims, soldiers, tanks, etc. to increase the level of immersion of the simulation.

5.5.1.3 Sound Editing

Sound design module is responsible for all audios which are used in simulation in order to increase the realism of the simulation especially for battle field mode. This system includes War Ambiance, Victim Sound and Medical Instrument Sounds.

5.5.1.4 Quiz Design

This sub-system manages all the question that are asked to the participant. This sub system includes Time Control, Result Panel and Question Panel.

5.5.1.5 Characteristic Mechanic Design

This design module is used for determining the participant’s abilities. Participant can interact with objects using HTC Vive, move around the environment, answer questions in the quizzes, fire guns and attend trainings.

5.6 ENVIRONMENT

5.6.1 Modelling Environment

In this project, 3D image-based modeling technique is used to create virtual environment in Simulacrum. Objects in real life are modelled virtually using modeling tools such as Blender and these models are transferred into Unity3D project. Unity3D is capable of recognizing 3D object with extensions of FBX, OBJ, etc. [38].

In our simulation, we have two different environments which include 3D models. First environment is training scene which includes 3D models of NPC (victim) and medical instruments. In *Figure 12*, a victim who is injured in training environment can be seen. In this moment, it is expected from the participant to examine the wounds of the victim and start treating that wound correctly using items in the inventory panel. Inventory panel contains all the items in the possession of the participant and these items are displayed in grid view on the left side of the panel. If the participant would like to use an item from the inventory, s/he will click on the button of that item and that item will be displayed on the right side of the panel. It can be observed that the wounded victim is treated in the image on the right side by selecting an item from the inventory and using it upon the victim.

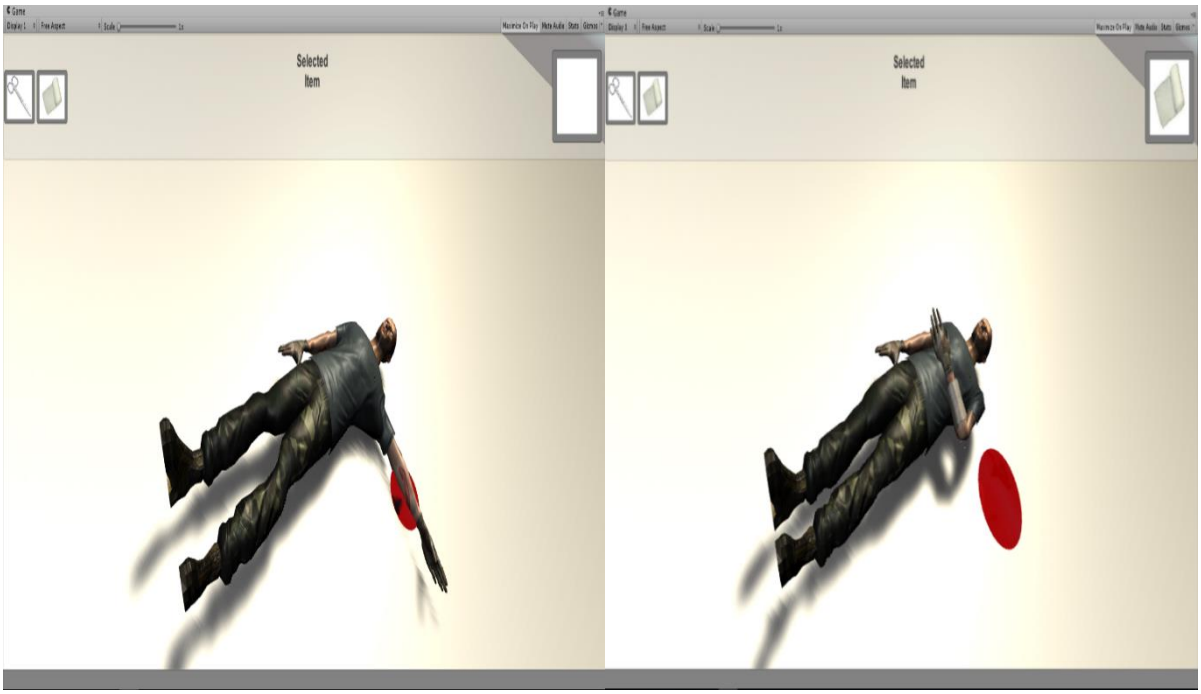

Figure 12 Wounded Person in Training Environment

Second environment is a battlefield. Apart from including NPC and medical instrument models, this environment also includes a terrain, tree, grass, armored vehicle, house and fighter jet models.

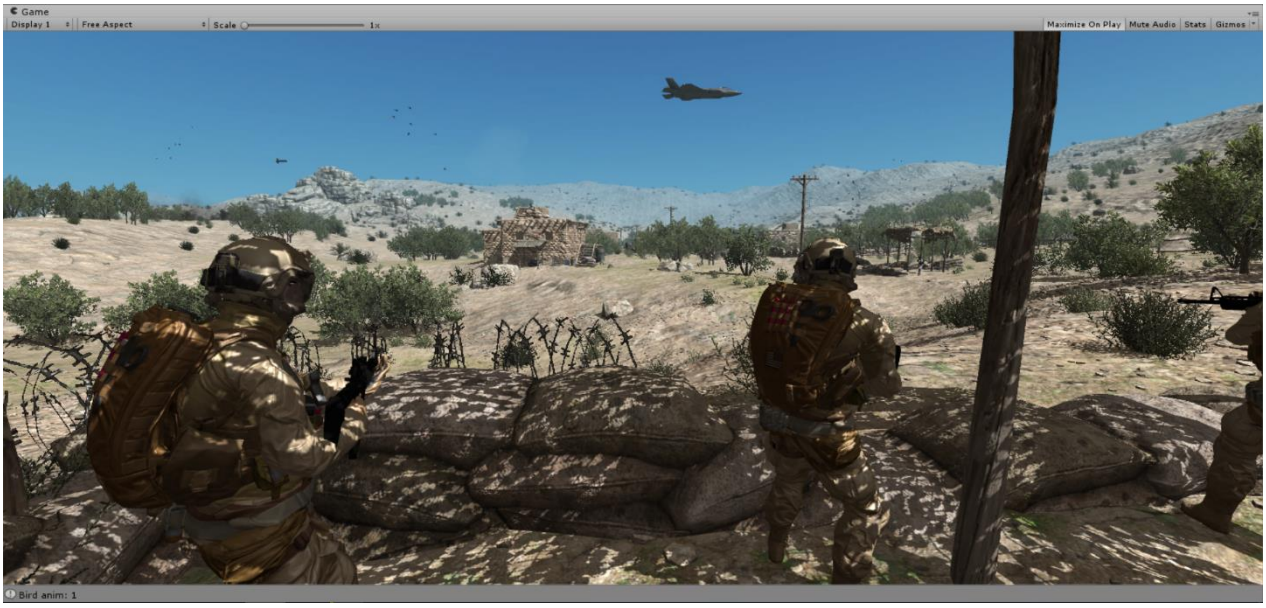

Figure 13 First Scene of Battlefield Environment

As it can be observed in *Figure 13* the participant shall start in a battle field along with his/her military unit. Initial objective of the participant is to neutralize every terrorist and secure the village in the *Figure 13*. Until any of the fellow soldiers are wounded, the participant shall act as a proper soldier as s/he is expected to fight with the terrorists using his/her gun.

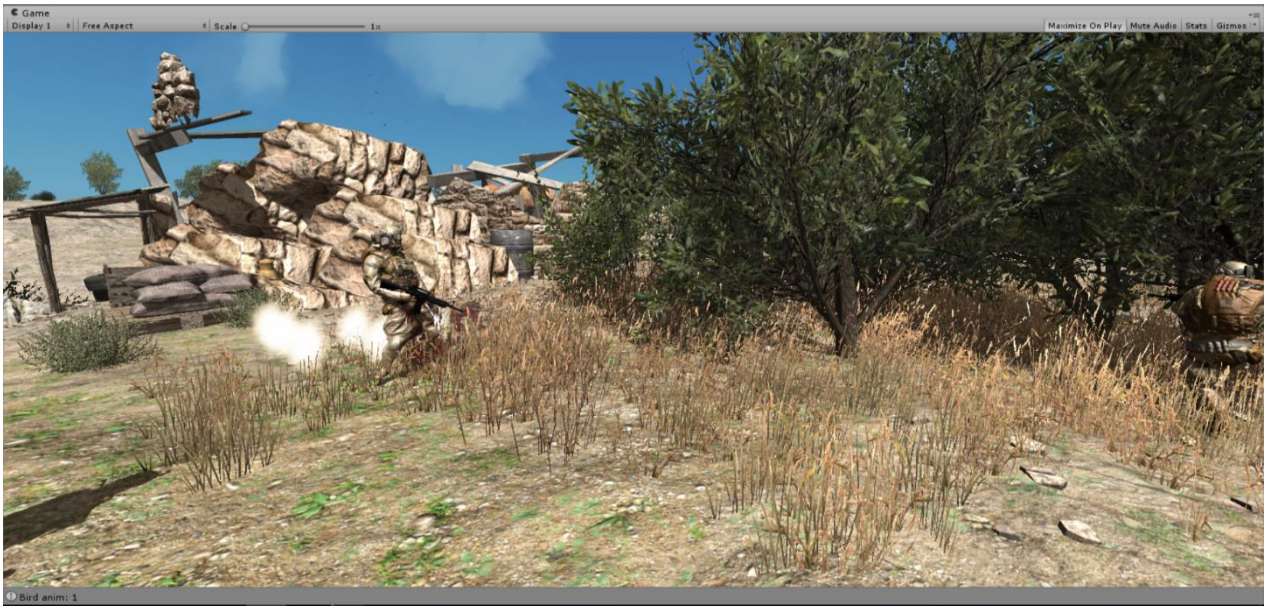

Figure 14 A Fellow Soldier Getting Shot Scene of Battlefield Environment

In *Figure 14*, it can be observed that it is the moment of a fellow soldier is getting shot by a random enemy. In a certain part of the scenario, this event is planned to occur. To allow participant to practice medical intervention techniques, this event will always occur in some part of the simulation. In this case, it is expected from the participant to stop fighting and start performing necessary medical intervention technique immediately.

Figure 15 Wounded Soldier Scene of Battlefield Environment

In *Figure 15*, as it is expected from the participant, s/he gets closer to the wounded soldier in order to perform medical intervention technique. In order to perform this technique, participant must get to the indicator which will appear next to the wounded soldier. After reaching to this indicator, functionalities such as fighting and moving of the participant shall not be used in this part. Instead, medic bag which belongs to the participant shall appear and it will be expected from the participant to perform necessary medical intervention technique by selecting required items from this bag.

5.7 HELP SYSTEM DESIGN

5.7.1 The Menu

5.7.1.1 Start Menu

1) Execute Simulacrum.exe file

2) Başlat, Ayarlar, Yardım and Çıkış selections are available (*Figure 16*)

Figure 16 Start Menu

5.7.1.2 Options Menu

1) Select Ayarlar button from Start Menu

2) Selections of Ses ve Fare Hassasiyeti are available

5.7.1.3 Instructions Menu

1) Select Yardım button from Start Menu

2) An image which represents how to use the system is displayed

5.7.1.4 Exit Menu

1) Select Çıkış button from Start Menu

2) Returned to Desktop

5.7.1.5 Mode Selection Menu

1) Select Başlat button from Start Menu

2) Eğitim Modu, Savaş Modu and Geri Dön selections are available (*Figure 17*)

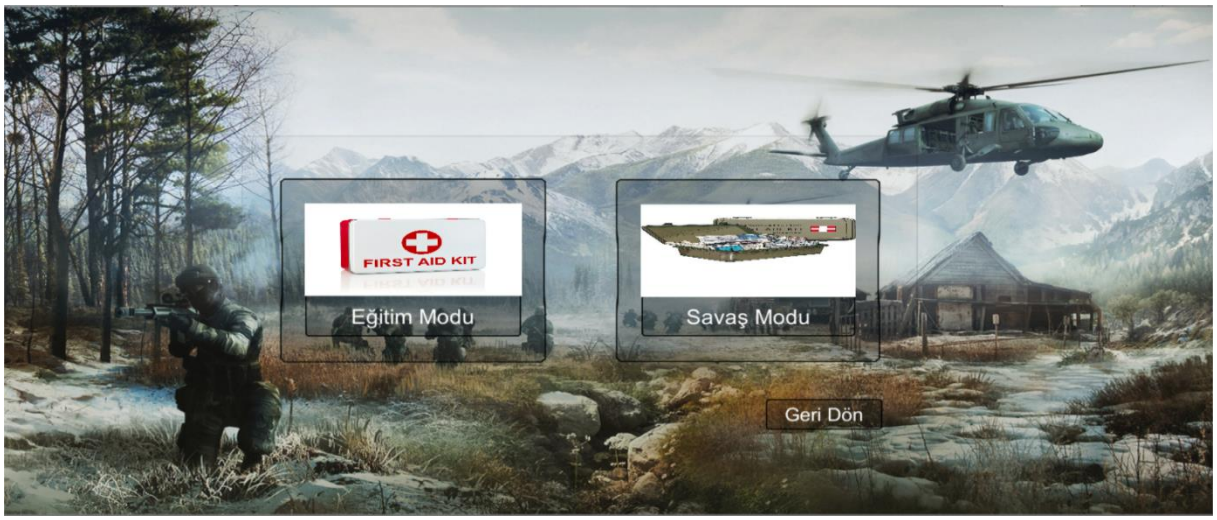

Figure 17 Mode Selection Menu

5.7.1.6 Training Mode

1) Select Eğitim Modu button from Mode Selection Menu

2) A drop-down list which contains medical intervention techniques and Geri Dön selections are available (*Figure 18*)

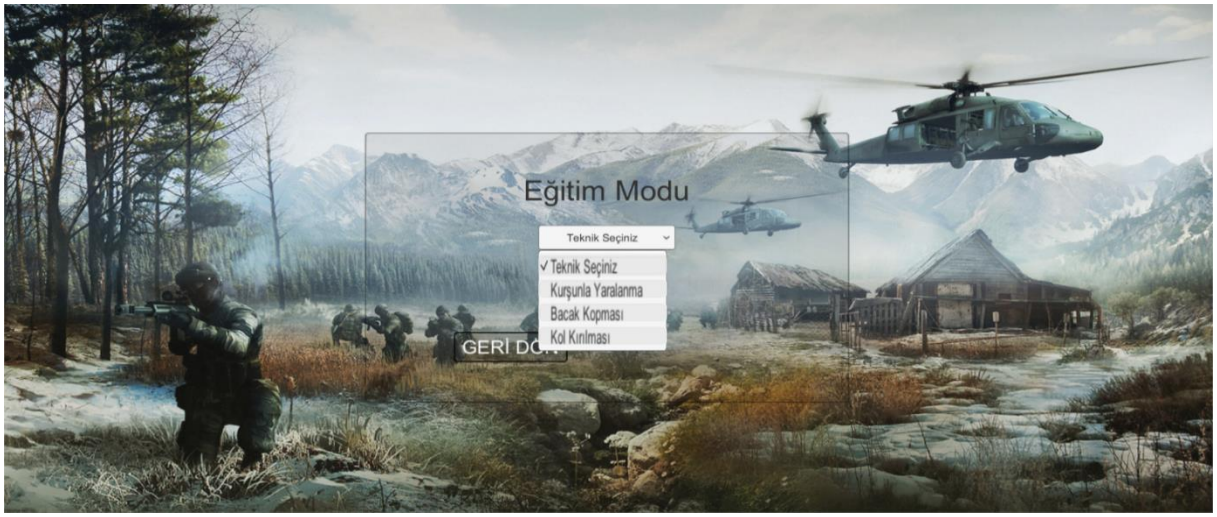

Figure 18 Training Mode Selection

5.7.1.7 Battlefield Mode

1) Select Savaş Modu button from Mode Selection Menu

2) A drop-down list which contains medical intervention techniques and a drop-down list which contains battlefield scenarios are available

5.7.2 Battlefield Mode

5.7.2.1 Movement

1) Başlat > Savaş Modu > Select a battlefield scenario and a medical intervention technique > Select Başlat

2) Press ‘W’ to go forward

3) Press ‘S’ to go backward

4) Press ‘A’ to go left

5) Press ‘D’ to go right

6) Follow your team which is the group of people that are closest to you (*Figure 19*)

Figure 19 Start of Battlefield Mode

5.7.2.2 Treatment Mission

1) Başlat > Savaş Modu > Select a battlefield scenario and a medical intervention technique > Select Başlat

2) Recognize the green area and move towards to it (*Figure 20*)

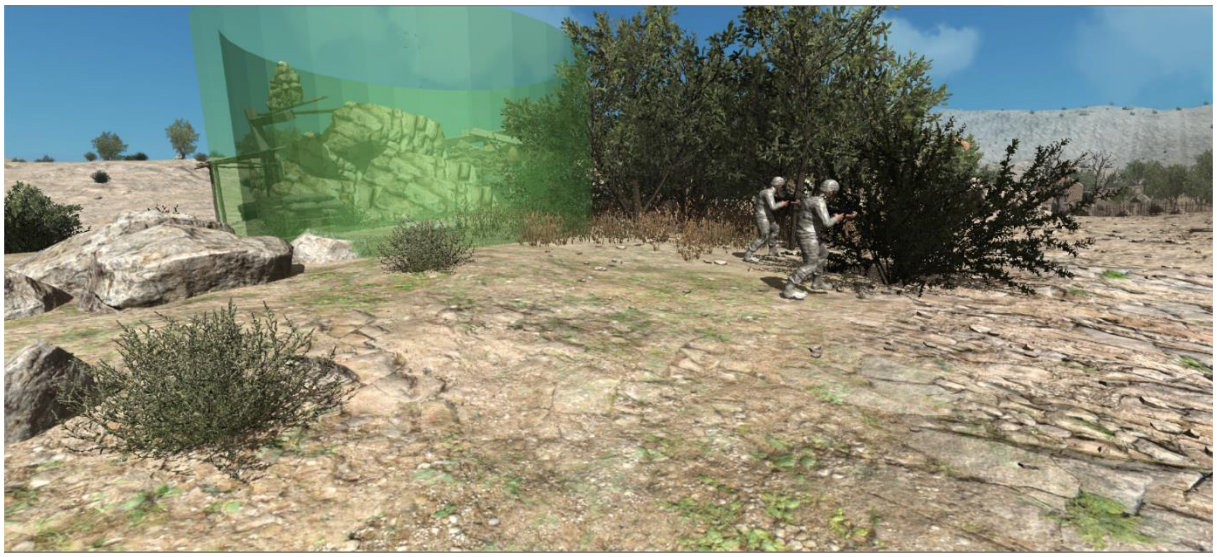

Figure 20 Battlefield Indicator

5.7.3 Treatment

5.7.3.1 Recognize the elements on the screen

1) Arrow on the top of the screen opens/closes the inventory panel

2) Arrow on the right of the screen opens/closes the objective panel

3) Buttons on the inventory panel represents the medical instruments and by clicking on them, 3D representation of the medical instruments are given to player

4) Items on the objective panel represents the current tasks that the player must complete

5) Ilerleme Seviyesi on the right-top of the screen represents completion of the current task (*Figure 21*)

Figure 21 Treatment Part

5.7.4 Required Equipment's

5.7.4.1 HTC Vive

1) Plug in both of the Base Stations and place them 4 meters apart from each other. Make sure one of them is on channel c and the other one is on channel b

2) Connect the headset to computer by plugging its HDMI and USB output

3) Activate the controllers by pressing the button on the bottom

4) Equip the both of the controllers and headset and stand in the middle of the two base stations (*Figure 22)*

Figure 22 HTC Vive Box Content

6. Test Plan

6.1 INTRODUCTION

6.1.1 Version Control

Table 3 Version Control

Version No	Description of Changes	Date
1.0	First Version	Apr 12, 2017
2.0	Second Version	May 17, 2017

6.1.2 Overview

The use case of Simulacrum: Simulated Virtual Reality for Emergency Medical Intervention in Battle Field Conditions' system users namely participant and admin which had been determined in SRS document will be tested.

6.1.3 Scope

This document encapsulates the test plan of the use cases, test design specifications and the test cases correspond to test plan.

6.1.4 Terminology

Table 4 Terminology

Acronym	Definition
GUI	Graphical User Interface (GUI)
TM	Training Mode
BM	Battlefield Mode

6.2 FEATURES TO BE TESTED

This section lists and gives a brief description of all the major features to be tested. For each major feature there will be a Test Design Specification added at the end of this document.

6.2.1 Graphical User Interface (GUI)

In project, graphical user interface components are used. The GUI part is divided into three parts which are Main Menu, Training and Battlefield. Every part of the GUI also includes smaller parts. GUI part includes testing of the functions of GUI components which are used in the project such as button, panel, text, etc.

6.2.2 Training Mode

This part includes test cases and test plan of Training Mode. Training Mode includes video panel, quiz panel and practice scene. An educative video shall be displayed to the participant and it will be expected from the participant to take a quiz and complete the objectives in the practice scene. Testing of the stated requirements will occur in this document.

6.2.3 Battlefield Mode

This part includes test cases and test plan of Battlefield Mode. In this mode, participant shall explore and interact with the virtual world. Also, the participant shall complete the objectives of the practice part in a different environment. The testing of these requirements will also occur in this document.

6.3 ITEM PASS/FAIL CRITERIA

6.3.1 Exit Criteria

- 100% of the test cases are executed
- 99.9% of the test cases passed
- All High and Medium Priority test cases passed

6.4 REFERENCES

[1] Group10_SRS_100, April 12, 2017

[2] Group10_SDD_100, April 12,2017

6.5 TEST DESIGN SPECIFICATIONS

6.5.1 Graphical User Interface (GUI)

6.5.1.1 Sub features to be tested

6.5.1.1.1 Start Button (GUI.STRT_BTN)

Participant can select a simulation mode with selecting “Start” button. After start button selected, a panel is displayed which includes two different simulation mode buttons.

6.5.1.1.2 Select Training & Battlefield Mode Button (GUI.STBM_BTN)

Participant can choose the simulation mode. If Training Mode is selected Select & Start Technique shall be displayed. If Battlefield Mode is selected Select Battlefield Scenario and Select & Start Technique shall be displayed.

6.5.1.1.3 Admin Login (GUI.ADLG)

Admin have to login to the system by entering password for being able to change question.

6.5.1.1.4 Exit Button (GUI.EXT_BTN)

Participant can close the application with selecting “Exit” button.

6.5.1.1.5 Pause Button (GUI.P_BTN)

Participant can pause simulation by selecting the “Pause” button.

6.5.1.1.6 Continue Button (GUI.CNT_BTN)

Participant can continue simulation by selecting the “Continue” button.

6.5.1.1.7 Change Volume Setting Button (GUI.CVS_BTN)

Participant can change volume by selecting the “Volume Setting” button.

6.5.1.1.8 Display Instruction Button (GUI.DINS_BTN)

Participant can gain information about how to use the simulation with selecting “Display Instruction” button. This button displays a panel which includes instructions about how to use the simulation.

6.5.1.1.9 Select & Start Technique (GUI.SST)

Participant can choose a technique to train by selecting it from the drop-down list and start the simulation by selecting “Start” button.

6.5.1.1.10 Display Result Panel (GUI.DS_PNL)

Participant can display the result which is related to selected mode.

6.5.1.1.11 Select Battlefield Scenario (GUI.SBS)

Participant can choose the battlefield environment from the drop-down list.

6.5.1.1.12 Objective Panel (GUI.OP)

Participant can display Objective Panel by selecting the “Arrow Button” on the right side of the screen.

6.5.1.1.13 Inventory Panel (GUI.IP)

Participant can display Inventory Panel by selecting the “Arrow Button” on the top of the screen.

6.5.1.1.14 Admin Control Add Question (GUI.ADC_ADDQ)

Admins can enter question to the system by entering the content of the question, choices which are A, B, C, D.

6.5.1.1.15 Admin Control Delete Question (GUI.ADC_DELQ)

Admins can delete question from the system by entering the ID of the information from the information list.

6.5.1.1.16 Admin Control Update Question (GUI.ADC_UPDQ)

Admins can update question from the system by entering the ID of the information from the information list.

6.5.1.2 Test Cases

Table 5 Test Cases

TC ID	Requirements	Priority	Scenario Description
GUI.S_STRT_BTN.01	3.2.1	H	Select “START” button. After selecting, mode selection panel will be displayed.

Table 6 Test Cases

TC ID	Requirements	Priority	Scenario Description
GUI.STBM_BTN.01	3.2.1	H	Select "Battlefield Mode" button. After selecting, "Select Battlefield Scenario" and "Select & Start Technique" panels will be displayed.
GUI.STBM_BTN.02	3.2.1	H	Select "Training Mode" button. After selecting, "Select & Start Technique" panel will be displayed.

Table 7 Test Cases

TC ID	Requirements	Priority	Scenario Description
GUI.ADLG.01	3.2.1	L	Enter a valid password.
GUI.ADLG.02	3.2.1	L	Enter an invalid password.

Table 8 Test Cases

TC ID	Requirements	Priority	Scenario Description
GUI.EXT_BTN.01	3.2.1	M	Select "Exit" button. After selecting, the application will be closed.

Table 9 Test Cases

TC ID	Requirements	Priority	Scenario Description
GUI.P_BTN.01	3.2.2	L	Select "Pause" button. After selecting, the simulation will be stopped.

Table 10 Test Cases

TC ID	Requirements	Priority	Scenario Description
GUI.CNT_BTN	3.2.2	L	Select “Continue” button. After selecting, the simulation will continue.

Table 11 Test Cases

TC ID	Requirements	Priority	Scenario Description
GUI.CVS_BTN	3.2.2	L	Select “Change Volume Setting”. After selecting, the volume of the application can be changed.

Table 12 Test Cases

TC ID	Requirements	Priority	Scenario Description
GUI.DINS_BTN	3.2.2	L	Select “Display Instructions” button. After selecting, the panel which explains how to use the simulation.

Table 13 Test Cases

TC ID	Requirements	Priority	Scenario Description
GUI.SST.01	3.2.3	H	Select a technique from drop-down list.
GUI.SST.02	3.2.3	H	Select “Start” button. After selecting, the simulation will be started.

Table 14 Test Cases

TC ID	Requirements	Priority	Scenario Description
GUI.DS_PNL.01	3.2.3	M	If the selected mode is “Training Mode”, then display quiz result.
GUI.DS_PNL.02	3.2.3	M	If the selected mode is “Battlefield Mode”, then display practice result.

Table 15 Test Cases

TC ID	Requirements	Priority	Scenario Description
GUI.SBS.01	3.2.4	H	Select a battlefield scenario from drop-downlist. After selecting, “Select and Start Technique” panel will be displayed.

Table 16 Test Cases

TC ID	Requirements	Priority	Scenario Description
GUI.OP.01	3.2.4	H	Select “Arrow” button from the right side of the screen. After selecting, a panel which displays all the objectives of the technique will be displayed.

Table 17 Test Cases

TC ID	Requirements	Priority	Scenario Description
GUI.IP.01	3.2.4	H	Select “Arrow” button from the top of the screen. After selecting, a panel which displays all the items which the participant possess will be displayed.

Table 18 Test Cases

TC ID	Requirements	Priority	Scenario Description
GUI.ADC_ADD Q.01	3.2.3	M	Enter content, A, B, C, D choices.
GUI.ADC_ADD Q.02	3.2.3	M	Enter content as blank, A, B, C, D choices .
GUI.ADC_ADD Q.03	3.2.3	M	Enter content, one of the A, B, C, D choices as blank.
GUI.ADC_DEL Q.01	3.2.3	M	Delete one of the question by entering a valid ID.
GUI.ADC_DEL Q.02	3.2.3	M	Delete one of the question by entering an invalid ID.
GUI.ADC_UPD Q.01	3.2.3	M	Update the content, A,B,C,D choices by entering a valid ID.

6.5.2 Training Mode (TM)

6.5.2.1 Subfeatures to be tested

6.5.2.1.1 Attend Video (TM.AV)

After the Training Mode is started, the video panel which includes a video that is related with the selected technique shall be displayed.

6.5.2.1.2 Take Quiz (TM.TQ)

After the video ends, the video panel shall be removed and the quiz panel shall be displayed. The quiz panel will include questions and choices that are related with the selected technique. The participant shall try to choose the correct answers for each question.

6.5.2.1.3 Attend Practice (TM.APRAC)

After participant gets a satisfactory result from the quiz, the quiz panel shall be removed and the practice part shall begin. When the practice part begins, “Arrow” buttons which is on the top and the right side of the screen will be displayed. Interaction with these buttons shall allow user to display and remove inventory and objective panels.

6.5.2.1.4 Interact With the Scene (TM.INTWS)

The participant can select an item from the inventory list by selecting a button from the panel. After a button is selected, 3D representation of the item will be displayed on the screen and the participant shall use this item to interact with the objects in the scene.

6.5.2.2 Test Cases

Table 19 Test Cases

TC ID	Requirements	Priority	Scenario Description
TM.AV.01	3.2.3	L	After selecting Training Mode, the video panel will be displayed.
TM.AV.02	3.2.3	L	The video panel will be closed before the video has ended if the participant decides to skip.

Table 20 Test Cases

TC ID	Requirements	Priority	Scenario Description
TM.TQ.01	3.2.3	L	Answer correctly all of the questions before the time is up.
TM.TQ.02	3.2.3	L	Answer incorrectly some of the questions before the time is up.
TM.TQ.03	3.2.3	L	Do not answer a question in time.

Table 21 Test Cases

TC ID	Requirements	Priority	Scenario Description
TM.APRAC.01	3.2.3	M	After the participant receives a satisfactory result from the quiz panel, the practice part shall be started.

Table 22 Test Cases

TC ID	Requirements	Priority	Scenario Description
TM.INTWS.01	3.2.3-3.2.4	H	The participant shall select an item from the inventory list. After selecting, the 3D model of the item will be given to the participant. (Hold Object)
TM.INTWS.02	3.2.3-3.2.4	H	Participant can remove the 3D model of the item. (Drop Objects)

6.5.3 Battlefield Mode (BM)

6.5.3.1 Subfeatures to be tested

6.5.3.1.1 Explore Scene (BM.ES)

User can explore the scene and move on scene. User can walk, jump, sprint and turn.

6.5.3.1.2 Watch Instructive Video (BM.WIV)

After selecting help button, instructive video will occur in the right-down side of the screen. This video will give information about selected medical intervention technique.

6.5.3.2 Test Cases

Table 23 Test Cases

TC ID	Requirements	Priority	Scenario Description
BM.ES.01	3.2.4	H	Press “w” button to move forward.
BM.ES.02	3.2.4	H	Press “s” button to move backward.
BM.ES.03	3.2.4	H	Press “d” button to move to right.
BM.ES.04	3.2.4	H	Press “a” button to move to left.
BM.ES.05	3.2.4	H	Press “shift” button to sprint.
BM.ES.06	3.2.4	M	Press space button to jump.
BM.ES.07	3.2.4	H	Use the mouse to turn.

Table 24 Test Cases

TC ID	Requirements	Priority	Scenario Description
BM.WIV.01	3.2.4	H	After selecting “Help ” button, video occurs on right side of the screen.

6.6 Detailed Test Cases

6.6.1 GUI.S_STRT_BTN.01

Table 25 GUI.S_STRT_BTN.01

TC_ID	GUI.S_STRT_BTN.01
Purpose	Starts mode selection panel correctly.
Requirements	3.2.1
Priority	High
Estimated Time Needed	1 Minutes
Dependency	The simulation is executed.
Setup	The simulation should install on the computer.
Procedure	[A01] Select “Start” button from main menu.
	[V01] Mode selection panel will be displayed on the screen.
Cleanup	Go back to previous page.

6.6.2 GUI.STBM_BTN.01

Table 26 GUI.STBM_BTN.01

TC_ID	GUI.STBM_BTN.01
Purpose	Starts battlefield mode.
Requirements	3.2.1
Priority	High
Estimated Time Needed	1 Minutes
Dependency	Selecting “Start” button which occurs in main menu.
Setup	Battlefield scenario selection panel is prepared.
Procedure	[A01] Select “Battlefield” button from the panel.
	[V01] Select Battlefield Scenario Panel will be displayed on the screen.
Cleanup	Go back to previous page.

6.6.3 GUI.STBM_BTN.02

Table 27 GUI.STBM_BTN.02

TC_ID	GUI.STBM_BTN.02
Purpose	Starts training mode.
Requirements	3.2.1
Priority	High
Estimated Time Needed	1 Minutes
Dependency	Selecting “Start” button which occurs in main menu.
Setup	Training scenario selection panel is prepared.
Procedure	[A01] Select “Training” button from the panel.
	[V01] Start & Select Technique panel will be displayed on the screen.
Cleanup	Go back to previous page.

6.6.4 GUI.ADLG.01

Table 28 GUI.ADLG.01

TC_ID	GUI.ADLG.01
Purpose	Enter a valid password.
Requirements	3.2.1
Priority	Low
Estimated Time Needed	2 Minutes
Dependency	-
Setup	An admin user should be created.
Procedure	[A01] Go to login page.
	[A02] Enter the valid password for the admin.
	[A03] Click on the “Login” button.
	[V01] Observe that the login is successful and the admin page appears.
Cleanup	Exit

6.6.5 GUI.ADLG.02

Table 29 GUI.ADLG.02

TC_ID	GUI.ADLG.02
Purpose	Enter an invalid password.
Requirements	3.2.1
Priority	Low
Estimated Time Needed	2 Minutes
Dependency	-
Setup	An admin user should be created.
Procedure	[A01] Go to login page.
	[A02] Enter the invalid password for the admin.
	[A03] Click on the “Login” button.
	[V01] Observe that “Password is invalid” error message is displayed.
Cleanup	Close admin page.

6.6.6 GUI.EXT_BTN.01

Table 30 GUI.EXT_BTN.01

TC_ID	GUI.EXT_BTN.01
Purpose	Exit from the simulation.
Requirements	3.2.1
Priority	High.
Estimated Time Needed	1 Minutes
Dependency	Battlefield mode should be started.
Setup	Exit button is scripted.
Procedure	[A01] Select “Options” button in the battlefield mode.
	[A02] Select “Exit” button.
	[V01] Verify that program is closed.
	[A03] Start application again.
	[A04] Select “Exit” button from the main menu.
	[V02] Verify that program is closed.

Cleanup	-

6.6.7 GUI.P_BTN.01

Table 31 GUI.P_BTN.01

TC_ID	GUI.P_BTN.01
Purpose	Pause the simulation.
Requirements	3.2.2
Priority	Low
Estimated Time Needed	2 Minutes
Dependency	Battlefield mode should be started.
Setup	The simulation should be started and pause button is scripted.
Procedure	[A01] Select “Options” button.
	[A02] Select “Pause” button.
	[V01] Observe that simulation is paused.
Cleanup	Close options menu.

6.6.8 GUI.CNT_BTN.01

Table 32 GUI.CNT_BTN.01

TC_ID	GUI.CNT_BTN.01
Purpose	Continue the simulation.
Requirements	3.2.2
Priority	Low
Estimated Time Needed	2 Minutes
Dependency	The simulation is in battlefield mode and should be paused.
Setup	The simulation should be started and continue button is scripted.
Procedure	[A01] Select “Options” button.
	[A02] Select “Continue” button.
	[V01] Observe that simulation is continued.
Cleanup	Close options menu.

6.6.9 GUI.CVS_BTN.01

Table 33 GUI.CVS_BTN.01

TC_ID	GUI.CVS_BTN.01
Purpose	Changing the volume setting.
Requirements	3.2.2
Priority	Low
Estimated Time Needed	2 Minutes
Dependency	Battlefield mode should be started.
Setup	The simulation should be started and changing volume is scripted.
Procedure	[A01] Select “Options” button.
	[A02] Select “Change Volume Setting” button.
	[A03] Change the slider position to minimum level.
	[V01] Notice that simulation sound is decreased.
Cleanup	Close options menu.

6.6.10 GUI.DINS_BTN.01

Table 34 GUI.DINS_BTN.01

TC_ID	GUI.DINS_BTN.01
Purpose	Display the instruction panel.
Requirements	3.2.2
Priority	Low
Estimated Time Needed	2 Minutes
Dependency	Battlefield mode should be started.
Setup	The simulation should be started and instruction panel is scripted.
Procedure	[A01] Select “Options” button.
	[A02] Select “Display Instruction” button.
	[V01] Instruction panel occurs in the screen.
Cleanup	Go back to previous page.

6.6.11 GUI.SST.01

Table 35 GUI.SST.01

TC_ID	GUI.SST.01
Purpose	Select proper medical intervention technique.
Requirements	3.2.3
Priority	High
Estimated Time Needed	1 Minutes
Dependency	Select Training & Battlefield Mode Button cases should pass.
Setup	Select technique is scripted.
Procedure	[A01] Select a technique in drop-down list.
	[V01] "Start" button should be visible.
Cleanup	Go back to previous page.

6.6.12 GUI.SST.02

Table 36 GUI.SST.02

TC_ID	GUI.SST.02
Purpose	Start simulation correctly.
Requirements	3.2.3
Priority	High
Estimated Time Needed	1 Minutes
Dependency	Select & Start Technique test case 1 should pass.
Setup	Start button is scripted.
Procedure	[A01] Select "Start" button.
	[V01] Simulation should be started according to selection of mode different simulation will start.
Cleanup	Exit the simulation.

6.6.13 GUI.DS_PNL.01

Table 37 GUI.DS_PNL.01

TC_ID	GUI.DS_PNL.01
Purpose	Display quiz result in training mode.
Requirements	3.2.3
Priority	Medium
Estimated Time Needed	5 Minutes
Dependency	Training mode should be started and video should be finished.
Setup	Quiz question should be loaded the program from txt file.
Procedure	[A01] Answer all of the question.
	[V01] Result of the result should be displayed on the screen.
Cleanup	Pass the practice part.

6.6.14 GUI.DS_PNL.02

Table 38 GUI.DS_PNL.02

TC_ID	GUI.DS_PNL.02
Purpose	Display medical intervention result in battlefield mode.
Requirements	3.2.3
Priority	Medium.
Estimated Time Needed	5 Minutes
Dependency	Treatment should be started in battlefield mode.
Setup	Battlefield mode should be started.
Procedure	[A01] Attend the treatment.
	[A02] Complete treatment according to objective panel.
	[V01] Result of the result of treatment should be displayed on the screen.
Cleanup	Exit.

6.6.15 GUI.SBS.01

Table 39 GUI.SBS.01

TC_ID	GUI.SBS.01
Purpose	Select proper battlefield scenario.
Requirements	3.2.3
Priority	High.
Estimated Time Needed	1 Minutes
Dependency	Selecting Battlefield mode is done.
Setup	Select battlefield scenario is scripted.
Procedure	[A01] Select a scenario in drop-down list.
	[V01] Start & Select Technique panel will be displayed on the screen.
Cleanup	Go back to previous page.

6.6.16 GUI.OP.01

Table 40 GUI.OP.01

TC_ID	GUI.OP.01
Purpose	Display all objectives in the both of modes.
Requirements	3.2.4
Priority	High
Estimated Time Needed	1 Minutes
Dependency	Simulation should be started.
Setup	Objective panel is scripted.
Procedure	[A01] Attend treatment in battlefield mode.
	[A02] Select “Arrow” button from the right side of the screen during the simulation start.
	[V01] Objective panel is displayed on the right side of the screen.
Cleanup	Close objective panel

6.6.17 GUI.IP.01

Table 41 GUI.IP.01

TC_ID	GUI.IP.01
Purpose	Display inventory panel in the both of modes.
Requirements	3.2.4
Priority	High
Estimated Time Needed	1 Minutes
Dependency	Simulation should be started.
Setup	Inventory panel is scripted.
Procedure	[A01] Attend treatment in battlefield mode.
	[A02] Select "Arrow" button from the top of the screen during the simulation start.
	[V01] Inventory panel is displayed on the top of the screen.
Cleanup	Close inventory panel

6.6.18 GUI.ADC_ADDQ.01

Table 42 GUI.ADC_ADDQ.01

TC_ID	GUI.ADC_ADDQ.01
Purpose	Enter content, A, B, C, D choices.
Requirements	3.2.3
Priority	Medium
Estimated Time Needed	5 Minutes
Dependency	Admin login test cases should be passed.
Setup	Login to the system as admin.
Procedure	[A01] Click "Add Question" button from the admin page.
	[V01] Observe that the question page is opened.
	[A02] Enter content.
	[A03] Enter A, B, C and D choices.
	[V02] Observe that "The question saved successfully." message is displayed.

Cleanup	Close question page

6.6.19 GUI.ADC_ADDQ.02

Table 43 GUI.ADC_ADDQ.02

TC_ID	GUI.ADC_ADDQ.02
Purpose	Enter content as blank, A, B, C, D choices.
Requirements	3.2.3
Priority	Medium
Estimated Time Needed	5 Minutes
Dependency	Admin login test cases should pass.
Setup	Login to the system as admin.
Procedure	[A01] Click "Add Question" button from the admin page.
	[V01] Observe that the question page is opened.
	[A02] Not enter content.
	[A03] Enter A,B,C and D choices.
	[V02] Observe that "Content is required!" message is displayed.
Cleanup	Close question page

6.6.20 GUI.ADC_ADDQ.03

Table 44 GUI.ADC_ADDQ.03

TC_ID	GUI.ADC_ADDQ.03
Purpose	Enter content, one of the A, B, C, D choices as blank.
Requirements	3.2.3
Priority	Medium
Estimated Time Needed	5 Minutes
Dependency	Admin login test cases should pass.
Setup	Login to the system as admin.
Procedure	[A01] Click "Add Question" button from the admin page.
	[V01] Observe that the question page is opened.
	[A02] Enter content.
	[A03] Not enter one of the A,B,C, D choices.

	[V02] Observe that “Please enter all the choices!” message is displayed.
Cleanup	Close question page

6.6.21 GUI.ADC_DELQ.01

Table 45 GUI.ADC_DELQ.01

TC_ID	GUI.ADC_DELQ.01
Purpose	Delete one of the question by entering a valid ID.
Requirements	3.2.3
Priority	Medium
Estimated Time Needed	5 Minutes
Dependency	Admin login test cases should pass.
Setup	Login to the system as admin.
Procedure	[A01] Click “Delete Question” button from the admin page.
	[V01] Observe that the list of all question is displayed.
	[A02] Enter a valid question ID.
	[V02] Observe that “Your question is deleted.” message is displayed.
	[V03] Observe that the ID that is chosen is not in the list.
Cleanup	Close delete question page

6.6.22 GUI.ADC_DELQ.02

Table 46 GUI.ADC_DELQ.02

TC_ID	GUI.ADC_DELQ.02
Purpose	Delete one of the question by entering an invalid ID.
Requirements	3.2.3
Priority	Medium
Estimated Time Needed	5 Minutes
Dependency	Admin login test cases should pass.
Setup	Login to the system as admin.

Procedure	[A01] Click “Delete Question” button from the admin page.
	[V01] Observe that the list of all questions is displayed.
	[A02] Enter an invalid question ID.
	[V02] Observe that “Your question ID is invalid!” message is displayed.
Cleanup	Close delete question page

6.6.23 GUI.ADC_UPDQ.01

Table 47 GUI.ADC_UPDQ.01

TC_ID	GUI.ADC_UPDQ.01
Purpose	Update one of the question by entering an valid ID.
Requirements	3.2.3
Priority	Medium
Estimated Time Needed	5 Minutes
Dependency	Admin login test cases should pass.
Setup	Login to the system as admin.
Procedure	[A01] Click “Update Question” button from the admin page.
	[V01] Observe that the list of all questions is displayed.
	[A02] Enter an valid question ID.
	[A03] Enter content.
	[A04] Enter A,B,C and D choices.
	[V02] Observe that “Your question is updated” message is displayed.
Cleanup	Close update question page

6.6.24 TM.AV.01

Table 48 TM.AV.01

TC_ID	TM.AV.01
Purpose	Video panel should be displayed after selecting Training Mode.
Requirements	3.2.3
Priority	Low
Estimated Time Needed	1 Minutes
Dependency	Select & Start Technique test cases should be passed.
Setup	Start training mode.
Procedure	[A01] Start training mode.
	[V01] Observe that video panel is displayed.
Cleanup	Exit

6.6.25 TM.AV.02

Table 49 TM.AV.02

TC_ID	TM.AV.02
Purpose	Video panel should be skipped.
Requirements	3.2.3
Priority	Low
Estimated Time Needed	1 Minutes
Dependency	Video test 1 case should be passed.
Setup	Start training mode.
Procedure	[A01] Press “ESC” button during video played.
	[V01] Observe that video is skipped.
Cleanup	Exit

6.6.26 TM.TQ.01

Table 50 TM.TQ.01

TC_ID	TM.TQ.01
Purpose	Answer correctly all of the questions before the time is up.
Requirements	3.2.3
Priority	Low
Estimated Time Needed	5 Minutes
Dependency	Video test cases should be passed.
Setup	Find the answer of the question from the text file.
Procedure	[A01] Select the correct answer by clicking on it before the time is up.
	[V01] Observe that result panel shows final result of quiz.
Cleanup	Close the question window

6.6.27 TM.TQ.02

Table 51 TM.TQ.02

TC_ID	TM.TQ.02
Purpose	Answer incorrectly some of the questions before the time is up.
Requirements	3.2.3
Priority	Low
Estimated Time Needed	5 Minutes
Dependency	Video test cases should be passed.
Setup	Find the answer of the question from the text file.
Procedure	[A01] Select the incorrect answer by clicking on it before the time is up.
	[V01] Observe that result panel shows final result of quiz.
Cleanup	Close the question window

6.6.28 TM.TQ.03

Table 52 TM.TQ.03

TC_ID	TM.TQ.03
Purpose	Do not answer questions in time.
Requirements	3.2.3
Priority	Low
Estimated Time Needed	5 Minutes
Dependency	Video test cases should be passed.
Setup	Find the answer of the question from the text file.
Procedure	[A01] Do not select one of the answers by clicking on it before the time is up.
	[V01] Observe that result panel shows final result of quiz.
Cleanup	Close the question window

6.6.29 TM.APRAC.01

Table 53 TM.APRAC.01

TC_ID	TM.APRAC.01
Purpose	Start practice in training mode.
Requirements	3.2.3
Priority	Medium
Estimated Time Needed	3 Minutes
Dependency	Take quiz test case 1 should be passed.
Setup	-
Procedure	[A01] Select “proceed” button which is placed into display quiz result panel.
	[V01] Observe that inventory panel, objective panel and wounded person in the middle of the screen appears.
Cleanup	Exit

6.6.30 TM.INTWS.01

Table 54 TM.INTWS.01

TC_ID	TM.INTWS.01
Purpose	Holding object.
Requirements	3.2.3-3.2.4
Priority	High
Estimated Time Needed	5 Minutes
Dependency	Practice of a first-aid technique should be started.
Setup	Simulation should be started.
Procedure	[A01] Select an item from inventory panel.
	[V01] Observe that 3D model of the item is created.
Cleanup	Exit

6.6.31 TM.INTWS.02

Table 55 TM.INTWS.02

TC_ID	TM.INTWS.02
Purpose	Holding object.
Requirements	3.2.3-3.2.4
Priority	High
Estimated Time Needed	5 Minutes
Dependency	Practice of a first-aid technique should be started.
Setup	Simulation should be started.
Procedure	[A01] Drop an item by pressing “ESC” button.
	[V01] Observe that 3D model of the item is removed.
Cleanup	Exit

6.6.32 BM.ES.01

Table 56 BM.ES.01

TC_ID	BM.ES.01
Purpose	Move first person to forward.
Requirements	3.2.4
Priority	High
Estimated Time Needed	3 Minutes
Dependency	Battlefield mode should be started.
Setup	Movement of first person is scripted.
Procedure	[A01] Select “Battlefield Scenario”.
	[A02] Select “Medical Intervention Technique”.
	[V01] Observe that “Start” button is visible.
	[A04] Select “Start” button.
	[A04] Press “w” button.
	[V01] Verify that the first person is moved forward.
Cleanup	Exit

6.6.33 BM.ES.02

Table 57 BM.ES.02

TC_ID	BM.ES.02
Purpose	Move first person to backward.
Requirements	3.2.4
Priority	High
Estimated Time Needed	3 Minutes
Dependency	Battlefield mode should be started.
Setup	Movement of first person is scripted.
Procedure	[A01] Select “Battlefield Scenario”.
	[A02] Select “Medical Intervention Technique”.
	[V01] Observe that “Start” button is visible.
	[A04] Select “Start” button.

	[A04] Press “s” button.
	[V01] Verify that the first person is moved backward.
Cleanup	Exit

6.6.34 BM.ES.03

Table 58 BM.ES.01

TC_ID	BM.ES.01
Purpose	Move first person to move right.
Requirements	3.2.4
Priority	High
Estimated Time Needed	3 Minutes
Dependency	Battlefield mode should be started.
Setup	Movement of first person is scripted.
Procedure	[A01] Select “Battlefield Scenario”.
	[A02] Select “Medical Intervention Technique”.
	[V01] Observe that “Start” button is visible.
	[A04] Select “Start” button.
	[A04] Press “d” button.
	[V01] Verify that the first person is moved right.
Cleanup	Exit

6.6.35 BM.ES.04

Table 59 BM.ES.04

TC_ID	BM.ES.04
Purpose	Move first person to move left.
Requirements	3.2.4
Priority	High
Estimated Time Needed	3 Minutes
Dependency	Battlefield mode should be started.
Setup	Movement of first person is scripted.
Procedure	[A01] Select “Battlefield Scenario”.

	[A02] Select “Medical Intervention Technique”.
	[V01] Observe that “Start” button is visible.
	[A04] Select “Start” button.
	[A04] Press “a” button.
	[V01] Verify that the first person is moved left.
Cleanup	Exit

6.6.36 BM.ES.05

Table 60 BM.ES.05

TC_ID	BM.ES.05
Purpose	Accelerate first person.
Requirements	3.2.4
Priority	High
Estimated Time Needed	3 Minutes
Dependency	Battlefield mode should be started.
Setup	Movement of first person is scripted.
Procedure	[A01] Select “Battlefield Scenario”.
	[A02] Select “Medical Intervention Technique”.
	[V01] Observe that “Start” button is visible.
	[A04] Select “Start” button.
	[A04] Press “Shift” button.
	[V01] Verify that the first person is accelerated.
Cleanup	Exit

6.6.37 BM.ES.06

Table 61 BM.ES.06

TC_ID	BM.ES.06
Purpose	Jump the first person.
Requirements	3.2.4
Priority	High
Estimated Time Needed	3 Minutes

Dependency	Battlefield mode should be started.
Setup	Movement of first person is scripted.
Procedure	[A01] Select “Battlefield Scenario”.
	[A02] Select “Medical Intervention Technique”.
	[V01] Observe that “Start” button is visible.
	[A04] Select “Start” button.
	[A04] Press “space” button.
	[V01] Verify that the first person is jumped.
Cleanup	Exit

6.6.38 BM.ES.07

Table 62 BM.ES.07

TC_ID	BM.ES.07
Purpose	Turn the screen with using mouse.
Requirements	3.2.4
Priority	High
Estimated Time Needed	3 Minutes
Dependency	Battlefield mode should be started.
Setup	Movement of first person is scripted.
Procedure	[A01] Select “Battlefield Scenario”.
	[A02] Select “Medical Intervention Technique”.
	[V01] Observe that “Start” button is visible.
	[A04] Select “Start” button.
	[A04] Move the mouse
	[V01] Verify that the screen is turned by rotating direction.
Cleanup	Exit

6.6.39 BM.WIV.01

Table 63 BM.WIV.01

TC_ID	BM.WIV.01
Purpose	Open the instructive video.

Requirements	3.2.4
Priority	High
Estimated Time Needed	3 Minutes
Dependency	Battlefield mode should be started.
Setup	Instructive video should be loaded the application.
Procedure	[A01] Select “Battlefield Scenario”.
	[A02] Select “Medical Intervention Technique”.
	[V01] Observe that “Start” button is visible.
	[A04] Select “Start” button.
	[A04] Press “Help” button.
	[V01] Observe that a video is displayed on the right side of the screen.
Cleanup	Exit

7. Test Results

7.1 Individual Test Results

Table 64 Individual Test Results

TC ID	Priority	Date Run	Run By	Result	Explanation
GUI.S_STRT_BTN.01	H	15.05.2017	Sedanur Doğan	Pass	Mode selection panel is displayed.
GUI.STBM_BTN.01	H	15.05.2017	Sedanur Doğan	Pass	Battlefield mode is started.
GUI.STBM_BTN.02	H	15.05.2017	Sedanur Doğan	Pass	Training mode is started.
GUI.ADLG.01	L	15.05.2017	Sedanur Doğan	Pass	Admin panel is displayed.
GUI.ADLG.02	L	15.05.2017	Mert Ali Gözcü	Pass	Admin panel is not displayed.

GUI.EXT_BTN.01	H	15.05.2017	Mert Ali Gözcü	Pass	Return the desktop.
GUI.P_BTN.01	L	15.05.2017	Nesil Meşurhan	Pass	Simulation is paused.
GUI.CNT_BTN.01	L	15.05.2017	Mert Ali Gözcü	Pass	Simulation is continued.
GUI.CVS_BTN.01	L	15.05.2017	Nesil Meşurhan	Pass	Volume is changed.
GUI.DINS_BTN.01	L	15.05.2017	Nesil Meşurhan	Pass	Instruction panel is displayed.
GUI.SST.01	H	15.05.2017	Sedanur Doğan	Pass	Medical intervention technique is selected.
GUI.SST.02	H	15.05.2017	Mert Ali Gözcü	Pass	Simulation is started.
GUI.DS_PNL.01	M	15.05.2017	Nesil Meşurhan	Pass	Earned result in training mode is displayed successfully.
GUI.DS_PNL.02	M	15.05.2017	Sedanur Doğan	Pass	Earned result in battlefield mode is displayed successfully.
GUI.SBS.01	H	15.05.2017	Mert Ali Gözcü	Pass	Battlefield scenario is selected from drop down list successfully.
GUI.OP.01	H	15.05.2017	Mert Ali Gözcü	Pass	All objectives are displayed by selecting “Arrow” button from the right side of the screen.
GUI.IP.01	M	15.05.2017	Nesil Meşurhan	Pass	Inventory panel is displayed by selecting “Arrow” button from top of the screen.
GUI.ADC_ADDQ.01	M	15.05.2017	Nesil Meşurhan	Pass	“The question saved successfully” message is displayed.
GUI.ADC_ADDQ.02	M	15.05.2017	Sedanur Doğan	Pass	“Content is required!” message is displayed.
GUI.ADC_ADDQ.03	M	15.05.2017	Sedanur Doğan	Pass	“Please enter all the choices!” message is displayed.
GUI.ADC_DELQ.01	M	15.05.2017	Nesil Meşurhan	Pass	“Your question is deleted.” message is displayed.

GUI.ADC_DELQ.02	M	15.05.2017	Nesil Meşurhan	Pass	"Your question ID is invalid!" message is displayed.
GUI.ADC_UPDQ.01	M	15.05.2017	Nesil Meşurhan	Pass	"Your question is updated" message is displayed.

Table 65 Individual Test Results

TC ID	Priority	Date Run	Run By	Result	Explanation
TM.AV.01	L	15.05.2017	Sedanur Doğan	Pass	Training video is displayed.
TM.AV.02	L	15.05.2017	Mert Ali Gözcü	Pass	Video is skipped and quiz panel is displayed.
TM.TQ.01	L	15.05.2017	Mert Ali Gözcü	Pass	Practice part of simulation is started.
TM.TQ.02	L	15.05.2017	Mert Ali Gözcü	Pass	Quiz part is restarted.
TM.TQ.03	L	15.05.2017	Mert Ali Gözcü	Pass	Quiz part is restarted.
TM.APRAC.01	M	15.05.2017	Nesil Meşurhan	Pass	Practice part is started successfully.
TM.INTWS.01	H	15.05.2017	Nesil Meşurhan	Pass	An item is selected from inventory and it is carried successfully.
TM.INTWS.02	H	15.05.2017	Mert Ali Gözcü	Pass	Carried item is dropped.

Table 66 Individual Test Results

TC ID	Priority	Date Run	Run By	Result	Explanation
BM.ES.01	H	15.05.2017	Nesil Meşurhan	Pass	Player is moved forward.
BM.ES.02	H	15.05.2017	Nesil Meşurhan	Pass	Player is moved backward.
BM.ES.03	H	15.05.2017	Sedanur Doğan	Pass	Player is moved to the right.
BM.ES.04	H	15.05.2017	Sedanur Doğan	Pass	Player is moved to the left.

BM.ES.05	H	15.05.2017	Sedanur Doğan	Pass	Player is moved faster.
BM.ES.06	H	15.05.2017	Mert Ali Gözcü	Pass	Player is jumped.
BM.ES.07	H	15.05.2017	Mert Ali Gözcü	Pass	Player's head is rotated.
BM.WIV.01	H	15.05.2017	Sedanur Doğan	Fail	Instructive videos will be added in the next release.

7.2 Summary of Test Results

Table 67 Test Results

Priority	Number of TCs	Executed	Passed
H	18	18	17
M	10	10	10
L	11	11	11
Total	**39**	**39**	**38**

We have executed 39 test cases and 38 test cases are passed. Also, 17 of high and all of the medium priority test cases are passed. Exit criteria is met.

7.3 Exit Criteria

We have executed all test cases and 97% of test cases are passed. Also, 96% of high and medium priority test cases are passed. Software development activities are completed within the anticipated cost. Software development activities are completed within the anticipated timeline. Exit criteria is met.

Table 68 Exit Criteria

Criteria	Met or Not
100% of the test cases are executed	M
95% of the test cases passed	M
95% of High and Medium Priority test cases passed	M
No high priority or severe bugs are left outstanding.	M

Verify if software development activities are completed within the projected cost.	M
Verify if software development activities are completed within the projected timelines.	M

7.4 Known Problems

All of the instructive videos are not prepared in time. Due to this fact, test case is failed. The problem will be solved when all of the videos are prepared.

7.5 Conclusion

This section includes the test results of the project “Simulacrum: Simulated Virtual Reality for Emergency Medical Intervention in Battle Field Conditions”. The test cases are implemented and 97% of the test cases are completed successfully. Software development activities are completed within the anticipated cost.

Current stage of the project is available to use. Failed test cases will be solved in time in order to increase the quality.

8. Conclusions

This document includes wide information about our project that titled as “Simulacrum: Simulated Virtual Reality for Emergency Medical Intervention in Battle Field Conditions”. In this project, we have aimed to teach medical intervention techniques in battlefield conditions for military personnel. We plan to use latest virtual reality technology product HTC Vive within our project. The purposes of selecting this product are increasing level of immersion and interaction between human and computer using HTC Vive controllers. Also, HTC Vive gives an area to move around to the user unlike most of the VR products.

To develop project, first of all, we have made a lot of research about VR Technology, its usage area and similar projects. We have analyzed the similar projects, and tried to understand what features have made them effective. We have gained a lot of information about VR Technology and how to develop a project that includes VR Technology products. After research part, we have received requirements from a representative of General Staff. Upon these requirements, a SRS document is prepared. After requirements are specified, design of the developing product are prepared and this design is explained in a SDD document. During this period, we have chosen our development methodology, designed the architecture of the product and to present the product to the customer, we have developed a basic prototype of the project.

Result of our research shows that there are not many training programs which aims to teach about medical intervention techniques in battlefield. Already training programs are costly and because of this fact, repeatability of these trainings are low. One of the advantage of our project is to develop a product that can be repeatable often without wasting any resources. Therefore the product can be considered as cost effective. Also, even though the product is developed considering that it will be used with HTC Vive, it does not have any dependency on the HTC Vive and can be worked even if the HTC Vive is not connected to the computer. One of the most important advantage of the developing product is that the product will teach about first aid and medical intervention techniques without any risk of injury. Even though the developing product has many advantages it also has several disadvantages. One of the foreseen problems is creating a realistic environment for the participant. Even though the HTC Vive is a great asset to realism level of the product, the details of the used 3D models in the simulation is rather important as well in this case. Since all the developers in the group are programmers and we cannot receive professional help regarding to 3D model designing whenever we desire, there is a chance that desired level of realism might not be achieved. Another problem is the product will be developed as it can only work with HTC Vive as VR product and HTC Vive is one of the most expensive VR product in the market. But we have aimed to solve this problem partially as we will develop the product which can be worked without any dependency on HTC Vive.

Acknowledgement

We are grateful for guidance we have received from Assist. Prof Dr. Murat Yılmaz and Specialist Ulaş Güleç. The help we received from them was a great asset to improve this project and ourselves.

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