ÇANKAYA UNIVERSITY
FACULTY OF ENGINEERING
COMPUTER ENGINEERING DEPARTMENT

Project Report

Version 2

CENG 408

Innovative System Design and Development II

P2017-03
VRelax: Investigation of Relaxing

Görkem Narinoğlu
201411041
Umut Efiloğlu
201311016

Advisor: *Dr. Faris Serdar Taşel*
Co-Advisor: *Assist. Prof. Dr. Murat Yılmaz*

Table of Contents

Abstract

Anxiety is a crucial disease for the people which is not only a problem that decreasing patients' life quality, but also challenging situation for psychologists who are trying to examine this kind of patients. This project creates an opportunity for psychologists to understand these patients' stressful moments, at the same time, allows patients to relax themselves on their own. Main purpose of this project is to detect participant's stress level and try to reduce stress with relaxing scenarios. Because of the advanced sense of reality that VR headsets provide, VRelax can comfort participants more effectively than trying to comfort the participant via talking with him/her. Project's main working principle is based on voice analysis process that a virtualized system created in a game engine will use this process to maximize utility, so participant shall be able to interact with the environment with different functional capabilities while analyzing stress. These interactions of participant and scenarios make the created world is more realistic to the participant which with this sense of reality makes reducing of stress relatively easy.

Key words:

Virtual Reality, HTC Vive, Voice Analysis, Relaxing Scenario, Investigation of Relaxing

Özet:

Kaygı insanlar için önemli bir rahatsızlıktır ve sadece hastaların yaşam kalitesini düşüren bir sorun değil aynı zamanda bu tür danışanları tedavi etmeye çalışan psikologlar için de zorlu bir durumdur. Bu proje, bu tür rahatsızlığı olan hastaların stresli anlarını analiz etmek için psikologlara bir fırsat yaratmakta, aynı zamanda hastaların kendi başlarına rahatlayabilmelerini sağlamaktadır. Bu projenin temel amacı ise katılımcının stres düzeyini saptamak ve rahatlatıcı senaryolar sayesinde stresi azaltmaya çalışmaktır. VRelax, sanal gerçeklik gözlükleri ile sağlanan gerçeklik duygusu sayesinde katılımcıyı sadece konuşarak rahatlatmaya çalışmaktan daha etkili bir çözüm sunar. Projenin temel çalışma prensibi, bir oyun motoru yardımıyla oluşturulan sanal bir sistemin, yararlılığı en üst düzeye çıkarmak için ses analiz sürecini kullanmaya dayalıdır. Böylece katılımcı, stresi analiz edip ölçerken çevre ile farklı etkileşimlerde bulunabilecektir. Katılımcının senaryolardaki bu etkileşimleri ve senaryoların kendisi, bu yaratılan dünyayı daha gerçekçi kılarak stresin azaltılmasını daha kolaylaştırır.

Anahtar Kelimeler:

Sanal Gerçeklik, HTC Vive, Ses Analizi, Rahatlama Senaryosu, Rahatlamanın İncelenmesi

1. Introduction

1.1 Company Background

Turkey's radical, visionary and domestic IT software company Mebitech Bilişim was founded in 2012. It has taken its place in the market since the day it was founded and improved itself throughout the time according to the requirements of new technology and market. In the corporate risk management applications, with the internationally accredited cloud (Data Center) located in Ankara and Istanbul, large number of customer services like Business Continuity are also provided by Mebitech.

This project is given to us by Özlem Albayrak who works as principal researcher at Mebitech Bilişim.

1.2 Problem Statement

Stimuli cause strong pressure for patients suffering intense anxiety problem. This pressure makes patients so stressful for psychological treatment, as well as, makes hard for patient to handle these stressful moments on his/her own. This project proposes new aspect to treat intense anxiety problem. This project provides the solution for patients to relax themselves on their own and assists psychologists to understand patients' stressful moments. One ability of VRelax is detecting of participant's stress level automatically which also eliminates the need of manual intervention by external system or user and simplifies using of this system. After detecting critical stress interval for participant, VRelax automatically start the relaxation scenario including visual and audio contents.

1.3 Related Work

There are some projects related with both voice analysis and virtual reality interaction, which are used as a guide/contribution/perspective for this project. One of these projects is "Speech Analysis Using Teager Energy Operator" which is also pointed in literature review as: "Teager pointed that analyzing speech signals according to energy required to generate signals." [1]

Another project related with this study is “Speech Stress Analysis based on Lie Detector for Loyalty Test”. This project is also mentioned in our literature review [10]. We have also found products that are directly related with the relaxing VR environment which are Relax VR which uses 360-degree videos to relax users [2], MonarchVR which is a mobile environmental and meditation application that gives the experience of being surrounded by monarch butterflies [3], and Atmosphaeres which are relaxing 360-degree spherical videos that provide relief from stress, anxiety & pain [4].

1.4 Solution Statement

Project aims to develop Unreal Engine VR Application that involves multiple relaxation scenarios to help consultants comfort themselves easily with experiencing their favorite sights and by recognizing their voice; analyze their stress amount and make inferences from it.

The solution for our main problem, stress analysis and reducibility, we will create interactive scenarios that will analyze the stress amount of the participant at the same time. Ability of VRelax is detecting of participant’s stress level automatically that eliminates manual intervention and make opportunity for the psychologists to understand participants stress better.

For the most important difficulties of the project which is creating realistic environment and combining stress analysis structure with these environments, we will search and find realistic objects with low polygons (sacrifice some quality for better performance) and if we cannot find suitable objects or textures, we will create objects and textures with the help of tools like Blender or Substance Painter which we expressed some of these tools throughout this report. Documentations, tutorials and helpful training videos will be useful to apply these solutions.

1.5 Contribution

In our researches we have found no VR application that uses speech recognition and signal processing to measure stress level. According to stress level application makes deductions and suggest suitable actions. It makes relaxing easier and more meaningful with analyzed data. This project could be improved for other psychologic treatments like fears or disorders.

2. Literature Search

2.1 Introduction

VRelax is the virtual reality (VR) project which is developed for patients who suffer exam anxiety. VRelax aims to detect stress level of participant via voice analysis and start the relaxing scenario for stressed participants.

Recent studies -pointed through this review- proved that emotions felt by people, basically, depend on the level of stimuli which indicate the changing of person's emotion. Changing of emotions can be detected by various methods specialized for special purposes. Because, VRelax needs to detect user's voice activity real time; Empirical Mode Decomposition (EMD) is the most appropriate method to detect voice signals. This method -including many different methods- is explained in detailed through this paper.

2.2 What is stress?

In short, stress is the disruption of homeostasis [5]. This disruption can occur for two reasons such as psychological stimuli and physical stimuli. These stimuli can be very different factors around us. High level noise, extremely hot and/or cold degrees can be given as examples to physical stimuli; various emotions and insomnia are examples to psychological stimuli. According to Hans Seyle (2011), stress is divided into three stages:

1. Alarm stage:
    1.1. Body identifies stressor.
    1.2. Adrenaline and cortisol (also known as stress hormone) are produced.
2. Resistance stage:
    2.1. Body tries to handle stress by using its resources.
3. Exhaustion stage:
    3.1. Body's resources are run out [6].

Stress increases muscle tension of all muscles of the body, including vocal chords. Therefore, production of speech is affected directly or indirectly because of tension -which leads effects on physiological microtremor that is present in speech-. Microtremor is, in short, low amplitude oscillation of reflex mechanism, and it controls the tension and the length of

stressed muscle. Microtremor occurs because of finite transmission delay between neurons to/from muscle. With the frequencies of microtremors, stress levels can be classified [6].

2.2.1 Theory of Voice Stress Analysis

There is a basic term for all voice stress analysis processes, which is micro-muscle tremors (MMT). These microtremors also occur in muscles used to generate sound while producing speech. Vibration in 8 to 12 Hz range is valid for every muscle in the body, including vocal chords; and this range points the relaxed (neutral) voice [8]. Analysis process is accomplished by using different databases. The most known database is SUSAS (Speech Under Stress Database). This database includes five domains, consisting of various of stress and emotions. 44 speakers generated 16,000 isolated-word utterances. These five stress domains are:

1) Psychiatric Analysis Data (speech under fear, anxiety, and depression)
2) Talking Styles (fast, slow, soft, angry, loud, question, clear)
3) Single tracking computer response task or speech produced in noise (Lompard effect)
4) Dual tracking computer response task
5) Subject motion-fear tasks (G-force, Lompard effect, noise, fear) [9]

2.3 Similar Works

2.3.1 Speech Analysis Using Teager Energy Operator

Teager pointed that analyzing speech signals according to energy required to generate signals. He also derived a nonlinear energy-tracking operator which is Teager Energy Operator (TEO). According to He, Lech, Memon, and Allen (2008), "The production of a speech signal could be regarded as an effect of amplitude and frequency modulation of separate oscillatory waves in the vocal tract. Therefore, speech signals could be modelled as a combination of several amplitude and frequency modulated (AM-FM) oscillatory components." [1].

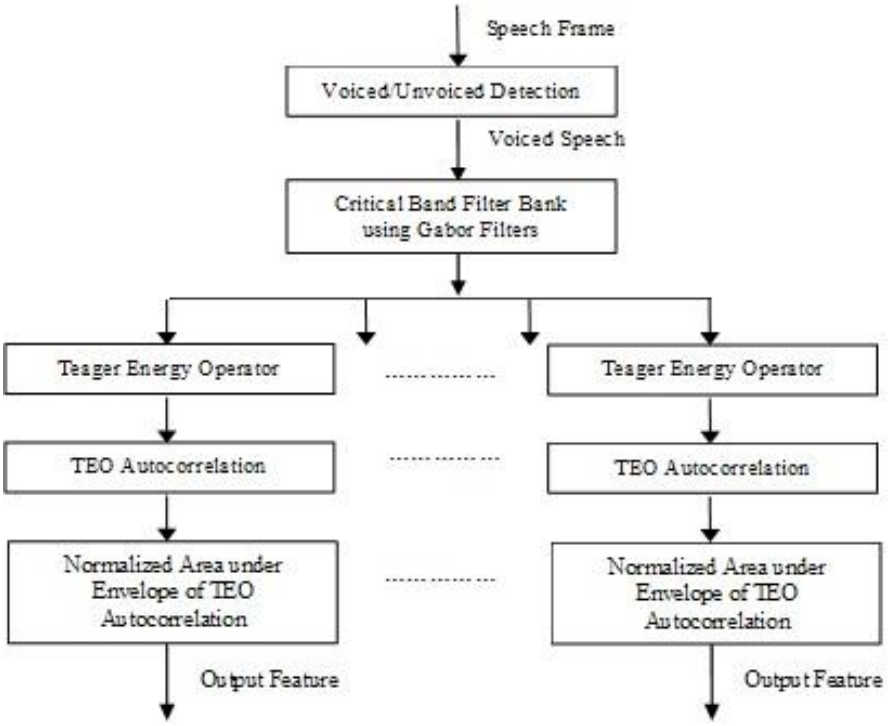


Figure 1: Flowchart of the TEO-CB analysis

2.3.2 Speech Stress Analysis based on Lie Detector for Loyalty Test

Lie detectors are used in especially military-based organizations. Blood pressure, ECG (pulse), EEG, number of eyes blinking per minute, lip movements, leg and hand movements are critical resources to find the result. Software application used for this system is focused on

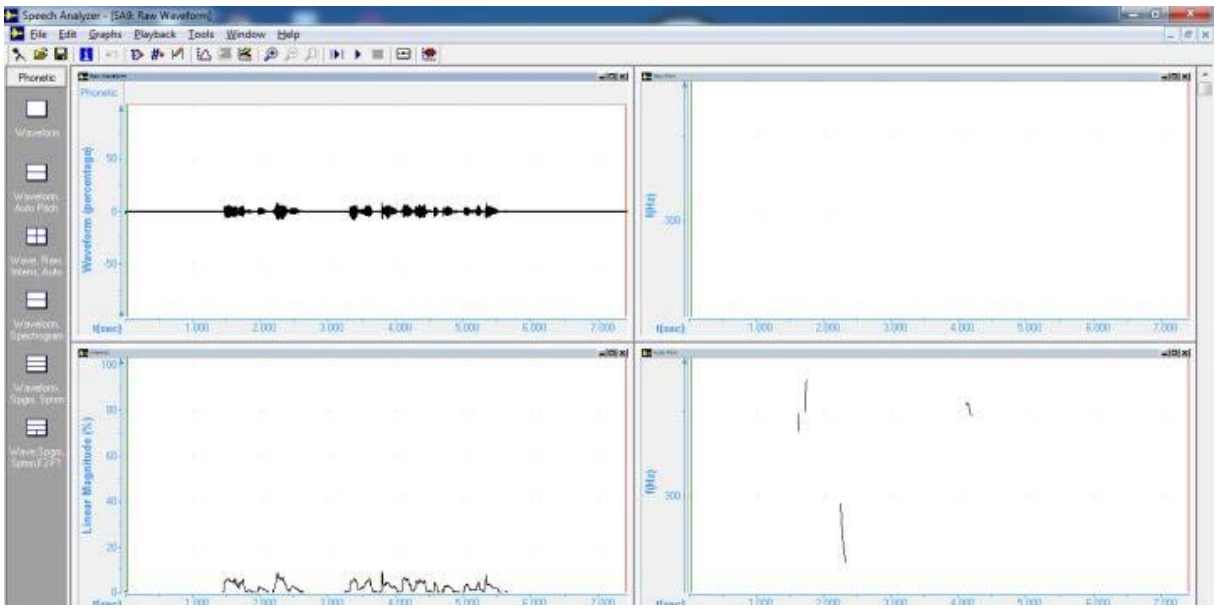


Figure 2: Police Enquiry (Police Voice)

computer network system and neural network of human being [10]. Sample process is shown below:

"Police Enquiry Question: When you plan to rob the cash from the bank? Normal Person: No sir, I came to deposit the cash, in the meanwhile they tried to snatch the cash from the casher. Liar: I was not in the picture." [10]

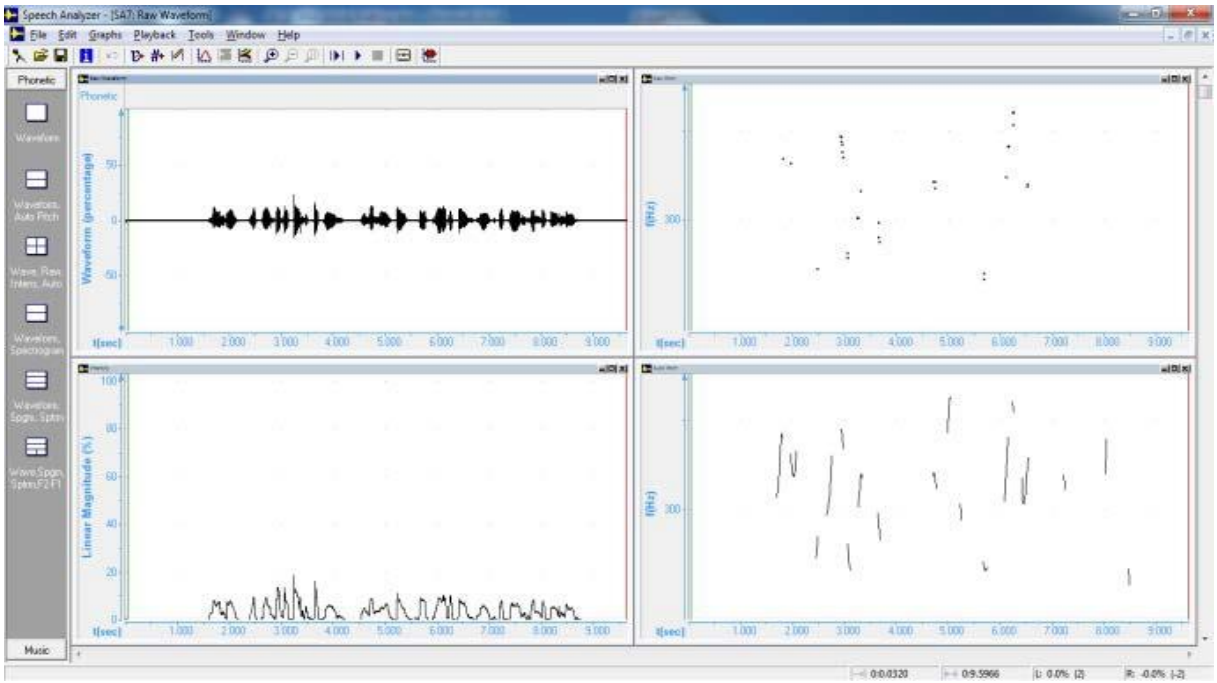


Figure 3: Voice Speech of a Normal Person (Normal Pitch)

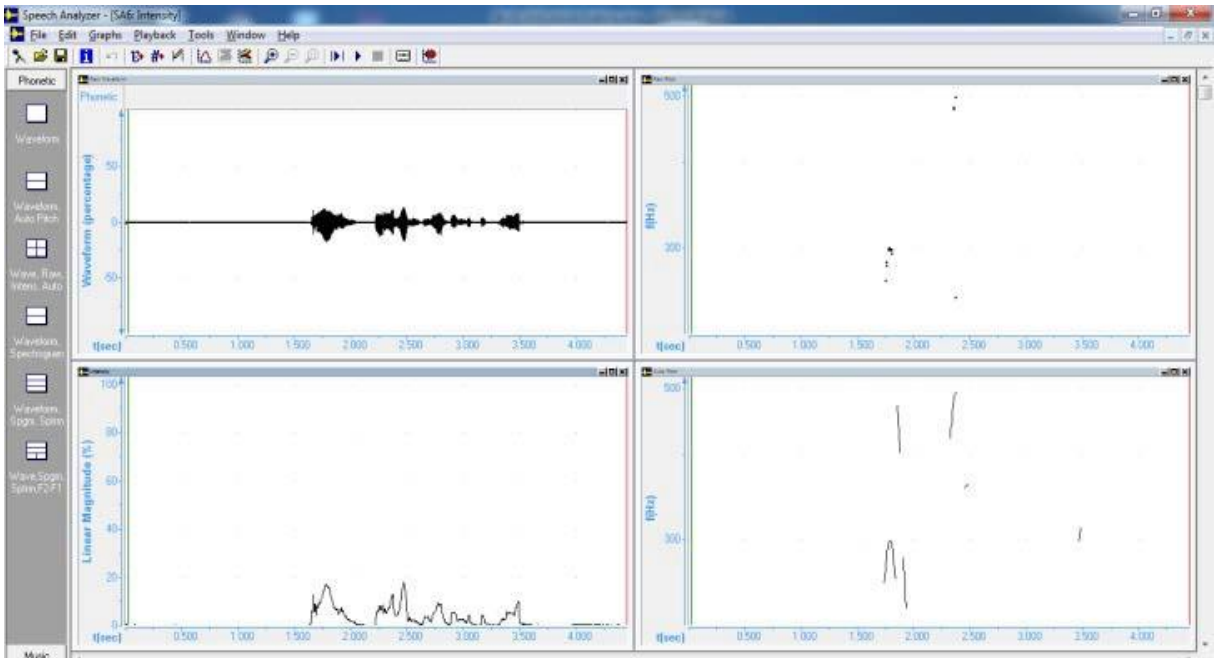


Figure 4: Voice Speech of an Abnormal Person (High Pitch)

2.3.3 Empirical Mode Decomposition

We know that analyzing voice stress is a critical process for various areas like law enforcement and military. While analyzing voice of an individual, we should also consider detection of deception. Therefore, using physiological microtremor with other voice characteristics such as tone and pitch (knowledge of tremors with the signal processing) for VSA (voice stress analysis) products is much more suitable process [6].

EMD (Empirical Mode Decomposition) is based on analyzing physical characteristics of the signal within divided time pieces. These decomposed numerous signals are known as IMFs (Intrinsic Mode Functions). These sets of signals must meet with following two conditions, according to Mbitiru, Tay, Zhang, and Adams [7]:

"1. The number of extrema and number of zero crossings throughout the dataset must either be equal or differ by one at most."

"2. At any point, the mean value of the envelope defined by local maxima and the envelope defined by the local minima is zero."

2.4 Stress in VR Environment

Stress and stress related problems such as fears and anxiety, are most common troubles that people must deal with in their lives. Nowadays, because of the stress that its levels rise for different reasons, the quality of people lives decreases and their personal and professional lives are negatively affected [11]. Virtual reality is used in many therapies in recent years [12] thus it is possible to reduce stress with the use of this technology too [13]. This method is called virtual reality therapy -which is also known as VRET (Virtual Reality Exposure Therapy)- is a kind of occupational or psychological therapy which is used with the technology of virtual reality. In this kind of therapy, patients present in a digitally created environments and complete their special tasks. It is a proved effective way [14] at treating PTSD (Posttraumatic Stress Disorder) as well as widely used as an alternative way of exposure therapy.

Virtual reality therapy has been found useful in many stress related phobias [15] [16] but not all researches met the methodological criteria and it should be noted that none of these studies eliminated stress for all consultant people [17] [18]. Generally, most of them helped to reduce stress and other related anxiety and phobias. According to cyberpsychology science

paper [19], people who suffers from PTSD, experience many different simulation stories throughout the VR therapy session and when participants' traumatic memories triggered, therapists tries to match the virtual environment with the real events. After the examination of which event or stimuli triggered the trauma on the participant, therapists try to calm down the participant and focus the event. With these therapies [19] patients experienced average of %40 decrease on the PTSD that they encounter.

There is a software called "Bravemind" shown in *Figure 5* which is a VR exposure therapy software created at the USC Institute for Creative Technologies [20], consists of several scenarios specifically for post-traumatic stress and distributed to many hospitals, military bases and university centers to produce meaningful reduction in stress related syndromes.

Figure 5: Bravemind Screenshot

There are some ethical and legal problems however according to Yellowlees, Holloway and Parish [24]. Article states that these kinds of applications used in mental health could cause ethical and legal problems due to its different clinical techniques. Treatment standards and ethical guidelines must be applied like that occurring in the real-world. "In any clinical setting, clinicians must follow the laws of their field and other existing guidelines." Security, privacy and confidentiality must be maintained and even if it's a non-real environment and scenario, the patient must be informed of any exception to confidentiality.

2.4.1 Using Game Engine to Create Realistic Environment

Researchers who want to create an environment in VR for the purpose of clinical simulations must deal with some problems [22]. These kinds of simulations require good real-life looking graphics and realistic effects and physics. Creating an entire software platform is hard to do so most of the developers use game engines for creating the world they want. One current engine for VR development that meets all the problems above is Unreal Engine from Epic Games. Unreal Engine is an open source game engine, so developers can edit existing functionalities and create new ones. They can simulate new scenarios or can take a base scenario created by thousands of people on the web.

3. Software Requirements Specification

3.1 Introduction

3.1.1 Purpose

The purpose of this document is describing the VR application which is called VRelax: Investigation of Relaxing. This application aims to reduce stress with relaxation scenarios to help consultants comfort themselves easily with experiencing their favorite sights and by recognizing their voice; analyze their stress amount and make inferences from it to analyze stress better. This document includes detailed information about requirements of the project. It explains user characteristics, software and hardware requirements, interfaces, project development methodologies. This document identifies the concerns of the stakeholders and how users interact with the application.

3.1.2 Scope of Project

Staying calm under effects of strong stimuli is not an easy challenge for patients who suffer intense anxiety problem. This issue makes almost impossible to do psychological treatment under stressful conditions, at the same time, it makes so difficult for patient to maintain these intense stressful situations on his own. This project allows psychologists to understand their stressful moments, and patients to relax themselves on their own.

VRelax aims to detect participant's stress level, and automatically start relaxing scenario. Due to the advanced sense of reality that VR headsets can provide, VRelax can

comfort participants more effectively than trying to comfort the participant via talking with him/her. Because of its advanced technical features according to other VR systems in the market, and its fully functional supportive properties for Unreal Engine; HTC Vive headset is used for this project.

VRelax will automatically detect the stress level of participants via their voice signals. This functionality will eliminate the need of manual intervention by external system or user and simplifies using of this system. After detecting critical stress interval for participant, VRelax automatically start the relaxation scenario including visual and audio contents.

3.1.3 Glossary

Table 1 Glossary of SRS

Term	Definition
Participant	The user who interacts with the simulation environment. Mostly students in this case.
Stakeholders	Person who contributes anything to the project.
Virtual Environment	Computer-generated, three-dimensional representation of a real world.
Virtual Reality (VR)	A realistic and immersive simulation of a three-dimensional environment which the user interacts.
Voice Recognition	The computerized analysis of spoken words to identify the speaker [1].
Voice Stress Analysis (VSA)	Deception of stress measured in the voice using voice recognition.
HTC Vive	Head-mounted virtual reality glasses with motion sensors
Stimuli	An event or a thing that evokes a reaction in a person

3.1.4 References

[1] Dictionary.com "speech recognition," in Dictionary.com Unabridged. Source location: Random House, Inc. http://www.dictionary.com/browse/speech-recognition. Available: http://www.dictionary.com/. Accessed: November 14, 2017.

3.1.5 Overview of Document

The remainder of this document includes two parts. The second part of the document provides overall description about VRelax: Investigation of Relaxing including development methodology and user characteristics. The third part explains functionalities of VRelax: Investigation of Relaxing. Brief descriptions are provided, and use cases explained in detail with diagrams. This section also includes software system attributes described in technical terms.

3.2 Overall Description

3.2.1 Product Perspective

VRelax: Investigation of Relaxing is a VR application that has the purpose of detecting voice signals, analyzing stress from those signals and reduce stress with scenarios created in virtual environment. Application includes different environments to reduce stress and for measuring stress it uses voice signals. The project can be divided into two parts: stress analysis with voice and reducing stress with simulations in VR. Application measures stress from participants voice and tries to reduce it with built-in scenarios.

3.2.2 Development Methodology

For developing our project, we chose to use Scrum which is an agile development methodology. Scrum is based on short cycle output and feedback generations. It aims developing most important requirements for the project and with this methodology we can easily apply changes needed throughout project development process. In Scrum workload is divided into sprints which is limited to one month or less. Every sprint has a definition of a design and stretchable plan that this plan will lead to next plan and eventually, conclusion of the product. Scrum comes with some responsibilities like development team should have a daily meeting for discussing what they did and what they will do next. Scrum allows teams to stay focus, collaborate and communicate more in fast changing project like ours and with these advantages, it is the best development methodology for developing VRelax.

3.2.3 User Characteristic

3.2.3.1 Participants (Generic User)

3.2.3.1.1 Participant must read English language due to stress analyze database is English.

3.2.3.1.2 Participant is expected to be able to use VR Application.

3.2.3.1.3 Participant is expected to be stressed for application to achieve its purpose.

3.2.4 Operating Environment

The application operates on Microsoft Windows and will be exported to HTC Vive as VR application. Early production demos and prototypes work on only Microsoft Windows without VR.

3.3 Requirements Specification

3.3.1 External Interface Requirements

3.3.1.1 User Interfaces

The only user interface the application has is the main menu and the GUI in the scenarios. They both will be built-in to the application and will be worked on Microsoft Windows.

3.3.1.2 Hardware Interfaces

Scenarios requires a powerful PC with external graphics card and an HTC Vive. HTC Vive requires necessary drivers installed for Windows and 1 USB and HDMI port to work.

3.3.1.3 Software Interfaces

There is only operating system to make connection and there is no external software to communicate so there are no external software interface requirements.

3.3.1.4 Communications Interfaces

An internet connection is not required so there is no external communication interface.

3.3.2 Functional Requirements

3.3.2.1 Main Menu Use Case

Use Case:

- Start Voice Test
- Apply Automated Scenario
- Choose Scenario
- Start Selected Scenario
- Change Volume
- Exit

Diagram:

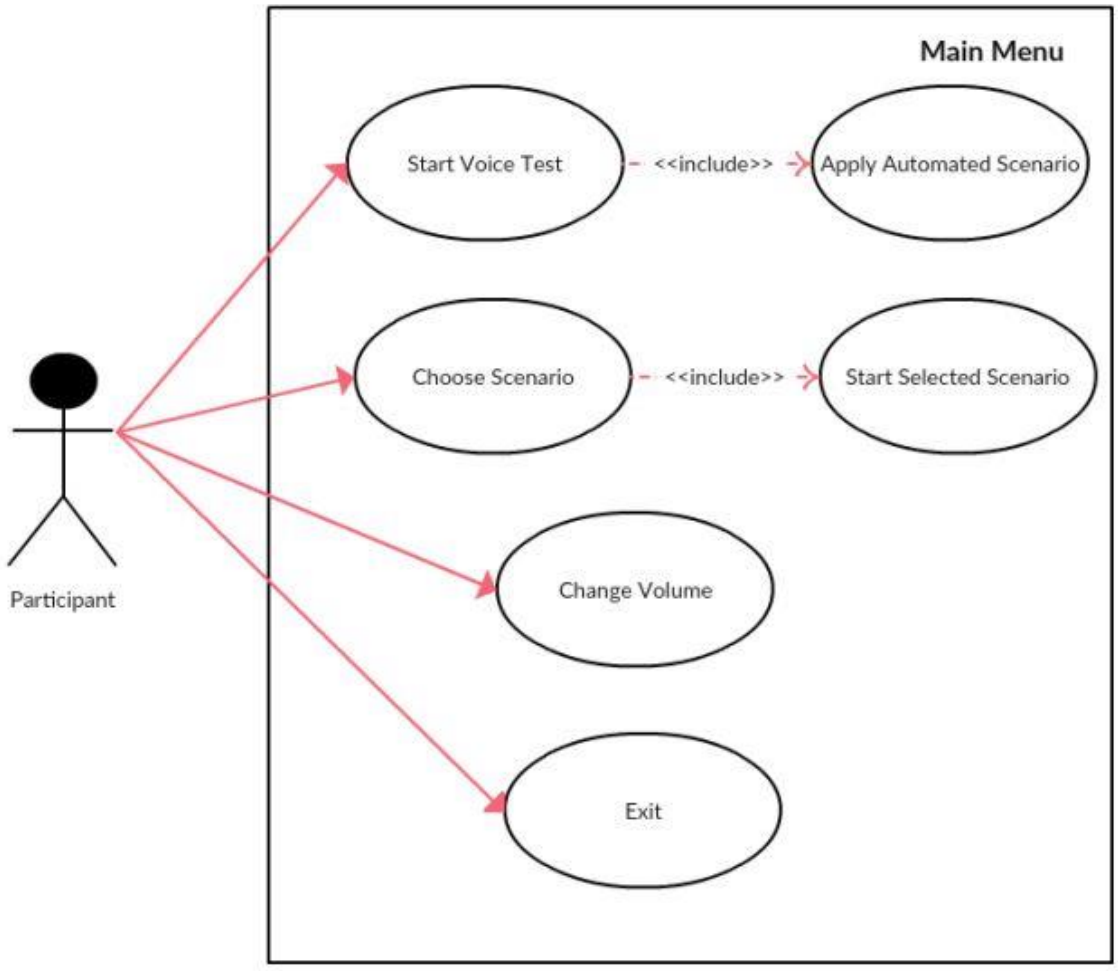


Figure 6: Use Case Diagram of Main Menu

Brief Description:

In the Main Menu Use Case diagram above (*Figure 6*), basic operations -that participant can do- are represented. Participant would choose from four distinct functions (and two additional included function), which are Start Voice Test, Apply Automated Scenario, Choose Scenario, Start Selected Scenario, Change Volume, and Exit functions.

Initial Step by Step Description:

1. Participant shall start voice test to stress analysis.
   1.1. If participant presses Start Voice Test button, then participant shall be redirected to voice test screen.
   1.2. Participant shall apply a scenario that will automatically start if participants stress level crosses the pre-defined level.
2. Participant can choose from two different relaxing scenarios which shall be visible with their thumbnails.
   2.1. Participant shall select the relaxing scenario that s/he desires. Then s/he can start the selected scenario.
3. Participant shall determine the volume level.
   3.1. If participant presses "+" button, voice level shall increase up to maximum voice level.
   3.2. If participant presses "-" button, voice level shall decrease up to minimum voice level.
4. Participant shall exit from the system.
   4.1. If participant presses Exit button, then VRelax: Investigation of Relaxing application shall terminate.

3.3.2.2 Seaside Scenario Use Case

Use Case:

- Throw a Rock
- Show Options Menu
- Resume Scenario
- Start Voice Stress Analysis
- Teleport to a Location

- Exit

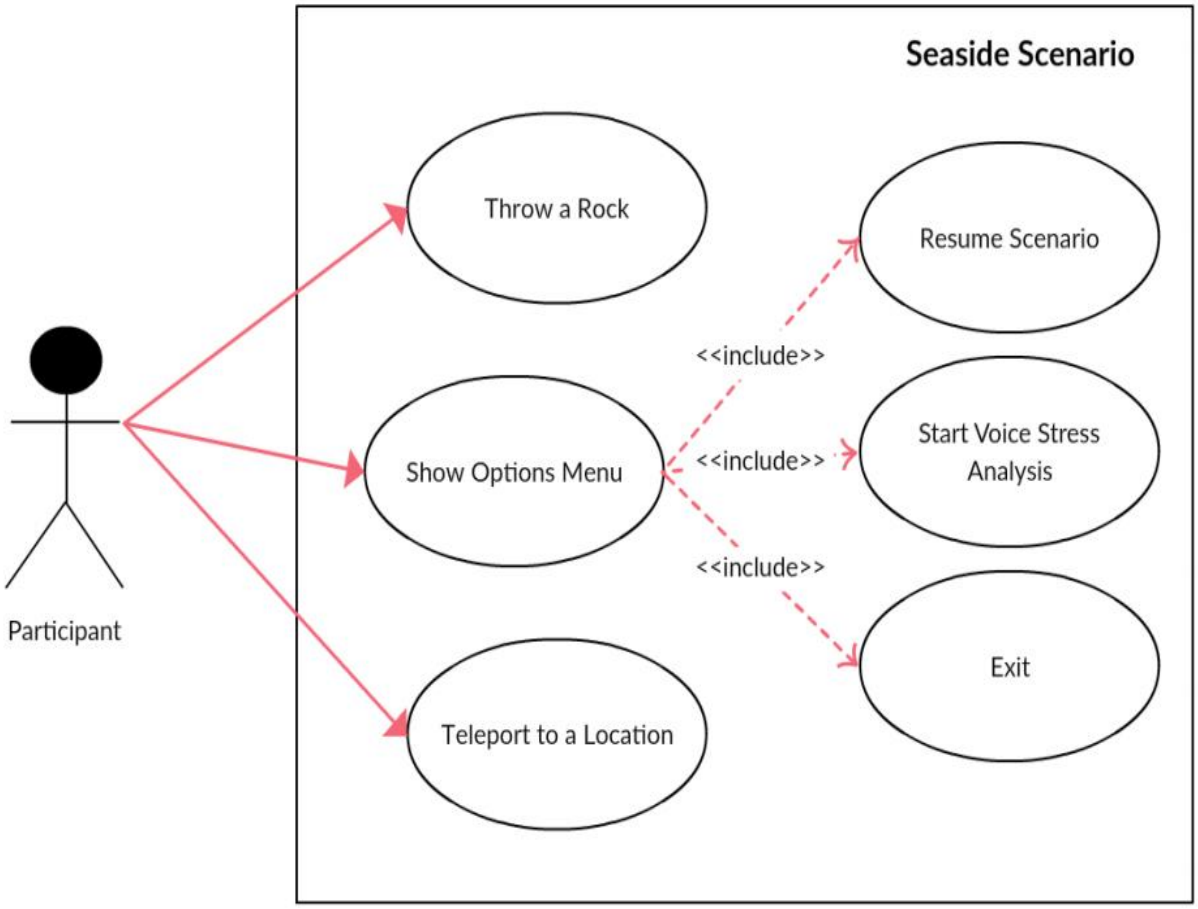


Figure 7: Use Case Diagram of Seaside Scenario

Diagram:

Brief Description:

In the Seaside Scenario Use Case diagram above (*Figure 7*), basic operations -that participant can do- are represented. Participant would choose from three distinct functions (and four additional included function), which are Throw a Rock, Show Options Menu, Resume Scenario, Start Voice Stress Analysis, Exit and Teleport to a Location functions.

Initial Step by Step Description:

1. Participant shall throw a rock into the sea to interact with the environment.
   1.1. Participant can get the rock and throw it by pressing trackpad button.
2. Participant shall open the options menu to access sub-functions.
   2.1. Participant can choose resume scenario to continue with opened scenario.

2.2. Participant can choose start voice stress analysis to enter stress analysis page.

2.3. Participant can choose exit to return main menu.

3. Participant shall teleport to the location that s/he desires.

3.1. If participant holds down the trigger button, a teleport location indicator shall be shown on the virtual environment.

3.2. If participant releases the trigger button, participant shall be teleported to selected location.

3.3.2.3 Creek in a Forest Scenario Use Case

Use Case:

- Collect Fruit
- Eat Fruit
- Show Options Menu
- Resume Scenario
- Start Voice Stress Analysis
- Exit
- Teleport to a Location

Diagram:

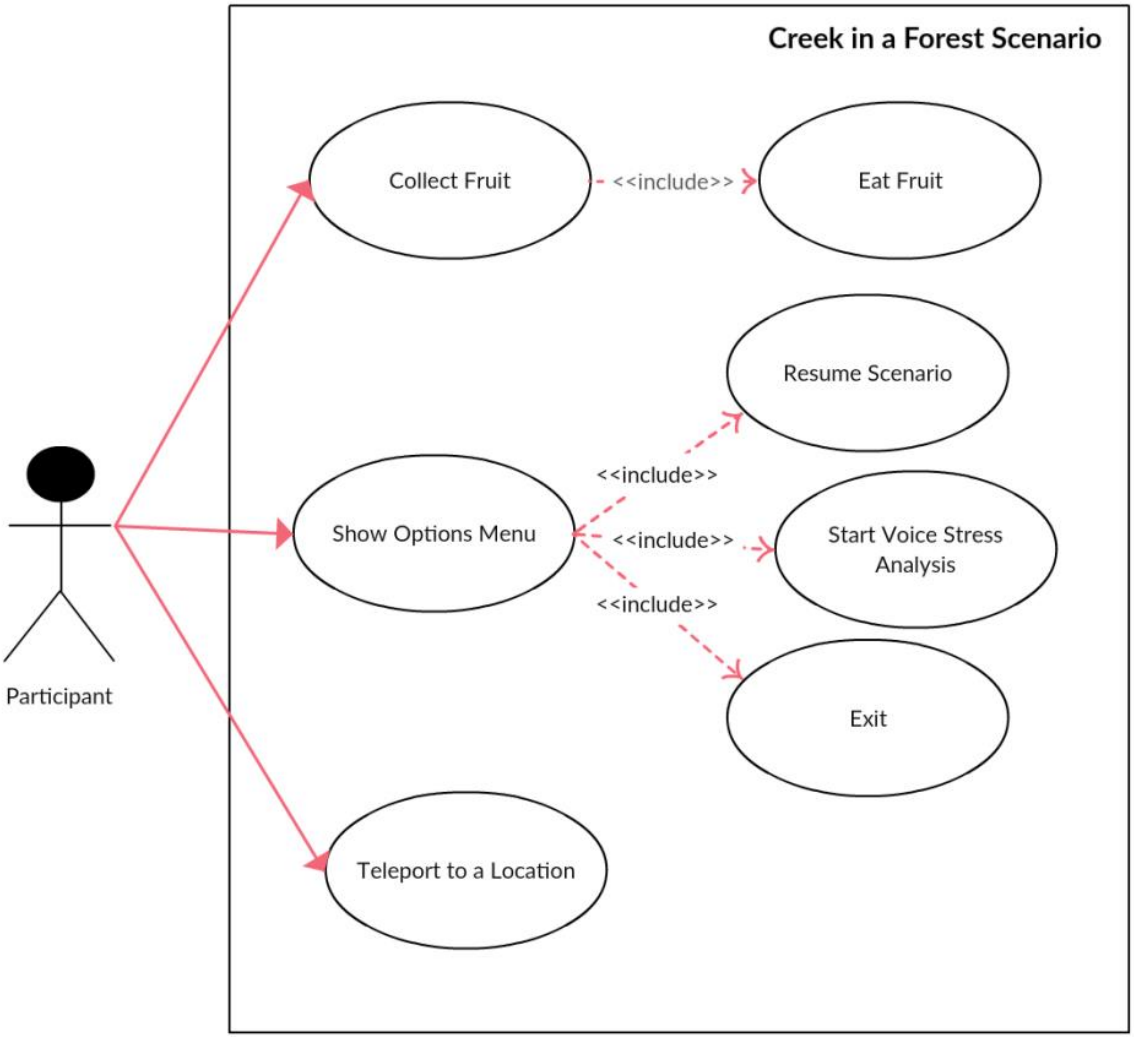


Figure 8: Use Case Diagram of Creek in a Forest Scenario

Brief Description:

In the Creek in a Forest Scenario Use Case diagram above (Figure 3), basic operations -that participant can do- are represented. Participant would choose from three distinct functions (and four additional included function), which are Collect Fruit, Eat Fruit, Show Options Menu, Resume Scenario, Start Voice Stress Analysis, Exit and Teleport to a Location functions.

Initial Step by Step Description:

1. Participant shall collect fruit(s) to interact with the environment.

1.1. If participant doesn't hold the fruit inside his/her hand, s/he shall get the fruit by collecting with teleporting over the fruits in the map.
1.2. If participant holds the fruit inside his/her hand, then s/he shall eat the fruit by pressing trackpad button.

2. Participant shall open the options menu to access sub-functions.
   2.1. Participant can choose resume scenario to continue with opened scenario.
   2.2. Participant can choose start voice stress analysis to enter stress analysis page.
   2.3. Participant can choose exit to return main menu.
3. Participant shall teleport to the location that s/he desires.
   3.1. If participant holds down the trigger button, a teleport location indicator shall be shown on the virtual environment.
   3.2. If participant releases the trigger button, participant shall be teleported to selected location.

3.3.3 Performance Requirements

There are minimum requirements [23] to run an HTC Vive VR application smoothly:

- GPU: NVIDIA GeForce GTX 1060, AMD RX 480 equivalent or better
- CPU: Intel i5-4590/AMD FX 8350 equivalent or better
- RAM: 4 GB or more
- Video output: HDMI 1.4, DisplayPort 1.2 or newer
- USB port: 1x USB 2.0 or better port
- OS: Windows 7 SP1, Windows 8.1 or later, Windows 10

3.3.4 Safety Requirements

When using HTC Vive there should be an open space in the room to prevent any injuries caused by the obstacles and using a VR Headset for a long time can cause dizziness and motion sickness, so participants should take a break after 45 minutes of use.

The product may trigger epileptic seizures or other symptoms linked to an epileptic condition so participants who has a previous history of epilepsy should consult a doctor.

3.3.5 Software System Attributes

3.3.5.1 Portability

- VRelax: Investigation of Relaxing is designed for HTC Vive using Unreal Engine. The application can mainly be used with HTC Vive, but it can work on other VR glasses like Oculus Rift. To do this simple changes and export operations can be integrated to the project with the help of Unreal Engine. Application also works without VR glasses.

3.3.5.2 Usability

- When the scenario started an indicator will show the stress level in real time.
- In the "Creek in the Forest" scenario, amount of fruits will be limited to 100 and only 1 fruit can be held before eating.
- In the "Seaside" scenario, rocks will be unlimited, so the participant can throw as many rocks as s/he wants.

3.3.5.3 Adaptability

- Acquired stress analysis data and the application itself shall be used in partially bound project KAYYEN [24]

3.3.5.4 Scalability

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

3.3.5.5 Performance

- Stress analysis should be finished under 10 minutes in scenarios and voice stress analysis test parts of the system.
- Scale adjustments should be done in different locations in different scenarios.
- Level of detail should be changed according to distance for the sake of optimization.

3.3.5.6 Interoperability

- Future implementations of VRelax: Investigation of Relaxing which its interfaces, functions and configurations are completely understood and finished, should be work with bound project KAYYEN.

4. Software Design Description

4.1 Introduction

4.1.1 Purpose

The purpose of this Software Design Document is providing the details of project titled as “VRelax: Investigation of Relaxing”. This application aims to reduce stress with relaxation scenarios to help consultants comfort themselves easily with experiencing their favorite sights and by recognizing their voice. The target audience is people who suffer intense anxiety problem. This issue makes almost impossible to do psychological treatment under stressful conditions, at the same time, it makes so difficult for patient to maintain these intense stressful situations on his own. This project allows psychologists to understand their stressful moments, and patients to relax themselves on their own.

The purpose of VRelax project is to detect participant’s stress level, and automatically start relaxing scenario. Because of the advanced sense of reality that VR headsets can provide, VRelax can comfort participants more effectively than trying to comfort the participant via talking with him/her. VRelax has two main functions which are “Start Voice Test” and “Start Selected Scenario”. When “Start Voice Test” function is selected, participant shall be redirected to voce test screen to analyze his/her voice via making him/her read the specific words. If participant’s voice is considered as in the critical anxiety level, then -selected or default- relaxing scenario shall start. This auto-transition feature supplies participant/psychologist freedom that s/he does not have to manually start relaxing scenario. Moreover; this feature of determining participant’s stress helps psychologists to understand patient’s reactions to multiple stimuli. When “Start Selected Scenario” function is selected, participant shall be redirected to selected -or default- scenario. According to selected scenario, participant will be able to interact with the environment with different functional capabilities. In the Seaside Scenario; participant can throw a rock to the sea, show or hide words, teleport to the desired

location, and exit from the scenario. In the Creek in a Forest Scenario; participant can collect fruit, show or hide words, teleport to the desired location, and exit from the scenario. These interactions of participant and scenarios make the created world is more real to the participant which makes participant easy to forget the stimulant(stimuli). With this sense of reality, relaxing participant becomes much easier.

This application operates on Microsoft Windows and will be exported to HTC Vive as VR application. HTC Vive fully supports Unreal Engine. Moreover; its wide angle and technical specifications give advantage to HTC Vive according to other VR brands.

For better understanding of this application, this SDD paper include activity diagram, UML diagram, and block diagram.

4.1.2 Scope

This document is a written description of the design of VRelax: Investigation of Relaxing. It contains all relevant information about designing this application.

Creating an entire software platform from scratch is a hard work to do. Especially if it is a system that is a 3D environment including different functions. To create a such thing, developers must create models, animations, physics of objects, AI of characters and also, they have to manage memory and threading processes manually. Game engines satisfies these needs to save the developers a huge workload, and project management becomes easier with fewer code writings. It facilitates the production of the game with the easy user interfaces. In our project we chose Unreal Engine [1] because it’s an open source program and it can create immersivity beautiful environments with its built-in shadow rendering. It supports C++ programming language, so we used those two to create functions, environmental elements and interfaces.

For 3D models, we used Blender 3D because it is an open source modeling tool and it has an easy to use interface, it supports rigging, simulation and animation creation [2]. We also used free assets and models from internet as long as models harmonize with the intended environment.

For creating materials and painting objects to create realistic look we may use substance painter. It is not essential to the project because of a limited time but with substance painter objects could look gorgeous to eyes.

Coding is a part of our project which we used C/C++ languages to implement voice stress analysis tool into our scenarios and to do that we used MATLAB and Visual Studio development tools. We followed algorithms and techniques and use SUSAS database both mentioned on literature review. Participant read the shown words in the app (can both be in scenario or voice test sections) to determine stress level.

Lastly, the VR system which we will be using is HTC Vive. Participants will use dedicated buttons in HTC Vive controller to do some actions. Before implementing the project to VR, we will create a Windows application then export and test it on VR to adjust scale of objects and optimize it to avoid unintended actions.

4.1.3 Glossary

Table 2 Glossary of SDD

Term	Definition
Block Diagram	Schema that components of the system categorized and shown in blocks
HTC Vive	Head-mounted virtual reality glasses with motion sensors
Participant	The user who interacts with the simulation environment. Mostly students in this case
SDD	Software Design Document
MATLAB	Program to calculate mathematical operations and functions
Virtual Environment (VR)	A realistic and immersive simulation of a three-dimensional environment which the user interacts.
Stimuli	An event or a thing that evokes a reaction in a person.

GUI	Graphical User Interface
AI	Artificial Intelligence

4.1.4 Motivation

We are two senior students in computer engineering who are interested in serious games. Our aim is to create combination of VR environment and voice analysis process. We both worked on a project called KAYYEN [21] which is like a preliminary project to our project and we both have taken the innovative game design course to understand gaming field better. In our internship we have worked on Unity Engine which is another game engine, used Blender and Substance Painter which we will make good use of them. Due to our ability to work on these texturing and modeling tools, we aware of the virtual environment objects which gives us to prepare our work more realistic. From time to time, we will also get support and consultancy from Mebitech which is the proposer company.

4.1.5 Overview of Document

The remainder of this document includes five parts. Section 2 is the Architectural Design which describes use cases in terms of conditions and basic sequences and priorities. Also, it contains class diagram of the system to understand variables reside in the system. Additionally, this section includes activity diagram of the entire VRelax application.

In the Section 3, a block diagram of the system displayed and explained briefly according to systems and sub-systems.

Section 4 is related to human interface design. In this section, we have shown user interfaces of menus and scenarios. Also, we briefly explained which functions can be accessed in these user interfaces.

Section 5 is references, and Section 6 is appendices to provide supporting details.

4.1.6 References

[1] "Game Engine Technology by Unreal", Unrealengine.com, 2017. [Online]. Available: https://www.unrealengine.com/en-US/what-is-unreal-engine-4. [Accessed: 16- Dec- 2017].

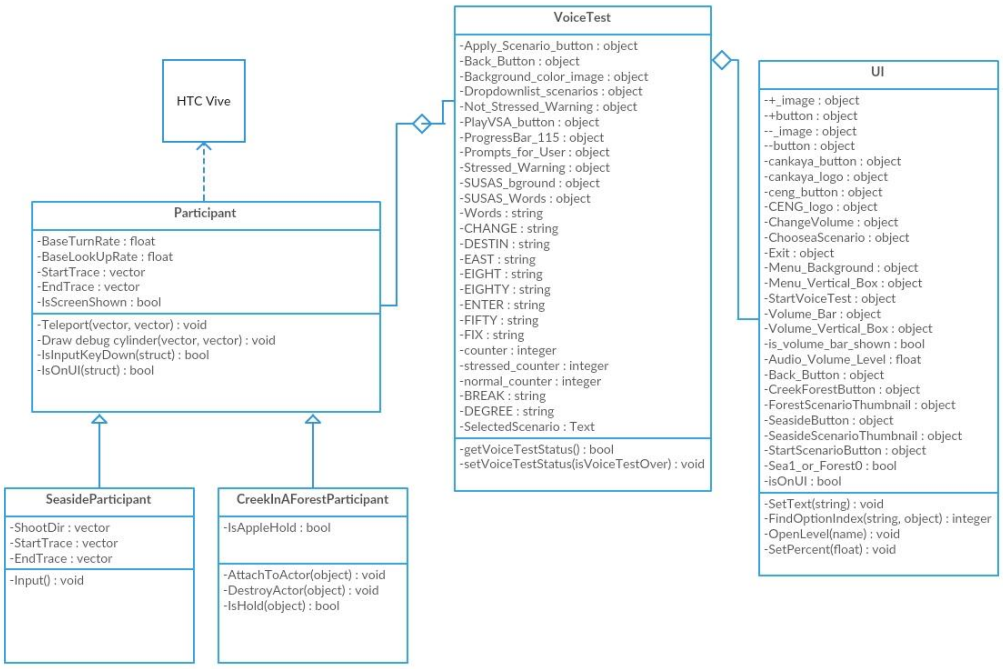


Figure 9: Class Diagram of VRelax

[2] B.Foundation, "About – blender.org", blender.org, 2016. [Online]. Available: https://www.blender.org/about/. [Accessed: 16-Dec-2017].

4.2 Architecture Design

4.2.1 Class Diagram

Figure 9 displays information about connections between the systems within the VRelax project. VoiceTest class decides the system's flow by determining participant's stress level. Participant class stands to represent the user of this system, who shall have the HTC Vive required for using the system. Participant shall have different functions in different scenarios which is shown via two separated classes -they are inherited from Participant Class- SeasideParticipant and CreekInAForestParticipant. UI Class represents the simple functions -affecting user interface- that user shall do in anyone of three scenes which are either scenarios or Voice Test screen. Scenario-dependent functions are specified in each Participant type -SeasideParticipant and CreekInAForestParticipant-.

4.2.2 Architecture Design of VRelax

4.2.2.1 Main Menu

Summary: This system is used by participant. Participant can start voice test, apply automated scenario, choose scenario, start selected scenario, change volume, and exit from the system.

Actor: Participant

Precondition: Participant must run the application with appropriate devices.

Basic Sequence:

1. Participant can start voice test by pressing “Start Voice Test” button from main menu. Participant shall "Apply Automated Scenario" before starting analysis. Applied scenario will automatically start if participants stress level crosses the pre-defined level. Participant shall press play button to start analysis.
2. Participant can choose the scenario that s/he want, by pressing “Choose Scenario” button from main menu. Participant, after choosing the scenario, can start selected scenario by pressing “Start Selected Scenario” button which will be functional after choosing the scenario.
3. Participant can change the default volume level by pressing “Change Volume” button from main menu.
4. Participant can exit from the system by pressing “Exit” button from main menu.

Exception: None

Post Conditions: None

Priority: Low

4.2.2.2 Seaside Scenario

Summary: This system is used by participant. Participant can throw a Rock, Show Options Menu, Resume Scenario, Start Voice Stress Analysis, Exit from the scenario and Teleport to a Location.

Actor: Participant

Precondition: Seaside Scenario must be started automatically or manually.

Basic Sequence:

1. Participant can get the rock and throw it by pressing trackpad button. Participant shall aim where to throw.
2. Participant can teleport to a location by using the trigger button, if participant holds down the trigger button, teleport location indicator will be shown on the virtual environment; if participant releases the button, then s/he will be teleported to the selected location.
3. Participant can open the options menu by pressing bound key/trigger.
4. Participant can resume the scenario by pressing "Resume Scenario" button.
5. Participant can start analysis by entering stress analysis page with “Start Voice Stress Analysis” button.
6. Participant can go to main menu by pressing “Exit” button.

Exception: None

Post Conditions: None

Priority: High

4.2.2.3 Creek in a Forest Scenario

Summary: This system is used by participant. Participant can collect fruit, eat fruit, Show Options Menu, Resume Scenario, Start Voice Stress Analysis, Exit from the scenario and Teleport to a Location.

Actor: Participant

Precondition: Creek in a Forest Scenario must be started automatically or manually.

Basic Sequence:

1. Participant can collect the fruit by teleporting over a fruit, if s/he does not hold the fruit inside his/her hand.
2. Participant can eat the fruit by pressing trackpad button, if s/he holds the fruit inside his/her hand.
3. Participant can teleport to a location by using the trigger button: if participant holds down the trigger button, teleport location indicator will be shown on the virtual environment; if participant releases the button, then s/he will be teleported to the selected location.
4. Participant can open the options menu by pressing bound key/trigger.
5. Participant can resume the scenario by pressing "Resume Scenario" button.
6. Participant can start analysis by entering stress analysis page with “Start Voice Stress Analysis” button.
7. Participant can go to main menu by pressing “Exit” button.

Exception: None

Post Conditions: None

Priority: High

4.2.3 Activity Diagram

Figure 10 shows how the entire VRelax application works as an activity diagram. When the application starts, participant shall have three options to choose, which are starting the voice

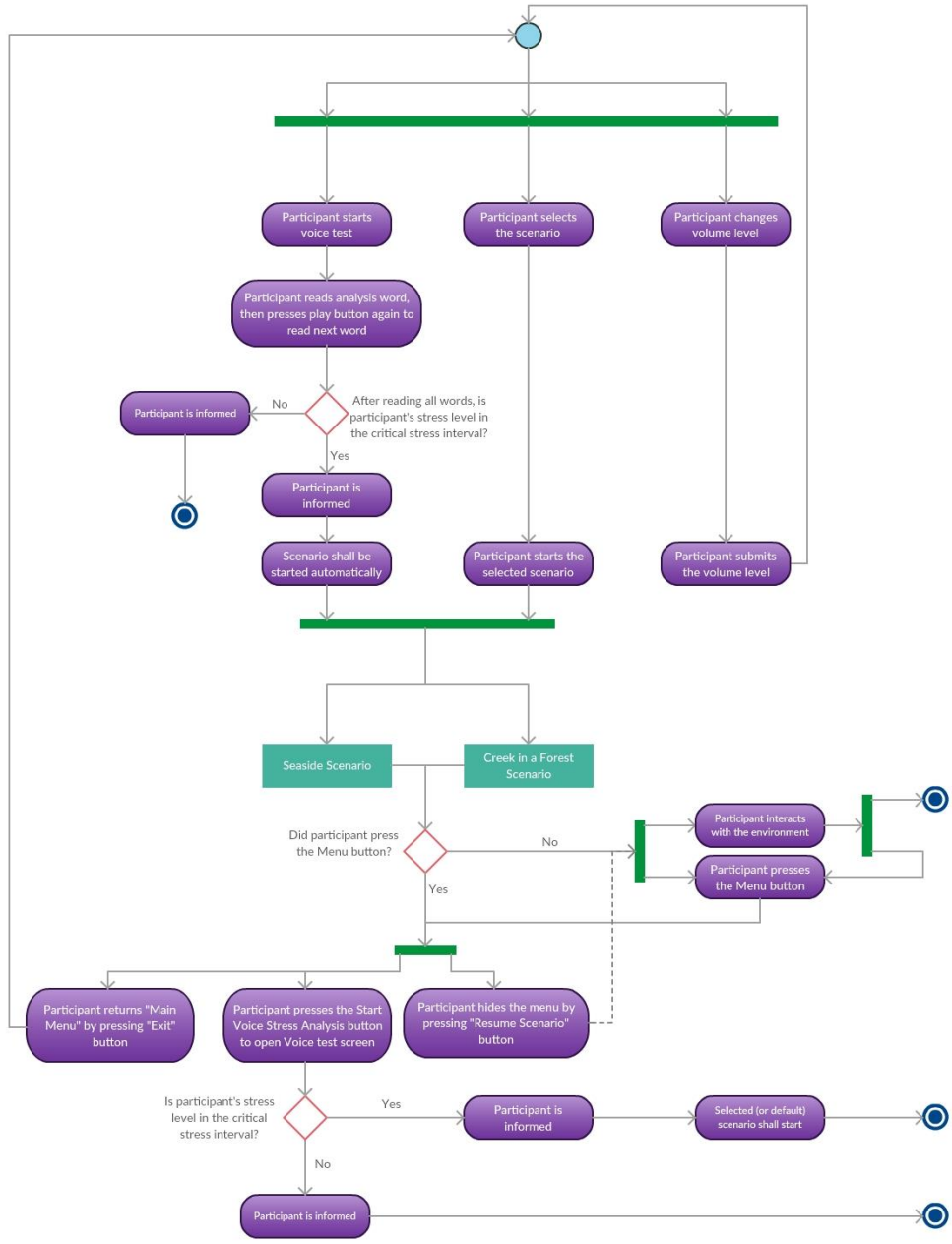


Figure 10: Activity Diagram of VRelax

test, selecting the scenario, and changing the volume level. If participant chooses to start the voice test, the s/he shall be directed to the voice test screen. In this screen, participant shall read the analysis words which shall be chosen according to specified analysis database. If participant's stress level is in the critical stress interval, then s/he shall be informed about his/her

stress level which is followed by that selected (or default) scenario shall be started. If participant's stress level is not in the critical stress interval, then s/he shall be informed about his/her stress level.

If participant chooses to select the scenario, the s/he shall be directed to the selection screen which contains the two relaxing scenarios, s/he then can start the selected scenario manually.

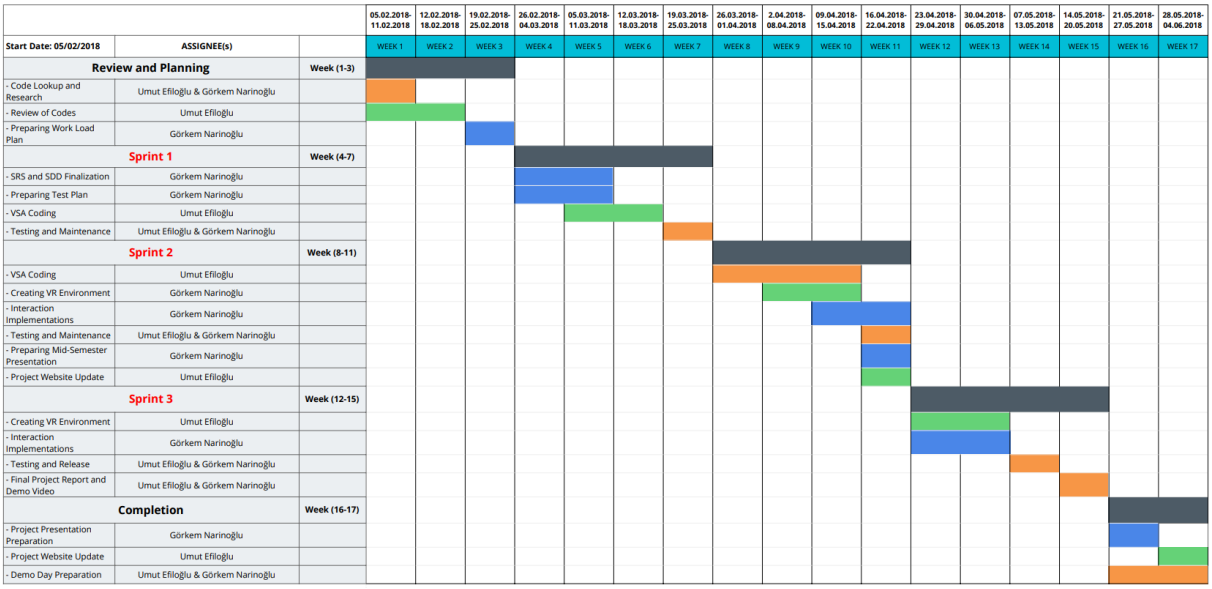
If participant chooses to change the volume level, then s/he shall be redirected to the volume option screen which includes the buttons to adjust the volume level. When s/he submits the volume level, then s/he shall be redirected to the main menu.

Started scenario can be either "Seaside Scenario" or "Creek in a Forest Scenario". When one of these scenarios is opened, voice analysis screen shall be hidden in default.

If participant chooses to interact with the environment, s/he shall have two options. One option is (theoretically) to interact with the environment forever. Other option is pressing the menu button to choose the voice analysis screen from this menu. This option could be chosen after interacting with the environment.

If menu is visible in the scenario, then participant shall have three options. One option is to hide the menu which shall take the participant to the step after negative answer of the nearest (previous) question. Other option is starting the voice analysis again by pressing the "Start Voice Stress Analysis" button, which shall end with re-evaluating the participant's stress level. If participant's stress level is in the critical stress interval, then s/he shall be informed about his/her stress level which is followed by that selected (or default) scenario shall be started. If participant's stress level is not in the critical stress interval, then s/he shall be informed about his/her stress level. Last option is "Exit" button which shall re-direct participant to the "Main Menu".

4.2.4 Work Load Table



Start Date: 05/02/2018	ASSIGNEE(s)		05.02.2018-11.02.2018 WEEK 1	12.02.2018-18.02.2018 WEEK 2	19.02.2018-25.02.2018 WEEK 3	26.02.2018-04.03.2018 WEEK 4	05.03.2018-11.03.2018 WEEK 5	12.03.2018-18.03.2018 WEEK 6	19.03.2018-25.03.2018 WEEK 7	26.03.2018-01.04.2018 WEEK 8	2.04.2018-08.04.2018 WEEK 9	09.04.2018-15.04.2018 WEEK 10	16.04.2018-22.04.2018 WEEK 11	23.04.2018-29.04.2018 WEEK 12	30.04.2018-06.05.2018 WEEK 13	07.05.2018-13.05.2018 WEEK 14	14.05.2018-20.05.2018 WEEK 15	21.05.2018-27.05.2018 WEEK 16	28.05.2018-04.06.2018 WEEK 17
Review and Planning		**Week (1-3)**																	
- Code Lookup and Research	Umut Efiloğlu & Görkem Narinoğlu																		
- Review of Codes	Umut Efiloğlu																		
- Preparing Work Load Plan	Görkem Narinoğlu																		
Sprint 1		**Week (4-7)**																	
- SRS and SDD Finalization	Görkem Narinoğlu																		
- Preparing Test Plan	Görkem Narinoğlu																		
- VSA Coding	Umut Efiloğlu																		
- Testing and Maintenance	Umut Efiloğlu & Görkem Narinoğlu																		
Sprint 2		**Week (8-11)**																	
- VSA Coding	Umut Efiloğlu																		
- Creating VR Environment	Görkem Narinoğlu																		
- Interaction Implementations	Görkem Narinoğlu																		
- Testing and Maintenance	Umut Efiloğlu & Görkem Narinoğlu																		
- Preparing Mid-Semester Presentation	Görkem Narinoğlu																		
- Project Website Update	Umut Efiloğlu																		
Sprint 3		**Week (12-15)**																	
- Creating VR Environment	Umut Efiloğlu																		
- Interaction Implementations	Görkem Narinoğlu																		
- Testing and Release	Umut Efiloğlu & Görkem Narinoğlu																		
- Final Project Report and Demo Video	Umut Efiloğlu & Görkem Narinoğlu																		
Completion		**Week (16-17)**																	
- Project Presentation Preparation	Görkem Narinoğlu																		
- Project Website Update	Umut Efiloğlu																		
- Demo Day Preparation	Umut Efiloğlu & Görkem Narinoğlu																		

Figure 11: Gantt Chart of Work Plan

Planning a large-scale project is important because that way we can complete different tasks in time. Gantt Chart in Figure 11 represents whole development plan of the project. It includes two parts. Introduction/Conclusion and Sprint parts. Every sprint has 27 days and at the end of the all sprints there is a testing task. We have also created a table that explains the main tasks briefly and shows the assignee of the tasks. Most of the time we have worked together on the same task but there are some cases we finished different tasks at the same time.

Work Package	Brief Description	Assignee(s)
Code Lookup and Research	Reviewing similar project codes, researching SUSAS database .wav files and trying to use the files.	Umut Efiloğlu & Görkem Narinoğlu
Review of Codes	Compiling and running similar Github projects that have been found.	Umut Efiloğlu
Preparing Work Load Plan	Writing down work packages and workloads for the project group. Editing SDD according to the work plan.	Görkem Narinoğlu

SRS and SDD Finalization	Revision of SDD and SRS according to the requirement and design changes.	Görkem Narinoğlu
Preparing Test Plan	Planning test cases and documenting them as Test Design Specifications.	Görkem Narinoğlu
VSA Coding (Sprint 1)	Creating stress analyzer application: implementing SUSAS database .wav files, usage of libraries and creating IMFs via EMD then proceed with Hilbert Transform.	Umut Efiloğlu
Testing and Maintenance (Sprint 1)	Testing fundamental modules and functions of first version VSA code piece, and bug fixes. Documenting of test results.	Umut Efiloğlu & Görkem Narinoğlu
VSA Coding (Sprint 2)	Creating stress analyzer application: GUI design, UE implementation attempts, finalizing VSA structure.	Umut Efiloğlu
Creating VR Environment (Sprint 2)	Creating scene, 3d objects, combining textures, materials and objects. Searching free to use materials and assets for the project.	Görkem Narinoğlu
Interaction Implementations (Sprint 2)	Creating and implementing actions and interactions like teleporting, eating fruit or throwing rock etc.	Görkem Narinoğlu
Testing and Maintenance (Sprint 2)	Testing VSA structure with all its modules, testing reliability of the structure, testing first version of VR Environment in desktop mode. Documenting of test results.	Umut Efiloğlu & Görkem Narinoğlu
Preparing Mid-Semester Presentation	Preparing short presentation to show what have been done so far and plans of future work.	Görkem Narinoğlu

Project Website Update	Adding updated stuff and editing existing ones on project website created in Wordpress.	Umut Efiloğlu
Creating VR Environment (Sprint 3)	Adding lightning, shadows and post processing effects to create depth and increase visual quality. Scaling objects and textures.	Umut Efiloğlu
Interaction Implementations (Sprint 3)	Implementing object physics and editing pre-configured action.	Görkem Narinoğlu
Testing and Release	Testing final product, bug fixes, documentation of final test results.	Umut Efiloğlu & Görkem Narinoğlu
Final Project Report and Demo Video	Preparing final project report and creating short demo video. Uploading it to YouTube.	Umut Efiloğlu & Görkem Narinoğlu
Project Presentation Preparation	Preparation and rehearsal of final presentation.	Görkem Narinoğlu
Project Website Update	Finalizing the website with adding final versions of the documents, screenshots and demo video.	Umut Efiloğlu
Demo Day Preparation	Final preparations of presenting the demo	Umut Efiloğlu & Görkem Narinoğlu

4.3 Use Case Realizations

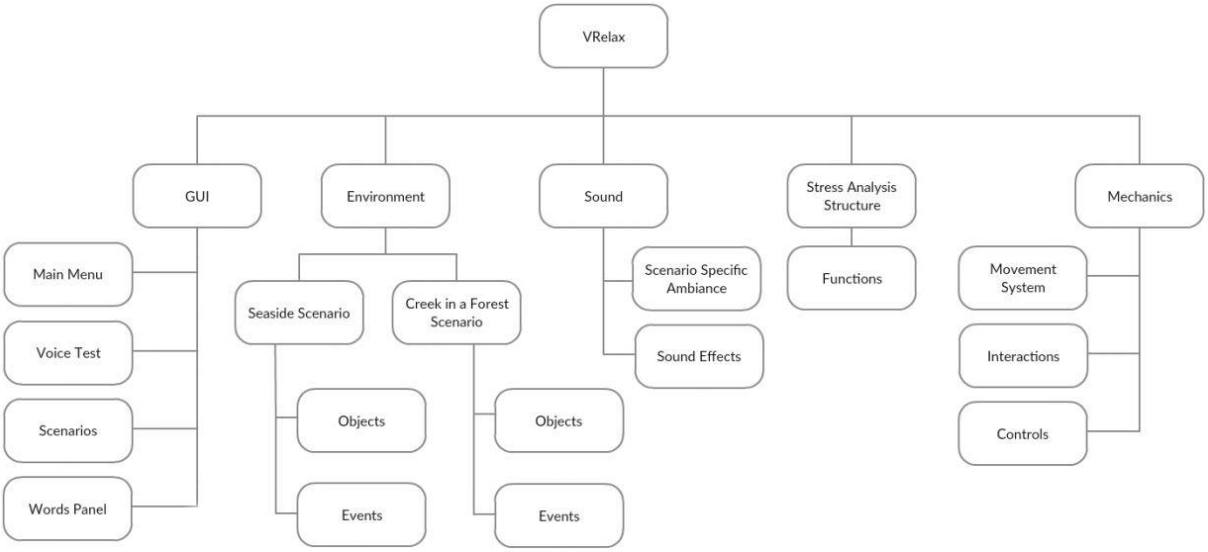


Figure 12: Project Components of VRelax

4.3.1 Brief Description of Block Diagram

Components of the VRelax Project are shown in the *Figure 12*. There are five core components of the system. These main components have sub-systems of their own and these components are shown as block diagram in the figure.

4.3.1.1 GUI

GUI design necessary for actors to interact with the system functions. There are four sub-system for GUI component which are Main Menu, Voice Test, Scenarios and Words Panel. Main Menu is the start page of the system. In Main menu participant can start a voice test, choose a scenario, adjust volume level or exit from the system. In the voice test screen, participant can start a voice test and analyze his/her stress level. There will be also scenarios list to select a scenario in the voice test menu and open it when the participants voice is stressful. In the scenarios menu thumbnail of the scenarios will be shown and participant can start a scenario that s/he desires. Words panel will be shown both in scenarios when s/he wants to show the words and in voice test page to analyze stress with those pre-defined words. Finally, information texts in the voice test page will give feedback to the participant about stress analysis process. Participant will use HTC Vive headset and a controller to access these menus. In the

earlier demos that before VR implementations, keyboard and mouse is required to access these menus.

4.3.1.2 Environment

Environment component is responsible for user interactions with the objects and events in the scenarios. There are two different scenarios and they have different Objects like fruits or rocks and beach or forest and both scenarios have events like throwing a rock to the sea or eating collected fruits. The participant can do these actions and participate these events with controller of the HTC Vive.

4.3.1.3 Sound

Sound is an essential component for this application because of relaxing purpose. The sound component is responsible for all sounds in the system which includes Scenario Specific Ambiance like music and Sound Effects like sea waves sound or tree leaves sound.

4.3.1.4 Stress Analysis Structure

This sub-system of the VRelax application responsible for the analysis of the voice. The sub-system of this component Functions which will operate in the background of the application, will calculate stress amount of the participant.

4.3.1.5 Mechanics

Every game system has mechanics, this module of the system is responsible for the mechanics of the VRelax. There are three sub-system which are Movement System, Interactions and Controls. Participant can move around the environment with teleport function, interact with the scenario specific objects or events using HTC Vive while background controls sub-system will handle actions. Controls is one of the core mechanics of the system due to frequent use of this module.

4.4 Human Interface Design

4.4.1 Scenario Environment

In our VR application, we have two different scenarios which means two different environments. They include materials, 3D models and objects. Seaside Scenario which is shown

Figure 13: User Interface of Seaside Scenario

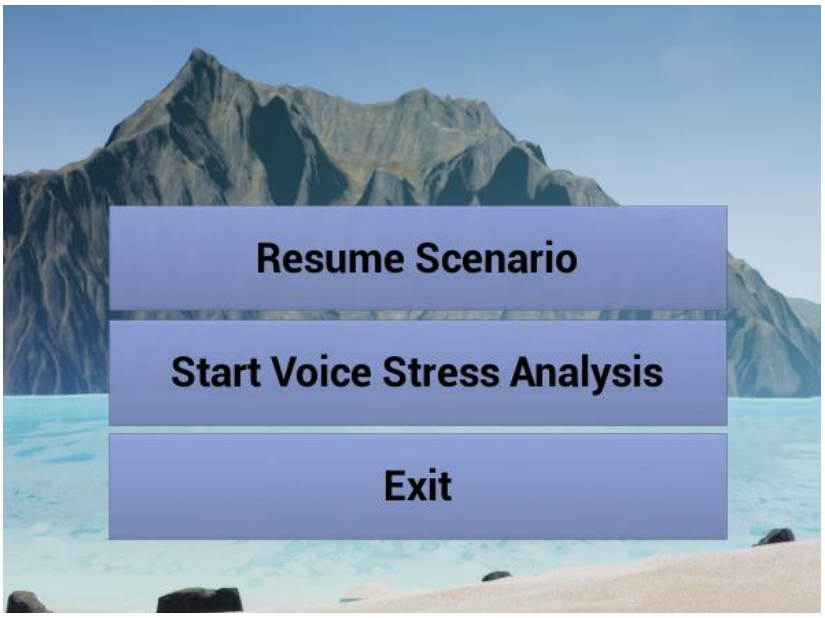


Figure 14: User Interface of Seaside Scenario Options

in *Figure 13* has materials like sand and sea and environment objects like rocks, grass, terrain. Participant can throw a rock to the sea or walk around in the environment with the teleport function which allows participant to move freely in the seaside.

Participant can exit anytime and return to main menu using options menu shown in Figure 14 bound to a key or trigger and with Start Voice Stress Analysis button to analyze stress with voice. This user interface of options applies both scenarios which they have the same functions.

Figure 15: User Interface of Creek in a Forest Scenario

Creek in a Forest Scenario which is shown in *Figure 15* has materials like wood and leaves and environment objects like rocks, grass, trees.

Participant can collect fruit from specific locations by teleporting over them and eat it or walk around in the environment with the teleport function which allows participant to move freely in the forest.

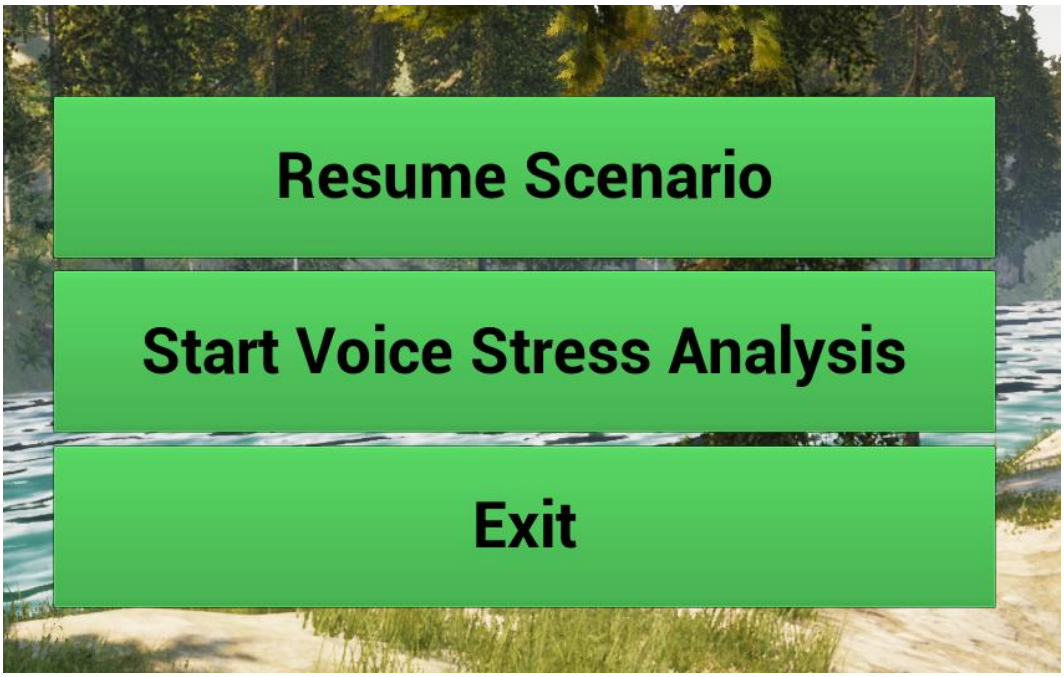


Figure 16: Options Menu of Creek in a Forest Scenario

Figure 16 shows the user interface of options menu. The difference between other scenario is only cosmetic so there are no functional changes.

4.4.2 Overview of Other User Interfaces

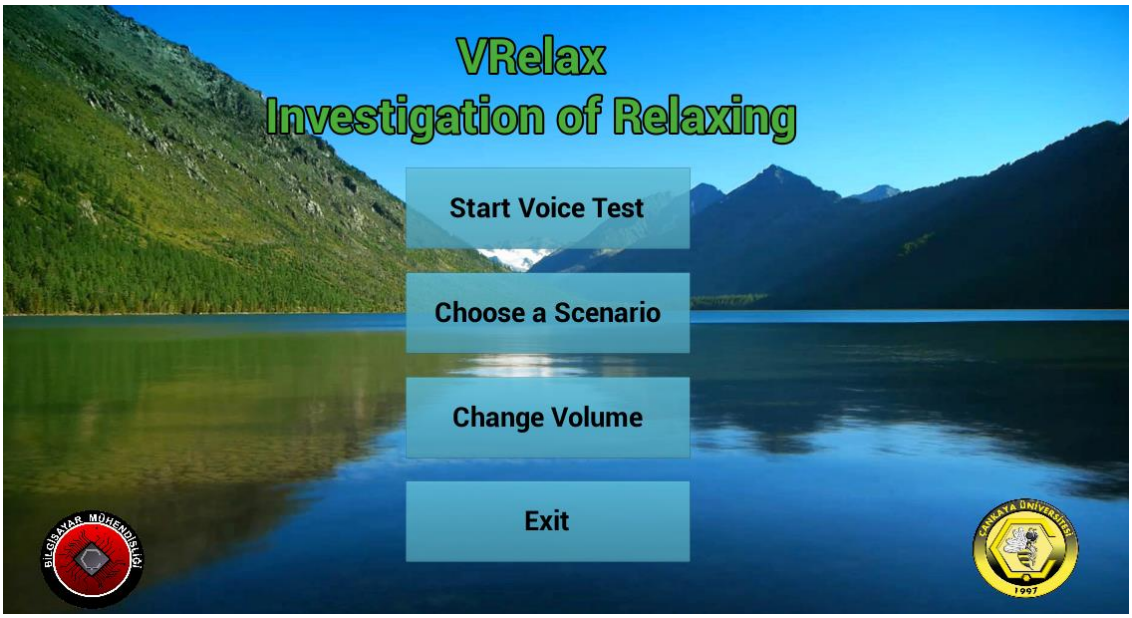


Figure 17: User Interface of Main Menu

The representation of main menu shown in *Figure 17*. From this screen participant can access all main functions of the system. All options except “Change Volume” which is shown

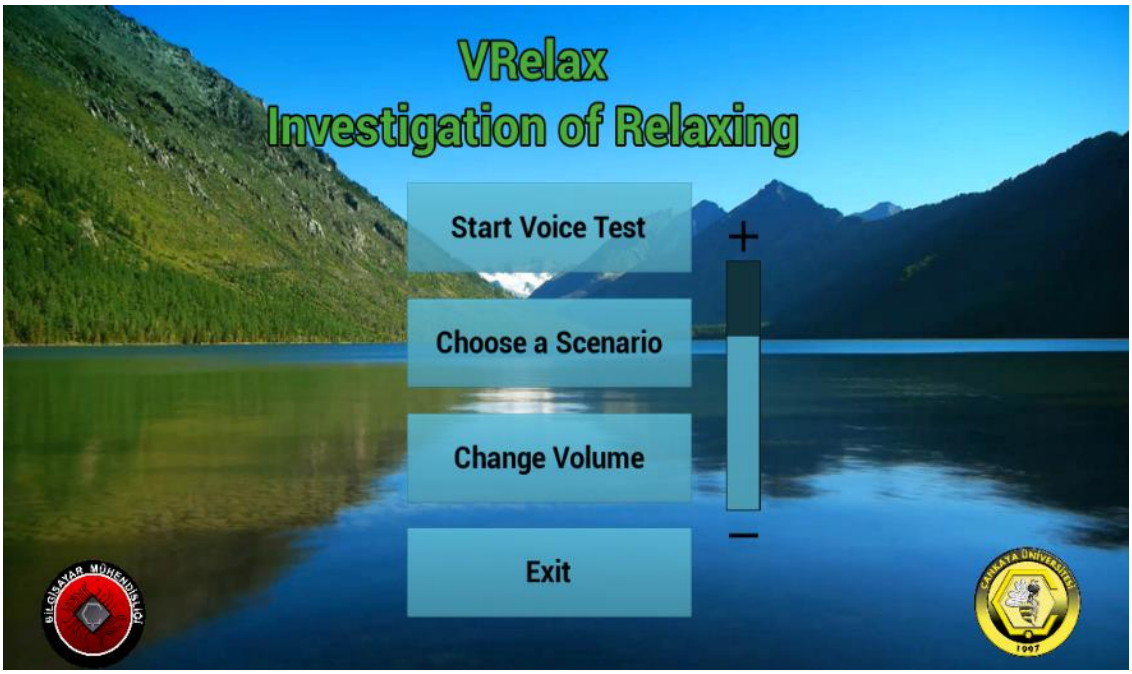


Figure 18: User Interface of Change Volume

in *Figure 18* will redirect participant to the new page to access sub-functions. Change Volume option will open a volume bar with “+” and “-” buttons to adjust volume of the application.

Figure 19: User Interface of Start Voice Test

In the “Start Voice Test” page shown in *Figure 19*, participant will choose a scenario and apply it to automatically start it when his/her stress level crosses the indicated level. SUSAS Database Words [25] will appear and change when the participant starts the analysis with the play button, while the participant reads the words, application will analyze the voice and give a feedback about participant’s stress level when analysis of all words is finished.

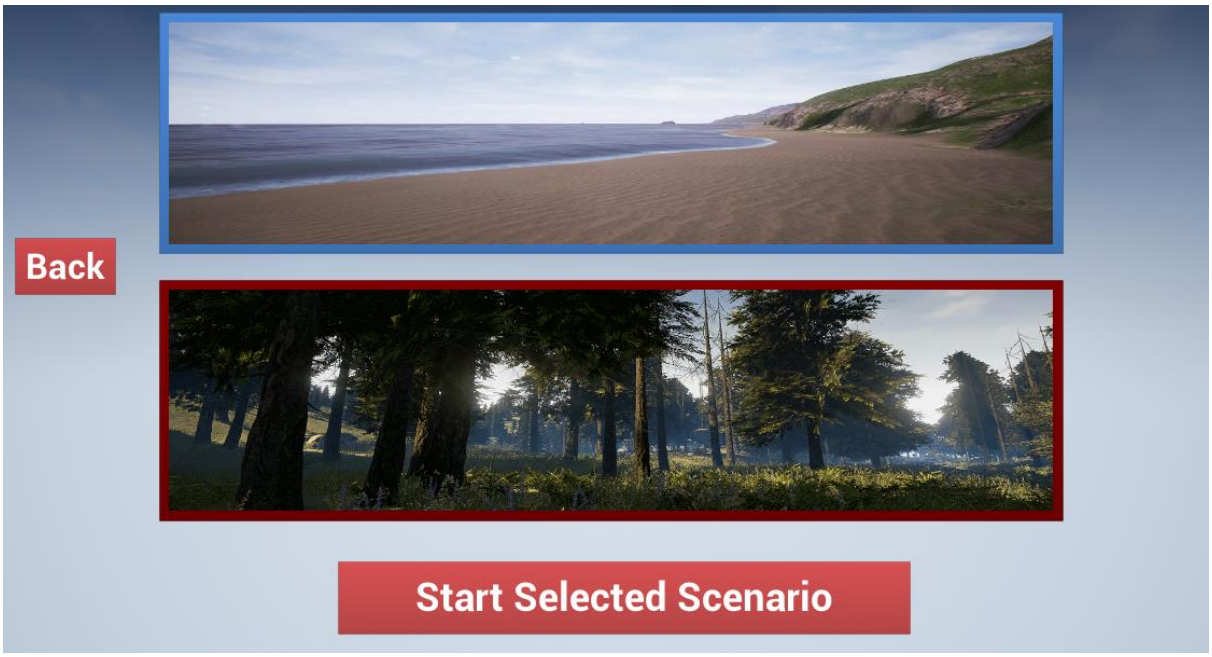


Figure 20: User Interface of Choose a Scenario

Finally, Choose a Scenario screen which is shown in *Figure 20* includes thumbnail images of the available scenarios and a start button to start the selected scenario. Selecting a scenario is indicated with a red border in this case.

5. Test Plan

5.1 INTRODUCTION

5.1.1 Version Control

Version No	Description of Changes	Date
1.0	First Version	Mar 13, 2018
2.0	Updated test cases according to changes in software.	May 20, 2018

5.1.2 Overview

The usage of VRelax: Investigation of Relaxing under different circumstances and use cases of users called participants that determined in SRS document will be tested.

5.1.3 Scope

This documents purpose is to ensure use cases with different circumstances work without any error. This document also covers test design specifications and the test cases of test plan.

5.1.4 Terminology

Acronym	Definition
GUI	Graphical User Interface
VSAS	Voice Stress Analysis Structure
SS	Seaside Scenario
CFS	Creek in a Forest Scenario

5.2 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.

5.2.1 Graphical User Interface (GUI)

To make transitions between menus and different functionalities, graphical user interface components are used. There are four sub-system for GUI to test out which the GUI components reside in Main Menu, Seaside Scenario, Creek in a Forest Scenario and Voice Stress Analysis Tool. Every sub-system also includes smaller parts. Testing GUI parts will include interface functions, panels, texts and bars, buttons, etc.

5.2.2 Voice Stress Analysis Structure (VSAS)

This part includes test plan and test cases of Voice Stress Analysis Structure. This structure is one of the most important parts of the project because it is based on this structure. Testing of this structure includes reading voice input, analyzing voice and prompts.

5.2.3 Seaside Scenario (SS)

This part includes test plan and test cases of first scenario which is Seaside Scenario. In this scenario, participant shall explore the beach and interact with the created environment. Testing of this feature includes interaction functions, ambiance and sound effects and movement mechanics.

5.2.4 Creek in a Forest Scenario (CFS)

This part includes test plan and test cases of second scenario which is Creek in a Forest Scenario. In this scenario, participant shall explore the forest and interact with the created environment. Testing of this feature includes interaction functions, ambiance and sound effects and movement mechanics.

5.3 FEATURES NOT TO BE TESTED

We won't be including testing of graphics and platform related cases like integrity of graphics and unity of textures, correct lightning, shadowing and optimization.

5.4 ITEM PASS/FAIL CRITERIA

5.4.1 Exit Criteria

- 100% of the test cases are executed
- 95% of the test cases passed
- All High and Medium Priority test cases passed

5.5 REFERENCES

[1] "SRS Document", GitHub, 2017. [Online]. Available: https://github.com/CankayaUniversity/ceng-407-408-project-vrelax-investigation-of-relaxing/wiki/Software-Requirements-Specification. [Accessed: 02- Mar- 2018].

[2] "SDD Document", GitHub, 2017. [Online]. Available: https://github.com/CankayaUniversity/ceng-407-408-project-vrelax-investigation-of-relaxing/wiki/Software-Design-Document. [Accessed: 02- Mar- 2018].

5.6 TEST DESIGN SPECIFICATIONS

5.6.1 Graphical User Interface (GUI)

5.6.1.1 Sub features to be tested

a. Start Voice Test Button (GUI.STRTVT_BTN)

Participant shall start voice test with this button. After this button pressed, a panel will be displayed with Database Panel.

b. SUSAS Database Words Panel (GUI.SUSAS_PNL)

Participant shall read words from the SUSAS Database to analyze voice.

c. Apply Scenario Button (GUI.APLSCEN_BTN)

Participant shall apply scenario to start automatically if stress level exceeds the critical interval.

d. Back Button (GUI.BCK_BTN)

Participant shall go back to main menu with this button.

e. Duration Bar (GUI.DUR_BAR)

Participant can see stress level with this bar. Bar color turns red or green according to stress level.

f. Choose a Scenario Button (GUI.CHOSCEN_BTN)

Participant shall choose a scenario with this button. After this button pressed, scenario thumbnails will show up.

g. Start Selected Scenario Button (GUI.STRTSCEN_BTN)

Participant shall start the selected scenario with this button.

h. Change Volume Button (GUI.CHNVOL_BTN)

Participant can change the volume level. After pressing the button, volume bar and “+” and “-” buttons will appear to turn up or turn down the volume.

i. Resume Scenario Button (GUI.RSMSCEN_BTN)

Participant shall open Voice Stress Analysis screen.

j. Start Voice Stress Analysis Button (GUI.VSASCEN_BTN)

Participant shall exit from the scenario with this button. Participant will be redirected to main menu.

k. Exit Button (GUI.EX_BTN)

Participant shall exit from the application with this button.

l. Exit from Scenario Button (GUI.EXSCEN_BTN)

Participant shall exit from the scenario with this button. Participant will be redirected to main menu.

5.6.1.2 Test Cases

TC ID	Requirements	Priority	Scenario Description
GUI.STRTVT_BTN	3.2.1	H	Press "Start" button. After pressing, Voice Test Screen will come up.
GUI.SUSAS_PNL	3.2.1	H	Display the SUSAS Database Words and initiate voice analysis.
GUI.APLSCEN_BTN.01	3.2.1	M	Apply the selected scenario, after that applied scenario will start if stress level exceeds critical interval.
GUI.APLSCEN_BTN.02	3.2.1	M	Select a scenario to apply from drop-down list.

GUI.BCK_BTN	3.2.1	L	Redirects to the main menu.
GUI.DUR_BAR	3.2.1	M	Display the remaining time before recording starts.
GUI.CHOSCEN_BTN	3.2.1	H	Press “Choose a Scenario” button. After pressing scenario thumbnails will come up.
GUI.STRTSCEN_BTN.01	3.2.1	M	Press “Start Selected Scenario” button. After pressing, selected scenario will start.
GUI.STRTSCEN_BTN.02	3.2.1	M	Select a scenario. After selecting, the thumbnail border will turn red.
GUI.CHNVOL_BTN.01	3.2.1	L	Press “Change Volume” button. After pressing, the volume bar will appear.
GUI.CHNVOL_BTN.02	3.2.1	L	Press “+” to turn up the volume. Press “-” to turn down the volume. Observe volume bar changes.
GUI.EX_BTN	3.2.1	L	Press “Exit” button. After pressing, the application will close.

GUI.RSMSCEN_BTN	3.2.2 – 3.2.3	M	Press “Resume Scenario” button. After pressing, opened scenario will be resumed.
GUI.VSASCEN_BTN	3.2.2 – 3.2.3	H	Press “Start Voice Stress Analysis” button. After pressing voice analysis screen will show up in the scenario.
GUI.EXSCEN_BTN	3.2.2 – 3.2.3	L	Press “Exit” button. After pressing, the scenario will close, and participant will redirect to main menu.

5.6.2 Voice Stress Analysis Structure (VSAS)

5.6.2.1 Sub features to be tested

a. Voice Input (VSAS.V_INPT)

Participant will read database words to a microphone and his/her voice will load as an input. Participant shall start speaking as soon as prompts / words show up.

b. Voice Analysis (VSAS.V_ANLYS)

Voice captured in “Voice Input” sub-feature will be used here to analyze stress amount.

c. Scenario Start Automation (VSAS.AUTO)

After analyzing stress with voice, if stress level exceeds critical interval, applied scenario will start automatically. The participant can change the default scenario to start.

d. Inform Participant (VSAS.INFO)

After analyzing voice, participant will be informed about his/her stress level both in VSA tool and in scenarios.

5.6.2.2 Test Cases

TC ID	Requirements	Priority	Scenario Description
VSAS.V_INPT	3.2.1 - 3.2.2 - 3.2.3	H	Read database words to give input. Check microphone and input.
VSAS.V_ANLYS	3.2.1 - 3.2.2 - 3.2.3	H	Analyze voice both with SUSAS database confirmed wav files and with voice input from the participant.
VSAS.AUTO	3.2.1 - 3.2.2 - 3.2.3	M	The applied scenario will automatically start if stress level exceeds the critical level.
VSAS.INFO.01	3.2.1 - 3.2.2 - 3.2.3	L	Participant will be informed about stress level and initiation of auto-scenario.
VSAS.INFO.02	3.2.1 - 3.2.2 - 3.2.3	L	Participant will be informed about stress level in the scenarios and continuation of the scenario.

5.6.3 Seaside Scenario (SS)

5.6.3.1 Sub features to be tested

a. Teleport-Movement System (SS.TP_SYS)

Participant shall teleport to any allowed place to explore environment. Participant can determine where to teleport with indicators.

b. Ambient Sound & Effects (SS.SFX)

Scenario specific ambient sounds and sound effects will play until the participant exits the scenario or starts VSA tool.

c. Interact With the Environment (SS.INTWE)

Participant interact with the scenario specific objects and scripted events.

5.6.3.2 Test Cases

TC ID	Requirements	Priority	Scenario Description
SS.TP_SYS.01	3.2.2	H	Hold down the trigger button to select teleport area indicated with blue location.
SS.TP_SYS.02	3.2.2	H	Release the trigger button to teleport selected location.
SS.SFX	3.2.2	M	Ambient sounds will be played during scenario. Sound effects may occur in case of some actions or scripted events.
SS.INTWE	3.2.2	H	If a rock is obtained, press trackpad button again to throw the rock and remove the 3D model from hand.

5.6.4 Creek in a Forest Scenario (CFS)

5.6.4.1 Sub features to be tested

a. Teleport-Movement System (CFS.TP_SYS)

Participant shall teleport to any allowed place to explore environment. Participant can determine where to teleport with indicators.

b. Ambient Sound & Effects (CFS.SFX)

Scenario specific ambient sounds and sound effects will play until the participant exits the scenario or starts VSA tool.

c. Interact With the Environment (CFS.INTWE)

Participant interact with the scenario specific objects and scripted events.

5.6.4.2 Test Cases

TC ID	Requirements	Priority	Scenario Description
CFS.TP_SYS.01	3.2.3	H	Hold down the trigger button to select teleport area indicated with blue location.
CFS.TP_SYS.02	3.2.3	H	Release the trigger button to teleport selected location.
CFS.SFX	3.2.3	M	Ambient sounds will be played during scenario. Sound effects may occur in case of some actions or scripted events.
CFS.INTWE.01	3.2.3	H	Teleport over a fruit to collect it.
CFS.INTWE.02	3.2.3	H	If a fruit is obtained, press trackpad button again to eat the fruit and remove the 3D model from hand.

5.7 DETAILED TEST CASES

5.7.1 GUI.STRTVT_BTN

TC_ID	GUI.STRTVT_BTN
Purpose	Starts Voice Stress Analysis tool with voice test screen correctly.
Requirements	3.2.1
Priority	High
Estimated Time Needed	1 Minute
Dependency	Application is executed, and main menu is displayed.
Setup	Application must be installed.
Procedure	[A01] Press “Start Voice Test” button from main menu.
	[V01] Voice test screen will be displayed on the screen.
Cleanup	Go back to previous page.

5.7.2 GUI.SUSAS_PNL

TC_ID	GUI.SUSAS_PNL
Purpose	Displays the SUSAS Database words and initiates voice analysis.

Requirements	3.2.1
Priority	High
Estimated Time Needed	2 Minutes
Dependency	Selecting “Start Voice Test” button from the main menu.
Setup	SUSAS Database wav files scripted and reference words come up.
Procedure	[A01] Press “Start Voice Test” button from main menu.
	[V01] Observe that panel comes up with pre-defined SUSAS words.
Cleanup	Go back to previous page.

5.7.3 GUI.APLSCEN_BTN.01

TC_ID	GUI.APLSCEN_BTN.01
Purpose	Applies a scenario to automatically start when triggered.
Requirements	3.2.1
Priority	Medium
Estimated Time Needed	1 Minute
Dependency	Selecting “Start Voice Test” button from the main menu.
Setup	Selected scenario prepared.
Procedure	[A01] Go to Voice Test Screen.
	[A02] Select a scenario from drop-down list.
	[A03] Click apply button.
	[V01] Observe that the selected scenario starts when triggered.
Cleanup	Go back to previous page.

5.7.4 GUI.APLSCEN_BTN.02

TC_ID	GUI.APLSCEN_BTN.02
Purpose	Displays available scenarios in a drop-down list to select.
Requirements	3.2.1
Priority	Medium
Estimated Time Needed	2 Minutes
Dependency	Selecting “Start Voice Test” button from the main menu.
Setup	List of scenarios scripted.
Procedure	[A01] Go to Voice Test Screen.
	[A02] Press drop-down list.
	[V01] Observe that the available scenarios are listed.
Cleanup	Go back to previous page.

5.7.5 GUI.BCK_BTN

TC_ID	GUI.BCK_BTN
Purpose	Returns back participant to main menu.
Requirements	3.2.1
Priority	Low
Estimated Time Needed	1 Minute

Dependency	Opening any page containing this button.
Setup	Back button loaded.
Procedure	[A01] Go to VSA Screen or Choose a Scenario page.
	[A02] Press back button.
	[V01] Observe that redirection to main menu.
Cleanup	-

5.7.6 GUI.DUR_BAR

TC_ID	GUI.DUR_BAR
Purpose	Displays the remaining time before recording starts.
Requirements	3.2.1
Priority	Medium
Estimated Time Needed	1 Minute
Dependency	Starting stress analysis.
Setup	Remaining time calculated.
Procedure	[A01] Go to Voice Test Screen.
	[A02] Press start button.
	[V01] Observe that remaining duration bar works as intended.
Cleanup	Go back to previous page.

5.7.7 GUI.CHOSCEN_BTN

TC_ID	GUI.CHOSCEN_BTN
Purpose	Starts scenario selection menu.
Requirements	3.2.1
Priority	High
Estimated Time Needed	1 Minute
Dependency	Application is executed, and main menu is displayed.
Setup	Scenario thumbnails and start button loaded.
Procedure	[A01] Press “Choose a Scenario” button
	[V01] Observe that scenario thumbnails for selecting displayed correctly.
Cleanup	Exit from the application.

5.7.8 GUI.STRTSCEN_BTN.01

TC_ID	GUI.STRTSCEN_BTN.01
Purpose	Starts selected scenario.
Requirements	3.2.1
Priority	Medium
Estimated Time Needed	5 Minutes
Dependency	Selecting “Choose a Scenario” button from the main menu.
Setup	Selected scenario is scripted.
Procedure	[A01] Go to Choose a Scenario menu.
	[A02] Select a scenario.
	[A03] Click Start Selected Scenario button.

	[V01] Observe that selected scenario launches correctly.
Cleanup	Go back to previous page.

5.7.9 GUI.STRTSCEN_BTN.02

TC_ID	GUI.STRTSCEN_BTN.02
Purpose	Indicator for which scenario is selected.
Requirements	3.2.1
Priority	Medium
Estimated Time Needed	1 Minute
Dependency	Selecting “Choose a Scenario” button from the main menu.
Setup	Thumbnail of selected scenario is updated.
Procedure	[A01] Go to Choose a Scenario menu.
	[A02] Select a scenario.
	[V01] Observe that the scenario is selected, and thumbnails border is red.
Cleanup	Go back to previous page.

5.7.10 GUI.CHNVOL_BTN.01

TC_ID	GUI.CHNVOL_BTN.01
Purpose	Displays the volume bar.
Requirements	3.2.1
Priority	Low
Estimated Time Needed	1 Minute
Dependency	Application is executed, and main menu is displayed.
Setup	Default volume scripted.
Procedure	[A01] Press “Change Volume” button from main menu.
	[V01] Observe that volume bar appears at the left side of the menu.
Cleanup	Exit from the application.

5.7.11 GUI.CHNVOL_BTN.02

TC_ID	GUI.CHNVOL_BTN.02
Purpose	Changes the volume of the application.
Requirements	3.2.1
Priority	Low
Estimated Time Needed	1 Minute
Dependency	Selecting “Change Volume” button from the scenario.
Setup	Application volume changes are updated.
Procedure	[A01] Press “+” button to turn up the volume.
	[V01] Observe that volume is increased, and change is displayed.
	[A02] Press “-” button to turn up the volume.
	[V02] Observe that volume is decreased, and change is displayed.

Cleanup	Exit from the application.

5.7.12 GUI.EX_BTN

TC_ID	GUI.EX_BTN
Purpose	Closes the VR application.
Requirements	3.2.1
Priority	Low
Estimated Time Needed	1 Minute
Dependency	Application is executed, and main menu is displayed.
Setup	Exit button is scripted, application closure prepared.
Procedure	[A01] Press “Exit” button.
	[V01] Observe that application closes correctly.
Cleanup	-

5.7.13 GUI.RSMSCEN_BTN

TC_ID	GUI.RSMSCEN_BTN
Purpose	Resume opened scenario.
Requirements	3.2.2 – 3.2.3
Priority	Medium
Estimated Time Needed	1 Minute
Dependency	A scenario is started, and options menu opened.
Setup	SUSAS Database wav files scripted and reference words come up, VSA tool started.
Procedure	[A01] Open options menu while in a scenario.
	[A02] Press “Resume Scenario” button.
	[V01] Observe that scenario resumes successfully.
Cleanup	Exit from the scenario or go back to scenario.

5.7.14 GUI.VSASCEN_BTN

TC_ID	GUI.VSASCEN_BTN
Purpose	Opens voice stress test page.
Requirements	3.2.2 – 3.2.3
Priority	High
Estimated Time Needed	2 Minutes
Dependency	VSA tool is started within a scenario.
Setup	Voice stress screen and functions are scripted.
Procedure	[A01] Open options menu while in a scenario.
	[A02] Press “Start Voice Stress Analysis” while in a scenario.
	[V01] Observe that VSA page opens correctly.
Cleanup	Exit from the scenario.

5.7.15 GUI.EXSCEN_BTN

TC_ID	GUI.EXSCEN_BTN
Purpose	Exits from the scenario and returns main menu.

Requirements	3.2.2 – 3.2.3
Priority	Low
Estimated Time Needed	1 Minute
Dependency	A scenario is started.
Setup	Exit button is scripted and close operations processed.
Procedure	[A01] Press “Exit” button.
	[V01] Observe that scenario closes correctly.
Cleanup	-

5.7.16 VSAS.V_INPT

TC_ID	VSAS.V_INPT
Purpose	Voice input with microphone.
Requirements	3.2.1 - 3.2.2 - 3.2.3
Priority	High
Estimated Time Needed	1 – 5 Minutes (According to words and speech speed)
Dependency	Voice Stress Analysis is started from the main menu or within a scenario.
Setup	Voice input is loaded into VSA.
Procedure	[A01] Go to VSA screen.
	[A02] Read database words with a clear voice.
	[V01] Observe that microphone and voice input work as intended.
Cleanup	Go back to previous screen.

5.7.17 VSAS.V_ANLYS

TC_ID	VSAS.V_ANLYS
Purpose	Analyze stress with voice signals.
Requirements	3.2.1 - 3.2.2 - 3.2.3
Priority	High
Estimated Time Needed	5 Minutes
Dependency	Starting VSA from the main menu or within a scenario.
Setup	VSA algorithms loaded and information scripted.
Procedure	[A01] Go to VSA screen.
	[A02] Complete stress analysis.
	[V01] Observe that voice analysis works and shows the stress amount.
Cleanup	Go back to previous screen.

5.7.18 VSAS.AUTO

TC_ID	VSAS.AUTO
Purpose	Starts selected scenario automatically by checking stress amount.
Requirements	3.2.1 - 3.2.2 - 3.2.3
Priority	Medium

Estimated Time Needed	1 Minute
Dependency	Applying a scenario.
Setup	Applied scenario is scripted and loaded.
Procedure	[A01] Go to VSA screen.
	[A02] Complete stress analysis.
	[V01] Observe that scenario is automatically starts if stress amount exceeds critical level.
	[V02] Observe that scenario doesn't start automatically if participant is not stressed.
Cleanup	Go to previous screen.

5.7.19 VSAS.INFO.01

TC_ID	VSAS.INFO.01
Purpose	Informs participant about stress level and initiation of auto start.
Requirements	3.2.1 - 3.2.2 - 3.2.3
Priority	Low
Estimated Time Needed	1 Minute
Dependency	Completing stress analysis.
Setup	Info prompt scripted.
Procedure	[A01] Complete stress analysis in VSA tool at main menu.
	[V01] Observe that participant is informed about stress level.
	[V02] Observe that participant is informed about initiation of auto scenario.
Cleanup	Exit from the VSA tool.

5.7.20 VSAS.INFO.02

TC_ID	VSAS.INFO.02
Purpose	Informs participant in the scenario about stress level.
Requirements	3.2.1 - 3.2.2 - 3.2.3
Priority	Low
Estimated Time Needed	1 Minute
Dependency	Completing stress analysis in a scenario.
Setup	Info prompt scripted.
Procedure	[A01] Complete stress analysis in VSA tool at a scenario.
	[V01] Observe that participant is informed about stress level.
Cleanup	Go back to previous menu.

5.7.21 SS.TP_SYS.01

TC_ID	SS.TP_SYS.01
Purpose	Indicates the desired teleport location.
Requirements	3.2.2
Priority	High
Estimated Time Needed	1 Minute

Dependency	Starting the Seaside Scenario.
Setup	Movement system is scripted and launched.
Procedure	[A01] Initiate the scenario.
	[A02] Hold down the trigger button.
	[V01] Observe that the teleport area is indicated.
Cleanup	Releasing the trigger button.

5.7.22 SS.TP_SYS.02

TC_ID	SS.TP_SYS.02
Purpose	Teleports the participant to a desired location.
Requirements	3.2.2
Priority	High
Estimated Time Needed	1 Minute
Dependency	Indicating the teleport location by holding down the trigger button.
Setup	Movement system and desired location is scripted.
Procedure	[A01] Release the trigger button.
	[V01] Observe that the participant is teleported as intended.
Cleanup	-

5.7.23 SS.SFX

TC_ID	SS.SFX
Purpose	Plays the ambient sounds and sound effects.
Requirements	3.2.2
Priority	Medium
Estimated Time Needed	2 Minutes
Dependency	Starting the Seaside Scenario.
Setup	Sound structure is launched.
Procedure	[A01] Move around the environment.
	[V01] Observe that sound effects of sea and wind works correctly.
Cleanup	Exit from the Seaside Scenario.

5.7.24 SS.INTWE

TC_ID	SS.INTWE
Purpose	Throws the rock.
Requirements	3.2.2
Priority	High
Estimated Time Needed	1 Minute
Dependency	Seaside Scenario opened and running.
Setup	Physics of rock are scripted.
Procedure	[A01] Aim with your sight.
	[A02] Press the trackpad button.
	[V01] Observe that the rock is thrown.
Cleanup	-

5.7.25 CFS.TP_SYS.01

TC_ID	CFS.TP_SYS.01
Purpose	Indicates the desired teleport location.
Requirements	3.2.3
Priority	High
Estimated Time Needed	1 Minute
Dependency	Starting the Creek in a Forest Scenario.
Setup	Movement system is scripted and launched.
Procedure	[A01] Initiate the scenario.
	[A02] Hold down the trigger button.
	[A03] Observe that the teleport area is indicated.
Cleanup	Releasing the trigger button.

5.7.26 CFS.TP_SYS.02

TC_ID	CFS.TP_SYS.02
Purpose	Teleports the participant to a desired location.
Requirements	3.2.3
Priority	High
Estimated Time Needed	1 Minute
Dependency	Indicating the teleport location by holding down the trigger button.
Setup	Movement system and desired location is scripted.
Procedure	[A01] Release the trigger button.
	[V01] Observe that the participant is teleported as intended.
Cleanup	-

5.7.27 CFS.SFX

TC_ID	CFS.SFX
Purpose	Plays the ambient sounds and sound effects.
Requirements	3.2.3
Priority	Medium
Estimated Time Needed	2 Minutes
Dependency	Starting the Creek in a Forest Scenario.
Setup	Sound structure is launched.
Procedure	[A01] Move around the environment.
	[V01] Observe that sound effects of creek, leaves and eating fruit works correctly.
Cleanup	Exit from the Creek in a Forest Scenario.

5.7.28 CFS.INTWE.01

TC_ID	CFS.INTWE.01
Purpose	Collects a fruit to interact.
Requirements	3.2.3
Priority	High

Estimated Time Needed	1 Minutes
Dependency	Starting the Creek in a Forest Scenario.
Setup	A fruit is scripted.
Procedure	[A01] Initiate the scenario.
	[A02] Teleport over a fruit.
	[V01] Observe that a fruit is obtained and removed from the world.
Cleanup	Pressing trackpad button again.

5.7.29 CFS.INTWE.02

TC_ID	CFS.INTWE.02
Purpose	Eats the fruit.
Requirements	3.2.3
Priority	High
Estimated Time Needed	1 Minutes
Dependency	Collecting a fruit by pressing trackpad button.
Setup	Animations are scripted.
Procedure	[A01] Press the trackpad button.
	[A02] Observe that the sound effect is played, and fruit is removed from hand.
Cleanup	-

6. Test Results

6.1 Individual Test Results

TC ID	Priority	Date Run	Run By	Result	Explanation
GUI.STRTVT_BTN	H	13.05.2018	Umut Efiloğlu	Pass	Voice test screen opened correctly
GUI.SUSAS_PNL	H	13.05.2018	Görkem Narinoğlu	Pass	SUSAS Database words appeared correctly
GUI.APLSCEN_BTN.01	M	13.05.2018	Görkem Narinoğlu	Pass	Selected scenario is applied correctly
GUI.APLSCEN_BTN.02	M	13.05.2018	Görkem Narinoğlu	Pass	Available scenario is appeared correctly

GUI.BCK_BTN	L	13.05.2018	Umut Efiloğlu	Pass	Main menu opened correctly
GUI.DUR_BAR	M	13.05.2018	Görkem Narinoğlu	Pass	Duration Bar is correct with minimal bug
GUI.CHOSCEN_BTN	H	13.05.2018	Umut Efiloğlu	Pass	Selectable scenarios are listed correctly
GUI.STRTSCEN_BTN.01	M	13.05.2018	Umut Efiloğlu	Pass	Selected scenario is started correctly
GUI.STRTSCEN_BTN.02	M	13.05.2018	Umut Efiloğlu	Pass	Indicator of selected scenario appeared correctly
GUI.CHNVOL_BTN.01	L	13.05.2018	Görkem Narinoğlu	Pass	Volume bar appeared correctly
GUI.CHNVOL_BTN.02	L	13.05.2018	Görkem Narinoğlu	Pass	Volume changed correctly
GUI.EX_BTN	L	13.05.2018	Görkem Narinoğlu	Pass	Application closed correctly
GUI.RSMSCEN_BTN	M	13.05.2018	Umut Efiloğlu	Pass	Opened scenario continued correctly
GUI.VSASCEN_BTN	H	13.05.2018	Umut Efiloğlu	Pass	Voice test screen opened correctly
GUI.EXSCEN_BTN	L	13.05.2018	Umut Efiloğlu	Pass	Exited from scenario and returned to main menu correctly
VSAS.V_INPT	H	13.05.2018	Görkem Narinoğlu	Pass	Voice input is recorded correctly
VSAS.V_ANLYS	H	13.05.2018	Görkem Narinoğlu	Pass	Stress amount of user is calculated correctly

VSAS.AUTO	M	13.05.2018	Görkem Narinoğlu	Fail	When stressed example is executed, this test shall be handled
VSAS.INFO.01	L	13.05.2018	Umut Efiloğlu	Pass	Participant is informed before scenario starts correctly
VSAS.INFO.02	L	13.05.2018	Umut Efiloğlu	Pass	Participant is informed correctly
SS.TP_SYS.01	H	13.05.2018	Umut Efiloğlu	Pass	Teleport location is indicated correctly
SS.TP_SYS.02	H	13.05.2018	Umut Efiloğlu	Pass	Participant is teleported correctly
SS.SFX	M	13.05.2018	Umut Efiloğlu	Fail	When ambient sound is added, this test shall be handled
SS.INTWE	H	13.05.2018	Umut Efiloğlu	Pass	Rock is thrown correctly
CFS.TP_SYS.01	H	13.05.2018	Görkem Narinoğlu	Pass	Teleport location is indicated correctly
CFS.TP_SYS.02	H	13.05.2018	Görkem Narinoğlu	Pass	Participant is teleported correctly
CFS.SFX	M	13.05.2018	Görkem Narinoğlu	Pass	Ambient sounds and sound effects are played correctly
CFS.INTWE.01	H	13.05.2018	Görkem Narinoğlu	Pass	Apple is collected correctly
CFS.INTWE.02	H	13.05.2018	Görkem Narinoğlu	Pass	Apple is eaten correctly

6.2 Summary of Test Results

Priority	Number of Tests	Executed	Passed
H	13	13	13
M	9	9	7
L	7	7	7
Total	**29**	**29**	**27**

We have executed 29 test cases, failed 2 medium cases. These 2 medium priority cases would be handled when appropriate conditions are satisfied. All low and high priority test cases are passed, so exit criteria is met.

6.3 Exit Criteria

All high priority test cases are met. There is no high priority bug remained. Exit criteria is met.

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

6.4 Known Problems

Ensemble Empirical Mode Decomposition (EEMD) algorithm take more time than expected. This situation lowers user satisfaction.

6.5 Conclusion

This section includes test results of project named “VRelax: Investigation of Relaxing”. While there is no known high priority bug in the application, running time of EEMD algorithm is too high than expected. This situation affects user experience in a bad way. Software development activities are completed within the anticipated cost.

Current stage of project is usable even if the project is in Alpha release. Running time and test case problems shall be handled with further releases.

7. Compilation/Installation Guide

This guide will describe how to install and compile VRelax from the release builds. Make sure to grab the latest build.

7.1 Prerequisites

- Unreal Engine 4.18.3 should be installed to run and compile the project. Newer versions will work however older versions won't open the project correctly.
- Project uses AutoTerrainCover and Victory Plugins, so they should be installed and added to the projects "Plugins" folder.
- Project use many materials both from the UE marketplace and from the web. The material and texture packages below should be obtained from the web if any package/material/texture not found errors occur when compiling.
    - Animation Starter Pack
    - Beach Summer Pack
    - BeachShader
    - EssentialTreeKit
    - GTFreeMaterials
    - LowPolyForest
    - KiteDemo
    - Showcase_Assets
    - Starter Content
- Visual Studio 2017 should be installed to compile the project. Older versions won't compile the project.
- GSL Libraries should be installed to compile/run the project. You can download GSL from this link.

7.2 Compile & Run From Editor

•Copy the source files with a base folder to Unreal Engine default projects folder. (Optional)

•Open the VRELAX_IoR.uproject file.

•Run the application from blue play button.

•You can change the play settings like Standalone Game or New Window (Optional)

Note: Sometimes Editor doesn't sync with Visual Studio solution so if any error occurs please refer compile/run from VS 2017 section below.

7.3 Compile & Run From Visual Studio 2017

- Open VRELAX_IoR.sln file.
- Go to Configuration Properties -> VC++ Directories -> Additional Include directories. Add GSL/include folder that you have downloaded.
- Go to Configuration Properties -> VC++ Directories -> Additional Library directories. Add GSL/lib folder that you have downloaded.
- Compile and run the project with green start button named "Local Windows Debugger".

7.4 Installation

- Download project files named "VRELAX_IoR_V1.0.0-alpha.rar" from here.
- Extract the files.
- Run the VRELAX_IoR.exe to run the application.

Note: If any Prerequisites error occurs try running UE4PrereqSetup_x64.exe file first located in \Engine\Extras\Redist\en-us

8. User Manual

8.1 BASICS

8.1.1 Read Me First

Please read this manual before using the application to ensure safe and proper use. Application requires high CPU, RAM, and GPU usage which can affect your device's overall performance. According to your device's quality, you may not get high frames per second.

There are minimum requirements to run an HTC Vive VR application smoothly:

Name	Definition of Requirement
GPU	NVIDIA GeForce GTX 1060, AMD RX 480 equivalent or better
CPU	Intel i5-4590/AMD FX 8350 equivalent or better

RAM	4 GB or more
Video output	HDMI 1.4, DisplayPort 1.2 or newer
USB port	1x USB 2.0 or better port
OS	Windows 7 SP1, Windows 8.1 or later, Windows 10

When using HTC Vive there should be an open space in the room to prevent any injuries caused by the obstacles and using a VR Headset for a long time can cause dizziness and motion sickness, so participants should take a break after 45 minutes of use.

The product may trigger epileptic seizures or other symptoms linked to an epileptic condition so participants who has a previous history of epilepsy should consult a doctor.

8.2 USER INTERFACE AND CONTROLS

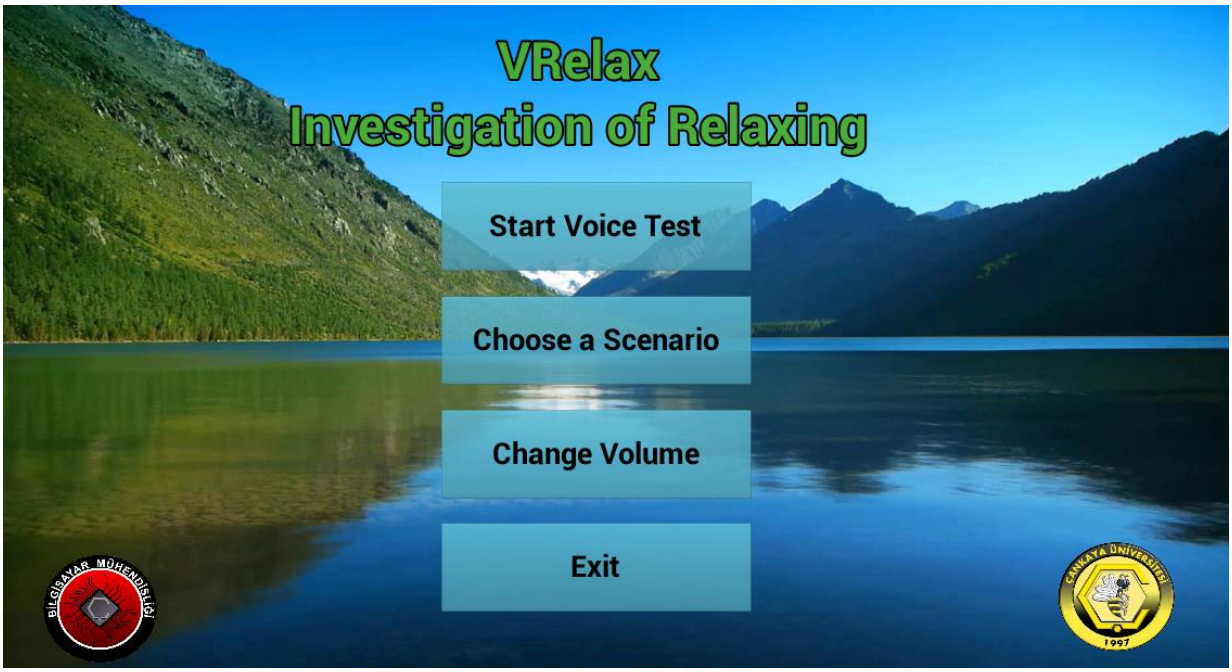


Figure 21: Main Menu of VRelax

In Main Menu, user shall have four options which are "Start Voice Test", "Choose a Scenario", "Change Volume", and "Exit". These options are:

UI Element	Definition
Start Voice Test	User shall be directed to the Voice Test Screen
Choose a Scenario	User shall be directed to the Scenario Choosing Screen
Change Volume	Volume Bar shall open at the right of the screen
Exit	Application shall close

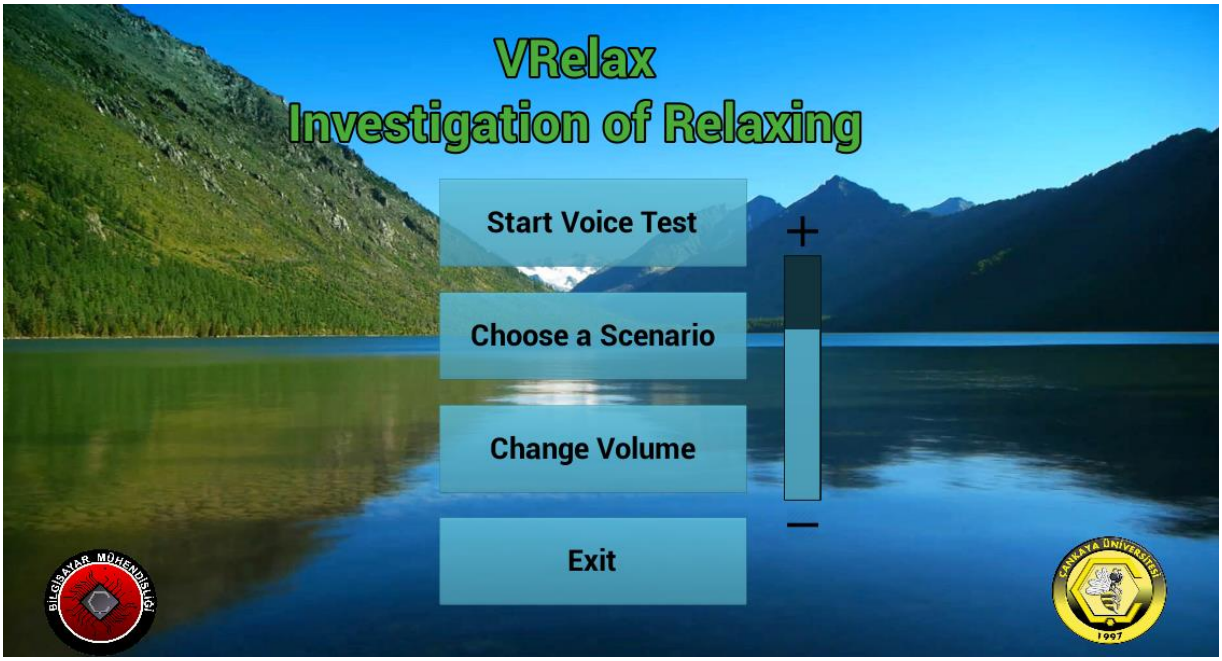


Figure 22: Change Volume Option

When Change Volume button is clicked, there shall be two buttons and one bar on the screen which are "Plus Button", "Minus Button", and "Volume Bar".

UI Element	Definition
Plus Button	When clicked, volume level shall increase
Minus Button	When clicked, volume level shall decrease
Volume Bar	Volume Bar represents the level of system volume

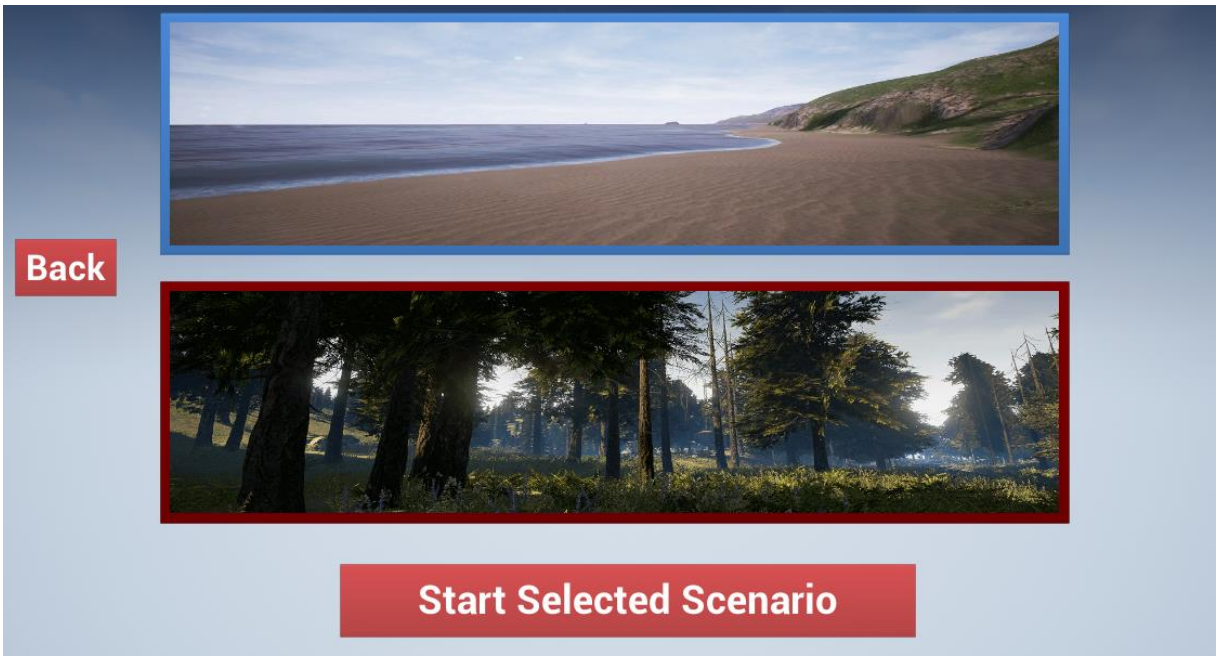


Figure 23: Choose a Scenario Button

When Choose a Scenario button is clicked in the Main Menu, Choosing Scenario Screen shall open. In this screen, there are "Back Button", "Start Selected Scenario Button", "Scenario Thumbnails", and "Red Box Outline".

UI Element	**Definition**
Back Button	When clicked, user shall be redirected to the Main Menu
Start Selected Scenario Button	When clicked, selected scenario shall start
Scenario Thumbnails	They represent scenarios, and they can be clicked to select desired scenario
Red Box Outline	Represents selected scenario

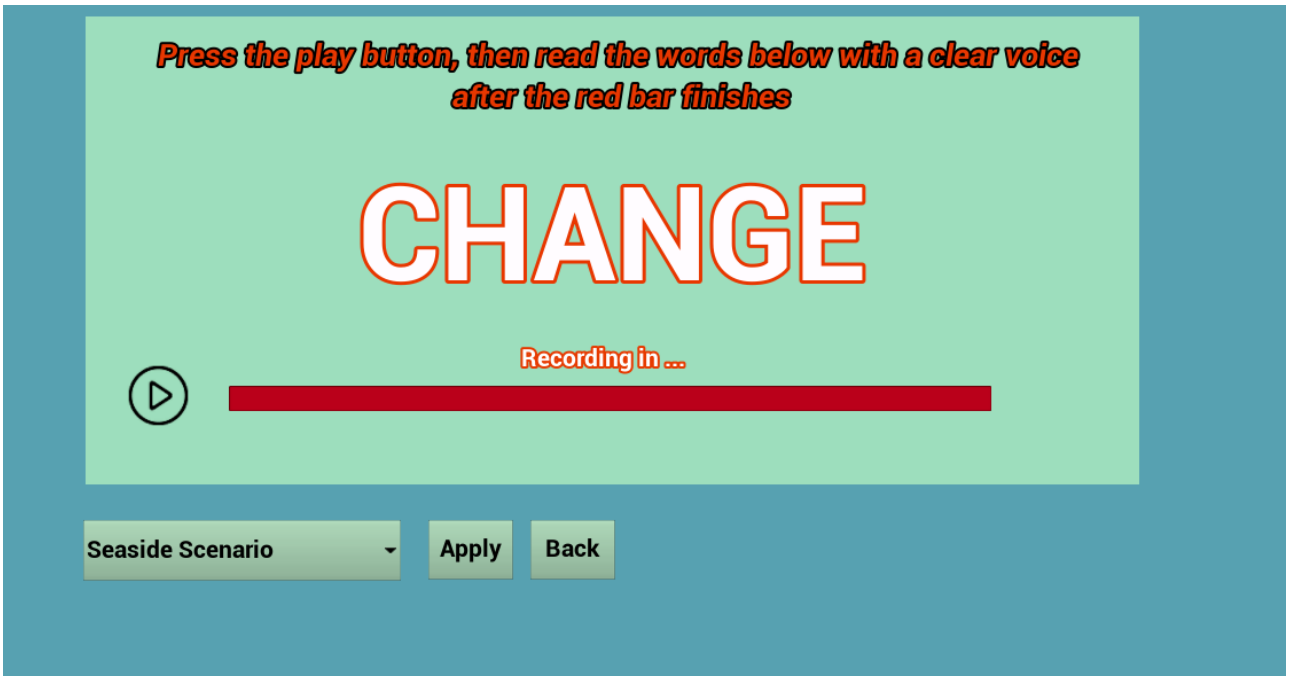


Figure 24: Voice Test Screen

When Start Voice Test button is clicked in the Main Menu, Voice Test Screen shall open. In this screen, there are "Play Button", "Choosing Scenario Dropdown Menu", "Apply Button", "Back Button", "Duration Bar", and three different texts.

UI Element	**Definition**
Play Button	When clicked, voice analysis process shall start after duration bar finishes
Choosing Scenario Dropdown Menu	When clicked, selectable scenarios shall appear
Apply Button	When clicked, selected scenario is applied
Back Button	User shall be redirected to the main menu
Duration Bar Button	When "Play Button" is clicked, duration bar shall finish within 3 seconds
Upper Text	Inform user about how s/he should use the system
Middle Text	SUSAS Database Words are written in this section
Lower Text	Inform user that his/her voice is recording

Figure 25: Seaside Scenario SS 1

Figure 26: Seaside Scenario SS 2

Figure 27: Seaside Scenario Thrown Rock

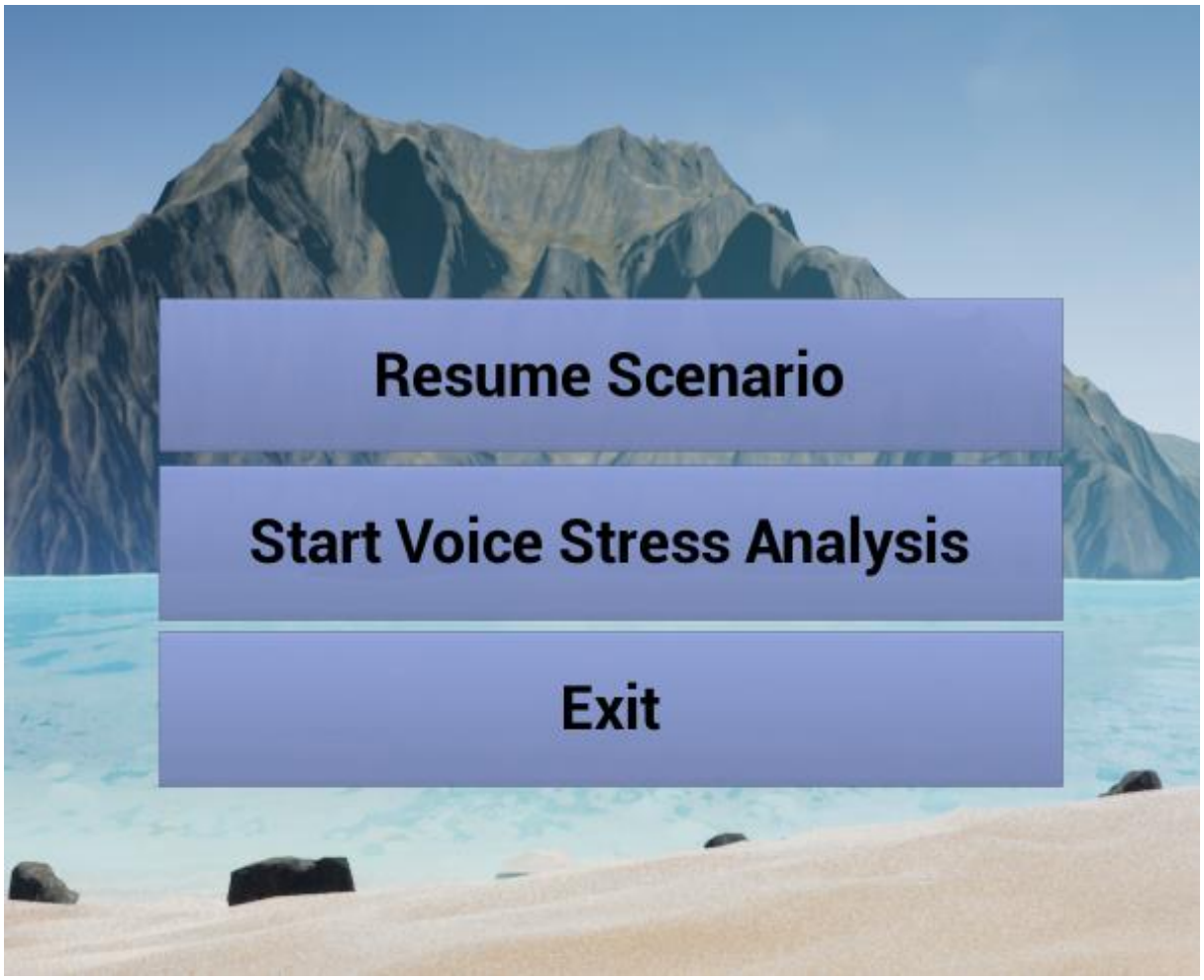


Figure 28: Seaside Scenario Option Menu

In Seaside Scenario; user can throw a rock, open the option Menu, and can choose one of three choices in the option menu. These choices are "Resume Scenario", "Start Voice Stress Analysis", and "Exit".

UI Element	**Definition**
Resume Scenario Button	When clicked, opened scenario shall continue
Start Voice Stress Analysis Button	When clicked, Voice Analysis screen shall open
Exit Button	When clicked, user shall be redirected to the Main Menu

HTC Vive Buttons	Definition
Grip Button	When pressed, Option Menu Shall open and game shall pause
Trackpad Button	When pressed, user shall throw a rock
Trigger Button	When pressed and hold, teleport indicator shall appear; when released user shall teleport to this location

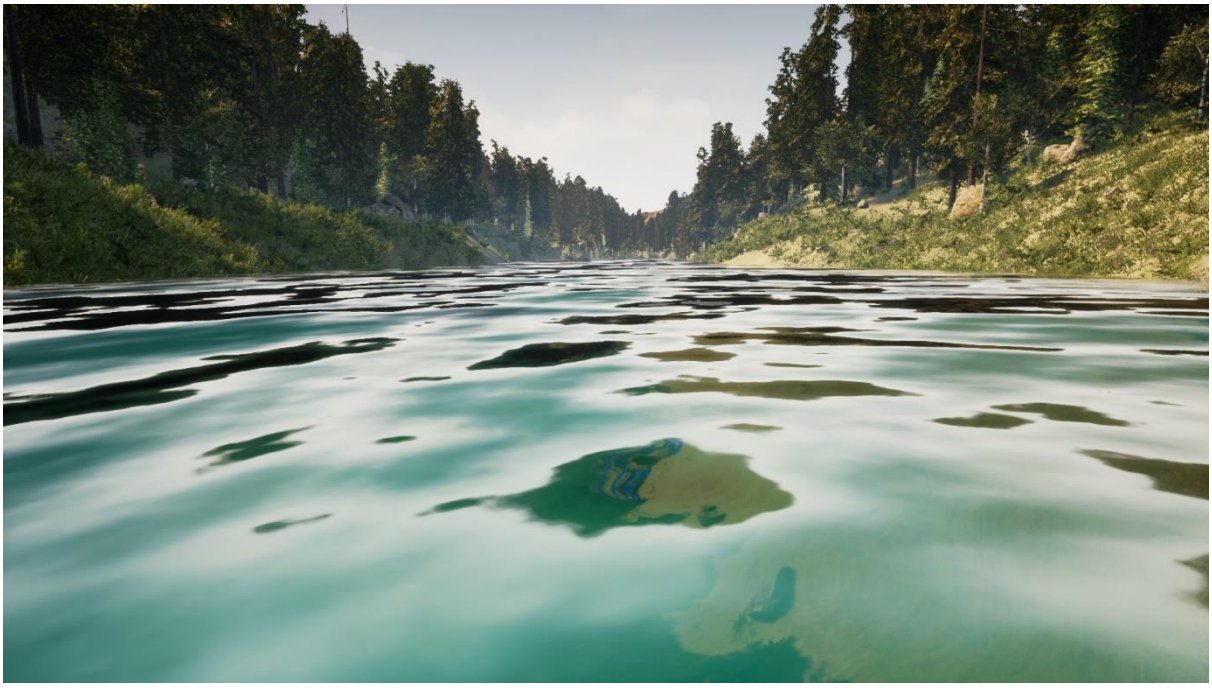


Figure 29: Creek In A Forest Scenario SS 1

Figure 30: Creek In A Forest Scenario SS 2

Figure 31: Apples In The World

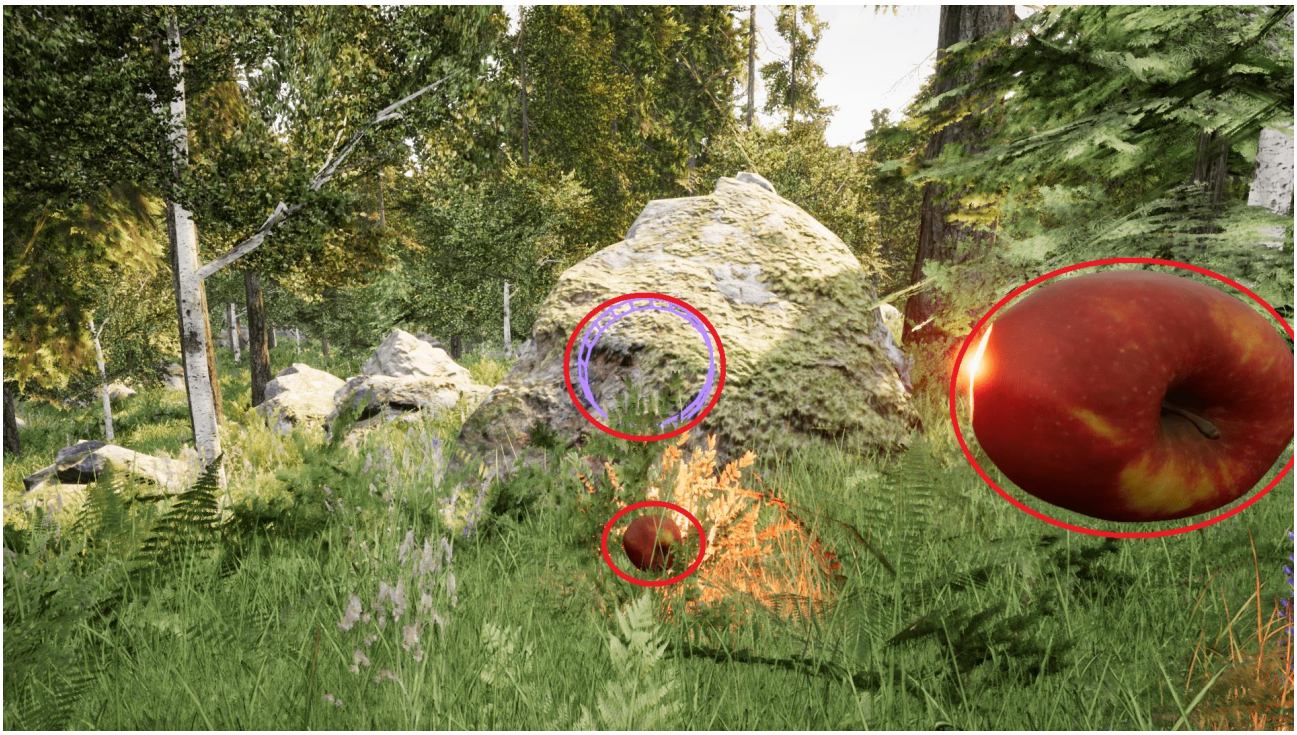


Figure 32: Teleport Indicator And Apples

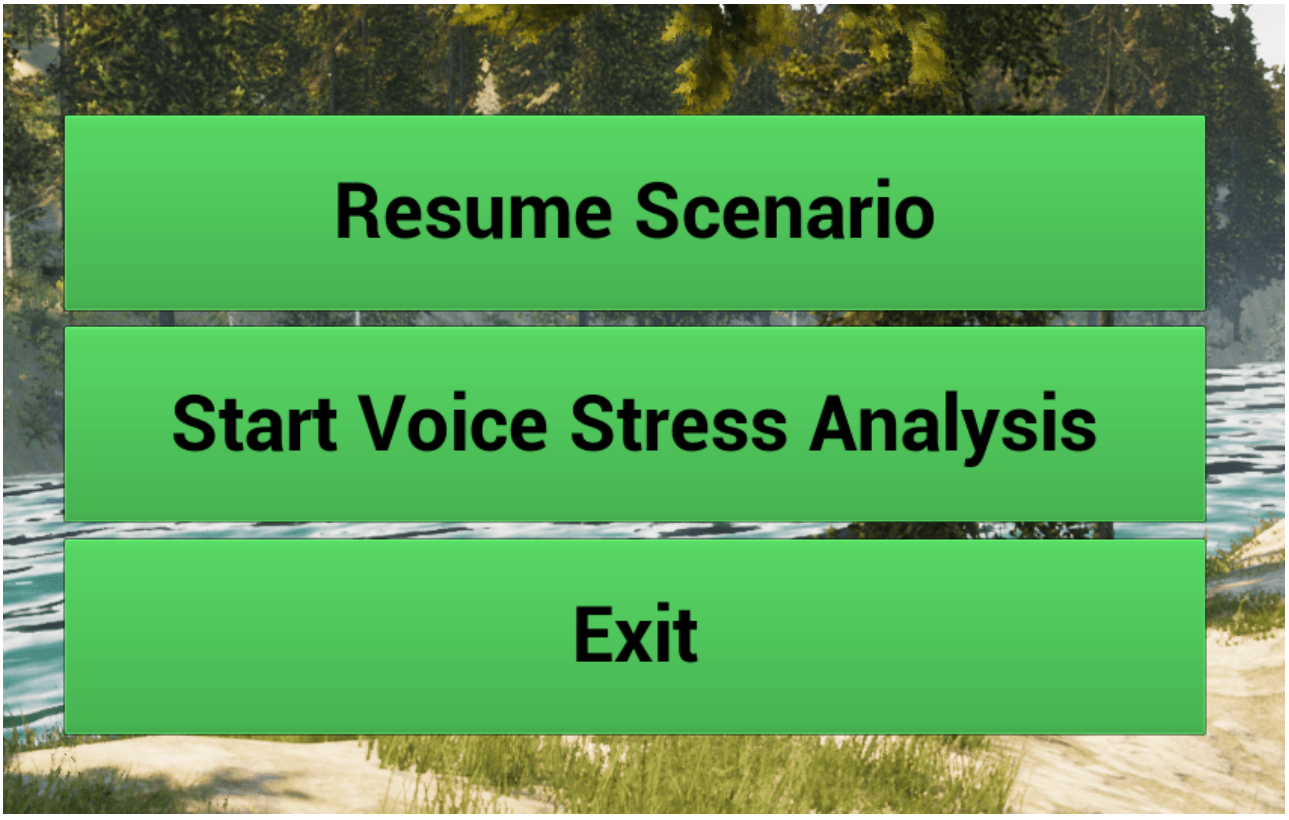


Figure 33: Creek In A Forest Option Menu

In Creek In A Forest Scenario; user can collect an -but only at a time- apple, eat an apple, open the option Menu, and can choose one of three choices in the option menu. These choices are "Resume Scenario", "Start Voice Stress Analysis", and "Exit".

UI Element	**Definition**
Resume Scenario Button	When clicked, opened scenario shall continue
Start Voice Stress Analysis Button	When clicked, Voice Analysis screen shall open
Exit Button	When clicked, user shall be redirected to the Main Menu

HTC Vive Buttons	**Definition**
Grip Button	When pressed, Option Menu Shall open and game shall pause
Trackpad Button	When pressed, user shall eat an apple if s/he has one
Trigger Button	When pressed and hold, teleport indicator shall appear; when released user shall teleport to this location

Creek In A Forest Scenario Specific UI and Controls	**Definition**
3D Apple Model	Apples are represented as 3D models. They can be found in the world. They spread red light around them in 3D world. When they are collected by user, they shall appear on the right side of the screen and stick to the user
Collecting an Apple	When user teleports on the apple, s/he shall automatically collect apple

9. Conclusions

This report includes detailed information about VRelax: Investigation of Relaxing. In this project, we have aimed to analyze stress with voice and reduce it with relaxing scenarios. We have planned to use HTC Vive for the VR system because of advanced technical features compared to other VR headsets and its compatibility with Unreal Engine.

To develop VRelax, we have made a lot of research about stress analysis, usage of VR technologies and similar works. We have analyzed different documents and projects to understand how to analyze stress with voice and learnt Unreal Engine fundamentals to get started for scenario implementations. After our research finished, we have determined the requirements of the project with both our supervisor and proposer company Mebitech. According to these requirements we have prepared an SRS document. In order to determine the design of the project we have prepared an SDD document for explaining design structures.

Our researches show that there are not many applications about this topic and they don't have a stress analysis tool like ours. In the future, we have implemented voice analysis structure and created immersive environments for our scenarios according to our SRS and SDD documents. We have revised the documents while developing the project, so these documents are not final version. There has been some disadvantages and difficulties for the developing project. Most important one was creating realistic environment. VR applications are demanding in terms of system requirements so using most realistic objects and textures are reducing performance and even could make the project unplayable. Another problem is that there is no example of implementing a voice analysis structure into the unreal engine environment, so we must combine them without destructive code approach.

In conclusion, while researching for our project and preparing these documents we have learned many things and we will continue to learn.

Acknowledgement

We are grateful for the help and guidance that we have received from our advisor Dr. Faris Serdar Taşel and co-advisor Assist. Prof. Dr. Murat Yılmaz. We improved both the project and ourselves thanks to their valuable comments and advices. We are also grateful to our proposer

company Mebitech for giving us this opportunity. This work couldn’t have been possible without the help received from them.

References

[1] L. He, M. Lech, S. Memon and N. Allen, "Recognition of Stress in Speech using Wavelet Analysis and Teager Energy Operator", Interspeech, 2008.

[2] Relaxvr.co. (2018). Relax VR - Rest, Relaxation & Meditation in Virtual Reality. [online] Available at: http://www.relaxvr.co/ [Accessed 10 Jan. 2018].

[3] MonarchVR. (n.d.). Home. [online] Available at: http://monarchvr.org/ [Accessed 10 Jan. 2018].

[4] Atmosphaeres. (n.d.). Immersive 360° Nature & Travel Videos & VR Experiences for personal wellbeing. [online] Available at: https://www.atmosphaeres.com/ [Accessed 10 Jan. 2018].

[5] According to Dictionary.com:

“The tendency of a system, especially the physiological system of higher animals, to maintain internal stability, owing to the coordinated response of its parts to any situation or stimulus that would tend to disturb its normal condition or function.”

[6] J. Zhang, N. Mbitiru, P. Tay and R. Adams, "Analysis of Stress in speech using adaptive Empirical Mode Decomposition", 2009 Conference Record of the Forty-Third Asilomar Conference on Signals, Systems and Computers, 2009.

[7] J. Zhang, N. Mbitiru, P. Tay and R. Adams, "Analysis of Stress in Speech Using Empirical Mode Decomposition", Proceedings of the 2008 IAJC-IJME International Conference, 2008.

[8] C. Hopkins, R. Ratley, D. Benincasa and J. Grieco, "Evaluation of Voice Stress Analysis Technology", Proceedings of the 38th Annual Hawaii International Conference on System Sciences, 2005.

[9] J. Hansen, "Analysis and compensation of speech under stress and noise for environmental robustness in speech recognition", Speech Communication, vol. 20, no. 1-2, pp. 151-173, 1996.

[10] A. Suresh and H. Shaheen, "Speech Stress Analysis based on Lie Detector for Loyalty Test", International Journal of Printing, Packaging & Allied Sciences, vol. 4, no. 1, pp. 631-638, 2016.

[11] C. Repetto, A. Gaggioli, F. Pallavicini, P. Cipresso, S. Raspelli & G. Riva, "Virtual reality and mobile phones in the treatment of generalized anxiety disorders: A phase-2 clinical trial". Personal and Ubiquitous Computing, 17(2), pp. 253–260, 2015.

[12] A. Rizzo, J. Difede, B. Rothbaum, J. M. Daughtry and G. Reger, "Virtual Reality as A Tool for Delivering PTSD Exposure Therapy," 2013.

[13] P. Oskam, "Virtual Reality Exposure Therapy (VRET) effectiveness and improvement.", in 2nd Twente Student Conference on IT, Twente, pp. 1-3, 2005.

[14] J. Difede and H. Hoffman, "Virtual Reality Exposure Therapy for World Trade Center Post-Traumatic Stress Disorder: A Case Report", CyberPsychology & Behavior, vol. 5, no. 6, pp. 529-535, 2002.

[15] M. Krijn, P. Emmelkamp, R. Olafsson and R. Biemond, "Virtual reality exposure therapy of anxiety disorders: A review", Clinical Psychology Review, vol. 24, no. 3, pp. 259-281, 2004.

[16] T. Parsons and A. Rizzo, "Affective outcomes of virtual reality exposure therapy for anxiety and specific phobias: A meta-analysis", Journal of Behavior Therapy and Experimental Psychiatry, vol. 39, no. 3, pp. 250-261, 2008.

[17] S. Côté and S. Bouchard, "Virtual reality exposure for phobias: A critical review", Journal of CyberTherapy and Rehabilitation, vol. 1, pp. 75-91, 2008.

[18] K. Meyerbröker and P. Emmelkamp, "Virtual reality exposure therapy in anxiety disorders: a systematic review of process-and-outcome studies", Depression and Anxiety, vol. 27, no. 10, pp. 933-944, 2010.

[19] L. Hodges, B. Rothbaum, R. Alarcon, D. Ready, F. Shahar, K. Graap, J. Pair, P. Hebert, D. Gotz, B. Wills and D. Baltzell, "A Virtual Environment for the Treatment of Chronic Combat-Related Post-Traumatic Stress Disorder", CyberPsychology & Behavior, vol. 2, no. 1, 1999.

[20] S. Ruzzo, "Bravemind: Virtual Reality Exposure Therapy", University of Southern California Institute, Los Angeles, 2005.

[21] P. Yellowlees, K. Holloway and M. Parish, "Therapy in Virtual Environments—Clinical and Ethical Issues", Telemedicine and e-Health, vol. 18, no. 7, pp. 558-564, 2012.

[22] A. M, C. Jorge and P. Couto, "Using a Game Engine for VR Simulations in Evacuation Planning", IEEE Computer Graphics and Applications, vol. 28, no. 3, pp. 6-12, 2008.

[23]"VIVE™ | Vive Ready Computers", Vive.com, 2017. [Online]. Available: https://www.vive.com/us/ready/. [Accessed: 08- Dec- 2017].

[24]"Ar-Ge | Mebitech Bilişim A.Ş.", KAYYEN, 2017. [Online]. Available: http://www.mebitech.com/arge?arge=17. [Accessed: 09- Dec- 2017].

[25] J. Hansen and S. Bou-Ghazale, "Getting Started with SUSAS: A Speech Under Simulated and Actual Stress Database", Fifth European Conference on Speech Communication and Technology, 1997.