UNIVERSITY OF THE PHILIPPINES MANILA
COLLEGE OF ARTS AND SCIENCES
DEPARTMENT OF PHYSICAL SCIENCES AND MATHEMATICS

SP Proposal

oVRnight: Developing a Virtual Reality Imagery Rehearsal Therapy Application for Nightmare Disorders

Submitted by:
Mikaella Louise D. Layug
[Month] 2024

Contents

I. Introduction **3**

a. Background of the Study 3

b. Statement of the Problem 4

c. Objectives of the Study 4

d. Research Questions 6

e. Significance of the Project 6

f. Scope and Limitations 6

g. Assumptions 7

II. Review of Related Literature **9**

III. Theoretical Framework **12**

IV. Design and Implementation **18**

V. Expected Output/Timeline

References

I. Introduction

A. Background of the Study

Nightmares are marked by intense negative emotions and usually take place during the rapid eye movement (REM) stage of sleep [1]. They are distressing dreams that can cause temporary fear, anxiety, or sadness, often occurring occasionally without significant impact on an individual's daily functioning. In contrast, Nightmare Disorder, as defined by the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) [2] and International Classification of Sleep Disorders (ICSD-3) [3], involves recurrent episodes of prolonged and extremely dysphoric nightmares that typically feature threats to one's physical integrity or safety. These nightmares occur at least once a week, lead to vivid recollections upon awakening, and result in substantial emotional turmoil and impairment in daily life [4,5]. While nightmares can be a common experience for many, Nightmare Disorder represents a clinically significant condition that disrupts sleep and adversely affects overall well-being.

This study will focus specifically on idiopathic nightmares, which occur independently of conditions such as post-traumatic stress disorder (PTSD). In contrast to trauma-related nightmares, idiopathic nightmares are not associated with any particular psychopathology, and their content can vary significantly [6]. Nevertheless, they still cause substantial emotional and psychological distress to the person experiencing them. Approximately 2 to 5% of the general population experiences nightmare disorder, which includes idiopathic nightmares [7]. Additionally, the causes of idiopathic nightmares remain under-researched, though they typically begin in childhood, with genetics potentially playing a moderate role [8].

Nightmare disorder can persist for decades if left untreated. Imagery Rehearsal Therapy (IRT), a cognitive-behavioral technique that involves recalling the nightmare, modifying the storyline to create a positive ending, and rehearsing the new version daily for 5–10 minutes, is the only non-pharmacological treatment for nightmare disorder that has a Level A recommendation [9]. IRT has been shown to reduce the frequency and intensity of nightmares. However, its effectiveness may be limited for individuals who struggle with generating visual imagery, as the therapy relies on the ability to create new mental images [10].

This is where virtual reality (VR) presents a promising alternative. Virtual reality (VR) immerses users in a 3D, computer-generated environment, either real or fictional, with interactive graphics and sensory feedback like sound, touch, and smell, creating a sense of presence in a physical space [11]. Immersive VR, in particular, allows users to experience a fully interactive 360-degree virtual environment by tracking their movements and updating the display accordingly [12]. By prioritizing user experience, it can improve access to psychological therapies and enhance treatment outcomes [13]. Its ability to simulate new realities may offer a more engaging and accessible option for individuals who struggle with traditional imagery techniques like IRT .

Although there have been significant advancements in virtual reality (VR) technology in the last decade, it remains relatively new. Consequently, there has been limited research dedicated to image rescripting techniques [14]. This study aims to explore Image Rehearsal Therapy (IRT) in VR, which shares similarities with image rescripting but specifically addresses nightmares. A closely related study by McNamara et al. (2018) examines Rescript—a virtual reality-based treatment that combines imagery rehearsal and rescripting for nightmares. This work lays a foundation for further investigation into related interventions. Building on their findings, my study will specifically focus on IRT and its application within virtual reality, aiming to enhance therapeutic outcomes for individuals experiencing Nightmare Disorders.

B. Statement of the Problem

Despite the effectiveness of Imagery Rehearsal Therapy (IRT) for Nightmare Disorder, its reliance on mental imagery presents challenges for individuals who struggle with visualization. Current treatments lack an alternative approach that caters to these individuals, and there is no known tool to assist them in overcoming this barrier. There is no known tool to help them aid this. This study seeks to address this gap by exploring the use of Virtual Reality (VR) to enhance the delivery of IRT.

C. Objectives of the Study

This research provides Virtual Reality Image Rehearsal Therapy (VR-IRT) system with the following functionalities:

The system accommodates two types of users: patients and sleep experts, and is divided into two components: the Mobile (VR) Application and the Website.

1. Patients can load and select from 5 common idiopathic nightmare scenarios:
    a. Falling
    b. Being Chased
    c. Being Shot
    d. Evil Force
    e. Failing an Exam
2. Patients can explore a variety of configurations to reimagine their nightmares. They can select different figures that will appear in the scenario, and customize the actions within the scenario–including actions for themselves, the figures, and changes to the environment itself.
    a. Falling:
        - Free-falling from a tall building
        - **Allowed changes:**
            1. Users can land on:
                a. Trampolines
                b. Soft Clouds
                c. Giant inflatable
            2. Users can:
                a. Fly
                b. Float
                c. Glide softly
    b. Being Chased:
        - A dark alley at night with a stranger following you.
        - **Allowed changes:**
            1. Environment:
                a. Bright, sunlit park
                b. Friendly neighborhood
                c. An amusement park
            2. Figure:
                a. Turns into a playful animal
                b. Turns to a friendly stranger
                c. Trips/Slips

c. **Being shot:**
    - An apocalyptic setting with bullets approaching you.
    - **Allowed changes:**
        1. **Environment:**
            a. A peaceful meadow
            b. A protective dome
            c. Time slow-mo
        2. **Bullet changes:**
            a. Bubbles
            b. Water
            c. Rubber ducks

d. **Evil Force:**
    - In a dark forest with monsters roaming around.
    - **Allowed changes:**
        1. **Environment**
            a. A peaceful meadow
            b. Fairies' company
            c. Bright, sunlit park
        2. **Monsters changes:**
            a. Turn cute
            b. Dance
            c. Become tiny

e. **Failing an Exam:**
    - In a classroom, taking an exam
    - **Allowed changes:**
        1. **Interactive elements:**
            a. Study helper
            b. Customizable Paper Theme
            c. Game mode
        2. **Outcome:**
            a. Perfect score
            b. Classmates cheering
            c. Teacher praising

3. Patients can visualize the rewritten nightmare scenario.

4. Patients can save their preferred configurations for each nightmare, allowing for easy access in future sessions.
5. Patients can pause or exit the VR session at any time.
6. Patients can log their nightmare experiences, review recorded logs, and access their session history entirely within the VR application.
7. Additionally, both Sleep Experts and Patients can access these recorded logs and session history through a website, providing added flexibility for tracking progress.

D. Research Questions

1. How can VR be helpful in enhancing therapeutic techniques for treating Nightmare Disorder?
2. In what ways do sleep experts believe the features of the VR-IRT system enhance the therapeutic experience compared to traditional methods?
3. What are sleep experts' perspectives on the adaptability of the VR-IRT system for different patient populations, including those with visualization difficulties?

E. Significance of the Project

This application provides Virtual Reality Image Rehearsal Therapy (VR-IRT) for individuals experiencing nightmare disorders by offering an immersive environment where they can safely rehearse and alter distressing dreams. It can also be a valuable tool for sleep experts, potentially aiding their treatment process by offering a more engaging and effective way to administer therapy and track patient progress.

F. Scope and Limitations

1. This application will focus on individuals diagnosed with nightmare disorders, particularly those who experience idiopathic nightmares.
2. This application only addresses the immersive experience of nightmares, which may not encompass all aspects of the disorder.
3. This application focuses on addressing only five common idiopathic nightmare themes.
4. While the application offers a variety of options for customization, the choices available are not exhaustive, and certain limitations exist. Users can select from

predefined environments, figures, and actions, but these selections may not encompass every possible variation or scenario.

5. The study's sample size may be limited, potentially affecting the generalizability of the findings to the wider population of individuals with nightmare disorders.
6. The application is only available in English, which may limit accessibility for non-English speaking users.
7. This application does not incorporate augmented reality features, focusing exclusively on virtual reality experiences.
8. Evaluating its effectiveness falls outside the scope of this study.

G. Assumptions

1. It is assumed that users have access to virtual reality goggles, headphones, and handheld devices, which may limit accessibility for individuals without this specific technology.
2. While the system can be utilized both during therapy sessions and outside of them, it is assumed that patients still visit sleep experts to discuss their progress and receive guidance on enhancing the effectiveness of the system.
3. It is assumed that users possess a basic level of technical proficiency, enabling them to effectively navigate the application and utilize its features.
4. It is assumed that users will actively participate in the experience by modifying scenarios and providing constructive feedback after each session, both of which are essential for enhancing the therapeutic process.
5. It is assumed that users do not have any health conditions (e.g., severe anxiety disorders, epilepsy) that could be exacerbated by immersive virtual reality experiences.

II. Review of Related Literature

Nightmare Disorder

The Diagnostic and Statistical Manual of Mental Disorders (DSM-5) [2] provides standardized criteria for diagnosing mental health conditions and brain related disorders. Similarly, the International Classification of Sleep Disorders (ICSD-3) [3] offers a detailed classification of sleep disorders based on diagnostic criteria and evidence-based research.

Both of these references include discussions of parasomnias—abnormal behaviors that occur during sleep. According to Howell (2012) [15], parasomnias are defined by unusual behaviors that arise during sleep. These behaviors are further classified into different categories, one of which is REM-related parasomnias. This category includes disorders that occur during the Rapid Eye Movement (REM) sleep stage. REM sleep is characterized by a highly active brain while the body's muscles remain mostly paralyzed to prevent dream enacting behavior (DEB). Disruptions in this process can lead to REM-related parasomnias, such as Nightmare Disorder.

Nightmare Disorder Criteria

A paper by Stefani & Högl (2020) [4] explores Nightmare Disorder. According to the ICSD-3, Criterion A for diagnosing Nightmare Disorder describes nightmares as "extended, extremely dysphoric, and well-remembered dreams that usually involve efforts to avoid threats to survival, security, or physical integrity." For Nightmare Disorder diagnosis, these nightmares must meet specific criteria outlined by the ICSD-3: First, individuals affected by this disorder often experience recurring, vivid nightmares that typically feature threats to their safety, security, or physical well-being. Second, upon waking, they generally regain alertness and orientation quickly, which contrasts with other parasomnias where disorientation may persist. Lastly, the nightmares affect social, professional, or other critical areas of functioning, resulting in clinically severe distress or impairment. Additionally, the DSM-5 specifies that for a diagnosis, nightmares should occur at least once a week. While nightmares can be a common experience for many, Nightmare Disorder represents a clinically significant condition that disrupts sleep and adversely affects overall well-being.

Idiopathic Nightmares and Themes

Sheaves et al. (2023) [8] identify two main types of Nightmare Disorder: posttraumatic nightmares, which are associated with specific traumatic events, and idiopathic nightmares, which lack a direct link to trauma. Idiopathic nightmares are thought to have a genetic component, and individuals who frequently experience them in childhood are three times more likely to face serious psychiatric disorders later in life compared to those who do not. Although these nightmares appear to be unrelated to trauma, their underlying causes remain largely unexplored. Idiopathic nightmares can vary significantly. Robert & Zadra's (2014) [16] study aimed to identify recurring themes in idiopathic nightmares. Participants first kept detailed daily logs of all remembered dreams over a period of 2-5 weeks, keeping

track of 9,796 dreams in total. These dream narratives were then subjected to a content analysis, where the researchers applied thematic categories grounded in prior literature, a modified Typical Dreams Questionnaire, and pilot testing. Findings identified Physical Aggression as the most frequent occurring theme in nightmares, appearing in 48.6% of cases, involving direct threats to physical safety such as attacks or kidnappings. Interpersonal Conflicts were also prevalent, found in 21.0% of nightmares, indicating social disputes or hostility. The third common theme, Failure or Helplessness, occurred in 16.2% of nightmares, involving scenarios where the dreamer feels incapable or out of control. Additionally, themes of Being Chased and encountering an Evil Forces were each reported in 11.1% of nightmares, featuring pursuits or supernatural encounters. Other themes, though less dominant, were still noteworthy. These included themes related to Health-Related Concerns and Death, Apprehension/Worry, Accidents, Disasters and Calamities, Insects, and Environmental Abnormality.

Pharmacological and Non-pharmacological treatments

Nadorff et al., (2014) [17] discusses several pharmacological and psychotherapeutic (or non-pharmacological) interventions for Nightmare Disorder. Many medications have been explored for treating nightmares, but since prazosin is the only medication that has continuously demonstrated effectiveness in treating nightmares and distressed awakenings, the American Academy of Sleep Medicine has given prazosin a level A recommendation for treating Nightmare Disorder. On the other hand, psychological interventions are generally preferred for treatment of nightmares because of its durable and fewer-side effects. Psychotherapeutic interventions include Imagery Rehearsal Therapy (IRT), a cognitive-behavioral technique that involves recalling the nightmare, modifying the storyline to create a positive ending, and rehearsing the new version daily for 5–10 minutes [9]. The foundation of IRT is the idea that nightmares are a learned behavior. Therefore, they can be replaced with a less disruptive behavior—in this case, a new dream that doesn't interfere with daily activities or sleep, as IRT aims to demonstrate.

Imagery Rehearsal Therapy

Krakow and Zadra (2006) [18] outline a four-session framework for Image Rehearsal Therapy (IRT), which consists of four distinct models they developed for their own study, while IRT itself is an established therapeutic approach for treating nightmares. The initial two sessions of IRT focus on helping patients recognize how nightmares develop into learned

behaviors, understand this cycle, and learn how to break it. Since nightmares often disturb sleep, they can lead to increased anxiety about going to bed. Because of the anticipation of nightmares, this dread of sleep can develop into a habit, causing the person to feel anxious every night before bed. Over time, this repetitive pattern of worry and disturbed sleep can turn nightmares into a learned habit, as the person comes to expect them to occur each night. The last two sessions help the patient connect with their imagery system and utilize both imagery and rehearsal to “change” their nightmare. The steps for IRT include selecting a nightmare, changing the nightmare into a better dream, rehearsing the new dream at a time of your choosing, and maintaining this practice daily. The study emphasizes that patients should rehearse only the new dream and not the previous nightmare. Additionally, for IRT to be effective, it's crucial that patients start with a less intense nightmare. When they begin with an overwhelming or trauma-related nightmare, they often encounter difficulties, finding the process of IRT ineffective or challenging to implement.

Virtual Reality

IRT has been shown to reduce the frequency and intensity of nightmares. However, its effectiveness may be limited for individuals who struggle with generating visual imagery, as the therapy relies on the ability to create new mental images [10]. Virtual reality (VR) provides a promising alternative by allowing users to engage directly with visual experiences, rather than relying solely on imagination. According to Hamad & Jia (2022) [12], VR is a three-dimensional, computer-generated virtual environment that people may interact with. Moreover, Immersive VR is a type of VR that uses devices like Head-Mounted Displays (HMDs) to create a fully engaging virtual environment that gives the impression that the user is actually "present" in the virtual world. Parsons (2016) [19] explores Virtual Reality Exposure Therapy (VRET), which enables users to experience and interact with realistic scenarios to treat anxiety and specific phobias without relying solely on their imagination. Parson’s study suggests that immersive Virtual Environments allow gradual exposure to emotional triggers in a controlled, safe setting, which creates scenarios that are difficult or unsafe to replicate in real life.

Systematic Review of Image Rescripting for VR

Gagliardi and Markowski (2024) [20] recently conducted a systematic review of 14 articles covering 12 distinct studies to examine the potential of Active Imagery Rescripting (AIR) using Virtual Reality (VR) for treating different psychological conditions. Image

Rescripting (IR) and Image Rehearsal Therapy (IRT) share a common goal of altering mental imagery to achieve a better emotional outcome However, while IR is designed to modify distressing past memories, IRT specifically targets the rehearsal and modification of recurring nightmares. Both approaches involve 'changing' mental imagery, but IR focuses on transforming real-life memories, whereas IRT is aimed at reducing nightmare frequency and intensity. In AIR, the patient is the active "rescriptor," meaning they have a sense of control over the reworking of the memory during therapy. This approach contrasts with traditional Imagery Rescripting (IR), where the therapist might play a more significant guiding role. While Imagery Rescripting (IR) has proven effective in traditional, in-person settings, this study explores approaches for implementing IR within a VR environment, which have garnered positive results. VR allows patients to assume the role of the 'rescriptor' of their traumatic memories, fostering a greater sense of control and empowerment. Additionally, VR environments can be customized to meet individual needs, enabling more personalized therapeutic interventions. The effectiveness of Imagery Rehearsal Therapy (IRT) in similar settings suggests promising potential for adapting IRT to VR as well

Virtual Reality Imagery Study (How VR helps in enhancing imagery)

A study by Bedir and Erhan (2021) [21] investigates how Virtual Reality-Based Imagery (VRBI) practices affect athletes' performance sports involving targets such as archery, curling, and bowling. It compares VRBI to the widely-used Visual Motor Behavior Rehearsal with Video Modeling (VMBR + VM) approach. The athletes were split into three groups at random: control, VMBR + VM, and VRBI. Over a four-week period, participants engaged in training, and their shot performance and imagery skills were measured. Results showed that VRBI training significantly improved both imagery skills and performance faster than VMBR + VM, highlighting the benefits of immersive VR environments in enhancing imagery training for athletes. Although their study focused on enhancing imagery skills for athletes, the benefits of VR's immersive nature are relevant to the current research. This aligns with the current study's objective of leveraging VR's ability to offer direct visual experiences, reducing reliance on the patient's imaginative capacity.

VR IRT Related Study (Just Focused on Pictures)

McNamara et al. (2018) [22] conducted a study that closely aligns with the objectives of this research. Rescript, a virtual reality-based treatment that combines imagery rehearsal and rescripting for nightmares. In their 4-week pilot study involving 19 participants, ReScript was assessed by having participants attend two sessions each week, using VR controllers via a VR Oculus headset to alter three scary or terrifying pictures for each session. The goal was

to transform these images into less intimidating ones to gain cognitive control over intrusive visuals and reduce their impact of nightmare distress, general anxiety, or these visions during the day. The study showed significant reductions in anxiety and nightmare-related distress, with no adverse effects reported, suggesting that ReScript could serve as a safe and effective short-term treatment. VR-based IRT for Nightmare Disorder builds Rescript's proven approach, potentially improving or expanding upon it.

II. Theoretical Framework

A. Nightmare Disorder

Nightmares are marked by intense negative emotions and usually take place during the rapid eye movement (REM) stage of sleep [1]. They are distressing dreams that can cause temporary fear, anxiety, or sadness, often occurring occasionally without significant impact on an individual's daily functioning. In contrast, Nightmare Disorder, as defined by the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) [2] and International Classification of Sleep Disorders (ICSD-3) [3], involves recurrent episodes of prolonged and extremely dysphoric nightmares that typically feature threats to one's physical integrity or safety. These nightmares occur at least once a week, lead to vivid recollections upon awakening, and result in substantial emotional turmoil and impairment in daily life [4,5]. While nightmares can be a common experience for many, Nightmare Disorder represents a clinically significant condition that disrupts sleep and adversely affects overall well-being.

1. Idiopathic Nightmares

Idiopathic nightmares occur independently of conditions such as post-traumatic stress disorder (PTSD). In contrast to trauma-related nightmares, idiopathic nightmares are not associated with any particular psychopathology, and their content can vary significantly [6]. Nevertheless, they still cause substantial emotional and psychological distress to the person experiencing them. Approximately 2 to 5% of the general population experiences nightmare disorder, which includes idiopathic nightmares [7]. Additionally, the causes of idiopathic nightmares remain under-researched, though they typically begin in childhood, with genetics potentially playing a moderate role [8].

2. How to Treat Nightmare Disorder

There are different types of treatments for Nightmare Disorder, ranging from pharmacological and non-pharmacological treatments. Prazosin is the most common medication for Nightmare Disorder (ND) with Level A recommendation. For non-pharmacological treatments of ND, there is Imagery Rehearsal Therapy, Exposure-Based Therapies, and Cognitive Based Therapies [17]. Among these, Imagery Rehearsal Therapy (IRT), a technique that involves recalling the nightmare, modifying the storyline to create a positive ending, and rehearsing the new version daily for 5–10 minutes, is the only non-pharmacological treatment for nightmare disorder that has a Level A recommendation [9]. IRT has been shown to reduce the frequency and intensity of nightmares.

B. The Four Principles of Medical Ethics

The four principles of medical ethics include the Principle of Beneficence, Nonmaleficence, Autonomy, and Justice [23].

B.1 Principle of Beneficence

This principle obligates the developer to design the system with the goal of actively promoting the patient's well-being. Unlike nonmaleficence, which focuses on avoiding harm, beneficence emphasizes improving the patient's condition. VR IRT adheres to this principle by providing features that allow users to rewrite their nightmares and visualize them as positive scenarios. By integrating immersiveness and enhancing imagery, VR IRT creates a more engaging and effective therapeutic experience to aid in reducing distress and improving the patient's psychological well-being.

B.2 Principle of Nonmaleficence

This principle requires that developers ensure the application does not cause harm to the patient. This includes avoiding physical harm, such as VR-induced motion sickness, as well as psychological harm, like overwhelming or retraumatizing scenarios. VR IRT is advised to be used for only 5-10 minutes per session, similar to how long traditional IRT is recommended to last. Additionally, the system has been carefully developed with a focus on visual design, ensuring that scenarios avoid disorienting elements that could lead to VR-induced motion sickness. Lastly, VR IRT is designed to ensure patients do not relive their original nightmares, as it only allows users to experience the rewritten scenarios.

B.3 Principle of Autonomy

This principle highlights the patient's right to make informed decisions about their own therapy, ensuring they have control over their experience. VR IRT aligns with this principle by enabling patients to use the system in the comfort of their own homes, under the guidance of sleep experts. Patients can configure nightmare scenarios to match their preferences, fostering a sense of ownership. Additionally, the system includes safe options such as the ability to pause or exit the therapy at any time, ensuring that patients remain in control throughout their sessions.

B.4 Principle of Justice

This principle emphasizes fair and equitable treatment for all users, ensuring that access to the therapy is not restricted by socioeconomic status, disability, or other limiting factors. Achieving Justice means designing an inclusive system that caters to a diverse range of patients. By utilizing affordable hardware, such as Google Cardboard for the headset and Realcontrol for the controller, the therapy becomes accessible to a broader audience. Additionally, offering the system free of charge ensures that financial barriers do not prevent individuals from benefiting.

C. Virtual Reality

Virtual reality (VR) immerses users in a 3D, computer-generated environment, either real or fictional, with interactive graphics and sensory feedback like sound, touch, and smell, creating a sense of presence in a physical space [11]. Immersive VR, in particular, allows users to experience a fully interactive 360-degree virtual environment by tracking their movements and updating the display accordingly [12]. By prioritizing user experience, it can improve access to psychological therapies and enhance treatment outcomes [13].

1. Head Mounted Display

An HMD (Head-Mounted Display) is a device worn on the head to create immersive Virtual Reality (VR) experiences. It works by displaying computer-generated images, slightly different for each eye, to produce a 3D effect that allows users to perceive depth in the virtual environment. Its main purpose is to fully immerse the user in a virtual world by blocking out the real world and dynamically adjusting the visuals based on the user's movements [24].

2. Google Cardboard

Google Cardboard is an affordable alternative to traditional VR headsets, providing an

easy and cost-effective solution for users to experience immersive virtual reality through their smartphones. It also includes an open-source Cardboard SDK, which provides essential VR functionalities such as motion tracking, stereoscopic rendering, and interactive features. This SDK enables developers to create immersive VR experiences that work seamlessly across both Android and iOS platforms [25. 26].

Figure 1: Google Cardboard

3. RealControl

RealControl is an affordable, DIY alternative to traditional VR controllers, allowing users to create their own immersive experience. By following the provided blueprint and assembly instructions, you can construct a functional VR controller using common materials like cardboard. This hands-on approach not only reduces costs but also offers a customizable solution for virtual reality interaction [27].

Figure 2: RealControl DIY instructions

D. Android

Android is an open-source, Linux-based mobile operating system. It was originally developed by Android Inc., which was acquired by Google in 2005. Google has since continued its development, primarily for touchscreen mobile devices like smartphones and tablets. To assist developers in creating Android applications, Google provides tools such as the Android SDK, Android Studio, and supports integration with platforms like Unity and Google Cardboard SDK, enabling the development of immersive VR applications [28, 29].

E. Unity Engine

The Unity Engine is a real-time development platform equipped with a comprehensive set of tools for building interactive 2D and 3D experiences, including virtual reality (VR). It enables developers to use C# scripting to manage game mechanics, user interactions, and other core functionalities. With advanced rendering pipelines, physics engines, visual scripting, and an extensive Asset Store, Unity simplifies the process of creating high-quality and engaging interactive projects [30].

F. Blender

Blender is a powerful, free, and open-source 3D creation tool that is widely used for creating assets for Unity projects. It supports every stage of 3D model creation, from basic

modeling to advanced sculpting and texturing, making it an excellent companion for Unity developers. With seamless support for file formats like FBX and GLTF, as well as advanced tools for rigging, animation, and PBR texturing, Blender ensures high-quality assets integrate smoothly into Unity workflows [31].

IV. Design and Implementation

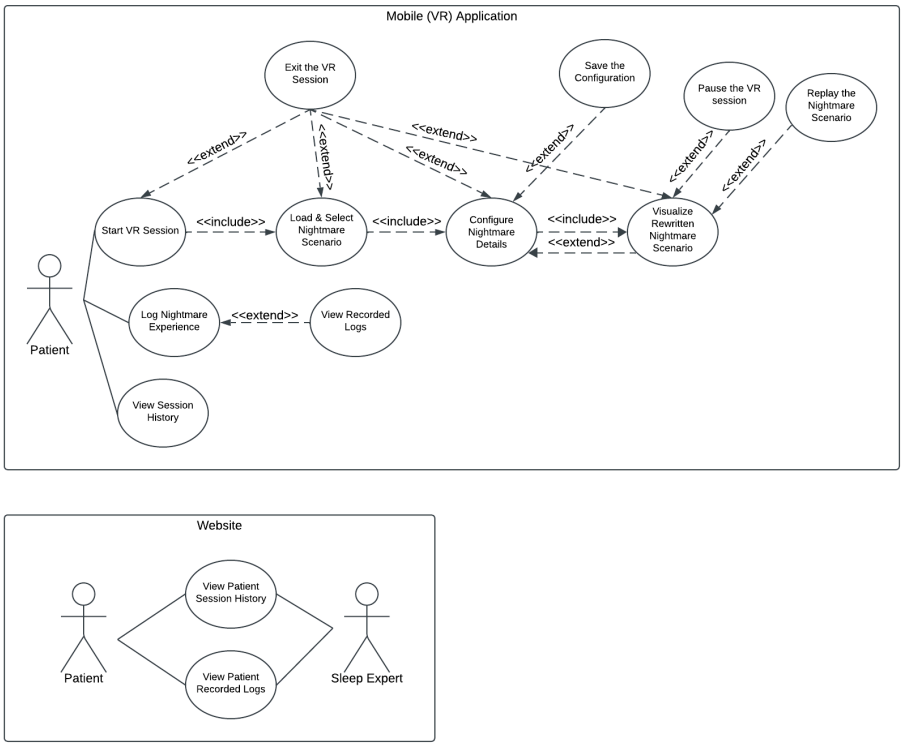

Figure 3: Use Case Diagram

A. Use Case Diagram

This use case diagram illustrates the interactions between the Patient and the Sleep Expert with the system, which is divided into two components: the Mobile (VR) Application and the Website.

The Patient is the central user in the Mobile Application, performing tasks related to their VR therapy sessions. The workflow begins with the Patient starting a VR session, which includes loading and selecting a nightmare scenario to address. Once a nightmare is selected, the Patient can configure the details of the nightmare, such as adjusting elements within the scenario. From there, the Patient has the option to save the configuration, exit the session, or proceed to visualize the rewritten nightmare in VR. The visualization phase includes optional actions, such as pausing the VR session, replaying the nightmare, or exiting. Additionally, the

Patient can log their nightmare experiences and review previously recorded logs and their session history.

The Website enables both the Patient and the Sleep Expert to access data related to the patient's VR sessions. This interface provides flexibility for users to access and analyze records. The Patient can conveniently view their session history and recorded logs, allowing them to reflect on their progress and therapy outcomes. Meanwhile, the Sleep Expert can access the same information, offering insights into the patient's journey and enabling them to provide tailored recommendations or adjustments to the therapy plan.

B. Activity Diagram

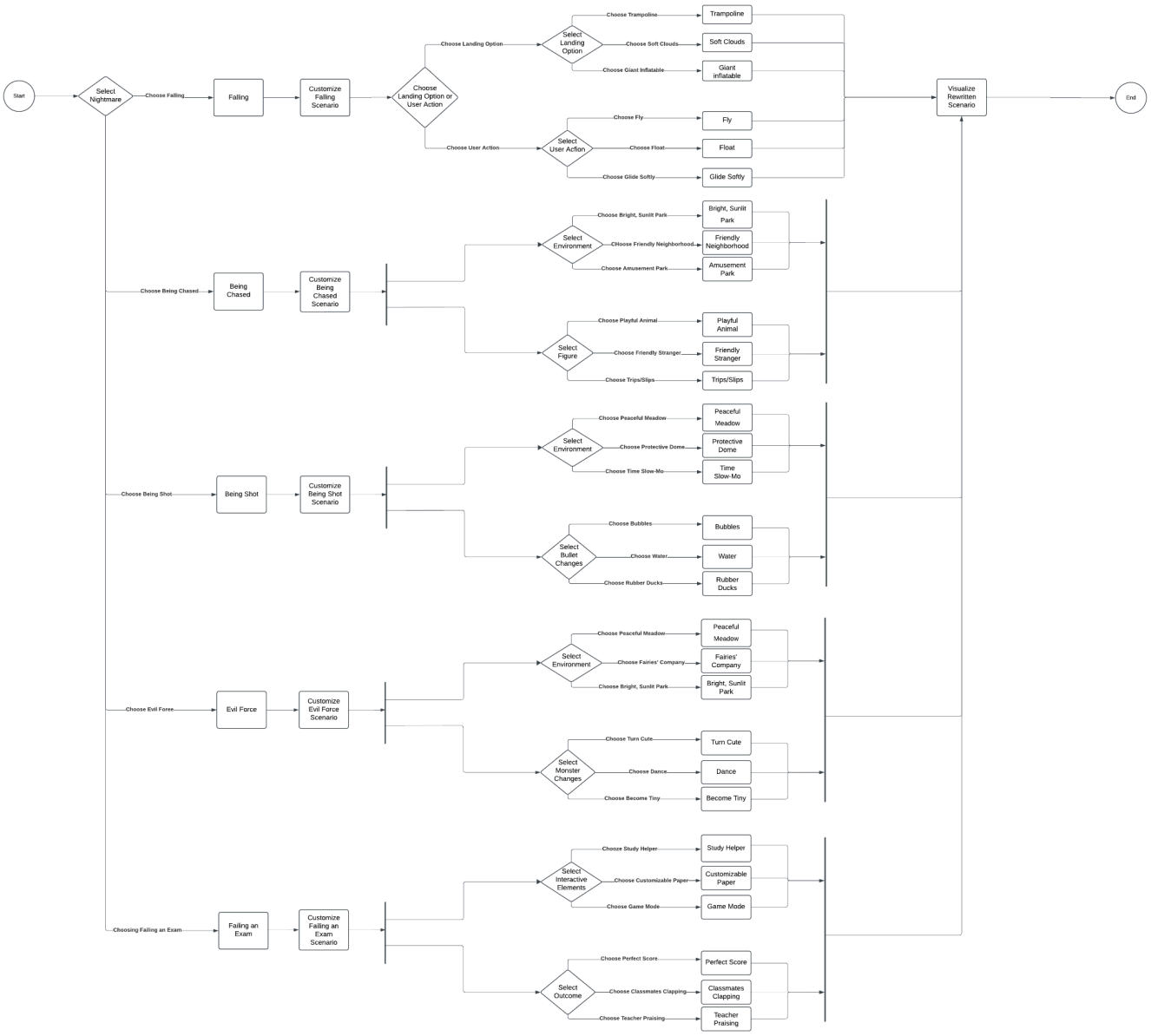

Figure 4: Activity Diagram

Patients can select and load from five common idiopathic nightmare scenarios, including Falling, Being Chased, Being Shot, Evil Force, and Failing an Exam. Each scenario offers patients the opportunity to explore a variety of configurations to reimagine their nightmares in a more positive way. Patients can select different figures to appear in the scenario, customize actions for themselves and the figures, and make changes to the environment, tailoring the experience to their preferences.

In the Falling scenario, where patients experience free-falling from a tall building, they can modify their landing experience by choosing trampolines, soft clouds, or giant inflatables. They can also adjust their actions, such as flying, floating, or gliding softly.

In the Being Chased scenario, set in a dark alley with a stranger following, patients can alter the environment to a bright sunlit park, a friendly neighborhood, or an amusement park. The figure chasing them can be transformed into a playful animal, a friendly stranger, or someone who slips and/or trips.

The Being Shot scenario takes place in an apocalyptic setting with bullets approaching the patient. Patients can change the environment to a peaceful meadow, a protective dome, or enable a slow-motion effect. They can also transform the bullets into harmless objects such as bubbles, water, or rubber ducks.

In the Evil Force scenario, set in a dark forest with monsters roaming around, patients can alter the environment to a peaceful meadow, a bright sunlit park, or a magical setting accompanied by fairies. The monsters can be modified to appear cute, dance playfully, or shrink into tiny, friendly beings.

In the Failing an Exam scenario, which takes place in a classroom during an exam, patients can enhance the interactivity by introducing a study helper, customizing the exam paper theme, or turning the exam into a game. Positive outcomes include achieving a perfect score, hearing classmates cheer, and receiving praise from the teacher.

C. Technical Architecture

The following smartphone specifications will be required to run the mobile application:

1. Android OS Version 7.0 or higher.
2. Screen Size between 4.7 inches and 6.5 inches to fit properly in the Google Cardboard
3. Gyroscope for accurate motion tracking in VR.
4. Accelerometer for head-tracking and movement detection.
5. Magnetometer for orientation tracking

6. At least 3 GB to run the app without lag

References

1. Garriques, V. R., Dhruve, D. M., & Nadorff, M. R. (2024). Nightmare Disorder. Sleep Medicine Clinics, 19(1), 111–119. https://pubmed.ncbi.nlm.nih.gov/38368059/
2. American Psychiatric Association. (2013). Diagnostic and Statistical Manual of Mental Disorders. Diagnostic and Statistical Manual of Mental Disorders, 5(5). https://doi.org/10.1176/appi.books.9780890425596
3. American Academy of Sleep Medicine, The International Classification of Sleep Disorders : Diagnostic & Coding Manual (ICSD-3), 3rd ed. ed., Westchester, Ill., 2014.
4. Stefani, A., & Högl, B. (2020). Nightmare Disorder and Isolated Sleep Paralysis. Neurotherapeutics, 18(1). https://doi.org/10.1007/s13311-020-00966-8
5. Neuspiel, D. R. (2024, February). Nightmare Disorder: Practice Essentials, Background, Pathophysiology. Medscape.com; Medscape. https://emedicine.medscape.com/article/914428-overview?form=fpf
6. Spoormaker, V. I., Schredl, M., & Bout, J. van den. (2006). Nightmares: from anxiety symptom to sleep disorder. Sleep Medicine Reviews, 10(1), 19–31. https://doi.org/10.1016/j.smrv.2005.06.001
7. Floyd, K., Hesse, C., Ray, C. D., & Mikkelson, A. C. (2024). Interpersonal Loneliness Predicts the Frequency and Intensity of Nightmares: An Examination of Theoretic Mechanisms. The Journal of Psychology, 1–21. https://doi.org/10.1080/00223980.2024.2378418
8. Sheaves, B., Rek, S., & Freeman, D. (2023). Nightmares and psychiatric symptoms: A systematic review of longitudinal, experimental, and clinical trial studies. Clinical Psychology Review, 102241. https://doi.org/10.1016/j.cpr.2022.102241
9. S. Schwartz, A. Clerget, and L. Perogamvros, “Enhancing imagery rehearsal therapy for nightmares with targeted memory reactivation,” Current Biology, vol. 0, no. 0, Oct. 2022, doi: https://doi.org/10.1016/j.cub.2022.09.032.

10. McNamara, P., Moore, K. H., Papelis, Y., Diallo, S., & Wildman, W. J. (2018). Virtual reality-enabled treatment of nightmares. Dreaming, 28(3), 205–224. https://doi.org/10.1037/drm0000088
11. Angelov, V., Petkov, E., Shipkovenski, G., & Kalushkov, T. (2020). Modern Virtual Reality Headsets. 2020 International Congress on Human-Computer Interaction, Optimization and Robotic Applications (HORA). https://doi.org/10.1109/hora49412.2020.9152604
12. Hamad, A., & Jia, B. (2022). How Virtual Reality Technology Has Changed Our Lives: An Overview of the Current and Potential Applications and Limitations. International Journal of Environmental Research and Public Health, 19(18). https://doi.org/10.3390/ijerph191811278
13. Freeman, D., Reeve, S., Robinson, A., Ehlers, A., Clark, D., Spanlang, B., & Slater, M. (2017). Virtual reality in the assessment, understanding, and treatment of mental health disorders. Psychological Medicine, 47(14), 2393–2400. https://doi.org/10.1017/s003329171700040x
14. Gagliardi, M., & Markowski, M. (2024). Active imagery rescripting in virtual reality as a promising tool to address psychological conditions. Computers in Human Behavior Reports, 100440.
15. Howell, M. J. (2012). Parasomnias: An Updated Review. Neurotherapeutics, 9(4), 753–775. https://doi.org/10.1007/s13311-012-0143-8
16. Robert, G., & Zadra, A. (2014). Thematic and Content Analysis of Idiopathic Nightmares and Bad Dreams. Sleep, 37(2), 409–417. https://doi.org/10.5665/sleep.3426
17. Nadorff, M. R., Lambdin, K. K., & Germain, A. (2014). Pharmacological and non-pharmacological treatments for nightmare disorder. International Review of Psychiatry, 26(2), 225–236. https://doi.org/10.3109/09540261.2014.888989
18. Krakow, B., & Zadra, A. (2006). Clinical Management of Chronic Nightmares: Imagery Rehearsal Therapy. Behavioral Sleep Medicine, 4(1), 45–70. https://doi.org/10.1207/s15402010bsm0401_4
19. Parsons, T. D. (2014). Virtual Reality Exposure Therapy for Anxiety and Specific Phobias. Encyclopedia of Information Science and Technology, Third Edition, 6475–6483. https://doi.org/10.4018/978-1-4666-5888-2.ch636

20. Gagliardi, M., & Markowski, M. (2024). Active imagery rescripting in virtual reality as a promising tool to address psychological conditions. Computers in Human Behavior Reports, 15, 100440. https://doi.org/10.1016/j.chbr.2024.100440
21. Bedir, D., & Erhan, S. E. (2021). The effect of virtual reality technology on the imagery skills and performance of target-based sports athletes. Frontiers in Psychology, 11, Article 2073. https://doi.org/10.3389/fpsyg.2020.02073
22. McNamara, P., Moore, K. H., Papelis, Y., Diallo, S., & Wildman, W. J. (2018). Virtual reality-enabled treatment of nightmares. Dreaming, 28(3), 205–224. https://doi.org/10.1037/drm0000088
23. Varkey, B. (2020). Principles of clinical ethics and their application to practice. Medical Principles and Practice, 30(1), 17–28. https://doi.org/10.1159/000509119
24. Lee, J.-H., Cheng, I-Chun., Hua, H., & Wu, S.-T. (2020). Fundamentals of Head‐Mounted Displays for Virtual and Augmented Reality. 259–336. https://doi.org/10.1002/9781119282211.ch8
25. Overview of Google Cardboard - Cardboard Manufacturer Help. (n.d.). Support.google.com. https://support.google.com/cardboard/manufacturers/answer/6321454?hl=en
26. Google. (2019). Google Cardboard – Google VR. Google.com. https://arvr.google.com/cardboard/
27. The Easiest Virtual Reality Solution – Realiteer. (2024). Realiteer.com. https://realiteer.com/technology/
28. Google. (2018). Android Developers. Android Developers. https://developer.android.com/
29. Google VR for everyone | Google for Developers. (2019). Google for Developers. https://developers.google.com/vr/
30. Technologies, U. (n.d.). Real-Time 3D Development Platform & Editor| Unity. Unity.com. https://unity.com/products/unity-engine

31. Blender Foundation. (2019). Features — blender.org. Blender.org. https://www.blender.org/features/