Exposure Therapy Simulator for Phobias

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***Abstract*—This project presents the design and development of Exposure Therapy Simulator for Phobias, a therapeutic simulation aimed at aiding individuals in overcoming specific phobias through controlled virtual exposure therapy. Implemented using Unity with HDRP and ray tracing capabilities, the system integrates AI-generated therapist dialogues via OpenAI API to provide dynamic coping strategies. The project emphasizes immersive first-person experiences within four distinct phobia environments to support psychological desensitization. Through progressive exposure in a controlled virtual environment, users can safely confront their fears while receiving real-time therapeutic guidance. Mental health professionals can utilize this application as a supplementary tool in clinical settings, offering patients a safe alternative to immediate real-world exposure.**

I. INTRODUCTION

Goals and Objectives

The primary goal of this project is to develop a Unity-based simulator that provides safe, customizable, and progressive exposure to phobias, thereby aiding in therapy. Exposure therapy is a proven treatment method, and by using Unity, we can replicate real-life triggers in a controlled, repeatable virtual space, helping users build coping strategies step by step.

Specific objectives include:

1. Create a VR-compatible first-person phobia therapy simulation with multiple phobia scenarios
2. Implement adaptive difficulty to adjust stress levels based on user performance
3. Log user data (time spent, actions taken) for analysis by clinicians or researchers
4. Ensure user safety with easily accessible exit options and gradual exposure
5. Develop four distinct phobia-specific scenarios:
    - Tachophobia (Fear of Speed)
    - Claustrophobia (Fear of Enclosed Spaces)
    - Nyctophobia (Fear of Darkness)
    - Hematophobia (Fear of Blood)
6. Integrate AI-driven therapist NPCs to provide dynamic coping strategies via real-time voice dialogues

Phobias, characterized by intense and irrational fears, affect a significant portion of the global population. Conventional therapeutic methods like exposure therapy face logistical and emotional challenges in real- world environments. This project proposes a virtual rehabilitation system simulating controlled phobia exposure using modern game technologies combined with AI-based therapeutic support.

Target Audience

The Exposure Therapy Simulator for Phobias is designed for:

- Individuals undergoing exposure therapy for specific phobias
- Mental health professionals who can use the simulator as an adjunct tool for therapy sessions
- Researchers exploring digital interventions for mental health conditions

Application Utility

This application is particularly useful because it:

- Provides safe exposure to phobia triggers without real-world risks
- Allows for precise control of exposure intensity and progression
- Makes therapy accessible in locations where traditional exposure might be impossible
- Offers consistent, repeatable therapeutic scenarios
- Integrates AI-guided coping mechanisms that adapt to user responses
- Enables data collection for tracking patient progress

II. Related Work

This section discusses related academic research and

developments in virtual reality exposure therapy for phobias.

1. The Development of Virtual Reality Therapy System for Acrophobia (Jang et al., 2002). This study developed an affordable, realistic virtual environment for treating acrophobia using a PC-based system. Through clinical trials, it was found that VR exposure induced strong fear responses and successfully reduced height phobia symptoms, validating VR's potential as an effective tool for therapeutic systematic desensitization.

2. Recent Progress in Virtual Reality Exposure Therapy for Phobias: A Systematic Review (Botella et al., 2017) This systematic review highlights VR's effectiveness in treating phobias and discusses how variables like presence influence therapeutic outcomes. VR is shown to improve exposure therapy's acceptance and flexibility. The study calls for more research into optimizing VR variables for better treatment efficacy.

3. Tips for Effective Implementation of Virtual Reality Exposure Therapy in Phobias (Krzystanek et al., 2021). This systematic review provides guidelines for effective VRET implementation, noting that session duration, frequency, and patient immersion are critical factors. VRET is effective across phobia types, with sustained long-term outcomes. Personalization and adjunct pharmacotherapy can enhance treatment success.

4. Virtual Reality in the Management of Hematophobia in Hospital Settings (Triviño-Martínez et al., 2024). This study demonstrated that VR significantly reduced anxiety during venipuncture in patients with moderate hematophobia, especially those under 40. VR serves as an effective, non-invasive tool in clinical settings to enhance patient experience and potentially improve treatment adherence.

5. Phobia Exposure Therapy Using Virtual and Augmented Reality: A Systematic Review (Albakri et al., 2022). This review evaluates the use of VR and AR in phobia exposure therapy, concluding that VR shows generally positive outcomes across various phobias. Some limitations remain for specific phobias. The study discusses the future integration of VR and AR technologies to optimize therapeutic interventions.

6. An Integration of Various Virtual Environments to Overcome Claustrophobia using VR (Meera et al., 2022). This paper developed user-friendly VR environments to treat claustrophobia through gradual exposure to different confined spaces. Using gaze-based teleportation for movement, the system minimized nausea while immersing users in various scenarios like tunnels and trial rooms to reduce phobic reactions.

7. Phobia Therapy Using Virtual Reality (Jashwanth et al., 2020). This study implemented VR environments to support exposure therapy for different phobias. Patients navigate virtual spaces using controllers while anxiety levels are monitored to adjust exposure intensity. The project emphasized cost-effective, accessible VR solutions integrated with cognitive-behavioral techniques.

Our project builds upon these foundations by combining adaptive exposure techniques with AI-driven therapeutic dialogue in a high-fidelity rendering environment, addressing limitations identified in previous systems regarding user engagement and emotional response.

III. IMPLEMENTATION

System Architecture

The implementation process followed these key phases:

Modeling Phase

- Environment modeling using Blender for creating detailed 3D assets
- Character and NPC modeling for therapist avatars and environmental agents
- Asset optimization for real-time rendering performance

Phobia Scene Implementations

Phobia	Key Exposure Techniques	Coping Mechanism
Tachophobia	Speed ramp-up, motion blur	Guided breathing, relaxation prompts
Claustrophobia	Collapsing walls, space reduction	Breathing pacing, reassurance
Nyctophobia	Light fade-out, echo sounds	Visualization techniques, AI calm support
Hematophobia	Blood visuals to surgery exposure	Desensitization talk, emotional support

Unity HDRP Integration Phase

- Import of models into Unity with HDRP setup
- Material creation using Physically Based Rendering approach
- Lighting setup with ray-traced effects for realistic shadows and reflections
- Scene composition for each phobia environment

Functionality Phase

- C# scripting for core interaction mechanics
- Implementation of adaptive difficulty system using timer-based triggers
- OpenAI API integration for dynamic therapist dialogues
- User interface development for control and safety features

Testing and Refinement Phase

- Iterative testing of phobia environments
- Performance optimization

- User feedback integration
- Final polish and bug fixing

Technical Specifications

- **Game Engine**: Unity 6000 LTS with HDRP and Ray Tracing
- **Programming Language**: C# for Unity scripts
- **AI Integration**: OpenAI API for NPC dialogues
- **3D Modeling**: Blender
    - **Audio**: Unity Audio Mixer with dynamic sound effects

IV. FUNCTIONALITY

1. Vision: Use of Textures and 3D Models

The application leverages high-quality textures and 3D models to create realistic environments that trigger genuine emotional responses. Each phobia scene features custom materials with normal, roughness, and displacement maps to achieve photorealistic surfaces.

The HDRP pipeline enables advanced visual features including:

- Volumetric lighting for atmospheric effects in the darkness phobia
- Screen-space reflections for realistic surfaces in the claustrophobia scene
- Motion blur effects in the tachophobia simulation
- Subsurface scattering for realistic blood simulation in the hematophobia scene

2. Sound: Speech, Music, and Ambient Sounds

Audio design plays a crucial role in creating immersive phobia experiences:

- **Ambient soundscapes** unique to each environment (e.g., wind howling at heights, mechanical noises in enclosed spaces)
- **Dynamic heartbeat audio** that increases in volume and tempo based on exposure duration
- **AI-generated therapist voice** providing real-time coping strategies through OpenAI's text-to- speech API
- **Meditation music** available through the safety menu for immediate anxiety reduction

3. Animation: Animated Objects

The environment features numerous animated elements:

- **Portal animations** in the main lobby, with swirling energy effects when approached
- **Collapsing walls** in the claustrophobia scene that gradually move inward over time
- **Flickering lights** in the nyctophobia scene that progressively dim to darkness
- **Animated medical procedures** in the hematophobia scene with increasing complexity
- **Speed indicators** in the tachophobia scene showing acceleration effects

4. Interactivity: User-Triggered Events

The application features numerous interactive elements:

- **Portal activation** - Users can press 'E' to enter specific phobia environments
- **Safety menu toggle** - Accessible at any time via the ESC key
- **Difficulty adjustment** - Users can manually increase or decrease exposure intensity
- **Therapist dialogue trigger** - Approaching the virtual therapist initiates supportive conversation
- **Grounding exercise activation** - Available in the safety menu to help manage anxiety
- **Environment interaction** - Scene-specific interactive objects (elevator buttons, light switches)
- **Session restart** - Option to reset the current exposure session

5. Characters/Avatars: Animated Agents

Each phobia environment includes AI-driven NPCs with specific behaviors:

- **Virtual therapists** that follow the user at an appropriate distance, offering support
- **Medical staff** in the hematophobia scene performing procedural animations
- **Elevator operators** in the claustrophobia scene with greeting behaviors

6. Sensors: Multiple Sensor Types

The application implements various sensor types:

- **Proximity sensors** - Detect when the user approaches phobia triggers, adjusting dialogue and environmental responses
- **Time sensors** - Track exposure duration to progressively increase difficulty
- **Gaze sensors** - Monitor where the user is looking to trigger appropriate responses
- **Interaction sensors** - Detect when users interact with specific objects

7. Player: First-Person Controller

The application uses a first-person controller for immersive experience:

- **Movement controls** using WASD keys and mouse look
- **Interaction** with E key for environment objects
- **Jump/crouch** capabilities for navigating complex environments
- **Camera effects** including breath fogging, heartbeat camera shake, and tunnel vision during anxiety peaks

8. AI Implementation: Navigation and Behaviors

The AI system includes:

- **OpenAI integration** for dynamic therapist dialogues based on user context
- **Behavior selection menu** allowing users to adjust NPC responses (supportive, challenging, or neutral)
- **Adaptive difficulty AI** that monitors user progression and adjusts scene intensity
- **Path-finding systems** for realistic NPC movement using Unity's NavMesh

9. Interface Elements: Menu System

The interface design includes:

- **Main lobby hub** with visually distinct portals to each phobia environment
- **Safety menu** with exit, pause, and grounding options
- **Settings panel** for adjusting graphics, sound, and difficulty preferences
- **Session report screen** showing exposure duration and progress statistics

10. Mobile Version with Joystick Navigation

A simplified mobile version implements:

- **On-screen joystick** for movement control
- **Tap interaction** for object manipulation
- **Simplified graphics** for mobile performance
- **Cloud synchronization** with desktop sessions

V. CONCLUSION

Summary

The Exposure Therapy Simulator for Phobias implements an immersive virtual reality exposure therapy system targeting four distinct phobias. By combining high-fidelity visuals through Unity's HDRP pipeline with AI-driven therapeutic support, the project creates a safe yet emotionally engaging environment for phobia treatment. The adaptive difficulty system ensures appropriate progression based on user comfort levels, while extensive safety features maintain ethical considerations throughout the experience.

Application Benefits

This VR application provides significant advantages for phobia treatment:

1. **Safety and control** - Users can confront fears without real-world risks
2. **Consistent exposure** - Standardized scenarios ensure reliable therapeutic progression
3. **Accessibility** - Treatment available regardless of physical constraints
4. **Data-driven approach** - Session metrics enable objective progress tracking
5. **AI support** - Dynamic therapeutic guidance without constant therapist presence
6. **Customizable intensity** - Personalized exposure progression based on individual needs

Appropriateness of Virtual Reality

Virtual reality is particularly appropriate for this application because:

1. It creates presence and immersion necessary for emotional engagement with phobic stimuli
2. It allows precise control over environmental variables impossible in real-world exposure
3. It enables impossible or impractical scenarios (extreme heights, specific medical procedures)
4. It provides immediate safety options not available in real-world exposure
5. The sensory engagement activates similar neurological pathways to real experiences

Problems Encountered

During development, several challenges emerged:

1. **Performance optimization** - Balancing visual fidelity with smooth frame rates, especially for VR
2. **AI response latency** - Ensuring timely therapeutic dialogues without noticeable delays
3. **Calibrating exposure intensity** - Creating appropriate progression without overwhelming users
4. **Cross-platform compatibility** - Adapting the experience for both desktop and mobile use

5. **Therapist dialogue authenticity** - Ensuring AI responses maintain therapeutic validity

Future Work

Future development will focus on:

1. **Biofeedback integration** - Incorporating heart rate sensors to dynamically adjust difficulty
2. **Expanded phobia scenarios** - Adding environments for additional common phobias
3. **Clinical validation studies** - Collaborating with psychology researchers to measure efficacy
4. **Multi-user therapist mode** - Allowing licensed professionals to join sessions remotely
5. **Enhanced AI capabilities** - Implementing more sophisticated dialogue systems and emotional recognition

This project demonstrates the potential of virtual environments combined with AI dialogue systems for supporting phobia rehabilitation, offering a promising tool for mental health practitioners and patients alike.

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- Unity Asset Store: Various environmental models and textures (https://assetstore.unity.com)
- OpenAI API: For NPC dialogue generation (https://openai.com/api)

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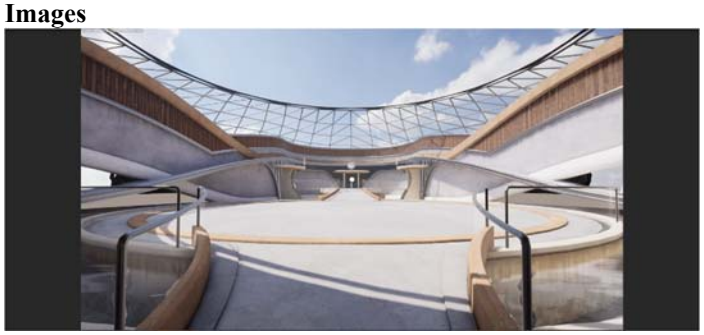
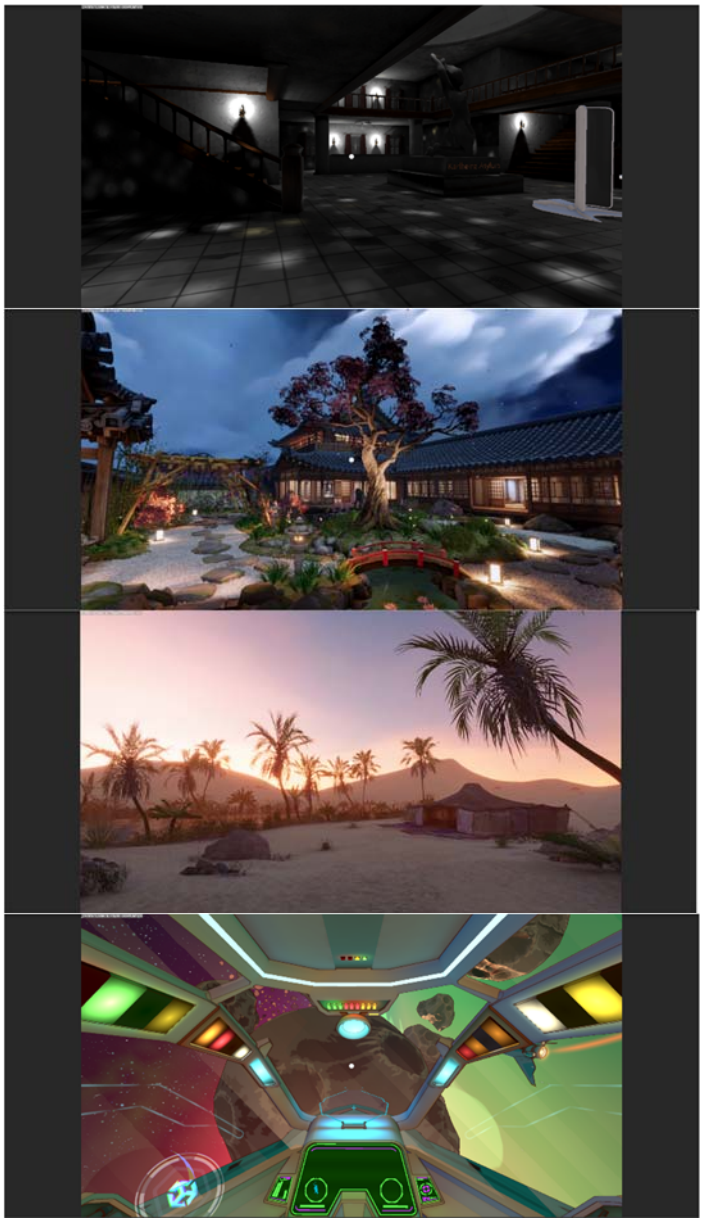
Images





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