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Ph.D. DISSERTATION DEFENSE

Candidate:	Pranav Parekh
Degree:	Doctor of Philosophy
School/Department:	School of Systems Engineering
Date:	In between 17th to 20th August
Time/Location:	A 2-hour slot between 11:AM to 5:00 PM. Meeting room TBD
Title:	Adaptive Virtual Reality for Social Skills Training
Chairperson:	Oluwafemi Richard Oyeleke
Committee Members:	Alparslan Emrah Bayrak, Carlo Lipizzi, Feng Liu

ABSTRACT

Communication skills are essential for individuals to thrive in today's fast-paced and socially demanding society. The ability to interact effectively in both informal and formal settings is a key component of personal and professional development. Virtual Reality (VR)–based simulations have emerged as a promising medium for training such soft skills by enabling immersive, repeatable, and controlled social interactions. This work is motivated by the observation that an individual's social competence is closely linked to the level of confidence they exhibit in social settings. The stress induced in these social settings serves as a measurable proxy for this confidence.

This research proposal is structured around the overarching goal of developing an adaptive VR-based simulation for Social Skills Training (SST). The first project focuses on simulation design and gamification, wherein we examine anxiety disorders with an emphasis on Social Anxiety Disorder (SAD). We explore the relationship between SST and exposure-based therapeutic approaches. We design four key social scenarios by creating avatars and integrating pre-scripted dialogues that reflect real-world interactions. The four scenarios are designed while keeping in mind the gamification concepts of Goal and Flow, which form the foundations of the simulation.

Building on this foundation, the second project introduces narrative as a core gamification concept through dynamic dialogue generation. We aim to address the limitations in prior SST simulations, particularly high response latency between avatars and users, which can disrupt immersion. To enhance realism, we review relevant gamification principles and integrate Natural Language Processing (NLP) models to introduce narrative into the simulation. We further propose and implement optimization strategies that significantly reduce response time. We achieve an improvement from 19.5 seconds in the unoptimized scenario to 3.3 seconds in the optimized version. This reduction enables more authentic and fluid interactions within the simulation. Finally, the third project focuses on introducing adaptivity through feedback loops. We discuss the introduction of the feedback loop by using Heart Rate Variability (HRV) as the physiological loop and voice indicators as the behavioral loop. We propose the implementation by using both conditional logic and computer vision for emotion recognition.

We also use HRV as a physiological indicator to establish evaluation metrics like affective fidelity and construct validity. The following metrics assess whether the participants elicit appropriate emotional

responses across users. Graphical analyses demonstrate that the simulation produces varied yet meaningful physiological responses, indicating its effectiveness as a training tool. Comparisons between pre-scripted and dynamically generated dialogues reveal that dynamic narratives result in lower HRV, suggesting increased stress and engagement. Together, these contributions demonstrate a progressive approach toward creating an adaptive, narrative-driven VR simulation that enhances SST through improved immersion, responsiveness, and personalization.