A Virtual Reality Interface Design for Children with Autism Spectrum Disorder to Improve Their Collaborative Problem Solving

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Introduction/Background

- **Autism Spectrum Disorder, also known as ASD,** is a condition characterized by neurological differences that result in developmental disabilities.
- Individuals with **ASD** commonly face **challenges in social communication** and **interaction,** and **exhibit restricted or repetitive behaviors and interests,** leading to unique patterns of learning, movement, or attention [1].
- According to the Centers for Disease Control and Prevention, 1 in 36 births in the United States in 2020 were identified as ASD, and thus **ASD intervention is critical to enhance their abilities and adjust to different situations** [2].
- **Benefits of virtual reality (VR) training** include enhanced safety, customizable task difficulty, instant feedback, better abstract idea comprehension, structured training sessions, automated progress evaluation, and error consequence-free environment [3, 4, 5].
- Although prior research has focused on teaching people with ASD various individual social competency subskills, such as emotion recognition, spatial awareness, and problem solving, more research is required to effectively assist many ASD individuals facing significant challenges with **social interaction and collaboration**.
- Although various studies have designed the social intervention of VR role-based game [6], further research is still needed to investigate the relationship between treatment integrity and social behavior frequency in VR-based social skill training for high-functioning autistic (HFA) children.
- In this study, we aim to design a novel VR interface to engage HFA children at the middle school levels to improve their social interactions through a set of VR collaborative problem-solving tasks for a more realistic, comprehensive, and effective form of intervention.

Research Questions and Planned User Study

- In our study, we design and implement a VR Role-Playing Game, featuring **artificial intelligence (AI) enabled Non-Player Characters (NPCs).** These NPCs are programmed to interact with players, aiding in **collaboratively solving problems and making decisions.**
- *RQ1: Is there any significant difference in the performance of collaborative tasks between children with ASD who have used the VR Role-Playing Game compared to those who have not?*
- *RQ2: How can we design and optimize the AI-enabled NPCs in the VR Role-Playing Game to interact more effectively with children with ASD, thereby facilitating improved problem-solving skills and better social interaction?*
- **User study:** We plan to recruit 10 children with Autism Spectrum Disorder (ASD), between the ages of 11 and 13. The gender distribution will adhere to the ratio of 4:1 for males to females, aligning with the prevalence rates provided by the Centers for Disease Control and Prevention (CDC).

Role-based VR Game Design

- In terms of game **visual effects**, previous research has shown that higher overall **fidelity** is not always necessary or advantageous over lower-fidelity simulations [7]. And low fidelity can actually allow children with autism to have better task performance [8].
- **Leadership development**: The proposed VR game would include decision-making tasks for autistic children, empowering them to take charge when collaborating with others and tackling challenging tasks. Giving children with ASD **leadership roles** in the virtual world can improve their learning, let them alter the virtual environment, and virtually perform the duties as an example [9].
- **Multiple scenario and roles:** The current studies of designing a role-based gaming (RPG) in VR show that it encourages users to be more motivated and engaged for learning [10]. VR Players can assume a different person or role to view the world from various angles, which can also test their creativity and imagination.
- **Fig. 1** indicates our initial VR interface.

Featured UI Designs

- **Locomotion** in VR has a direct impact on a variety of user experience elements, including enjoyment, annoyance, fatigue, motion sickness, and presence. According to the studies, ASD patients preferred joystick, point & teleport [11].

- **Animated instructions** will be designed to engage children with ASD, given their preference for receiving training in virtual reality (VR) through plain text presented on a written instruction board [12].

- **AI-enabled** non-player characters (NPCs) will aid children with ASD in collaborative problem-solving and decision-making. Careful attention should be given to the visual design of virtual characters to prevent uncanny **valley effects.**

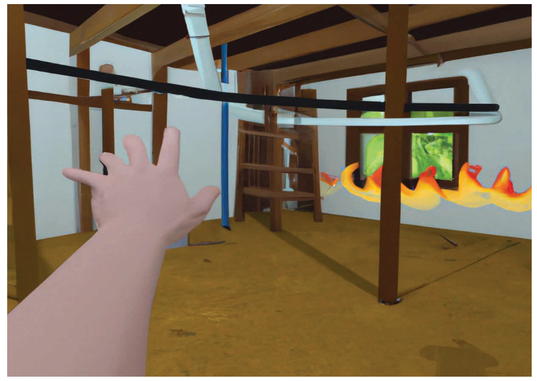

Fig 1. Initial Prototype of the Proposed VR Platform

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References: Available upon request.