AutiSim: A Virtual Reality Simulation Game Based on the Autism Spectrum Disorder

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***Abstract*—Technologies with altering reality like virtual reality (VR) have become more relevant to the public for their capabilities in the entertainment and healthcare field, as well as affordable for everyone. However, the emphasis on mental health-related simulation is often ignored due to technical complexities and wrong representation. Therefore, this study leverages the immersive capabilities of VR to create an engaging and educational game experience that simulates the sensory and social challenges faced by individuals with autism spectrum disorder (ASD). The study involves designing and implementing a VR game that places users in various scenarios reflecting the daily experiences of autistic individuals. The VR game aims to educate players about common misconceptions, sensory sensitivities, and social difficulties associated with autism. A literature review on XR technology and ASD was conducted during the pre-production phase to explore past research on autism in video games and shape the overall game vision. The study continues with developing an immersive simulation game using VR with locomotive motion controls and an artificial intelligence non-playable character (AI NPC) with Speech-To-Text function. Finally, the testing phase used two approaches: quantitative analysis, using the System Usability Scale (SUS) to assess usability and the Simulator Sickness Questionnaire (SSQ) to identify discomfort issues such as headaches and blurriness during gameplay, and qualitative analysis, gathering expert's feedback on the VR game's content and teaching effectiveness.**

Keywords*—*Virtual reality; simulation game; autism; artificial intelligence

I. Introduction

Advancements in computer science, engineering, and human-computer interaction (HCI) have driven rapid development in spatial interface technologies, including virtual reality (VR), augmented reality (AR), and mixed reality (MR) [1]. These technologies, collectively referred to as extended reality (XR), have gained widespread attention in both academia and industry due to significant improvements in hardware that make devices lighter, more affordable, and increasingly powerful [2]. Among these, VR stands out for its unique ability to replicate real-life situations in a highly immersive manner, making it a valuable tool in healthcare, therapy, and education by providing realistic training and fostering empathy through experiential learning [3].

While VR's applications in physical health and technical training have been widely explored, its potential for simulating mental health conditions such as Autism Spectrum Disorder (ASD) remains underutilized. Media portrayals of autism frequently rely on stereotypes or fail to accurately reflect the lived experiences of individuals on the spectrum, resulting in widespread misconceptions and reinforcing social stigma [4][5]. Poorly designed simulations that do not align with authentic experiences or educational goals can further mislead users rather than help them understand the challenges faced by the autism community.

As a response to these challenges, the present study introduces an alternative approach with the development of an interactive VR simulation game that emphasizes exploration and interactivity. Designed to immerse players in the daily sensory and social experiences of individuals with ASD, the simulation seeks to cultivate empathy and enhance public awareness through experiential engagement. Central to this initiative is a threefold objective. First, to study and compare how ASD has been depicted in existing VR games aimed at public education. Second, to design and develop an immersive representative simulation of the lived experiences of autistic individuals and third, to evaluate the simulation's usability and its effectiveness in fostering empathy and greater awareness among users.

Guided by these objectives, this study is driven by the overarching research question. How effectively can an immersive VR simulation game be designed around exploration and interactivity that accurately represents the experiences of individuals with ASD compared to existing VR representations? In order to address this question, this study investigates current approaches to ASD representation in VR, explores methods for creating a more authentic visual and spatial audio experience, accurate user-centered simulation, and assesses the impact of the resulting experience in terms of usability testing, simulation sickness (SUS) and expert's feedback.

The remainder of this study is structured as follows: A review of related literature on VR technologies and autism representation in Section II; a detailed explanation of game design and development methodology in Section III; presentation of results from a conducted evaluation in Section IV; and a concluding discussion on the study's contributions, limitations, and potential directions for future research in Section V.

II. Literature Review

The term virtual reality (VR) describes an interactive, three-dimensional computer-generated environment that users can interact with. Usually, VR is accessed through a computer that can project 3D data onto a display, such as a head-mounted display (HMD) or isolated screens, along with user identification sensors [6]. Virtual reality can be broadly classified into two types, which are immersive and non-immersive [7]. Non-immersive virtual reality presents information virtually by utilizing a collection of screens surrounding the user [8]. Driving or flying simulators are a common example of this, where the user sits in a chair with many screens surrounding them, creating the illusion of being in the driver's seat or cockpit without being there. Immersive VR is the process of presenting VR content to users based on their position and movement using a wearable display, such as an HMD [9], so they may experience the entire 360 degrees of the virtual world. One of the most marketable features of VR technology, this immersive experience is what most people associate with VR.

Inside-out tracking technology is revolutionizing virtual reality, as demonstrated by devices like Oculus Quest 2 [10], as this method depends on the complex interaction of built-in cameras and sensors in the VR headgear. This depends on the intricate interaction between the VR headset's integrated cameras and sensors [11]. Together, these elements give users a responsive and intensely immersive experience. What makes it more convenient is that this technology is used in everyday smartphones powered by Android and iOS [12].

On the other hand, inside a predetermined play area, outside-in tracking provides accurate and dependable tracking. VR headsets and controllers are tracked in terms of location and orientation by devices like the Oculus, HTC Vive and XR-3, which make use of external sensors or base stations. By replicating this tracking method, Fig. 1 illustrates the flowchart of how the AutiSim will operate using an Oculus headset and Unreal Engine. This method guarantees precision, which makes it a great option for applications that need accuracy, such as professional simulations or architectural design [13].

According to current understanding, autism is a neuro-cognitive disorder characterized by excessive masculine features, difficulty empathizing, and a lack of ability to understand the thoughts of others [14]. Autism is described as a "triad of impairments" characterized by "impaired social interaction, verbal and nonverbal communication, and repetitive and stereotyped behaviors" among affected individuals [15]. There is currently no known cause or treatment [16] for the most thorough investigation to far points to a genetic cause [17].

Hans Asperger originally identified Asperger syndrome (AS) in 1944 as the behavioral profile of people who struggle with socialization and communication [18]. Since then, AS has generated a lot of discussion and attention. While AS was added as a separate diagnostic category in the Diagnostic and Statistical Manual of Mental Disorders (DSM-4, 1994), its diagnostic label was eliminated in the Diagnostic and Statistical Manual of Mental Disorders (DSM–5), the edition that followed, nearly twenty years later. Rather, autism spectrum disorders (ASD), a more inclusive category, were added to ASD [19]. A youngster with a level 1 spectrum disorder will struggle with social communication, yet have an above-average IQ and outstanding linguistic skills [20].

Rett syndrome (RTT) is a rare, severe neurodevelopmental disorder that affects almost exclusively females. The syndrome was first described in 1966 by Andreas Rett in the German medical literature. Development appears normal during the first 6 to 18 months of life but is followed by regression of motor and language skills. The clinical phenotype of RTT is broad and can be classified into two main categories: typical (classic) RTT and atypical (variant) RTT [21].

Theodor Heller discovered a group of kids in 1908, 35 years before autism was first recognized. These kids displayed average development until the age of 3 or 4 before experiencing a dramatic and abrupt regression in their speech and cognitive abilities. This condition was known as "*dementia infantalis*", and it was frequently linked to mood dysregulation, which included anxiety and aggression [22]. Nowadays, this condition is known as Child Disintegrative Disorder (CDD).

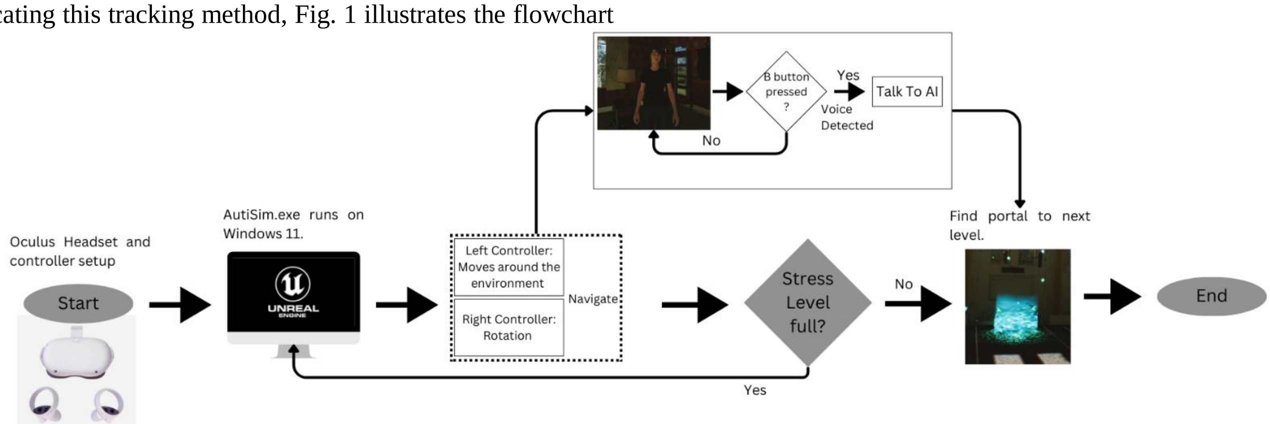

Fig. 1. Flowchart of how AutiSim will operate.

Most people think of Kanner's Syndrome in children when they think about autism. This form of autism is referred to as classic autistic disorder. Excessive sensitivity to stimuli (smell, light, noise, taste, or touch), trouble comprehending or communicating with people, and minimal eye contact are some of its symptoms. Youngsters with Kanner's syndrome frequently show little interest in their surroundings and a great desire for consistency. These children often appear to be self-centered, struggling to understand and respond to social cues that lead to difficulty in engaging with others [23].

The National Autistic Society Channel posted a video titled "Autism TMI Virtual Reality Experience" on YouTube back in June 2016. The video featured a 360-degree virtual reality experience that allowed viewers to manipulate the surroundings and observe an autistic child named "Alex" in a shopping centre. As of June 17, 2024, the film has received over 1.4 million views on YouTube and has received mixed reactions from both the autism community and people in general. With a focus on the unpleasant emotions that an autistic person experiencing a "meltdown" or "shutdown" may encounter in public, the application seeks to convey the overwhelming sensory experience that surroundings like these can cause for an autistic person [24].

Released in October 2016 for the Oculus Rift S, "The Autism Simulator" is one of the few games available on the Meta market. The premise of the simulation quoted “By observing too many details, getting drawn in by anomalies, and attempting to put the anomalies into a regular order, we provide you with a singular experience. Because of this, people with autism tend to be extremely focused, easily frightened, distracted, or violent.” [25].

In conclusion, the literature review highlights the diverse landscape of research and initiatives at the intersection of VR technology and autism awareness. Through a comprehensive examination of existing literature, the proposed research has gained valuable insights into the potential of VR to facilitate immersive and impactful experiences that foster understanding, empathy, and awareness of autism spectrum disorder.

Additionally, the analysis of the literature identifies new directions and best practices in the development, application, and assessment of VR-based awareness games. User engagement, accessibility, ethical issues, and the integration of evidence-based therapy techniques into VR experiences are among the key factors identified. The findings from various studies and projects offer valuable insights to guide the development of a VR initiative for autism awareness.

III. MATERIALS AND METHODS

This study introduces an integrated analytical methodology framework for AutiSim, as shown in Fig. 2, by utilizing the Game Design Life Cycle (GDLC) model that has been widely used and applied innovatively within VR environments [27]. The methodology framework for this study consists of the following phases: Pre-Production, Production and Evaluation.

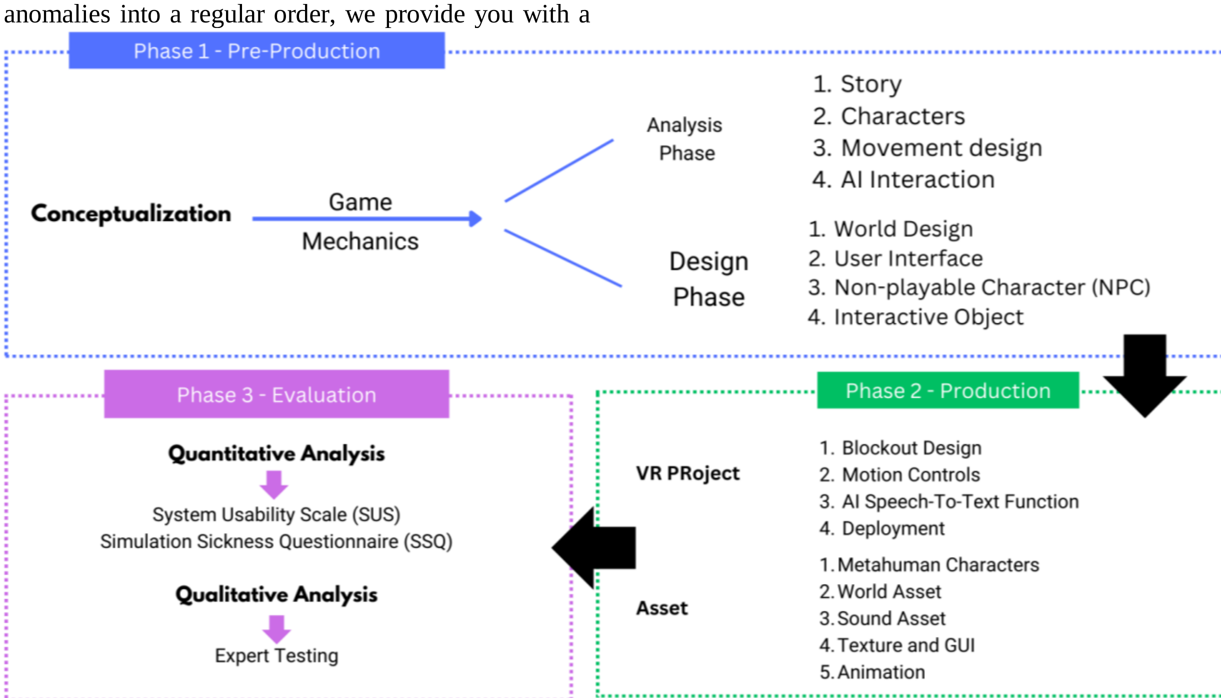

Fig. 2. Framework of AutiSim.

A. *Phase 1 (Pre-Production)*

The first phase involves establishing goals for an immersive autism simulation, with a focus on conceptualizing the layout design and integrating user data. The framework emphasizes enhancing user engagement through interactive objects, spatial audio simulation and real time responses from AI to simulate a realistic life situation. This approach tends to create more immersive environment, allowing users to interact with the virtual world in a way that closely replicates real-world experiences.

With the proposed enhancement aimed at creating a more immersive and engaging experience within the virtual world, the default movement mechanic in Unreal Engine originally based on teleportation is replaced with a more realistic locomotion system. Teleportation is initially implemented as the default method to help users become familiar with basic VR mechanics and to ease them into the virtual environment without overwhelming them. This method allows users to jump from one point to another, making it an effective tool for quick and easy navigation. However, once users are comfortable, the system transitions to locomotion, enabling them to move through the virtual space more naturally, as they would in the real world.

Unlike teleportation, which restricts users to predefined spots, locomotion grants continuous movement throughout the environment. This shift not only enhances spatial awareness but also contributes to a deeper sense of presence, making the experience feel more lifelike. The benefits of this transition can be observed in improved user interaction and engagement, as illustrated in Fig. 3.

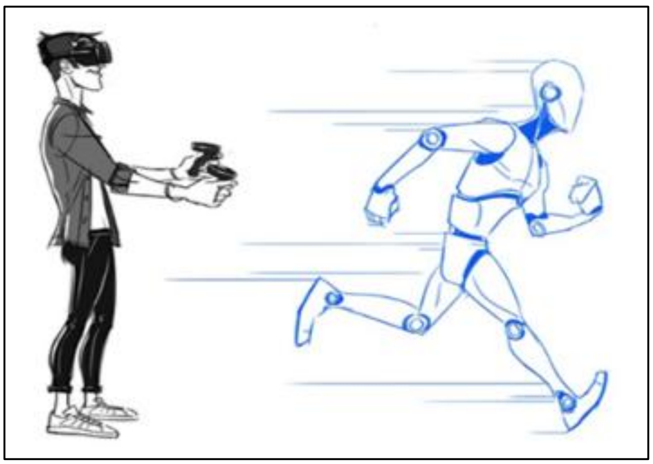

Fig. 3. Implementation of locomotion in VR.

AutiSim featured a visually appealing graphical user interface (GUI) designed to guide users smoothly from the very beginning of the game. The interface plays a crucial role in helping users feel comfortable and confident as they navigate through the virtual environment. The GUI is developed with usability and inclusivity in mind, incorporating simple language, recognizable icons, and consistent design patterns to reduce the cognitive load and prevent users from feeling overwhelmed. Key features such as intuitive menu transitions and easy-to-understand navigation options contribute to a seamless experience. Additionally, the interface will offer feedback through brief introductory explanations about the game as users progress, supporting them in making choices and understanding the outcomes of their actions. Fig. 4 illustrates the final design of the main menu in AutiSim, highlighting its clean layout, user-focused design, and ability to support a smooth onboarding process for both new and returning users.

AI non-playable characters (NPC) created by using Metahuman Creator are integrated into virtual environments to significantly enhance the immersive experience of the autism simulation game. These highly realistic avatars are meticulously crafted with detailed facial features, expressive gestures, and naturalistic movements, aligning seamlessly with the simulation's aesthetic and functional goals. The advanced customization tools of Metahuman Creator enable the creation of diverse and relatable characters, tailored to reflect unique traits, appearances, and personalities. This customization enriches the user experience by fostering deeper emotional connections and facilitating authentic, meaningful interactions within the virtual world. These characters play a pivotal role in replicating real-world social dynamics, making the simulation both educational and impactful, particularly in raising awareness about autism-related challenges. By portraying realistic behaviors, they provide users with an engaging and relatable environment that deepens their understanding of the condition. Fig. 5 and Fig. 6 showcase the transformation of character models, emphasizing the progression from initial designs to fully polished avatars.

Fig. 4. Main menu's design.

Fig. 5. Mother's character design.

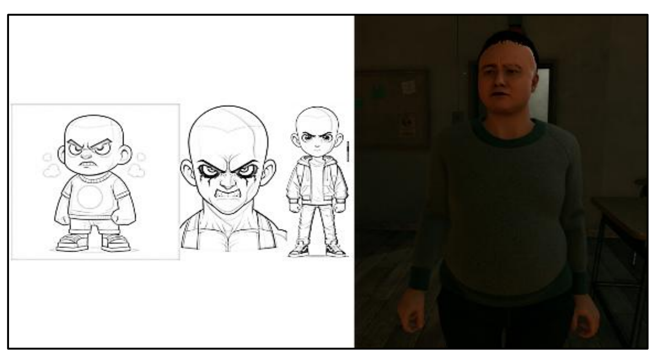

Fig. 6. Bully's character design.

Without a defined set of rules, an interactive experience cannot be categorized as a video game. Therefore, both the winning and losing conditions must be established. In each level, the winning condition is to locate the objective marker hidden within the environment while keeping the stress level as low as possible. On the other hand, the losing condition occurs when the player's stress level is maxed out, causing the game to restart from the beginning of the level.

B. Phase-2 (Production)

In Phase 2, the project moves to the production stage, where the detailed levels and scenes for AutiSim are created and finalized. This includes realistic virtual settings like an old house, a classroom, and a train station, all designed to closely resemble real places and sensory experiences. The goal is to make the simulation feel lifelike and engaging. To improve how users interact with the game, features like hand tracking for natural gestures and haptic feedback for touch sensations are added. Various software tools support this work: Unreal Engine is used for building the game, Blender for making 3D models, and Adobe Illustrator for designing visual elements and the user interface. Together, these tools help create an interactive and immersive experience that meets the aims of AutiSim.

As shown in Fig. 7, Level 1 takes place in an old brick house with a cozy, nostalgic design that feels like early childhood. This setting represents the player's younger years, from about age 3 to 12, and helps them feel comfortable as they start the game. The familiar rooms and decorations make it easy to get used to the simulation. The main purpose of Level 1 is to teach players how to move around, interact with objects, and understand basic controls through simple tutorials and prompts. Some of the basic interactions provided include a healing mechanic, moving around the character and interacting with the AI character to learn more about autism and how it can affect someone's daily life situation.

Fig. 7. Level 1 design.

Level 2 introduces players as high school students, aged approximately 13 to 18, attending a regular public high school, instead of a special needs school, as displayed in Fig. 8. The challenge in this level is to navigate out of the classroom without interacting with others, reflecting the tendency of individuals with ASD to prefer solitude and avoid social engagement. Additionally, other students (represented by AI NPCs) may observe and mock the player, further emphasizing the social difficulties often experienced by those with ASD. The environment is designed to simulate a realistic and sometimes overwhelming school setting, with background chatter, shifting body language, and unpredictable peer behavior. This level encourages players to develop awareness of how social anxiety and overstimulation can affect decision-making and behavior in typical school environments.

Level 3 introduces players to adulthood, where the character is around 18 to 25 years old, with the objective of catching a train as quickly as possible to avoid noise disturbances in a public place. The train station environment is heavily inspired by the design of Keretapi Tanah Melayu Berhad (KTMB) stations across Peninsular Malaysia, featuring the iconic yellow and blue signboards to provide a strong sense of localization for players. This familiar setting enhances immersion and cultural relevance. Realistic sounds such as train engine noises and crowd chatter are added to simulate the sensory challenges often faced by individuals with Autism Spectrum Disorder (ASD). Fig. 9 shows the level design for Level 3.

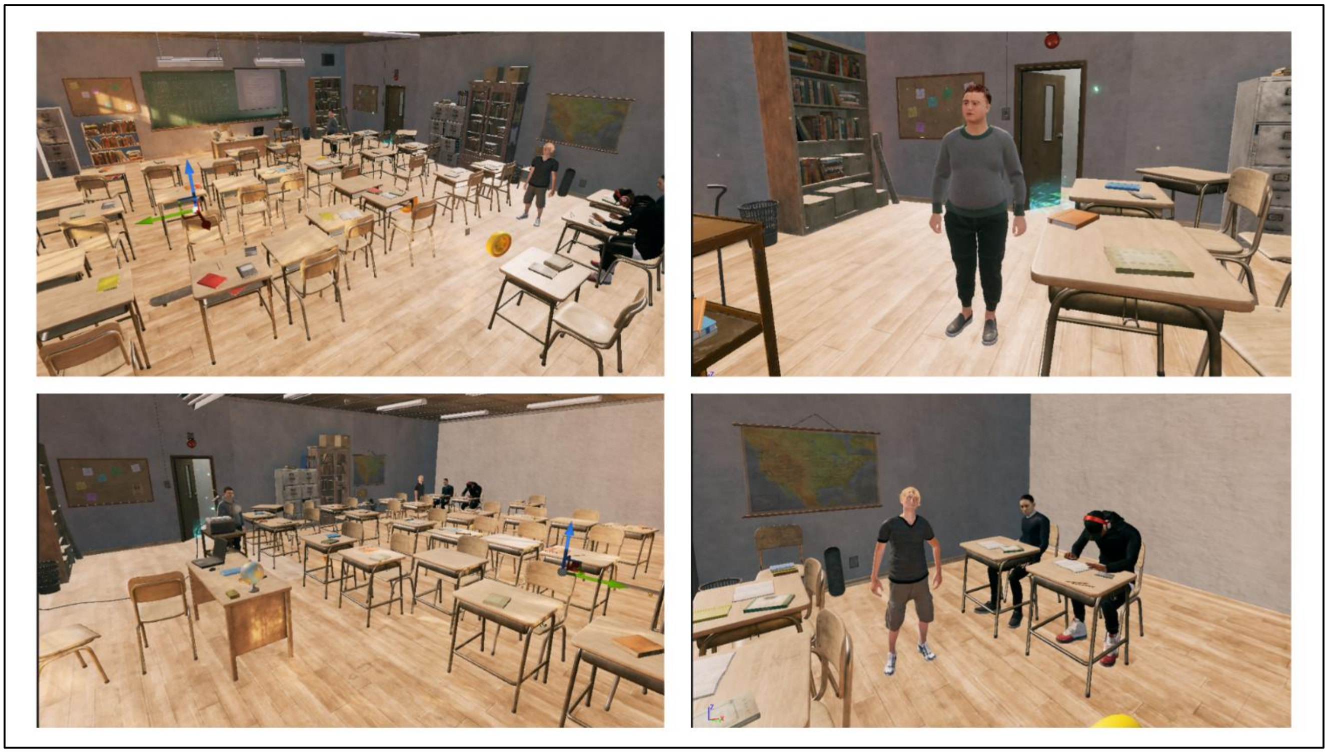

Fig. 8. Level 2 design.

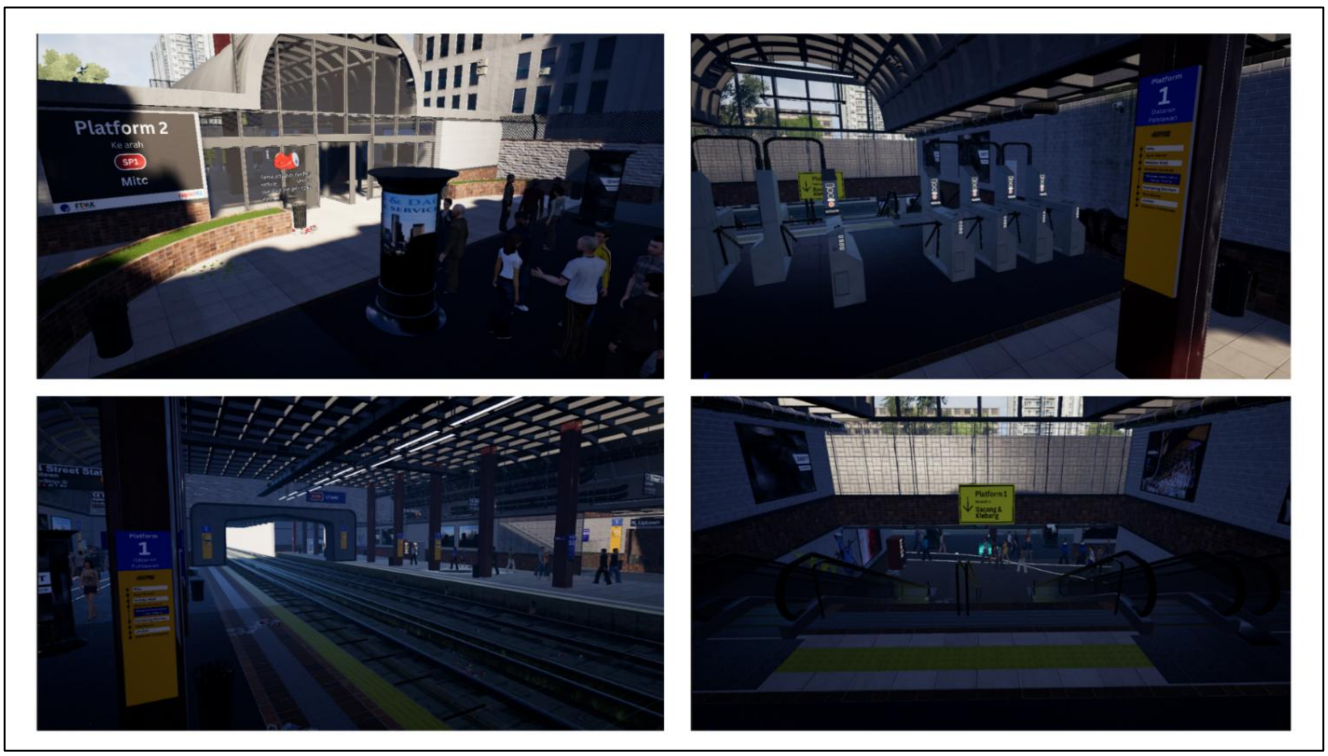

Fig. 9. Level 3 design.

This game incorporates spatial audio in combination with visual and damage effects to replicate the sensory challenges often experienced by individuals on the autism spectrum when exposed to overwhelming or sensitive stimuli, such as loud or high-pitched sounds. These sensory elements are designed to simulate real-world experiences, helping players and observers gain a deeper understanding of how such stimuli can impact focus, comfort, and overall functioning. One example of this occurs when the player steps into a designated hitbox area, which immediately triggers the sound of a boiling kettle with an intentionally sharp and continuous noise that may be distressing or distracting for some individuals. In response to this audio cue, a blurriness effect overlays the screen to visually simulate sensory overload, accompanied by a gradual reduction in the player's health or energy to reflect the mental and emotional strain caused by the stimulus. This combination of spatial audio and reactive visuals adds an extra layer of immersion and empathy-building to the gameplay. Fig. 10 illustrates how the blur effect disrupts the player's field of vision, demonstrating the potential impact of sensory overstimulation on everyday activities within the virtual environment.

Fig. 10. Blur effect triggers when encountering an obstacle.

As for the character, a 3D photogrammetry technique is used to create realistic human features [26] [27]. The process involves capturing a high-resolution, panoramic 360-degree photo of the model's face to ensure that every detail is accurately recorded—from the broader facial contours and bone structure to subtle features like skin texture, fine wrinkles, and expression lines. This comprehensive scanning technique allows for an exceptionally lifelike digital representation of the individual's face. The Reality Scan app is employed as the primary software tool in this process, chosen for its ability to process and reconstruct detailed 3D models with high fidelity. An iPhone 11 serves as the scanning device, offering a balance between mobility, accessibility, and image quality. Together, this combination of hardware and software produces a remarkably realistic output, often requiring little or no manual adjustment or post-processing. The simplicity and efficiency of the setup make it ideal for quick integration into the development pipeline, especially for projects focused on creating immersive virtual environments. Fig. 11 illustrates the step-by-step process and shows the result of the facial scan, highlighting the precision and clarity of the digital model.

With the 3D character featuring realistic facial details completed, a facial capture technique is further implemented to animate the character's face using an iPhone 11 and LiveLink by Unreal Engine. This technique enables real-time projection of facial movements onto the 3D model, along with voice integration, to create a tutorial introduction to the game. The tutorial will pop up in the main menu, guiding players on what to expect and what they will learn, improving their overall experience and understanding of the game. Fig. 12 highlights the facial capture process and the resulting animations, showcasing the seamless integration of these elements into the game.

Fig. 11. The process of how character is created.

Fig. 12. The facial capture for the introduction.

C. Phase-3(Testing)

For the final phase, the evaluation involved both quantitative and qualitative analysis through a series of testing sessions with students and experts [28] [29]. Quantitative analysis was carried out using the System Usability Scale (SUS) and the Simulator Sickness Questionnaire (SSQ) method. SUS was measured through a 10-question survey, with the total score calculated and converted to a final score between 0 and 100. Higher scores indicate better usability, with scores above 68 generally considered above average. SSQ collected feedback on any discomfort or symptoms users experienced during the VR sessions, addressing potential issues to improve user comfort.

As for qualitative analysis, it was performed through expert testing, offering valuable insights from their experiences with the VR content, which informed further improvements. The expert testing involved professionals from both the VR technology and autism fields, ensuring a comprehensive evaluation from both technical and therapeutic perspectives.

IV. Results and Discussion

A. System Usability Scale (SUS)

This section presents the results of the System Usability Scale (SUS) assessment conducted to evaluate the overall usability and user experience of the application. The evaluation involved a total of ten participants, consisting of seven students and three teachers from SMK Tunku Syed Idrus Tampin. Participants were selected to represent both the target users and educational facilitators who would potentially engage with or guide the use of the application in a real-world setting. Each participant completed the SUS questionnaire after interacting with the system, providing feedback on aspects such as ease of use, functionality, and overall satisfaction. The responses were then scored and analyzed to produce a quantitative measure of the system's usability. The results, summarized in Table I, offer valuable insight into how effectively the application meets user expectations and identifies areas for potential improvement. SUS results for ten participants.

TABLE I. SUS RESULTS FOR 10 PARTICIPANTS

Participants	Raw Score	Final Score
P1	40	92.5
P2	25	75
P3	39	80
P4	25	50
P5	44	50
P6	20	85
P7	44	67.5
P8	21	70
P9	43	72.5
P10	26	87.5
Average		73

The AutiSim SUS score was 73, just above the industry benchmark of 68 [29]. Users thought the game worked well, was simple to learn, and had a good interface and usability [30] [31]. Although virtual reality (VR) technology is not yet widely accessible due to the need for specialized and often costly hardware, the above-average System Usability Scale (SUS) score indicates that the game is positively received and well-accepted by users despite these limitations. This suggests strong potential for wider adoption as accessibility improves over time. The high usability rating reflects the effectiveness of the game's design, interface, and interactive elements in delivering an engaging experience [32]. For further enhancing the user satisfaction and improving future SUS scores, optimizing the game's performance, particularly the frame rate and addressing the key issues highlighted in user feedback will be essential.

B. Simulation Sickness Questionnaire (SSQ)

In this section, the same ten participants completed a pre-session Simulator Sickness Questionnaire (pre-SSQ) first to assess their initial condition. After experiencing the VR project, they filled out another post-session Simulator Sickness Questionnaire (post-SSQ) to evaluate any changes. The radar chart in Fig. 13 shows the results from the SSQ questionnaire.

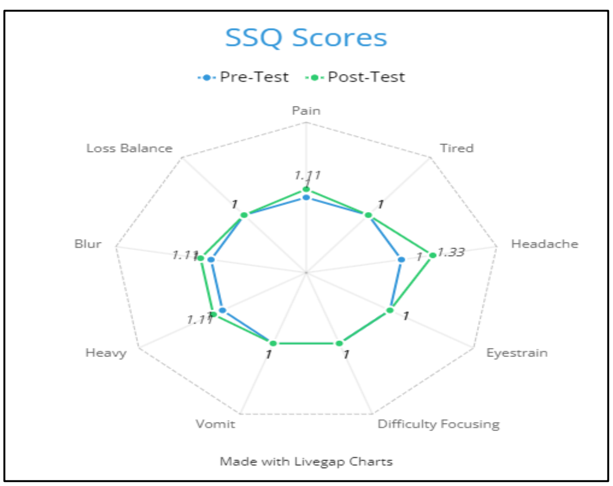

Fig. 13. SSQ's results.

The SSQ results in Fig. 13 show a slight increase in Pain, Blur, and Heavy (from 1 to 1.11), and Headache (from 1 to 1.33) after the VR session, while other symptoms like Tired, Eyestrain, Difficulty Focusing, Vomiting, and Loss of Balance remained unchanged. This suggests mild fatigue and headache, but no major issues with other symptoms. Overall, the results indicate a positive user experience with only minor discomfort, typical for first-time VR users. These results show that AutiSim managed to deliver an immersive experience with minimal discomfort, demonstrating its potential for effective use in future sessions.

C. Expert Testing

For expert testing, the evaluation was conducted with five experts. The first expert is a leading authority in virtual and mixed reality, the second is a game design specialist, the third is the head coordinator of the National Autistic Society of Malaysia, Melaka, and the other two are teachers with expertise in working with individuals on the autism spectrum. Fig. 14 shows the results chart of the expert testing for AutiSim.

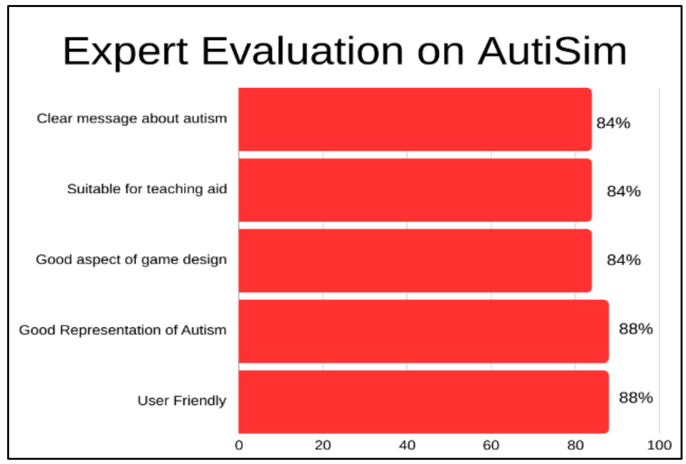

Fig. 14. Expert evaluation's chart.

User friendly refers to aspects such as movement, interaction, and speaking controls. 88% of the experts agreed that AutiSim is easy to use, highlighting the smooth locomotion system that allows players to move fluidly, as opposed to a typical teleportation scheme. Additionally, the ability to rotate the camera using both the headset and the left controller enhances the user experience, providing players with more control over their movement and camera positioning.

Next, a proper representation of autism is essential, as incorrect portrayals can lead to misunderstandings and misperceptions about the condition. It is important to highlight aspects such as slow movement, overwhelming surrounding sounds, and increased stress due to specific interactions, as these are characteristics often experienced by individuals with autism in real life. This was supported by 88% of the experts, who agreed that AutiSim accurately represents these aspects, contributing to a better understanding of the challenges faced by individuals on the autism spectrum.

Furthermore, 84% of experts agreed that AutiSim has a good game design, is well-suited as a teaching aid, and provides meaningful subject matter. These results highlight AutiSim significant potential as an educational tool, effectively raising awareness and deepening understanding of autism. By combining engaging gameplay with rich educational content, AutiSim stands out as an exceptional resource for fostering empathy and promoting knowledge across diverse learning environments.

Since the expert testing was conducted in relevant environments, specifically in the VR technology and autism fields, as shown in Fig. 15, Fig. 16, and Fig. 17, respectively. Valuable feedback was gathered to improve the game. One insightful suggestion from the VR expert was that porting the game to mobile devices, such as smartphones, could help people better understand autism.

While the expert in the autism field, led by the head coordinator of the National Autistic Society of Malaysia (NASOM), Melaka branch, with over 10 years of experience, stated that the game could be a game changer for people, offering a unique way to experience autism through a game format. Additionally, it was suggested that future updates could include the ability for players to interact in multiple languages.

Fig. 15. VR Expert testing AutiSim.

Fig. 16. Head of coordinator NASOM trying the simulation.

Fig. 17. NASOM staff trying the simulation.

Overall, based on the expert testing conducted. AutiSim reflects highly positive feedback, with experts from both the VR technology and autism fields recognizing its potential as an impactful tool for raising awareness and fostering a deeper understanding of autism. The immersive experience was lauded for its ability to provide users with a unique and engaging way to experience the challenges faced by individuals with autism. The game's design, including its educational value and realistic portrayal of autism-related experiences, was praised. Experts also suggested that porting the game to mobile devices could make it more accessible to a wider audience. Additionally, it was recommended that integrating additional features, such as multi-language support, could further enhance the game's accessibility and broaden its reach. These positive insights indicate that AutiSim has the potential to be a valuable resource in both educational and awareness-raising contexts.

V. Conclusion

In conclusion, AutiSim highlight its potential as a transformative tool for raising awareness and understanding of autism spectrum disorder (ASD). Utilizing the immersive capabilities of virtual reality, AutiSim offers an engaging and realistic experience that replicates the sensory and social challenges faced by individuals with autism. The project followed a structured methodology based on the Game Design Life Cycle (GDLC), encompassing pre-production, production, and evaluation phases, ensuring a well-rounded and effective approach.

During the pre-production phase, a literature review guided the conceptualization of the game, addressing gaps in the representation of autism in existing games. This phase also defined the immersive features of AutiSim, including locomotive movement, AI-driven non-playable characters (NPCs), and realistic environments. The production phase brought these concepts to life using advanced software like Metahuman Creator, Unreal Engine, and Reality Scan, resulting in a highly realistic and educational simulation. The game's multi-level design allowed players to explore autism-related challenges across different life stages, providing a comprehensive learning experience.

The evaluation phase utilized both quantitative and qualitative methods to assess the game's effectiveness. The System Usability Scale (SUS) scored 73, exceeding the industry benchmark, indicating user satisfaction and ease of use. The

Simulator Sickness Questionnaire (SSQ) showed minor increases in symptoms like headache and fatigue, which are typical for first-time VR users, but overall results indicated a positive user experience. Expert testing further validated the game's effectiveness, with 84% agreeing it is suitable as a teaching aid and 88% commending its accurate representation of autism-related experiences. Experts also provided actionable suggestions, such as adding multi-language support, optimizing visuals for smoother performance, and porting the game to mobile devices to improve accessibility.

Despite these promising results, the project has certain limitations that need to be addressed in future work. The limitations of this project include the restricted capability for AI characters to communicate with users in multiple languages, as the current system supports voice interaction in only one language due to resources and budget constraints. Furthermore, the study faced technical and hardware challenges in implementing the project as a fully standalone application that runs natively on a VR headset, which required significant optimization and affected the seamless deployment and performance of the simulation.

In summary, AutiSim effectively combines education and entertainment through innovative VR technology and a well-executed design. With planned refinements based on SUS, SSQ and experts' feedback, the game has the potential to become a useful resource in educational settings and public awareness initiatives, promoting empathy, understanding, and acceptance.

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