VR learning Tool for Diabetes Distress

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***Abstract*—Diabetes is a chronic health condition affecting 40.1 million people in United States [5]. Being diagnosed with diabetes can be overwhelming and confusing. Diabetes distress is an emotional burden caused by living with diabetes and constant effort in self-management of the condition. This project "VR learning Tool for Diabetes Distress" presents an immersive virtual environment to facilitate self-access Diabetes Distress Screening using the DDS17 framework. This application combines calming garden settings with a fully equipped virtual health center with educational posters and video displays covering all four domains of diabetes distress with AI powered coach built using ConvAI, capable of answering questions in real time. Developed in Unity, this application delivers engaging first-person experience in reducing stigma and improving accessibility of diabetes screening and patient education for diabetes self-management for adults affected with diabetes distress.**

Keywords—DDS17, Diabetes Distress Screening, Virtual environment, artificial Intelligence, ConvAI, Immersive experience, diabetes self-management

I. Introduction

Diabetes is one of the most prevalent chronic conditions worldwide. Not only physical but it also causes significant psychological burden on those living with the condition. Diabetes distress is defined as emotional and psychological concerns specific to managing diabetes [6]. It has been widely recognized as critical yet often overlooked and mistaken for depression. The Diabetes Distress Scale DD17 is a validate screening tool with 17 questions developed to measure diabetes related distress among four domains: emotional burden, physician-related distress, regime-related distress, and interpersonal distress[7][2]. Early identification of diabetes distress is important in self-management behavior, glycemic control, and overall quality of life[4]. However, traditional healthcare settings often lack resources and time needed to adequately address psychological issues. This project addresses this gap by developing an immersive virtual environment that combines DDS17 screening with AI coaching system to support users across all four domains of diabetes distress.

Fig 1– Showing Health Center and the Environment around

A. Goals and Objectives

The objective of the project is to build an application aimed to provide an immersive, relaxing, user friendly, virtual environment for self-assessing diabetes distress using DDS17 evaluation framework and interactive educational material along with AI powered coaches [7]. DDS17 Framework used set of 17 question that measure diabetes relate distress across four domains [2]:

- Emotional Burden (Q1, Q3, Q8, Q11, Q14)- addressing feeling of anger , fear, depression and being overwhelmed by diabetes
- Physician -Related Distress (Q2, Q4, Q9, Q15)- concerns about patient-doctor relationship and quality of care
- Regimen-Related Distress (Q5, Q6, Q10, Q12, Q16)- challenges with blood sugar testing, meal planning and daily self-management
- Interpersonal Distress (Q7, Q13, Q17) – lack of support from friends and family

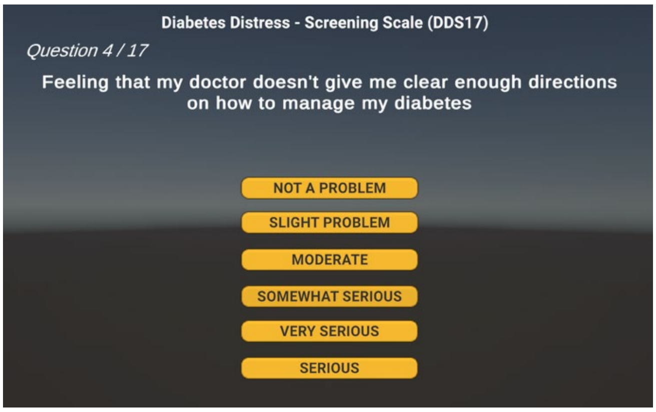

Fig 2 – DDS17 Quiz Questions

B. Modeling

The environment was designed to simulate a realistic suburban setting centered around a park, that provides user an easy navigation through the environment to get to the center. There are interconnected roads with sidewalks, streetlights, moving cars, and surrounding buildings. The Unity Health Center is the main building located across the park. The whole scene is set inside a skybox with an open field and trees. The park consists of flower beds, a fountain at the center and seating areas, and trees on either side of it. When entering the healthcare, the door opens automatically, and a reception can be seen with an AI powered receptionist. Lobby consists of seating on both sides of the center with stairs leading to the second floor. The quiz scene loads only when the user interacts with laptop place on table on right side of the lobby. There are four rooms in the building with posters and video players. The textures and material used in all buildings and environments use high quality texture sourced from the unity Asset Store to ensure realism.

Fig 3– Garden with fountain and NPCs interacting with each other

C. *Programming*

The application was built using a Unity 3D platform that used C# programming. C# programming scripts were used for opening and closing doors, NPC integration, building user interface, and user interaction.

II. RELATED WORK

Diabetes distress has been widely studied as a critical psychological component of diabetes management. Previous research states that individuals with Type 2 diabetes often experience emotional burdens that have negatively impacted adherence to treatment and overall health outcomes. The traditional screening tools such as the DDS17 questionnaire have been effective in clinical settings but are often unimplemented due to limited time, accessibility, and patient engagement [2].

VR-based systems are commonly used to create immersive environments that improve patient engagement, reduce anxiety, and enhance learning outcomes[5]. Studies have shown that interactive VR experiences can increase retention of health-related information compared to traditional methods [9]. With it, artificial intelligence Ai driven conversational agents have been integrated into healthcare systems to provide real-time assistance, and personalized recommendation. ConvAI enable natural interaction between users and virtual agents, making healthcare guidance more accessible.

Previous work in VR-based mental health systems, such as an enhanced mental health diagnostic VR application developed by previous students, has demonstrated the effectiveness of immersive environments for psychological assessment and user engagement. However, these systems are typically made for mental health conditions and do not focus specifically on diabetes-related distress or integrate structured clinical tools such as DDS17. But while playing or watching the video, it gave the experience of VR and helped to initiate the project.

III. IMPLEMENTATION

The implementation consists of Three phases:

A. *Modeling Phase*

The main center was modeled using Unity ProBuilder and other elements such as buildings, trees, and roads were added. Water in the fountain was added using a particle system. Terrain was added with trees and ground texture to make it look more realistic and unify the scene with the image in the sky box. In the health center, posters from public health resources like CDC and ADA were added.

B. *Behaviours, Scripts and functionality*

After modeling phase C# scripts were used to add NPC behaviors, automated systems, triggers for user interface panel and user interactivity such as playing videos.

C. *User Interaction*

The application is built for personal computers with first person controller. Users interact using WASD for navigation and mouse for looking around.

IV. FUNCTIONALITY.

A. *Vision*

The visual design of this project focuses on creating a calm and immersive environment to reduce user anxiety and it also let user to explore the environment. This project consists of a suburban setting with a central park, greenery, and a structured healthcare center that provides a sense of familiarity and comfort for the people of the region. High-quality textures, realistic lighting, and spatial design enhance the user's sense of presence within the virtual environment. The greenery around the environment with wind animation almost gives the experience of being present on the environment. Visuals such as signboards, posters, and interactive objects guide users intuitively through different parts of the project or the environment.

Fig 4– Garden view leading up to Health Canter

B. Sound

Sound design is very important for making experiences feel more real and engaging. The sounds of birds singing, wind blowing, and water moving from the fountain help make the place feel calm and peaceful. The background music helps calm the mind and promotes a better mood. This helps make the experience easier to use and feels more realistic.

C. Animation

Animations are used to make the environment smooth and interactive and most common examples include automatic door opening, moving vehicles, and subtle environmental movements such as trees moving with the wind. These animations enhance realism and make the environment feel alive. The NPC in the game also adds to the beauty of the environment. Character animations for AI agents also improve engagement by simulating natural human-like interactions.

D. Interactivity

The project provides multiple layers of interactivity. Users can navigate freely within the environment and the buildings; players can follow the traffic rules. They can interact with objects such as tablets or laptops to initiate the DDS17 questionnaire and engage with educational materials like posters and videos which are posted on the walls of the Healthcare center. With it, the user can also scan the QR codes to get more knowledge on the Diabetics which is provided with the posters. Interactive triggers are implemented using C# scripts to respond to user actions, this ensures a seamless and responsive experience.

Fig 6– Room with Poster, interactive display and ConvAi NPC

E. Characters/Avatars

AI-powered non-player characters (NPCs), including a receptionist and virtual coach, are implemented into the environment. These avatars in the Healthcare center can assist users by providing information they need, answering questions, and guiding them through the task. The use of these avatars enhances user comfort and creates a more engaging and supportive experience.

Fig 5 – NPC character taking rest in the Garden

F. Sensor

The system in this application has utilized standard input devices such as keyboard and mouse for interaction. While no other advanced physical sensors are used, the application is designed in a way that can be extended to VR headsets and motion controllers in the future tests.

G. Player

The user is represented as a first-person player within the virtual environment. Movement is controlled using the traditional keyboard inputs (WASD), while the mouse is used for camera control and interaction. This perspective increases immersive nature and allows users to explore the environment naturally. Multiplayer systems are integrated in the application to make this application more effective for its cause.

H. AI Implementation

The AI component in this application is implemented using ConvAI to provide real-time conversational support. You can interact with them verbally, and you could also read the conversation through the chat box. The AI coach is capable of answering user queries related to diabetes management and distress [6]. It will enhance user engagement by offering personalized guidance and it also simulating human-like interaction, which will make the experience more interactive.

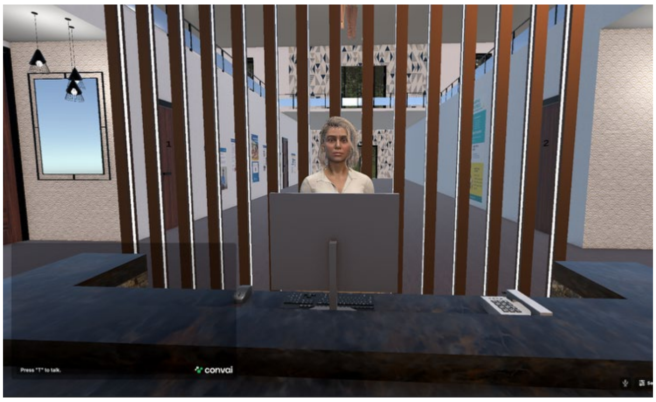

Fig 7 – ConvAi integrated Receptionist

I. Interface Elements

The user interface in this application includes interactive panels, quiz screens, posters and signs, and informational diabetic displays. The DDS17 questionnaire is presented in a clear and structured format to make sure the ease of use for patients. UI elements are designed to be very minimal and to the point, avoiding cognitive overload while maintaining functionality.

J. Integration and Requirements

The system integrates multiple components including Unity 3D for environment development. C# is used for scripting, ConvAI for AI interaction, Photon PUN for multiplayer, and multimedia elements for educational content. The application is made to runs on personal computers with basic hardware requirements, which ensures accessibility.

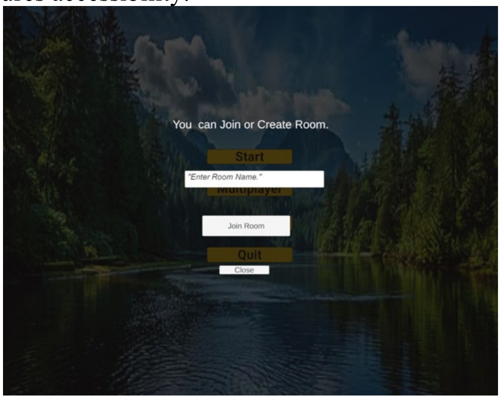

Fig 8– Multiplayer Lobby by Photon

V. Conclusion

This project presents a standard approach to addressing diabetes distress through an immersive VR-based learning tool. By integrating the DDS17 screening framework with a virtual environment and AI-powered coaching, this application provides an engaging and accessible platform for self-assessment and education [2][9] The system successfully demonstrates how technology can be a bridge of gaps in traditional healthcare by offering users a safe, interactive, and informative space to understand and manage their condition. The accessibility of this application to even a non-techie individual is a key point here. The combination of visual immersion, animation, interactivity, and intelligent assistance enhances user engagement and promotes better self-management practices.

Acknowledgment *(Heading 5)*

The authors would like to thank Dr. Sharma for their guidance and support throughout the development of this project. We would like to appreciate the prior students who completed similar projects which helped us to understand and initiate the project in good terms. We also acknowledge the University of North Texas for providing resources and an academic environment that facilitated the successful completion of this work.

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