

A Mobile Application Featuring Advances in Immersive Augmented Reality Interventions to Support Depression Patients

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Abstract- Depression is a global mental health concern that affects millions of people worldwide. Traditional treatment methods, though effective, may encounter obstacles such as stigma and limited resources. In response, mobile mental health apps have gained popularity due to their convenience, accessibility, and potential for personalized care. Advances in immersive augmented reality (AR) have shown potential in supporting interventions for depression patients. By leveraging the capabilities of AR, these interventions aim to enhance traditional treatments and provide accessible support to a wider population of patients. This paper introduces "ConnectWell," a high-end mobile app that harnesses the power of AR to revolutionize depression management. ConnectWell transcends conventional app functionalities by seamlessly integrating AR-based patient-therapist communication, guided meditation, group therapy sessions, skill-building exercises, and coping strategies. A state-of-the-art AI-powered chatbot augments the app's capabilities, offering continuous personalized support, guidance, and resource sharing. Additionally, the app is thoughtfully integrated with compatible smartwatches to monitor users' physiological data, enabling real-time mood assessment and tailored interventions. The app serves as a supportive and compassionate virtual friend, providing positive responses and guidance whenever depression patients need someone to talk to and seek help. Utilizing the full potential of these mobile applications for supporting depression patients necessitates a thorough investigation into the adoption and dissemination of AR in conventional clinical practice. The paper concludes with a call for further research and development to investigate the feasibility and benefits of haptic-enhanced AR in mental health interventions.

Keywords: Mobile application, Immersive augmented reality, AR-based interventions, Depression, Personalized experiences, Interactive elements, Real-time monitoring

I. INTRODUCTION

Depression is a significant mental health concern affecting millions of people worldwide. Traditional treatment approaches, including therapy and medicine, have shown to be effective, but they might not always be available to everyone owing to obstacles such as cost, stigma, and a lack of resources. The financial cost works as a deciding factor that prevents an individual from seeking mental health care. Free availability is one of the main reasons behind the

popularity of the Apps related to mental health issues (Islam and Choudhury, 2020).

Furthermore, depression is a subjective condition, each patient requires a unique approach. Therapy sessions and drug administration are common components of traditional therapeutic procedures, but the development of technology has opened opportunities for innovative approaches that might support conventional techniques. Mobile applications and other technology-driven interventions can bridge the gap in this situation. Mobile applications (apps) have emerged as promising tools for helping people with depression in recent years because they provide Convenience, accessibility, and individualized assistance. Zhang *et al.* (2019) argued that clinically meaningful activities—learning, goal setting, and self-tracking—may reduce the depression symptoms of a user.

Mental health apps can provide information, build awareness, and monitor mood and behavioral patterns. But the efficiency of the apps will depend on several factors as pointed out by East and Harvard (2015) that well-designed mental health mobile apps that present content in interactive, engaging, and stimulating ways can promote cognitive learning, personal growth, and mental health enhancement.

Chatbots are an emerging technology that shows potential for mobile Mental Health apps to boost user engagement and adherence (Oh *et al.*, 2021). Mental Health (MH) chatbots are AI-powered chatbots that provide MH support, guidance, and resources through a conversational interface (Dekker *et al.*, 2020). These chatbots replicate human interactions, respond to user inputs, and deliver tailored Mental Health care (Inkster *et al.*, 2018).

Augmented Reality (AR) is the technology that aims to digitally integrate and expand the physical environment or the user's world, in real-time, by adding layers of digital information (Arena *et al.*, 2022). It is a revolutionary technology that has the potential to transform various aspects of human lives.

Through AR, digital objects are registered, using cameras and sensors that track a user's position in an absolute location, such that when a person moves, the object stays in the programmed position (Miller *et al.*, 2019). Therefore, AR has the potential to play a transformative role in the field of depression by providing innovative approaches to

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assessment, treatment, and support. AR systems feature social interaction by employing embodied agents, which are characters whose verbal and nonverbal behavior are generated algorithmically in response to users' behavior (Miller *et al.*, 2019).

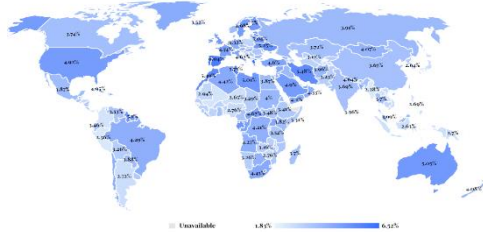


Figure 1 – Current depression rates.
Source: (Wisevoter, 2023)

II. LITERATURE REVIEW

A. What is Depression?

WHO defines depression as a mental disorder which involves a depressed mood or loss of pleasure or interest in activities for long periods of time. Approximately 280 million people in the world have depression while more than 700 000 people die due to suicide every year (Depressive disorder (depression), 2023). The current depression rates of the countries as shown in Figure 1.0 highlights depression as a world problem.

B. Technologies to Manage Depression.

Augmented Reality:

Augmented Reality (AR) is an innovative technology that seamlessly merges virtual elements with the real world, transforming how we perceive and interact with our surroundings (Azuma, 1997). By overlaying computer-generated content onto the physical environment, AR enhances user experiences by providing additional information, interactive visuals, and immersive interactions (Billinghurst and Kato, 2002).

AR offers the advantage of being accessible through commonly available devices like smartphones, tablets, and smart glasses, enabling widespread adoption and eliminating the need for specialized equipment (Rauschnabel *et al.*, 2017). This accessibility and mobility make AR a versatile tool that can be utilized on the go and in various settings, from classrooms to industrial workspaces. Whether it is enhancing user engagement, facilitating immersive learning experiences, or improving productivity and safety in various fields, AR has the potential to reshape how we interact with information and our environment (Lee, 2012).

Compared to Virtual Reality (VR), which immerses users in entirely virtual environments, AR maintains the user's connection to the real world, making it a more practical

Users of depression management software may encounter an immersive and engaging world by using AR, which encourages engagement, empowerment, and general well-being. The outcome of this research will strive to unlock new doors for improving treatment outcomes and enhancing the lives of people dealing with this crippling ailment by evaluating the problem domain and investigating the possibility of AR-based software for patients with depression.

solution for various applications (Milgram and Kishino, 1994). Numerous studies have explored the utilization of Augmented Reality (AR) in mental health applications addressing various aspects of depression management. One area of focus is patient-therapist communication using AR and the app enables virtual therapy sessions, eliminating geographical barriers and providing flexibility for individuals with depression (Dinh *et al.*, 2023).

Furthermore, therapy sessions using AR have shown promising results in enhancing traditional therapeutic approaches. By creating immersive and interactive environments, AR-based therapy sessions facilitate cognitive restructuring, exposure therapy, and mindfulness exercises, leading to reductions in depressive symptoms and improved overall well-being (Wiebe *et al.*, 2022).

I) Other relevant technologies:

The integration of a chatbot offers continuous support and guidance for patients. The chatbot serves as a virtual assistant, providing emotional support and coping strategies to individuals with depression, thus increasing access to personalized care (Zou *et al.*, 2023).

The app incorporates the strategic integration of Artificial Intelligence (AI) and the Internet of Things (IoT) for enhanced functionality and performance. AI algorithms can be employed for personalization, tailoring the app's content and interventions to the specific needs such as through chatbots, track decision making progress and preferences of individuals with depression. By leveraging IoT technologies, such as wearable devices and sensors, the platform enables continuous monitoring of various physiological and behavioral parameters during exergaming sessions (Koulouris *et al.*, 2022). IoT is essential for tracking emotional indicators like heart rate, sleep patterns, and levels of physical activity by using smartwatch sensors. These sensors make it possible to gather real-time information about a user's emotional health, which AI systems can then examine.

The integration of smartwatches allows the tracking of physiological parameters and presents an opportunity for

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Table 1: Comparison of Available Apps and Proposed App

Mental Health App	Patient-Therapist Communication	Chatbot for Patients	Group Therapy Sessions	Emergency Notifications	Connectable to Watch for Mood Tracking	Emergency Contact Call	Pill Counter	Nearby Pharmacy Locator	Private Diary	Audio (Music)	Augmented Reality	Additional Features
Moodpath	-	-	-	✓	-	-	-	-	✓	-	-	Mood Tracking using Questionnaires
Sanvello	-	-	-	✓	-	-	-	-	-	-	-	CBT Exercises
7 Cups	-	✓	-	✓	-	✓	-	-	-	-	-	Emotional Support
Talkspace	✓	-	✓	✓	-	✓	-	-	-	-	-	Online Therapy
BetterHelp	✓	-	✓	✓	-	✓	-	-	-	-	-	Virtual Counseling
Woebot	-	✓	-	✓	-	-	-	-	✓	-	-	AI Therapy
MindShift	-	-	-	✓	-	-	-	-	-	-	-	Anxiety Management
Youper	-	-	-	✓	-	✓	-	-	✓	-	-	Emotional Assistant
Calm	-	-	-	✓	-	-	-	-	-	✓	-	Meditation, Relaxation
Headspace	-	-	-	✓	-	-	-	-	-	✓	-	Meditation, Mindfulness
Daylio	-	-	-	✓	-	-	✓	-	✓	-	-	Mood Tracking, Journaling
ConnectWell	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	Immersive Interaction through Augmented Reality

comprehensive monitoring and assessment. By connecting with a smartwatch to measure heart rate, temperature, and other relevant indicators, the app can capture valuable data to track patients' moods and overall well-being (Goldfine *et al.*, 2020).

Virtual reality (VR) is a technology that allows a user to interact with a computer-simulated environment, whether that environment is a simulation of the real world or an imaginary world (Misra P, 2021).

The advantages of Augmented Reality (AR) over Virtual Reality (VR) examine the unique ability of AR to create a novel environment that does not require a complete break from physical reality. While not as immersive as VR and AR apps may be more accessible and user-friendly given that many can be accessed through a smartphone and do not require additional equipment (Jackson *et al.*, 2021). Additionally, AR fosters social and collaborative experiences, enabling multiple users to interact with shared augmented content simultaneously. Furthermore, the accessibility and cost-effectiveness of AR are other main advantages.

C. Gap Analysis

To develop a successful solution the existing solutions are evaluated, and the following gap analysis (Table 2.1) presents similar applications and features in the already existing applications.

III. PROBLEM DOMAIN

For many people, conventional methods such as therapy and medication have proven successful. However, various factors hinder the comprehensive management of depression, including limited accessibility, stigma, and the need for personalized interventions. Stigma has been identified as an overlooked social determinant of health that plays a vital role in the distribution of life chances and health status for PWSMI (People Diagnosed with a Serious

Mental Illness) through the production of inequities and stress (Segarra *et al.*, 2019).

The challenge of accessing mental health care is a major impediment to treating depression. Many people have trouble getting to therapy appointments and receiving psychiatric care because of monetary restrictions, location restrictions, or lengthy wait times, many people suffer in silence, seeking no therapy, and relying on self-care techniques to escape disgrace. As a result, there is a critical need for alternative treatments that may fill the gap between people and professionals.

Lack of investment in mental health care and lack of trained healthcare providers is another reason for the increment of Depression patients around the world. Furthermore, each person's unique symptoms, triggers, and coping mechanisms vary due to the extremely personalized nature of depression. Traditional therapy methods frequently use a one-size-fits-all approach, which might not be able to meet the unique needs of individuals with depression. To create treatments that are effective, personalization and customization are essential.

IV. METHODOLOGY

This research study utilized a mixed-methods approach to gain comprehensive insights into the topic of depression. Firstly, qualitative study of a series of interviews were conducted with experienced consultants and counselors who possessed expertise in the field of mental health. These interviews aimed to obtain professional perspectives, valuable insights, and expert opinions on various aspects of depression. The purposive sampling method was used to access the intended respondents and in-depth face-to-face interviews were conducted approximately 30 minutes to 1 hour. The qualitative data collected were analyzed to identify common key words and develop themes. The information obtained from the interviews provided a foundation for developing a questionnaire to gather data

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from a larger sample of participants. The questionnaire was designed to collect the experiences and requirements to design the new solution. The questionnaire was administered using a Google Form and distributed among a diverse group of individuals through snow-ball sampling method. The questionnaire included a combination of multiple-choice and open-ended questions, covering participants' personal experiences with depression, attitudes toward seeking help, and potential coping strategies. The quantitative data was analyzed using Excel and identified the patterns and the summarized information. The insights gained from both the interviews and the questionnaire responses were then synthesized to provide a comprehensive understanding of depression, considering both professional expertise and lived experiences.

V. DISCUSSION

A. Interview Results

These experts emphasized the crucial role of support from family and friends, as well as the importance of having someone to talk to when individuals with depression are feeling low. Consultant 1 stated, "*Individuals in an unstable position often seek solace in engaging conversations with loved ones and professionals.*" They further highlighted the effectiveness of virtual connections in reaching and assisting patients.

Counselor 1 further highlighted, "*Common obstacles faced by depression patients in their daily lives are, memory loss, lack of enthusiasm, and reduced engagement in activities.*" In Summary, the study findings revealed valuable insights into the prevalence of depression, participants' willingness to seek medical advice, their preferred coping mechanisms, and their perceptions of alternative forms of therapy.

B. Questionnaire Results

The results are based on the 67 participants who responded. The questionnaire consisted of multiple-choice and open-ended questions related to participants' experiences with depression. The results revealed that a significant proportion of participants reported personal experiences with depression or knowing someone who has, and many expressed hesitations to seek medical advice due to fear of stigma, lack of affordable healthcare, negative past experiences, and the belief that symptoms would improve on their own.

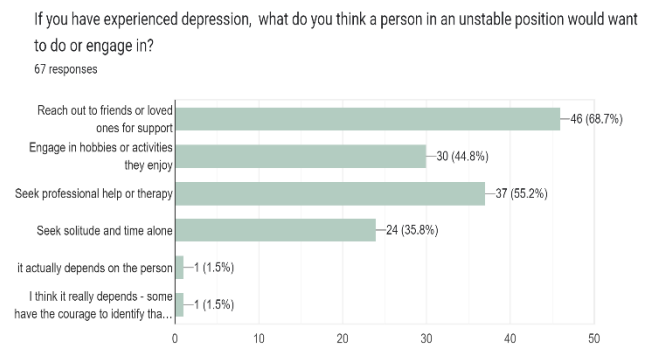


Figure 2 – Connecting with loved ones.

The findings from the questionnaire responses depicted in the above figure 2.0 highlight the significance of two key strategies in coping with depression: 68.7% majority believed that reaching out to friends or loved ones for support is good and 55.2% believe seeking professional help or therapy is good. Another 44.8% prefer to engage in hobbies or activities they enjoy while 35.8% seek solitude and time alone.

Additionally, most participants expressed a preference for physical therapy, although online therapy was also deemed important. A percentage of 68.7% of participants highlighted the desire for automatic notifications regarding depression among their social circle, emphasizing the need for external support.

Do you believe that individuals with depression would prefer to connect with their loved ones through means other than voice calls or video calls...n connect better and feel the presence of another?

67 responses

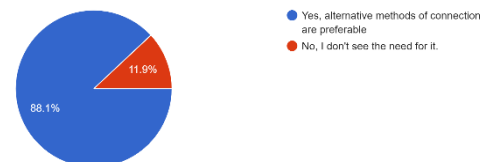


Figure 3 – Connecting with loved ones.

As shown in Figure 3.0, 88.1% of participants highlighted the desire for automatic notifications regarding depression among their social circle, emphasizing the need for external support. Furthermore, participants expressed a preference for alternative means of connecting with loved ones when feeling down, such as Augmented Reality (AR), as it allows for enhanced presence and connection. The study also indicated a willingness among participants to engage in group therapy sessions and suggested the potential benefits of using AR technology in managing depression.

VI. PROPOSED SOLUTION - "CONNECTWELL"

A mobile application is proposed to address the challenges associated with depression and promote mental well-being. This app facilitates access to therapeutic materials and

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features while facilitating communication and connection among patients through AR technology.

Key features of the proposed solution are:

a) Patient - Therapist Communication:

ConnectWell revolutionizes the patient-therapist relationship by enabling augmented reality-based interactions. Patients can have face-to-face sessions with their therapists as well as their loved ones such as family and friends, no matter their physical location. The mobile app enables users, particularly patients, to update their emergency contact list with the consent and involvement of their guardians and therapist. The app's functionality ensures that any changes made to the emergency contact list trigger notifications to the relevant parties. By incorporating this feature, the app aims to protect the patient from potential negative consequences and provide a reliable support system during emergency situations.

Individuals can externalize their emotions and experiences using avatars or virtual representations, which facilitates emotional processing and communication with therapists. Through the app, therapists can use expressive gestures, body language, and express themselves through facial expressions to create a more individualized and immersive therapy environment. To communicate through augmented reality (AR), you can use the following devices, AR-enabled Device: This refers to a device capable of displaying augmented reality content. It can be a smartphone, tablet, or wearable device like smart glasses or a head-mounted display (HMD). Examples of AR-enabled devices include Apple's iPhone and iPad (supporting ARKit), Android smartphones and tablets (supporting ARCore), and Microsoft HoloLens. By using the device's camera, sensors, and processing power, mobile phones can track the environment and overlay virtual content in the real world.

b) Guided Meditation and Mindfulness:

AR can create virtual environments that mimic serene and calming settings, such as peaceful landscapes or soothing natural scenes. Viczko, *et al.*(2021) demonstrated that a brief phone-based AR meditation could significantly decrease negative mood states while significantly increasing positive mood states in 4 minutes. During treatment sessions, patients can fully immerse themselves in these settings, promoting emotional healing and relaxation. Users can interact with virtual features to encourage relaxation and foster a sense of the present currently through visualizing soothing scenes, listening to audio instructions, and visualizing soothing scenes.

c) Group Therapy Sessions:

ConnectWell facilitates virtual group therapy sessions moderated by licensed therapists through AR. In a welcoming and comfortable setting, patients can interact with those going through similar circumstances, share their stories, and get assistance. These meetings encourage a sense of belonging, reduce feelings of isolation, and boost mutual learning and development.

d) Skill-Building and Coping Strategies:

AR can be used to create interactive simulations and scenarios that give people a safe and controlled setting to practice coping mechanisms, problem-solving abilities, and social skills. This provides a practical and engaging way to learn and reinforce effective strategies for managing depression symptoms.

e) Chatbot for Patients:

The program includes an intelligent chatbot using AI that serves as a virtual friend and provides daily support to sufferers. The chatbot offers sympathetic responses, identifies useful resources, and offers coping mechanisms. It also helps users track their mood fluctuations over time and provides data insights to therapists for more personalized care.

f) Comprehensive Resources:

A directory of nearby pharmacies and medical facilities which are tracked using Google Maps as an API, emergency contacts, and audio content database including certified audios of therapists and counselors all around the world, motivational speeches, and personalized audio recordings. By accurately identifying the mood, AI can enhance user experiences through personalized recommendations, mood-based playlists, and adaptive user interfaces. These tools guarantee that users may efficiently manage their mental health and have easy access to essential services.

g) Pill counter:

Upon setting up the system, users are prompted to provide information about their prescribed medications, including the name of the medication, dosage instructions, and the number of pills available. Users can also choose to disclose their medical information, including the reason they are taking a prescription and any pertinent medical problems. Daily, or as per the user's preference, the system sends reminders to prompt users to take their medication. Depending on the dosage schedule that the user specifies, these reminders can be programmed for execution repeatedly during the day. The app updates

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the database's pill count once the user confirms they have taken the medication.

The system sends messages to the user and any specified emergency contacts if the number of pills left for a specific medicine drops below a predetermined threshold (for example, less than 5 tablets). This guarantees that the patient and their trusted contacts are both informed of the urgency of the medication refill.

The Pill Counter feature provides a convenient and efficient way for users to stay on track with their medication schedules.

h) **Personal Diary and Goal Setting:**

ConnectWell encourages users to maintain a personal journal where they can record their thoughts, feelings, and progress. It also has a goal-setting function that enables users to establish daily, weekly, and monthly goals. This feature gives users a sense of purpose and accomplishment. Users are motivated and on track via reminders and notifications.

i) **Guided Relaxation Exercises:**

To assist users with managing their stress, anxiety, and depressive symptoms, the app provides a number of guided relaxation techniques. These exercises include deep breathing techniques, mindfulness practices, progressive muscle relaxation, and other evidence-based interventions. Users are able to personalize their relaxation sessions based on their preferences and needs.

j) **Decision-making Progress:**

The mobile app enables users to track and monitor the daily decision-making progress of individuals experiencing depression. The app leverages Artificial Intelligence (AI) to send daily messages and notifications that prompt users to reflect on their decision-making process. Users can assess the positivity or negativity of their decisions, evaluate emotional control, and analyze the smoothness of emotional flow throughout the day. The collected data is made accessible to therapists, the users themselves, and their loved ones, facilitating a comprehensive understanding of the individual's progress over time.

k) **Mood tracking through a questionnaire:**

This app includes a feature that prompts users to answer a set of simple questions two or three times a day, aimed at tracking their mood. By regularly collecting this data, the app can monitor any negative responses and trigger an alert system if the patient's mood indicates distress or worsening mental health. In such cases, the app would automatically notify the

designated emergency contacts, including family members, ensuring that timely support can be provided to the patient.

l) **Integration with Smartwatches:**

ConnectWell can seamlessly connect with compatible IoT smartwatches to track patients' physiological data, such as heart rate, temperature, and sleep patterns. This information can be utilized to assess the user's mood to provide therapists with insightful information.

When the system detects abnormalities or fluctuations in the user's heart rate, temperature, or other monitored parameters that exceed predefined thresholds, it triggers an alert. The program instantly notifies the user and any emergency contacts they've specified in such circumstances. The emergency contacts receive notifications with the relevant information about the detected changes, allowing them to reach out to the user and offer assistance or intervention as needed.

m) **Administrative privileges for Therapists:**

The app's administrative dashboard would be accessible to therapists, giving them the ability to manage patient accounts, organize therapy groups, and build personalized treatment plans for specific patients. This feature empowers therapists to oversee and guide the therapeutic process.

Group Therapy Sessions: Therapists can schedule and moderate group therapy sessions within the app. Participants can virtually attend the session, interact with one another, and take part in therapeutic activities that are facilitated by the therapist using AR.

Personalized Therapy Sessions: Through the AR platform, therapists can hold one-on-one treatment sessions with their patients in a secure and private setting.

Resource Sharing: Therapists may share digital flyers, posters, and educational materials with their patients via the app.

Session Reminders and Notifications: Patients can receive automated messages and reminders from the app regarding their forthcoming therapy appointments, group activities, and resource updates.

Progress Tracking: The app allows therapists to keep tabs on their patients' progress. They have access to information on patient-reported outcomes, session attendance, and other pertinent indicators. The therapists can update the selected emergency contacts of the patients accordingly.

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ConnectWell represents a significant step forward in providing comprehensive support and fostering connectivity for individuals struggling with depression. Users are given the opportunity to actively participate in their mental health journey and enhance their general well-being by utilizing ConnectWell's intuitive interface and extensive features.

VII. CONCLUSION

Depression has been identified one of the growing mental health concerns after the Covid pandemic that affects millions of children and adults worldwide. The literature proves the feasibility of employing technologies to support depression patients and there are successful implementations. However, the use of Immersive Augmented Reality Interventions and artificial intelligence are in infancy stage. The research has shown that the adoption of AR in mental health interventions holds great promise. This research paper introduces "ConnectWell," a groundbreaking mobile application that harnesses the power of augmented reality (AR) to revolutionize the management of depression. The global issue of depression, the limitations of conventional treatments, and the possibility for technology-driven therapies to fill in the gaps in mental health care have all been carefully examined in this study. "ConnectWell" goes beyond typical mental health apps by seamlessly integrating AR-based patient-therapist communication, guided meditation, group therapy, coping strategies, and an AI-powered chatbot. This solution's compatibility with smartwatches enables real-time mood assessment and personalized interventions to predict suitable activities. Through AR, individuals can access virtual therapeutic environments, connect with others in group sessions, and practice coping strategies in immersive simulations. By combining the convenience of mobile apps, the immersive nature of AR, and the capabilities of AI, ConnectWell offers a comprehensive and personalized approach to supporting individuals dealing with depression. In essence, "ConnectWell" represents a significant advancement in the field of depression management, offering a transformative solution that combines innovation, accessibility, personalization, and compassionate support.

VIII. FUTURE WORK

In future work, there is a promising avenue to explore the integration of haptic technology with augmented reality (AR) to enhance therapeutic experience for patients. By incorporating haptic feedback into AR environments, it becomes possible to create a more immersive and interactive setting where patients can not only visually perceive but also physically interact with virtual elements. This advancement would enable patients to engage in tactile experiences, such as touching, hugging, and feeling the presence of virtual objects or entities. The integration of haptic technology with AR has the potential to revolutionize the way we design and deliver mental health interventions, providing a richer and more engaging environment that can potentially enhance the effectiveness

of therapeutic interventions and promote a sense of connection and presence for patients. Furthermore, in addition to haptic technology, the utilization of haptic wearables could play a significant role in tracking and monitoring patients' moods. These wearables could provide real-time data on physiological indicators, such as heart rate and skin conductance, which can be correlated with the patient's emotional state. By incorporating mood tracking through haptic wearables, future interventions can gain valuable insights into patients' emotional well-being, enabling personalized and targeted support. Further research can be carried-out to predict depression patients' moods using machine learning algorithms and provide early warnings or control actions that will drastically reduce the suicide rates. The future developments in this area are needed to explore the potential of emerging technologies to minimize the global depression rate.

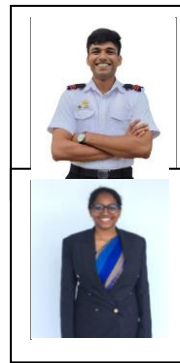
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