Augmented Reality for the Assessment and Treatment of Children with ADHD for Autism Detection

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ABSTRACT
In the current world, attention deficit hyperactivity disorder, or ADHD, is a major problem that needs to be handled. ADHD treatment is difficult because it is not an emergency, is expensive, has side effects, and may not be beneficial. Because it makes people—especially children—prone to impulsive decisions that impede their success in the job, in school, and in other spheres of life, ADHD is difficult to manage. An alternative strategy that has shown promise in the treatment of mental disorders and improving cognitive abilities is neuro feedback therapy, also known as play therapy. This method is based on real-time feedback of an individual's brainwave activity, which is typically collected through an electroencephalogram, or EEG. Conversely, prolonged exposure to repetitive feedback may lead to lesser engagement since individuals may find it difficult to continue engaging and lose interest in the process. A thorough evaluation of augmented reality's application in the context of pediatric ADHD has been conducted, with a focus on the advantages of developing games especially for children with ADHD. The purpose of this study was to examine the fundamentals of augmented reality (AR) systems that support the diagnosis and management of ADHD in children by utilizing AR technology in a group of kids.

KEYWORDS: Augmented Reality, Autism Detection, ADHD (attention deficit hyperactivity disorder), Neuro feedback therapy.

1 INTRODUCTION

A real-time, direct or indirect representation of the real world that has been modified or enhanced with computer-generated data is referred to as "augmented reality" (AR). Through the integration of virtual data with their immediate environment, augmented reality (AR) enables people to engage more deeply and completely experience the real world. [1], [2]. Augmented reality (AR) possesses the same potential to stimulate all five senses as virtual reality (VR). AR can aid in compensating for damaged senses by bringing valuable information into the actual world.[3], [4]. Furthermore, since interacting with the real world is the primary advantage of augmented reality (AR), it may be utilized in both indoor and outdoor environments.

Because a fixed AR system is confined to a particular location and limits user movement to predefined zones, it might be necessary to relocate the entire system setup. The advantage of these systems is that they are still dependable and constant. Action tracking adds more controls and processing capability to an otherwise immobile arrangement, enhancing the realism of the augmented reality experience. Both inside and outdoor use of fixed AR is feasible. However, mobile augmented reality is different from AR on mobile phones in that it lets users place the AR system anywhere they like. [5]. Although this may result in a reduction in computational power, users can utilize this interface with freedom because the portable technology required to implement the AR system is easily accessible wherever they choose. Augmented reality on the move, or mobile AR, is widely used, and its main platform is smartphones because almost everyone in developed countries owns a cell phone that can be used as a "computer." Static and mobile AR components are used to create mixed reality. The AR system can be transitioned more smoothly, and mobile AR is a sensible option because it doesn't require significant advancements in wearable technology [6].

Normally, the user has to carry the computer system, but these difficulties can be avoided if the apparatus is built inside an automobile. However, the viability of mixed deployable AR has greatly grown because to developments in portable technology. A viewfinder, which is typically a camera, is required to record environmental data because augmented reality (AR) replaces real-world elements with virtual ones or superimposes virtual items on the real world. Users can then experience augmented reality (AR) in two ways: through smart device display, where virtual objects appear on the screen, or through mounted spatial view, which facilitates spatial AR. Thanks to continuous technical breakthroughs, state-of-the-art augmented reality technology has been designed with portable screens in mind, combining the advantages of both approaches.[7]. Holograms and video projection are examples of optical components used in spatial augmented reality to project information directly onto actual objects without the need for a traditional monitor. Multiple people collaborating on a single virtual object could be made possible with this approach's potential for further advancement. [8-9].

In the field of healthcare, augmented reality technology is still in its infancy, especially when it comes to ADHD. A significant number of youngsters suffer with ADHD, a neurodevelopmental illness that highlights the need for prompt intervention to stop it from continuing into adulthood. Non-pharmacological approaches such as behavioral training, neuro feedback, play therapy and cognitive training have gained popularity recently as beneficial substitutes that therapists support in order to lessen the need for medication in children. However, research indicates that patients' motivation, focus, and attention spans can be improved by simply adding an augmented reality component to current therapy. [10]. Since the results reported here just scratch the surface of the therapies' potential, the future looks bright for the clinical implementation of AR-based treatments. The AR application is designed to promote cognitive performance in people with ADHD. It is especially intended for patients who are 8 years of age and older. It helps with tasks like attention, impulsivity reduction, and planning, organizing, and carrying out everyday activities.

- AR technology is particularly good at producing aesthetically pleasing virtual worlds that draw users in and increase interaction.
- Augmented Reality (AR) provides a means for users to engage with virtual items in the actual world, enabling a smooth transition between virtual and real-world experiences.

- Augmented reality (AR) is a state-of-the-art, highly technologically advanced technology that simulates three-dimensional (3D) settings, allowing users to fully immerse themselves and have realistic experiences.

2 RELATED WORK

Despite the fact that ADHD affects a large percentage of children, treating it in childhood is the best method to prevent it from persisting into adulthood [11]. Non-pharmacological therapies have becoming more and more common as therapists are realizing that they are more effective than medications for children and can frequently lower the likelihood of drug dependence.[12]. Play therapy, behavioral therapy, neuro feedback, and cognitive training are some of these treatments. A variety of non-pharmacological therapies, such as robotics, the Internet of Things (IoT), artificial intelligence (AI), virtual reality (VR), augmented reality (AR), mixed reality (MR), and extended reality (XR), have also been developed to address this neurodevelopmental condition (NDD). In this study, we present an overview of the usage of augmented reality (AR) technology from the viewpoint of the patient and contrast it with the advantages and disadvantages of existing methods. This article aims to educate readers on the most effective ways to treat ADHD with augmented reality (AR). [13]. The selected works are the focal point of the systematic review, which is structured around the following key questions:

- Which research has focused on the use of augmented reality to improve the quality of life for those with the ADHD?
- What crucial areas of the patients' recovery, such their social skills, their capacity for learning, and their ability to finish tasks, have these research enhanced? Which augmented reality technology were used for these?
- In what ways have these research been beneficial?
- Which major drawbacks or difficulties have these research pointed out?

In order to shed light on the potential advantages and disadvantages of augmented reality in the context of ADHD rehabilitation, the systematic review will address these concerns in order to provide a thorough understanding of the application.[14]. ADHD treatments aim to prevent academic failure and social disorders. In recent years, as an adjuvant to non-pharmacological therapies (such as psychological, psychoeducational, & occupational therapies), technical help has been provided through the use of developing technologies like IoT, AI, VR, AR,MR,XR, as well as, particular, robots. They looked into the feasibility of deploying a social robot during speech therapy interventions after having used robotic aid in speech therapy for children with ADHD [15-17]. Treatments for ASD and ADHD are expected to benefit from experiments centered on human-robot communication and attention modeling [18-20]. The cognitive architecture of the Bioloid employs a motion selection module for a number of purposes. When the kids are engaged in these activities, the robot records the duration of their attention spans and stores the data in its memory. The implementation of the interaction scenario tasks, which were directed by the robot's short-term memory, was aided by the Bioloid's long-term memory. They offer a novel technique for diagnosing ADHD in kids [21]. This study presents the creation of a robotic helper that uses machine learning techniques in addition to an evaluation tool that is akin to a game and is intended to efficiently record children's movements in order

to analyze symptoms of ADHD. Thanks to its sensors, the behavior of the kids may be automatically measured by the robot Silbot. Children participate in activities led by Silbot during the assessment as a part of the evaluation procedure. These exercises are intended to show how three primary characteristics—deficits in executive function and working memory, hyperactivity and impulsivity, and inattentiveness—can be used to assess ADHD. As the youngster advances through the levels, the test's complexity progressively rises, and passing each test is a prerequisite.

Currently, a strategy for treating children with ADHD is being developed. In order to implement this technology, augmented reality glasses and a single-channel, non-invasive brain-computer interface (BCI) based on steady-state theory must be created. The foundation for visually evoked potentials is the use of steady-state visual evoked potentials (SSVEPs) [22]. By focusing on flashing stimuli and employing eye blinks through the BCI channel, an inexperienced user can operate a robot (SanBot Elf) in this system. This method provides an efficient way to treat hyperactivity, impulsivity, and focus issues in ADHD patients. The goal of the augmented reality application is to create a rehabilitation robot that can be remotely controlled by a child and can respond to commands via speech or movement, depending on the user's preferred behaviors. By guaranteeing active patient participation, this strategy eventually improves the efficacy of the rehabilitation process. The Raspberry Pi server received data from the robot and sent it over WiFi in JSON format. There is no need for any prior training for the feature extraction algorithm used here. The user can concurrently sense the robot's motions and visual stimuli thanks to optical see-through augmented reality (AR) technology. Four ADHD patients, ages six to eight, underwent initial testing, and the results showed great promise.

2.1 AR implication on ADHD

Real and virtual data are merged in what Milgram et al. called a "Virtuality Continuum." The integration of a certain set of virtual features into the physical environment is known as augmented reality, or AR. As a result, "augmented reality" (AR) refers to a collection of technical instruments that seamlessly combine the virtual and the actual world in three dimensions [23]. An important turning point in augmented reality was reached in 1968 with Sutherland's groundbreaking technological development of an optical see-through Head-Mounted Display. However, other display formats, including hand-held or spatial displays, can also be used in addition to head-mounted displays to enjoy augmented reality. When explained, the appeal of augmented reality to people with ADHD becomes more evident. Studies show that kids with ADHD frequently struggle when it comes to creative, unstructured pretend play. This kind of play is thought to be a factor in the decline of social connection and is acknowledged for its developmental significance in the formation of essential life skills. Studies have indicated that the use of augmented reality (AR) technology improves kids' impromptu involvement in solo and group pretend play. A three-dimensional augmented reality-based application for human-computer interaction was presented by Kerdvibulvech et al., who emphasized the technology's potential for social innovation. In order to assess the learning process through the use of mobile augmented reality applications, Lumbreras et al. help individuals engage with others [24]. Using AR systems as a teaching tool, the ability of three elementary-aged ADHD children to complete a chain assignment is examined [25].

A mobile AR application created as a game is evaluated to determine how it affects children's interaction, taking into account the difficulties that children with ADHD have in reading facial expressions and the emotions connected with them [26-28].

Using a multiplayer augmented reality (AR) game equipped with haptic feedback and brain-computer interface (BCI), the researchers proposed a novel way to treat ADHD in children. With the help of seven domain experts with a range of relevant experiences, they conducted exploratory user research to evaluate their methodology [29-30]. According to the results, different technologies may live in harmony with one another, and the game's haptic elements and multiplayer mode are considered fun supplements to more traditional therapy methods. Potential avenues for future research in patient-centered neuro feedback systems for the treatment of ADHD are paved by this study. The most prevalent behavioral illness among children, according to a number of authors, is attention deficit hyperactivity disorder (ADHD). There are a few things to take into account when correctly diagnosing ADHD in kids. Inattentiveness, distractibility, subpar academic performance, impulsivity, hyperactivity, and behavioral issues at home and at school are a few examples of these variables [31]. Video games played on VR technology are known as virtual reality (VR) games. Player immersion is a major component of these games, and it is usually enhanced by the use of a head-mounted display (HMD) or other headgear that has one or more controllers and stereoscopic displays [32]. Singular value decomposition (SVD) was used by Eslami and Saeed to classify ADHD patients based on discrepancies between them. In a similar spirit, Sadatnezhad et al. used EEG waves and linear discriminant analysis to identify symptoms of ADHD. Similar techniques were also used by Ghassemi et al. to pinpoint features in EEG data linked to ADHD.

3 Methodology Adopted

They go one step further and use Augmented Reality inside the framework of a virtual telekinetic game to boost engagement. Three elements make up the system: an AR mobile application to present the feedback, MATLAB to signal processing, and an Emotiv headset for EEG recording. A detailed description of the Neuro feedback protocol, signal processing techniques, and software and hardware implementation is provided [33]. Their next move is to evaluate the nuances of the procedure by running a pilot trial with a sample of healthy kids. The results of the study showed that the standard method's instruments for differentiating between ADHD in children are not up to par with the needs for care. The researchers provide an alternate digital tool that they created using the AR Foundation Software Development Kit (SDK) in conjunction with the Unity3D game engine, and it is intended for use with Android mobile devices. The goal of this tool is to make the differential diagnostic procedure easier. By examining the family context, it helps psychologists make an early diagnosis of possible family-related problems that might be aggravating the patient's illness. It also provides a virtual substitute for the memory tile cognitive behavioral game. Through the use of Augmented Reality (AR) smart glasses and flashing icons, the suggested system enables real-time control of a social robot by the user. This novel method improves user control and interaction, and the social robot has already shown promising results when used to treat ADHD. A one-month therapy program was carried out with 7 participants after an initial evaluation of the children's adherence to therapy, which involved 18 individuals [34], [35]. The youngsters were given different tasks to do during the tests according to how engaged they were.

Results demonstrated that even with a very small number of therapy sessions, all participants improved on the various tests given, as measured by the Italian Battery for ADHD. Table 1shows the existing surveys on ADHD.

Table 1: Survey on existing research

Author	**Methodology**	**Advantage**	**Research Gap**
[11]	HoloLens is used	It is widely used in Medical .it is very helpful for patients.	Implementation of this technology in video game.
[3]	Prototype modeling is designed where planning	It is used to scan the objects.	Addition of more objects may be considered.
[4]	AAR applications and BPSP's is used.	It is used for blind and partially sighted people.	The nature connectedness for BPSPs, the design of AAR.
[5]	HMD and AR are used.	it is used to increase the sound Awareness of the deaf people.	The more diverse or complex sound of hearing.
[6]	SSEVP Algorithm is used.	Robots are moved by blinking their eyes and focusing on flickering stimuli.	utilizing cutting-edge techniques to help youngsters with ADHD recover.
[8]	Conners' Teacher Rating Scale (CTRS)	There are different tests conducted for tracking.	Focus could be levied on studies comparing treatment and control groups
[9]	Neurophysiological testing, AULA virtual Reality test.	Different Analysis is performed on the test result.	A chance of improving the accuracy of diagnosis.
[10]	Clinical features of children, Robotic trust intervention.	The youngster cooperated during the entire TruST-intervention.	The absence of ambulation and poor seated function.
[11]	Participants and Group Assignment.	Gross motor activity is going to be measured the children activities.	The greater levels of gross movement that don't interfere with academic performance were overlooked by the author.
[12]	to look into the long-term implications on the growing human brain of a reduced serotonin synthesis	The consequences of TPH1 mutations in mothers versus fathers were examined across all families.	Replication studies are required for ADHD patients.

[22]	Examine the VC's diagnostic validity in relation to a conventional continuous performance exam.	The notable variations in performance between the typical computerized environment and the virtual one	potential threat to internal validity as evidence for the external validity of this research
[23]	DJINNI comprises an innovative virtual reality exposure therapy system	The feasible and effective AR/virtual reality-based exposure therapy.	Do not differ on the cognitive absorption perceived by the children.

3.1 LIMITATION

Augmented reality (AR) undoubtedly has its drawbacks and issues, just like any other technology. While there are many useful applications for mobile devices with augmented reality capabilities, it's crucial to understand that technology improvements also present issues and concerns for society. Prior to AR's complete commercialization and incorporation into mainstream use, it is imperative to address a number of difficulties as it continues to develop and may even become more widely used. These concerns could involve, among other things, ethical, societal, and privacy difficulties.

- Progress in technology ought to prioritize enhancing comprehension of organic body motions, resulting in more lightweight and slender augmented reality displays.
- Internet access is still a problem, particularly in environments where diagnosis is provided by healthcare providers and connectivity may be spotty.
- It is imperative to address the affordability of augmented reality (AR) gadgets, since their exorbitant current costs may impede their widespread adoption, especially for those coping with health-related concerns.

4 RESULTS

A thorough survey was carried out by looking over 50 articles. Of these, 10 were found to be duplicates and were removed, and 8 were found to be irrelevant and were also removed. Of the articles that remained, 10 (33%) examined how well technologies could diagnose symptoms of ADHD, and another 10 articles (23%) examined how they could improve the process of diagnosing ADHD. The present study revealed a number of studies that used different methodologies to assess cognitive-based therapy procedures in an efficient manner. These techniques were used in a variety of games created to improve various diagnostic procedures for kids with ADHD. MR games, web-based AR, VR-CPT, VRC, and other techniques were among those found; they were all intended to treat the symptoms of ADHD.

5 CONCLUSION

The aim of this study was to use augmented reality (AR) technology that a group of children in order to investigate the essential elements of AR systems that facilitate the identification and management of ADHD in children. Examining how well AR system manipulation exercises identify autism and enhance the lives of kids with ADHD was a major area of concern.

Among other things, among the goals of the AR tasks were comprehending human emotions, conversing, and having conversations. This study thoroughly reviewed the usage of augmented reality in ADHD therapy and investigated the advantages of incorporating augmented reality into games created especially for kids with ADHD.

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