State of the art

Wildcard: virtual reality for children with IDD

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Abstract :

Problems related to IDD and in general to ASD (autism spectrum disorders) are becoming wider spread across the globe, with an incidence of approximately 4 per 10000 to 6 per 1000 children [1]. With the growing of their area of effect, the study of their behavior and of the possible mitigations becomes more significant, and in the last decades the literature is increasingly recognizing the potential benefits of VR in supporting the learning process, particularly related to social situations, in children with autism [2]. In this study we investigate the current state of the art in the field of VR used as treatment to investigate ASDs, especially the ones related to loss of attention in the patients.

Contents

Introduction

Intellectual Developmental Disabilities IDD and Autism Spectrum Disorder ASD are forms of disabilities that can occur during the developmental period and, since autism is a wide spectrum-based disorder, they need to be studied and analyzed through applications that need to be adapted for each individual[3]. Main deficits associated with this disability are: communication, social interaction, adherence to routines and repetitive behaviors[4]. Many studies have observed that samples of people with ASD manifest high visual memory and greater affinity for technology, but also high abilities with mathematical calculations and musical skills. [3]

Virtual reality has proven to be a valuable educational tool used with children with these disabilities and it is effective for teaching street-crossing skills to children and adolescents with autism.[5]. This technology is defined as a model of reality with which a human can interact, obtaining information by ordinary human senses such as sigh and sound and interacting with the model using ordinary actions such as gesture and position provided via motion tracking. [3] These features allow for greater immersion and it can increase the results obtained during learning activities by eliminating environmental distractions and helping individuals maintain focus.[6] Despite this, the clutter also appears to have an effect in VR applications for people with ASD. Environments with little clutter worked better. For example, when there were less objects to collide with in the virtual world, users with ASD navigated the environment more easily[3]

Virtual reality is also being used for the study and measurement of attention. Common attentional behaviors are gaze position, eye contact and response time. Different studies say that that gaze position or eye contact may not indicate a child is paying attention, so the learning outcome should also be evaluated in order to measure the attention of such child .[5] Studies on virtual reality based intervention for children with ASD shows how long children are able to remain interested in or maintain attention to the desired object or stimuli presented to them and this can be linked to the significant effect of sustained attention in all forms of learning be it academics, communication, or social skills. There is further evidence that virtual reality interventions play an important role in promoting social skills in children with ASD using joint attention, as evidenced by multiple studies. Other types of attention; orientation and shifting are also relevant when attention is initiated to one stimulus and when attention is redirected (redirected) to another stimulus.[5]

Eye tracking is another parameter for measuring the level of attention in individuals under analysis. There are several ways of accomplishing this, but the most common is to shine an infrared beam into the eye and capture the reflected image with a video camera. Two points are identified from the captured image: the reflection from the cornea of the eye, which is usually the brightest point in the image, and the pupil is usually the second brightest. The relative positions of these two points provide enough information to determine where a person is looking on the screen. [7] One of the first studies to use eye tracking for autism monitored the eye movements in five adult males with autism and five controls and used photographs of facial expressions as a test of emotions recognition. Autistic subjects spent a smaller percentage of time examining key facial features (eyes, nose, mouth)[8] Eye-tracking can also be used with video clips, as demonstrated in a study by Klin et al.. They have analyzed the gaze patterns of 15 young males with autism, and 15 controls, watching film clips of characters engaged in social interactions. Subjects were not given a specific task and were only asked to watch a video clip. Video clips are more valid than static photographs because they simulate real-world social situations where multiple distractions are present in the scene. [9]

1 Studies of interest

In the next section, we expose the state of research in the field of virtual reality for the threatment of children with IDD, listing some of the results obtained by various experiments.

Teach shopping task form a supermarket with a virtual environment software that operates on a laptop or desktop and requires the use of keyboard arrows and a mouse. The results show that among the intervention group, significant improvements were found in the attention component and in the executive functions component. The intervention group showed a significant improvement in all the accuracy indices in shopping task. [10]

A program based on a two-dimensional flat screen projection system. This system has motion-capture capabilities, where a tracking camera is able to capture and project a child's image and motions on screen in real-time. The results demonstrate improvements in contextual processing ability from baseline to treatment for each child, with average increases from 15% to 46%. All children maintained a high level of performance at the two-week follow-up assessment. This test had the limitation of a potential eye damage. [11]

VR training using an innovative tool, BTS-Nirvana, a medical device based on VR, the first using a two-dimensional flat-screen projection system with optoelectronic infrared sensors, through which the patient can simply interact by his movements. Authors found a significant increase of attention processes. This case-study showed that VR could be helpful to potentiate cognitive and adaptive behavioral with regard to attention process, spatial cognition, and visual-motor integration. [12]

VR for teaching money skills. The training intervention was developed using Unity 3D and C# scripting. The application was developed to run on the HTC Vive VR hardware The virtual coins and bills were designed using textures from images of real danish money. The coins and bills could be grabbed by the player using the grab button on the HTC Vive controller and released again by releasing the same button. Four out of the five participants showed some improvement in their money skills after five training sessions with the VR application. [13]

VR based supermarket shopping training system. The intervention was developed using Autodesk Maya and Unity. HTC Vive was chosen to run the application due to its effective room scale tracking. The signals are than captured via the infrared sensors placed on the VIVE head-mounted display. The study indicates some positive effects of a head-mounted display-based VR simulation to train DLS of individuals. As a limitation, the weight of devices was mentioned. [14]

VR driving simulator. Models in the virtual driving environment, such as traffic lights, stop signs, and vehicles, were developed with the modeling tools ESRI CityEngine and Autodesk Maya. The game development platform Unity3D was used to implement the system logic. In this case no differences were found in performance data, however, these findings could support future work into driving simulator technologies, which could provide opportunities to practice driving skills in cost-effective, supportive, and safe environments. [15]

Teach driving simulator. The commercially available DGS-78 VRDS is a realistic driver's cockpit with side and rear-view mirrors. The driver's view is projected onto a 2.44 m (8 ft) diameter, 210° curved screen. This study demonstrated feasibility and potential efficacy of VRDST for novice ASD drivers. The limitations that have been put in evidence are the obtrusive or irritating nature of wearing eye-tracking glasses and the fact that time of follow up duration is limit. [16]

The VRH method uses a head-mounted display to create a non-threatening, virtual reality environment, where the hypnotherapeutic process can be implemented to stimulate the attention of the patient. As a result they believed it was an effective technique to gain their son's attention, and this, combined with the fact that the boys found it enjoyable and engaging, led them to believe there is significantly potential for this particular treatment modality. [17]

VR for teaching street-crossing skills.For each participant in the study, low, stable scores were observed during baseline and an increase in scores was seen after each VR training condition. Findings suggest that immersive VR is a promising medium for the delivery of safety skills training to individuals with ASD. However the study a have lack of testing in the natural environment,indeed only the skill of crossing safe street was trained and evaluated. [18]

Teach street-crossing skills through the use of a virtual environment. Three keyboard keys (marked on a standard keyboard with round, colored stickers) were used to change the user's viewpoint to the right or to the left or to initiate street crossing. Users who succeeded in safely crossing the street automatically proceeded to the next stage. Significant differences were found between the performance of the experimental and control groups within the VE. Half of the experimental subjects made considerable improvements. [19]

The participants were required to stand in front of the screen, at a distance of approximately 2m. Instead of using mouse and keyboard to interact with the VE, they used a markerless motion capture device. Also in this case thanks to the device the participants are taught to cross the street. The ability to follow the street signs.They found no significant changes in path length, figural distance, and composition index. [20]

VR is used to teach how to escape the fire and survive.Children from 6 to 12 years are divided in two groups.The VR group, however, learned these skills in considerably less time. [21]

Conclusion

The studies briefly introduced certify the fact that at the moment virtual reality and virtual environments in general are widely used with great results in the field of cognitive improvement for patients with IDD and ASD.

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