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Research Paper

Assistive Technologies for Children with Autism Spectrum Disorders

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Abstract
Assistive technology is broad and multifaceted. For persons with disabilities the assistive part refers to their greater independence to perform tasks they previously were unable to perform or were able to perform with great difficulty. In this context the technology path refers to the software or devices designed to assist people with tasks. In this paper focus of assistive technology to assistive technologies used by people with lesser disabilities help them accomplish tasks that they cannot accomplish otherwise or could not do easily. The author specializesin technology for people with learning disabilities and mild cognitive impairment.
Key Words*: Assistive Technology, Autism Spectrum Disorder, Virtual Reality.*

I. INTRODUCTION

The secret of education lies in respecting the pupil. It is not for you to choose what he shall know, what he shall do. It is chosen and foreordained and he only holds the key to his own secret.

Ralph Waldo Emerson (1803-1882)

Assistive technology products include hardware and software products such as screen readers and voice recognition products that provide accessibility for those with vision, hearing, dexterity and mobility, language and communication or learning disabilities. Learning disabilities as regarded as difficulties with reading, writing, speaking, listening, spelling or reasoning or math. Learning disabilities are thought to be a result of a central nervous system dysfunction. Individuals with such disabilities have trouble taking in information through their senses and processing that information accurately to the brain (Cercone &Naruedomkul, 2013). The author focusses on assistive technologies for students, however the products describe are in no way limited to students. These products and software can offer powerful instruments to students with learning disabilities by providing remedial or compensatory support in the classroom and for independent learning.

We know that children with autism like order, that they are often very visual and that they can be quite literal. They deserve beautiful resources and symbols that make sense. If a picture does not explain visually, it is pointless and the child will stop looking at the pictures for information (Devine, 2014).

Children with autism often have a visual learning style, but they may also need the visuals to support social learning and for their physical and emotional wellbeing. Using visual can be a support strategy for children with autism because they cut down the need for too much language. We must understand how vital it is when supporting children with autism that we reduce and simplify teacher talk (Devine, 2016). Children with autism can also find school (mainstream or special) extremely difficult. They can suffer extreme sensory overload, anxiety, communication difficulties and fine motor difficulties.

The autistic author Judy Endow explains:

People with autism are often visual thinkers. It is not something we decide, but rather the way our brain handles information. We do not know when we are little that most other people think with words rather than with colors and pictures. This makes it difficult in school as delivery of information quickly becomes language-based as pictures drop away after the first few years.

TEACHING CHILDREN WITH AUTISM SPECTRUM DISORDER-NEED OF THE HOUR

Visual systems are so important to children with ASC, providing emotional as well as educational support. For these children too much verbal language can be impossible to tolerable. When a child with autism is experiencing anxiety, the last thing they need is lots of verbal inputs. We reduce language and use more visuals. Too much language can cause them anxiety and physical pain. So, visuals are not only essentials for comprehension, but for their physical comfort and emotional wellbeing. Teaching children with ASCs for so long as made passionate about supporting their success. When a child has a learning difficulty associated with their ASC, visual support can make the world of difference.

Teaching to the learning style of the student may make an impact on whether or not the child can attend to and process the information which is presented. This, in turn, can affect the child's performance in school as well as his/her behavior. Therefore, it is important that educators assess for learning style as soon as an autistic child enters the school system and that they adapt their teaching styles in rapport with the strength of the student. This will ensure that the autistic child has the greatest chance for success in school.

ASSISTIVE TECHNOLOGIES – THE PRESENT DAY

Assistive technologies have seen a tremendous growth in the past decade. With rapid advancements in computing technology, multimedia processing and reduction in computing costs, a wide array of assistive technology products has made it to the market. Primarily these developments were intended for the computer gaming industry to render three-dimensional immersive games. But these developments also found vast applications in numerous areas like education, medicine and the entertainment industry. The developments in assistive technology could be traced to two important directions - the development of Virtual Reality Headsets with head tracking technology and the development of tools that could provide Human-Computer Interaction, or input and feedback devices.

The growth of Human Computer Interaction devices in the past decade could be closely tied to the development computer gaming technology. The Nintendo Wii (http://www.wii.com) started a revolution that aimed at motion sensing controllers through the use of accelerometers and infrared cameras. This was followed by the development of the Microsoft Kinect (https://en.wikipedia.org/wiki/Kinect) platform which aimed at creating a controller-less gaming system, by using the position of human limbs as the controller input. A pattern of dots was projected into the space in the front of the Kinect Device and a camera was used to image the pattern of dots to deduce a 3D depth map, which could then be processed to detect the presence of a human player in front of the controller and to subsequently compute the orientation of the player's limbs. Developments also include the Leap Motion Controller (http://www.leapmotion.com) which used infrared cameras to create a depth map of an area above the sensor to detect the presence and position of a hand or a pencil to interact with the computer program. There are also controllers like the Neurosky Headset (http://www.neurosky.com), which was an electroencephalogram (EEG) sensor, that allowed the user to interact with computer programs through controlling their brain waves - by consciously changing their patterns of relaxation and alertness. There were also major developments in the field of haptics, which aimed at rendering force feedback to the user. Novint Falcon (http://www.novint.com/index.php/novintfalcon) and the upcoming Novint XIO (http://www.novint.com/index.php/products/novintxio) are some of the notable products.

On the Virtual Reality Headset side, there have been tremendous developments. However, we look at the three major developments that have happened and will shape the assistive technology in the days to come.

ASSISTIVE TECHNOLOGIES FOR CHILDREN WITH AUTISM SPECTRUM DISORDER

Oculus Rift and HTC Vive

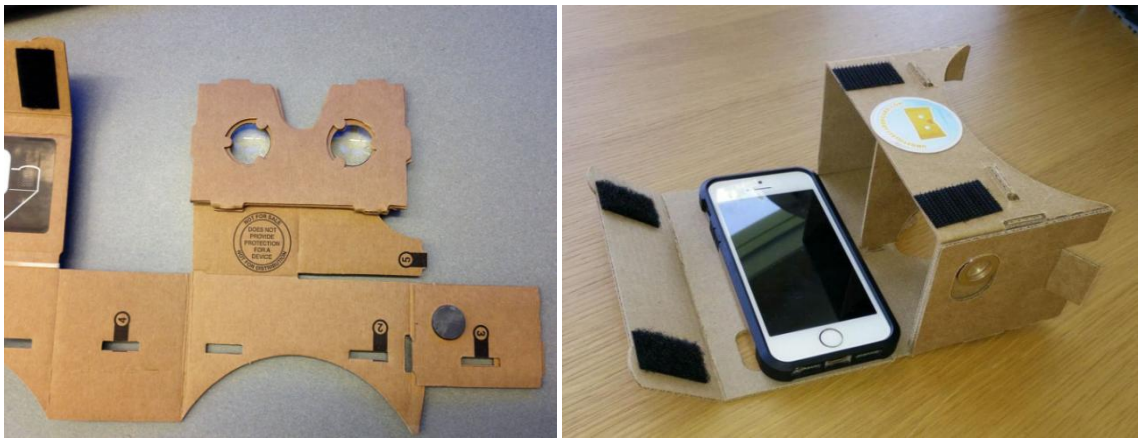
Oculus Rift (http://www.oculus.com) in Figure 1(a) from Oculus VR and Vive (http://www.htcvive.com) in Figure 1(b) from HTC are two of the modern, state-of-the-art and competing VR platforms in the market today. Both provide wide angle view, low latency and head-tracking. Both use light source-based methods for tracking the position of the display. Oculus Rift was developed as a Kickstarter(crowdfunding) campaign, whereas Vive was jointly developed by HTC and Valve Corporation. Both these headset platforms are already favourites among Virtual Reality and gaming enthusiasts. However, both the controllers are priced very high for easy adoption - Oculus Rift at US Dollar 599 and HTC Vive at a price of US Dollar 799.

(a) Oculus Rift(b) HTC Vive

Figure 1: Oculus Rift and HTC Vive

Project Google Cardboard

Google Cardboard (http://vr.google.com/cardboard) is an ultra-cheap VR headset designed and developed by Google Engineers David Coz and Damien Henry at the Google Cultural Institute in Paris. The goal was to use the universally available wide and high-resolution displays of the modern day smartphones to render virtual environments in 3D. The entire design could be made out of cheap cardboard cut into a precise shape, a pair of focal lenses, a pair of magnets, a velcro fastener and a rubber band as shown in Figure 2 (a). The cost of all the items put together will be less than 300 Indian Rupees. The Google Cardboard headsets could be purchased from Google or any one of the other vendors on the Google Store at http://store.google.com. The construction plans for the headset is also available on the Google Cardboard Website and detailed instructions for manufacturing the same are also provided.



(a) An Unfolded Google Cardboard (b) An Assembled Google Cardboard with a phone

Figure 2: Google Cardboard

Once the kit is assembled, a smartphone can be inserted on to the space provided and is held in place by the velcro attached to the cardboard structure as shown in Figure 2(b). The optics are so-placed that the split images formed on the smartphone screen are directed to each individual eye by applying the required distortion corrections. The images form a stereoscopic projection with a very wide field of view for the user. There is also a magnetic switch which is formed by a simple magnet and a washer. The phone's magnetic field sensor can pick up the fluctuations on the magnetic field and this simple switch can be used by the user to interact with the mobile application and thereby with the virtual environment. The latest versions of Google Cardboard come with a lever that can create a touch event on the smartphone screen, thereby making the headset compatible with smartphones that do not have a magnetic field sensor.

Google provides Software Development Kits (SDKs) for interested developers to develop apps for the Google Cardboard Platform. These applications could be developed for Android as well as for the Apple iPhones. The recent Google I/O developer conference in 2016 has announced a new platform called Daydream (http://vr.google.com/daydream), which develops on the Google Cardboard platform and is an upcoming development that will greatly enhance Virtual Reality capabilities of mobile devices by providing low latency controllers, sensors and displays. Google Daydream will be a specification for mobile phone manufacturers to make VR ready smartphones and controllers for a highly interactive user experience.

Holograms and the Microsoft HoloLens

Along with the developments in Virtual reality, developments have also taken place in the field of Augmented Reality and Mixed Reality. Augmented reality is the technology of viewing real-world data, augmented with sensory data from various sensors or other processing information coming from a computer, which can aid the user in functioning in the real world. A major development in the field had been the development of products like Google Glass (https://en.wikipedia.org/wiki/Google_Glass) that can overlay information such as internet data, maps and other information from the User's phone on a display, mounted on a pair of eyeglasses. Augmented reality is different from Virtual Reality in the sense that the Virtual Reality may not be connected to the real-world at all.

The concept of mixed-reality goes even further and blends augmented reality and virtual reality, where elements of the real-world can be superimposed with a virtual reality environment making more sophisticated interactions possible. One of the products that facilitates these developments is the upcoming Microsoft HoloLens (https://www.microsoft.com/microsoft-hololens/en-us)as shown in Figure 3. The HoloLens uses a pair of lenses to project Holograms - 3-dimensional objects that could be placed at any orientation / spatial position with respect to the user. These Holograms could be elements of a computer game, a virtual laboratory or class room, a map or anything of interest.The developments in Microsoft Hololens are going to revolutionise multiple fields including computer games, education, medical technology, engineering simulations etc. The controller is expected to hit the markets soon and currently developer versions of the device are shipping at a price of US Dollar 3,000.

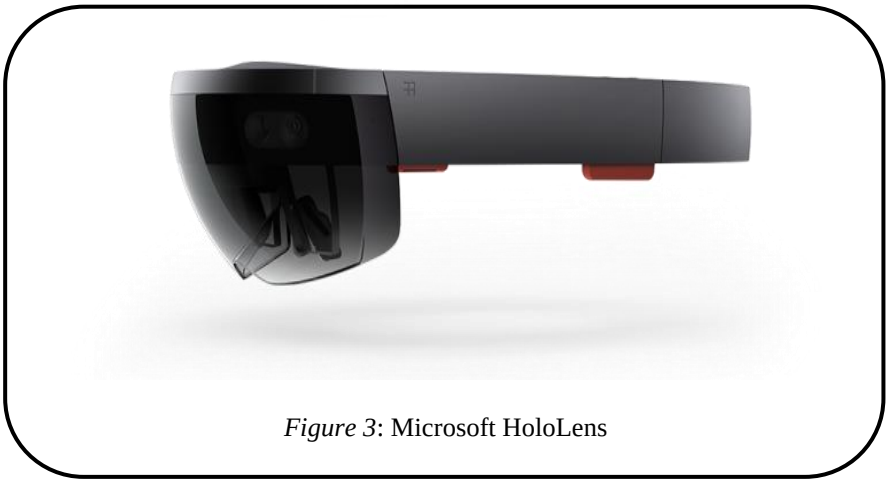


Figure 3: Microsoft HoloLens

II. CONCLUSION

Interventions with modern developments in information and communication technologies are an active area of research to improve learning outcomes in students with autism spectrum disorders. One of the developments is the progress made in the area of computer graphics, multimedia and virtual reality. This paper briefly introduces the assistive technologywith the help of VR technologies. The paper then goes on to outline some of the recent developments that have happened in the field of Virtual Reality, which has made the technology accessible, cost-effective and the experience - more immersive. It was found that Virtual Reality holds promise in the field. Also, the various developments that happened in the field of Virtual Reality Technology were explored and it was found that a lot of developments have happened in the recent past. Even though the cost is prohibitive for wide scale adoption, there are alternatives like the Google Cardboard that could be adopted at much cheaper cost, while providing a decent Virtual Reality Experience. However, the availability of applications that could be tailored to the need of the student is still lacking in this area. It is important that a research effort be taken up in this direction, so that there is more widespread availability of tools and learning material available for Virtual Reality environments to aid and intervene the learning of students with autism spectrum disorders and similar ailments.

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