Exploring the use of Artificial Intelligence and Virtual Reality to Aid Brain Injury Recovery

Emma Kroll
University College Dublin

Introduction

Assistive technology has come a long way in recent years. With the rise of Artificial Intelligence (AI) and Virtual Reality (VR), we are just scratching the surface of how we can use these technologies to aid the population.

Methodology

Assistive AI

AI has become incredibly useful in allowing people of all ranges of abilities to function independently. In a study conducted in Korea, scientists used AI to solve a problem many with limited motion and voice capabilities face daily [1]. Using AI, researchers determined a way for patients without the ability to speak to call their caregivers. This system works with a three-step process based on a convolutional neural network (CNN) system. This was chosen based on a system of elimination demonstrated in Figure 1.

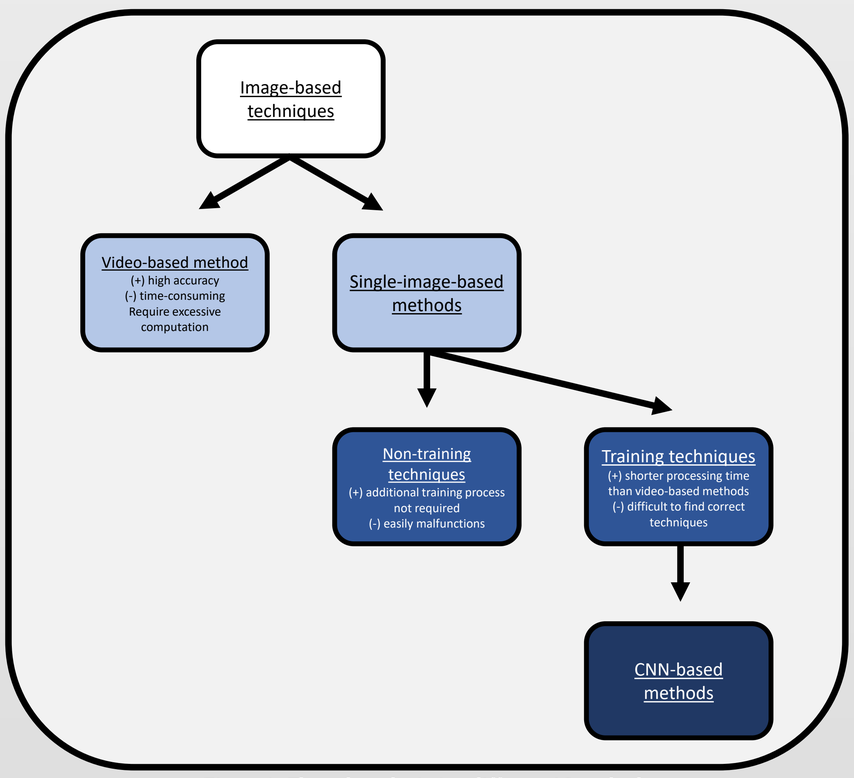

Figure 1: Flow chart depicting different AI methods

This convolutional neural network is a machine learning (ML) technology that can analyze large amounts of data accurately. Other methods break up large amounts of data into smaller sections, potentially skewing the end result, but CNN weights each input and then analyzes the entire set of data based on the weights of its parts, meaning it considers the entire data set more fully than other ML technologies [2].

In this project, CNN was used to train the AI to determine if an image of an eye was open or closed. Using a regular camera, a patient was photographed five times per second. If three or more of these images were determined to contain closed eyes, then the computer determined the patient's eye was closed, and if this status continued for three or more seconds, it alerted a program that played a sound to alert a patient's caretaker.

VR Therapy

VR can be used to stimulate multiple different areas of the brain at once, allowing a more complete and multidisciplinary therapy experience. Studies have shown that multidisciplinary approaches like these actually have a more significant positive impact than other types of therapies [3]. By including auditory and visual stimuli, the brain is more active during the therapy session. These programs also help to reacclimate patients to activities, such as driving, without risking endangering the patient or those around them, as seen in Figure 2 [4].

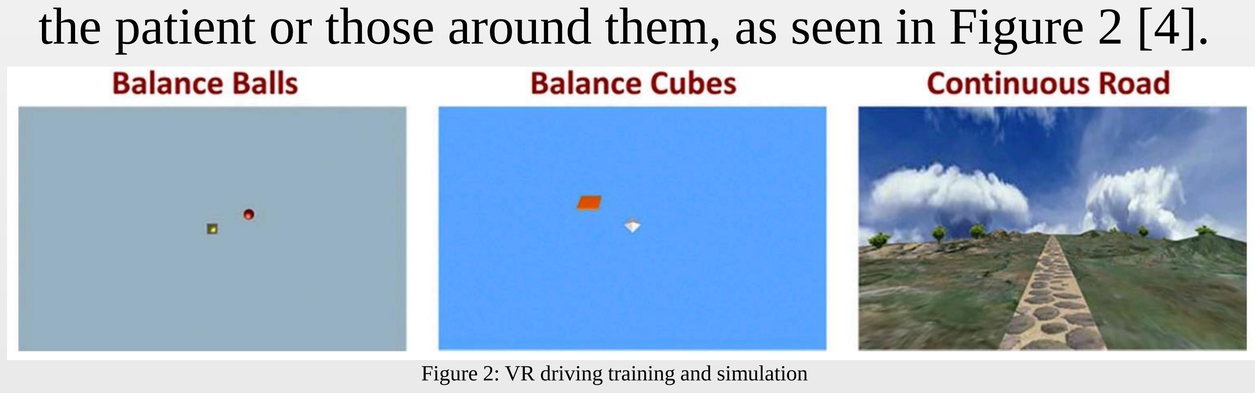

Figure 2: VR driving training and simulation

CAREN VE Task Performance Scores

CAREN VE Task	PTSD Diagnosis	Mean	Standard Deviation	*N*
Balance Balls (Seconds)	No PTSD Comorbid PTSD	60.8	17.1	63
		75.4	34.4	147
Balance Cubes—Static (Seconds)	No PTSD Comorbid PTSD	58.5	19.5	62
		68.8	22.9	147
Balance Cubes—PM (Seconds)	No PTSD Comorbid PTSD	52.4	11.9	57
		66.7	25.0	120
Continuous Road (m/s)	No PTSD Comorbid PTSD	1.07	0.28	53
		0.96	0.26	121

Figure 3: table depicting VR simulation results

In addition to simulated driving, VR programs can simulate grocery shopping, social interaction, and more to help patients transition to daily life following a severe Acquired Brain Injury (sABI).

Discussion

The An Saol Foundation has partnered with Professor Goodman's SMARTlab to bring AI and VR to patients in Ireland diagnosed with sABI. 40%-60% of patients with this condition are misdiagnosed as being in a permanently vegetative state, and even those who are correctly diagnosed are commonly not given the necessary tools to succeed. Saol and SMARTlabs intend to decrease the pressure on a patient and their family to increase the chances of a patient making progress in their rehabilitation [5].

References: [1]J. H. Lee, T. Kang, B. K. Choi, I. H. Han, B. C. Kim and J. H. Ro, "Application of Deep Learning System into the Development of Communication Device for Quadriplegic Patient," Korean J Neurotrauma, 2019. [2] F. Jiang, Y. Jiang, H. Zhi, Y. Dong, H. Li, S. Ma, Y. Wang, Q. Dong, H. Shen and Y. Wang, "Artificial intelligence in healthcare: past, present and future," Stroke and Vascular Neurology, 2017. [3] P. A. N. A. D. P. W. D. Turner-Stokes L, "Multi-disciplinary rehabilitation for acquired brain injury in adults," Cochrane Database of Systematic Reviews, no. 12, 2015 . [4] M. G. Maggio, R. De Luca, F. Molonia, B. Porcari, M. Destro, C. Casella, R. Salvati, P. Bramanti and R. S. Calabro, "Cognitive rehabilitation in patients with traumatic brain injury: A Narrative Review on the Emerging use of Virtual Reality," Journal of Clinical Neuroscience, 2018. [5] L. Goodman, P. Schäler and R. Schäler, "Life and Living: co- designing real and virtual spaces for survivors of severe acquired brain injury," IEEE VSSM, 2017. [6] An Saol Foundation Ltd., "Life and Living with a Severe Acquired Brain Injury (sABI)".[7] M. M. Onakomaiya, S. E. Kruger, K. B. Highland, P. N. Kodosky, M. M. Pape and M. J. Roy, "Expanding Clinical Assessment for Traumatic Brain Injury and Comorbid Post-Traumatic Stress Disorder: A Retrospective Analysis of Virtual Environment Tasks in the Computer-Assisted Rehabilitation Environment," Military Medicine, p. 128–136, 2017.