Virtual Reality in Neuro-Rehabilitation and Beyond

Amanda Carr, OTRL, CBIS
Origami Brain Injury Rehabilitation Center
Director of Rehabilitation
Amanda.Carr@origamirehab.org

Objectives

- Define virtual reality (VR)
- Review commercially available devices, clinical applications, and contraindications of use

What is Virtual Reality?

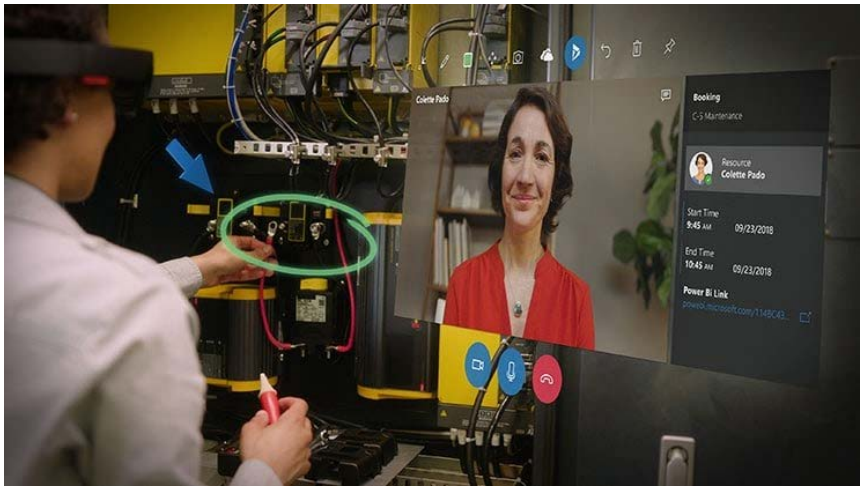
- “A way for humans to visualize, manipulate, and interact with computers and extremely complex data” (Aukstakalnis and Blatner, 1992)
- “Computer-generated scenario (a virtual world) with which the user can interact in 3 dimensions” (Keshner, 2004)
- “An artificial environment which is experienced through sensory stimuli (such as sights and sounds) provided by a computer and in which one's actions partially determine what happens in the environment”(Merriam-Webster, 2018)

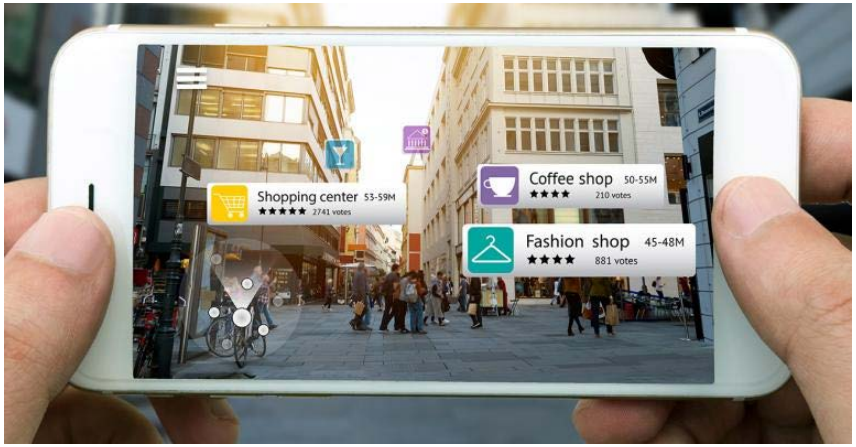
The experience may include...

- Virtual environment appears life-sized and 3 Dimensional
- Immersive levels that may vary
- Tracking of the user's motions, especially the eye and head movements, so that it can react and change the images on the display or initiate any related events.
- Depth of Information: referring to the quality and amount of data achieved through the display resolution, graphics quality and complexity of the environment, sound quality, haptic feedback, etc. (Steuer, 1995)
- Breadth of Information: referring to how many senses are being stimulated, most basic of being audio and visual, while more advanced systems involve additional multisensory feedback to enhance the immersion. (Steuer, 1995)

Variable Realities

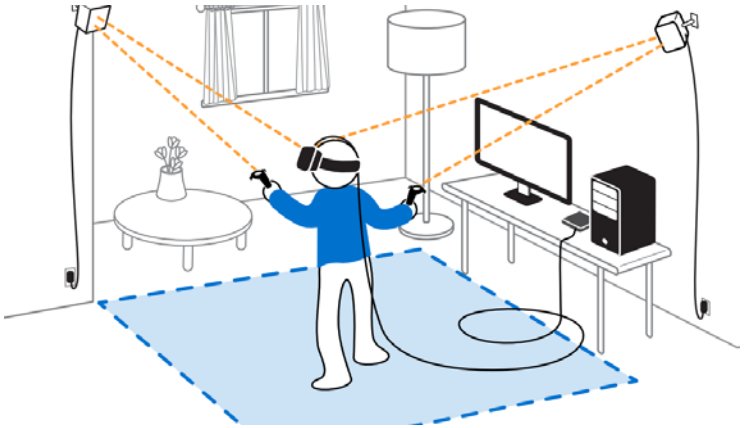
- **Augmented reality (AR)** adds digital elements to a live view often by using the camera on a smartphone. Snapchat lenses and Pokemon Go.
- **Virtual reality (VR)** implies a complete immersion experience that transports users into a number of real-world and imagined environments
- **Mixed reality (MR)** experience combines elements of both AR and VR where real-world and digital objects interact. Microsoft's HoloLens

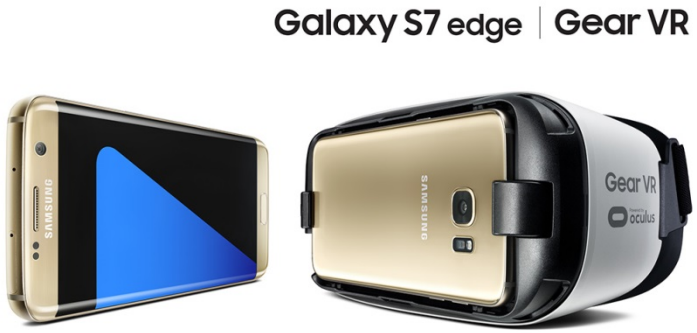




Device Options

- Mobile
- Tethered
- Stand-Alone





Consumer Device Overview (not exclusive)

- Fully Immersive Devices
  - HTC Vive
  - Oculus Rift
  - Sony Playstation VR
  - Samsung Gear VR
  - Google Daydream View
  - PlayStation VR
  - Oculus Go
  - Mirage Solo with Daydream
  - Google Cardboard
- Semi-Immersive Devices
  - Xbox Kinect
  - Nintendo Wii
  - PlayStation Move

HTC Vive

- 90 Hz refresh rate
- 1080×1200 resolution per eye
- 110° field of view
- 2 Vive motion controllers
- 2 Lighthouse base station cameras
- Games offered by Steam
- Room Scale setup feature
- 11.5’ x 11.5’ play area (2 base stations)
- Requires computer tethering for use

Oculus Rift

- 90 Hz refresh rate
- 1080×1200 resolution per eye
- 110° field of view
- Oculus Touch motion controllers
- 2-4 external USB sensors
- 5’x5’ play area (using 2 sensors)
- Games by Oculus or Steam
- Requires computer tethering for use

Medical Device/Software Overview

- Driving Simulators
- Able Eyes
- NeuroCom
- Hocoma Robotics + Software
- RTI FES Cycle Systems and Displays
- Saebo VR
- SeeMe
- Gesturetek Irex

Clinic Considerations

- Space Requirements
- Portability & setup demands
- Time / Maintenance (updates)
- Clinical oversight
- Additional hardware requirements / Cost
- Therapeutic Activities

Virtual Reality in the Clinic

- Precautions & Contraindications
- Populations
- Therapeutic Applications

Contraindications & Precautions

- Monocular Vision
- Seizures
- Severe Vertigo/Vestibular Impairment
- Orientation
- **Simulation Sickness**
- Head and neck strength
- Health conditions that can be exacerbated with use
- Predisposition to overstimulation
- Prolonged Usage

Populations

- Traumatic Brain Injury
- Stroke
- Spinal Cord Injury
- PTSD/ Mental Health
- Pediatrics
- Orthopedic

Therapeutic Applications

- Strengthening /AROM
- Vision / Perception
- Balance / Coordination
- Pain Management
- Cognition

Strengthening/AROM

- Gross & Fine Motor- Adaptations available
  - Adaptive Grips
  - Gloves
  - Controller Joy Stick
  - Eye Gaze
  - MAS, Deltoid Aides, etc.
- Unilateral vs. Bilateral

Game Options: Fruit Ninja, Box VR, Sprint Vector, Audioshield

Vision / Processing

- Visual scanning and sequencing
- Convergence insufficiency

Game Options: Car Racing Cardboard, The Blu, Fruit Ninja, Ocean Rift, VR Sports

Balance / Coordination

- Dynamic, Static, Seated, Standing
- External devices (walker, bolster, parallel bars)
- Growing research to improve vestibular function, gait, and coordination

Game Options: Tumble, Keep Balance, RecRoom

Pain Management / Mental Health

- "nonpharmacological form of analgesia by exerting an array of emotional affective, emotion-based cognitive and attentional processes on the body's intricate pain modulation system." (Li, 2012)
- Guided Meditation
- Cognitive behavioral therapy
- Mindfulness and Relaxation
- Exposure therapy
- Distraction related VR therapy

Game Options: Guided Meditation VR, The Blu, Relax VR

Cognition

- Attention and concentration
- Information Processing
- Memory
- Problem Solving

- Game Options: Sea Hero Quest, Job Simulator, Chair in a Room, Supermarket VR

Why Virtual Reality?

- Becoming a standard educational tool
- Same functional skills and goals within a different platform
- Interdisciplinary applications
- May experience increased motivation
- Growing research to support application in rehabilitation
- Apply Clinic Considerations*

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