

# Virtual Reality System Integration

## Introduction

Virtual Reality (VR) is an interactive technology that uses a head-mounted display (HMD) and hand motion controllers to introduce immersive 3-D experiences. VR can be the future of worldwide communication because it is quickly being adapted into multiple fields [1]. Some current uses of VR are for video games, field and surgical training, virtual trade shows, data visualization, education and exposure therapy [2]. This technical review summarizes a few VR headsets on the market, explains the technical aspects of VR systems, and provides hardware and software requirements for integration.

## Market Comparison of VR Headsets

VR headsets vary based on their price, graphics display, form fit, and motion controls. Some of the most popularly reviewed VR headsets include HTC Vive, Oculus Rift, HTC Vive Pro, Oculus Go, PlayStation VR, Samsung Gear VR and Google Daydream View. The HTC Vive (~ \$500) provides the best overall experience due to its 1080p screens, dual motion controllers, and advanced room-scale tracking. The Oculus Rift (~ \$400) is on par with the HTC Vive in all areas except that its room-scale tracking is not as good. The HTC Vive Pro (~ \$800) is the most expensive product because of its advanced resolution of 2880 x 1600. The Oculus Go (~ \$200) does not have the best form factor design as it is rather heavy and leaks in light. The Oculus Go is a stand-alone device that does not require a smartphone or PC for processing. The PlayStation VR (~ \$300) is best for console gaming. While it has spotty motion controls and allows light to leak in, the PlayStation VR doesn't require anything other than a PlayStation 4 console for processing which makes it ideal for gaming. Samsung Gear VR (~ \$130) and Google Daydream View (~ \$100) are mobile headsets which utilize mobile phones as the display for the head-mounted display. The Samsung Gear VR is compatible with only Samsung phones while Google Daydream View can use any Android phone [3]. **Need summarizing statement here.**

## Technological Functions of Head Mounted Displays

HMDs performance is measured by the resolution, refresh rate, frame rate, latency, and field of view. Standard resolution is around 1080p and lower end is the resolution of a smartphone. The average field of view is from 100° to 110°. The minimum frame rate is 60 frames per second, which correlates to a refresh rate of 60 Hz. The maximum latency delay is around 20 ms for most HMDs [4].

Positional audio attached onto the HMD allows for deeper immersion and helps form the 3-D world by having multiple speakers that form a surround-sound effect [4]. Visual, aural, and haptic

feedback allows for the most realistic experience but also require more integrated hardware and software. Magnetometers, accelerometers, and gyroscopes are key sensors on the HMD and peripherals that calculate orientation and movement inputs, which are used for tracking [5]. Room sensors provide feedback for spatial positioning. The feedback rate of these sensors determines the latency of the simulation.

Communication for the data can be either wired or wireless and utilize TCP/IP protocols [5]. Most HMDs have bulky cables for LAN data transfer that limit movement and comfort.

### **System Integration**

VR requires processing power either through a PC, console or smartphone to process inputs, simulations and renderings received from the VR system. An operating system software generates the virtual environment. Input devices provide feedback, create a natural navigation system in the virtual world and can come in many forms like joysticks, wands, and motion trackers [4].

#### *Tracking Software*

Head tracking, motion tracking, and eye tracking takes the users inputs and processes them to maintain the illusion of immersion [4]. Predictive tracking for HMDs renders images based on the predicted movement and orientation from sensors detecting angular velocity, linear acceleration, and gravitational data [5].

#### *Relevant Applications in Robotics*

Integrating VR systems into robotics is a revolutionary development that could change the future of operations. Brown University is developing software allowing for robots to be controlled remotely in virtual reality with the HTC Vive [6]. It is meant to feel like the operator is inside the robot's head. The challenge with controlling a robot is that the surroundings must be rendered in Unity, requiring high performance systems. Brown's research team utilized LAN communications to transfer data from the virtual space to the user space and transferred data via internet to the robot space [6]. Also, MIT's Computer Science and Artificial Intelligence Laboratory is integrating the Oculus Rift with controlling robots [7].

## Works Cited

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