Audio Displays and Haptic Displays

Haptic display

Haptic technology transmits tactile information using sensations such as vibration, touch, and force feedback. Virtual reality systems and real-worth technologies use haptics to enhance interactions with humans.

One of the goals of haptics is to allow a virtual reality system to make humans feel as if the experiences it portrays are ‘real’. A commonplace haptic technology is mobile phone vibrations during gaming to boost immersion.

Haptics leverage force and tactile feedback to enable users and computers to interface with each other. The former simulates certain physical features of the object being virtualized, such as pressure and weight. The latter portrays the object’s texture (for instance, smoothness or roughness).

How exactly do haptics work? Before we dive into the workings of this technology, let’s first understand the role of the human skin. This complex organ is full of touch receptors and nerve endings called the somatosensory system. This system notifies the brain of heat, cold, pain, and other sensations that humans feel.

Touch receptors transmit sensations by conveying signals to the closest neuron, which then signals the next closest neuron until the brain receives the signal. The brain then determines the response to the sensation. This entire process takes under a second.

Audio and graphics stimulate our sense of sound and sight to transmit information. Similarly, haptics stimulates our somatosensory system to pass on information and provide context. For instance, when a user holds down an application icon on the app tray of an Apple iPhone, their finger experiences a ‘pull’ sensation. The haptic motors of the iPhone generate this sensation to communicate that the app is ready to be moved, deleted, or categorized.

The vibrations, forces, and other movements of haptic systems are created mechanically using different methods. The most common method is an eccentric rotating mass (ERM) actuator. The rapid spinning of the ERM causes instability in the force from the weight, leading to movements in the motor and, subsequently, haptic feedback.

Linear resonant actuators (LRA) are another method to create haptic feedback. In this method, a magnet joined with a spring is bound by a coil and secured using an outer layer. The coil is electromagnetically energized to drive the magnetic mass to vibrate, creating a feedback sensation.

Apart from LRA and ERM, other emerging technologies are also being used to provide haptic feedback in more accessible and realistic ways. Experts use Haptics for functions such as teaching, training, entertainment, and remote hands-on operations.

Types of Haptic Technologies

1. Graspable

Graspable devices (think joysticks) are a standard haptic technology that generates kinesthetic feedback. The tactical vibrations, movements, and resistance caused by these devices enable users to increase immersion in gaming and even operate robots more effectively in remote or virtual conditions.

Interesting examples of this technology in action include bomb disposal and space exploration. In the latter use case, astronauts or on-ground personnel use haptics-controlled robots to repair equipment (such as spacecraft parts or satellites) without leaving the vessel or even Earth.

2. Touchable

Touchable haptic technology is prevalent in consumer applications; think smartphones that respond to taps, rotations, and other user movements. Advances in the touchable haptics space will soon enable the technology to replicate object movements and textures (known as haptography).

For instance, companies could leverage programmable textures to allow customers to feel clothing materials such as cotton or silk before purchasing, all from the comfort of their homes.

3. Wearable

Wearable haptic technology simulates a sensation of contact by leveraging tactile stimuli, including pressure, vibration, and even temperature.

A fast-emerging use case of wearable haptics is virtual reality (VR) gloves that mimic real-world sensations and transmit and receive inputs from users controlling their virtual avatars or remote robots.

A common example is a glove fitted with some form of tactile display, such as small vibrators.

Audio Display Device

In March 2018, Bose did something unexpected. They released a new wearable prototype at SXSW: 3D printed, augmented reality audio sunglasses. Instead of adding artificial visuals, they focus on sound-based augmented reality (AR), using motion sensors with GPS information from the user's smartphone to trigger audio cues. This is a new take on what we've come to expect from AR.

Sound has always been a fundamental part of our lives. It adds more texture, context and meaning to our daily interactions and immerses us. Yet, while sound serves as one of the dimensions we look for in today's movies and video games, virtual and augmented reality sound it is often overlooked.

Why is Virtual and Augmented Reality Audio Overlooked?

The development of AR/VR begins in optics. Visual immersion is priority for developers as they work toward overcoming field of view (FOV) limitations with existing devices. After all, visuals typically serve as the main branch of the AR/VR experience.

Then there are technical design challenges. Our eyes are away from our ears, which presents unique obstacles to tackling device design. Today's wearables typically have a horizontal fit over the eyes and come in bulky form factors. Extending them to fit the ears would expand the vertical reach, thereby adding to the bulkiness of the device.

When we shift the focus from wearables to smartphones, we run into a new set of challenges. In their current form, smartphones only provide a 'flavor' of AR/VR. In either case, sound is experienced directly through the device speakers or through an additional set of headphones. In the case of virtual reality, the user could be looking at three different form factors to immerse themselves: the smartphone, headset and headphones. And even then, the experience can still be somewhat clunky.

Finally, there are battery concerns with untethered devices. The processing power required for AR/VR visuals considerably impacts the battery life of the device. Adding acoustics that match the visuals can further affect battery life, leading to less-than-desirable user experiences. Combined with the high cost of manufacturing today's gadgets, it is easy to see why virtual and augmented reality audio may not be a priority in development.