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# Haptic Technology

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**ABSTRACT:** Users are given the illusion that they are touching or Manipulating a real Physical Object ‘Haptics’ is a technology that adds the sense of touch to virtual environments.

This seminar discusses the important concepts in Haptics, some of the most commonly used haptics systems like ‘Phantom’, ‘Cyber glove’, ‘Ultra Haptic Device’ and such similar devices. Following this, a description about how sensors and actuators are used for tracking the position and movement of the haptic systems, is provided.

The different types of force rendering algorithms are discussed next. The seminar explains the blocks in force rendering. Then a few applications of haptic systems are taken up for discussion.

## I. INTRODUCTION

Haptic technology refers to technology that interfaces the user with a virtual environment via the sense of touch by applying forces, vibrations, and/or motions to the user. Haptic technology, often referred to as haptics, represents an exciting and transformative field that revolutionizes the way humans interact with machines and digital environments. Unlike traditional interfaces that rely primarily on visual and auditory feedback, haptics leverages the sense of touch to create realistic and immersive experiences. Through the use of actuators, sensors, and sophisticated algorithms, haptic technology enables the simulation of tactile sensations, allowing users to feel and interact with virtual objects as if they were physically present. This mechanical stimulation may be used to assist in the creation of virtual objects (objects existing only in a computer simulation), for control of such virtual objects, and to enhance the remote control of machines and devices (teleoperators).

This emerging technology promises to have wide reaching applications as it already has in some fields. For example, haptic technology has made it possible to investigate in detail how the human sense of touch works by allowing the creation of carefully controlled haptic virtual objects. These objects are used to systematically probe human haptic capabilities, which would otherwise be difficult to achieve. These new research tools contribute to our understanding of how touch and its underlying brain functions work. Although haptic devices are capable of measuring bulk or reactive forces that are applied by the user, it should not to be confused with touch or tactile sensors that measure the pressure or force exerted by the user to the interface.

## II. WORKING OF HAPTIC

### Basic system configuration

Basically, a haptic system consists of two parts namely the human part and the machine part. In the figure shown above, the human part (left) senses and controls the position of the hand, while the machine part (right) exerts forces from the hand to simulate contact with a virtual object. Also, both the systems will be provided with necessary sensors, processors and actuators. In the case of the human system, nerve receptors performs sensing, brain performs processing and muscles performs actuation of the motion performed by the hand while in the case of the machine system, the above mentioned functions are performed by the encoders, computer and motors respectively.

Basically, the haptic information provided by the system will be the combination of (i) Tactile information and (ii) Kinesthetic information.

Tactile information refers the information acquired by the sensors which are actually connected to the skin of the human body with a particular reference to the spatial distribution of pressure, or more generally, tractions, across the contact area.

For example when we handle flexible materials like fabric and paper, we sense the pressure variation across the fingertip. This is actually a sort of tactile information. Tactile sensing is /also the basis of complex perceptual tasks like medical palpation, where physicians locate hidden anatomical structures and evaluate tissue properties using their hands. Kinesthetic information refers to the information acquired through the sensors in the joints. Interaction forces are normally perceived through a combination of these two information's.

**Creation of Virtual environment (Virtual reality).**

Virtual reality is the technology which allows a user to interact with a computer simulated environment, whether that environment is a simulation of the real world or an imaginary world. Most current virtual reality environments are primarily visual experiences, displayed either on a computer screen or through special or stereoscopic displays, but some simulations include additional sensory information, such as sound through speakers or headphones. Some advanced, haptic systems now include tactile information, generally known as force feedback, in medical and gaming applications. Users can interact with a virtual environment or a virtual artifact (VA) either through the use of standard input devices such as a keyboard and mouse, or through multimodal devices such as a wired glove, the Polhemus boom arm, and omnidirectional treadmill. The simulated environment can be similar to the real world, for example, simulations for pilot or combat training, or it can differ significantly from reality, as in VR games. In practice, it is currently very difficult to create a high-fidelity virtual reality experience, due largely to technical limitations on processing power, image resolution and communication bandwidth. However, those limitations are expected to eventually be overcome as processor, imaging and data communication technologies become more powerful and cost-effective over time. Virtual Reality is often used to describe a wide variety of applications, commonly associated with its immersive, highly visual, 3D environments. The development of CAD software, graphics hardware acceleration, head mounted displays; database gloves and miniaturization have helped popularize the motion. The most successful use of virtual reality is the computer generated 3-D simulators. The pilots use flight simulators. These flight simulators have designed just like cockpit of the airplanes or the helicopter.

**Haptic feedback**

Virtual reality (VR) applications strive to simulate real or imaginary scenes with which users can interact and perceive the effects of their actions in real time. Ideally the user interacts with the simulation via all five senses. However, today's typical VR applications rely on a smaller subset, typically vision, hearing, and more recently, touch. Figure below shows the structure of a VR application incorporating visual, auditory, and haptic feedback.

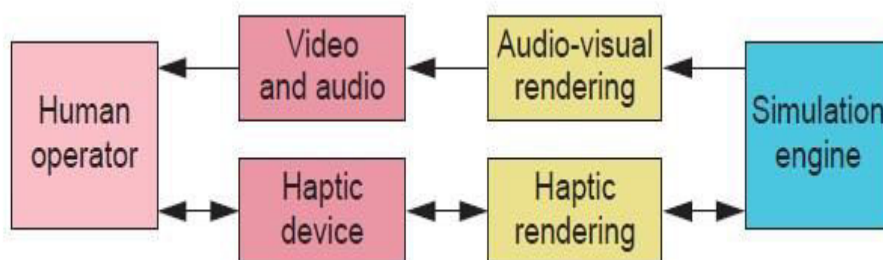


Fig No 2.1 Haptic Feedback Block Diagram

The application's main elements are:

1. The simulation engine, responsible for computing the virtual environments. Behavior over time;
2. Visual, auditory, and haptic rendering algorithms, which compute the virtual .Environment's graphic, sound, and force responses toward the user.
3. Transducers, which convert visual, audio, and force signals from the Computer into a form the operator can perceive.

The human operator typically holds or wears the haptic interface device and perceives audiovisual feedback from audio (computer speakers, headphones, and so on) and visual displays (for example a computer screen or head-mounted display). Whereas audio and visual channels feature unidirectional information and energy flow (from the simulation engine toward the user), the haptic modality exchanges information and energy in two directions, from and toward the user. This bi-directionality is often referred to as the single most important feature of the haptic interaction modality

### III. CONCLUSION

Finally we shouldn't forget that touch and physical interaction are among the fundamental ways in which we come to understand our world and to effect changes in it. This is true on a developmental as well as an evolutionary level. For early primates to survive in a physical world, as Frank Wilson suggested, "a new physics would eventually have to come into their brain, a new way of registering and representing the behavior of objects moving and changing under the control of the hand. It is precisely such a representational system—a syntax of cause and effect, of stories, and of experiments, each having a beginning, a middle, and an end—that one finds at the deepest levels of the organization of human language."

Our efforts to communicate information by rendering how objects feel through haptic technology, and the excitement in our pursuit, might reflect a deeper desire to speak with an inner, physically based language that has yet to be given a true voice.

As technology continues to evolve, haptic technology stands at the forefront, revolutionizing the way we interact with our digital world. By leveraging touch and tactile sensations, haptic technology enhances our sensory experiences, bringing us closer to a future where virtual and physical realities seamlessly blend together.

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