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Introduction : What is Haptics? Haptics refers to sensing and manipulation through touch. The word comes from the Greek ‘haptesthai’, meaning ‘to touch’. The history of the haptic interface dates back to the 1950s, when a master-slave system was proposed by Goertz (1952). Haptic interfaces were established out of the field of tele- operation, which was then employed in the remote manipulation of radioactive materials. The ultimate goal of the tele- operation system was "transparency". That is, an user interacting with the master device in a master- slave pair should not be able to distinguish between using the master controller and manipulating the actual tool itself. Early haptic interface systems were therefore developed purely for telerobotic applications. Working of Haptic Devices Architecture for Haptic feedback: Basic architecture for a virtual reality application incorporating visual, auditory, and haptic feedback. Simulation engine: Responsible for computing the virtual environment’s behavior over time. Visual, auditory, and haptic rendering algorithms: Compute the virtual environment’s graphic, sound, and force responses toward the user. Transducers : Convert visual, audio, and force signals from the computer into a form the operator can perceive. Rendering: Process by which desired sensory stimuli are imposed on the user to convey information about a virtual haptic object. 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 (a computer screen or head-mounted display, for example). Audio and visual channels feature unidirectional information and energy flow (from the simulation engine towards the user) whereas, 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. System architecture for haptic rendering: An avatar is the virtual representation of the haptic interface through which the user physically interacts with the virtual environment. Haptic-rendering algorithms compute the correct interaction forces between the haptic interface representation inside the virtual environment and the virtual objects populating the environment. Moreover, haptic rendering algorithms ensure that the haptic device correctly renders such forces on the human operator. Collision-detection algorithms detect collisions between objects and avatars in the virtual environment and yield information about where, when, and ideally to what extent collisions (penetrations, indentations, contact area, and so on) have occurred. Force-response algorithms compute the interaction force between avatars and virtual objects when a collision is detected. This force approximates as closely as possible the contact forces that would

normally arise during contact between real objects. Hardware limitations prevent haptic devices from applying the exact force computed by the force-response algorithms to the user. Control algorithms command the haptic device in such a way that minimizes the error between ideal and applicable forces. The discrete-time nature of the haptic- rendering algorithms often makes this difficult. The force response algorithms’ return values are the actual force and torque vectors that will be commanded to the haptic device. Existing haptic rendering techniques are currently based upon two main principles: "point-interaction" or "ray-based". In point interactions, a single point, usually the distal point of a probe, thimble or stylus employed for direct interaction with the user, is employed in the simulation of collisions. The point penetrates the virtual objects, and the depth of indentation is calculated between the current point and a point on the surface of the object. Forces are then generated according to physical models, such as spring stiffness or a spring-damper model. In ray-based rendering, the user interface mechanism, for example, a probe, is modeled in the virtual environment as a finite ray. Orientation is thus taken into account, and collisions are determined between the simulated probe and virtual objects. Collision detection algorithms return the intersection point between the ray and the surface of the simulated object. Computing contact-response forces: Humans perceive contact with real objects through sensors (mechanoreceptors) located in their skin, joints, tendons, and muscles. We make a simple distinction between the information these two types of sensors can acquire. Tactile information refers to the information acquired through sensors in the skin with particular reference to the spatial distribution of pressure, or more generally, tractions, across the contact area. To handle flexible materials like fabric and paper, we sense the pressure variation across the fingertip. 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. To provide a haptic simulation experience, systems are designed to recreate the contact forces a user would perceive when touching a real object. There are two types of forces: 1.Forces due to object geometry. 2.Forces due to object surface properties, such as texture and friction. Geometry-dependent-force-rendering algorithms: The first type of force-rendering algorithms aspires to recreate the force interaction a user would feel when touching a frictionless and textureless object. Force-rendering algorithms are also grouped by the number of Degrees-of-freedom (DOF) necessary to describe the interaction force being rendered. Surface property-dependent force-rendering algorithms: All real surfaces contain tiny irregularities or indentations. Higher accuracy, however, sacrifices speed, a critical factor in real-time applications. Any choice of modeling technique must consider this tradeoff. Keeping this trade-off in mind, researchers have developed more accurate haptic-rendering algorithms for friction. In computer graphics, texture mapping adds realism to computer-generated scenes by projecting a bitmap image onto surfaces being rendered. The same can be done haptically. Controlling forces delivered through haptic interfaces: Once such forces have been computed, they must be applied to the user. Limitations of haptic device technology, however, have sometimes made applying the force’s exact value as computed by force-rendering algorithms impossible. They are as follows: • Haptic interfaces can only exert forces with limited magnitude and not equally well in all directions • Haptic devices aren’t ideal force transducers. An ideal haptic device would render zero impedance when simulating movement in free space, and any finite impedance when simulating contact with an object featuring such impedance characteristics. The friction, inertia, and backlash present in most haptic devices prevent them from meeting this ideal. • A third issue is that haptic-rendering algorithms operate in discrete time whereas users operate in continuous time.

Finally, haptic device position sensors have finite resolution. Consequently, attempting to determine where and when contact occurs always results in a quantization error. It can create stability problems. All of these issues can limit a haptic application’s realism. High servo rates (or low servo rate periods) are a key issue for stable haptic interaction. Haptic Devices Types of Haptic devices: There are two main types of haptic devices: • Devices that allow users to touch and manipulate 3-dimentional virtual objects. • Devices that allow users to "feel" textures of 2-dementional objects. Another distinction between haptic interface devices is their intrinsic mechanical behavior. Impedance haptic devices simulate mechanical impedance—they read position and send force. Simpler to design and much cheaper to produce, impedance-type architectures are most common. Admittance haptic devices simulate mechanical admittance—they read force and send position. Admittance-based devices are generally used for applications requiring high forces in a large workspace. LOGITECH WINGMAN FORCE FEEDBACK MOUSE It is attached to a base that replaces the mouse mat and contains the motors used to provide forces back to the user. Interface use is to aid computer users who are blind or visually disabled; or who are tactile/Kinesthetic learners by providing a slight resistance at the edges of windows and buttons so that the user can "feel" the Graphical User Interface (GUI). This technology can also provide resistance to textures in computer images, which enables computer users to "feel" pictures such as maps and drawings. PHANTOM: The PHANTOM provides single point, 3D force- feedback to the user via a stylus (or thimble) attached to a moveable arm. The position of the stylus point/fingertip is tracked, and resistive force is applied to it when the device comes into 'contact' with the virtual model, providing accurate, ground referenced force feedback. The physical working space is determined by the extent of the arm, and a number of models are available to suit different user requirements. The phantom system is controlled by three direct current (DC) motors that have sensors and encoders attached to them. The number of motors corresponds to the number of degrees of freedom a particular phantom system has, although most systems produced have 3 motors. The encoders track the user’s motion or position along the x, y and z coordinates the motors track the forces exerted on the user along the x, y and z-axis. From the motors there is a cable that connects to an aluminum linkage, which connects to a passive gimbals which attaches to the thimble or stylus. A gimbal is a device that permits a body freedom of motion in any direction or suspends it so that it will remain level at all times. Used in surgical simulations and remote operation of robotics in hazardous environments Cyber Glove: Cyber Glove can sense the position and movement of the fingers and wrist.