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Haptics: Technology Based on Touch

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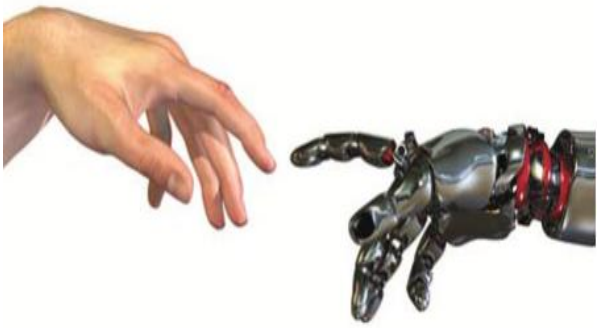
ABSTRACT
Haptics is any form of non verbal communication. It refers to haptic technology, haptic communication and haptic perception. It allows a person to feel input from haptic technology interfaces with the users through the sense of touch. It uses tactile feedback,
executed by applying force or motion on a body of a person, in the form of vibration. Haptic effects are enabled by the actuators that apply force on the skin, so that the user can feel the force .Haptic communication means by which a people and other human beings or animals communicate via touching. In this paper, we will discuss the basic concepts behind haptic technology and other haptic devices and their applications in our day to day life.

Keywords *- Haptic technology, Kinesthetic, Sensors, Actuators, Tactile.*

1. INTRODUCTION

Haptic is a term derived from the Greek word "haptikos" means pertaining to sense of touch. Haptics is a newest technology to arrive in the world of computer interface devices. It is a tactile feedback technology that takes advantage of user's sense of touch by applying force, vibrations or motion to the user. This mechanical stimulation is used to assist in the creation of virtual objects. Although the other sensory modalities such as vision and audition have been investigated in details but sense of touch has been neglected [1]. So, Haptic technology has made it possible to investigate in details how the human sense of touch works by allowing the creation of careful control haptic virtual objects. These objects are used to systematically probe human haptic capabilities which would otherwise be difficult to achieve. The term Haptics has been used for years by researchers in human psychophysics who study how people use their hands to sense and manipulate objects [9, 10].



2. WORKING OF HAPTICS

Haptics consists of two parts namely human part and machine part as shown in fig.1 below. Human part controls the position of the hand while machine part exerts force from the hand to stimulate contact with virtual objects. In case of Haptics, computer acts as a brain, sensing devices performs the same function as muscles do in our body and actuators/motors works as a skin surfaces.

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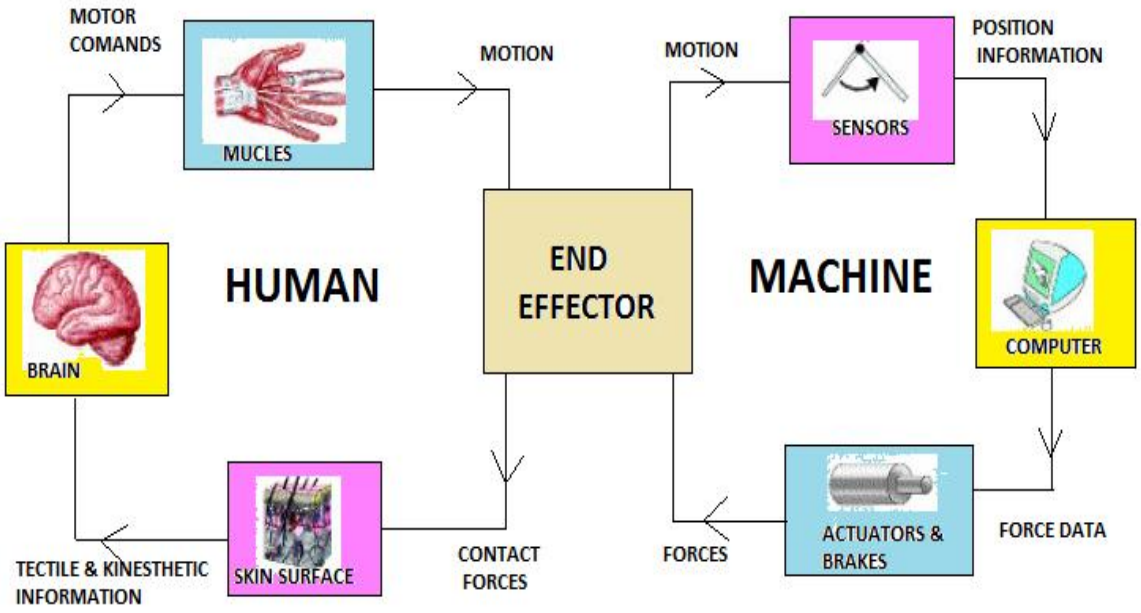

Figure 1: Basic configuration of Haptics

The key elements which are used to interface with computer are sensors, actuators, real time algorithm, and application programming interface [4, 5]. Haptic information provided by the system will be the combination of tactile information and kinesthetic information.

- Tactile information refers to the awareness of stimulation to the outer surface of the body.
- Kinesthetic information refers to the awareness of limbs position and moment as well as muscles tension.

Haptics can be subdivided into three areas:

2.1 Human Haptics

Human haptics is the study of human sensing and manipulation through touch. Human haptic system consists of two subsystems: motor subsystem and sensory subsystem. Both the systems are strongly linked with each other. Human use to different forms of haptic exploration: active and passive. Active haptic exploration is used when user controls its action and passive haptic exploration is used when another person guides the hand or fingers of the user [9].

2.2 Computer Haptics

Computer haptics is an algorithm and software associated with generating and rendering the touch and feel of virtual objects. Computer haptics is a rapidly emerging area of research that is concern with the techniques and the process associated with generating and displaying the touch and feel of virtual objects to a human operator through a force reflecting device. It includes software architecture needed for haptics interaction and synchronization with visual and other display modalities.

2.3 Machine Haptics

Machine haptics refers to design, construction and use of machine to replace or augment human touch. Haptic interfaces are devices composed of mechanical components in physical contact with the human body for the purpose of exchanging information with the human nervous system. In performing tasks with a haptic interface, the human user conveys desired motor actions by physically manipulating the interface, which in turns displays tactual sensory information to the user by appropriately stimulating his or her tactile and kinesthetic sensory systems [9]. Thus in general, haptic interfaces can be viewed as having two basic functions:

- To measure the positions and contact forces of the user's hand
- To display contact forces and positions to the user.

3. TOUCHING REAL AND VIRTUAL OBJECT

When a human user touches a real object directly or through a tool, forces are imposed on the user's skin. The associated sensory information, mediated by sensors in the skin, joints tendons and muscles, is conveyed to the brain by nervous system and leads to haptics perception. The subsequent motor commands issued by the brain activate the muscles and results in motion that modifies the touch sensory information.
In order to create this effect a weak current is given area of the device that is being used for interaction. If the material is conductive ,a capacitive set up will be created when dry finger touches it .the capacitive set-up will generate an oscillating electric field around the skin and finger tips ,which then go on to create a variable sensation of fiction depending on the frequency and applied signal. The ability to control friction by varying the frequency and amplitude will allow to create different 'virtual surrounding' as desired.

4. APPLICATIONS

There has been significant progress in haptics technology but the incorporation of haptics into virtual environments is still in its infancy. A wide range of the new society's human activities including communication, education, art, entertainment, commerce and science would forever change if we learned how to capture, manipulate and reproduce haptic sensory stimuli that are nearly indistinguishable from reality. For the field to move forward, many commercial and technological barriers need to be overcome.

4.1 GUI

Video game makers had been using passive haptics. They took the advantages of vibrating joysticks, controllers and steering wheels to reinforce on-screen activity but future video games will enable player to feel and manipulate virtual solids, fluids , tools and avatars. Nokia phone designer have perfected tactile touch screen that makes on-screen buttons behaves as if they were real buttons. When the user presses the button, he or she feels moment in and out.

4.2 Tele Robots

In telerobotic system, a human operator controls the moment of a robot that is located some distance away. Tele-operated robots are limited to very simple task such as aiming a camera and sending back visual images. Haptics now makes it possible to include touch cues in addition to audio, video and visual cues in telepresence models [3].

4.3 Geo Sciences

In petroleum exploration, developing accurate models of subsurface environment is complex and challenging problem. Novint has developed customized software to make it possible to work in 3D with 3D data by adding haptic feedback and providing real time 3D interaction to existing visualization techniques.

4.4 Medicine

Haptics is manipulating micro and macro robots for minimal invasive surgery (laparoscopy) and remote surgery using tele-operators. It is using in remote diagnosis for telemedicine. It provides aids for the disabled such as haptic interfaces for the blind and rehabilitation robotics. In ophthalmology, "haptic" refers to a supporting spring, two of which hold an artificial lens within the lens capsule (after surgical removal of cataracts) [4]. Haptics in medicals allows training of future doctors in surgical procedure without the need of actual human body.

4.5 Military

Military uses flight simulators to train pilots using haptics. Training missions may include how to fly in battle, how to recover in an emergency, or how to coordinate air support with ground operations. The Army
uses several specific haptic devices to train soldiers to drive vehicles like tanks or the heavily-armored Stryker vehicle [8].

4.6 Cultural

Haptic technologies are available that let museums add this missing aspect back into their computer-based exhibits. They allow the visual displays to be extended to make them more realistic, useful and engaging for visitors and scholars. This has many potential benefits for museums, for example in allowing greater access to rare and fragile objects, allowing access for people who live far away and cannot easily get the museum, improving the opportunities for blind and visually-impaired people, and increasing the number of artefacts on display. Haptic devices have a lot to offer museums and are likely to have a big impact on the quality and usefulness of computer-based exhibits [7].

4.7 Education

In the Education field the sense of touch and force-feedback can offer great improvements to the existing teaching methods, thus enhancing the quality of education procedures. Haptics Educational Applications are an under development research field and some non-commercial applications have been developed for the above haptic interfaces. In our research and study, the applications and the device are oriented to each other and both to educational purposes [6].

5. CHALLENGES

The main challenge in designing a haptics device is to make the control interface feel exactly like the tool being used originally by the operator. Haptic is still not very common technology and facing challenges in terms of cost, complexity, portability and debugging issues. Precision of touch requires lot of advance design. With only a sense of touch, haptic interfaces cannot deliver warnings. Haptics applications required complex and specialized hardware and significant processing power. Complexity means many haptics project rely on fixed installations of equipment. Software compatibility is also another issue facing by haptics technology. Touch plays a key role when examining objects in the real world but until recently it was not possible to use this realistically in virtual environments and computer-based displays. This has meant that some of these displays lacked realism and usefulness [1].

6. CONCLUSION

Haptics technology is built into a device to create tactile feedback, so that the user feels while touching the screen of a mobile device. For example, immersion software combined with actuators, allows sensations like the feel of a button .It makes the product feel more real and can improve the user experience, particularly for people not used to touch screens. As technology advances, computer power grows; haptic devices and effects evolve and get more realistic. Future applications of haptic technology cover a wide spectrum of human interaction with technology. Current research focuses on the mastery of tactile interaction with holograms and distant objects, which if successful may result in applications and advancements in gaming, movies, manufacturing, medical, and other industries. The medical industry stands to gain from virtual and telepresence surgeries, which provide new options for medical care. The clothing retail industry could gain from haptic technology by allowing users to "feel" the texture of clothes for sale on the internet. The merging of wearable consumer electronics with haptics technology thus allows people to interact 'physical' with virtual object as if they were real-world object Future advancements in haptic technology may create new industries that were previously not feasible or realistic.

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