State of art of haptic technology

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***Abstract*: Haptic technology is tactile feedback technology. Haptic technology take advantage of user sense of touch by applying force, vibration or motion to the user. Haptic refers to manipulation and sensing through touch. In the proposed paper we have discussed an overview, important concepts in haptic technology, discusses the most broadly used haptics system like 'phantom', 'cyberglove' devices. We have explained in details how haptic technology implemented in various fields of study. In the proposed paper also includes how haptic technology works, its applications its advantages, its disadvantages, and its future applications.**

***Keywords:* Haptics, Phantom, Cyberglove, haptic applications.**

I. INTRODUCTION

The word 'haptic' originated from the Greek word "haptikos" meaning pertaining to the sense of touch and comes from the Greek verb "haptesthai" meaning to "contact" or to "touch". Haptic technology is intuitive. Haptic technology is tactile feedback technology. Haptic technology take advantage of user sense of touch by applying force, vibration or motion to the user. Haptic refers to manipulation and sensing through touch. This mechanical stimulation can be used to aid in the virtual objects. (Objects existing only in computer simulation), for control of such virtual objects and to enhance the remote control of devices and machines. The wide reaching applications of haptic technology are already emerging in some fields.For example, haptic technology has made it feasible to investigate in detail how the human sense of touch works by allowing the creature of carefully controlled haptic virtual objects. These objects are used to systematically probe human haptic capabilities, which would otherwise be hard to accomplish. These new research tools contribute to our understanding of how touch and its underlying brain functions work. Although haptic devices are able 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. Human can interact with computer through body movement and sensation using haptic interface. The haptic technology use in surgical training, mobile, games etc. These are the several applications of haptic technology.

II. LITERATURE REVIEW

In the early 20th century, the word haptic psychophysicists introduced to label the subfield of their studies that addressed human touch-based manipulation and perception. In the 1970s and 1980s, significant research efforts in a absolutely different field, robotics also began to focus on perception and manipulation by touch. Initially concerned with building autonomous robots, researchers soon found that building a dexterous robotic hand was much more subtle and complex than their initial naive hopes had suggested.

In time these two communities, one that aspired to create devices with knack inspired by human abilities found productive mutual interest in topic such as sensory design and processing, manipulation and grasp control, haptic information encoding and object representation, and grammars for describing physical tasks and one that sought to understand the human hand.

In the early 1990s a new usage of the word haptics began to appear. The concreation of several emerging technologies made virtualized haptics, or computer haptics possible. Much like computer haptics, and computer graphics. Computer haptics enables the display of simulated objects to humans in an interactive mode. However, computer haptics uses a display technology through which objects can be physically palpated.Haptic interfaces are divided into two categories:

1. Tactile feedback
2. Force feedback

Tactile feedback Interfaces deals with surface properties such as temperature, roughness and smoothness. Force feedback Interfaces are used to explore and modify virtual/remote objects in three physical dimensions in application including computer-aided assembly, computer assisted surgery and computer aided assembly.

III. WORKING OF HAPTIC TECHNOLOGY

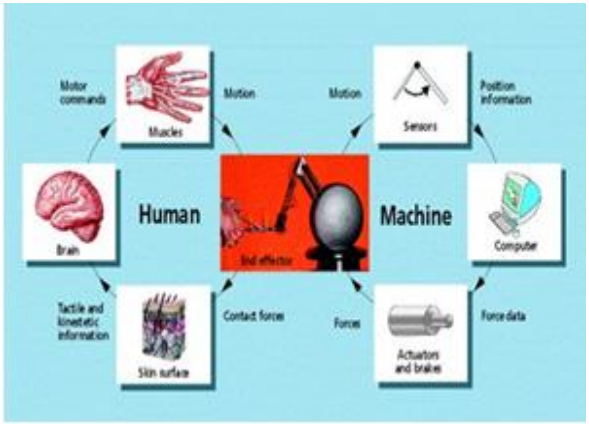

Fig1: Basic configuration of haptics

A haptic system compost of two parts the human part and the machine part. In the figure (1) shown above, the human part (left side) and machine part (right side). The human part senses and controls the position of hand. In the figure shown above, the machine part exerts forces from the hand to simulate contact with virtual object. Also both the systems will be provided with compulsory 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 end effector is a sensitive haptic device. It has various sensors which sense the change in angle, amount of force applied and gives this information to the computer. The computer then process this information and gives specific instructions to an actuator. The actuator is a device that puts something in an automatic action. The actuator then applied force to haptic device, is perceived as feedback force is felt on the surface of the skin and this faaling is interpreted by the brain. This is the basic cycle of haptics.

Haptics refers to two kind of information:

1. Tactile information: This refers to the information acquired by the sensors connected to the user's body.
2. Kinesthetic information: This refers to the information acquired by the sensors in the joints Interaction forces are normally perceived through a combination of these two information.sensors in the jointsInteraction forces are normally perceived through a combination of these two information.

IV. HAPTIC DEVICES

A haptic devices is called as haptic interface. Haptic devices are mechanical devices .haptic devices is also called as input output devices. A haptic device is provides a physical interface between the virtual environment and the user by means of a computer. physical interface can be done through an input/output device that senses the body's movement, such as joystick or data glove. Using haptic devices, the user can not only receive information from the computer but can also Provide information to the computer in the form of a felt sensation on some part of the body. This is referred to as a haptic interface. In haptic devices sophisticated devices designed for medical, industrial or scientific applications such as 'PHANTOM' device.

COMMONLY USED HAPTIC INTERFACING DEVICES:-

1. PHANTOM
2. CYBERGLOVE

A. Phantom

The PHANTOM is a haptic interfacing device developed by a company named Sensible technologies. Figure (2) shows the PHANTOM device. The PHANTOM device is most widely used in industry, medical field and games applications etc. The PHANTOM operates in which virtual 3 dimensional space is called haptic sense. It is provide six degree of freedom positional sensing. It is used for providing a 3D touch to the virtual objects. It provides a programmable sense of feel that allows the user to feel the texture and proportion of the virtual object with a very high degree of realism. It provides a programmable sense of feel that allows the user to feel the texture and proportion of the virtual object with a very high degree of realism.

Fig2: Phantom

B. Cyber glove

Fig3: Cyber glove

The principle of a Cyber glove is very simple and easy to understand. Figure (3). Shows the cyber glove. It consists of opposing the movement of the hand in the same way that an object squeezed between the fingers resists the movement of the latter. In the absence of real object, the glove must be capable, of recreating the forces applied by the object on the human hand with (a) the same intensity and (b) the same direction. These two condition can solved by requiring the glove to apply a torque equal to the interphalangian joint. The advantages of this structure as given bellow:

- Allows four degree of freedom.
- Located on the back of the hand.
- Adapted to different size of fingure.
- apply different forces on each phalanx

V. BASIC HAPTIC CONCEPT

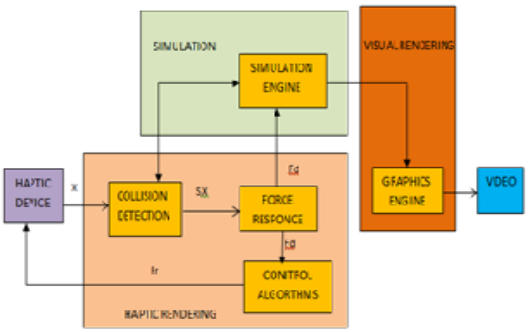

Fig4: Haptic system block diagram

A. Haptic communication

This means by which machines and humans communicate via touch. It is mostly concern networking issues.

B. Haptic perception

This is the process of understanding the characteristics of objects through touch.

C. Haptic interface

This consists of a software based computer control mechanism and haptic device. It enables machine- human communication through sense of touch. By using a haptic interface someone can't only provide the information to the computer but can also receipt information from the computer in the form of physical sensation on someparts of the body.

D. Haptic rendering

This is the process of calculating the sense of touch particularly force. It involves sampling the position sensors at the haptic device to obtain the users position within the virtual environment.The position information received is used to search whether there are any collisions between any objects and user in the virtual environment. In case a collision is detect. The haptic rendering module will calculate the appropriate feedback forces that will ultimately be applied onto the user through the actuators. Haptic rendering is a system that consist of three parts, collision response algorithm, a control algorithm and collision detection algorithm.

VI. COMPARISON OF HAPTIC DEVICES

Table1 shows the three different types of characteristics of haptic devices. Generally haptic devices must have eight basic characteristics such as back drive friction, workspace, maximum force, maximum torque, stiffness, resolution, backlash, apparent mass. In haptic devices maximum torque, maximum force, workspace, resolution, stiffness must be maximized and backlash, apparent mass and back drive friction must be minimized in order to simulate accurate any virtual enables environment.

Table1. Comparison of haptic device types

Characteristics of Haptic Devices	Cable Driven	Magnetic Levitation	Mechanical Arm
Maximum force	Unsatisfied	Satisfied	Satisfied
stiffness	Satisfied	Satisfied	Satisfied
Workspace	Unsatisfied	Unsatisfied	Satisfied
Resolution	Unsatisfied	Satisfied	Satisfied
Maximum torque	Unsatisfied	Satisfied	Satisfied
Apparent mass	Satisfied	Satisfied	Satisfied
Backlash	Satisfied	Satisfied	Satisfied
Back driven friction	Satisfied	Satisfied	Satisfied

VII. APPLICATIONS

A. Haptics for medical field

Haptic technology for medical simulation has very useful. Touch and kinesthetic are effortless senses which are important for fast, subtle, accurate information with our environment. These prove to be excessive crucial for the invasive procedure. These include interventional radiology remote surgery and laparoscopy. In open surgery, surgeons heavily on touch to distinguish healthy tissue from disease infected tissue. The benefit of using haptic technology is that surgeons can perform large number of same operation with less fatigue. In ophthalmology, the sufficing spring that hold artificial lens within lens can after remove of cataract are done. Furthermore the virtual haptic feedback is useful for finding of medical problem through touch. Recent technology based on haptic is also used in fields of prosthetics.

Haptics has a very large future scope in the medical field applications. It will be probable to construct a central work station which will be used by surgeons will become remote operation. The surgeons will become a telepresence. This will lead to an increased availability in expert medical care. Haptics provide a resistance feedback and tactile to surgeons operating on Robotic devices. As surgery is carried on ligament are felt directly worked on patient. Haptics technology can also develop technology to simulate surgery. Simulated surgery can be used for training. Haptics aids in simulation by creating realistic environment of touch. Similar to telepresence surgery, surgeons can feel simulated ligaments or pressure of virtual incisions as if real. This will be help in training of surgeons.

B. Graphical user interfaces

Video game makers have been early adopters of static haptics which take benefit of vibrating controllers, stereo wheels and joystics to reinforce on screen activity. But future video games will players to feel and manipulate virtual solids, avatars, tools and fluids. The Novint Falcon haptics comptroller allows you to tell the difference between shotgun blast and pistol report, or to feel the resistance of longbows rope, as you pull back an arrow.

Fig5: Graphical Interface for Laptop Games.

Graphical user interfaces, like those that define Mac operation environments and Windows will also advantage greatly from haptic interactions.Imagine being capable to feel receive force feedback as you depress button and graphic buttons. Some touch screen manufacturers are already experimenting with technology. Nokia phone designers have faultless a tactile touch screen that makes on screen buttons to behave as if they were actual buttons. When a user depresses the button she or he feels movement in and movement out. He hears an audible click. Nokia engineers practised this by placing two small piezoelectric sensor pad under the screen and designing the screen and designing the screen so it could more slighted when pressed. Everything, sound and movement is synchronized completely to simulate actual button manipulation.

C. Telerobotics

In telerobotics system, a human operator controls the agitation of a robot that is located some distance apart. Some teleported robots are restricted to excessive simple task, such as aiming a camera and sending back visual images. Now haptics creates it probable to incorporate touch cues in addition to virtual and audio cues in telepresence models. It will not be long before planel and astronomers scientists actually manipulate and hold a martion rock through an overhang haptics enabled telerobot, a spindly touch version of the mars detection tramp.

D. Data visualisation

Animation and graphics are used to analyze or solve the problems in data visualization. Data visualisation are used for visually impaired people and scientific analysis. Haptic using a high quality accurate data visualisation is possible. For visually impaired people touch is used as a channel for provide information. Scientific data visualisation is used for molecular interaction, force field analysis and fluid flow model. Using graphical standard made from haptic feedback, for the blind people a real city can be explored.

E. Arts and design

Touching is unlimited to feeling but allows interactivity in real time with virtual objects. Thus haptic are used in virtual arts, such as graphic design or sound synthesis and animation. Haptic device allows the artist to have direct contact with a virtual instrument and produces real time images or sound. Haptic is enables virtual sculpting and modelling. Modelling and sculpting are based on the tactile feedback model. Hence with touch virtual sculpting haptic feedback becomes easier.

VIII. ADVANTAGES

1. Working time is reduced.
2. Increment confidence in medical field.
3. Communication is centered through touch and the digital world can behave like the real world.
4. Haptic hardware and software designers can feel the real result as if she/he were handling physical objects.

IX. DISADVANTAGES

1. Implementation of haptic technology is costly.
2. Large size and weight.
3. The accuracy of touch require a lots of advance design.

X. FUTURE APPLICATIONS OF HAPTIC TECHNOLOGY

A. Holographic interaction

Using haptic technology in the holographic interaction the user receives tactile response from holograph as if it were a real object. It is based on using ultrasound waves there by creating acoustic radiation pressure. It is through tactile response that user perceives the object.

B. Biometric haptics

Haptic technology can be used for biometric. Conventional biometric require a password and unique ID. These can incommodious to remember. These password are not secure these can be hacked without being any information these are not safe and secure. Using the haptic in biometric measures the velocity, position and force. After these measurements unique physical patterns can developed these can be used for identification.

C. E-Commerce

E- commercemeans electronics commerce. Using haptic technology in electronics commerce enables consumers are physically attract with commodity.The properties such as texture, roughness can be determined, felt by touching the product. Before buying the product consumers usually like to feel and touch the product.

D. Education

Haptic technology can allow for visualisation of geometric problems in actual 3D space. Haptic technology allows a better and clear understanding of the problem which is beneficial in the field of education.

XI. CONCLUSION

Haptic technology has proved that virtual objects can be touched, controlled and felt. Day by day, the cost of haptic technology is reducing. Haptic technology has very large future scope in every possible field. Haptic technology gaining applications in every possible field like medical, art, education, games, entertainment. Haptic technology reduces the work time. Haptic device acts as input and output device. Haptic technology has made simple and easier to use. Many people purchase this technology because its implementation cost is less.

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