HAPTIC TECHNOLOGY IN SURGICAL SIMULATION AND MEDICAL TRAINING

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Abstract—**Engineering has its wide range of applications in every field, even in the medical field. It is because of one of the technologies i.e. haptic technology and it is because of this technology that even the surgeries found to be most complicated are successful. Haptic technology gives the illusion to users that they are touching or manipulating a real physical object and it is haptic technology that provides a "sense of touch" to virtual environment.**

In this paper, basic concepts of haptic and haptic devices are discussed, how the sense of touch is produced and force feedback mechanisms by haptic rendering and how haptic devices are used for medical training. The main focus of this paper is on the use of "Haptic technology in Surgical Simulation and Medical Training." Haptic devices work as an alternative method for training in medical field for better results.

Keywords— **haptic technology, haptic devices, tactile display, force feedback, haptic rendering, surgical simulation.**

I. INTRODUCTION

This Haptic is originated from 'Haptesthai' a Greek word which means 'to touch'. Haptic has changed the way of human interaction with computers and communication ideas. Haptic enables the user to interact with virtual environment by a sense of touch and user can easily sense of tactile realness i.e. shape, texture, weight, etc. of an object. Haptic technology helps in understanding how the human sense of touch works in real life. Well, in surgical simulation and medical training the use of haptic technology is achieved through various haptic devices which make use of force feedback.

The haptic system comprises of two parts- human part and another machine part. The human part is used to sense and control the hand's position while, the force is exerted by the machine part to simulate contact with virtual object.

In case of the human system, nerve receptors perform the action of sensing, brain performs processing and muscles are used to perform actuation of the motion performed by the hand while in case of the machine system, the functions (sensing, processing, and actuation of motion) are performed by the encoders, computer and motors respectively.

Overall, human system feels the touch sense while the machine system is used to feel the virtual objects and transfer the signal to human body.

II. HAPTIC RENDERING

The process where the user feels the force through force feedback devices is haptic rendering. Due to haptic rendering the user can feel, touch and operate the virtual objects. Haptic rendering helps in building up the user's experience in virtual environment.

The haptic interaction takes place in two ways:-

1. Haptics interface with computer system.
2. Human nervous system

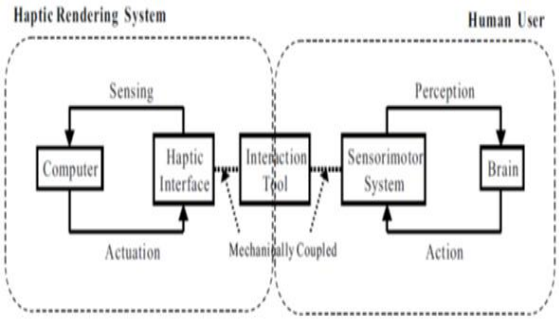

Fig: Haptic Rendering System

III. HAPTIC DEVICES

Haptic devices are those devices that provide an interface between the user and the virtual environment. With the help of these devices the user can feed information to the computer and also receive it in the form of felt sensation.

These devices can be broadly classified into:-

a. Virtual reality/ Tele-robotics based devices:-
   - Exoskeletons and Stationary device
   - Gloves and wearable devices
   - Point-source and Specific task devices
   - Locomotion Interfaces

b. Feedback devices:-
   - Force feedback devices
   - Tactile displays

Some of the haptic interfacing devices commonly used are:-

- Phantom
- Cyber glove

1) *Phantom*: - This haptic device is used to interact with virtual environment where 3D touch is provided to the virtual objects. It provides a virtual environment of very high resolution by which the user feels the virtual object with realism. This device consists of motor arm generates 3D objects. This device can be used in medical field to practice the surgery before actual surgery takes place.

2) *Cyber Glove*: The Cyber Glove device is a lightweight, force-reflecting exoskeleton that fits over a Cyber Glove data glove (wired version) and adds resistive force feedback to each finger. With the Cyber Glove force feedback system, users are able to feel the size and shape of computer generated 3D objects in a simulated virtual world.

IV. USE OF HAPTIC TECHNOLOGY IN MEDICAL TRAINING AND SURGICAL SIMULATION

Use of haptic technology in medical field has been a primary application. Haptic rendering algorithms detect contact between virtual organs and surgical instruments and with the help of haptic interface devices render organ-force responses to the users. For easy working of haptic rendering, the Minimally Invasive Surgical tools into two groups based on their functions.

1. **Long, thin, straight probes** for palpating or puncturing the tissue and for
Injection (puncture and injection needles and palpation probes)

2**. Articulated tools** for pulling, clamping, gripping, and cutting soft tissues (such as biopsy and punch forceps, hook scissors, and grasping forceps).

Few practices where haptic tools are used:-

- *Needle Insertion*- Needle insertion is a process which is necessary during surgery and other operations where doctors insert the needle in patient's body to inject medicines. It is one of the most important steps and should be carried out in proper manner and with care.
- *Laparoscopic*- Laparoscopic surgery, or also known as Minimally Invasive Surgery, is a surgical procedure which is performed through small incisions, using long thin

tools to perform the procedure within the body.

- *Endoscopy*- A clinician feeding an endoscope into a patient will experience resistance between this flexible tool and the patient's body. There have been several examples where endoscopes have been used with haptics in a simulator to give an appropriate physiological response and accurate tool behaviour.

CONCLUSIONS

Haptic technology is the only solution, which provides high range of interaction that cannot be provided by BMI or virtual reality. The main aim of this research paper is to study the basics of haptic technology in surgical simulation and medical training. Haptic technology is one of the emerging technologies which can be used in medical training to help surgeons in practicing surgeries and also make it easy to study the medical science. Haptic technology makes it easy for surgeons to perform their surgeries successfully and understand the risk they may encounter at the time of real time surgeries.

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