

The Study of Haptics in Medical Training Simulation

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Abstract: Haptics is the science of applying touch sensation and control to interaction with computer applications. By using special input/output devices like joysticks users can receive feedback from computer applications in the form of felt sensations in the hand or other parts of the body. In combination with a visual display, haptics technology can be used to train people for tasks requiring hand-eye coordination, such as surgery, military training, and space ship maneuvers. It can also be used for games in which you feel as well as see your interactions with images. The role of haptics within virtual medical training applications, particularly, where it can be used to aid a practitioner to learn and practice a task.

Key Words - Devices, Haptic Rendering, Haptic Perception, Medical, Simulator, Virtual World, Virtual Reality (VR)

I. INTRODUCTION

Haptic technology has made it possible to investigate 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 research tools contribute to the understanding of how touch and its underlying brain functions work. Haptic is the technology that comprises of virtual environment with sense of touch and motion to user. This technology can be used to create virtual objects which exist in computer world and it helps to enhance remote control. Haptics is the technology that helps to understand how the human sense works in real life with the help of various haptics devices. Haptics is the technology which helps to understand the relation between the human touch sense and responses given by nervous system. Haptics technology can be used in different fields to train people such as military training for soldiers, surgery practice for doctors, creating real-life experience in video games etc. Also haptics can be used in imaging applications which will help to feel the object present in the image.

Haptics is originated from the Greek word *haptikos* which belongs to the sense of touch.

II. WORKING OF HAPTICS

A. Basic System Configuration

Haptics system can be divided in two parts. First part consists of human sense technology which feels the touch sense while other part is haptics machine device which will be used to feel the virtual objects and that part will transfer the signal to human body. Both the system performs the actions like sensing, motion processing, touch and response with the help of nerve receptors, brain, computer, devices.

B. Haptic Feedback

Feedback is the response given to a particular action performed. Haptics system provides a feedback after performing an action that feedback has to be relevant to the action performed. The feedback is transferred to human nervous system through haptic device that would be used by the user. Virtual reality is the system application which helps to feel the real life scenario in virtual environment like holding an object in hand etc. The actions will be performed in virtual life but haptics gives it a real life effect. The user interacts with the system with the help of touch, vision and sound. The Figure below shows the structure of a VR application incorporating visual, auditory, and haptic feedback.

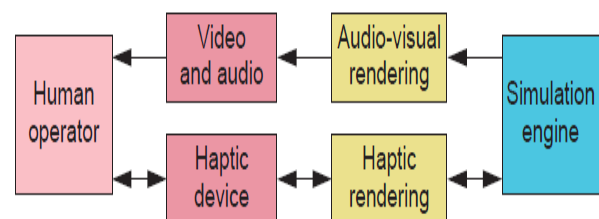


Fig. 1. Haptic Feedback Block Diagram [8]

- 1) The haptic device or simulation engine is responsible for creating a virtual environment.
- 2) Audio, Video and haptic programs are responsible to communicate with user
- 3) Transducers are used to deliver the signals generated by haptic devices to user.

To use haptics system, the haptics device should be used to communicate with the virtual world. These devices help to receive audio and touch sense from haptics environment.

Haptics system also comprises of visual display to see the object of virtual environment. Audio and display device helps to exchange information from and to the user. This is the most important feature of this technology which takes information process it and gives results.

III. HAPTICS DEVICES

A. PHANTOM



Fig 2.1 Haptics Feedback Device

It is a haptic device that is used to communicate with virtual environment which provides 3D touch to the objects in virtual world. This device provides a very high resolution virtual environment using which user can feel virtual object with realism. The device consists of motor arm which is to be used by the user to communicate with the system. This device can generate 3D objects. This device can be used to draw any images or also in medical science to practice the surgery before actual surgery.

B. Cyber Glove



Fig. 2.2 Haptics Feedback device

The principle of a Cyber glove is simple. 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. The glove must therefore be capable, in the absence of a real object, of recreating the forces applied by the object on the human hand with the same intensity and the same direction. These two conditions can be simplified by requiring the glove to apply a torque equal to the interphalangean joint.

IV. HAPTIC RENDERING

A. Haptics Interface

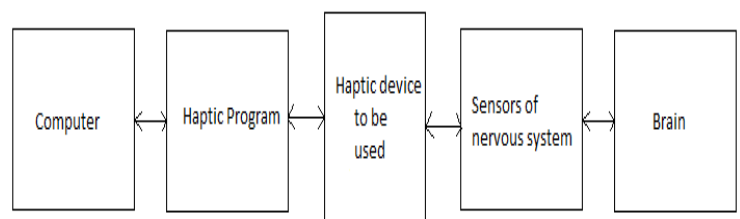


Fig. 3 Working of Haptics System

The haptic interaction takes place by using following two substances :

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

Both systems recognize the environment and produce the information and generate results. For processing, haptic interface program communicates with the computer system and along with that the sense that is received through device is passed to computer system. With the help of haptic device this system is mechanically connected to user ,where the

sensor motor system of human body is attached through haptic device and the signals received are processed by nervous system to take particular action signals are passed on to Human Brain. The human brain guesses the sense received by haptic device and based on that actions are generated by brain.

V. ROLE OF HAPTICS IN MEDICAL TRAINING SIMULATORS

Haptics can be used in medical simulation which involves giving training to surgeons and surgical students to practice more. Doctors can perform remote surgery in emergency instead of going to an operation room to carry out the operation. The use of this technology in medicine provides an advantage to doctors that they can perform more similar operation in less time-span and no problems during actual surgery. The use of haptics in medical training simulation involves needle insertion, surgical training, knee arthroscopy and laparoscopy, endoscopy.

A. NEEDLE INSERTION

Needle insertion is required during surgery and other operations where doctors have to insert a needle in patients body to inject him with medicines. This is the most important step as it should be carried out in a well manner.

B. LAPAROSCOPY

Laparoscopic surgery, or minimally invasive surgery, is a surgical procedure performed through small incisions, using long thin tools to perform a procedure within the body.

C. 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 behavior. Commercial products for endoscopy include GI and URO Mentor from Symbionix and, Endoscopy AccuTouch from Immersion.

Various haptic interfaces for medical simulation may prove especially useful for training of minimally invasive procedures (laparoscopy/interventional radiology) and remote surgery using teleoperators. In the future, expert surgeons may work from a central workstation, performing operations in various locations, with machine setup and patient preparation performed by local nursing staff. Rather than traveling to an operating room, fatigue. It is well documented that a surgeon who performs more procedures of a given kind will have statistically better outcomes for his patients. Haptic interfaces are also used in rehabilitation robotics. The surgeon instead becomes a telepresence. A particular advantage of this type of work is that the surgeon can perform many more operations of a similar type, and with less

VI. ISSUES OF HAPTICS IN VIRTUAL ENVIRONMENT

Maximizing the use human performance in VEs is essential to the success of this technology. Of equal importance is ensuring the health and welfare of users who interact with this environment. If the human element in these system is ignored or maximized, it could result in discomfort, or injury. It is essential that VE developers ensure that advances in VE technology do not come at the expense of human wellbeing.

There are several health and safety issues that may affect users of VEs. The direct effects can be looked at from a microscopic level. The indirect effects include physiological after effects and psychological disturbance.

A. DIRECT EFFECTS

1. The eyes may be affected by the electromagnetic field of VEs if the exposure is sufficiently intense or prolonged.
2. **Cybersickness:** One of the important health issues that may influence the advancement of VE technology is cybersickness. Cybersickness is a form of motion sickness that occurs as a result of exposure to VEs. Cybersickness poses a serious threat to the usability of VR systems. Users of VE system may experience various levels of sickness ranging from a slight headache to an emetic response. Although there are many suggestions about the causes of cybersickness, to date there are no definitive predictive theories, although there are models in general.

B. INDIRECT EFFECTS

The use of VEs produce disturbing aftereffects, such as head spinning, postural ataxia, reduced eye-hand coordination, vestibular disturbances or sickness. The VE technology community should collaboratively establish health and safety standards that can direct and guide future developments.

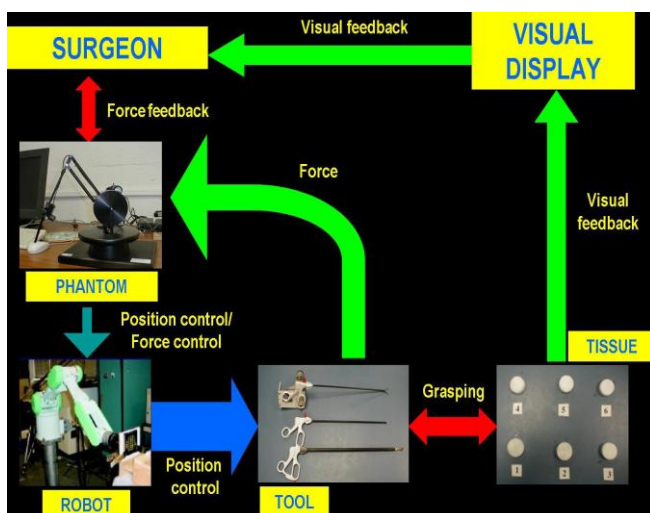


Fig. 4 Medical Training Purpose [8]

VII. LIMITATIONS OF HAPTIC SYSTEM

Haptic interfaces can only exert forces with limited magnitude and not equally well in all directions, thus rendering algorithms must ensure that no output components saturate, as this would lead to erroneous or discontinuous application of forces to the user. In addition, 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 setup of haptics technology is much complex and sometimes difficult to manage. Also if it is to be used in medical field by doctors then this technology should not cause any injuries to the patient if it is to be used by surgeons during real time surgery.

VIII. CONCLUSION

The main aim of this research paper is to study the basics of Haptics technology in medical science and its issues faced by users. Haptics technology is the emerging technology which can be used in medical science to help surgeons in their practice and also to make it easy to study the medical science. Doctors can use haptics technology to understand the risk in advance that may arise at the time of real time surgery. On the other hand haptics has some issues related to virtual environment like haptics setup, difficulty in use, difference in real time environment and haptics virtual environment. The effects of the virtual environment on human body can also be considered as a major limitation of the technology.

IX. ACKNOWLEDGEMENT

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Chinmay S. Deshpande is currently studying in Mumbai University at IMCOST, Thane since 2012, pursuing MCA with excellent academics and having interest in Studying New Technologies.