

Haptic Technology: The Next Big Revolution

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Abstract— The haptics technology is a feedback technology which uses the sense of touch of the humans. This in turn helps to human being to come in contact with the objects that are not present in real. And it is achieved by applying various forces, motions and vibrations by the haptic device as instructed by the computer systems. So human beings are able feel the objects which are present in the virtual environment. This paper proceeds with what is haptics technology, how does it work, the various devices used and major area of application.

Keywords—Haptics; Rendering; Actuators; Feedback.

I. INTRODUCTION

The field of computers has evolved from room big size computers to computers as small as palm size. But what’s next in the field of computer science? It is haptics the science of touch and feel[1]. Till date we were able to use the sense of sight, sense of hearing but with the help of haptics we can use the sense of touch i.e. we can feel what we are viewing on the computer screen. With the help of haptics interface devices a new revolution in the computer technology can be bought, which indeed would change the experience or the way of using the computers we have been using till date. The computers in the modern world have been an integral part for the survival of human beings, as it is used in each and every field of work and area of application. With the help of haptics

we can take the computer technology to the next high level, which would be very helpful in enhancing the use of computer technology.

II. HOW DOES HAPTICS TECHNOLOGY WORK?

As we know our body is controlled by the brain. It is the one which gives out the messages to all the muscles for the functioning of the body parts. When a human body comes in contact with any physical object then with the sense of touch we are able to feel that object and the muscle below the skin send out a message to the brain for recognizing that object. In the similar way when human wants to feel an object using haptic device, which is not present in the real world then this process takes place; as the human comes in contact with the haptic device, this device uses its sensors to sense the force applied by the touch and sends out this information to the computer. Then the computer processes this information and gives out results to the device. Now this device gives a feedback force to the human. This feedback force felt by the human body on the surface of the skin and then interpreted by the human brain helps in feeling the virtual object. This process has been explained in Fig. 1. Here haptics uses the concept of virtual reality. Virtual reality allows humans to interact with computer simulated environment.[4]

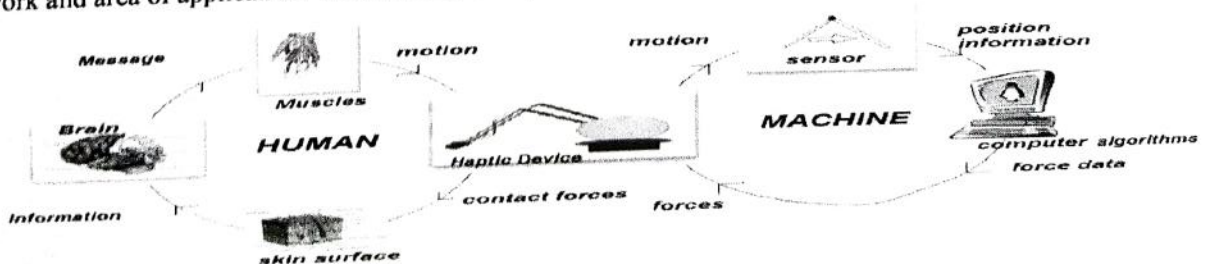


Fig .1. Working of haptics

The process used by computer system to perform the calculation for the haptic device is known as haptic rendering [3]. This process mainly consists of three algorithms:

- Collision detection algorithms: This algorithm uses information collected by the sensors to find collision between objects and human beings to give the degree of penetration.
- Force response algorithms: This algorithm reckons interaction forces between human beings and virtual objects involved in a collision.
- Control algorithms: This algorithm collects interaction force information from force response and applies them on the haptic device [2].

III. HAPTIC DEVICES

Haptic devices or haptic interface are the devices that stimulate the sense of touch and provide communication between the user and the computer [5]. Haptic devices sense the physical manipulations of the user and provide pragmatic touch sensations through the input/output devices [12]. By using the haptic devices, the user can also retrieve information from the computer in the form of sensations and not only feeding the data and information to the computer. Haptic devices are complex devices in which the user manipulates the end effector of the haptic device and the encoded output is transmitted to an interface controller where it is processed to calculate the position and orientation of the end effector. This information is sent to the computer and the feedback force is determined which is then applied through actuators to provide desired touch sensations.

A. Geomagic haptic devices



Fig. 2. Geomagic Haptic device [14]

Geomagic, a professional engineering software brand provides Geomagic haptic devices that incorporate a sense of touch into commercial applications and 3 D modeling systems. These devices as shown in Fig. 2, can accurately measure the position and the different alignments of the input devices used [6]. These devices interact with the virtual objects and simulate the touch with the help of the motors being used in the devices. The series of Geomagic haptic devices that are available are Geomagic Touch, Geomagic Touch X, Geomagic Phantom Premium. There are wide variety of Geomagic haptic devices to fit any set of requirements such as range of motion, position and forces. The range of motions supported by Geomagic

Touch and Geomagic Touch X are identical to that of motion of the hand pivoting at the wrist [7]. Whereas, range of motions supported by Geomagic Phantom Premium is analogue to that of the hand movement pivoted at the elbow or the shoulder. These devices allow user's hands to feel virtual objects.

B. Novint Falcon

Novint Falcon of Novint Technologies allow users to experience a sense of touch on their computers by modifying the way they interact with it. It represents remarkable 3D touch technology and accessibility [8]. Novint Falcon that added third sense to computers empowered an evolution in various products like video games. Novint Falcon enhances the 3D touch for the consumers. Novint Falcon devices have remarkable control due to the motor connected to the arm of the device that updates position one thousand times in a second. The motors are strong enough to provide strong sensations of interacted objects [9]. The quality and stability of device is highly impressive. This device has been shown below in Fig. 3.

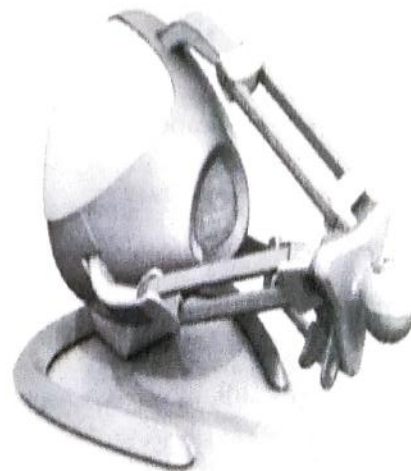


Fig. 3. Novint Falcon [15]

C. Force Dimension Haptic Devices

Force Dimension haptic devices include Sigma, Omega.x and Delta.x. Sigma.7 is uniquely identified for its 7 degrees of freedom that include high precision active grasping capability. It covers the whole array of movement of human hand. Sigma is the most accomplished master devices available. Omega.x series includes Omega.3, Omega.7 haptic devices. Omega.3 haptic devices are renowned for the high-end force feedback. The effectors of the Omega.x family can be upgraded by the user depending upon their application. Delta series includes Delta.3 and Delta.6 haptic devices.

superior mechanical stiffness, great precision and the highly efficient performance of the delta.x series make it remarkable. Some of the Force dimension haptic devices have been shown in Fig. 4., Fig. 5. , Fig. 6. & Fig. 7 [13].



Fig .4. Sigma.x haptic device[16]



Fig. 5. Omega.3 haptic device[17]



Fig. 6. Delta.3 haptic device[18]



Fig . 7. Delta.6 haptic device[19]

Haptic gloves

Haptic gloves as shown in Fig. 8. are a type of wearable device that enables the user to sense what they see in the virtual world. The device does not rely on vibration motors and external cables. This device provides sensation of touch by applying pressure on the user's hands with the help of the small bladders that are placed in the gloves [11]. When the user grabs an object in the virtual world, the device inflates the selective bladders which in turn apply pressure on the user's hands. The bladders present at

the fingertip inflate and deflate independently depending upon the type of the interacted object.



Fig .8. Haptic Gloves[20]

E. Magnetic levitation haptic device

Magnetic levitation haptic devices have 3 degree of freedom haptics interface [10]. Maglev haptics is a new technology for the high-fidelity interaction for the virtual objects. This device has been illustrated in Fig. 9. Maglev systems involve the principles of Lorentz levitation. To interact with the virtual environments, the user has to grab a levitated tool handle. These devices have high potential for precise positioning. The device contains large coils that are wound around the handle. Current in the coils interact with magnetic fields and generate forces and torques to provide haptic feedback.



Fig. 9. Magnetic levitation haptic device[21]

IV. AREAS OF APPLICATIONS

A. In Military operations

So many soldiers in India and across the world lose their lives every year because of the wars on the borders due various social and economical issues prevailing in the society. With the help of haptic devices we can save the lives of the soldiers, as with these devices the soldiers can operate the arms from the control rooms. Also the haptic device can be quite utilitarian for training the new candidates in the army.

B. In Astronomy study

As we know that till date Earth is the only planet in the solar system to have life on it, so to be able to study all other planets in the solar system i.e. find life on them the haptics technology can be serviceable for the astronomers for operating the space ships. As it is not feasible for human beings to survive in the space-

ship for hundreds of days, also in the climate of the other planet. While sitting in the space station the astronomers can feel the ground and examine the soil of the other planet [5].

C. Medicine

Introduction of haptics in medical field will be very beneficial. Practitioners and doctors would be able to perform operations and telesurgery with better accuracy. Haptic interfaces in medical devices enable doctors with haptics alerts and feedbacks that act as a guidance while performing surgical operations. The advanced technology helps in increasing clinical expertise and minimise medical errors. Haptic devices are also used to monitor critical signs in the medication process [4].

D. In online shopping

Till date we are able to just view the products that we are buying from the e-commerce portals but with the incorporation of the haptic device customers can also touch and feel the products that they are going to buy. This technology would give a big boost to this sector [2].

E. Virtual Education

Many researchers have revealed that a large amount of people understand and learn better when along with the visual and auditory learning, education involves movement and touch. Till now the traditional method of education involves only reading and hearing. With the introduction of haptics in the education, students get better opportunity for better understanding. For example, physics can be taught to students by providing them an opportunity to experience the different forces exerted on the objects. Various forces can be tested and sensory feedback gives students an improved way of learning [2].

V. CONCLUSION

Haptics technology is very behooveful for the military, medical purpose and other areas [3]. Also it is the next big step in the field of computer system as it is a powerful technology as it uses the sense of touch. This technology can change the experience of using computer systems as they are being used till date. Various researches have been done and are being done to achieve the optimal results. The haptic devices made till date are also being modified to give more and more realistic experience with minimal hardware possible and at low cost to be able to make it commercially viable. Hence haptic devices would soon become the part of our daily lives.

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