Haptic Technology and its Application

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Abstract-Basic outline of Haptic Technology is presented in this paper. Haptic technology deals with the virtual environment but people can actually feel the environment before them as it is a real one. It consists of basic sensors to the complicated hardware that are hard to understand. It also has the evolution from the mid of 1980's to till date. It was firstly used in aircrafts to control surface measures. Later on it has its own influence in many applications such as medical, military, gaming, in museum, lots of training centres.

Keywords: Haptics, virtual, touch, haptic interface, ultra haptics, sensors, proprioceptors, actuators, tactile engine, 3-D interface, PHANTOM, joysticks, cybergrasp.

INTRODUCTION

Haptic Technology is the technology where we can apply the science of touch sensations to the software applications and also to control it. The touch sensations what we apply on to them can be observed by the sensors present in them and that can be implemented in the screen for virtual view. Haptic Technology is gaining higher acceptance as the key part of virtual reality.

Virtual reality and haptics are interlinked with each other. Virtual reality is the environment where one can explore with his /her senses in a place that does not exist in real. But he/she can feel the real environment with this technology.

EVOLUTION

Earlier, computers were used to control the machines in the real environment which is around 1940's. But in 1980's, scientists could develop the virtual environment called 3-D environment where you can see the virtual objects in front of you. But the touch and sense of the object is not achieved.

The PHANTOM Interface of haptics from SensAble Technologies was one of the first developed haptic systems to be sold commercially. Despite collecting information from many different points it simulates the sense from a single point of contact. This was achieved using stylus. This stylus would exert pressure from the system and send it to the user.

Based on the pressure exerted the user can feel whether the simulated objects are soft or hard objects. This is also helpful in sensing the temperature, weight, area of the virtual object.

Next on the evolution is CyberGrasp system from Immersion Corporation. This looks like a hand called exoskeleton and each finger of our hand receives the force feedback. With this interface the user can able to feel the size and shape of the virtual object. This consists of actuators so that we can prevent the user's fingers to collide with virtual objects.

Then the researches from the Carnegie Mellon University used the electromagnet in the interface construction. That looks similar to a joystick, which is what we use now- a-days in virtual games like the tennis and cricket etc. The advantage of this allows the user to remain immersed in the virtual environment without any interruptions with virtual objects.

Table 1: Evolution of haptics:

Year	Name of the Interface	Company
1980 - mid of 1980 s	3-D interface	By American scientists
1990 – 2000 s	PHANTOM interface	SensABLE Technology
Mid of 2000 s	CyberGrasp	Immersion Corporation
At present	Joystick , Ultra haptics	Researchers from Carnegie Mellon University.

We now presently have the ultra haptics which uses the ultra sound waves in the construction to produce the ultrasonic waves to pressurise the air in the environment through which a virtual object is made in the environment.

WORKING

The working of the haptic interfaces is quite similar to the working of the human hands. Hands offer many movements. This kind of movements is often called by the scientists as degree of freedom. This degree of freedom is the move done by a single joint. With 22 joints in our hand scientists say we have 22 degrees of freedom in our single hand. The skin of our body is rich with receptors. Those are the one which sends and receives the data what we touch in our hand to the brain and vice versa.

Consider the user has to pick a base ball in the hand, and then the datas like shape, size, and angle are sent to the brain by the proprioceptors. These are also the receptors that carry the signals to the brain. When a finger touches the ball, contact is made between them. The feed back of this touch is of two types as Kinesthetic and tactile. These feedbacks are called force feedback.

Similarly, force feedback is the same information that a person must receive from the system. The haptic interfaces devices would allow users to feel the virtual objects via force feedback.

This kind of functions is done haptic interfaces which include tactile sensors and proprioceptor sensors and actuators.

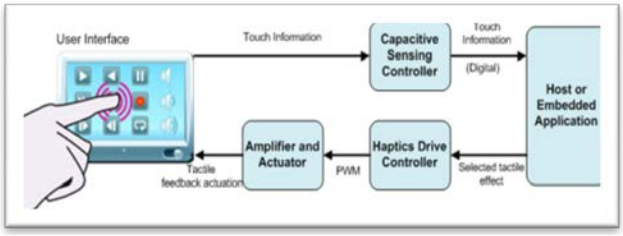

Figure 1 Working Mechanism of haptic interface

CONSTRUCTION

The most common vibration motor is ERM (Eccentric Rotating Mass Vibration Motor). It also has the LRA vibrator unit. It is called Linear Resonant Actuator. It uses different mechanism than the ERM. ERM and LRA are used in haptic interfaces for receiving vibrations of pressure from human hand. It also has tactic engine, tactile sensors, proprioceptor sensors and actuators are main components.

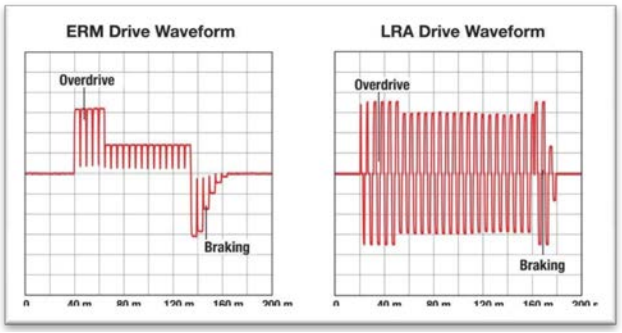

Figure 2 Comparisons of LRA and ERM.

A. *Tactile Engine*

What we use for the mouse in laptops, are called as track pads. Track pads are those which can be used to receive our touch sensations when the user gives a pressure or force on to it. This is also a kind of haptics that humans use in our daily life.

The tactile engine is little advanced form of this track pads in laptops. It is generally small in size which implies force to the user opposite to the direction in which

the user gives the force. It does not feel single click of force and not a single stage it makes it double by amplification.

B. *Tactile sensors*

They are the kind of transducers that are designed in such a manner to sense the physical touch. It is composed of sensors to measure different type of knowledge about the touch such as angle, size shape, motor speed, torque of motion etc. Tactile sensor technologies are capacitive sensors, piezoelectric sensors, optical sensors, Magnetic sensors, Binary Sensors and Piezoresistive sensors

C. Actuators

We have Linear Resonant Actuator (LRA) in haptic interface. It is one of the vibration motors in the construction. It produces the oscillating force. It depends on the AC voltage to drive the pressure sent to the interface, unlike the Eccentric Mass Motor (ERM). The voice coil remains stationary inside the device but due to the actuators it produces the vibrations against a moving mass. By making it move up and down LRA will be displaced and then it makes the vibrations. It looks similar like the speaker producing the sound.

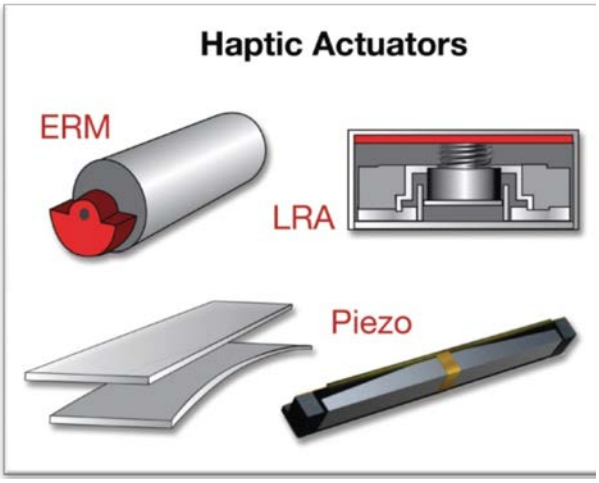

Figure 3 Haptic Actuators includes LRA and ERM

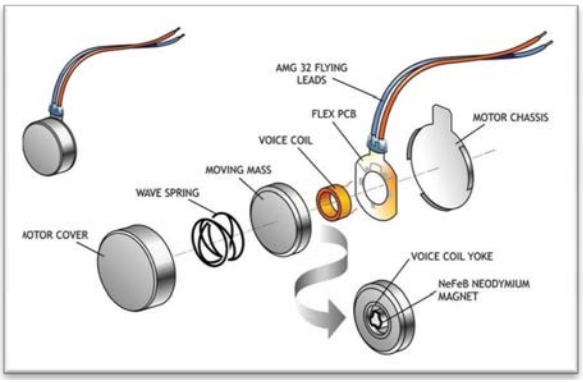

Figure 4 Construction inside

APPLICATIONS

Gaming

Haptic Technology has been used for more than 2 decades in video games. If anyone is aware of racing games like motorbike arcade game developed by Sega the knowledge of the haptics is known very well. In this game haptics are attached to the steering, under the seat etc. The user can actually feel the bike running in the streets of Tokyo. When the motorbike is crashed with any of the other bikes in the race the steering of the user vibrate to indicate the collision.

This is the foremost prior technology used in the technology of haptics. At present days we use the joysticks for playing games in virtual environment. Joysticks are one the present day haptic interfaces which uses the force from touch to play with virtual opponent. Joystick delivers the angle of rotation of our hand, moment of torque, velocity at which the hand is swing in the air, force we apply on it etc. All these are captured properly and delivered to make virtual environment into a real one.

Examples of haptic games are shuttle games, it can be played with two humans programmed as they two are like the opponents, and cricket is also played to feel the real environment.

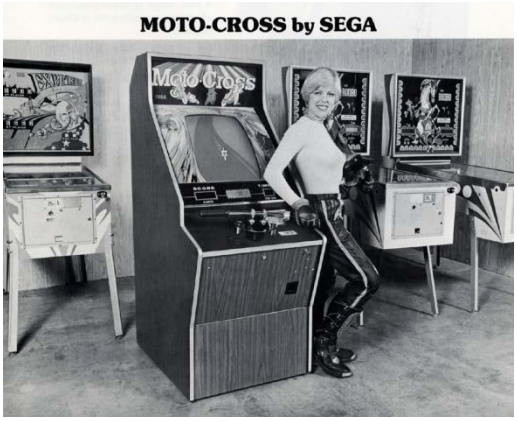

Figure 5 Moto cross haptic game device.

Medical

Students of medicine used the plastic models for their training before they enter into the profession. This increases the use of plastic in the ecosystem which was leading to the degradation of ecology. But the development of haptic technology made the training session far useful to the trainee doctors. The use of plastics is drastically reduced after this. Using this technology the trainee doctors can train themselves in the virtual environment without affecting any humans or the ecology.

It can be applicable from minor endoscopy of organs to the major surgeries like angioplasty and open heart surgery, laproscopy etc.

Even testing of veins is also done using the haptics. The trainees are given virtual veins and nerves to experiment them. They are supposed to the same in this technology. Based on this the marks and grades are provided to the trainee doctors.

Military

Military is another area where this haptics has the vast impact for trainee soldiers. This would increase the confidence for the soldier before they enter into the battle field. Once all the trainee soldiers are selected on the basis of fitness then they are first trained inside a room, where they are equipped with the haptic technology requirements. Through which they could see the virtual environment before them which is of battle field with soldiers of other countries. To protect themselves from the opposite person they have to fire with dummy gun given to them. This gun would shoot the enemy. Based on this soldiers are trained without affecting the human life.

CONCLUSION

Though we have many advantages in this haptic technology we have some kind of disadvantages. The disadvantages of this technology with regards to the implementation of this new technology are the costs associated with it; sometimes companies cannot afford such interfacing equipment within their organization. This technology has not become very common; therefore, it is still relatively expensive and may not be affordable to the average income homeowner and a small business person.

We have lot of merits but cost of this huge technology remains unreachable to the ordinary man so it cannot be practiced in ordinary man's daily life. But haptic technology with its advantages stands out with it unique features.

SUGGESTIONS

Since the demerits of haptic technology are associated with the cost we have to concern with reducing the price of those haptic interfaces. There present more number of components in the interfaces. If the designer reduces the number of components in the interface then cost would reduce considerably.

In such a case we have important components as proprioceptive sensors and actuators along with this we have tactile sensors also. The function of this tactile sensor is to sense what object is in contact with the proprioceptive sensor performs sensing function and sends the signal to the processing operation. Somehow sensing is performed by the proprioceptive sensor. So

need of tactile sensor is less in the interface in order to reduce the cost.

In other case some of the interfaces use both ERM and LRA actuators for receiving vibrations from the user. Considering the reduction of cost designer can use any one of the actuators. Since both of them have similar functions it would not affect the performance. So removing any of the actuators can make the haptic cost less.

These are the methods which can be implemented to make the haptic devices available for ordinary people for their daily use.

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