VR IN SURGERY

INTRODUCTION

- Advancements in computing power have enable continued growth in virtual reality, visualization, and simulation technologies.
- Virtual reality is defined as human computer interface that simulate realistic environments while enabling participant interaction, as a 3D digital world that accurately models actual environment.
- The term virtual reality was coined by Jaron Lanier.

NEED FOR VIRTUAL SURGERY

- In surgery, the life of the patient is of utmost importance and surgeon cannot experiment on the patient body.

- Many patients have lost lives because of surgical errors.

- VR provide a good tool to experiment the various complications arise during surgery.

WHAT IS VIRTUAL SURGERY?

- Virtual surgery, in general is a Virtual Reality technique of simulating surgery procedure, which help Surgeons improve surgery plans and practice surgery process on 3D models.
- This helps the surgeon to have clear picture of the outcome of surgery.
- The surgeon can view the anatomy from wide range of angles.
- The virtual surgery is based on the patient specific model, so when the real surgery takes place, the surgeon is already familiar with all the specific operations that are to be employed.

HISTORY

- The first virtual surgery was performed on 17 August 2009 when Dr.David Clarke in Halifax, Nova Scotia removed a brain tumour 24 hours after removing a simulated tumour.
- Project Odysseus was developed to form a 3D image of a person's liver and the vasculature of the liver to allow surgeons to train before a surgery. The modeling also allows the surgeon to see how the liver is segmented.
- France Telecom also developed a communication system for the project called Argonaute.

VIRTUAL REALITY APPLICATIONS IN SURGERY

1. Training and Education.

2. Surgical Planning.

3. Image Guidance.

4. Tele-surgery

TRAINING AND EDUCATION

- Traditionally, textbook images or cadavers were used for training purposes.

- VR simulators allow users to view the anatomy from a wide range of angles and “fly through” organs to examine bodies from inside.

- The experience can be highly interactive allowing students to strip away the various layers of tissues and muscles to examine each organ separately.

SURGICAL PLANNING

- In traditional surgery planning, the surgeon calculates various parameters and procedure for surgery from his earlier experience and imagination.
- This leads to lots of errors and even to the risk of losing the life of the patients.
- The incorporation of the virtual reality techniques helps in reducing the errors and plans the surgery in the most reliable manner.
- 3D reconstruction has proven particularly useful in planning stereotactic and minimally invasive neurosurgical procedures.

IMAGE GUIDANCE

- The integration of advanced imaging technology, image processing and 3D graphical capabilities has led to great interest in image guided and computer-aided surgery.

- Navigation in surgery relates on stereotactic principles, based on the ability to locate a given point using geometric reference.

- It also proved useful in Robotic Surgery, a new technique in which surgeon remotely manipulate robotic tool inside the patient body.

TELE-SURGERY

- Tele-surgery allows surgeons to operate on people who are physically separated from themselves.

- This is usually done through robots provided with video cameras.

- More advanced system has been used to perform Coronary Anastomosis on ex-vivo swine hearts and in human undergoing endoscopic Coronary Artery Bypass grafting.

VIRTUAL SURGERY SIMULATION

3D SIMULATION

- Generate a 3D model of the part of the body that undergoes surgery.
- Depending on this simulation needed, anatomical images can be derived from a series of patient's Magnetic Resonance Images (MRI), Computed Tomography (CT) or video recording, which are 2D images.
- Images are segmented and constraints are imposed.

- Image is digitally mapped on to the polygonal mesh.
- VR designers often portray the tissue as polygonal meshes that react like an array of masses connected by springs and dampers.
- Advances in medical graphic allows ordinary medical scan of a patient anatomy be enhanced into virtual 3D views.
- 3D images are color enhanced to highlight, say bone or blood vessels.

TOUCH SIMULATION

- In this, a haptic-touch sensation is simulated.
- Physicians rely a great deal on their sense of touch for everything from routine diagnosis to complex, life saving surgical procedure.
- A low update rate is needed for soft tissues whereas hard tissues require high update rate.
- For simulating touch sensation, we have to calculate the forces applied to cut, puncture the various tissues.
- Physical model is made assuming that tissues are polygon meshes that interact like an array of masses connected by springs and dampers.

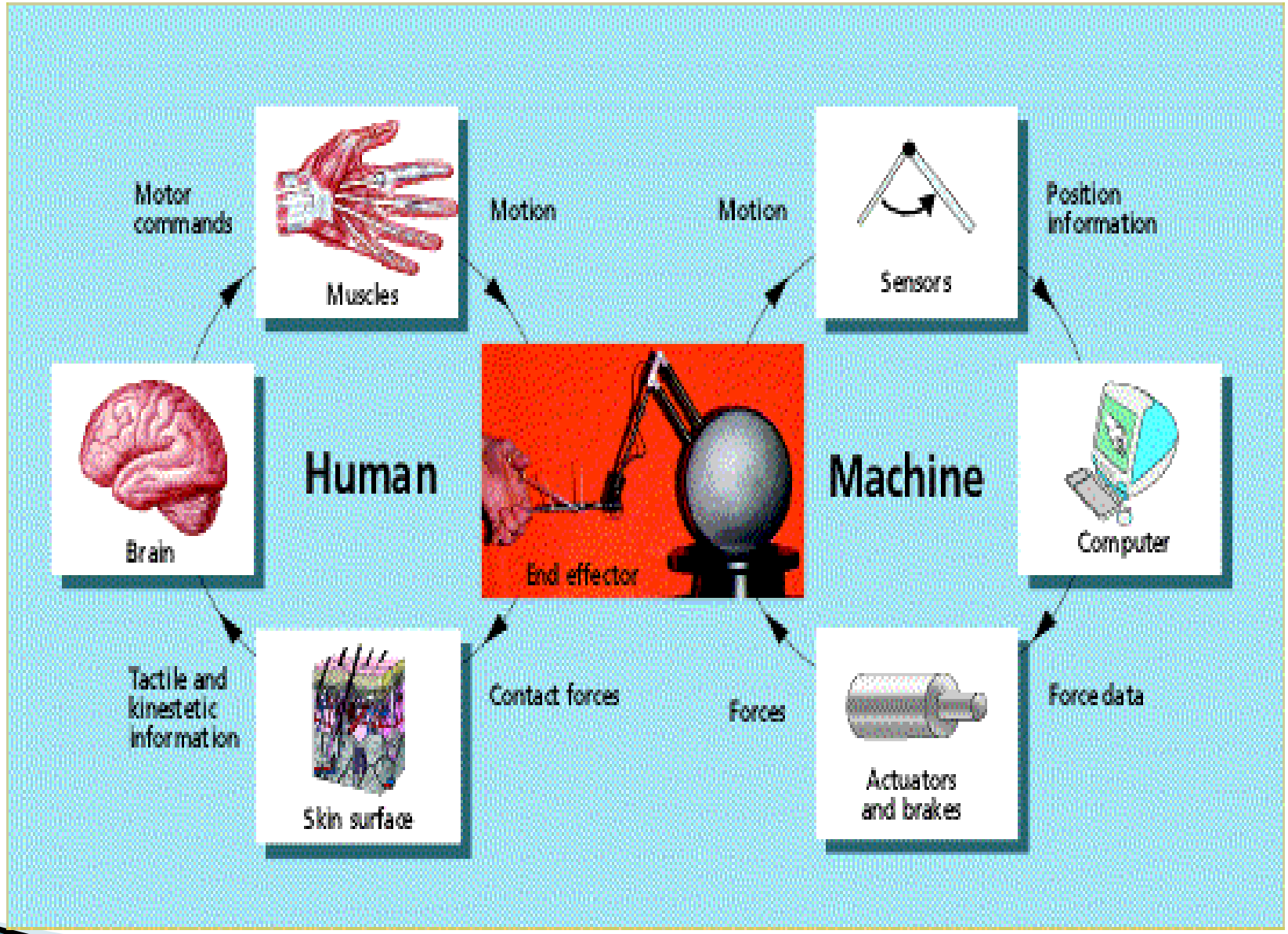
- The parameter values are derived using complex nonlinear equations and the reaction forces are also calculated.

- The equations to solve such a complex problem are known, but so far the calculations cannot be made fast enough to update a display at 30Hz.

- Most difficult to simulate is two floppy objects interacting with each other, since the mechanics of such interaction are complicated, because each object may deform the other.

VIRTUAL SURGERY SIMULATOR

- Consists of a powerful PC which runs the software and an interfacer- haptic interface.
- Usually the haptic interfacer works on force feedback loop.
- Haptic interaction is a new field of research that adds the sense of touch to virtual environments.
- Some haptic devices include joysticks, keyboard and gloves that all provide the user with some kind of sensation.
- The addition of haptics to virtual environments has provided computer users with the ability of expression in multiple dimensions.


Motor commands
Muscles
Motion
Motion
Sensors
Position information
Brain
Human
End effector
Machine
Computer
Tactile and kinestetic information
Skin surface
Contact forces
Forces
Actuators and brakes
Force data

- A human hand moves the end effecter, causing the device to relay its position via sensors to a computer running a VR simulation.

- In the left hand loop, forces on the end effecter are detected and relayed to user's brain.

- Force feedback occur in real time to convey a sense of realism.

- The haptic device's driver card plugs into usually a 500MHz PC equipped with a standard graphic card and a regular color monitor.

PHANTOM DESKTOP 3D TOUCH SYSTEM- A HAPTIC INTERFACER

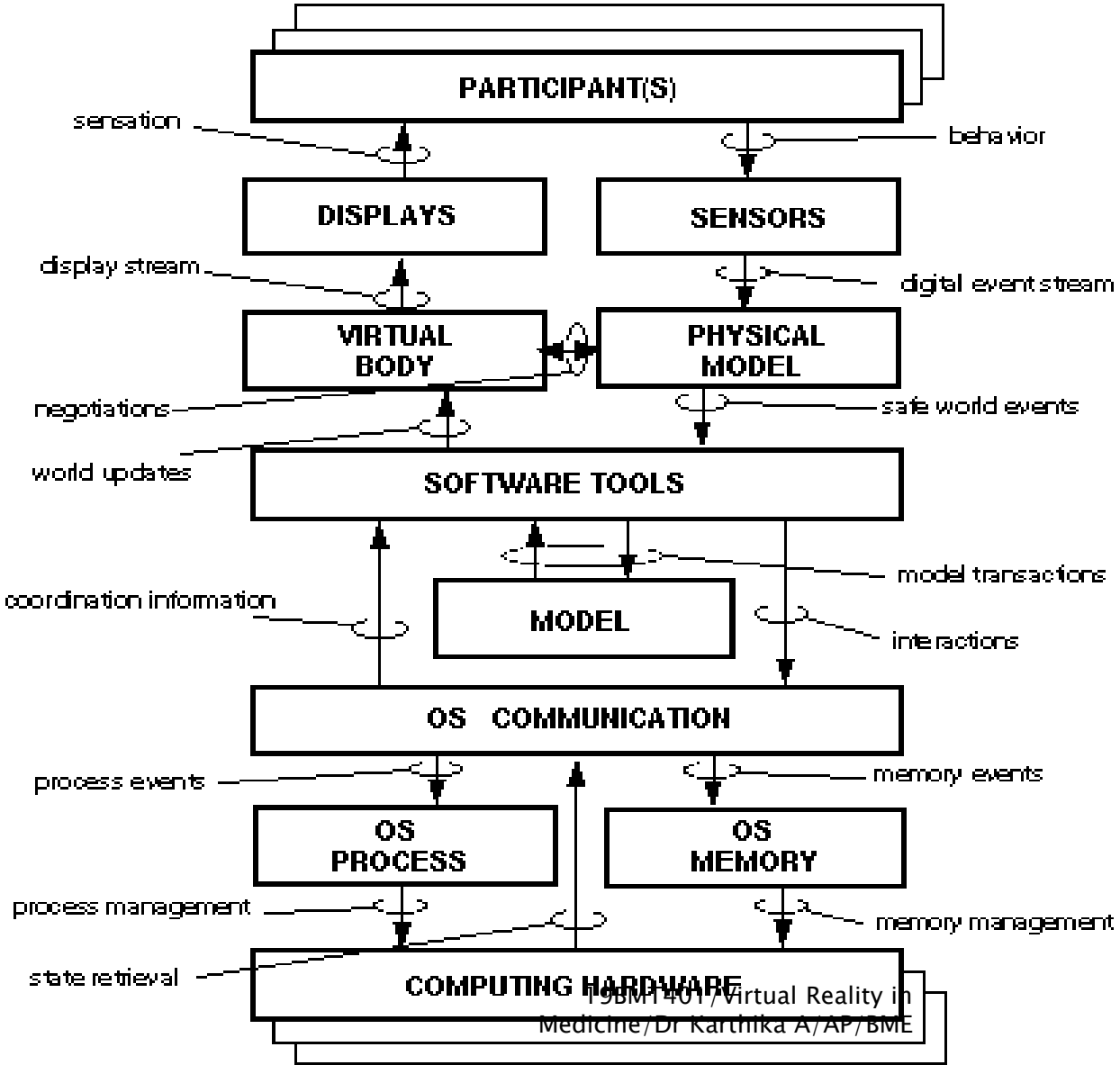
- Manufactured by SensAble technologies.
- Workspace of 6 x 5 x 5 inch.
- Position sensing with 6 degrees of freedom and force-feedback with 3 degrees of freedom.
- A software package aptly named GHOST, translates characteristics such as elasticity and roughness into commands for the arm, and the arm's actuators in turn produce the force needed to simulate the virtual environment.
- Among the medical procedures that can be simulated are catheter insertion, needle injection, suturing and surgical operations.

- Connects to the computer via an extended parallel port (EPP).
- Powered by a compact, universal (110/230 VAC) power supply.

Features :

- CE certified
- Portable design and compact footprint for workplace flexibility
- Wrist rest to maximize user comfort
- Multi function indicator light
- Compact workspace for ease-of-use
- Constructed of metal components and injection moulded, carbon fiber reinforced plastics
- Automatic workspace calibration

STRUCTURE OF A VR SYSTEM



- The behavior and sensory transducing subsystem (labeled participant, sensors and display) converts natural behavior into digital information and digital information into physical consequence.

- The virtual toolkit subsystem (the physical model, virtual body, software tools and model) coordinates display and computational hardware, software functions and resources, and world models.

- The computational subsystem (the operating system and hardware) customizes the VR software to a particular machine architecture.

- Presence is the impression of being within the virtual environment.

- In contrast, *participant inclusion* is defined by the boundary between the software model of the participant and the virtual environment.

ADVANTAGES OF VIRTUAL SURGERY

- Intelligent computer backup minimizes the number of medical ‘mistakes’.
- More effective use of minimal-access surgical technique.
- Better training in anatomy and surgical skill, with reduced need for cadavers.

CHALLENGES

- Shortcomings in the realism of the simulations.
- Cost and processing power of available hardware.
- Need to improve human-computer interfaces.
- Time delays in the simulator's response to the users movements.

CONCLUSION

- Medical virtual reality has come a long way in the past 10 years as a result of advances in computer imaging.
- They are cost effective and can improve the quality of care.
- Despite some concerns, the benefits of VR systems in medicines have clearly been established in several areas, including improved training, better access to services, and increase cost effectiveness and accuracy in performing certain conventional surgical procedures.

THANK YOU