

# Interactive Virtual Environments

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## *Introduction*

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### **(Abstract)**

Modern virtual environments allow us to capture and manipulate multimodal - visual, auditory, haptic or other nature - sensor-based and/or synthetic models of 3D objects and phenomena. The behaviour and evolution of these object and phenomenon models can be driven by physical sensor data or by animation scripts. Human users can interact and directly manipulate objects within the virtual environment. This technology has already found promising applications in industry, communications, tele-robotics, medicine and healthcare, security and entertainment.

The **first part** of the course will discuss *video and haptic sensor systems for multimodal acquisition and human-computer interfaces, as well as real-time NN modeling of 3D object shape and elastic behaviour*. 3D tracking, modelling and animation techniques for *human face, body and gestures* will also be presented.

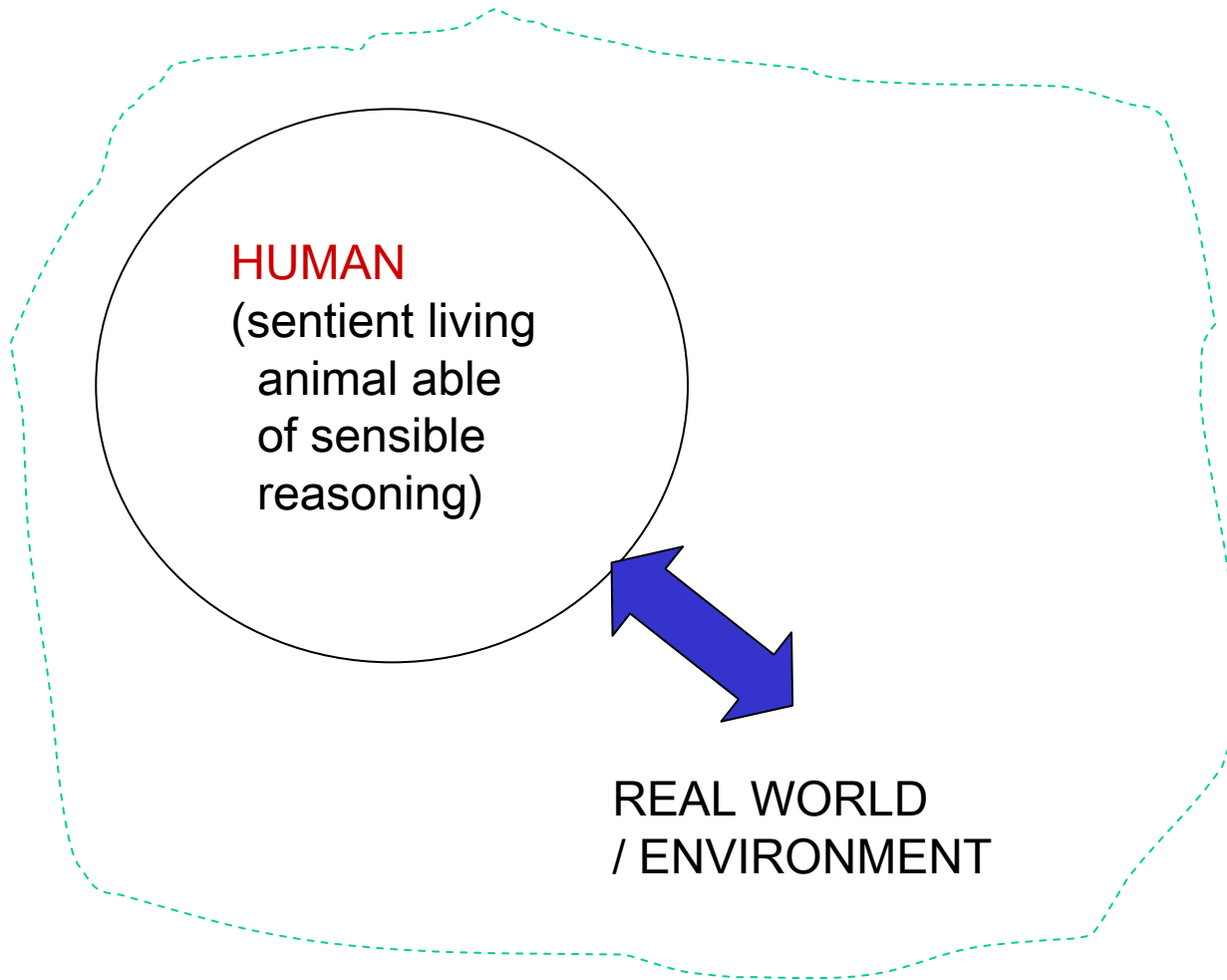
The **second part** of the course will address basic principles and discuss scenarios of *symbiotic human-computer interaction* for the next evolutionary stage of the computing technology. It will be a symbiotic partnership where humans will contribute human-specific capabilities complementing those of the computers. The leader/assistant role of the human and the computer partner, respectively, will be decided on the basis of maximizing the overall efficiency of the symbiotic team.

### Reference

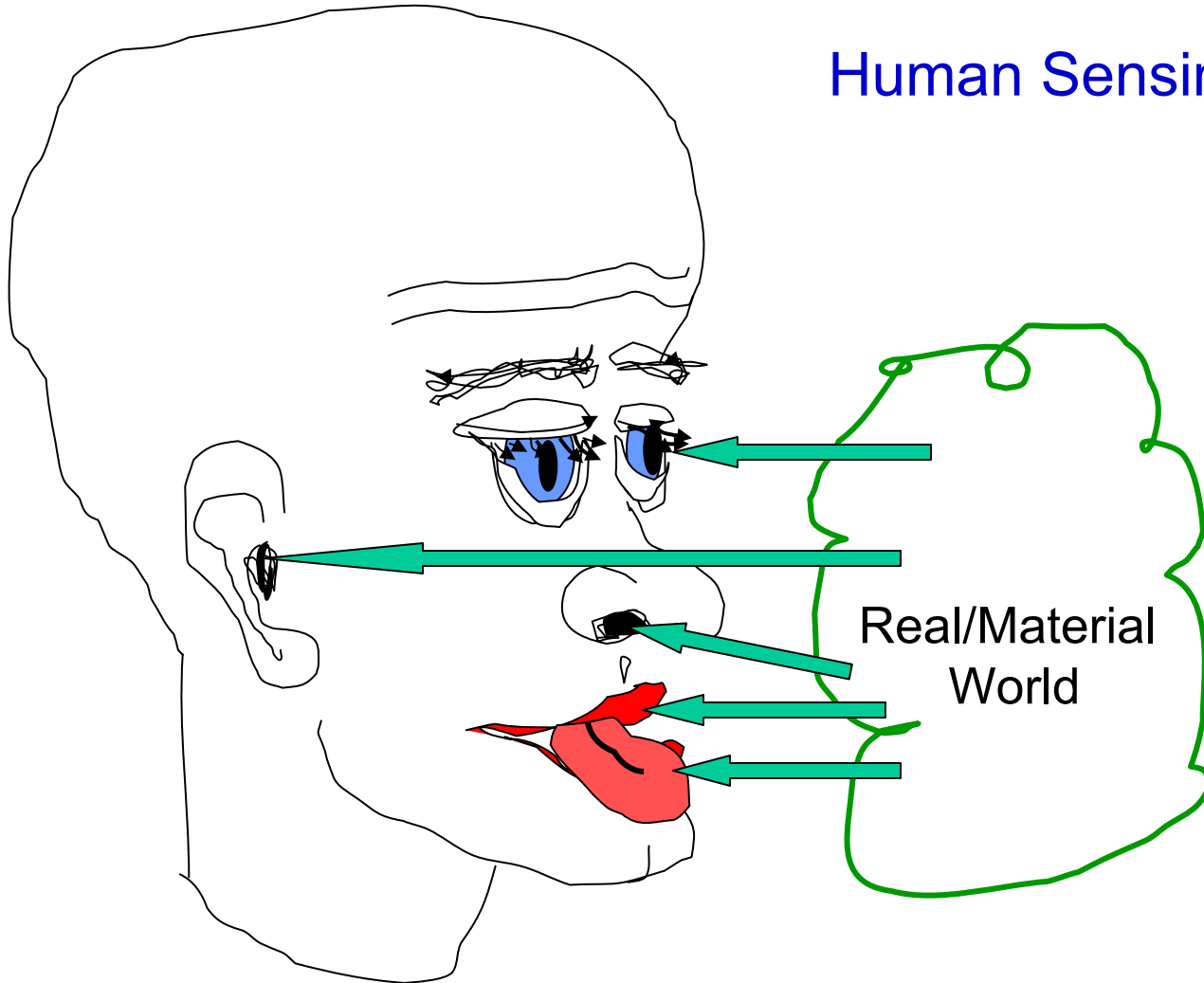
[1] G. Burdea and Ph. Coiffet, *Virtual Reality Technology*, (2<sup>nd</sup> edition with CD-ROM), Wiley, New Jersey, 2003, (ISBN 0471360899).

- Natural and Virtual Reality
- Virtual Reality
- Interactive Virtual Reality
- Virtualized Reality
- Augmented Reality

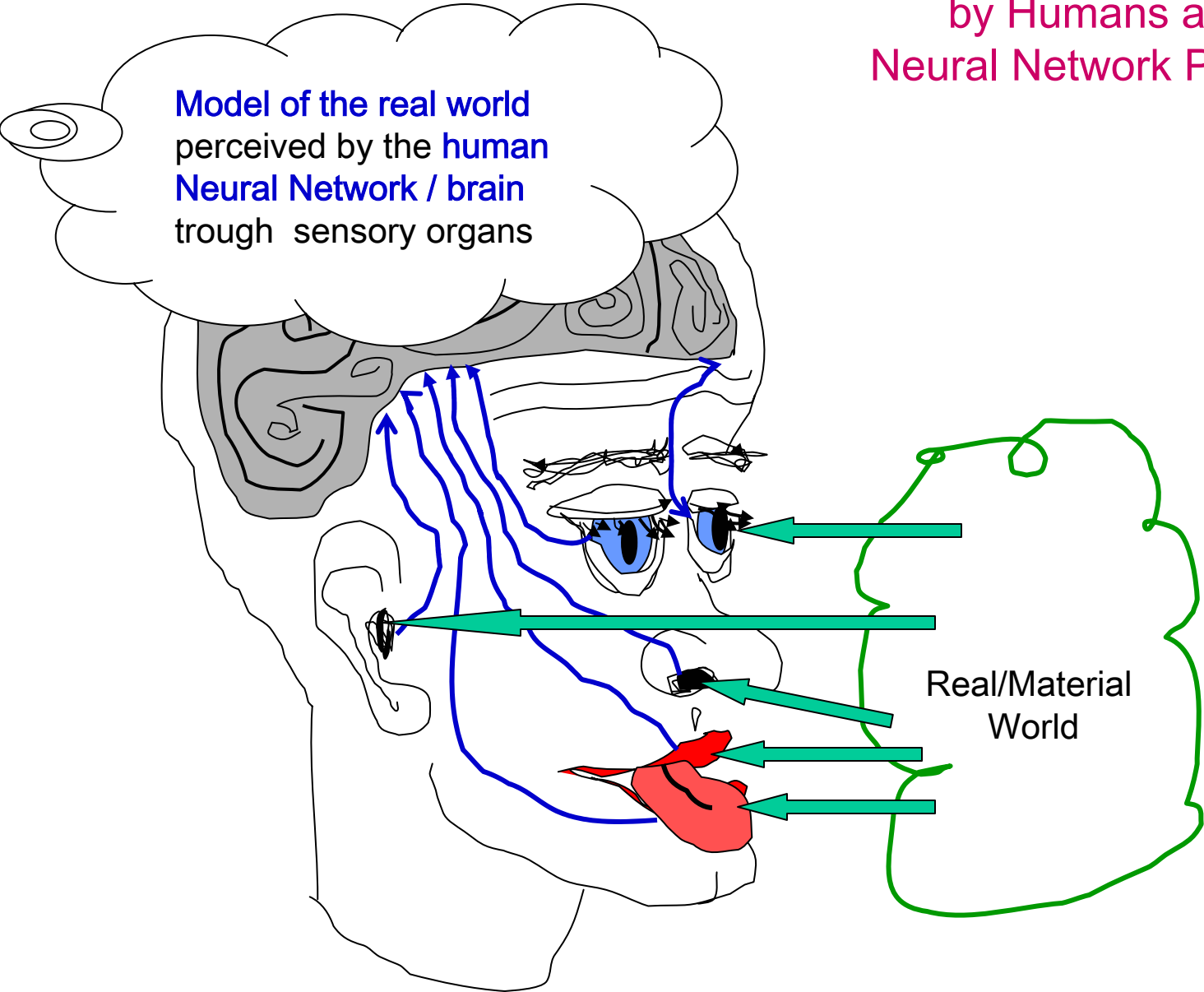
# HUMAN PERCEPTION OF REALITY



# Human Sensing

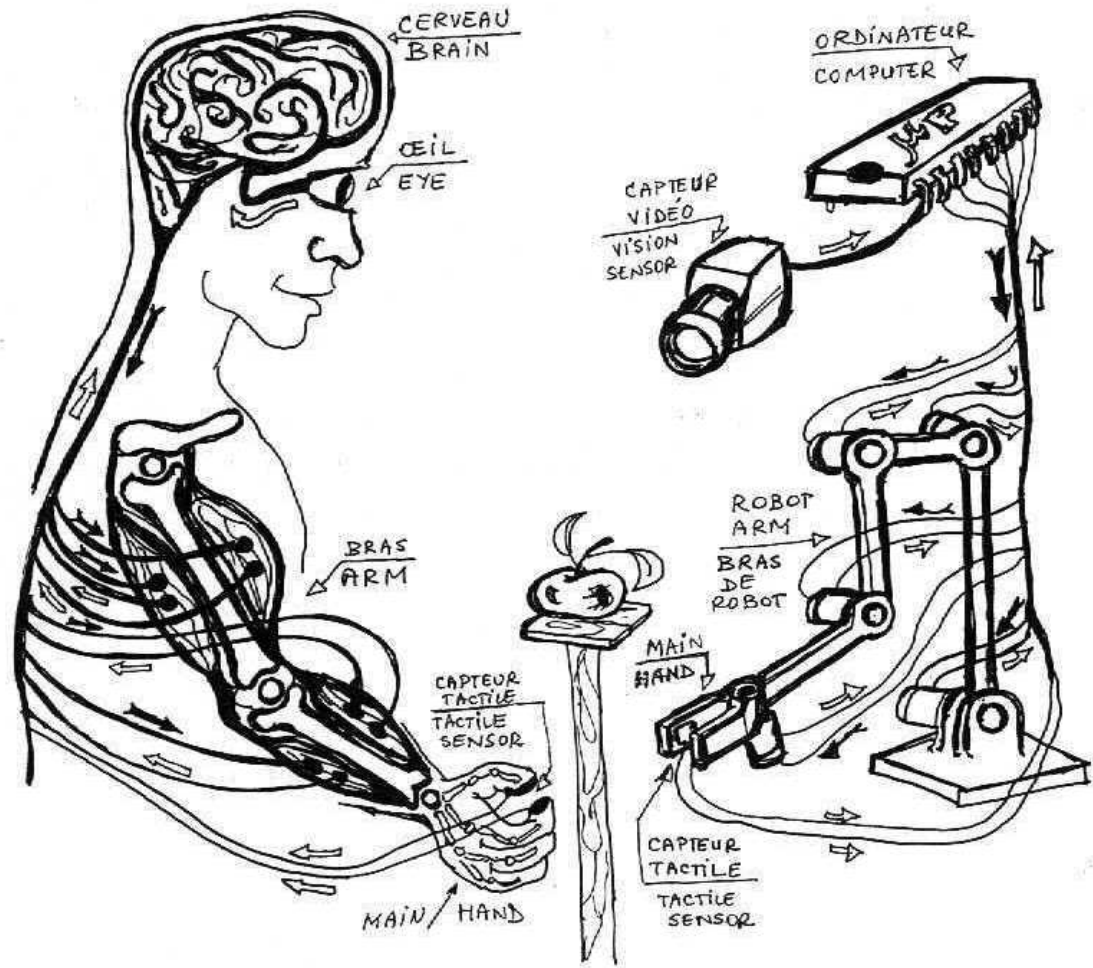


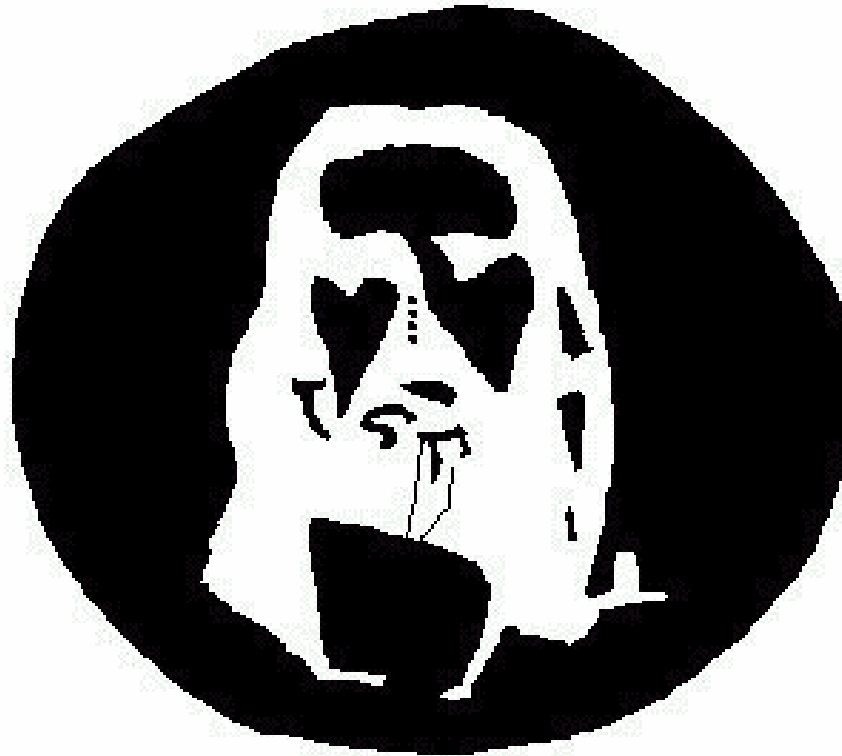
# Reality Perception by Humans as a Neural Network Process



Model of the real world  
perceived by the human  
Neural Network / brain  
trough sensory organs

Real/Material  
World





- 1) Relax and concentrate on the 4 dots in the middle of the picture for approx. 30-40 secs.
- 2) Then, take a look at a wall near you (resp. any smooth, single coloured surface)
- 3) You will see a circle of light developing
- 4) Start blinking your eyes a couple of times and you will see a figure emerging.

# What Is Virtual Reality?

A Web-Based Introduction  
Version 4 – Draft 1,  
September, 1998

Jerry Isdale

*<http://www.isdale.com/jerry/VR/WhatIsVR.html>*

>>> *What Is Virtual Reality? -A Web-Based Introduction, by Jerry Isdale*

1. Overview
2. A Taxonomy of Virtual Reality
3. Types of VR Systems
4. VR Hardware
5. Levels of VR Hardware Systems
6. VR System Technical Approaches
7. Available VR Software Systems
8. Aspects of A VR Program
9. Other Senses
10. World Space
11. World Database
12. World Authoring versus Playback
13. World Design
14. Fiction Books Related to VR

**Virtual Environments** allow humans to visualize, manipulate and interact with computer models and extremely complex data. Computer generated visual, auditory, force or other sensory outputs to the human user can be mixed with the sensor based models of the real world to generate a virtual world within the computer.

- ❑ This *virtual environment* (VE) may be a CAD like model, a scientific simulation, or a view into a database.
- ❑ The *users can interact and directly manipulate objects within VE*. Some virtual environments are animated by other processes, simulations, or simple animation scripts.
- ❑ VE technology has already found *applications* in industrial design, communications, telerobotics, scientific research, medicine, training & education, and entertainment.

## Types of VR Systems ... according to [Isdale]

- ❑ **Window on World Systems (WoW)**, or Desktop VR.
- ❑ **Video Mapping** .... variation of the WoW approach where the user watches a monitor that shows his body's silhouette interaction with the world.
- ❑ **Immersive Systems** .... completely immerse the user's personal viewpoint inside the virtual world. These "immersive" VR systems are equipped with *Head Mounted Displays (HMD)*, or a '*Cave*' or room in which the viewer stands. The "*Holodeck*" used in the "Star Trek: The Next Generation" is an extrapolation of this technology.

## Types of VR Systems... according to [Isdale]

- ❑ **Telepresence** .... links remote sensors in the real world with the senses of a human operator. *Applications* => remote sensors might be located teleoperated robots for fire fire fighting, space or undersea operations. Surgeons are using instruments on cables having a video camera at the point of operation.
- ❑ **Mixed Reality**, or Seamless Simulation,...mixes the Telepresence and Virtual Reality systems. The computer generated inputs are merged with telepresence inputs and/or the users view of the real world. *Applications* => surgeon's view of a brain surgery is overlaid with images from earlier CAT scans and real-time ultrasound. A fighter pilot sees computer generated maps and data displays inside his HMD.

## Virtualized Reality

- Prof. Takeo Kanade, Robotics Institute,  
Carnegie Mellon University, Pittsburgh, PA, USA  
<http://www.cs.cmu.edu/~virtualized-reality/>

*“In contrast to virtual reality, in which synthetic environments are created, Virtualized Reality is based on events taking place in the real world, which are captured and processed by computer manipulation”,*

## >>> Virtualized Reality

- Prof. Pierre Boulanger, University of Alberta, Edmonton, AB, Canada  
<http://www.cs.ualberta.ca/~pierreb/>

*“Virtualized reality is a generalization of the standard visual simulation paradigm where the model and the actions used in the simulated world are extracted from various sensors and information retrieval systems. The resulting visual simulation aims at an exact representation of the real world allowing for photo realistic rendering, telepresence, remote control, and intuitive information queries”.*

## Augmented Reality & Computer Augmented Environments

- Prof. Jim Vallino, Departments of Computer Science and Software Engineering Rochester Institute of Technology, Rochester, USA, <http://www.se.rit.edu/~jrv/research/ar/>

“The basic difference between the Augmented Reality and the Virtual Reality is the immersiveness of the system. Virtual reality strives for a totally immersive environment. The visual, and in some systems aural and proprioceptive, senses are under control of the system. In contrast, an augmented reality system is augmenting the real world scene necessitating that the user maintains a sense of presence in that world. The virtual images are merged with the real view to create the augmented display. There must be a mechanism to combine the real and virtual that is not present in other virtual reality work”

## >>> Augmented Reality & Computer Augmented Environments

- ❑ **SONY Links on Augmented Reality Projects**

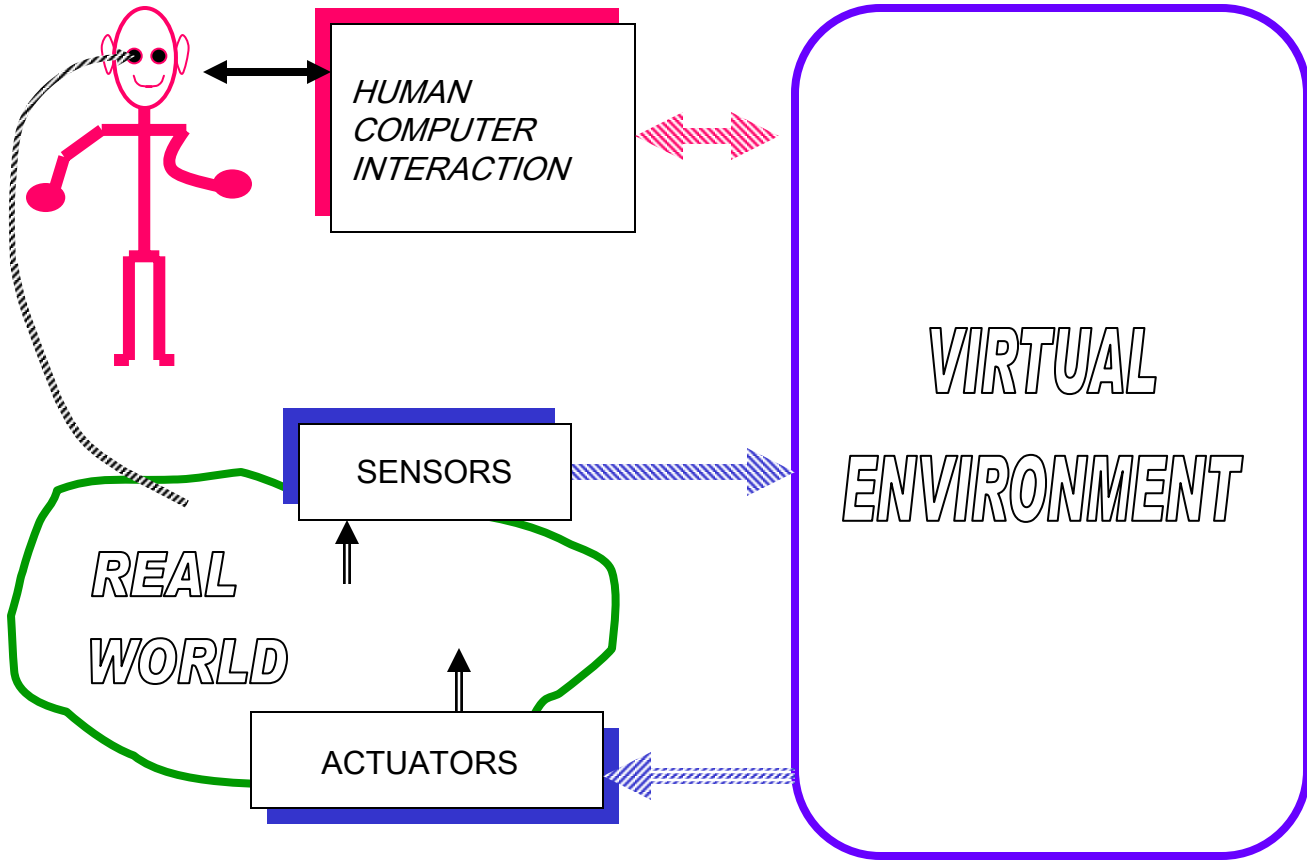
<http://www.csl.sony.co.jp/project/ar/ref.html>

- ❑ **US Department of the Navy, Office of Naval Research,  
“Battlefield Augmented Reality System (BARS)”**

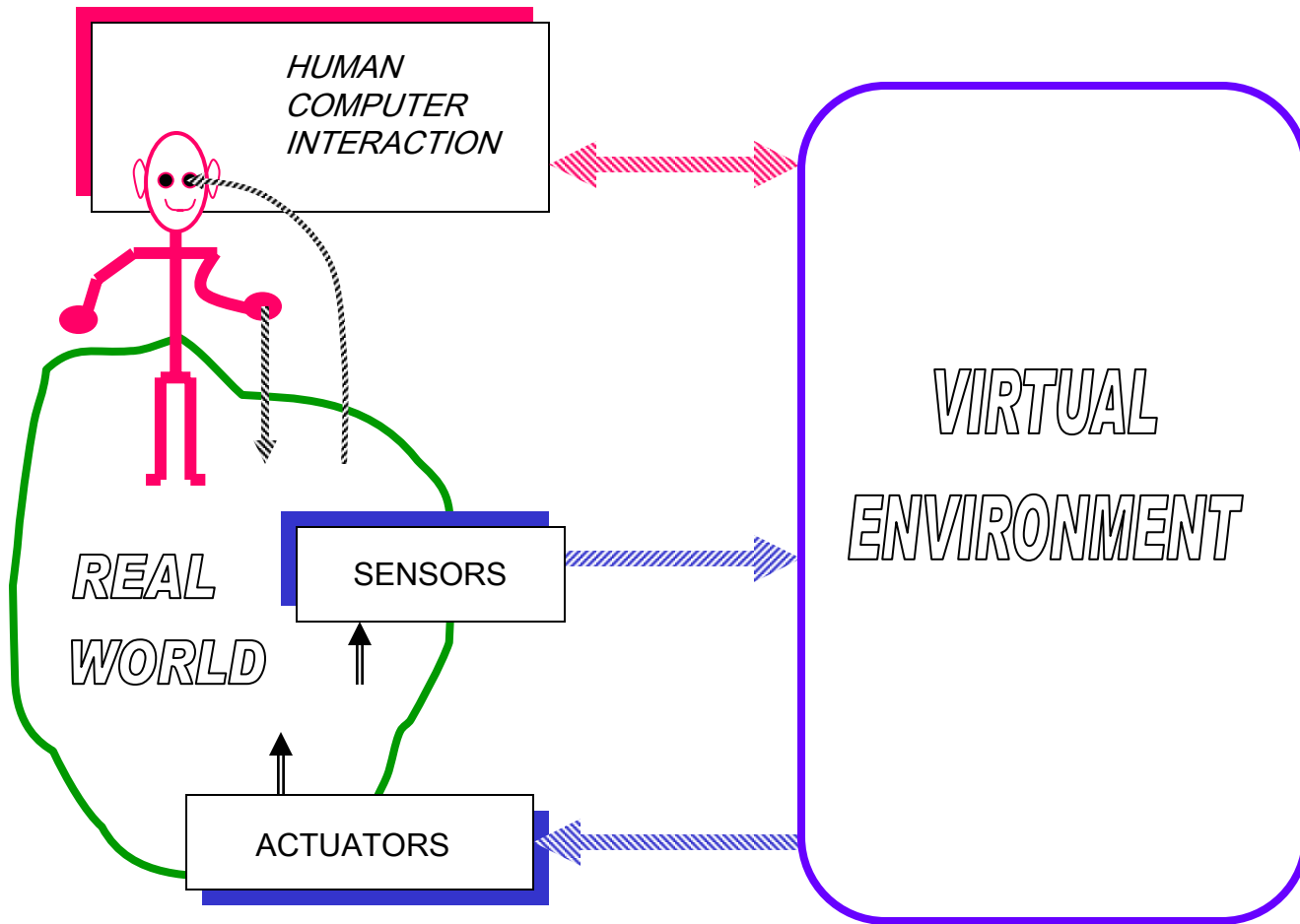
- ❑ **US National Tele-Immersion Initiative**

<http://www.advanced.org/teleimmersion.html>

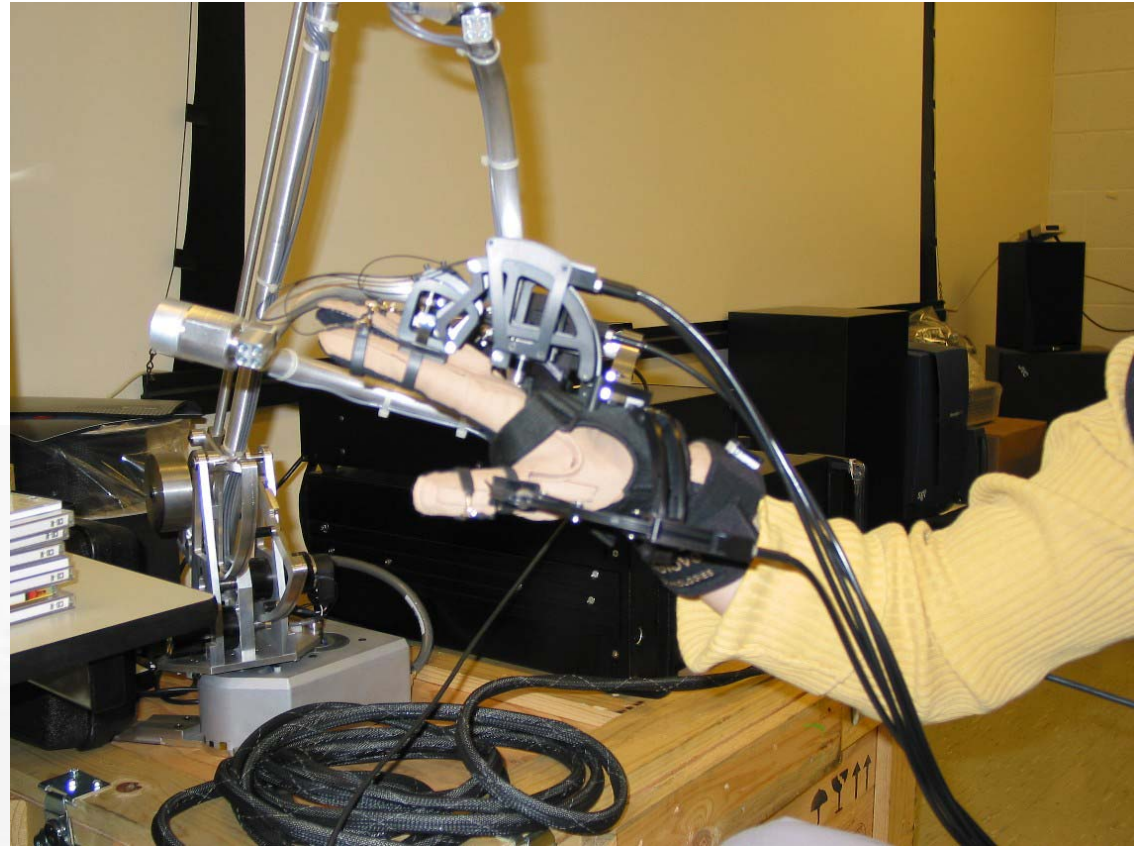
“Tele-Immersion (National Tele-immersion Initiative - NTII) will enable users at geographically distributed sites to collaborate in real time in a shared, simulated environment as if they were in the same physical room. This new paradigm for human-computer interaction is the ultimate synthesis of networking and media technologies and, as such, it is the greatest technical challenge for Internet”.



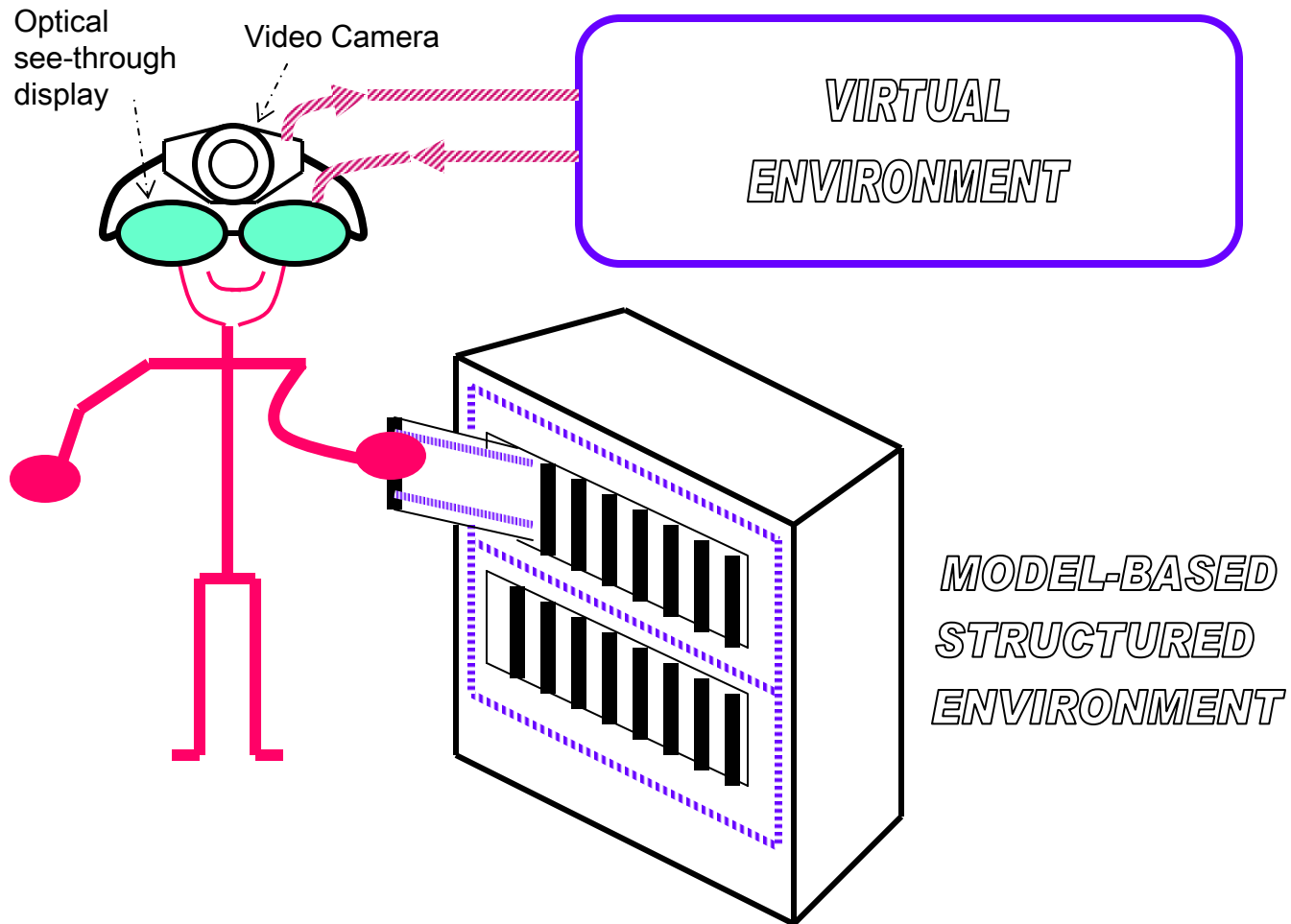
Interfacing virtual environments with the real world and human operators



Human interaction with the real world and in augmented virtual reality



Commercial Virtual Hand Toolkit for CyberGlove/Grasp ,  
Head Mounted Display, and see through visual display



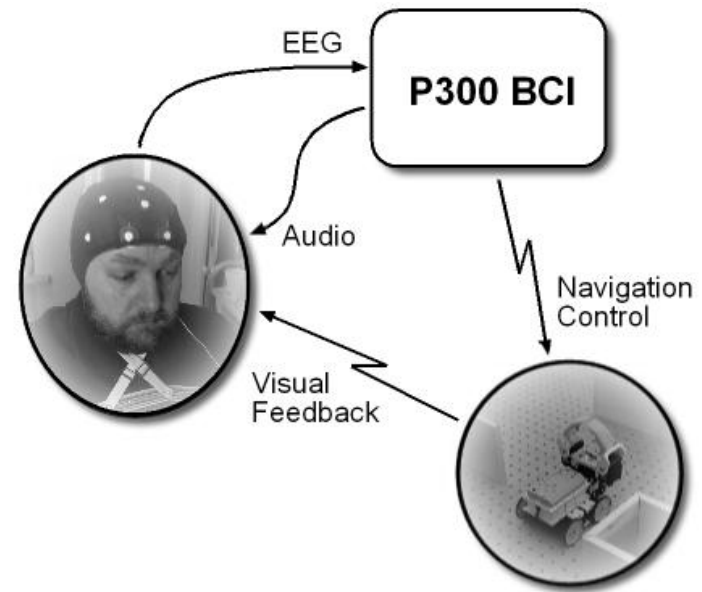
Human operator using augmented virtual reality in a structured real world.

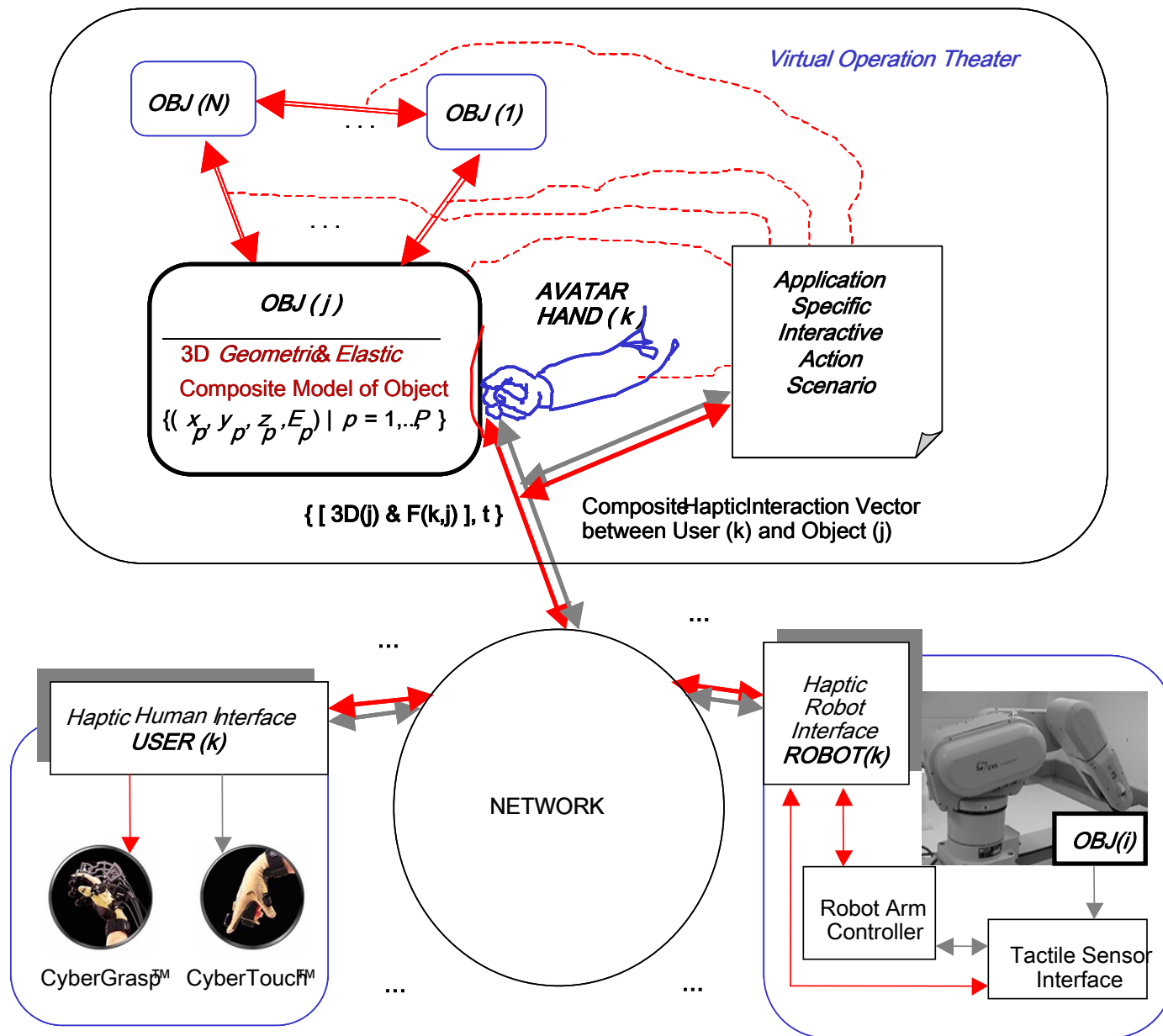


Computer vision recognition of the pseudo-random binary code, which is then used as augmented reality information.

## Neural Network Classification of Brain-Computer Interface Data for the Telecontrol of Symbiotic Sensor Agents

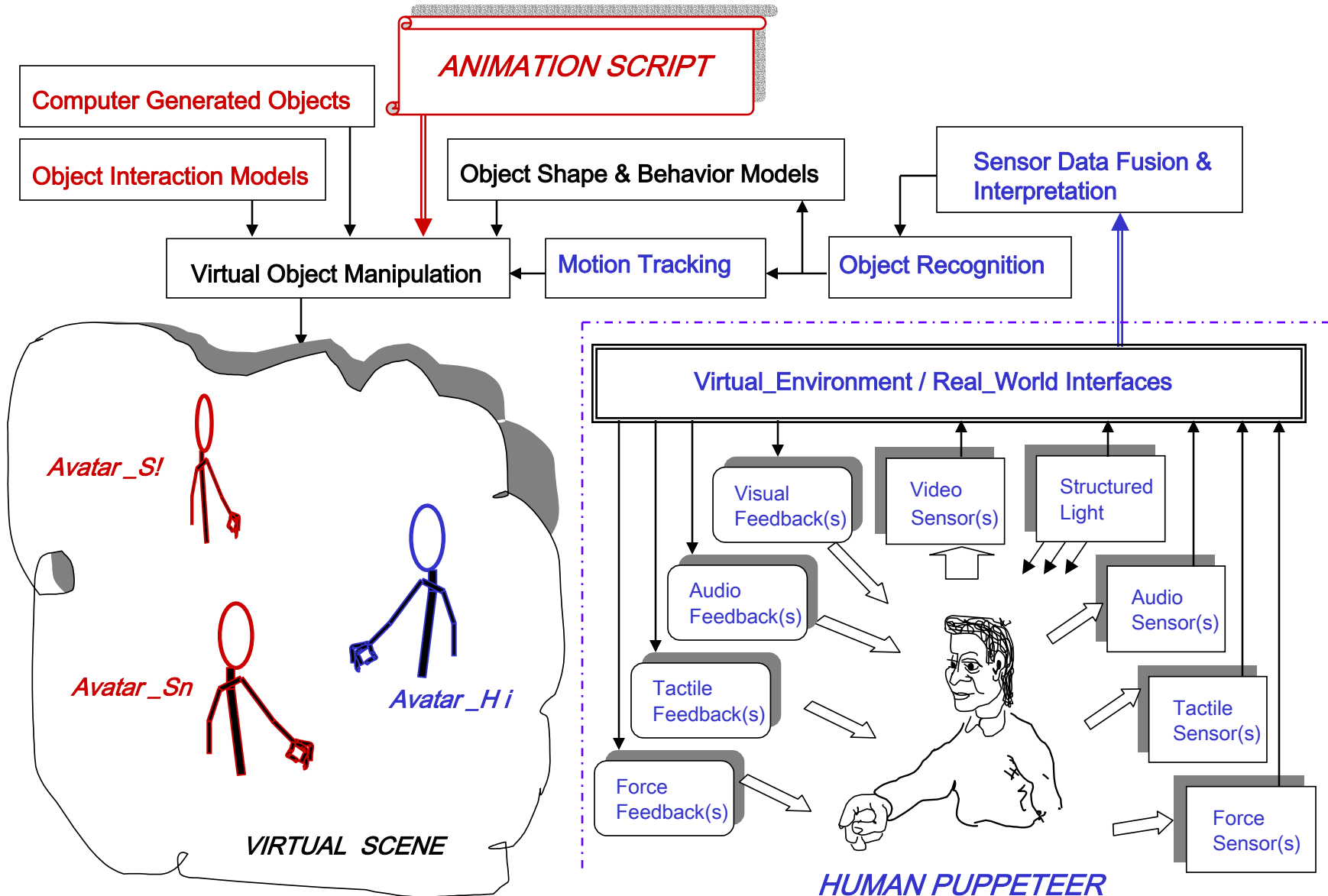
The Brain-Computer Interfaces (BCI) system is based on the well-known oddball paradigm that uses a positive deflection in EEG signal of about 300ms (P300) after rare expected stimuli is evoked. The advantage is that subjects do not have to be trained to generate the P300 effect as it occurs naturally in human subjects. We are using auditory stimuli to generate the P300 responses and a less computationally intensive MLP feed-forward NN for the classification of the EEG responses. In our experimental setup a human teleoperator equipped with visual and audio HCI, and a BCI controls at the strategic level the movements of an intelligent semi-autonomous RSA equipped with an on board camera and three IR sensors that semi- autonomously navigates through a maze using a tactical-level obstacle-avoidance algorithm



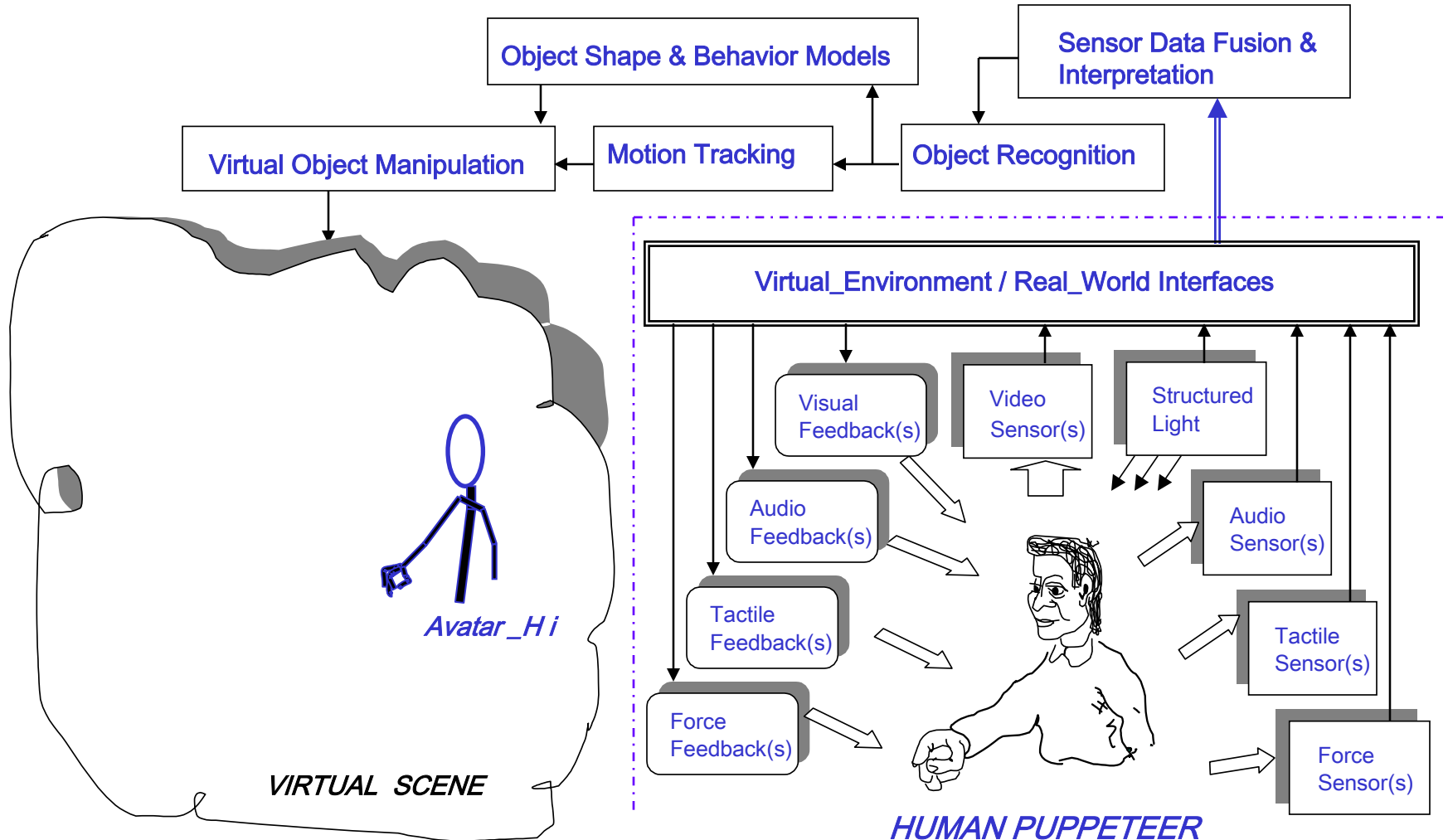


**Interactive Model-Based Hapto-Visual Teleoperation** - a human operator equipped with haptic HCI can telemanipulate physical objects with the help of a robotic equipped with haptic sensors.

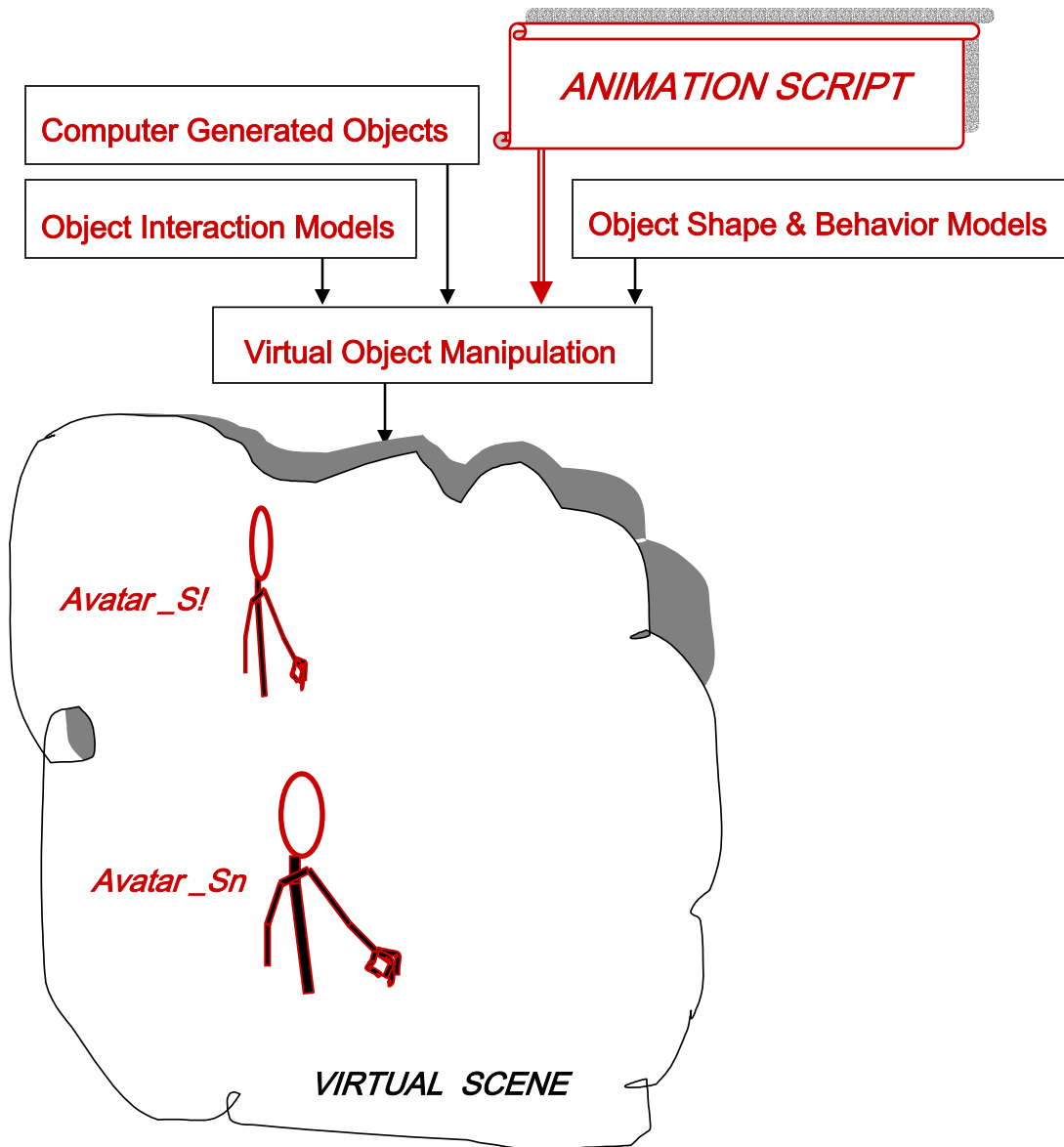
# SCRIPT-BASED and GESTURE-BASED INTERACTIVE AVATAR ANIMATION

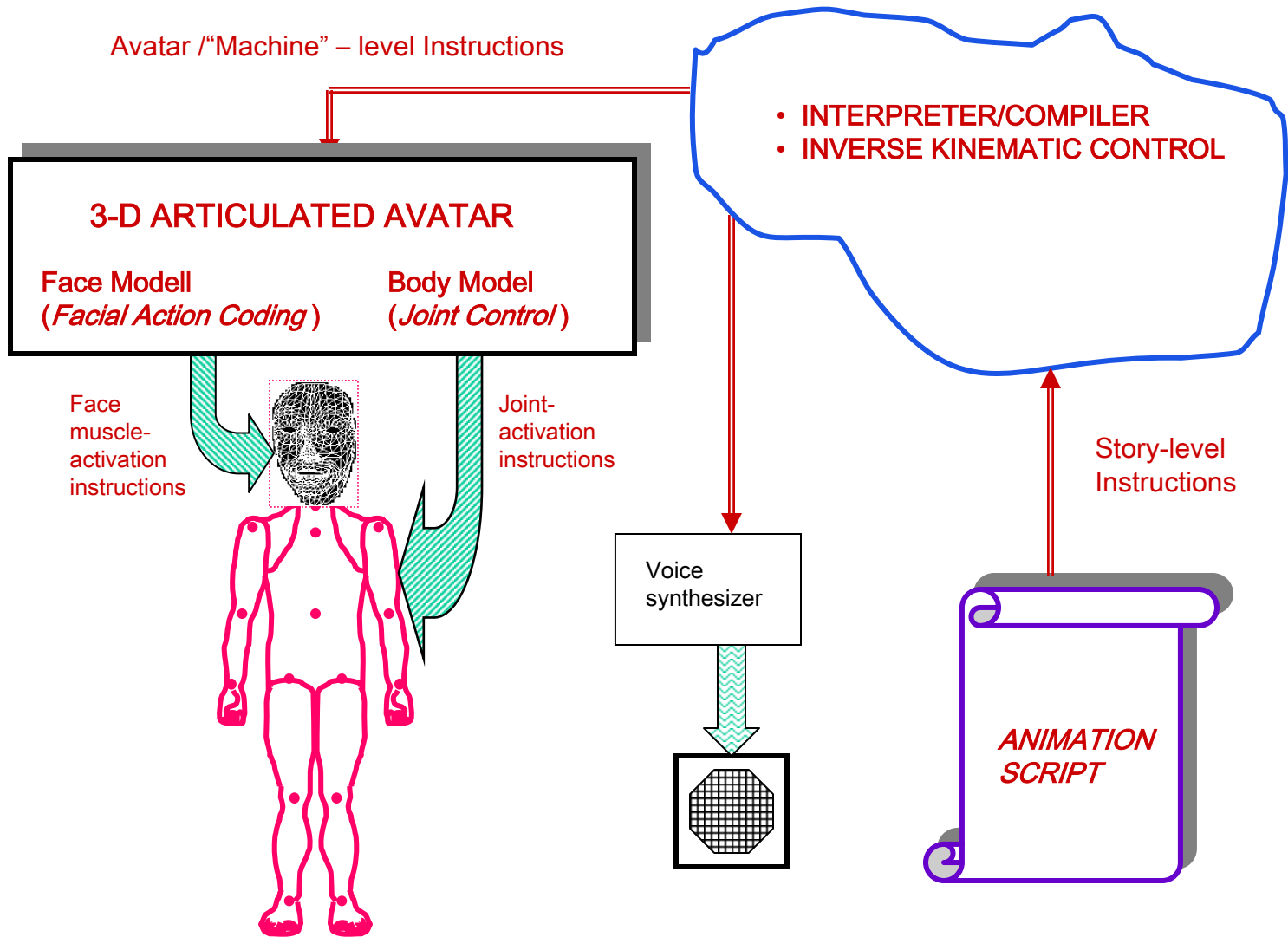


# GESTURE-BASED INTERACTIVE AVATAR ANIMATION



# SCRIPT-BASED INTERACTIVE AVATAR ANIMATION





## STORY-LEVEL INSTRUCTIONS

.....

DaneelA sits on the chair#4.

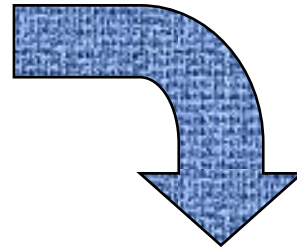
**DanielA writes “Hello” on stationary.**

He sees HappyCat under the white table .

DaneelA starts smiling.

HappyCat grins back.

.....



## SKILL-LEVEL (“MACRO”) INSTRUCTIONS

.....

**DanielA’s right hand moves the pen to follow the trace representing “H”.**

DanielA’s right hand moves the pen to follow the trace representing “e”.

DanielA’s right hand moves the pen to follow the trace representing “l”.

DanielA’s right hand moves the pen to follow the trace representing “l”.

DanielA’s right hand moves the pen to follow the trace representing “o”.

.....

SKILL-LEVEL ("MACRO") INSTRUCTIONS

...

Daniela's right hand moves the pen to follow the trace representing "H".

...



Daniela's specific style of moving his right arm joints to write "H"  
( *NN model capturing Daniela's writing personality* )

Rotate Wrist to  $a^i$

Rotate Elbow to  $b^j$

Rotate Shoulder to  $g^k$

*3-D Model of Daniela's Right Hand*

