Biology Inspired
21st Century Robotics

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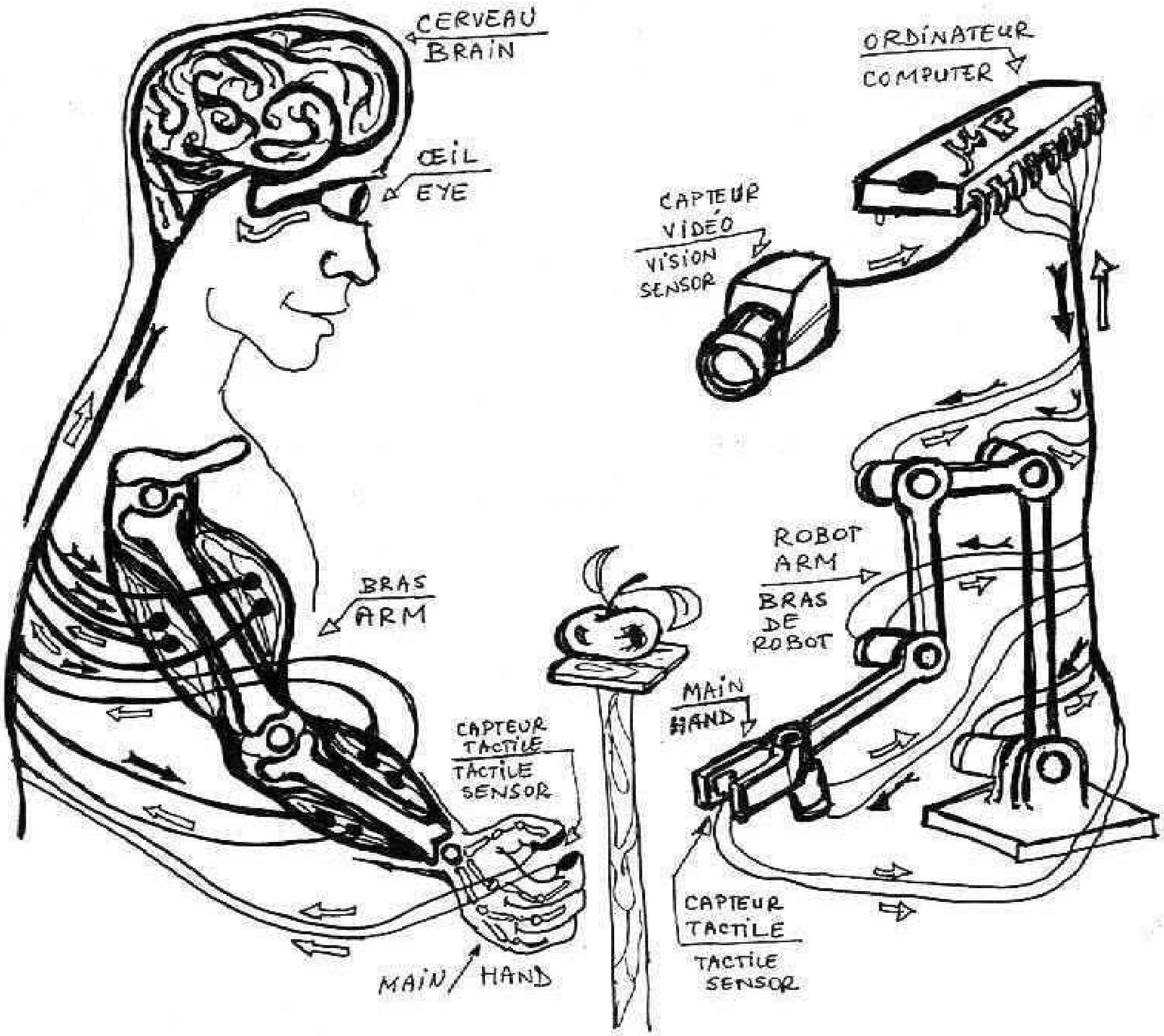
- 2010 -

Humanoid Robots


CERVEAU
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BRAS
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ROBOT
MAIN
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CAPTEUR
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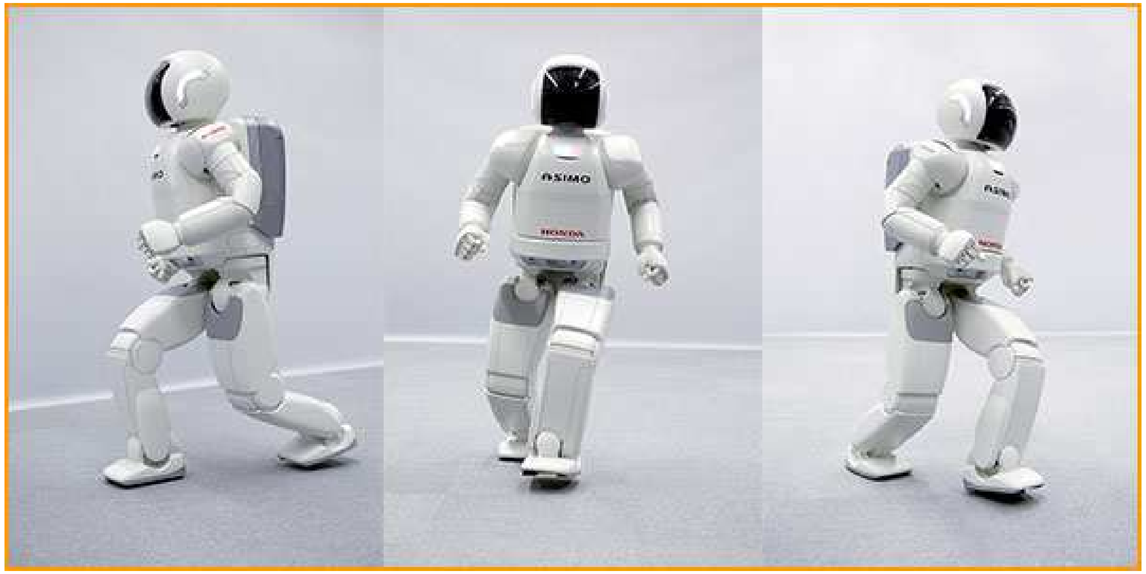
TACTILE
SENSOR


ASIMO
The Honda Humanoid Robot ASIMO
"While we were sleeping"
1986
1991
1993
2000
History
Robot Development Process


ASIMO

Robot with soft hands chats, serves meal

http://www.reuters.com/article/email/idUSN2747274920071127

(Tue Nov 27, 200)

TOKYO (Reuters) - A pearly white robot that looks a little like E.T. boosted a man out of bed, chatted and helped prepare his breakfast with its deft hands in Tokyo Tuesday, in a further sign robots are becoming more like their human inventors.

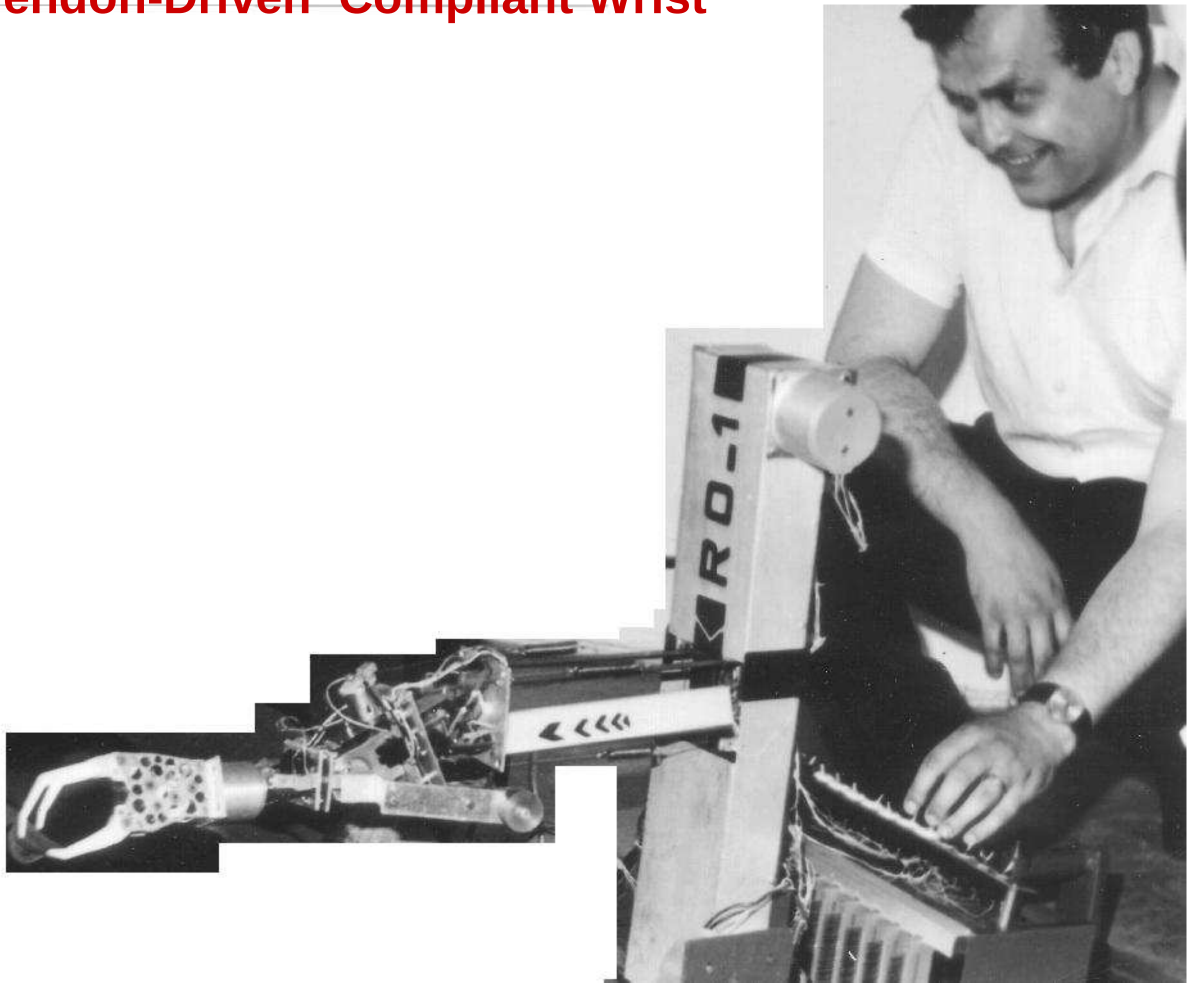
- Twendy-One, named as a 21st century edition of a previous robot, Wendy, has soft hands and fingers that gently grip, enough strength to support humans as they sit up and stand, and supple movements that respond to human touch.

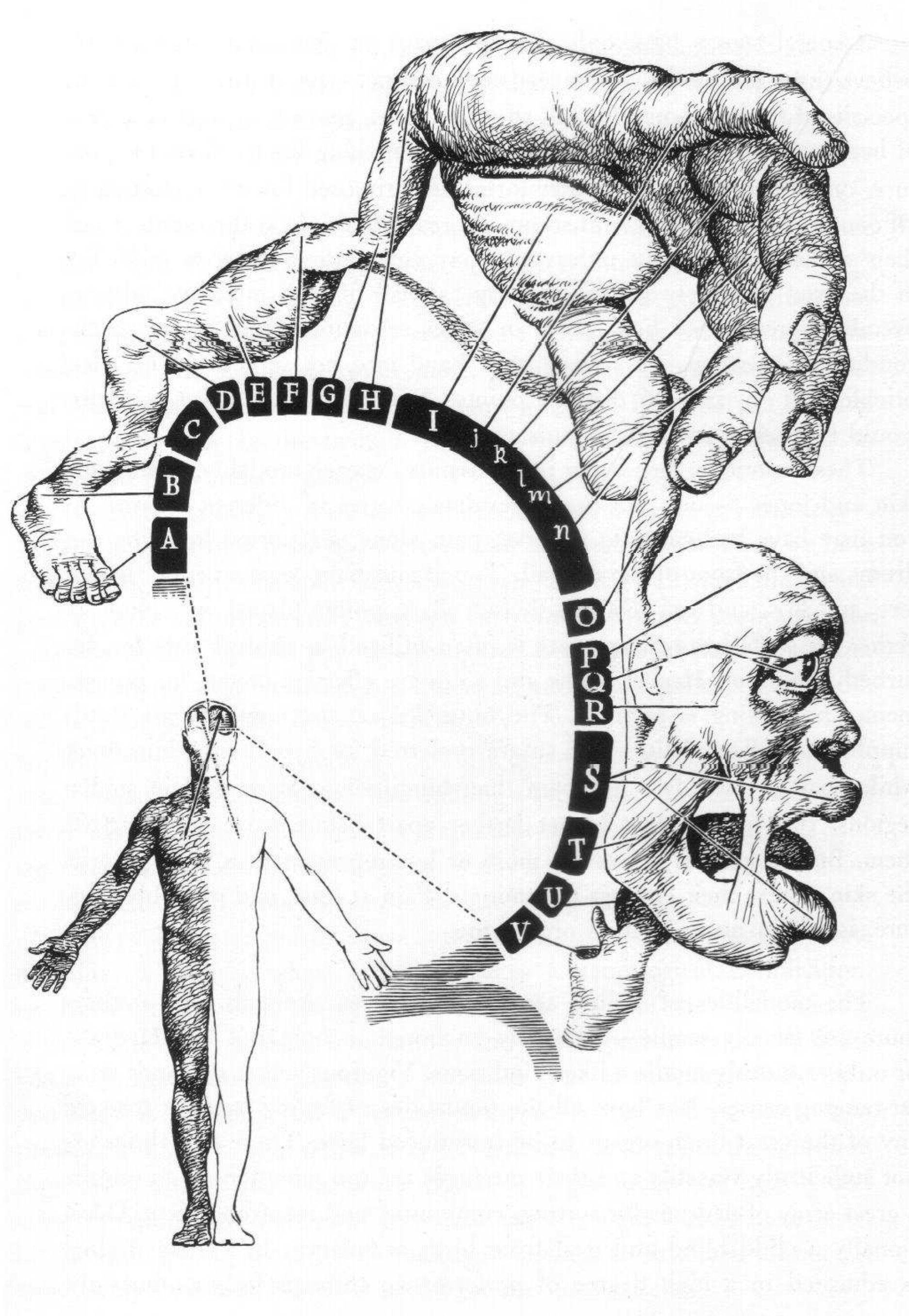
It can pick up a loaf of bread without crushing it, serve toast and help lift people out of bed. "It's the first robot in the world with this much system integration," said Shigeki Sugano, professor of mechanical engineering at Waseda University, who led the Twendy-One project (http://twendyone.com) and demonstrated the result on Tuesday. "It's difficult to balance strength with flexibility."

The robot is a little shorter than an average Japanese woman at 1.5 m (5 ft), but heavy-set at 111 kg (245 lb). Its long arms and a face shaped like a giant squashed bean mean it resembles the alien movie character E.T. Twendy-One has taken nearly seven years and a budget of several million dollars to pull together all the high-tech features, including the ability to speak and 241 pressure-sensors in each silicon-wrapped hand, into the soft and flexible robot.

- The robot put toast on a plate and fetched ketchup from a fridge when asked, after greeting its patient for the demonstration with a robotic "good morning" and "bon appetit." Sugano said he hoped to develop a commercially viable robot that could help the elderly and maybe work in offices by 2015 with a price tag of around $200,000.But for now, it is still a work in progress. Twendy-One has just 15 minutes of battery life and its computer-laden back has a tendency to overheat after each use. "The robot is so complicated that even for us, it's difficult to get it to move," Sugano said.(Reporting by Yoko Kubota; Editing by Jerry Norton

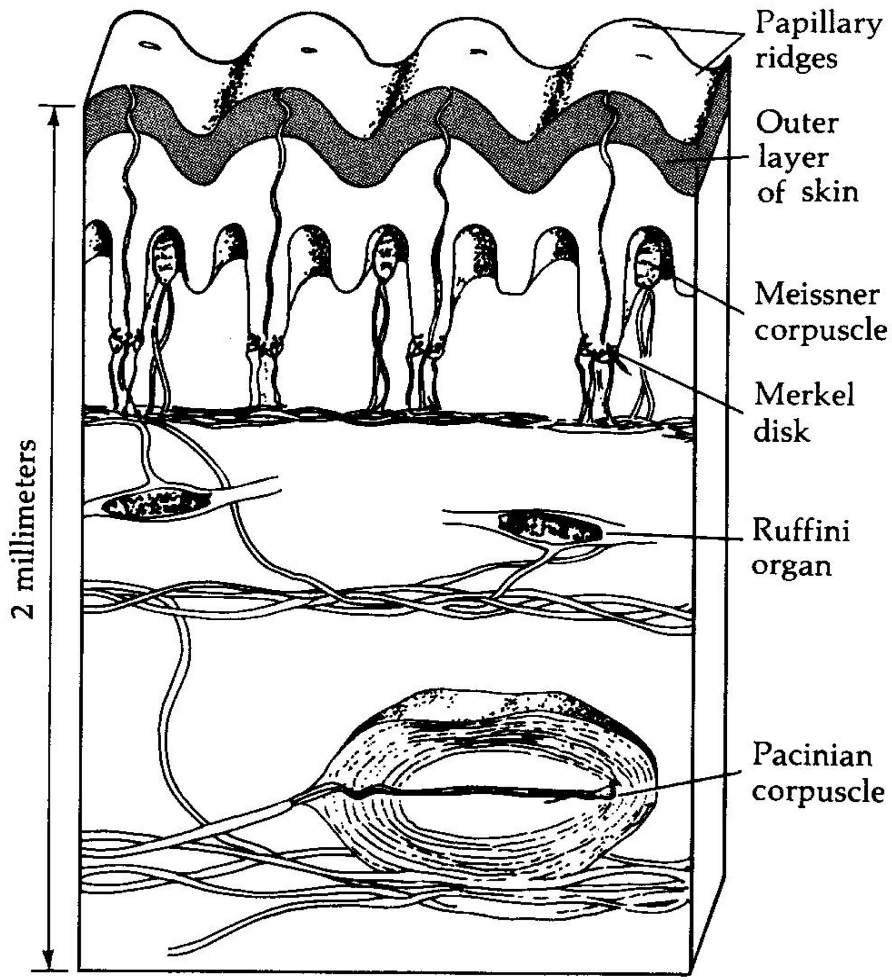
Robot Hand and Tendon-Driven Compliant Wrist





The sensory cortex: an oblique strip, on the side of each hemisphere, receives sensations from parts on the opposite side of the body and head: foot (A), leg (B, C, hip (D), trunk (E), shoulder (F), arm (G, H), **hand (I, J, K, L, M, N),** neck (O), cranium (P), eye (Q), temple (R), lips (S), cheek (T), tongue (U), and larynx (V). Highly sensitive parts of the body, such as the hand, lips, and tongue have proportionally large mapping areas, the foot, leg, hip, shoulder, arm, eye, cheek, and larynx have intermediate sized mapping areas, while the trunk, neck, cranium, and temple have smaller mapping areas.
(from [H. Chandler Elliott, *The Shape of Intelligence - The Evolution of the Human Brain*, Drawings by A. Ravielli, Charles Scribner's Sons, NY, 1969])

The skin of a human finger contains four types of **cutaneous sensing elements** distributed within the skin: *Meissner's corpuscles* for sensing velocity and movement across the skin; *Merkel's disks* for sensing sustained pressure and shapes; *Pacinian corpuscles* for sensing pressure changes and vibrations of about 250 Hz; and *Ruffini corpuscles* for sensing skin stretch and slip. (from R. Sekuler and R. Balke, Perception, McGraw-Hill, 1990)



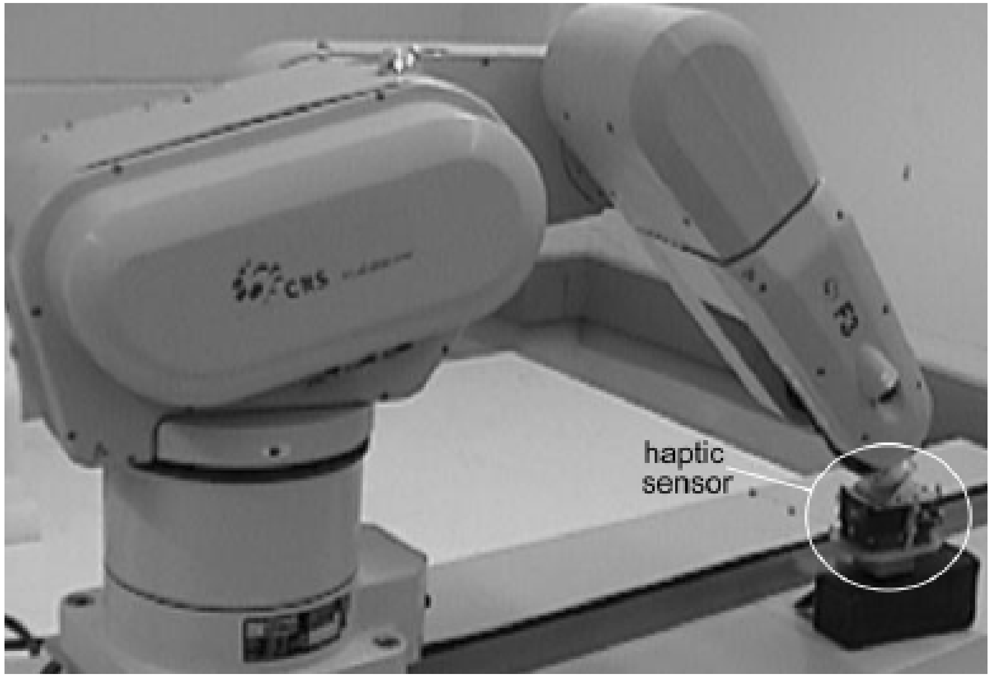
Robot Haptic Sensors

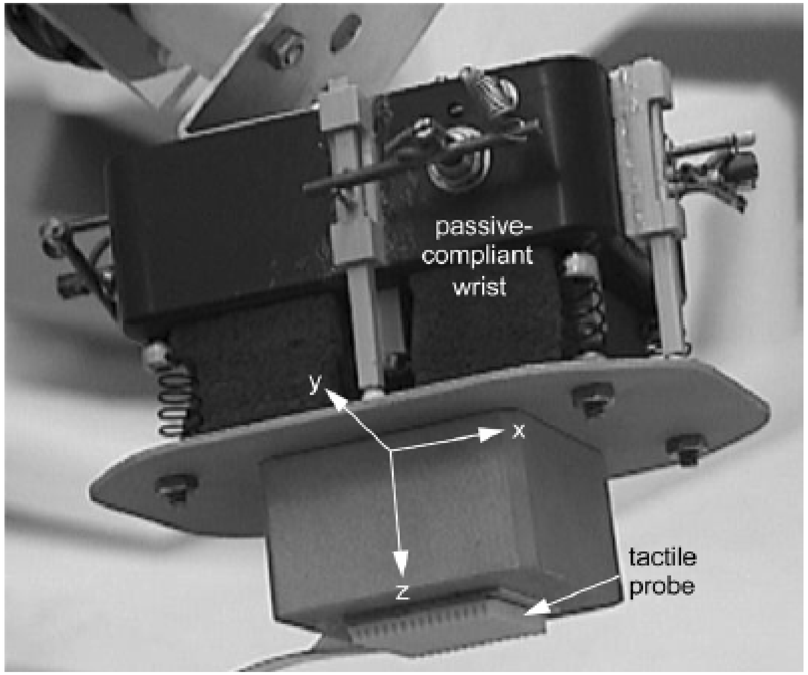
Haptic perception is the result of an active deliberate contact exploratory sensing act.

A **tactile probe** provides the local “cutaneous” information about the touched area of the object.

A **robotic carrier** providing the “kinesthetic” capability is used to move the tactile probe around on the explored object surface and to provide the contact force needed for the probe to extract the desired cutaneous information (e.g. local 3D geometric shape, elastic properties, and/or termic impedance) of the touched object area .

The local *information provided by the tactile probe is integrated with the kinesthetic position parameters of the carrier* resulting in a *composite* **haptic model** (global geometric and elastic profiles, termic impedance map) of the explored 3D object.

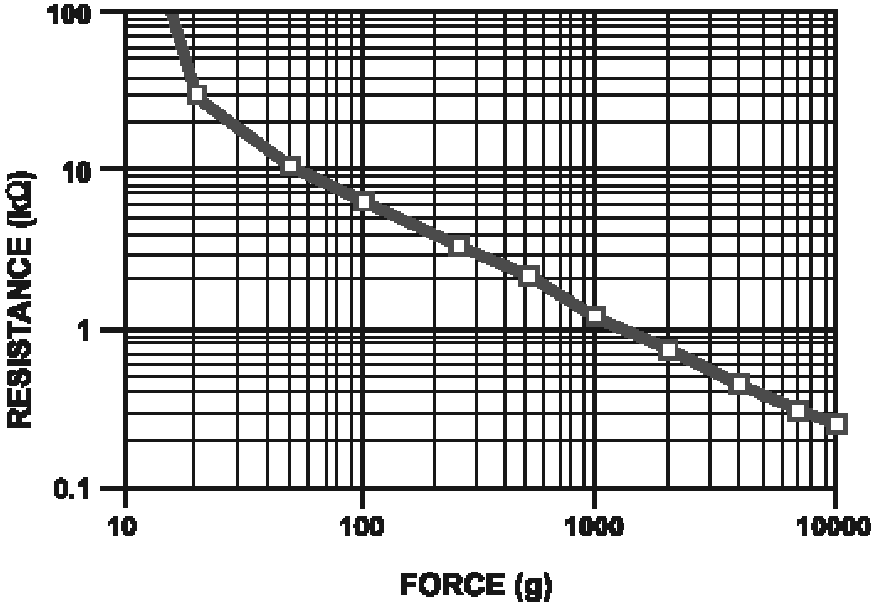


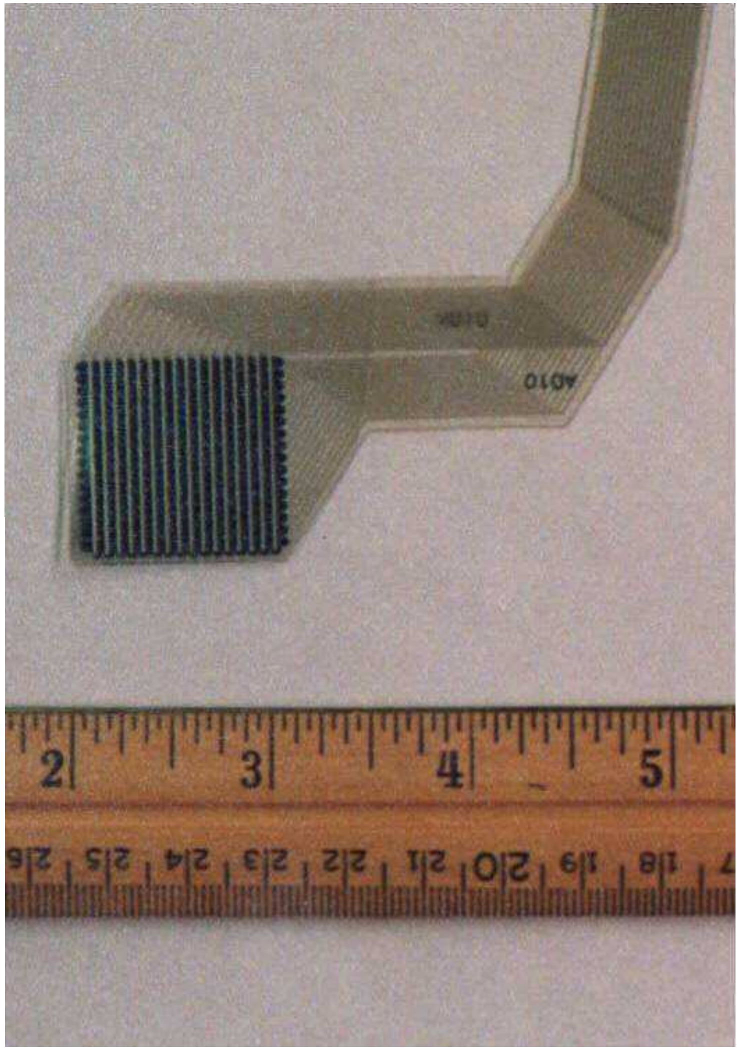


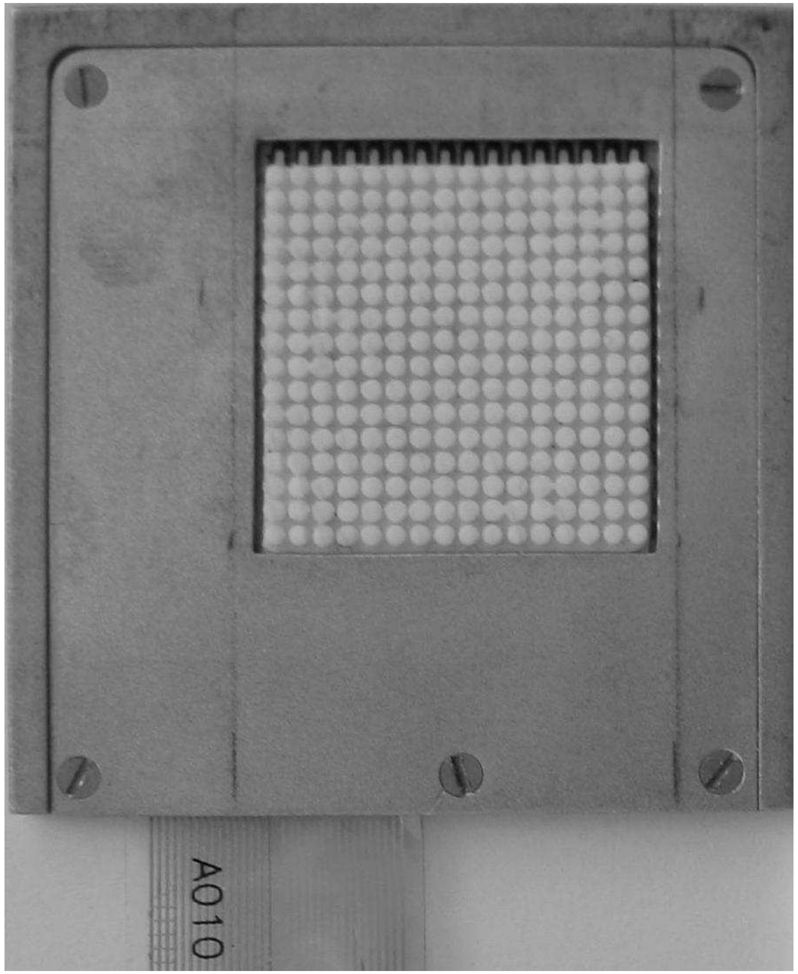
Biology-inspired robot haptic perception system consists of a **robot manipulator,** an instrumented **passive-compliant wrist** and a **tactile probe** array. Position sensors placed in the robot joints and on the instrumented passive-compliant wrist provide the kinesthetic information. The compliant wrist allows the probe to accommodate the constraints of the touched object surface and thus to increase the local cutaneous information extracted during the active exploration process under the force provided by the robot.

The tactile probe is based on a 16-by-16 matrix of **Force Sensing Resistor (FSR)** elements spaced 1.58 mm apart on a 6.5 cm2 (1 sq. inch) area.

The FSR elements have an exponentially decreasing electrical resistance with applied normal force: the resistance changes by two orders of magnitude over a pressure range of 1 N/cm2 to 100 N/cm2.

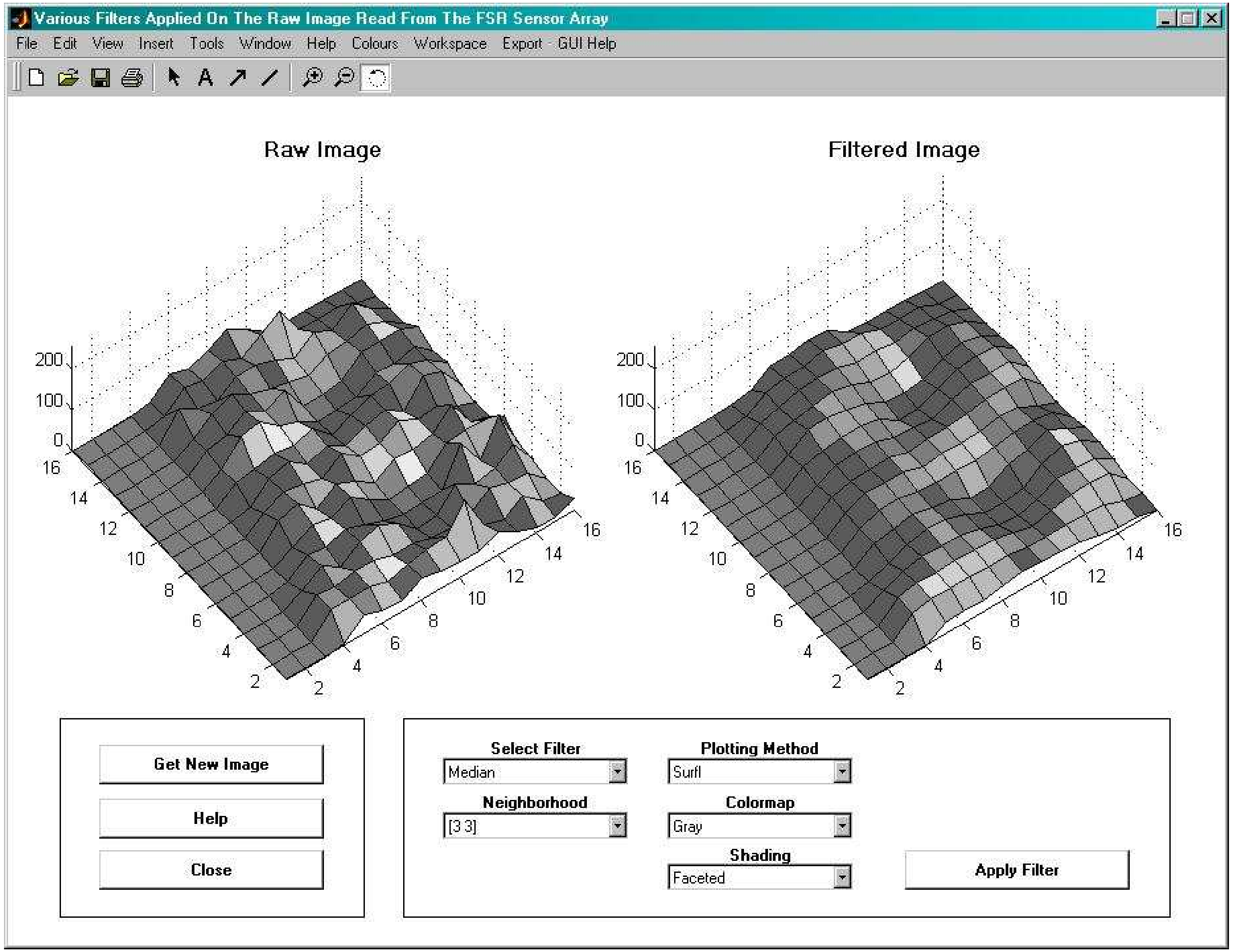






The tabs of the elastic overlay are arranged in a 16-by-16 array having a tab on top of each node of the *FSR* matrix.

This tab configuration provides a *de facto* spatial sampling, which reduces the elastic overlay's blurring effect on the high 2D sampling resolution of the *FSR* transducer.



Example of GUI window (from [C. Pasca, *Smart Tactile Sensor*, M.A.Sc. Thesis, University of Ottawa, 2004])

Expressive Robotic Human-like Head

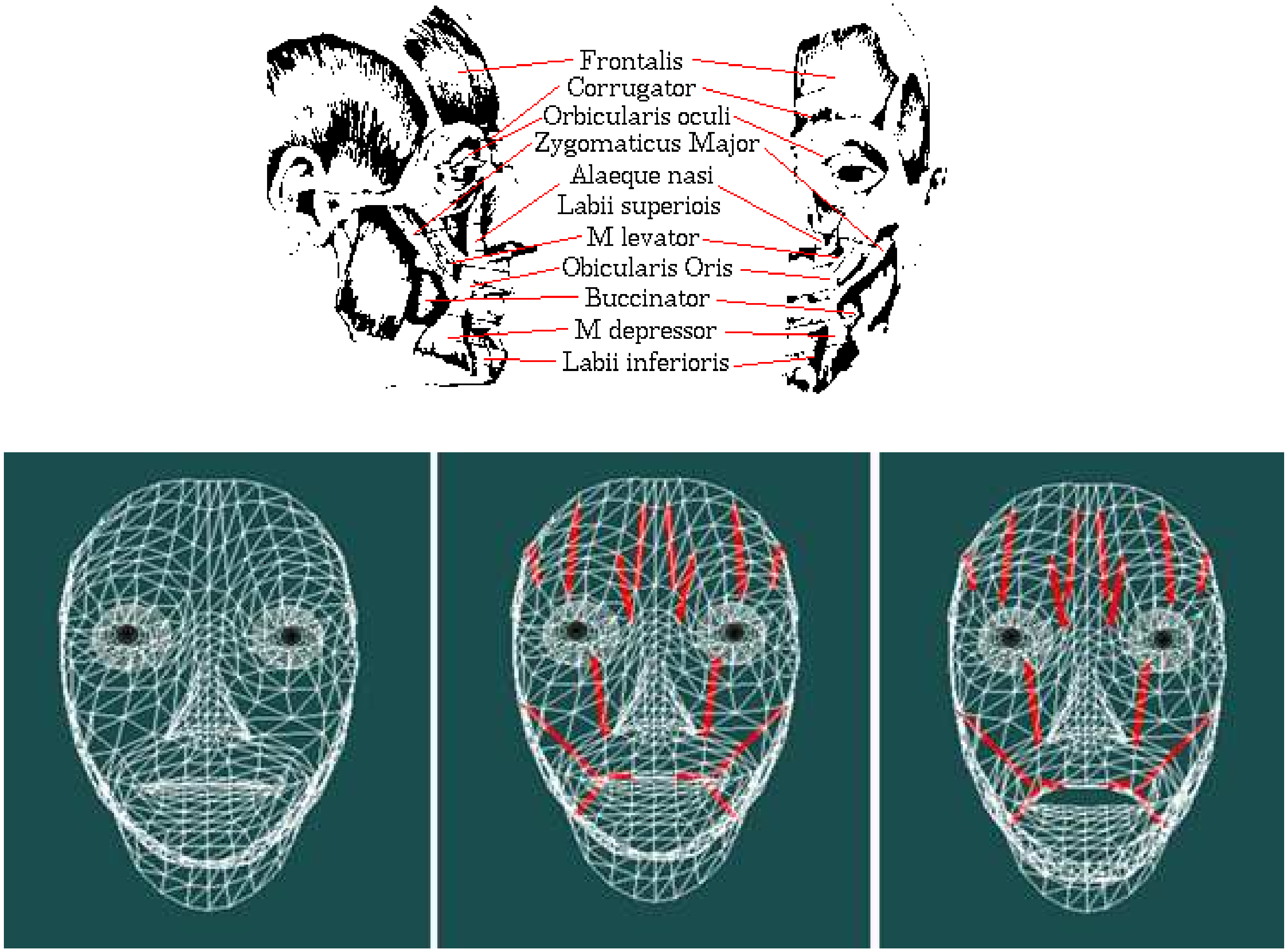
Interest in facial expression can be dated back to the mid 19th century, when Charles Darwin wrote *The Expression of the Emotions in Man and Animals*.
Later, two sign communication psychologists, Ekman and Friesen, developed the anatomically oriented *Facial Action Coding System* (FACS) based on numerous experiments with facial muscles. They defined the *Action Unit* (AU) as a basic visual facial movement, which cannot be decomposed into smaller units. The distinguishable expression space is reduced to a comprehensive system, which could distinguish all possible visually facial expressions by using only 46 AUs. Complex facial expressions can be obtained by combining different AUs.

- M.D. Cordea, "*A 3D Anthropometric Muscle-Based Active Appearance Model for Model-Based Video Coding*," Ph.D. Thesis, 2007.
- M. Bondy, "*Voice Stream Based Lip Animation for Audio-Video Communication*," M.A.Sc. Thesis, 2001.
- M.D. Cordea, "*Real Time 3D Head Pose Recovery for Model Based Video Coding*," M.A.Sc. Thesis, 1999.

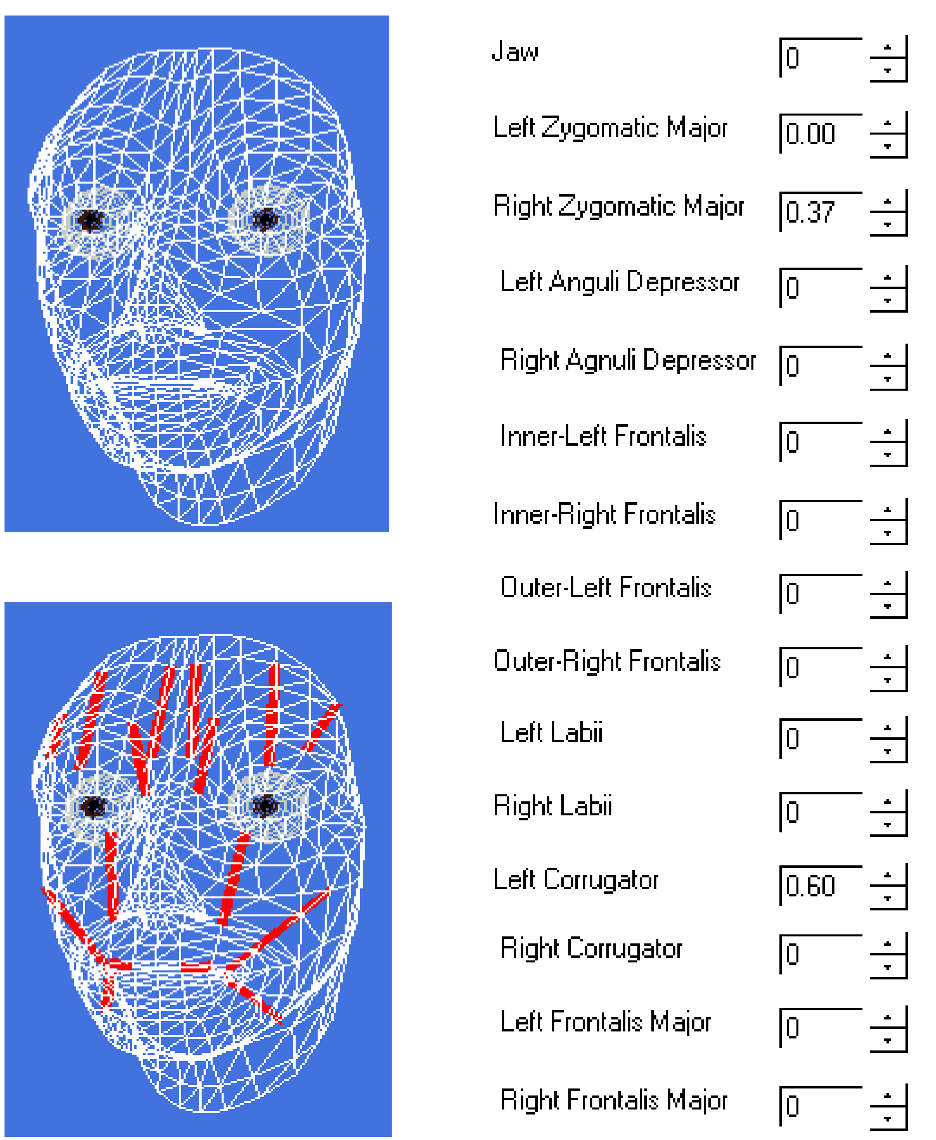
A humanoid robot, without its facial skin, is displayed at Japan's largest robot convention in Tokyo on Nov. 28, 2007.

3D Face Modeling

- Modeling and animating realistic faces require knowledge of anatomy
  - Anthropometric (external) representation
    - Measurements of living subjects
    - Statistics based on age, health, etc.
  - Muscle/Skin (internal) representation
    - Over 200 facial muscles
    - Over 14,000 possible expressions



3D generic face deformed using muscle-based control



Facial expressions are described using the ***Facial Action Coding System***, allowing to control the movements of specific facial muscles.

Neutral

Happy

Sad

Surprised

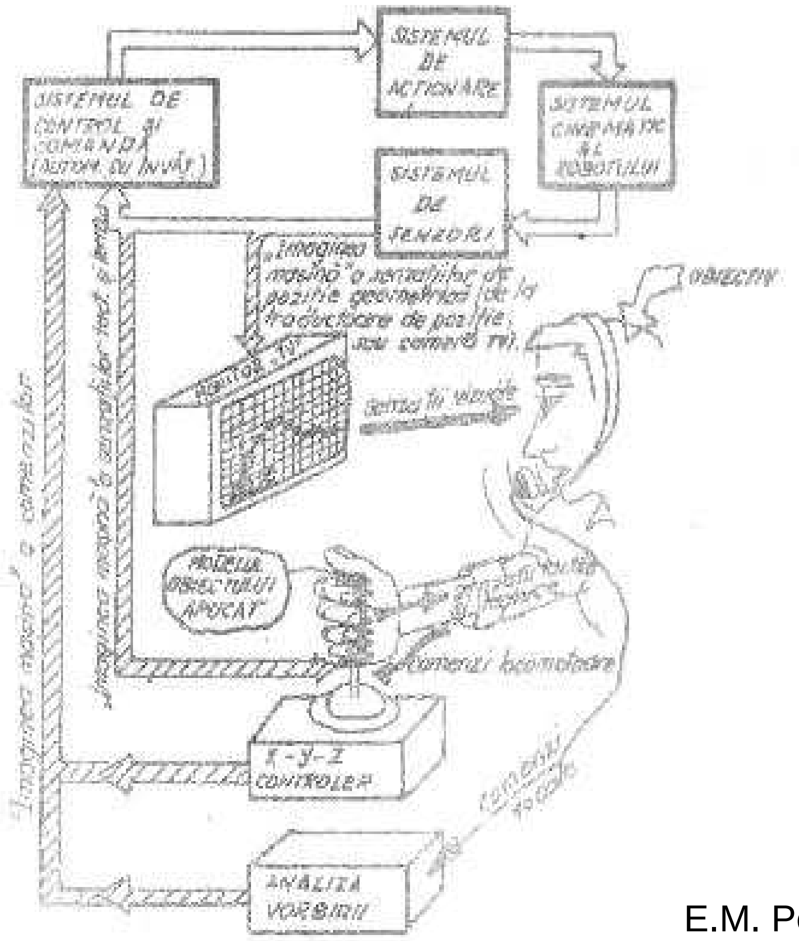
- Combining different muscle actions it becomes possible to obtain a variety of ***facial expressions*** of Marius’ avatar:

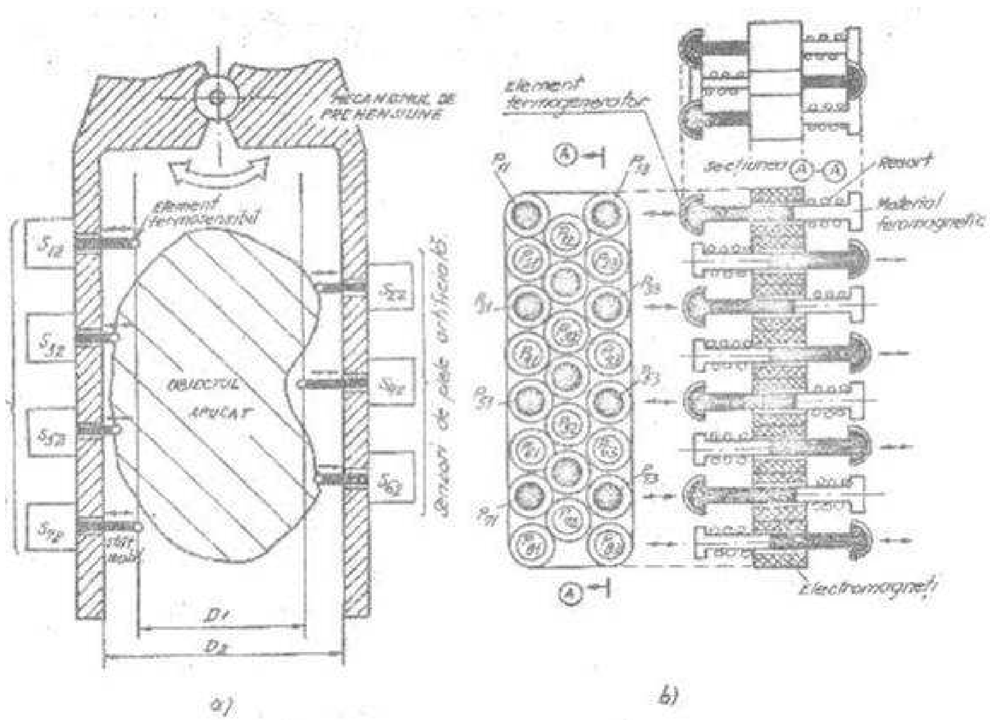
Human-Computer Interaction for Teleoperation

The *symbiotic teleoperation system* has a bilateral architecture allowing to connect the *human operator* and the *robotic partner* as transparently as possible.

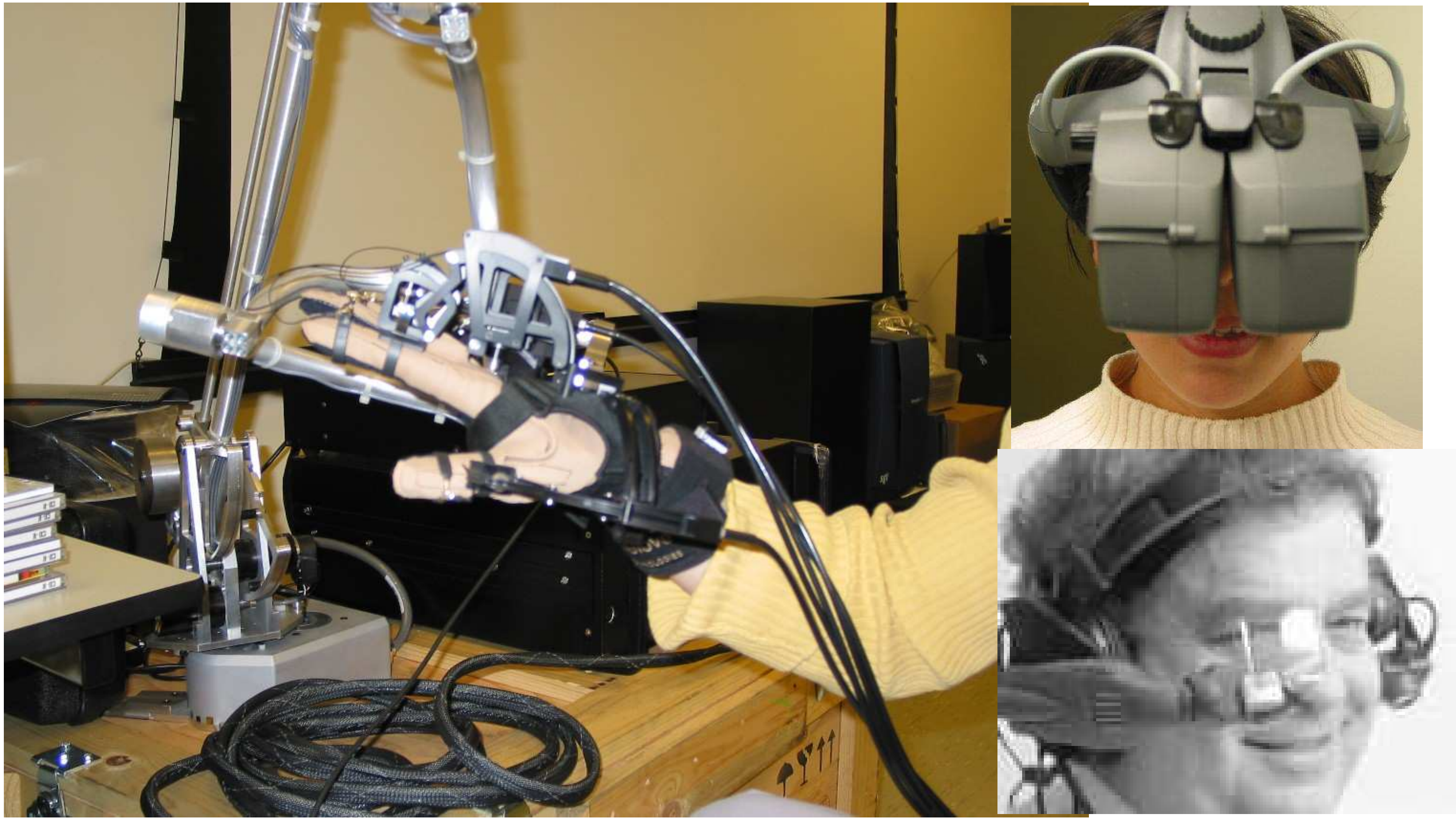
Conformal (1:1) mapping of human & robot sensory and perception frameworks

Haptic Sensor and Human Interface for a Tele-Robotic System

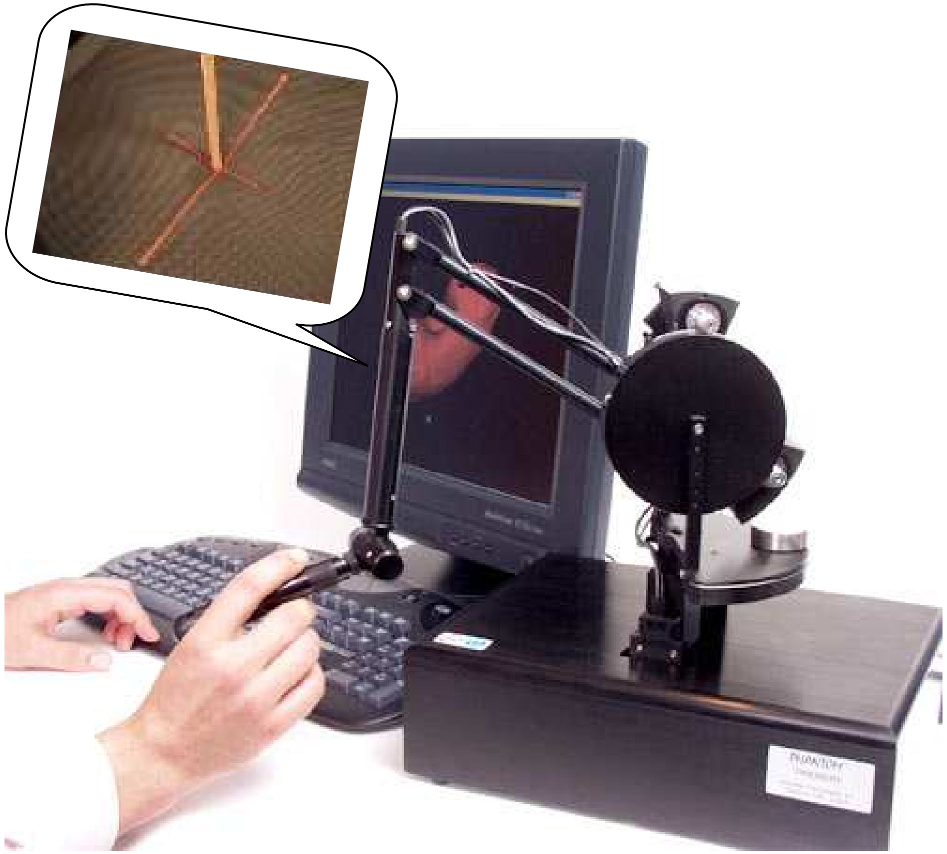




E.M. Petriu, D.C. Petriu, V. Cretu, "Control System for an Interactive Programmable Robot," *Proc. CNETAC Nat. Conf. Electronics, Telecomms, Control, and Computers*, (in Romanian), pp. 227-235, Bucharest, Romania, Nov. 1982.



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



A desktop *hapto-visual human interface* allows a human teleoperator to experience the haptic feeling profiles at the point of contact as well as to see the image of a larger area around the point of contact on the explored object as captured by a video camera mounted on the robot manipulator. It includes a *PHANTOM® 6DOF* haptic device representing the **handheld replica of the probing rode** that provides the haptic feedback consisting of the 3D geometric coordinates of the point of contact measured by the laser range finder system and the force vector and torque components measured by the 6 DOF force-torque sensor at the point of contact.

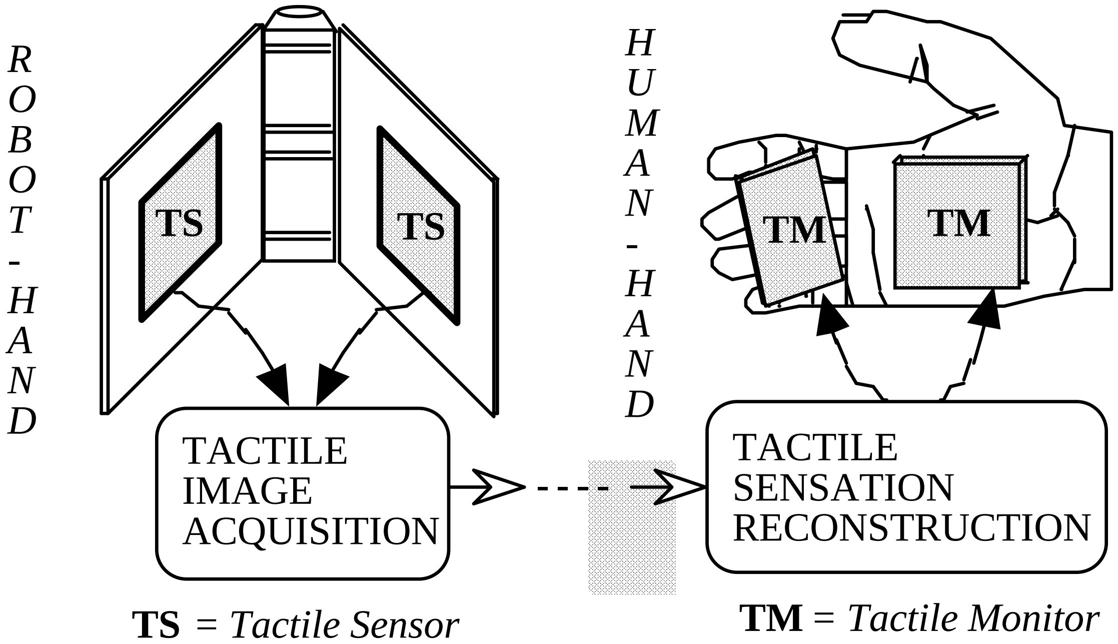
Immersionn_3D Interaction *<http://www.immersion.com/>*

CyberGlove®

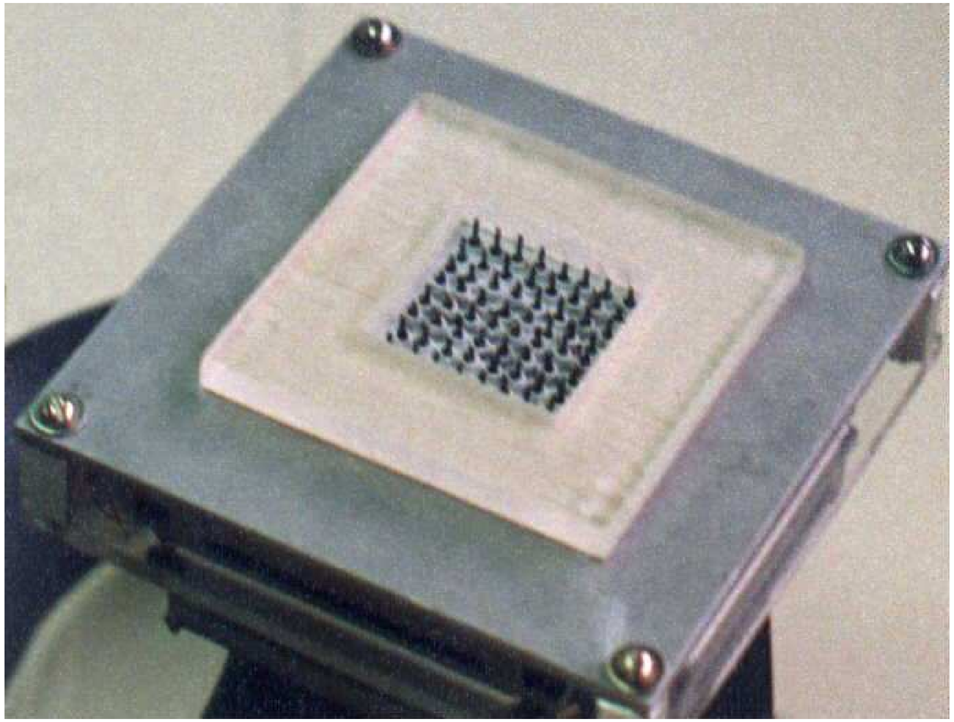
CyberTouch™

CyberGrasp™

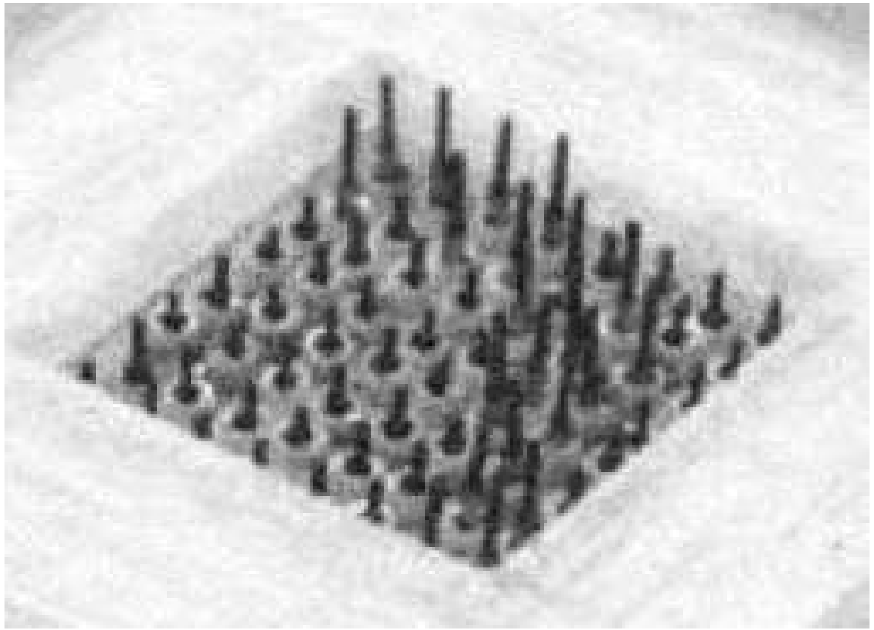
CyberForce®



A tactile human interface placed on the operator's palm allows the human teleoperator to virtually feel by touch the object profile measured by the tactile sensors placed in the jaws of the robot gripper (from [E.M. Petriu, W.S. McMath, "Tactile Operator Interface for Semi-autonomous Robotic Applications," *Proc.Int. Symposium on Artificial Intell. Robotics Automat. in Space, i-SAIRS'92*, pp.77-82, Toulouse, France, 1992.])



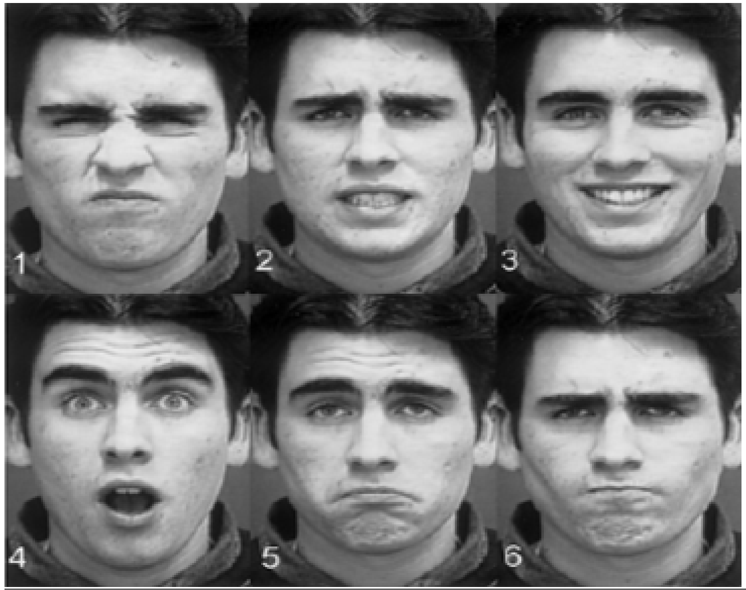
Cutaneous tactile human interface developed at the University of Ottawa. It consists of an 8-by-8 array of vibrotactile stimulators. The active area is 6.5 cm2 (same as the tactile sensor).

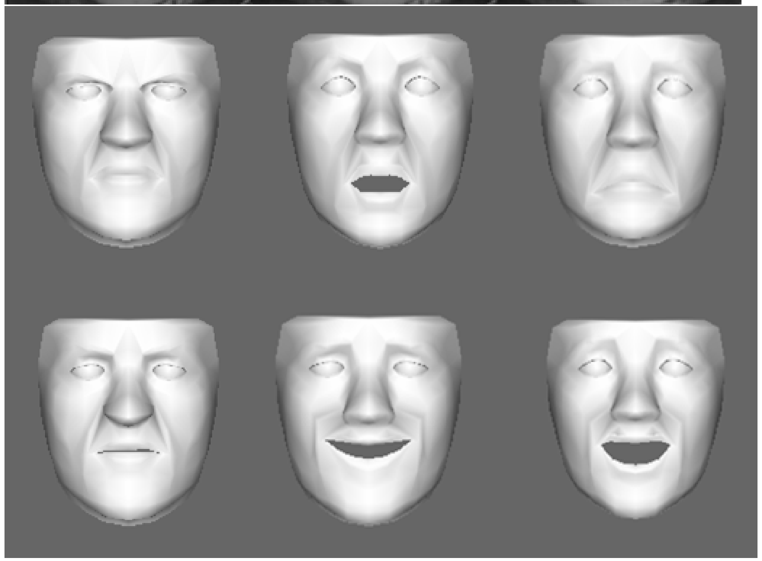


Each stimulator corresponds to a 2-by-2 window in the tactile sensor array. The vibrotactile stimulators are used as binary devices that are activated when at least two of the corresponding *taxels* (tactile elements) in the tactile sensor array window are "on". The figure shows a curved edge tactile feedback .

Tactile fingertip human interface developed at the University of Ottawa. It consists of miniature vibrators placed on the fingertips. The vibrators are individually controlled using a dynamic model of the visco-elastic tactile sensing mechanisms in the human fingertip.

Facial Expression Recognition using a 3D Anthropometric Muscle-Based Active Appearance Model





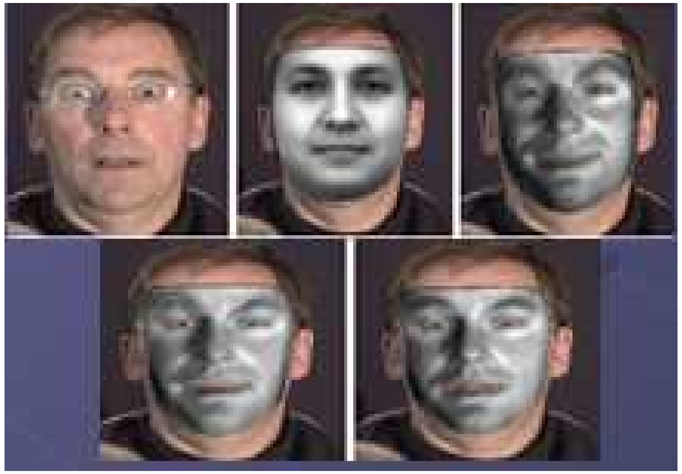
- Facial Action Coding System
  - 7 pairs of muscles + “Jaw Drop” = Expression Space
- Muscle “contractions” control mesh deformation in “Anthropometric-Expression (AE)” space
- Texture intensities are warped into the geometry of the shape
  - Shape: apply PCA in AE space
  - Appearance: apply PCA in texture space
- Model defined by rigid (rotation, translation) and non-rigid motion (AE)
- Model instances synthesized from AE space,

Facial Expression Recognition

- Person Dependent

AU	Signification	No.	Correct	False	Missed	Confused	Recognition Rate
0	Neutral	20	19	1	0	0	95%
1	Inner Brow Raiser	24	21	0	3	0	87.5%
2	Outer Brow Raiser	52	41	1	9	1	78.8%
4	Brow Lowerer	42	41	0	0	1	97.6%
12	Lip Corner Puller	51	48	3	0	0	94.1%
15	Lip Corner Depressor	18	17	0	1	0	94.4%
26	Jaw Drop	74	55	0	19	0	74.3%
Total		281	242	5	32	2	86.1%
False Alarm: 1.7%, Missed: 11.3%							

- Person Independent

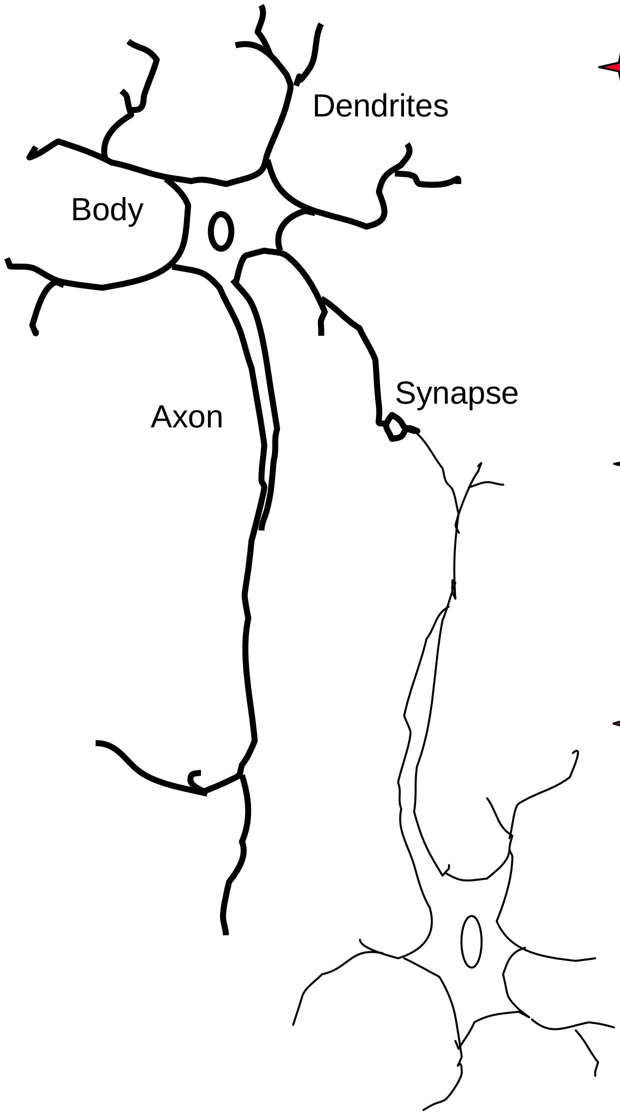


AU	Signification	No.	Correct	False	Missed	Confused	Recognition Rate
0	Neutral	20	17	3	0	0	85.0%
1	Inner Brow Raiser	10	8	0	2	0	80.0%
2	Outer Brow Raiser	27	20	1	5	1	74.0%
4	Brow Lowerer	24	21	1	1	1	87.5%
12	Lip Corner Puller	17	13	0	4	0	76.4%
15	Lip Corner Depressor	13	10	1	2	0	76.9%
26	Jaw Drop	24	14	0	10	0	58.3%
Total		135	103	6	24	2	76.2%
False Alarm: 4.4%, Missed: 17.7%							

Biology Inspired Neural Networks

Looking for a model to prove that algebraic operations with analog variables can be performed by logic gates, Professor **J. von Neuman** advanced in 1956 the *idea of representing analog variables by the mean rate of random-pulse streams [J. von Neuman, "***Probabilistic logics and the synthesis of reliable organisms from unreliable components***," in Automata Studies, (C.E. Shannon, Ed.), Princeton, NJ, Princeton University Press, 1956].*

Biological Neurons

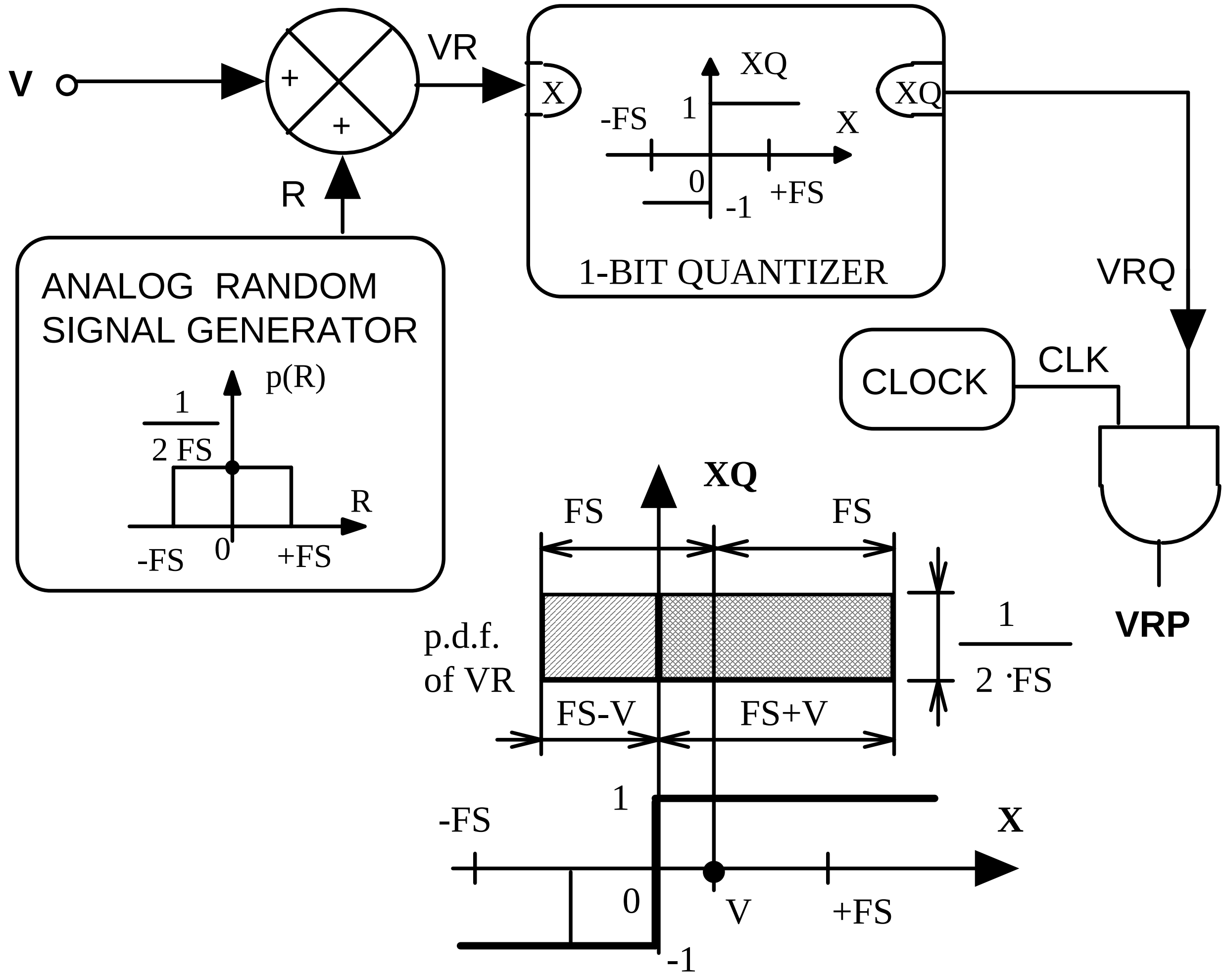


- **Dendrites** carry electrical signals in into the neuron body. The neuron **body** integrates and thresholds the incoming signals.The **axon** is a single long nerve fiber that carries the signal from the neuron body to other neurons. A **synapse** is the connection between dendrites of two neurons.

- *Memories* are formed by the modification of the **synaptic strengths** which can change during the entire life of the neural systems.

- **Neurons are rather slow (10^{-3} s)** when compared with the modern electronic circuits. ==> The brain is faster than an electronic computer because of its massively parallel structure. The **brain has approximately 10^{11} highly connected neurons** (approx. 10^4 connections per neuron).

Analog/Random-Pulse Conversion



Random-Pulse/Digital Conversion

The *deterministic component of the random-pulse sequence*, conveniently unbiased and rescaled for this purpose to take values +1 and -1 (instead of 1 and respectively 0) , can be calculated as a **statistical estimation** from the quantization diagram:

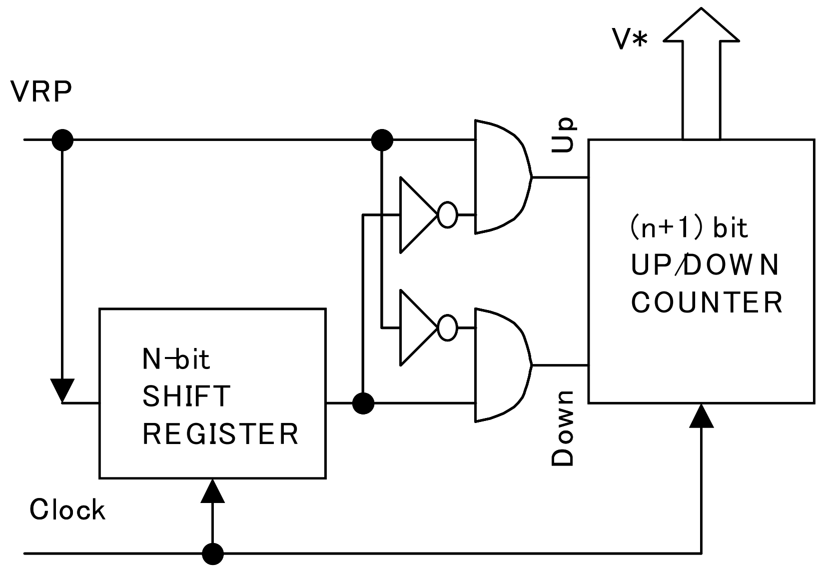
$$E[VRP] = (+1)\ .p[VR>=0] + (-1)\ .p[VR<0] = p(VRP) - p(VRP')$$
$$= (FS+V)/(2.FS) - (FS-V)/(2.FS) = V/FS;$$

This finally gives the deterministic analog value V associated with the binary VRP sequence:

$$\mathbf{V = [\mathit{p}(VRP) - \mathit{p}(VRP')]\ .\ FS\ ;}$$

where the *apostrophe* (') denotes a logical inversion.

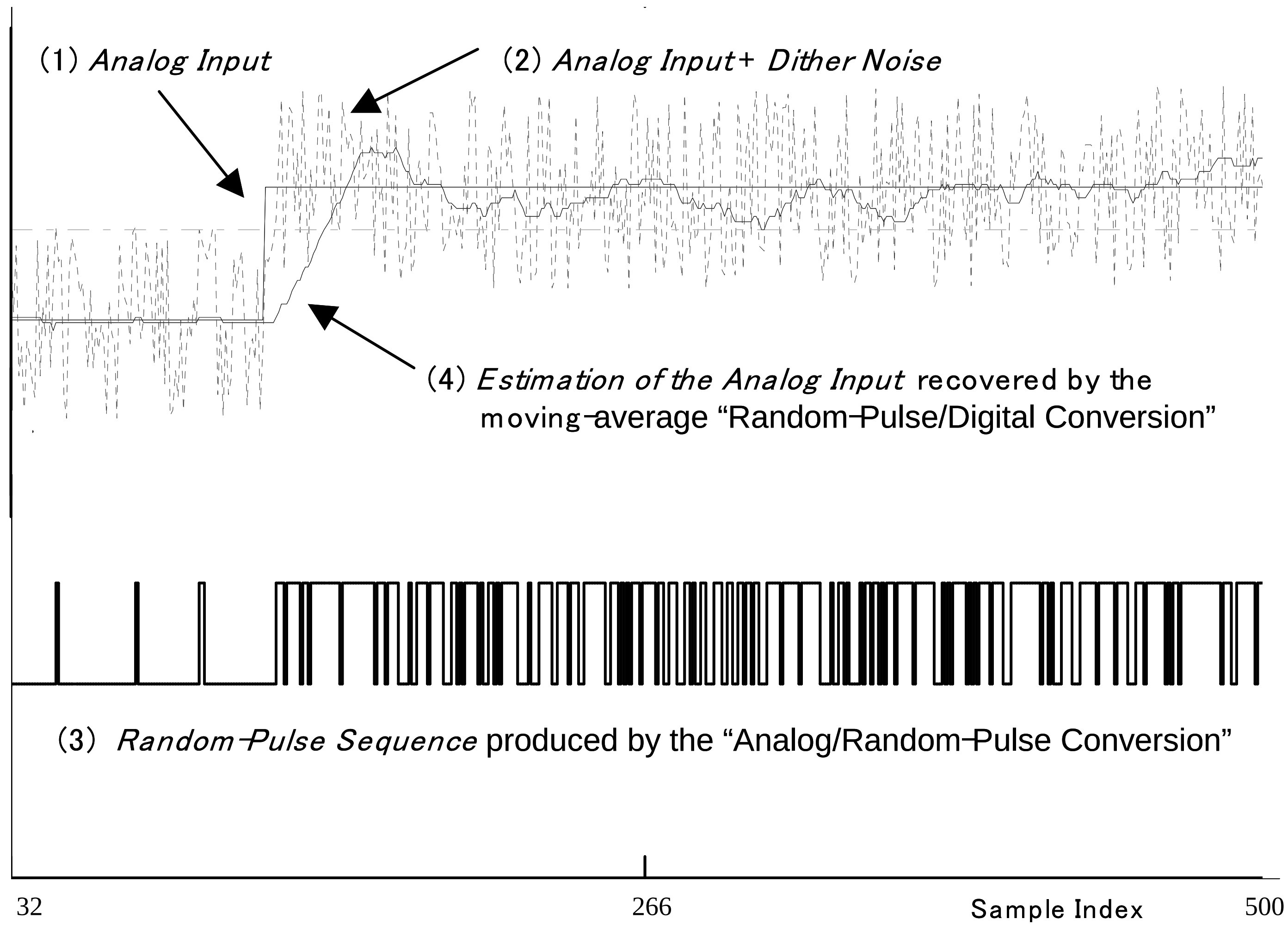
Random-Pulse/Digital Conversion using the Moving Average Algorithm .



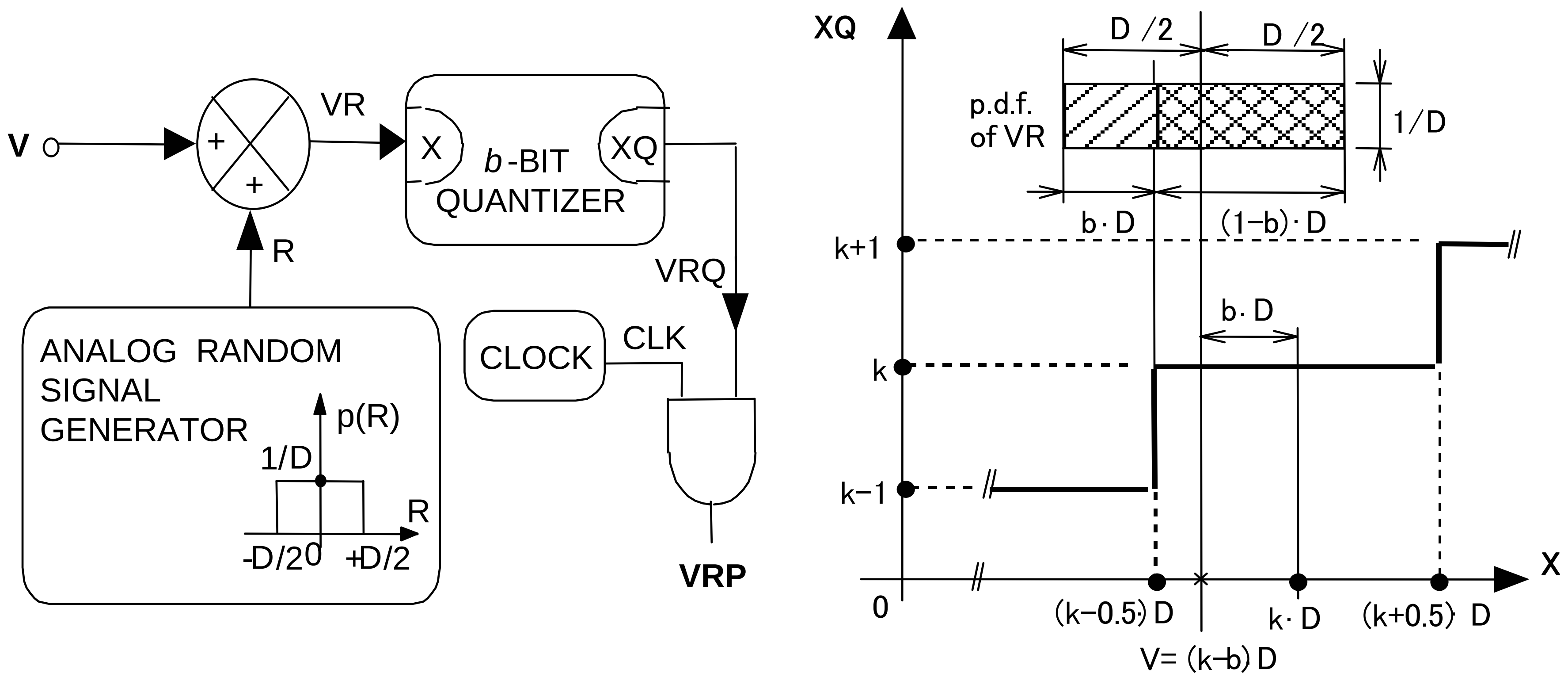
$$V*_N = \frac{1}{N}\sum_{i=1}^{N} VRP_i = \frac{1}{N}\left(\sum_{i=1}^{N-1} VRP_i + VRP_N\right);$$

$$V*_N = V*_{N-1} + \frac{VRP_N - VRP_0}{N};$$

Analog/Random-Pulse and Random-Pulse/Digital Conversion



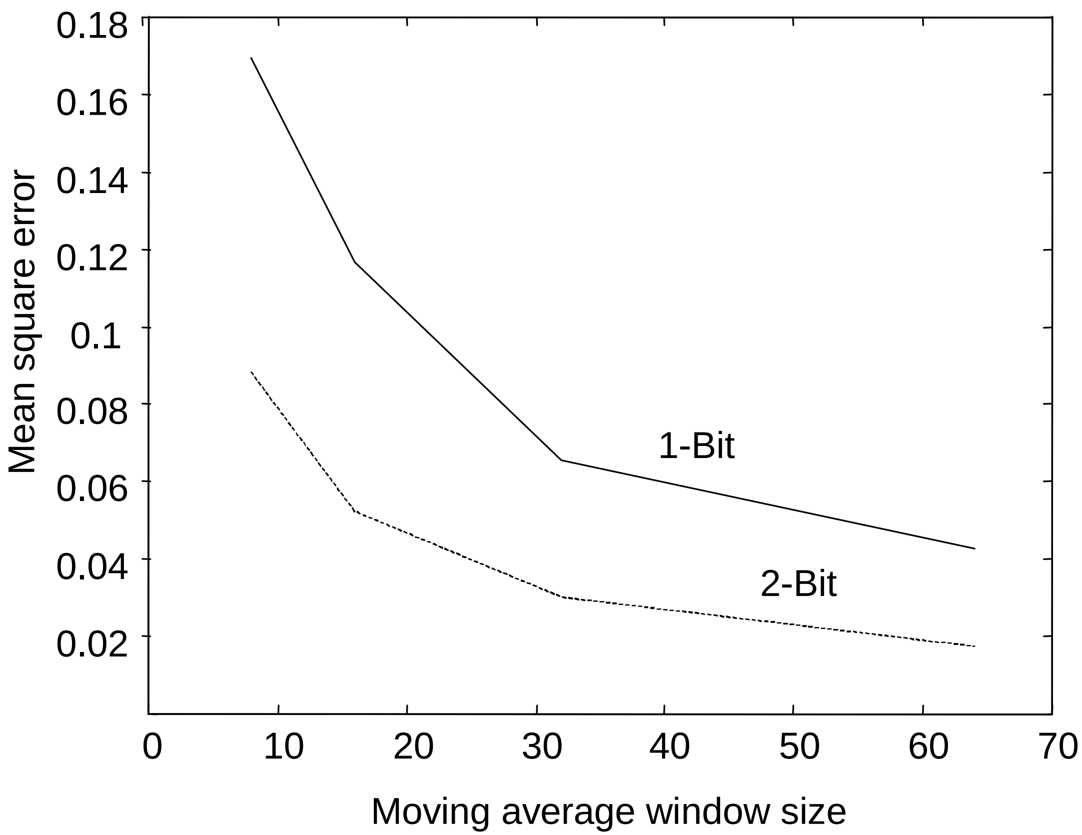
Stochastic Data Representation



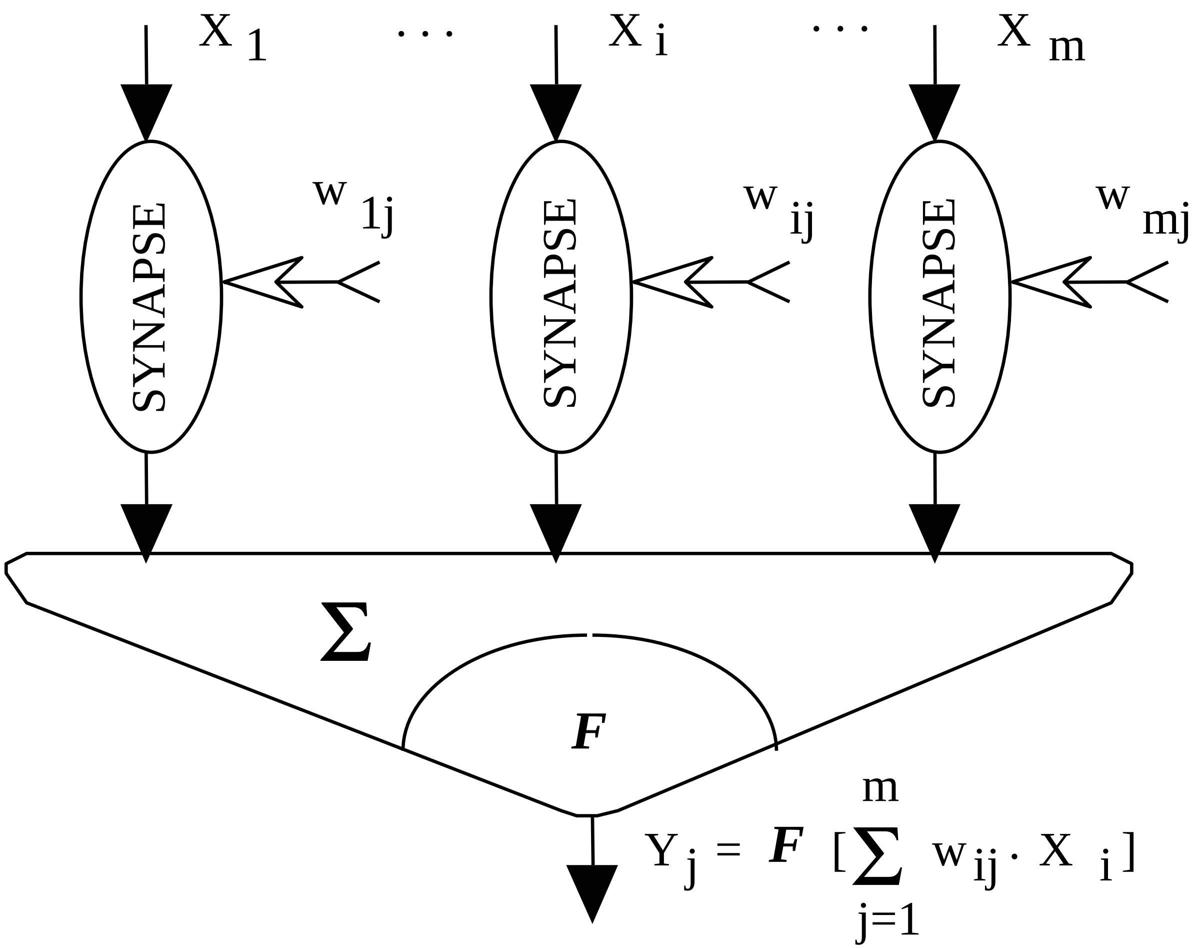
Generalized b-bit analog/random-data conversion

E.M. Petriu, L. Zhao, S.R. Das, V.Z. Groza, A. Cornell, “Instrumentation Applications of Multibit Random-Data Representation,” *IEEE Trans. Instrum. Meas.*, Vol. 52, No. 1, pp. 175- 181, 2003.

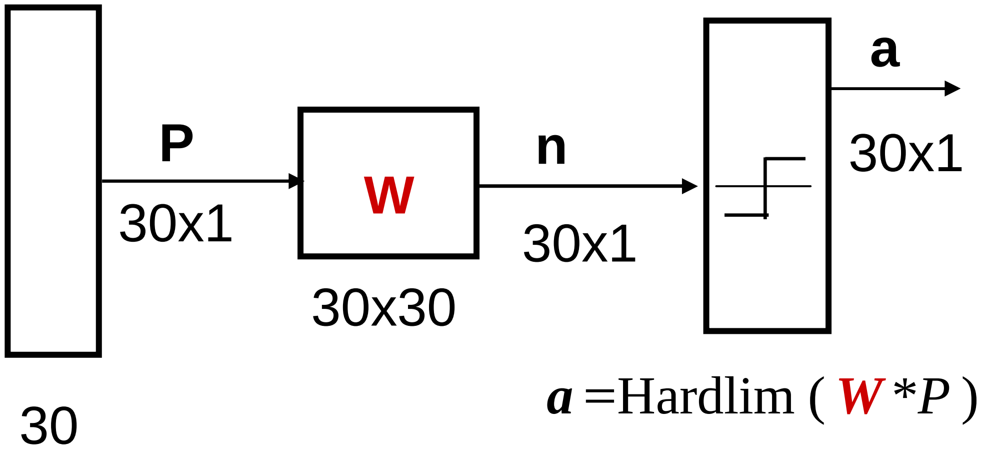
Quantization levels	Relative mean square error
2	72.23
3	5.75
4	2.75
...	...
8	1.23
...	...
analog	1



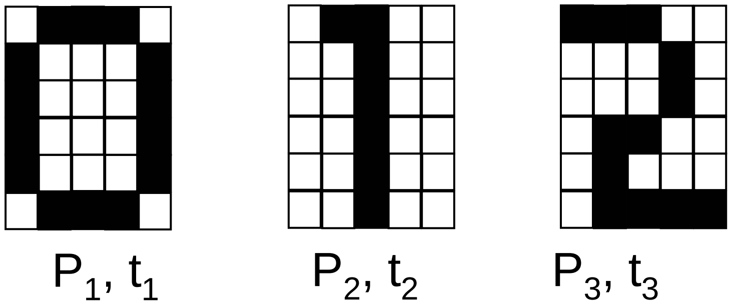
Neural Network Architectures Using Stochastic Data Representation



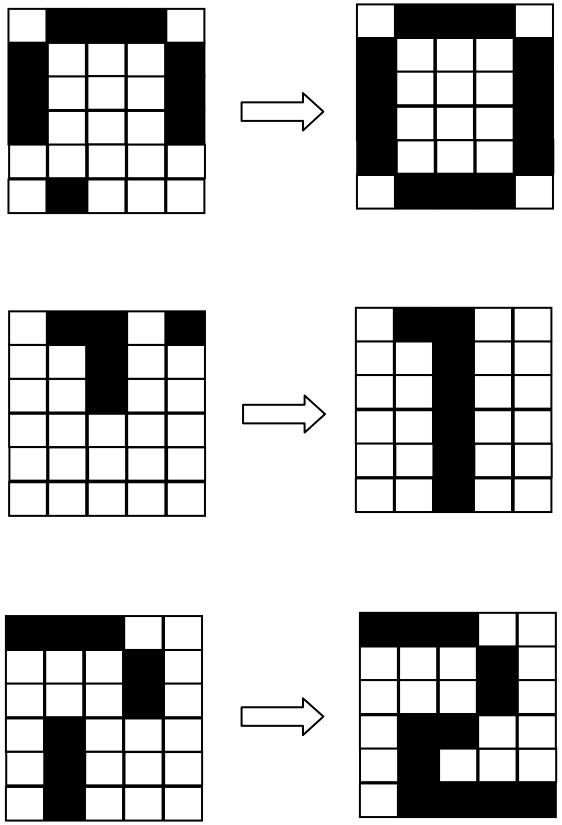
Auto-associative memory NN architecture



$$a = \text{Hardlim}\,(W * P)$$



Training set



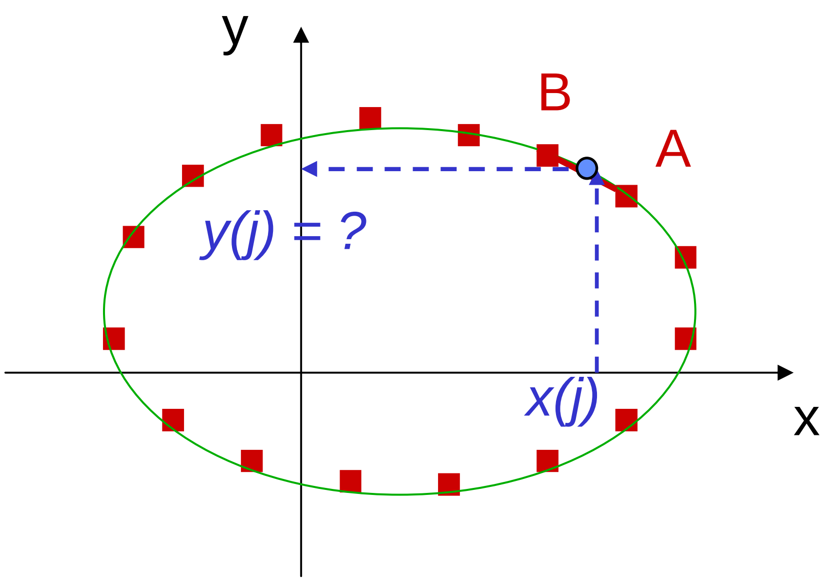
Recovery of 30% occluded patterns

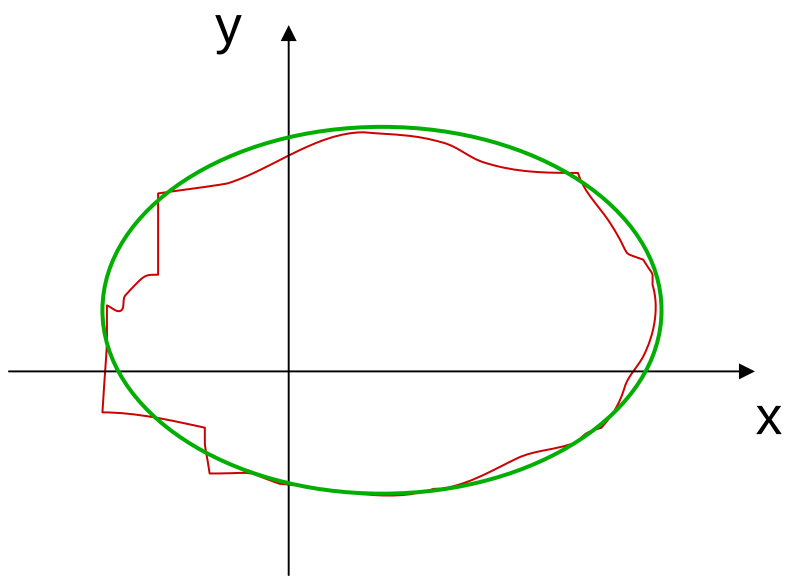
Neural Network vs. Analog Computer Modelling

- Both the **Analog Computers** and **Neural Networks** are ***continuous modelling devices***.

- **Neural Networks don't require a prior mathematical models.** A *learning algorithm* is used to adjust by trial and error during the learning phase the synaptic weights of the neurons.

Discreet vs. Continuous Modelling of Physical Objects and Processes





DISCREET MODEL

- ***sampling*** => *INTERPOLATION COST*

  y(j) = y(A) +

  [x(j)-x(B)] · [y(B)-x(A)] / [x(A)-x(B)]

CONTINUOUS MODEL

- *NO sampling* =>

  NO INTEPPOLATION COST

NN Modelling of 3D Object Shape

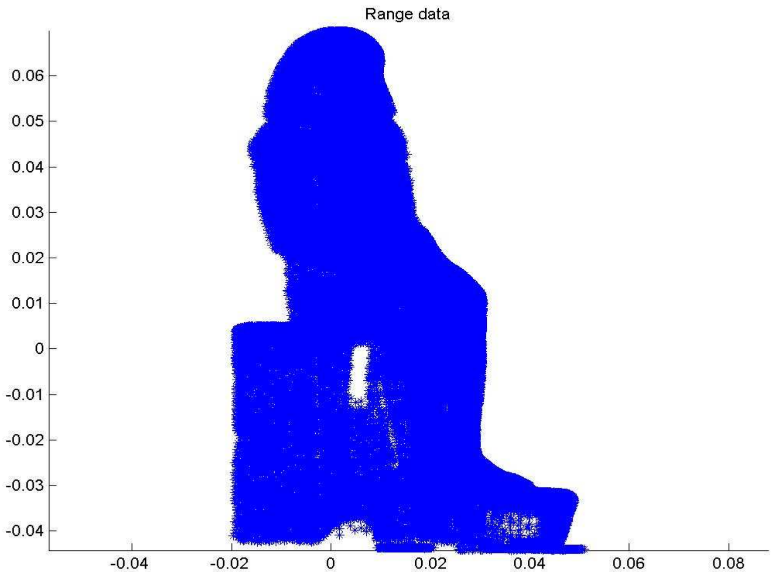
Compare the performance of three NN architectures used for 3D object shape modelling:

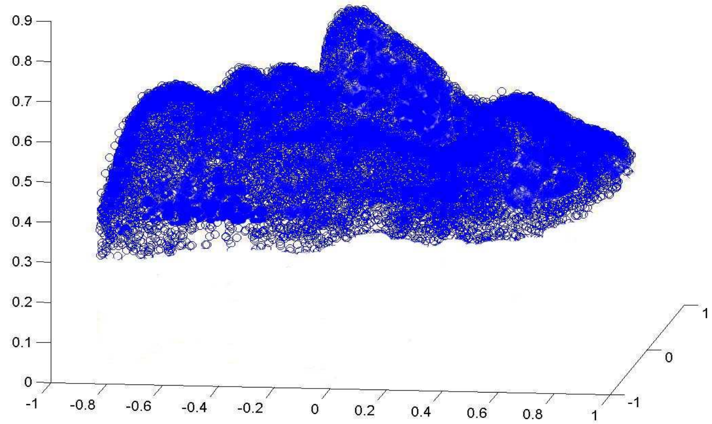
- Multilayer Feedforward (*MLFF*)
- Self-Organizing Map (*SOM*)
- Neural Gas Network

A.-M. Cretu, E.M. Petriu, G.G. Patry, "Neural-Network-Based Models of 3-D Objects for Virtualized Reality: A Comparative Study**,"** *IEEE Trans. Instrum. Meas.,"* Vol. 55, No. 1, pp.99-111, 2006.

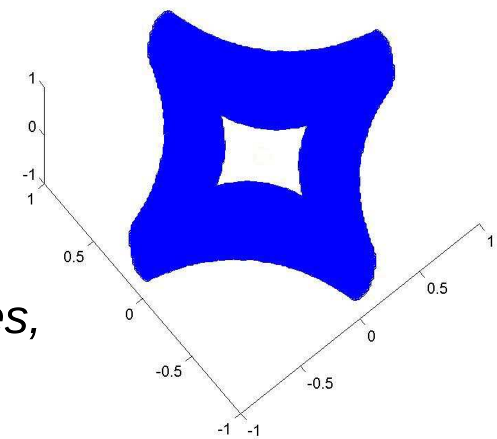
MLFF Representation - Results

19000 points, 14-7-1,
4 extra surfaces,
d=0.055, 1100 epochs,
3.3 hrs





51096 points, 20-10-1,
5 extra surfaces,
d=0.055, 2000 epochs,
5.2 hrs.



2500 points, 12-6-1,
2 extra surfaces,
d=0.06,
1020 epochs,
45 min.

SOM and Neural Gas Modelling - Results

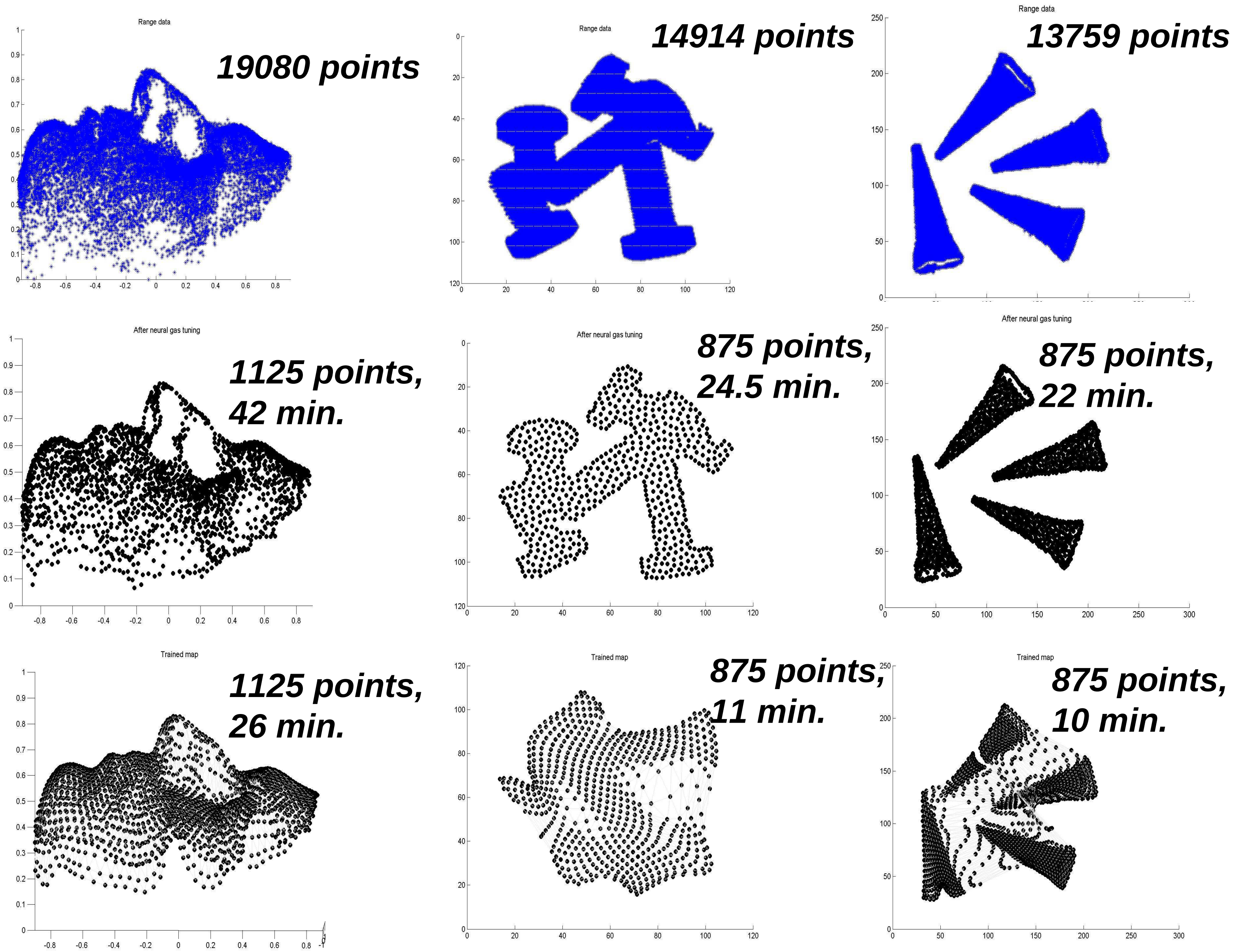
Initial point-cloud

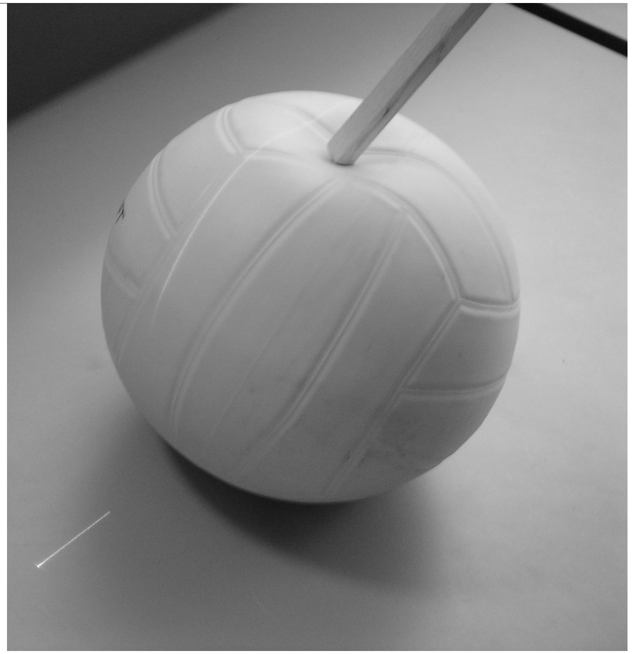
Neural Gas

er= 0.0098

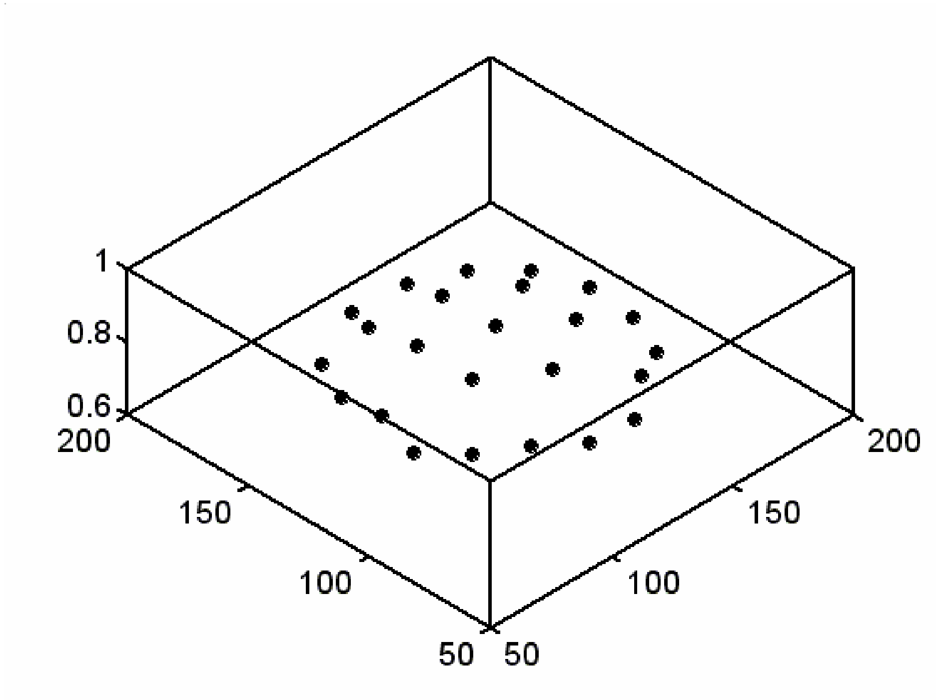
SOM

er= 0.0125



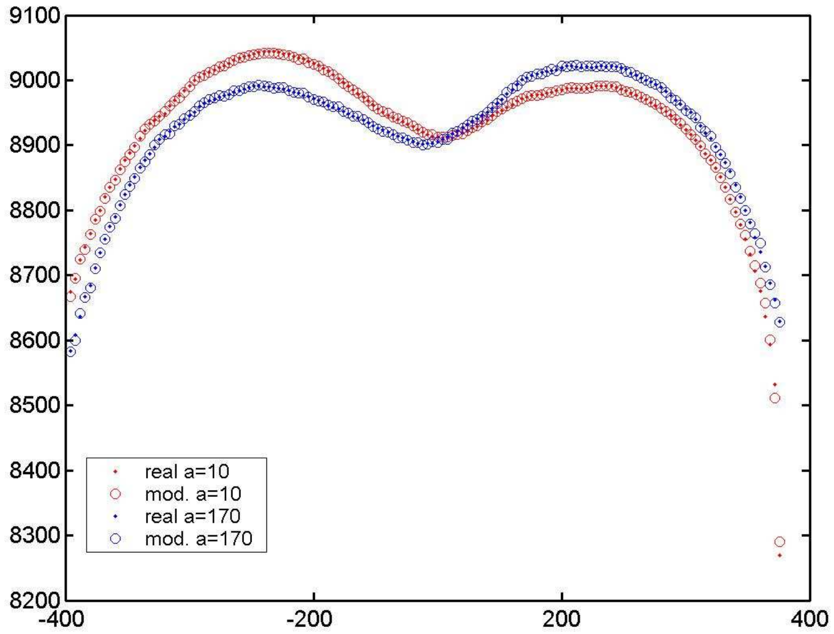


Elastic ball used
for experimentation.

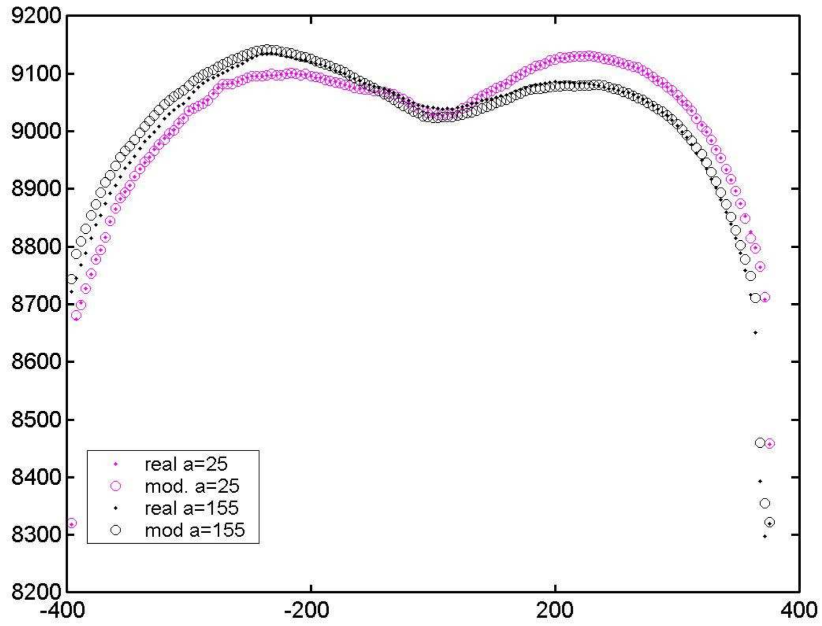


Sampling points selected with
the neural gas network for the ball.

(from A.M. Cretu, E.M. Petriu, P.Payeur "Neural Network Mapping and Clustering of Elastic Behavior from Tactile and Range Imaging for Virtualized Reality Applications," submitted to *IEEE Tr. Instr. Meas.,* Nov. 2006).



(a)



(b)

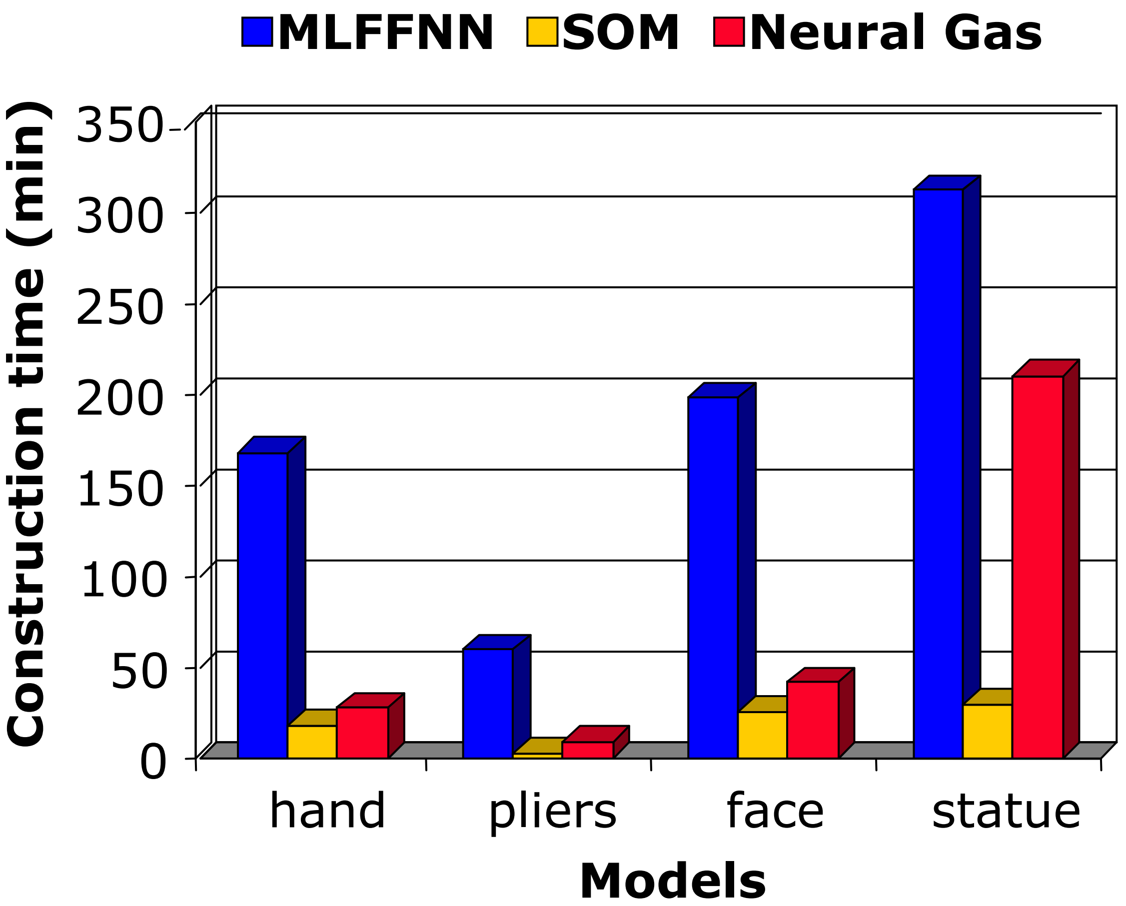
Real and modeled deformation curves using neural network for rubber under forces applied at different angles:

a) F=65N, α_1=10° and F=65N, α_2=170°,

b) F=36N, α_1=25°, and F=36N, α_2=155

(from .A.M. Cretu, E.M. Petriu, P.Payeur "Neural Network Mapping and Clustering of Elastic Behavior from Tactile and Range Imaging for Virtualized Reality Applications," submitted to *IEEE Tr. Instr. Meas.,* Nov. 2006).

MLFF, SOM, and *Natural Gas* Modelling Performance Comparison: Construction Time



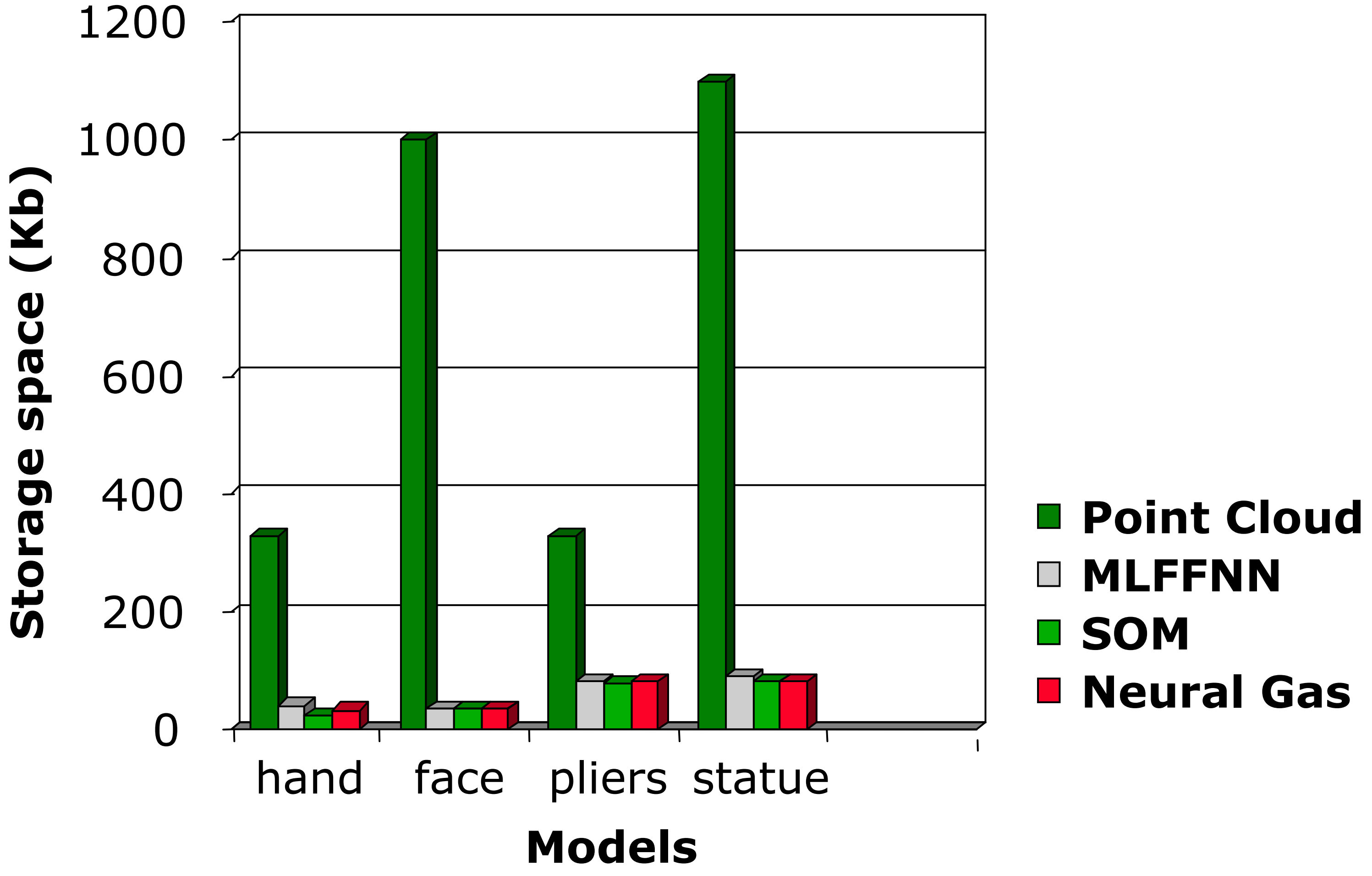
MLFNN

- computational time = construction time + generation time+rendering

SOM and Neural Gas

- computational time = construction time + rendering

MLFF, SOM, and *Natural Gas* Modelling Performance Comparison: Compactness



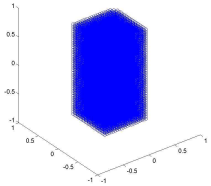
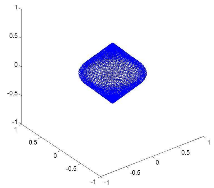
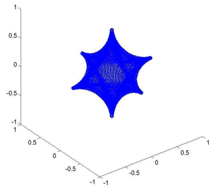
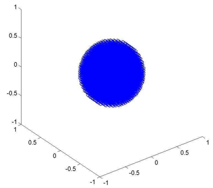
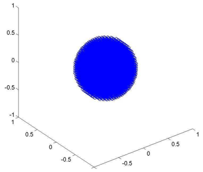
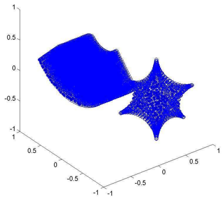
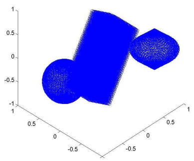
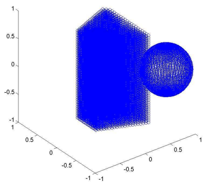
MLFF, SOM, and *Natural Gas* Modelling of 3D Objects
- conclusions -

* The use of neural network modeling is advantageous from the point of view simplicity and compactness.

* *MLFNN* – provide continuous models, information on the entire object space, convenient for many applications, however they are time consuming.

* *SOM and Neural Gas* – provide compressed models while maintaining the properties of the objects, have very good accuracy, and they are less time consuming

* The use of any specific techniques depends on the application requirements.

				
	2.4%	4.9%	1.6%	99.1%
	93.3%	3.3%	91.7%	3.1%
	95%	99.1%	5.78%	98.3%
	91.7%	6.6%	1.6%	92.5%

Symbiotic Human-Computer Partnership

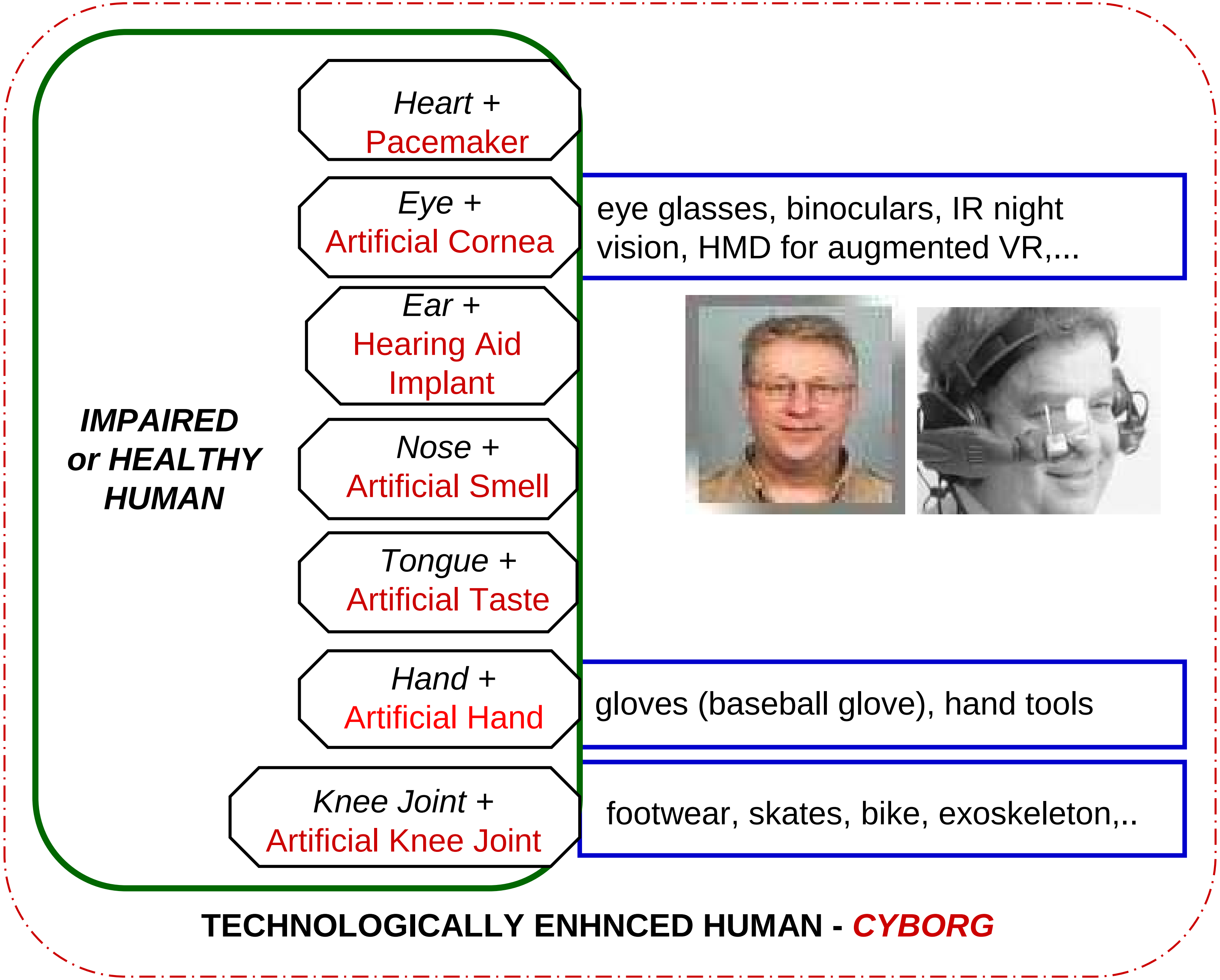
Cybernetic Perspective

As the interdisciplinary study of the structure of regulatory systems, closely related to control theory and systems theory, cybernetics is equally applicable to physical and social that is, language-based systems.

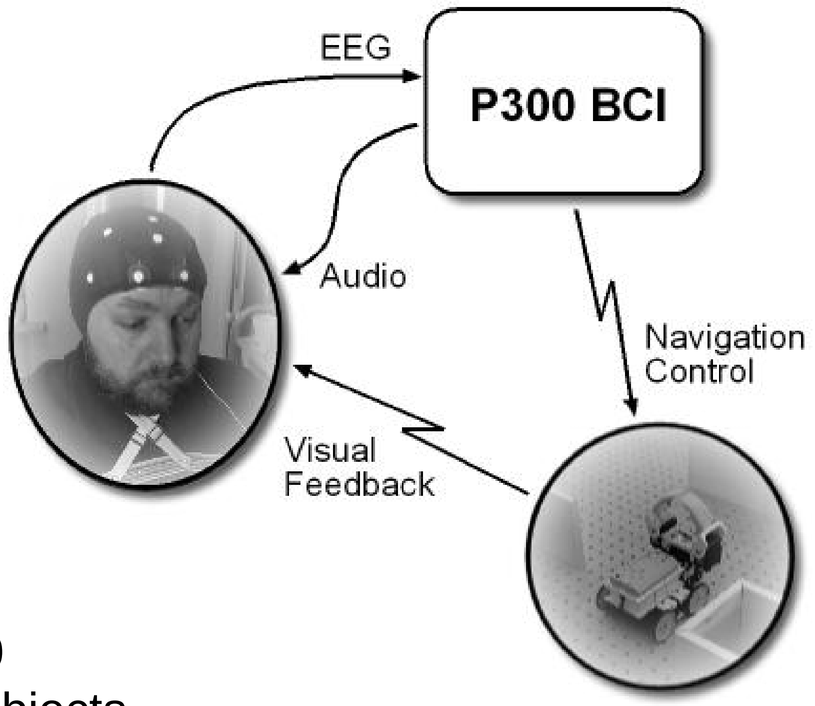
Cybernetics is preeminent when the system under scrutiny is involved in a closed signal loop, where action by the system in an environment causes some change in the environment and that change is manifest to the system via information, or feedback, that causes the system to adapt to new conditions: the system changes its behaviour. This "circular causal" relationship is necessary and sufficient for a cybernetic perspective

Discussing the aims of the human-computer symbiosis, **Licklider** writes in his seminal paper “Man-Computer Symbiosis, ”*IRE Trans. on Human Factors in Electronics*, Vol. HFE-1, pp. 4 -11, March 1960. “*It seems likely that the contributions of human operators and equipment will blend together so completely in many operations that it will be difficult to separate them neatly in analysis. That would be the case if, in gathering data on which to base a decision, for example, both the man and the computer came up with relevant precedents from experience and if the computer then suggested a course of action that agreed with the man's intuitive judgment*.”

Enhancing Human Natural Capabilities … Including Survivability


Heart +
Pacemaker
Eye +
Artificial Cornea
eye glasses, binoculars, IR night vision, HMD for augmented VR,...
Ear +
Hearing Aid Implant
IMPAIRED or HEALTHY HUMAN
Nose +
Artificial Smell
Tongue +
Artificial Taste
Hand +
Artificial Hand
gloves (baseball glove), hand tools
Knee Joint +
Artificial Knee Joint
footwear, skates, bike, exoskeleton,..
TECHNOLOGICALLY ENHNCED HUMAN - CYBORG

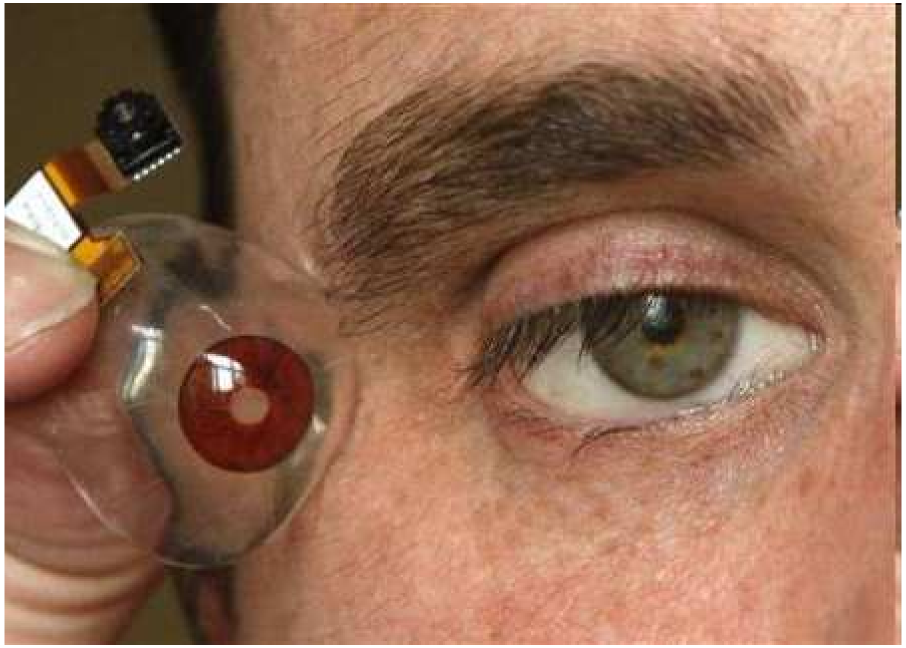
Neural Network Classification of Brain-Computer Interface Data for the Telecontrol of Symbiotic Sensor Agents



Brain-Computer Interfaces (BCI) 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

Prosthetic Eye [REUTERS/Yves Herman]

Canada's filmmaker Rob Spence, who lost his right eye when he was a child, shows a prototype of a prosthetic eye which will be transformed into a video camera, during a conference in Brussels March 5, 2009.
Spence, director and producer in Toronto, said he would use the eye-cam the same way he uses a video camera to carry out the so-called "EyeBorg Project".
In using his eye as a wireless video camera, Spence wants to make a documentary about how video and humanity intersect especially with regards to surveillance.



http://www.reuters.com/news/pictures/rpSlideshows?articleId=USRTXCF63#a=6

Honda to Showcase Experimental

Walking Assist Device at BARRIER FREE 2008

http://world.honda.com/news/2008/c080422Experimental-Walking-Assist-Device/

TOKYO, Japan, April 22, 2008– Honda Motor Co., Ltd. will showcase an experimental model of a walking assist device which could support walking for the elderly and other people with weakened leg muscles, at the Int. Trade Fair on Barrier Free Equipments & Rehabilitation for the Elderly & the Disabled (BARRIER FREE 2008) … at Intex Osaka, Friday, April 25 through Sunday, April 27, 2008 Honda began research of a walking assist device in 1999 with a goal to provide more people with the joy of mobility.

…..

The cooperative control technology utilized for this device is a unique Honda innovation … Applying cooperative control based on the information obtained from hip angle sensors, the motors provide optimal assistance based on a command from the control CPU.

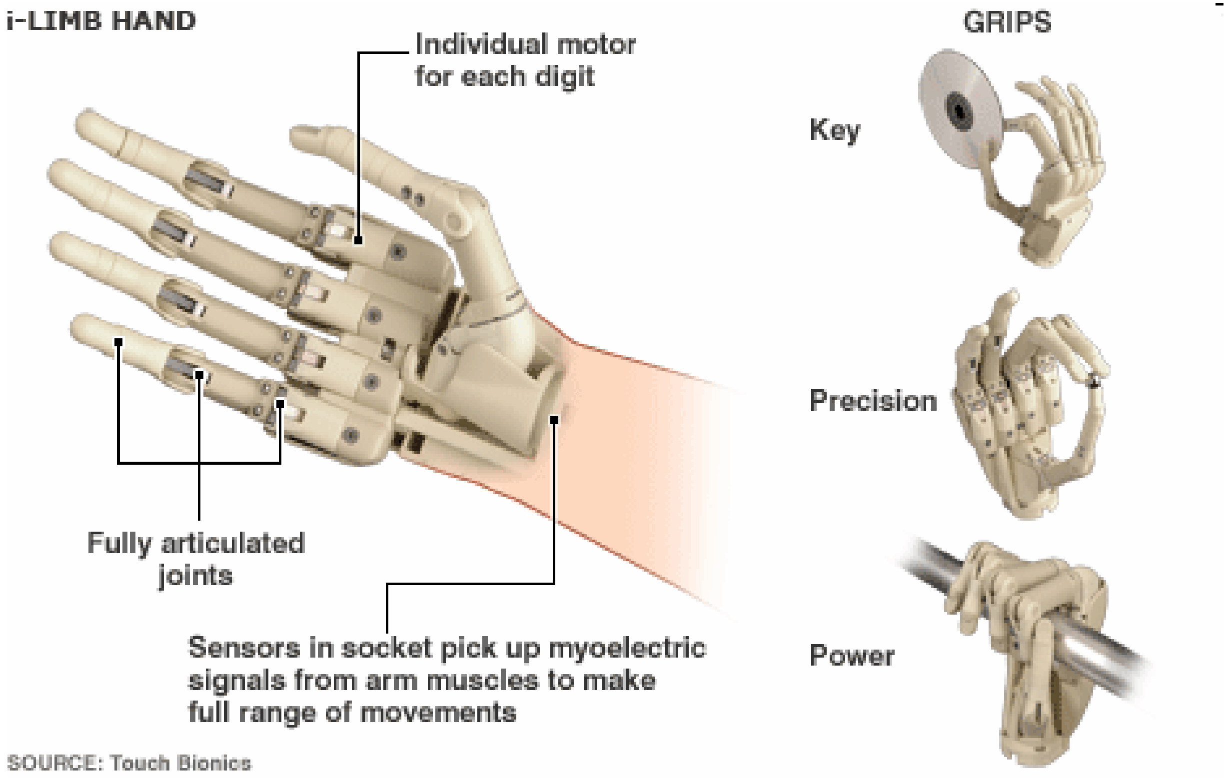
Robo-skeleton lets paralysed walk
http://news.bbc.co.uk/2/hi/health/7582240.stm

A robotic suit is helping people paralysed from the waist down do what was previously considered impossible - stand, walk and climb stairs. ReWalk users wear a backpack device and braces on their legs and select the activity they want from a remote control wrist band. Leaning forwards activates body sensors setting the robotic legs in motion. Users walk with crutches, controlling the suit through changes in centre of gravity and upper body movements.

The i-LIMB, a prosthetic device with five individually powered digits, beat three other finalists to win 2008 MacRobert award.

http://news.bbc.co.uk/2/hi/science/nature/7443866.stm

"The hand has two main unique features," explained Stuart Mead, CEO of Touch Bionics. "The first is that we put a motor into each finger, which means that each finger is independently driven and can articulate. "The second is that the thumb is rotatable through 90 degrees, in the same way as our thumbs are. "The hand is the first prosthetic hand that replicates both the form and the function of the human hand."



Brain Prosthesis which learns/models with an ever increasing fidelity the behaviour of the natural brain so it can be used as *behavioural-memory prosthesis* (**BMP**) to make up for the loss in the natural brain's functions due to dementia, Alzheimer disease, etc. It is quite conceivable that such a BMP could arrive in extremis to complete replace the functions of the natural brain.

Moth Pupa + MEMS Chip = Remote Controlled Cyborg Insect

http://blogs.spectrum.ieee.org/automaton/2009/02/17/moth_pupa_mems_chip_remote_controlled_cyborg_insect.html

IEEE Spectrum On Line - IEEE Spectrum's blog on robots and other silicon-brained contraptions

Turning moths (or pigeons, rats, beetles, bees, and sharks, for that matter) into remote controlled cyborg critters has long been a goal of mad scientists and DARPA program managers. Spectrum's Sally Adee reports on the latest initiatives of DARPA's HI-MEMS, or Hybrid Insect Micro-Electro-Mechanical Systems project. …researchers at the Boyce Thompson Institute for Plant Research, in Ithaca, N.Y …are making progress toward their goal of growing MEMS-insect hybrids. In a paper presented at *IEEE MEMS 2009* they describe "silicon neural interfaces for gas sensors that were inserted into insects during the pupal phase." The idea is that the moths could carry such sensors during search-and-rescue and reconnaissance missions.

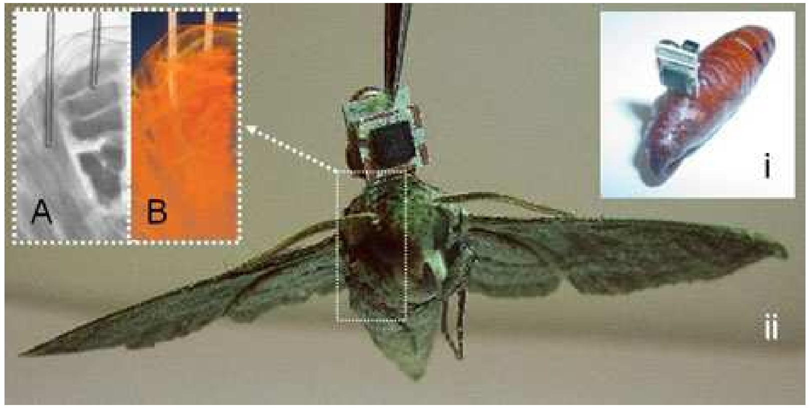


PHOTO: Boyce Thompson Institute

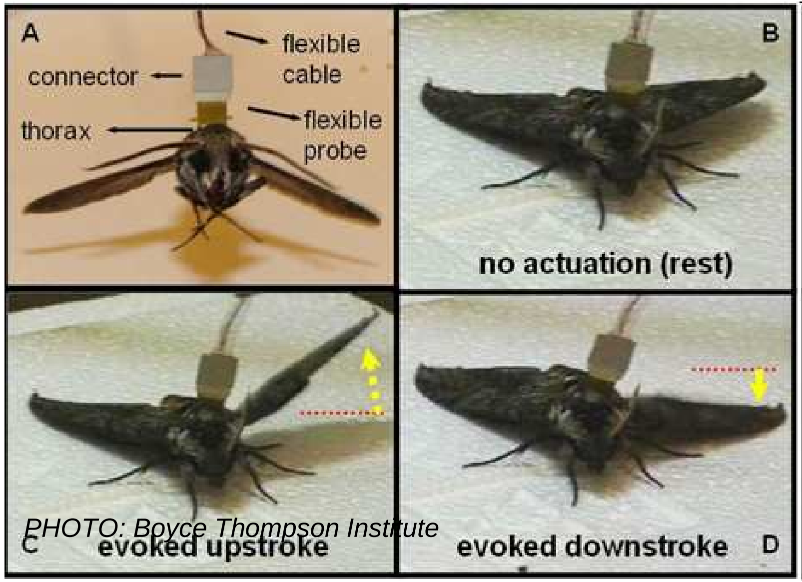


PHOTO: Boyce Thompson Institute

Machines will achieve human-level artificial intelligence by 2029, a leading US inventor has predicted.

http://news.bbc.co.uk/2/hi/americas/7248875.stm

Humanity is on the brink of advances that will see tiny robots implanted in people's brains to make them more intelligent, said **Ray Kurzweil.**
The engineer believes machines and humans will eventually merge through devices implanted in the body to boost intelligence and health.

Tiny machines could roam the body curing diseases

Man versus machine

"I've made the case that we will have both the hardware and the software to achieve human level artificial intelligence with the broad suppleness of human intelligence including our emotional intelligence by 2029," he said. ….. "We'll have intelligent nanobots go into our brains through the capillaries and interact directly with our biological neurons," The nanobots, he said, would "make us smarter, remember things better and automatically go into full emergent virtual reality environments through the nervous system".

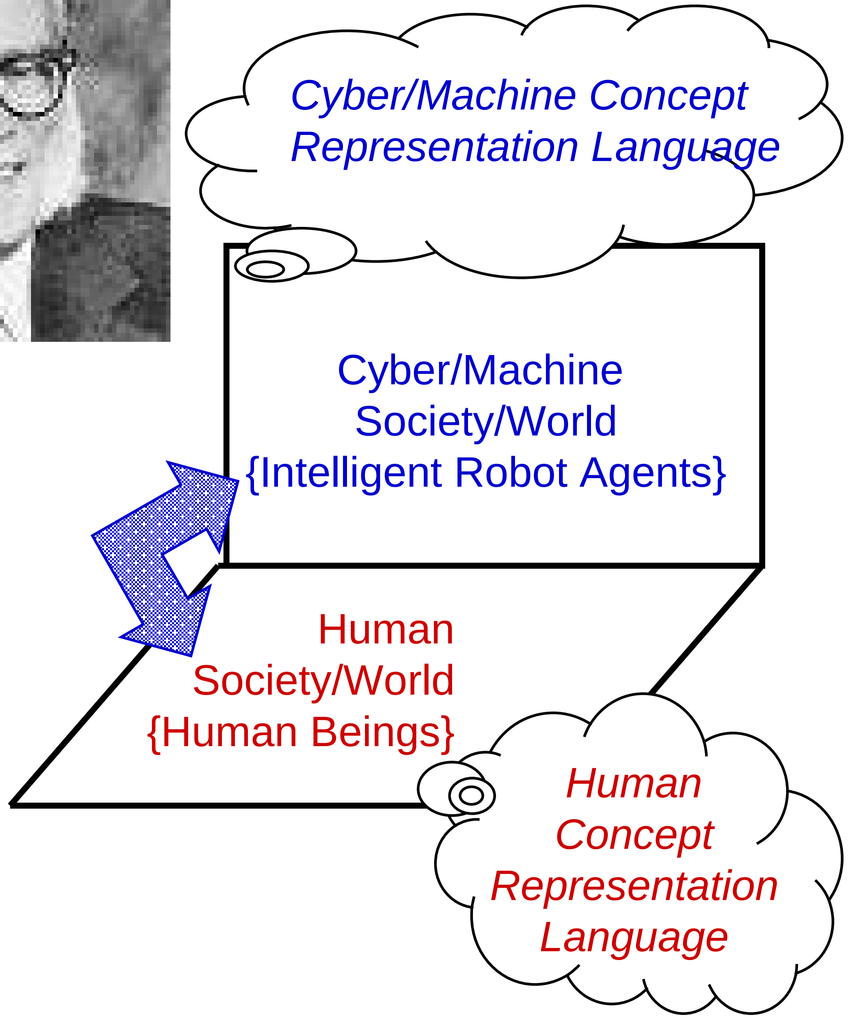
Mr Kurzweil is one of 18 influential thinkers chosen to identify the great technological challenges facing humanity in the 21st century by the US National Academy of Engineering.

Asimov's laws of the robotics:

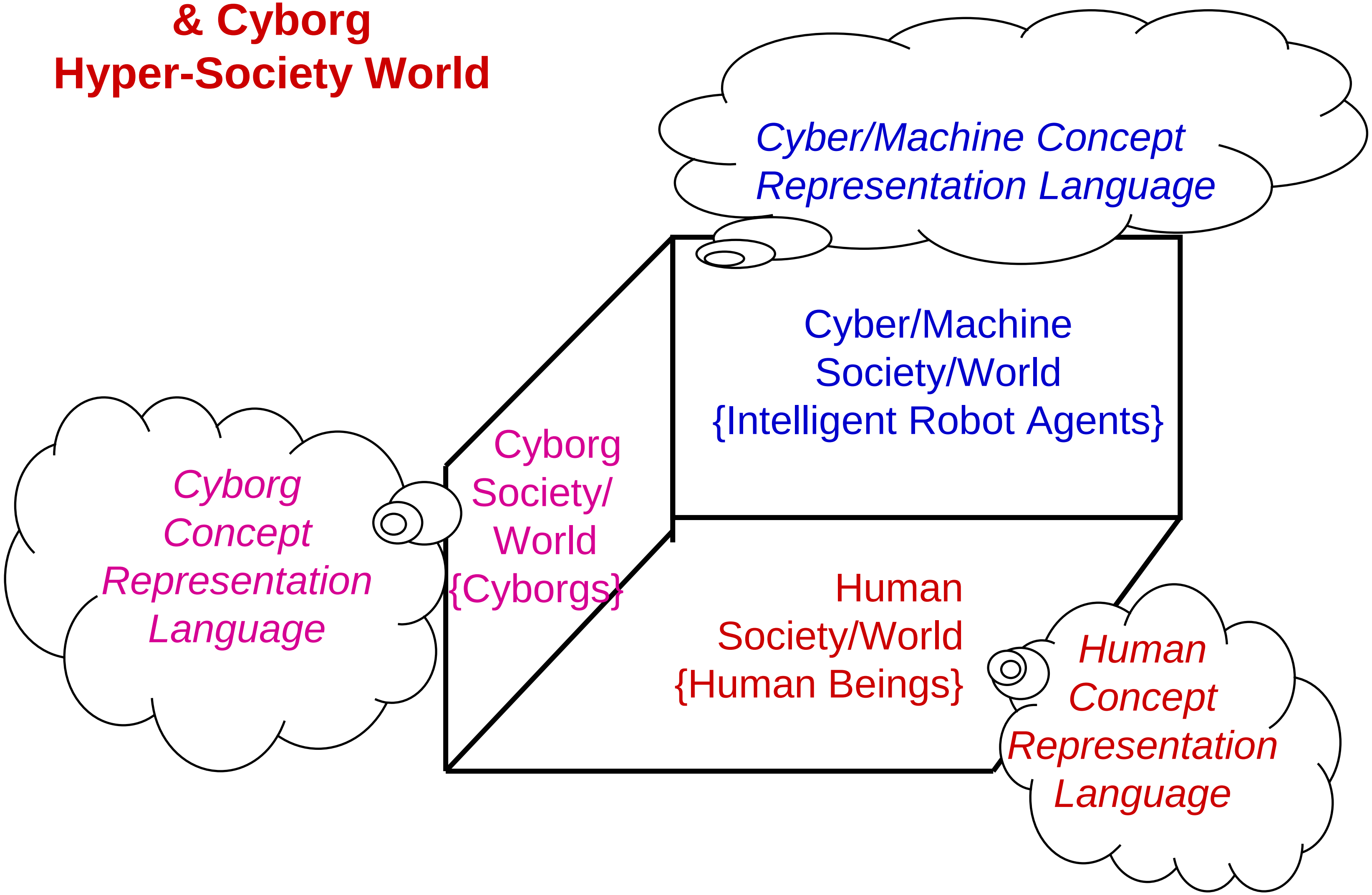
1st law: "A robot must not harm a human being or, through inaction allow one to come to harm".

2nd law: "A robot must always obey human beings unless that is in conflict with the 1st law".

3rd law: "A robot must protect itself from harm unless that is in conflict with the 1st and 2nd law".



Multi-Cultural
Human & Cyber
& Cyborg
Hyper-Society World



***Asimov's laws of the robotics*:**

0^{th} law: "A robot may not injure humanity or, through inaction, allow humanity to come to harm."

1^{st} law- updated: "A robot must not harm a human being or, through inaction allow one to come to harm, unless this would violate the 0^{th} law."

2^{nd} law: "A robot must always obey human beings unless that is in conflict with the 1^{st} law".

3^{rd} law: "A robot must protect itself from harm unless that is in conflict with the 1^{st} and 2^{nd} law".

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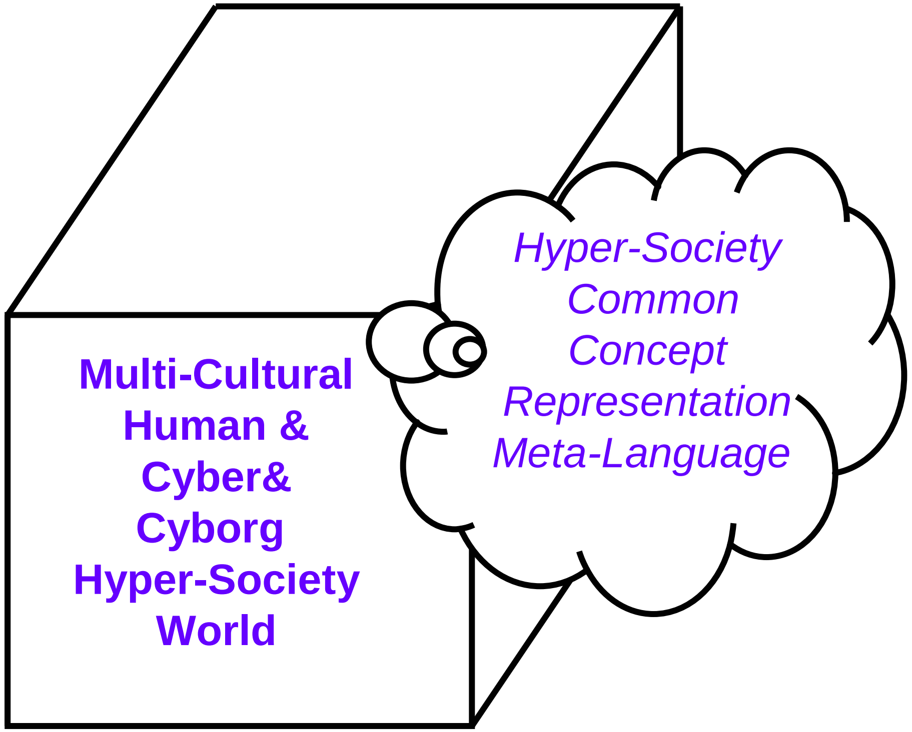
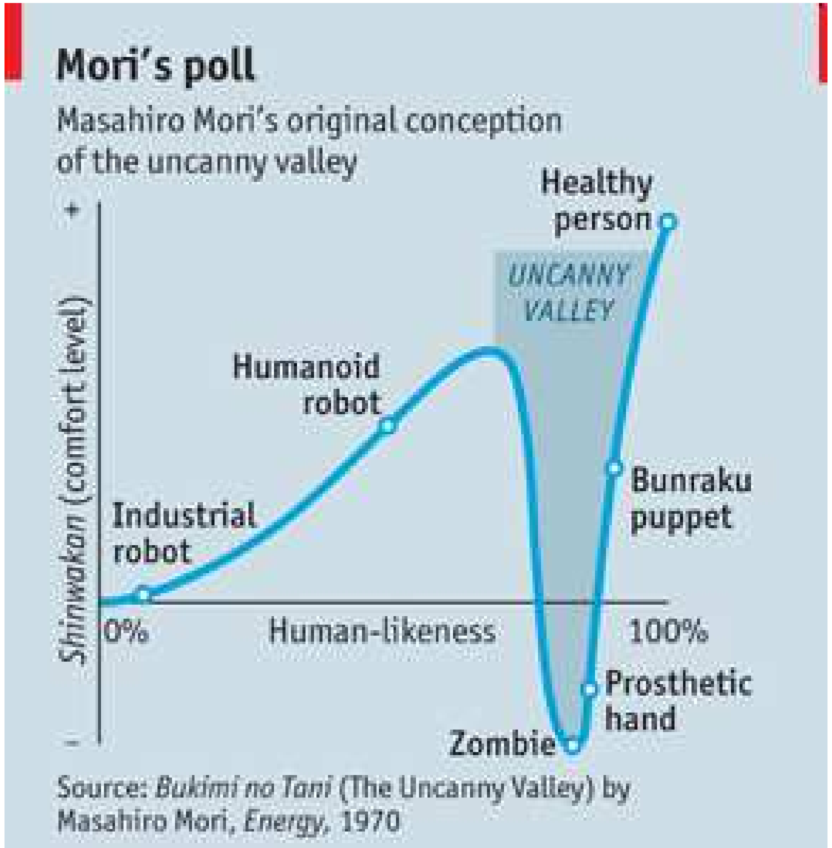
[*] I. Asimov, *Robots and Empire*, Doubleday & Co., NY 1985, p.291



Moral, Ethical, Theological, Legal, Biological, Psychological, Social, …. Challenges in a CYBORG Hyper-Society World

Crossing the uncanny valley:
As computer graphics and robots get more human, they often seem more surreal

[The Economist, Nov 18th 2010 , http://www.economist.com/node/17519716]



"The idea of the **uncanny valley** was originally proposed by Masahiro Mori, a Japanese roboticist, in 1970. Though he had no hard data, his intuition was that increasing humanness in a robot was positive only up to a certain point. Dr Mori drew a graph with "human-likeness" on the horizontal axis and a quality he called *shinwakan* (variously translated as "familiarity" and "comfort level") on the vertical one. As an object or image looks and behaves more like a human, the viewer's level of *shinwakan* increases. Beyond a certain point, however, the not-quite-human object strikes people as creepy, and *shinwakan* drops. This is the uncanny valley. Only when the object becomes almost indistinguishable from a human does *shinwakan* increase again."

Moral, Ethical, Theological, Legal, Biological, Psychological Social, Economic, Challenges in a CYBORG Hyper-Society World

[Normal Human Partner] + [Pacemaker-fitted Human Partner]
= [Acceptable Married (incl. Lovers) Couple]

[Normal Human Partner] + [Advanced Augmented Symbiont Partner]
= [Acceptable Married (incl. Lovers)_Couple] ?

[Normal Human Partner] + [Robot Partner]
= [Acceptable Married (incl. Lovers)_Couple] ???

Sex and marriage with robots? It could happen Robots soon will become more human-like in appearance, researcher says

http://www.msnbc.msn.com/id/21271545/

By Charles Q. Choi / Special to LiveScience, Fri., Oct. 12, 2007

Humans could marry robots within the century. And consummate those vows. "My forecast is that around 2050, the state of Massachusetts will be the first jurisdiction to legalize marriages with robots," artificial intelligence researcher David Levy at the University of Maastricht in the Netherlands told LiveScience.

Will we humans one day truly love robots just like we love other humans?

http://blogs.spectrum.ieee.org/automaton/2008/04/08/will_we_humans_one_day_truly_love_robots_just_like_we_love_other_humans.html

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Rent an Actroid to love and marry

http://blogs.spectrum.ieee.org/automaton/2008/04/09/rent_an_actroid_to_love_and_marry.html

Merci

THANK YOU

Vielen Dank

متشكرم

Gracias

Teşekkürler

Hvala

Köszönettel

Multumesc

謝 謝

Bedankt

Obrigado!

Grazie

Asante

ありがとう！

Ευχαριστώ

شكريا

Dankie

감사합니다

Urakoze

شكراً

ขอบคุณ

WAD MAHAD
SAN TAHAY

DMnvwd

Díky

GADDA GUEY