STATE OF THE ART IN HUMAN COMPUTER INTERACTION

INTERACTION AND INTELLIGENCE

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Tokyo Denki Univ.

CONTENTS

- INTRODUCTION

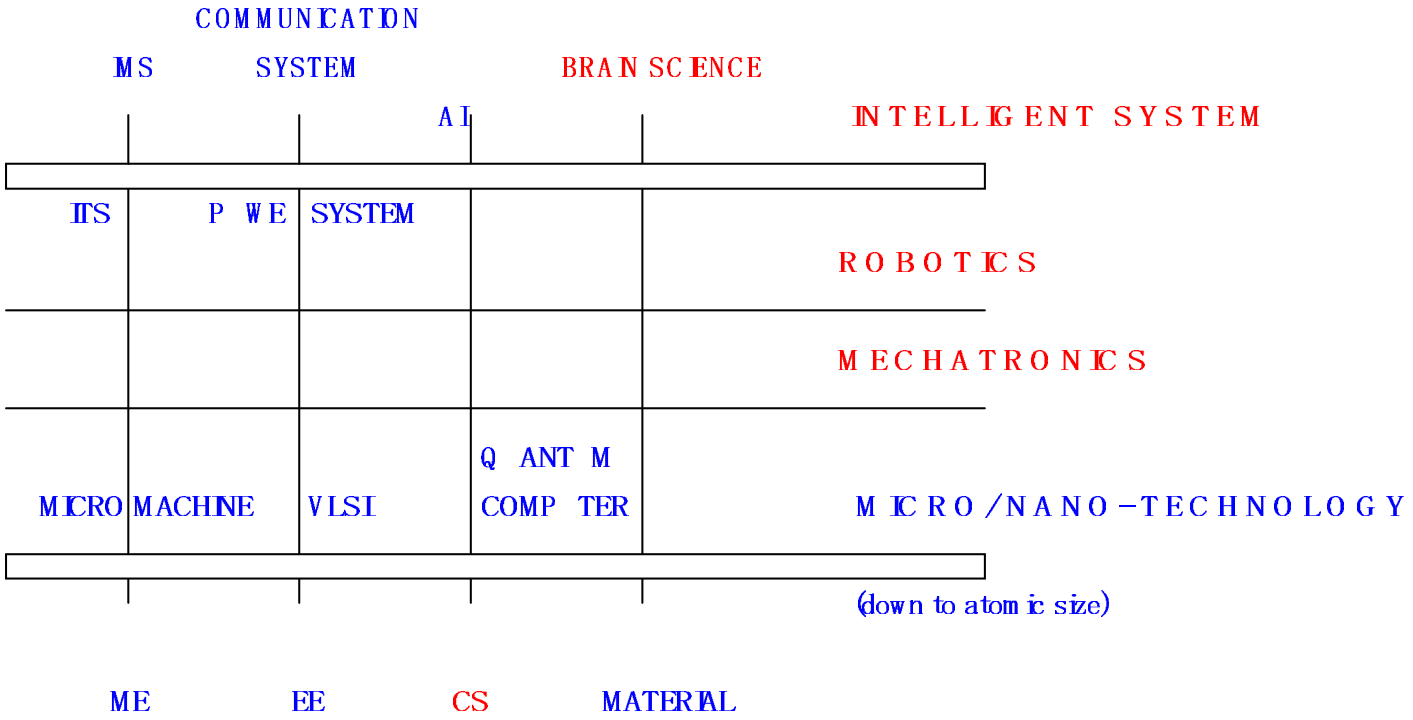
- ROLE OF SCIENCE AND TECHNOLOGY IN FUTURE SOCIETY

- CURRENT STATUS OF HUMAN COMPUTER INTERACTION

- PROJECT “INTERACTION AND INTELLIGENCE”

- SEVERAL EXAMPLES

- CONCLUDING REMARKS


COMMUNICATION
MS
SYSTEM
BRAIN SCIENCE
AI
INTELLIGENT SYSTEM
ITS
PWE
SYSTEM
ROBOTICS
MECHATRONICS
QUANTM
MICRO MACHINE
VLSI
COMPUTER
MICRO/NANO-TECHNOLOGY
(down to atomic size)
ME
EE
CS
MATERIAL

WHERE ARE WE

Science and Technology

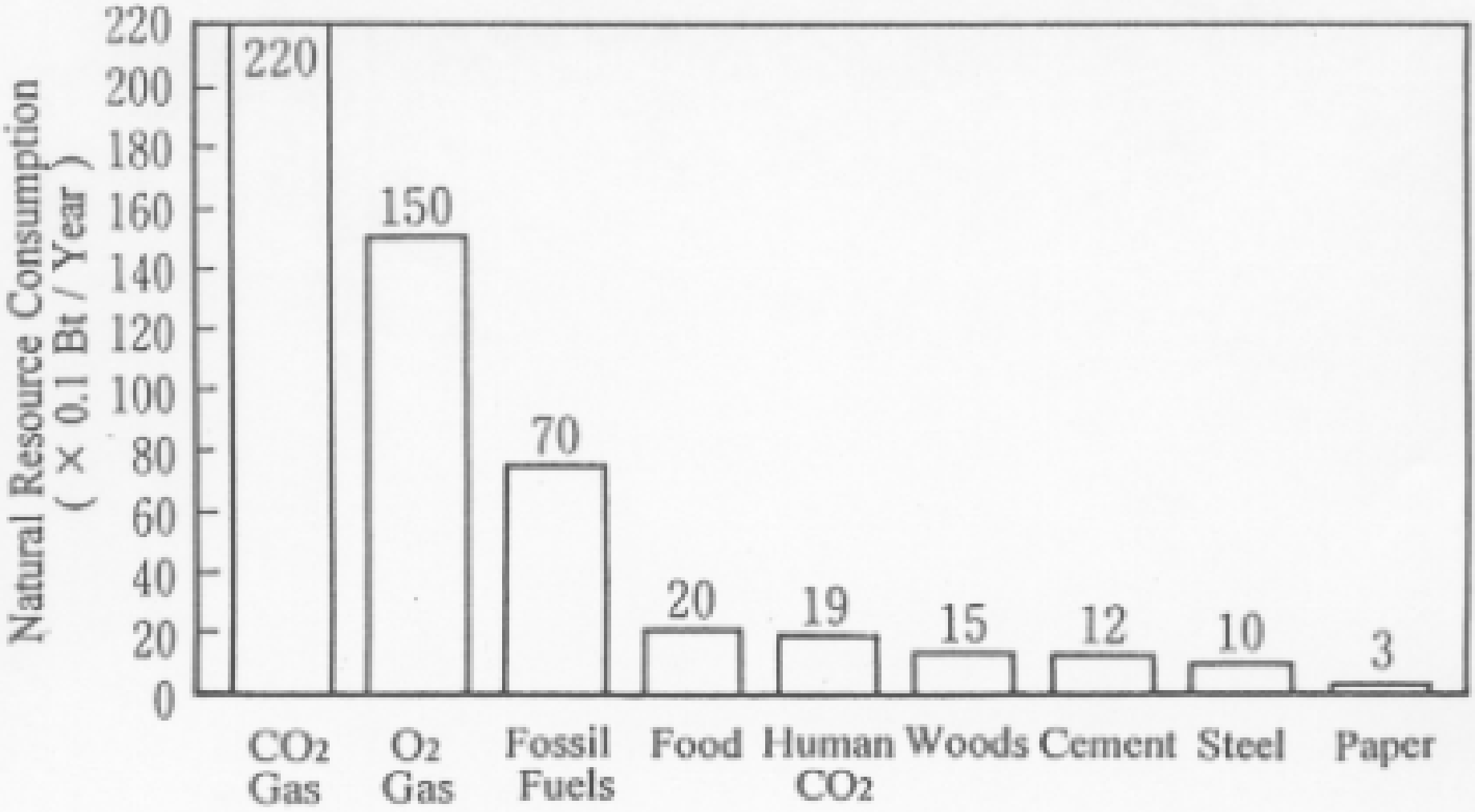
Past: War and Economic Growth

Present: Economic Growth
Human Survival

Future: Intelligent Human Life

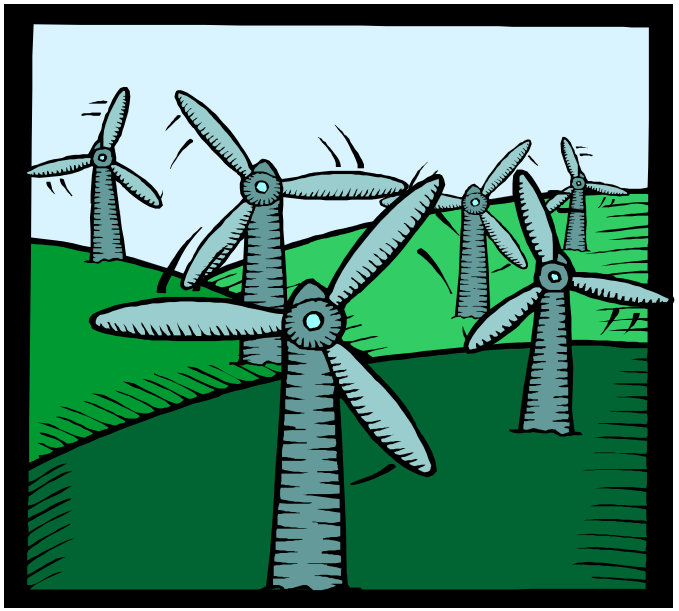
OUR GOALS

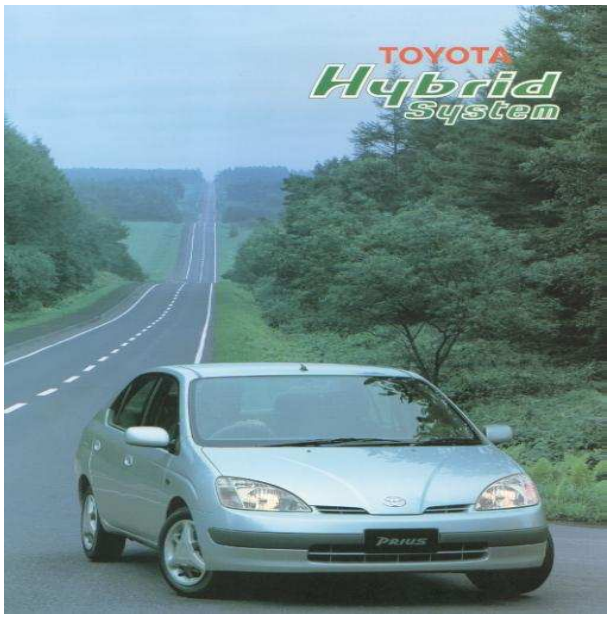
- **CLEAN ENVIRONMENT**
- **HAPPY AGING SOCIETY**
- **INTELLIGENT HUMAN LIFE**


Natural Resource Consumption
(× 0.1 Bt / Year)
220
200
180
160
140
120
100
80
60
40
20
0
220
150
70
20
19
15
12
10
3
CO2 Gas
O2 Gas
Fossil Fuels
Food
Human CO2
Woods
Cement
Steel
Paper

ENVIRONMENTAL ISSUES

- **DISTRIBUTED POWER SYSTEMS**
- **ELECTRIC/HYBRID VEHICLES**






'00 11 2

ELECTRIC VEHICLE

HYBRID CAR

100km/3litter gas

FUEL CELL EV

ZERO EMISSION

CO_2 ISSUE

One human generates 1 Kg CO_2/day

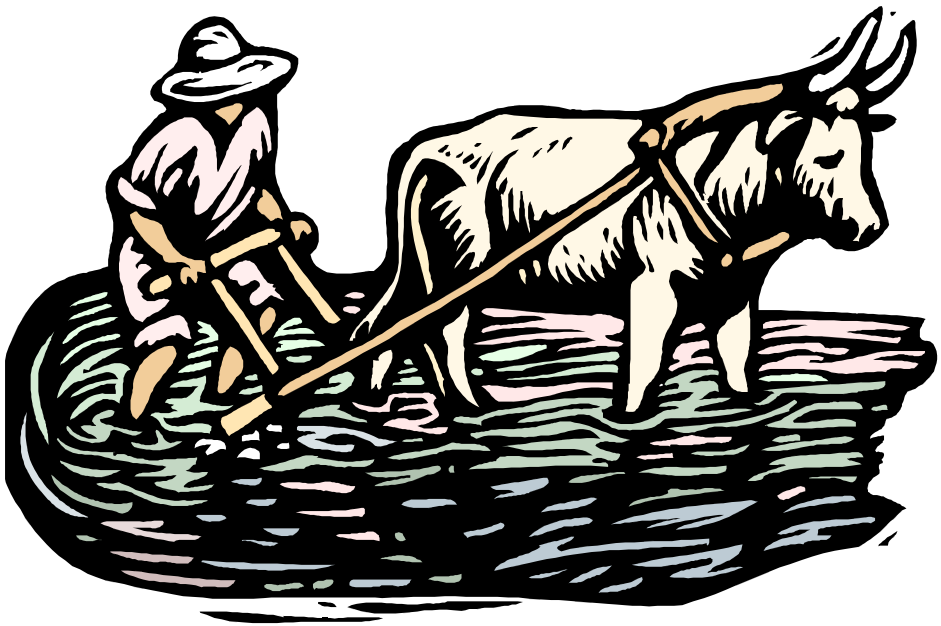
Human society generates
ten times CO_2 of human generation

This means
one human has ten mechanical slaves

Slaves are
air conditioners, cars, heaters,
telephones, PCs, etc

One Japanese has 25 slaves
One American has 55 slaves

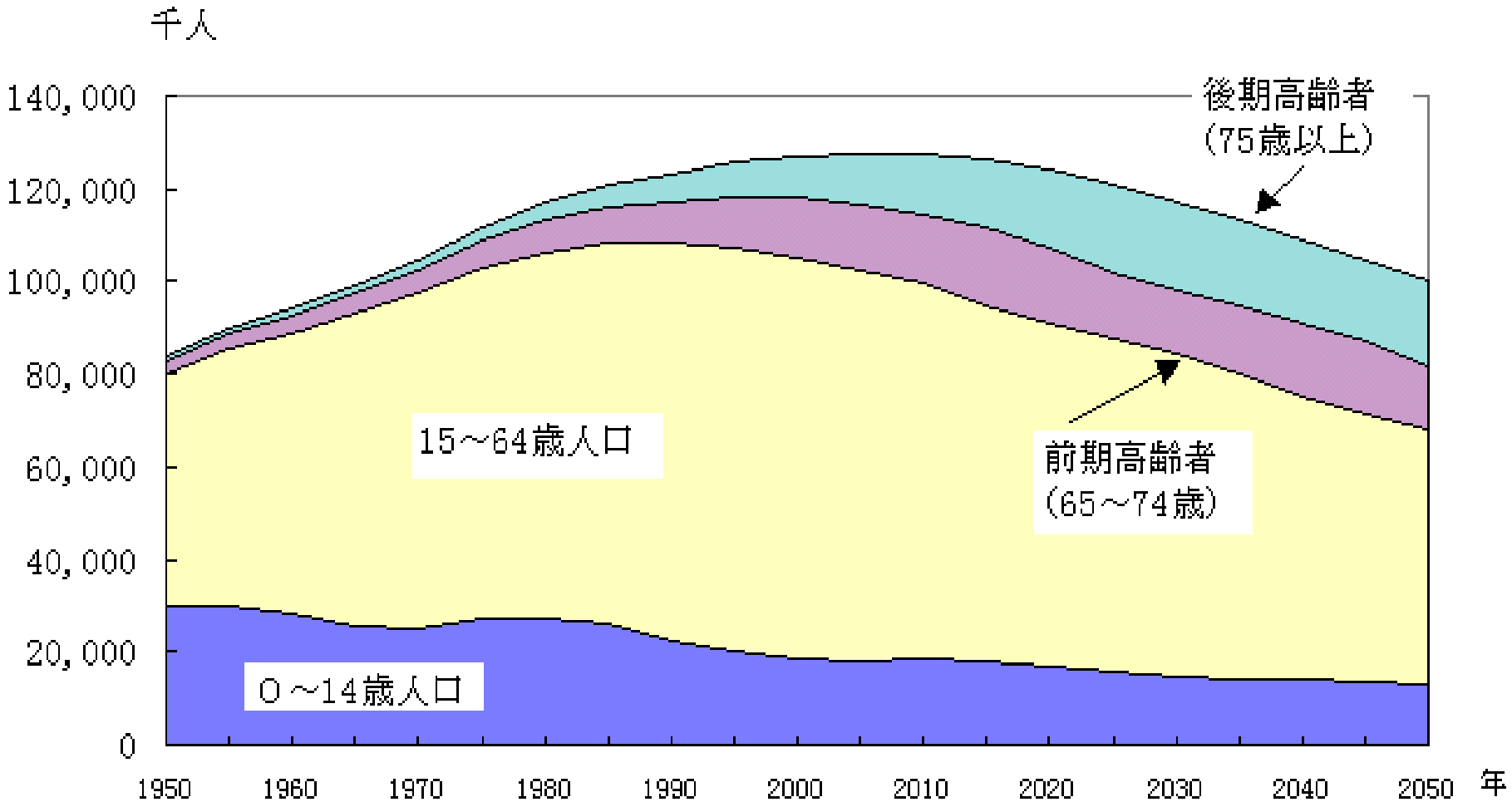
How many
For German?



OUR GOALS

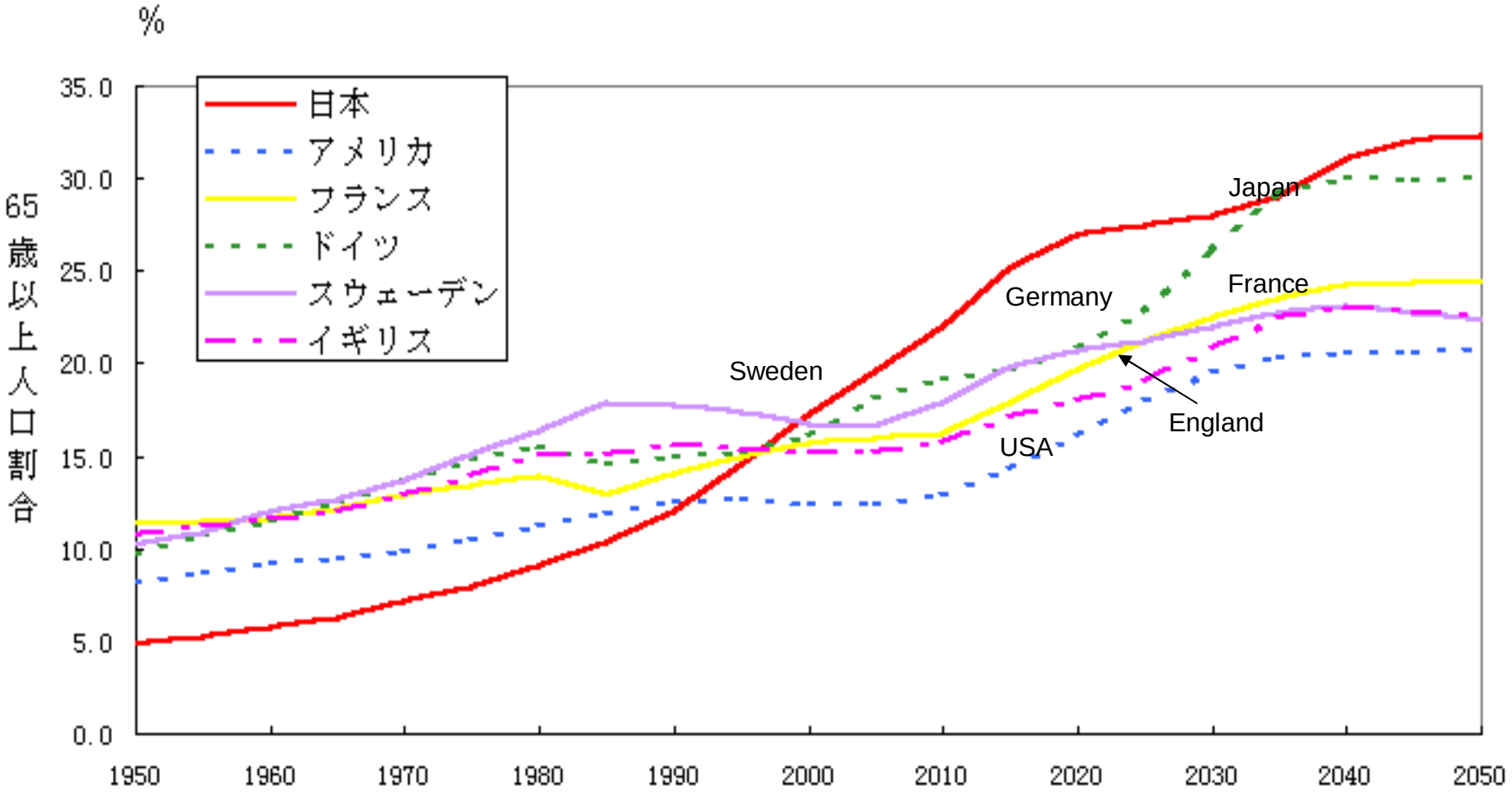
- **CLEAN ENVIRONMENT**
- **HAPPY AGING SOCIETY**
- **INTELLIGENT HUMAN LIFE**

Population of Japan



資料：総務庁統計局「国勢調査」
厚生省国立社会保障・人口問題研究所「日本の将来推計人口」（平成９年１月推計：中位推計）

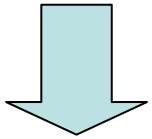
Percentage of Population 65 Years Old and Over



資料：総務庁統計局「国勢調査」

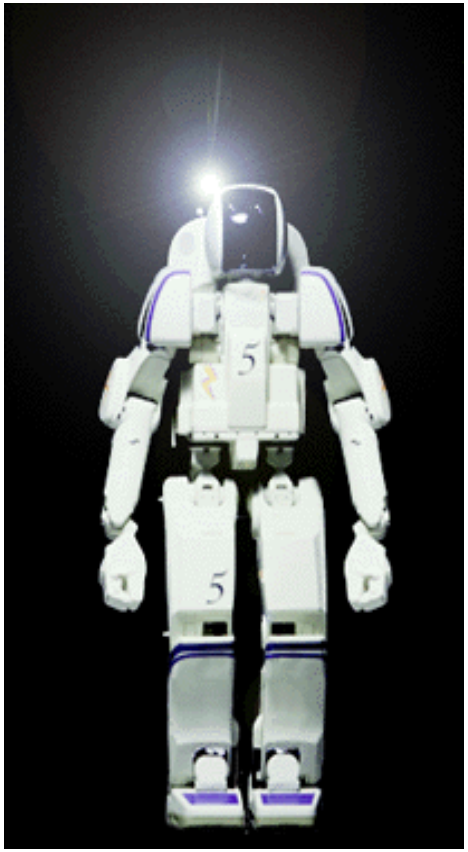
Robots in Aging Societies

- We need robots,
  - which could be used in unknown environments,



Intelligent Robots
with improved autonomy.
with improved abilities by cooperating with humans.

Intelligent Autonomous Robots



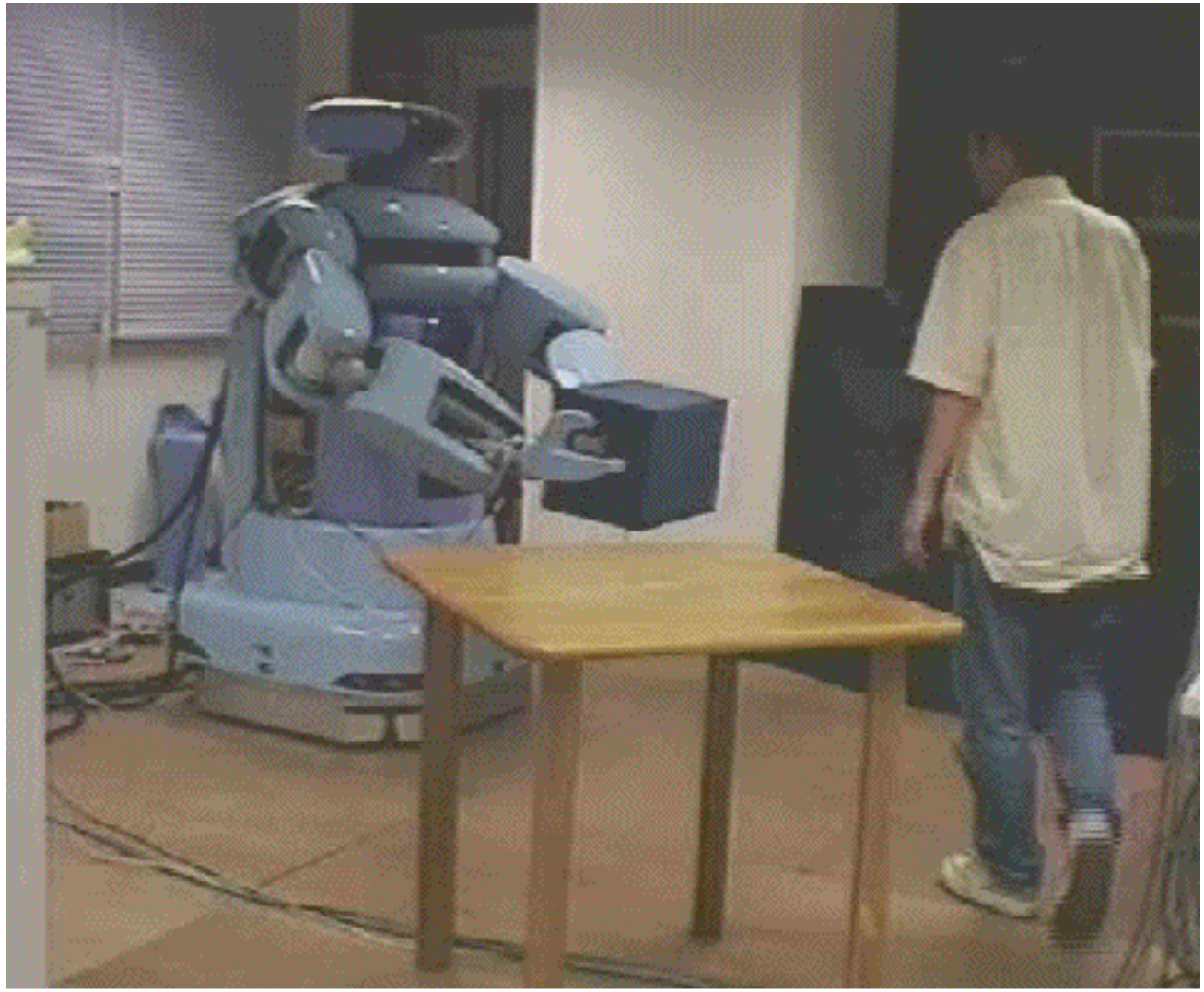
- Robots with mobility
  - humanoid robots
  - which could be used together with humans.
  - mobile manipulators
  - robot helpers
  - robot assistants

Human Friendly Robots

MR Helper
- Mobile Robot Helper -

DR Helper
- Distributed Robot Helpers -

Manipulation of an Object with MR Helper

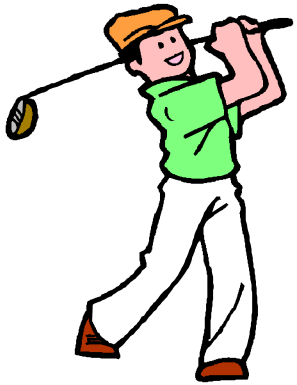


OUR GOALS

- **CLEAN ENVIRONMENT**
- **HAPPY AGING SOCIETY**
- **INTELLIGENT HUMAN LIFE**

Future Direction
beyond the year 2050

Science and Technology which Enhances Human Intelligence

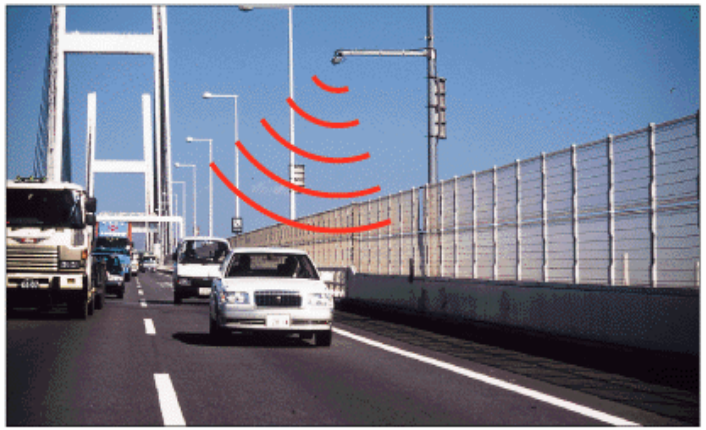


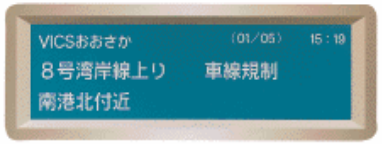
THE KEY ISSUE IS

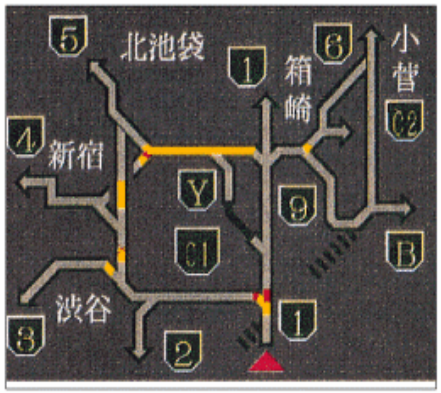
HUMAN COMPUTER INTERACTION

INTELLIGENT TRANSPORTATION SYSTEM

VICS







※VICS;Vehicle Information and Communication System

AHS

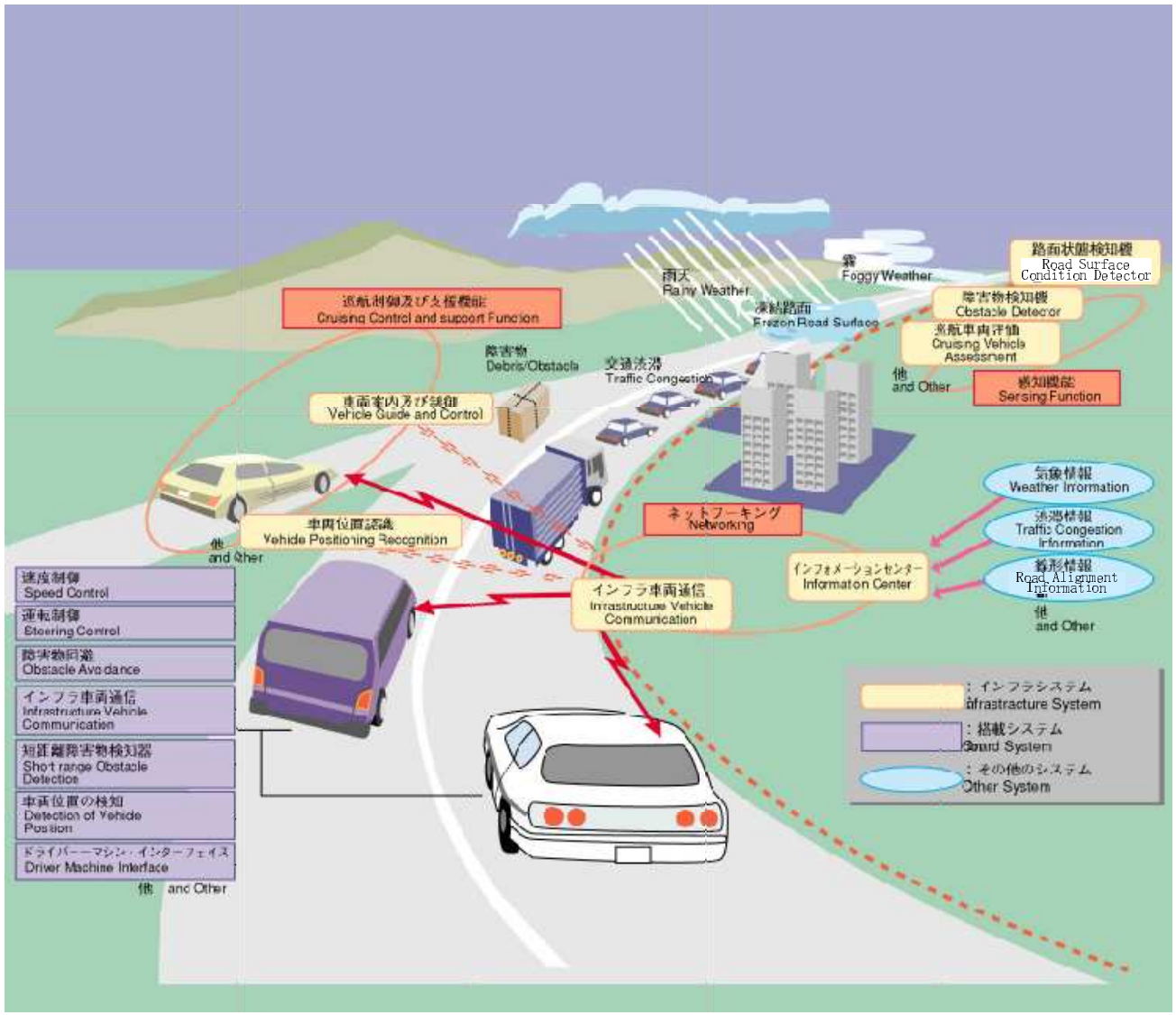
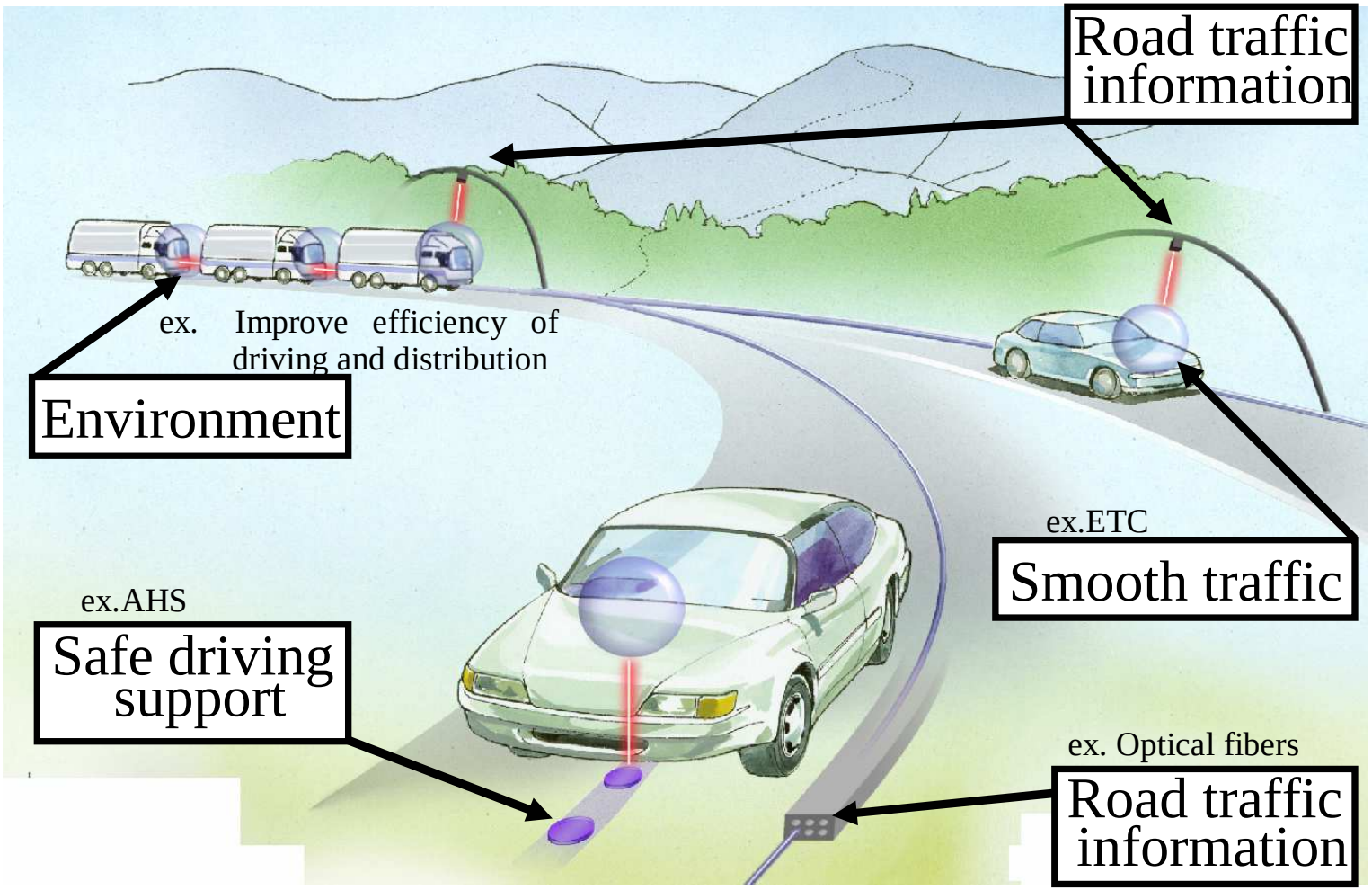
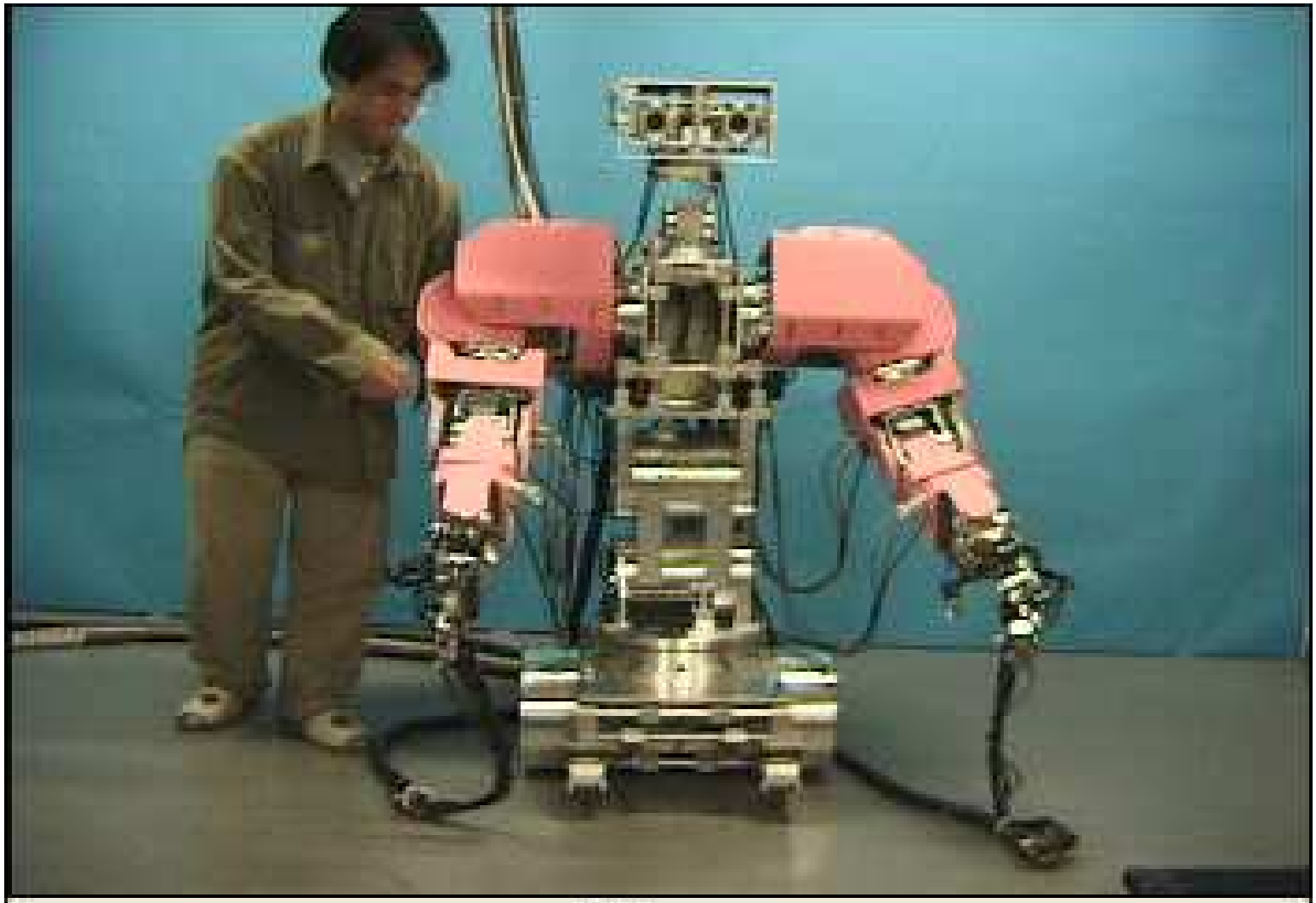

Cruising Control and support Function
Vehicle Guide and Control
Vehicle Positioning Recognition
Networking
Infrastructure Vehicle Communication
Information Center
Weather Information
Traffic Congestion Information
Road Alignment Information
Sensing Function
Cruising Vehicle Assessment
Obstacle Detector
Road Surface Condition Detector
Rainy Weather
Foggy Weather
Frozen Road Surface
Debris/Obstacle
Traffic Congestion
and Other
Speed Control
Steering Control
Obstacle Avoidance
Infrastructure Vehicle Communication
Short range Obstacle Detection
Detection of Vehicle Position
Driver Machine Interface
: Infrastracture System
: Other System

Image of Smartway



早稲田1



早稲田2

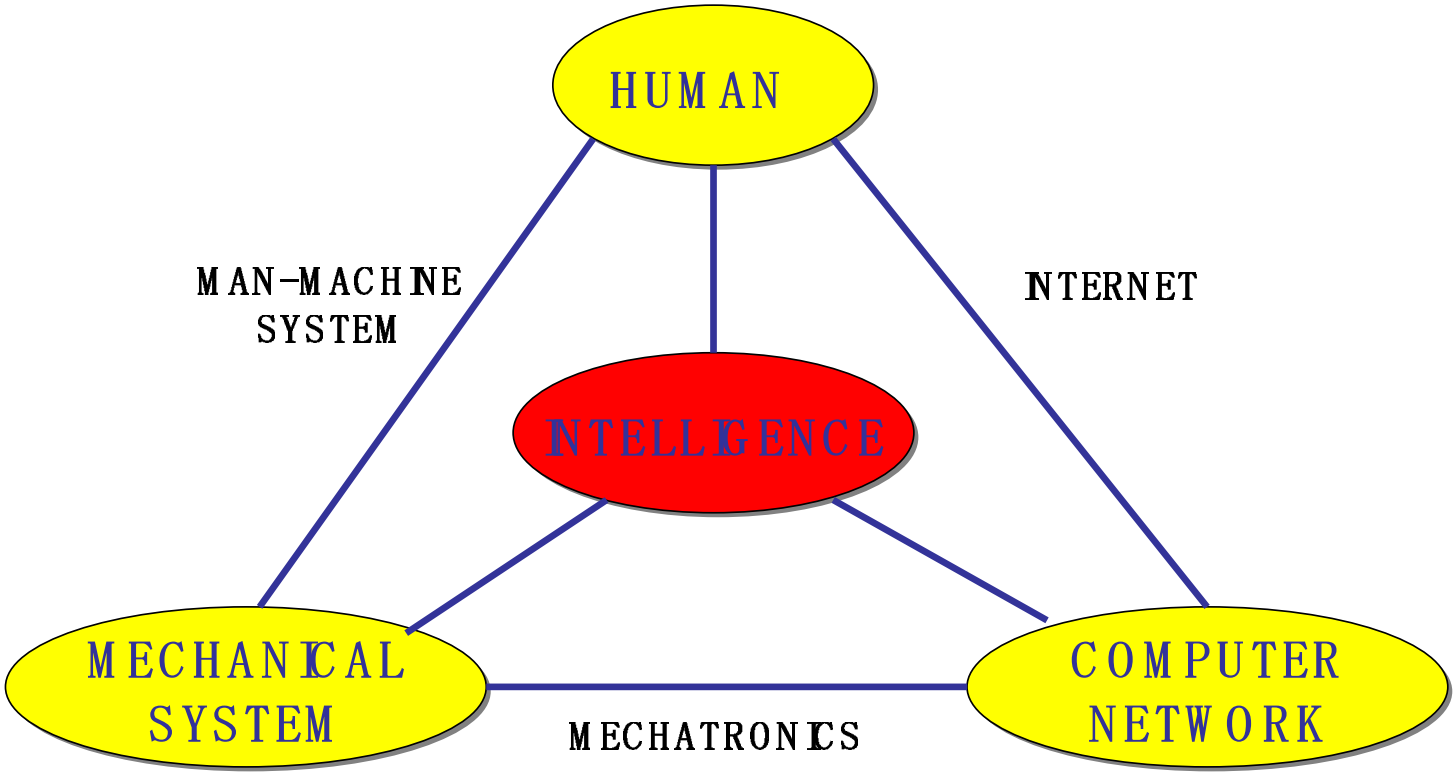
CURRENT STSTUS OF HUMAN-COMPUTER INTERACTION

- MAJOR COMPONENTS

- IMPORTANT ISSUE TO BE SOLVED

- MAJOR RESEARCH TOPICS

INTERACTION AND INTELLIGENCE



HUMAN-COMPUTER ASYMMETRY

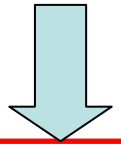
“This interaction between human and computer/mechanical system is, unfortunately, asymmetrical at this point of time”

Human beings easily understand the computer’s way of thinking, because computers and mechanical systems are human-made.

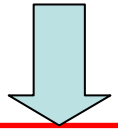
On the other hand, computers do not understand human way of thinking, because computers do not have psychological model of human beings.

HUMAN-MACHINE ASYMMETRY

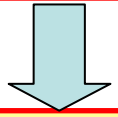
HUMAN BEINGS EASILY UNDERSTAND COMPUTER'S WAY OH THINKING



COMPUTERS DO NOT UNDERSTAND HUMAN PSYCHOLOGY



ASYMMETRY OF INTERACTION



PSYCHOLOGY APPROACH

MAJOR TOPICS

HUMAN-MACHINE SYSTEMS

NETWORK INTERACTION

INTELLIGENT MECHATRONICS

INTERACTION IN BIO AND MICRO/NANO WORLD

PSYCHOLOGICAL APPROACH

INTERACTION AND INTELLIGENCE

FUMIO HARASHIMA
PROJECT LEADER
PRESTO
JAPAN SCIECE AND TECHNOLOGY CORPORATION

PAST

SCIENCE AND TECHNOLOGY
in 20th CENTURY
Liberated People from
Physically Painful Labor

GOAL in 2050

SCIENCE AND TECHNOLOGY
in 21st CENTURY
Will Liberate People from
Mentally Painful Labor

PROJECT GOAL
2000-2005

The goal of this research area is to develop so-called "artificial life" which maximally enhances human abilities on intelligent and/or physical actions. It is expected for both human beings and mechanical systems to grow more intelligent through mutual interaction, either physically or on information basis.

PROJECT TEAM

LEADER:
FUMIO HARASHIMA

ADVISERS:
S.ISHIJIMA (TMIT)
T.INOUE (GENESIS INST.)
M.IBUKA (YOKOGAWA)
K.KAWACHI (UNIV. OF TOKYO)
K.KOSUGE (TOHOKU UNIV.)
K.TANIE (AIST)
T.FUKUDA (NAGOYA UNIV.)
S.YUTA (TSUKUBA UNIV.)

BUDGET:
~1 billion yen
~10 billion won

RESERCHERS:
20
(as of the end of 2002)

Human-Machine Systems

1. **Life Support Robot Moving Together with Human**
   A. Ohya, Univ. of Tsukuba
2. **Development on Muscle Suit for Supporting Human Activity**
   H.Kobayashi, Science Univ. of Tokyo
3. **Development of a Surface Acoustic Wave Tactile Display System**
   M.Takasaki, Saitama Univ.
4. **Development of Wearable Fluid Power Adaptable to the Human Body**
   T. Tsukagoshi, Tokyo Inst. Tech
5. **Structured Learning for Constructing Interrelation between Human and Robot**
   N. Kubota, Fukui Univ.
6. **Human/Environment-adaptive Intelligent Walking Support System**
   Y. Hirata, Tohoku Univ.

Network Interaction

1. **Development of knowledge-acquisition Support System through WWW information retrieval Process**
   Y. Takama, Tokyo Metro. Inst. Tech

2. **Discovery of Communities in the Web**
   T. Murata, NII

Intelligent Mechatronics

1. Intelligent Space based on Interaction with Distributed Intelligent Network Devices
   H. Hashimoto, Univ. of Tokyo
2. Nonlinear Dynamic Approach to the Development of the Collective Intelligent Robotic Systems
   K. Sugawara, Univ. of Electro-Communications
3. Acquisition of spatial structure through interaction with the environment
   M. Tomonou, JST
4. Developing a small, lightweight helicopter for environmental measurements over a city and for monitoring a disaster area
   S. Sunada, Osaka Prefecture Univ.

Interaction in Bio and Micro/Nano World

1. **Intelligent Bio-Micro Laboratory**
   F. Arai, Nagoya Univ.

2. **Development of the New Generation of Nano-Measurement System and Application to Bio-molecules**
   A. Ishijima, Nagoya Univ.

3. **Pattern detection by living neuronal networks cultured on microelectrode arrays**
   S. Kudou, AIST

Psychological Approach

1. **Evolutionary Networked Intelligence for Human Centered Systems**
   T. Yamaguchi, Tokyo Metro. Inst. Tech

2. **Research on Learning in Cohabitation of Human and Robot**
   T. Shibata, AIST

3. **Story-Teller Technologies Created from Subconscious Information**
   N. Tosa, ATR

4. **Interaction between Recognition and Direction: A Study of Interaction Methodology for a Communication Robot**
   R. Imai, KEIO Univ.

5. **A Study on Scene Understanding by Learning**
   O. Hasegawa, TIT

Research on Learning in Cohabitation of Human and Robot: T. Shibata, AIST

The purposes of the experimental System are:

- Change/Transition of Human-Robot Interaction by Time

- Seal Like Robot: Paro

- Investigate Way of Interaction between Human and Paro in Psychological Experiment

- Monitor Sensory Data into Paro

- Control of Paro Remotely Depending on Purpose of Experiment

Remote-Paro at a Living Room for Psychological Experiment

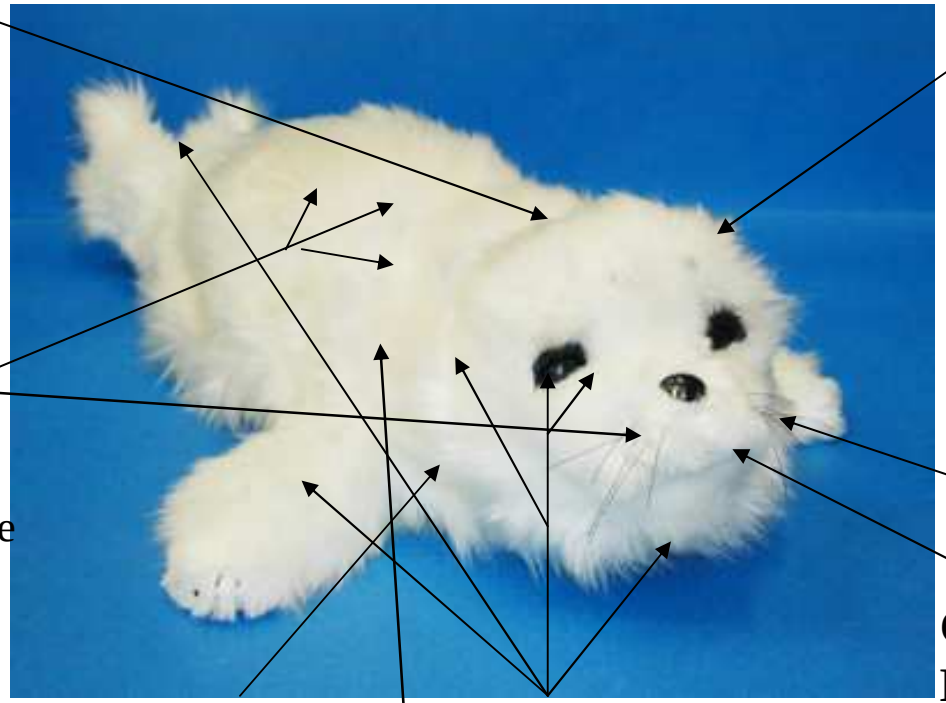
Intelligence

32 bit RISC CPU

Behavior Generation

3D Sound Localization

Speech Recognition
(Name Learning)



Audition
3 Microphones

Tactile
12 Ubiquitous Surface Tactile Sensor
Stereo Whisker Sensors

Anti-Bacterial Artificial Fur

Speaker

Charging Battery

Posture
3 Axis Acceleration

7 Actuators
2 for Neck, 2 Front Legs, 1 Back Leg, 2 Eyes

Temperature at CPU, Battery, and Each Actuator

Robotics Research 2000

Mental Commit Robots

Mechanical Engineering Laboratory
AIST, MITI, Japan

E-MCR

Story-Teller Technologies Created from Subconscious Information:

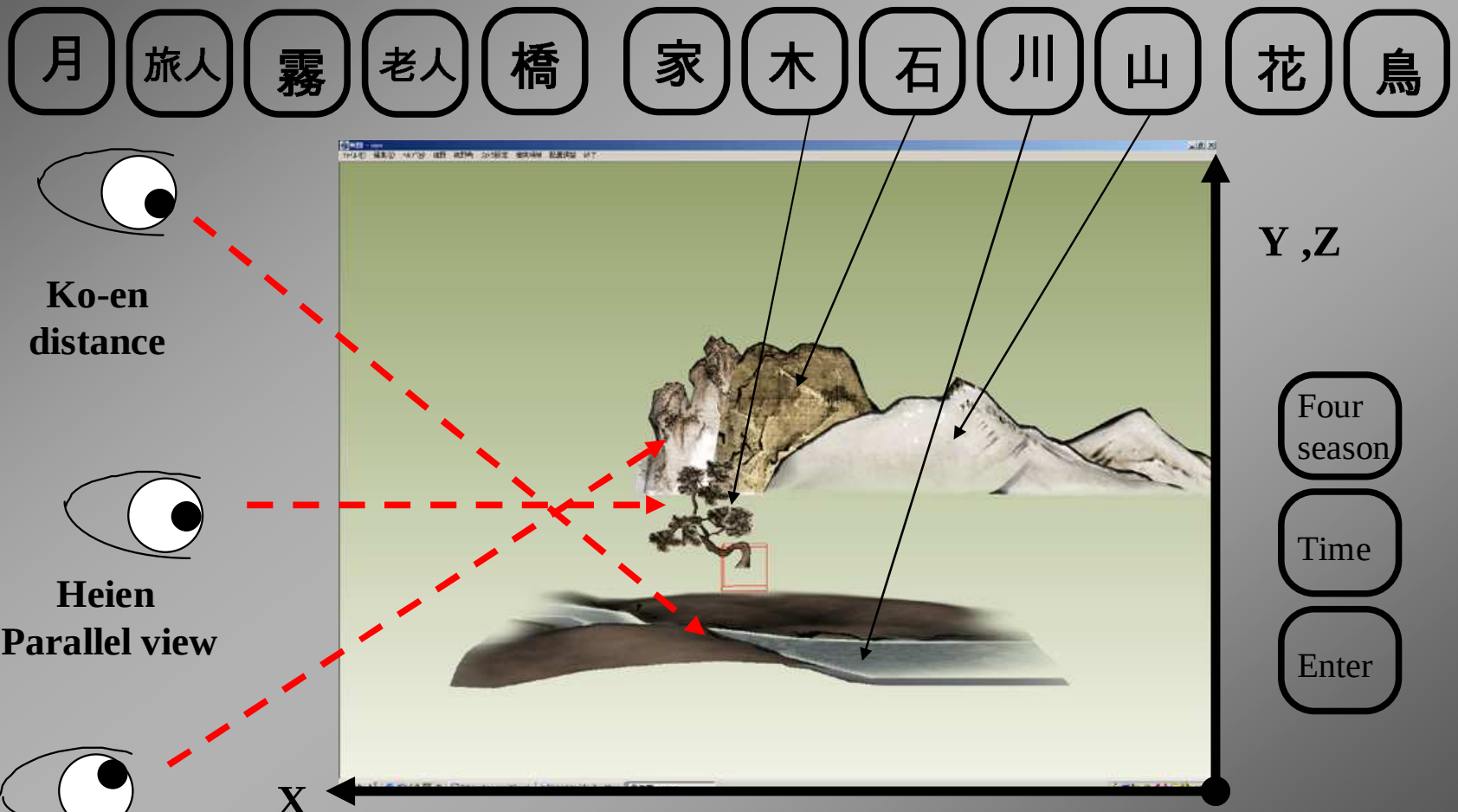
N. Tosa, ATR

In order to create a model of research on unconscious communication,
we developed a way to create Zen sansuiga (ink brush paintings)
and Zen koans (paradoxes for meditation).
As an art form of Zen, sansuiga (ink brush paintings) are not simply
landscapes. They are drawings of mental state of the people who drew them.
The users are able to draw 3-D ink brush paintings of their own mental states,
and then travel into that space with a bird's eye view.
When users approach trees or mountains, those objects become narrators,
speaking haiku (short, 17 syllable poems) and instructing the user.
The users come down onto these objects, and enter a space of
Zen dialogues with questions and answers.

Ink Painting Engine

An user selects an hieroglyphics icon such as mountain, river,Person, and so on and display them as he/she like.

Computer recognize the place of each icon and create a 3D Sansui Landscape



2D icon transformed 3D Sansui landscape image

Storyteller Generation

Object as Storyteller

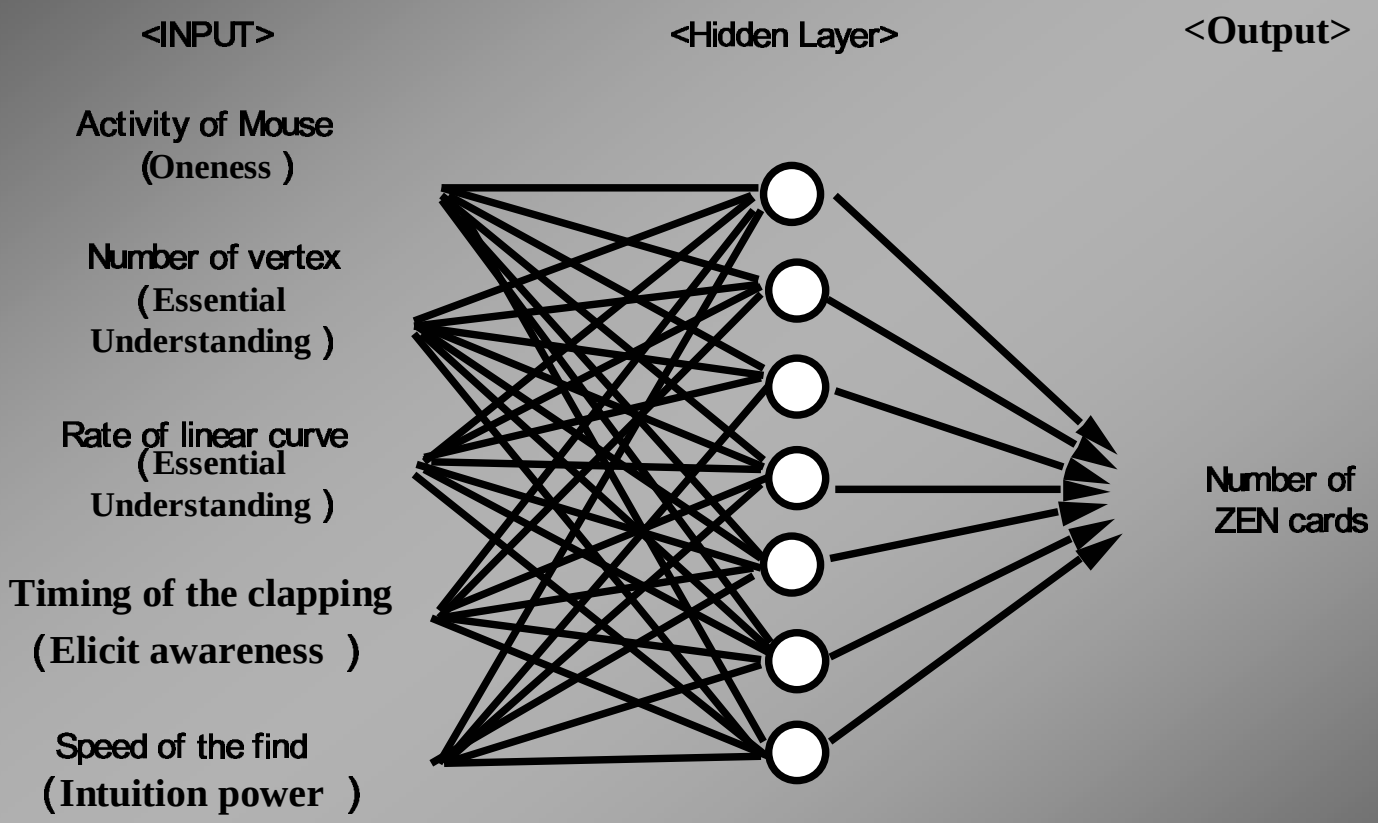
Year's end, all corners of this floating world, swept.

Autumn- even the birds and clouds look old.

Cormorant fishing: how stirring, how saddening.

User can enter their own picture from a bird's view.
When the user is close to the object, the object replies with Haiku (Japanese poem) or Moves to the Zen Koan (Zen Interaction) scene.

Transformation of Neural Network from Zen Model



After calculation of 100 times used by seven hidden layers, the computer analyzes one output. This output is the result of the user's value and decision of the number of Zen cards. The neural network convergence value is decided up to 0.01.

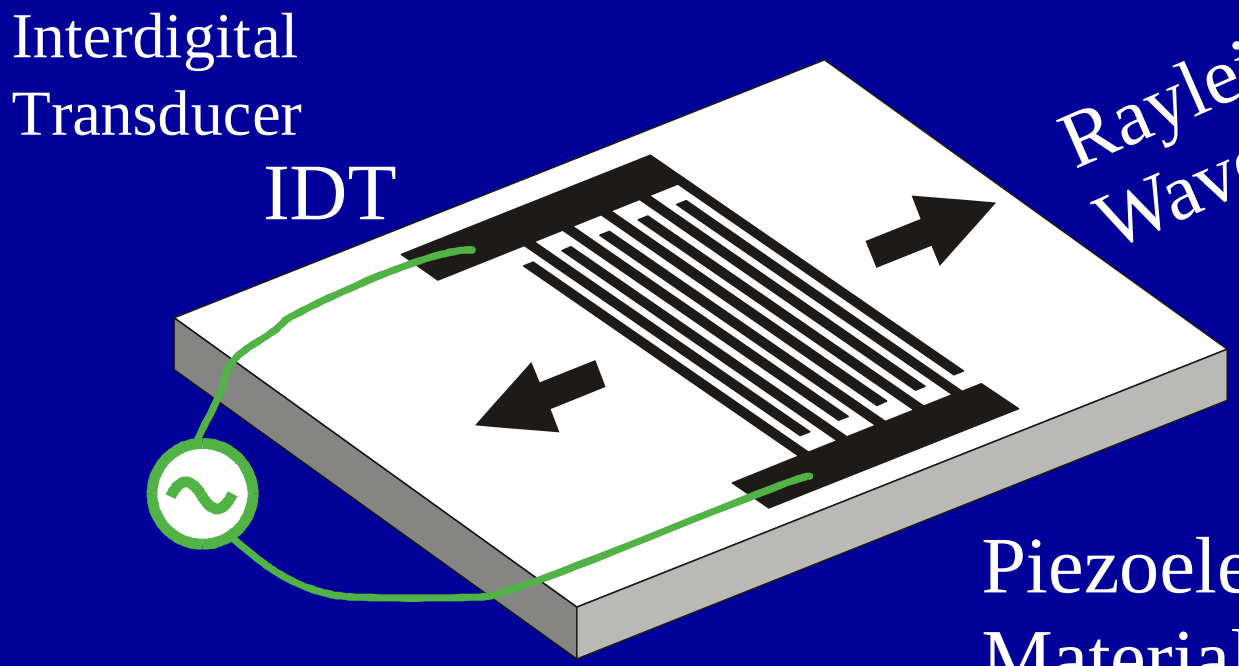
Development of a SAW Tactile Display System:
M.Takasaki, Saitama Univ.

Haptic Sensation (Touching something …)

- Proprioception : Sense of Weight, Resistance, …
  : Received by Muscles
  : Force Feedback Joystick, PHANTOM

- Tactile Sensation : Sense of Roughness, Friction, …
  :Received by Mechanoreceptors

Rayleigh Wave Excitation



Discovery of Communities in the Web:
T. Murata, NII

Purposes

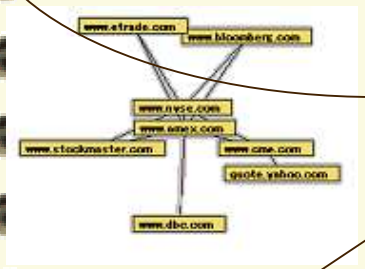
- **Analysis of the characteristics of Web community discovery methods**

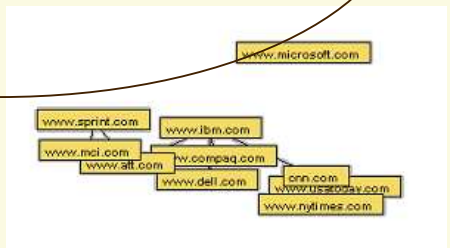
- **Implementation of user community discovery system**

Discovery of Communities in the Web

Discovery of Web communities

Modeling graph structure of hyperlinks



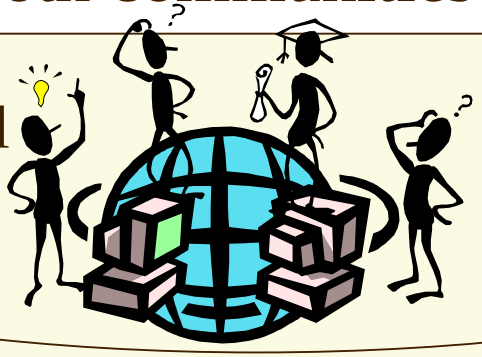


Discovery of user communities

Grouping users of similar interests

Interactions between both communities

Information retrieval from the Web

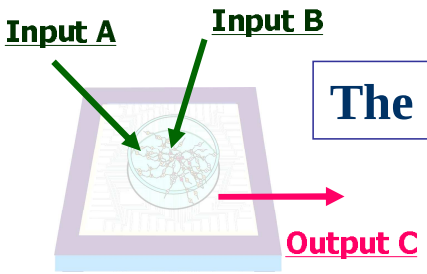


Prediction of dynamic changes

Pattern detection by living neuronal networks cultured on microelectrode arrays: S. Kudou, AIST

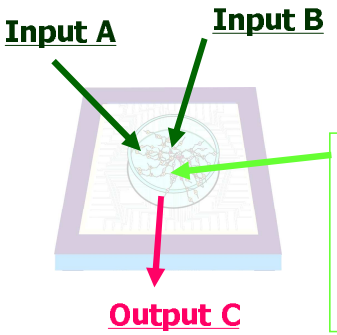
To realize Bio-electro information machine …

A.We have to train a living neuronal network to behave conveniently to us.



The network may get algorisms automatically

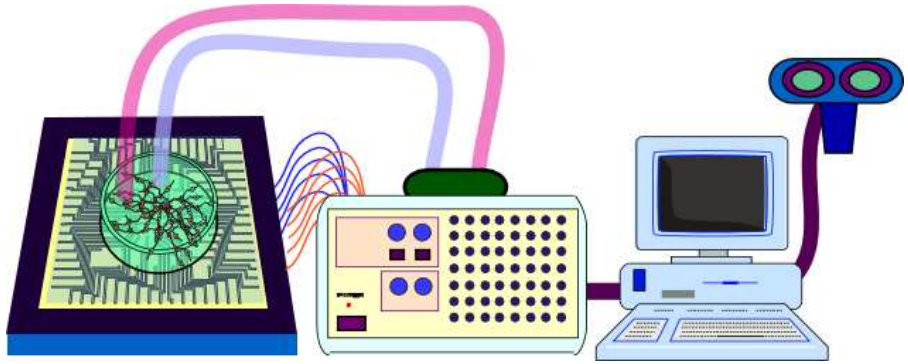
B.We have to establish a method to control a living neuronal network.



We step in computation of the network.

Electrical stimulation
Drug
Functional proteins…and so on.

Bio-electro information machine



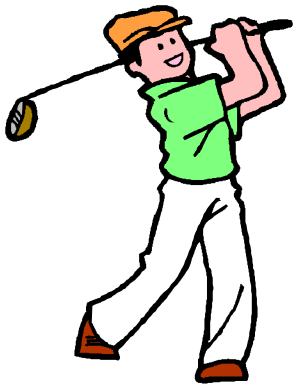
The ultimate goal is man-machine interface which connect our mind to computers and network systems.

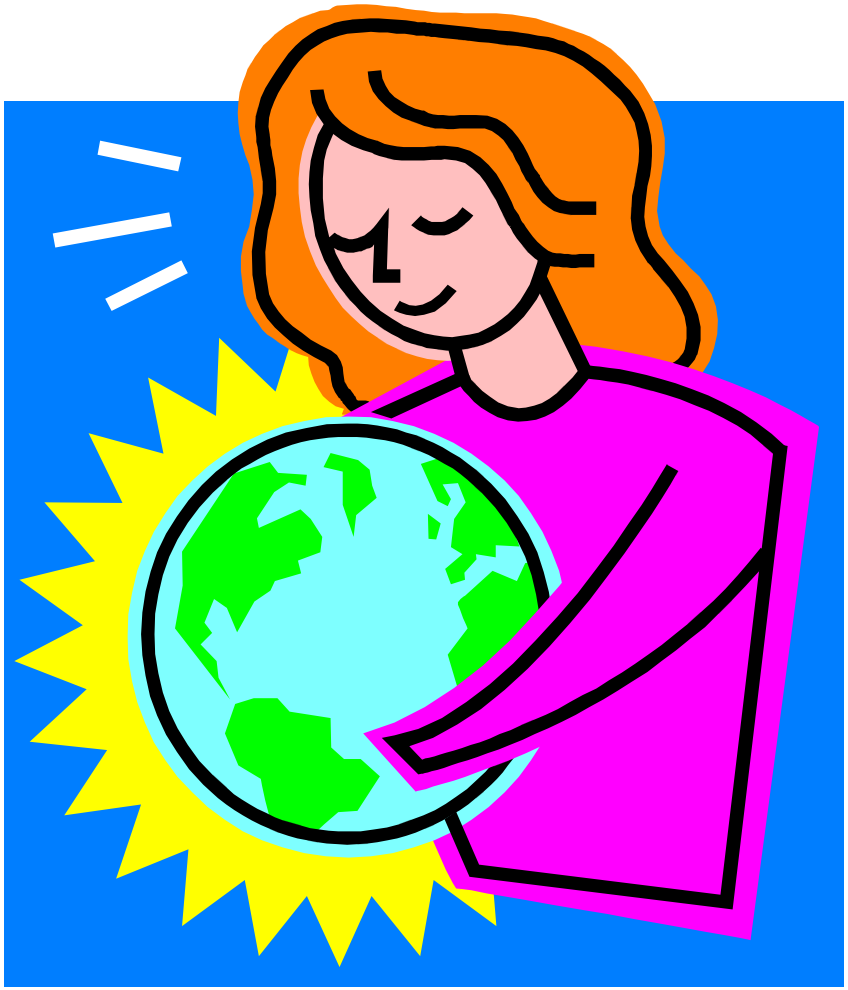
Conclusion

Human-Computer Interaction is one of key technologies for the future human society.

Many kinds of science and technology should be combined into this technology.

They are computer science, systems engineering, mechatronics, bio-technology, nano-technology, psychology, sociology, arts, etc.





OUR GOAL

Beautiful, Intelligent Human life which is fully supported by science and technology