STATE OF THE ART IN
HUMAN COMPUTER INTERACTION

INTERACTION AND INTELLIGENCE

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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
ENVIRONMENTAL ISSUES

- DISTRIBUTED POWER SYSTEMS
- ELECTRIC/HYBRID VEHICLES
ELECTRIC VEHICLE

HYBRID CAR
100km/3litter gas

FUEL CELL EV
ZERO EMISSION
CO₂ ISSUE

One human generates 1 Kg CO₂/day

Human society generates ten times CO₂ 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」
厚生労働省国立社会保障・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

Japan
USA
France
Germany
Sweden
England

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
Image of Smartway

- Environment
  - ex. Improve efficiency of driving and distribution

- Safe driving support
  - ex. AHS

- Road traffic information
  - ex. ETC
  - ex. Optical fibers

- Smooth traffic
早稲田2
CURRENT STATUS OF HUMAN-COMPUTER INTERACTION

- MAJOR COMPONENTS

- IMPORTANT ISSUE TO BE SOLVED

- MAJOR RESEARCH TOPICS
INTERACTION AND INTELLIGENCE

HUMAN

MAN–MACHINE SYSTEM

INTELLIGENCE

INTERNET

MECHANICAL SYSTEM

MECHATRONICS

COMPUTER NETWORK
“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 OF 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 SCIENCE 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
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
   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.

   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)

Tactile
- 12 Ubiquitous Surface Tactile Sensors
- Stereo Whisker Sensors
- Anti-Bacterial Artificial Fur

Posture
- 3 Axis Acceleration

Audition
- 3 Microphones

Speaker

Charging Battery

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

Temperature
- at CPU, Battery, and Each Actuator
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.
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

Interdigital Transducer
IDT

Rayleigh Wave

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