

# Development of High Performance Humanoid Robots

Hiroshi ISHIGURO

Team Osaka

JST ERATO Asada Synergistic Intelligence Project  
Department of Adaptive Machine Systems, Osaka University  
ATR Intelligent Robotics and Communications Laboratories

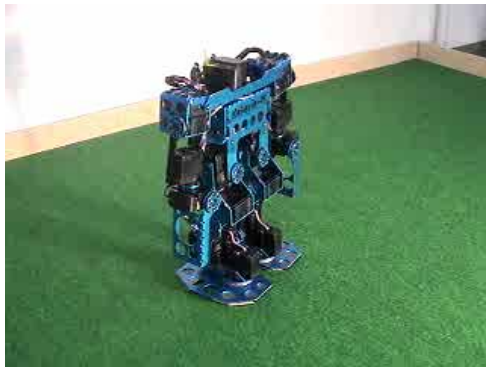
ishiguro@ams.eng.osaka-u.ac.jp  
www.ed.ams.eng.osaka-u.ac.jp

**Team Osaka**

# Dynamic actions of humanoids

**Humanoids can have better performance**

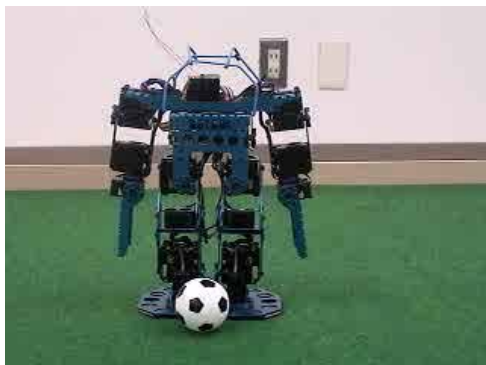
**Standing**



**Kicking**



**Throwing**



**Horizontal bar**



## Horizontal bar



## Horizontal bar



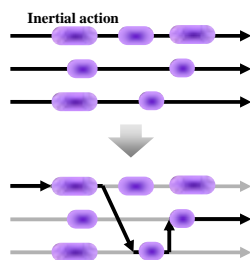
## Ultra C?



## *ERATO Asada Project*

Development of the editor  
New research direction for high performance  
humanoids

Physical relationships with the complex environment  
Combination of various behaviors realized with inertial actions



How to construct the action network?

## *Team Osaka*

VisiON  
The autonomous soccer robot

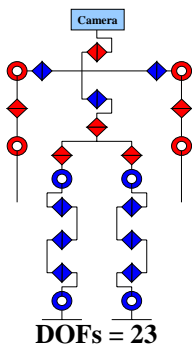
### Champion in RoboCup



### Development of the humanoid



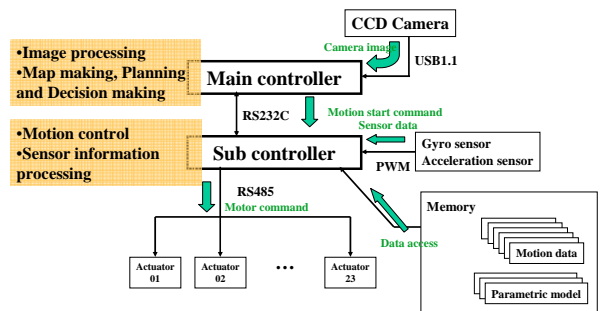
### Mechanical structure



Specification of Actuator

Name	Red DX-116	Blue DX-117
Torque [kg · cm]	22	31
Speed [sec / 60 deg]	0.14	0.10
Weight [g]	66	66
Size [mm <sup>3</sup> ]	46.3 × 31 × 36.8	46.3 × 31 × 36.8
Control	RS-485	RS-485

### Architecture



### CPU Specification



Main controller



Sub controller

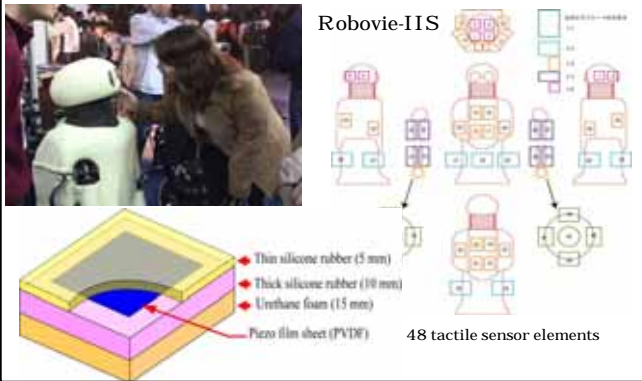
	Main controller	Sub controller
CPU	AMD GEODE 400 MHz	SH2-7054 40 MHz
ROM	4 GB (Compact Flash)	384 + 64 KB
RAM	256 MB	16 + 512KB
Interface	RS232, USB1.1 Wireless LAN	RS232, 485
OS	Windows 2000	None
Purpose	•Image processing •Autonomous control	•Motion control •Stabilizing motion

### ATR & Osaka University

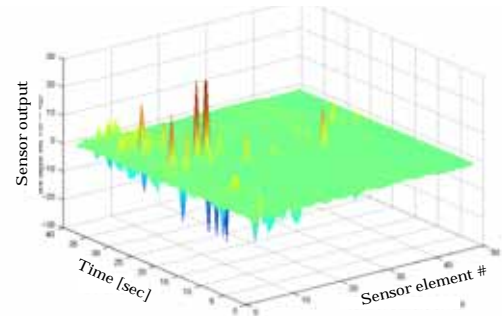
### Importance of skin sensors

New device for sensory-motor mapping

## Robots with soft sensor skin



## Example of sensor outputs



**An adult hugs Robovie-IIS**

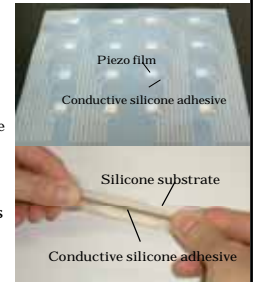
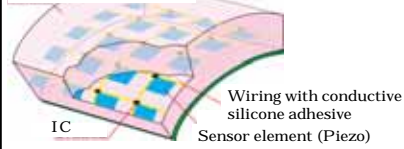
## Expectation of human postures from touch patterns



## Improvement of the soft sensor skin

Prof. Suganuma, Prof Inoue (Osaka Univ.)

Soft material (Silicone)



- High-density arrangement of sensor elements
- Simple wiring to the host PC
- Robust wiring against ripping

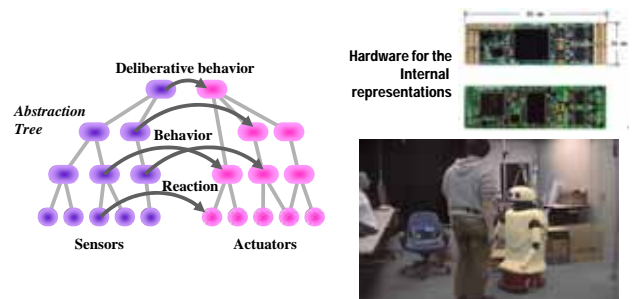
➔ **Wiring with conductive silicone adhesive & Self-organizing sensor network**

## ERATO Asada Project

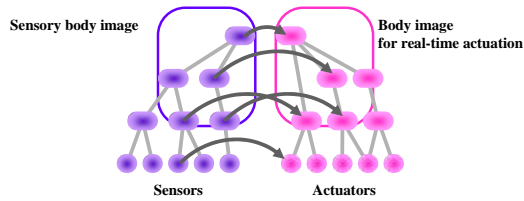
## Development of more complex humanoids

New research direction for high performance humanoids

## Self-organizing sensor networks Sensory motor mapping Efficient and robust robot control

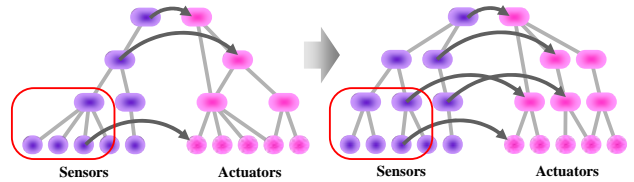


### Self-organizing sensor networks Time segmentation in the network



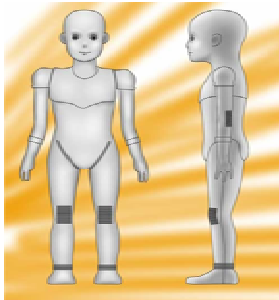
- How to compensate time delays between sensors and actuators
- Duplicated body images
- How to segment the time axis? The total system cannot synchronize with a single clock.

### Self-organizing sensor networks Relations among symbols



- Process of classification of the sensory data tells us relations among symbols.
- Symbol emergence for symbol manipulation

### M<sup>3</sup>: Man Made Man Less than a human and more than a robot



- About 50 pneumatic actuators
- Piezo skin sensor covering the whole body
- Self-organizing sensor-actuator network
- Eyes, ears
- Vocal mechanism
- Walking?

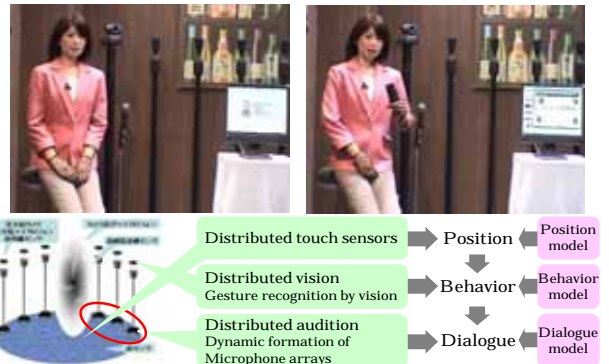
### Osaka University & ATR

## Toward more humanlike robots

Integration of science and engineering



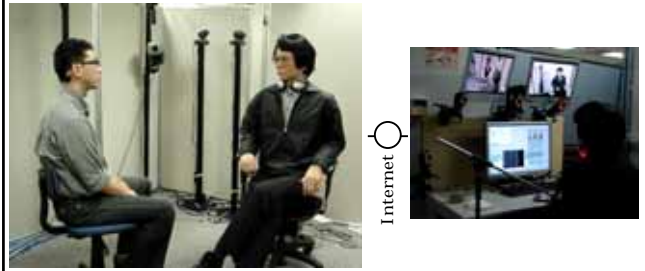
### Human behavior recognition by the sensor network



### Developed geminoid



### Tele-operation system through the Internet



- Motion capture system for measuring the lip movements
- Behavior selection by using GUI (6 behaviors)

### Meeting by using the geminoid



- Both of I and the visitors can quickly, less than 5 minutes, adapt to the conversation through the geminoid.