

2004/10/06

**WTEC International Assessment of
R&D in Robotics**

Toward Sensory-Motor Coordination

**Shinichi Hirai
Dept. Robotics
Ritsumeikan Univ.**

Department of Robotics

Established at 1996

Faculty members (2004)

S.Arimoto	A.Ishii	T.Isaka
R.Ozawa	K.Kanaoka	
S.Kawamura	N.Tejima	K.Nagai
M.Nokata	S.Hirai	H.Maeda
M.Makikawa	T.Watanabe	

Education & Research on
Mechatronics Technology

Collaboration

Education

Dept. Robotics

**Dept. Micro System
Technology**

**Dept. VLSI System
Design**

**Dept. Human and
Computer Intelligence**

Research

**Research Center for Robotics
and Flexible Automation**

**Research Center for Sports
and Healthcare Technology**

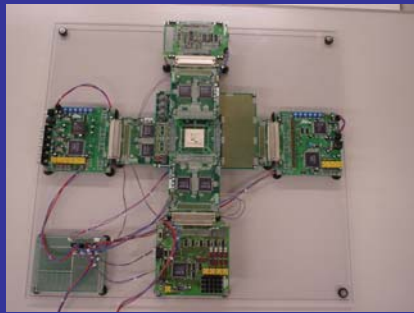
**Research Institute for
MicroSystem Technology**

VLSI Center

**SR (Synchrotron Radiation)
Center**

Hirai Lab.

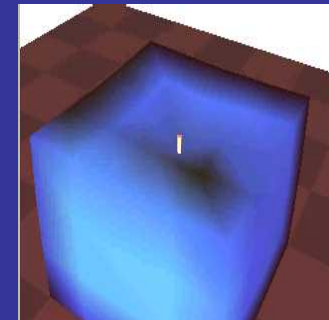
Laboratory for Integrated Machine Intelligence



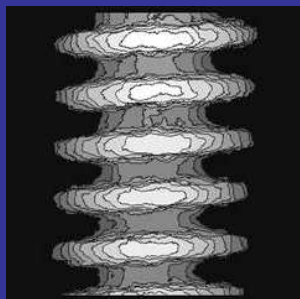
FPGA vision



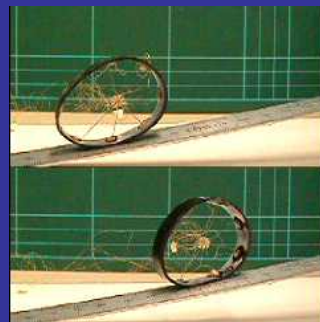
Soft-fingered manipulation



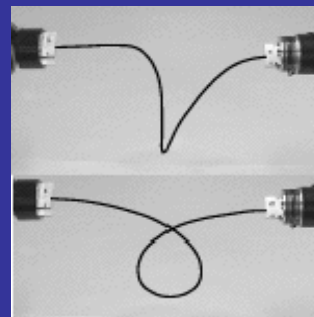
Virtual rheological object



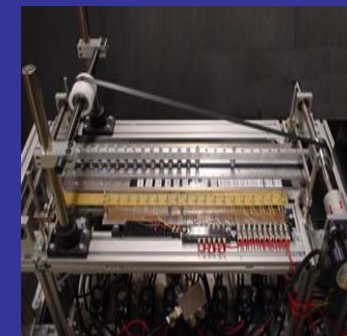
3D imaging



Locomotion by deformation



Linear object manipulation



Card handling

Sensing

Action

Control of Soft Objects and Structures

FPGA-based Vision

2001-

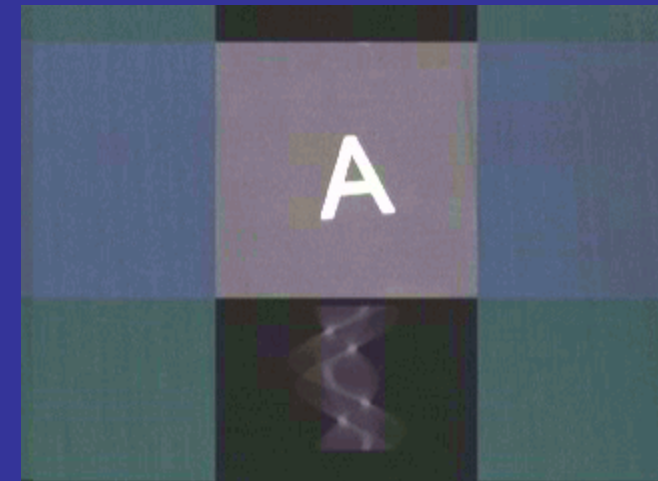
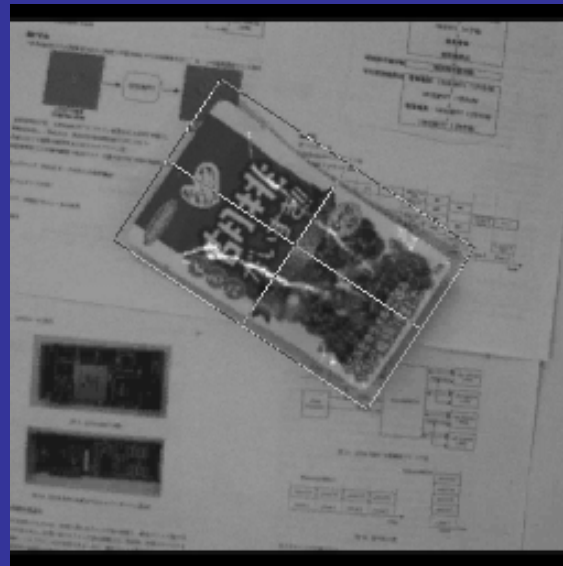
Time Consuming Algorithms

- Matched Filtering
- Phase-Only Correlation
- Hough-Fourier Transform Method
- Generalized Hough Transform
- Argument Voting Method

**Implementation on FPGA
to reduce computation
time in good cost
performance**



matched filtering

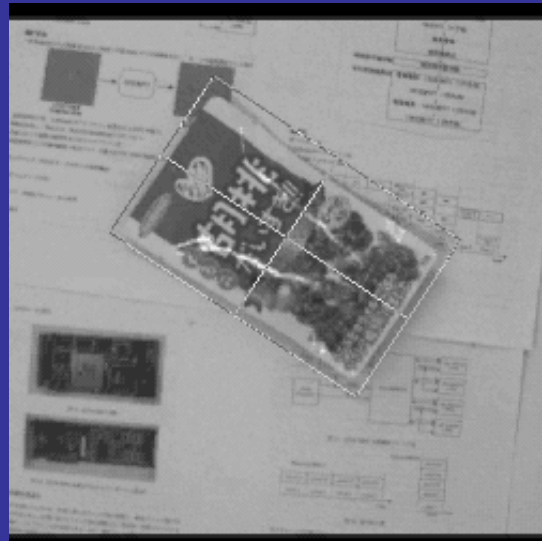


Radon transform

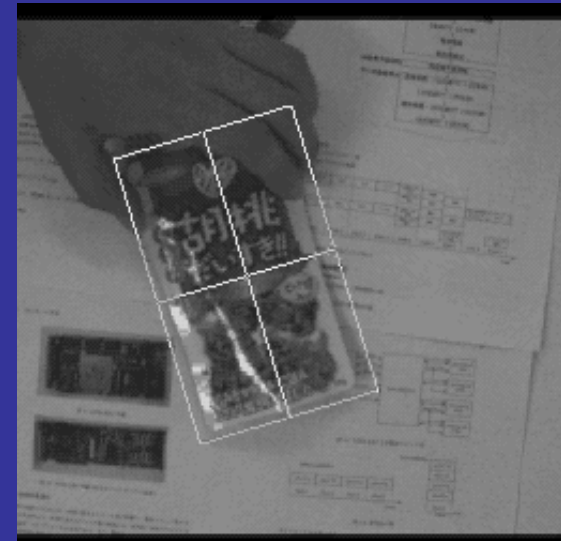
Robust Image Registration



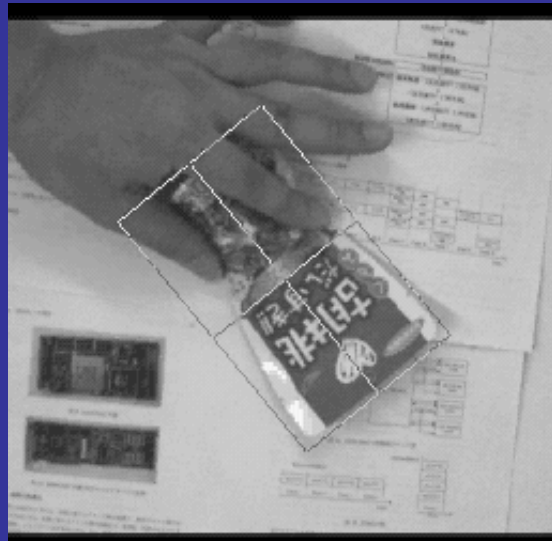
template image



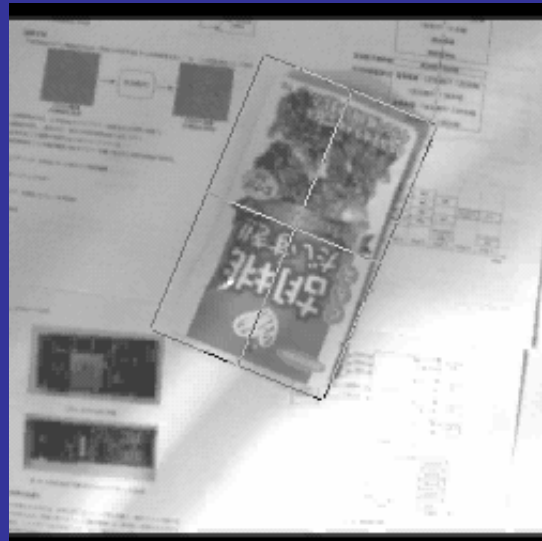
input image



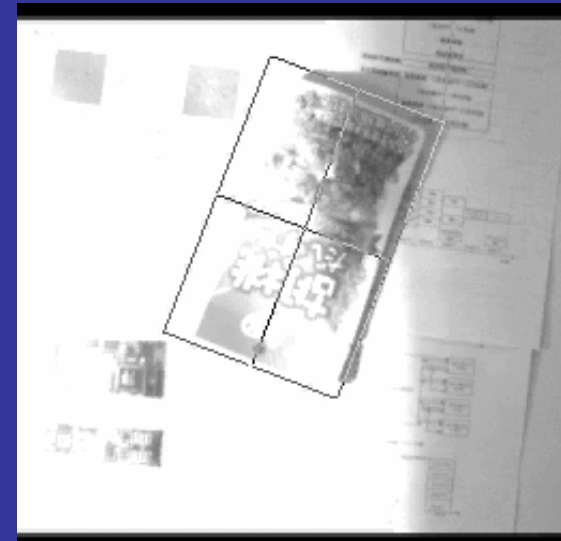
occlusion



deformation



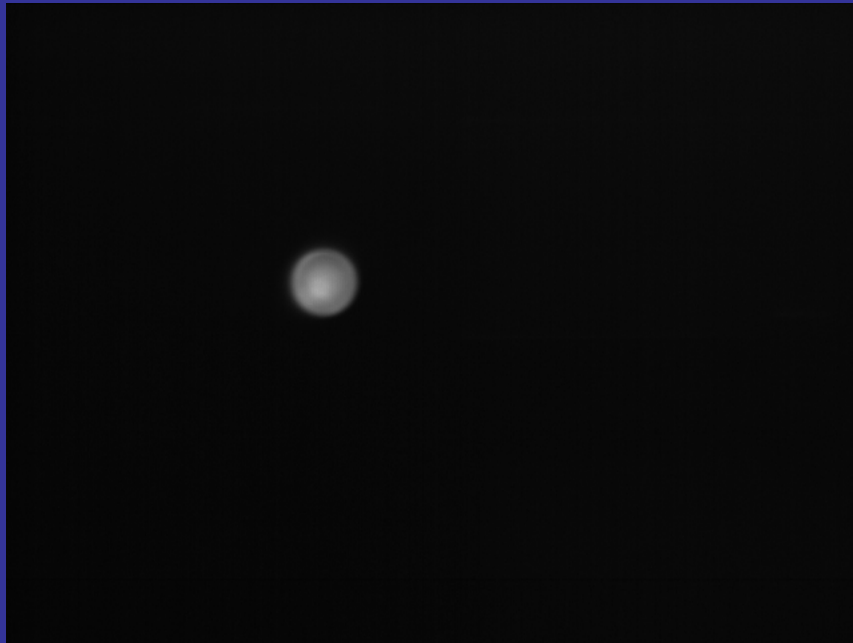
illumination change



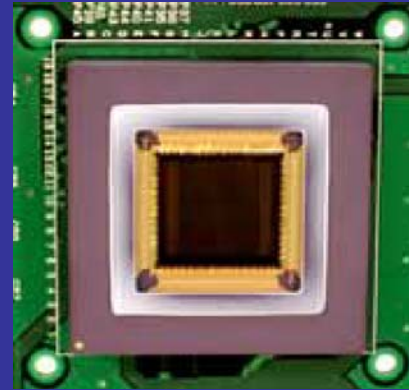
halation

CMOS+FPGA Vision

2004-



1000fps

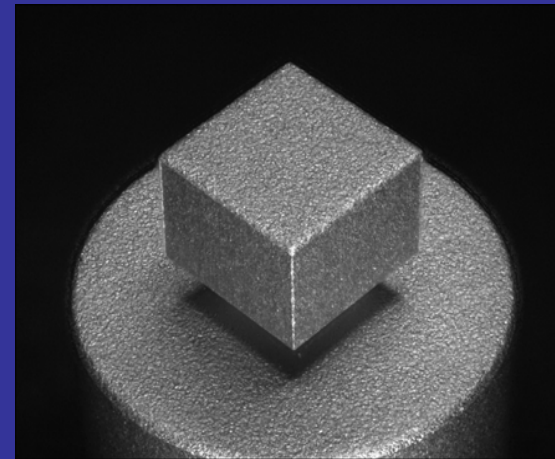
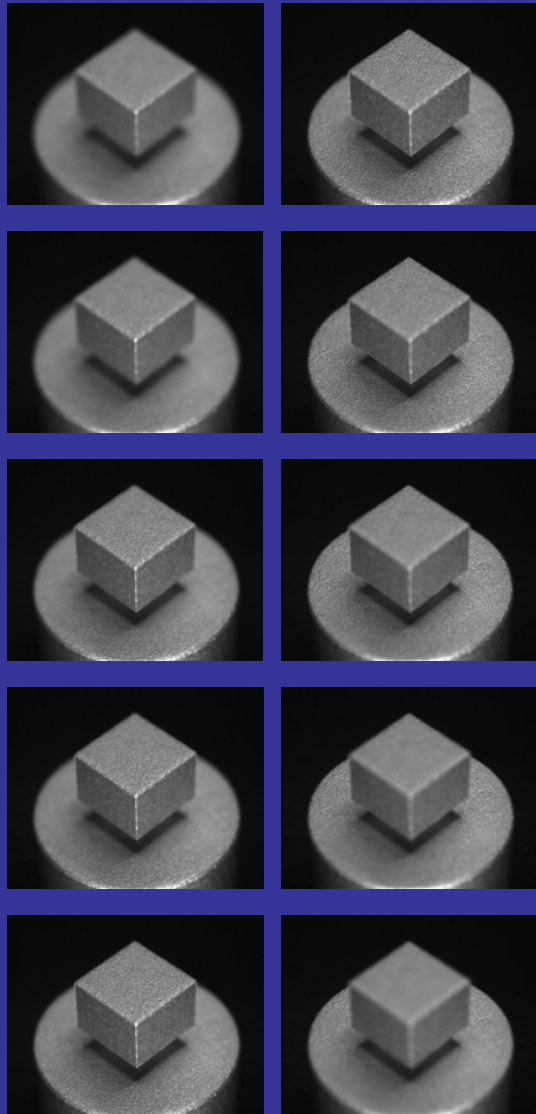


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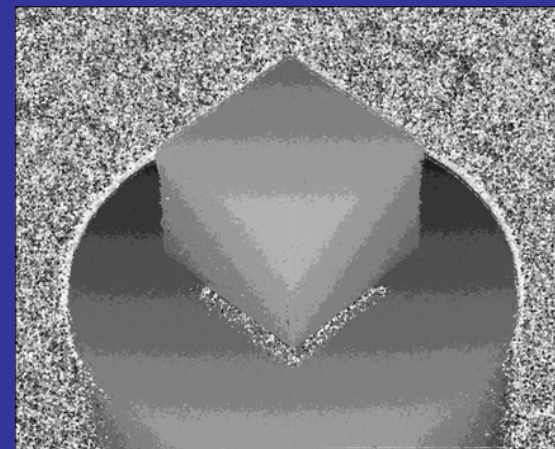
vision in control loop

3D Imaging by Varifocal Mirror



2001-

Entirely focused image

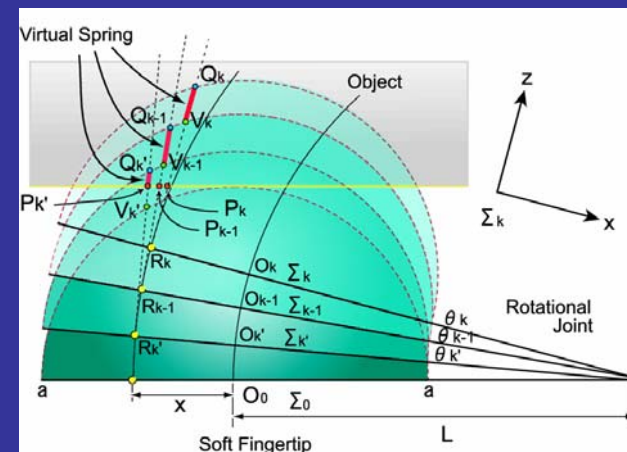
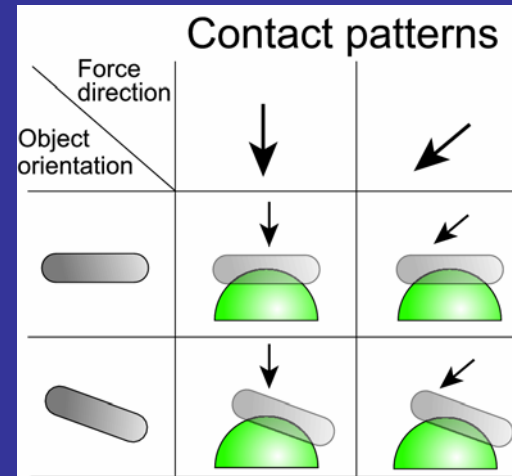
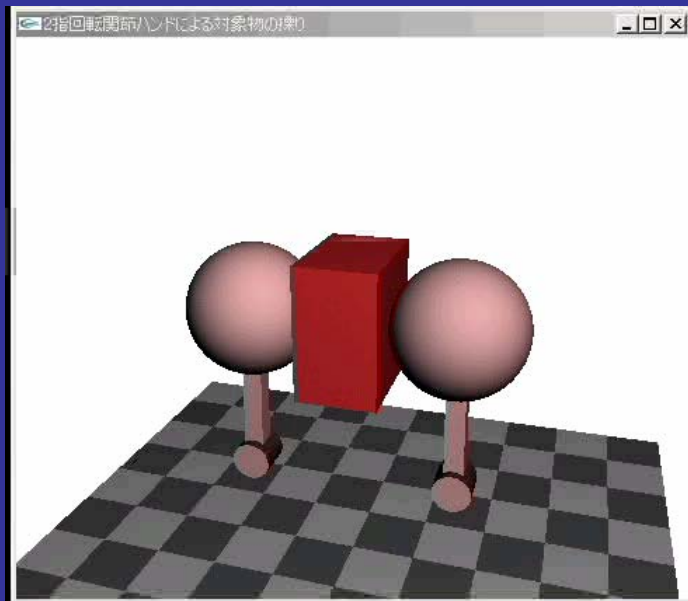


Distance image

Soft-fingered Manipulation

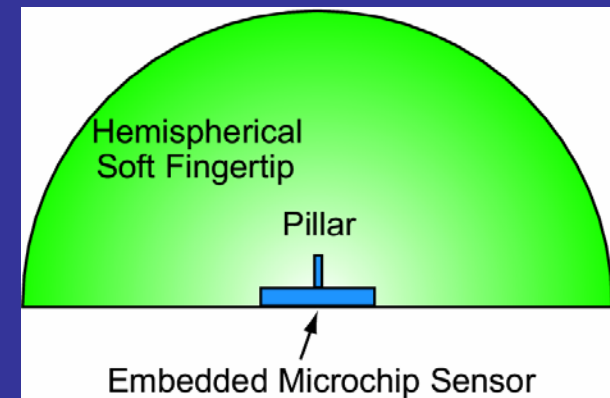
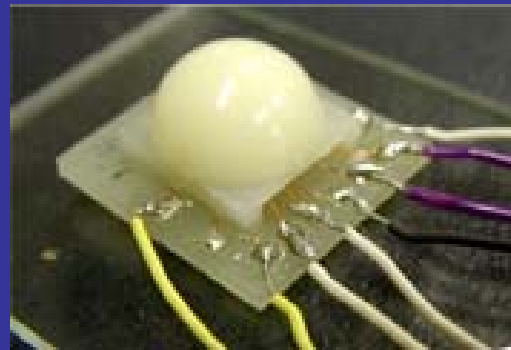
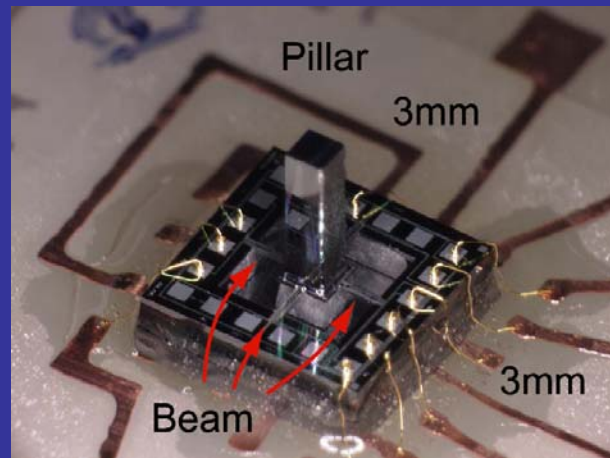
2002-

Soft-fingertip Model

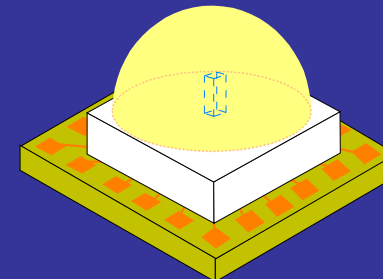
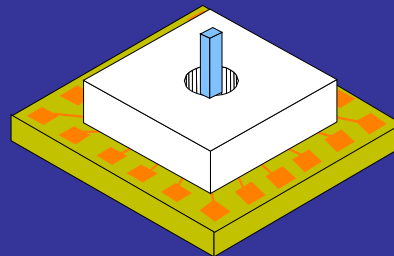
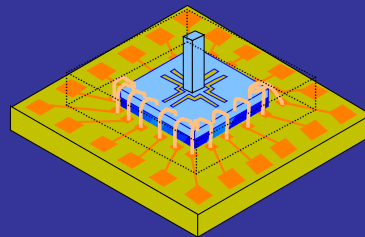


Embedded Force Sensor for Soft-fingered Manipulation

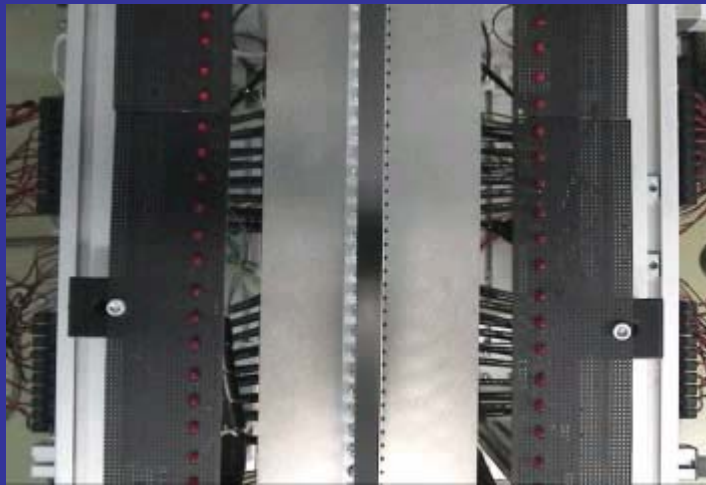
2003-



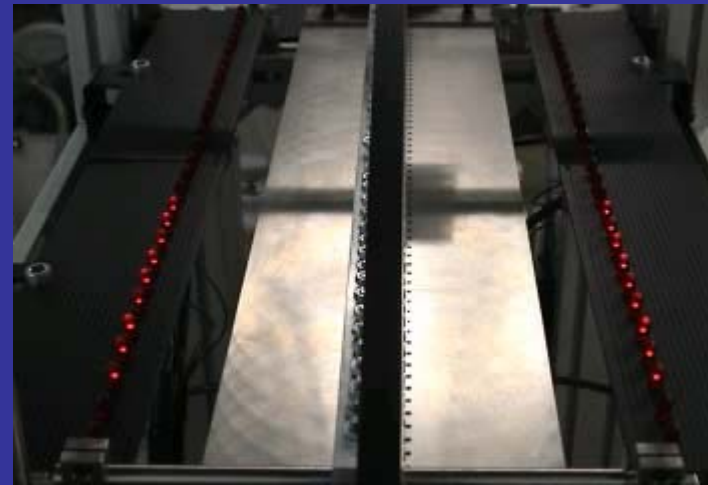
Micro 6-DOF force/moment sensor



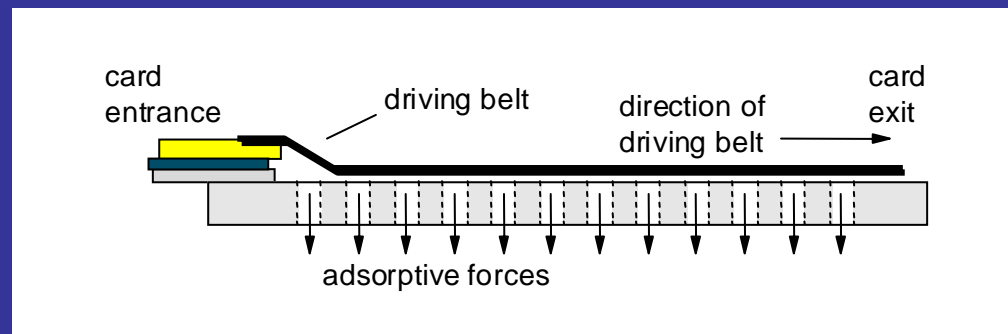
Separation/Skew Control of Cards via Vacuum Hole Array



Separation of 15 cards



Skew control of card



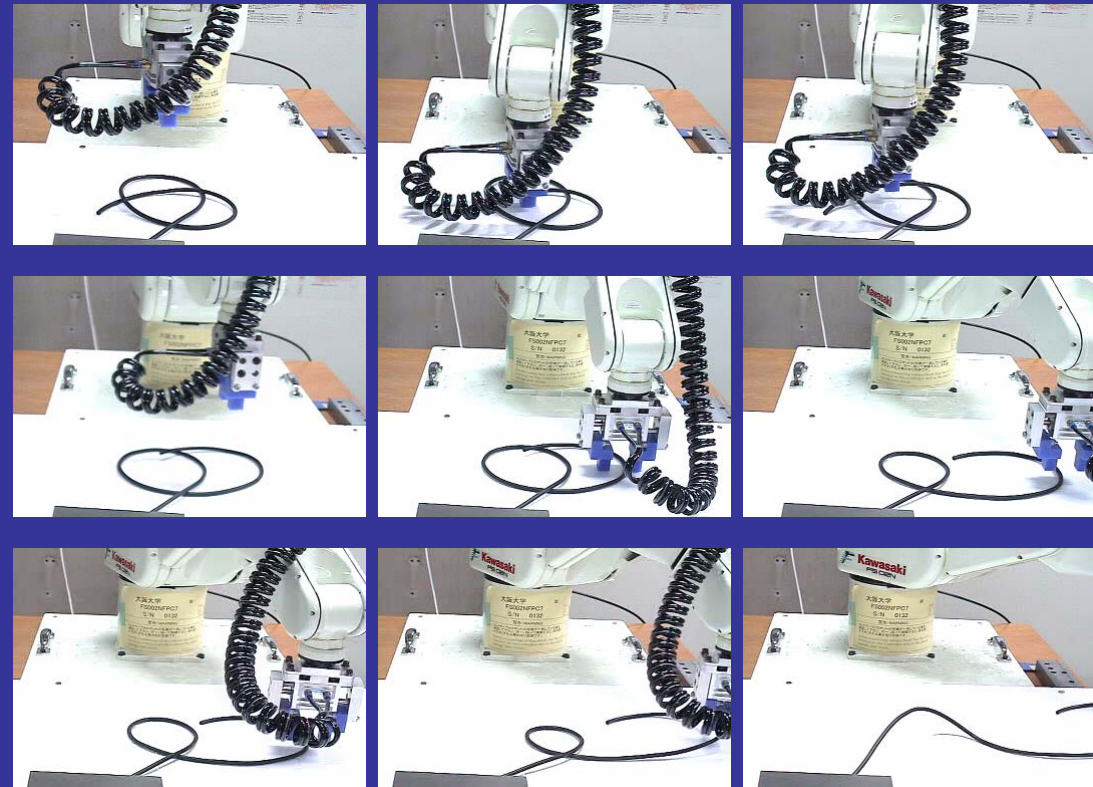
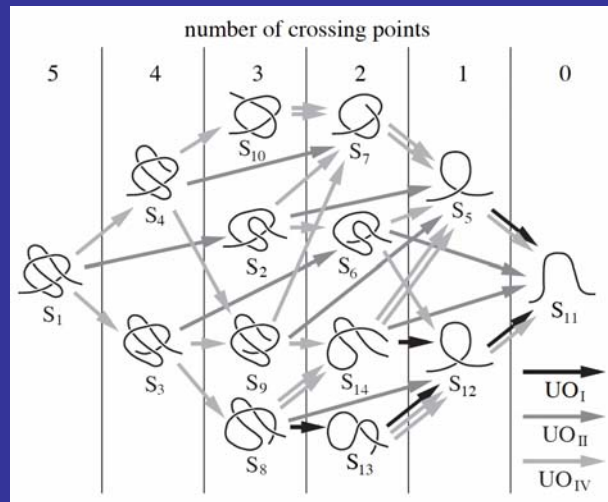
2000-

2000-

Linear Object Manipulation



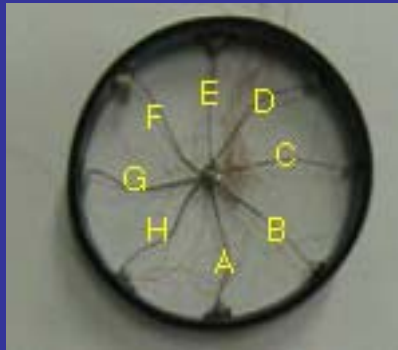
Differential geometry
coordinates



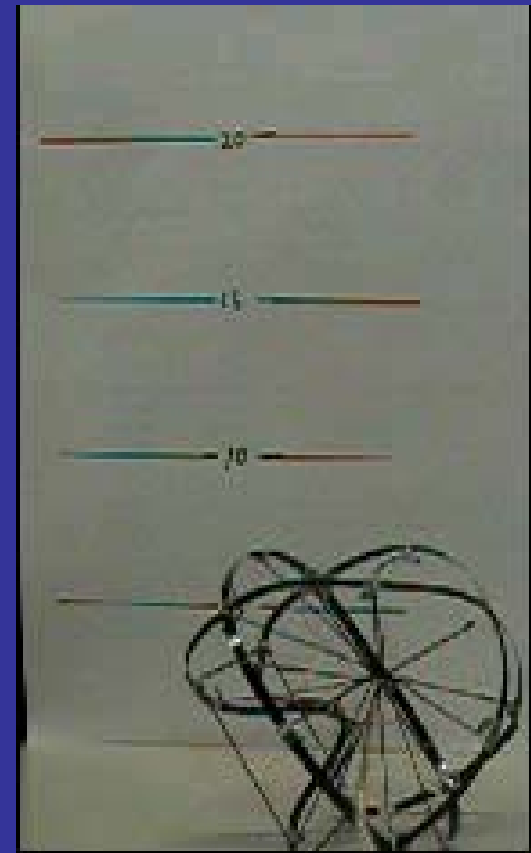
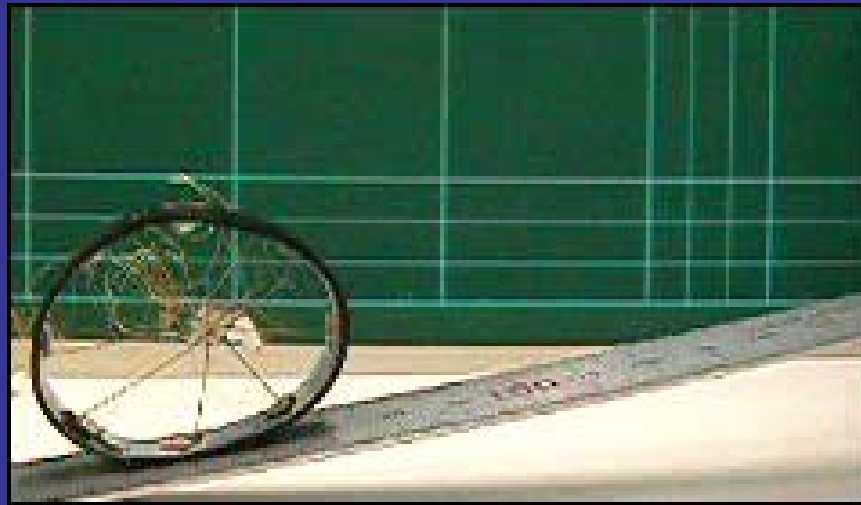
Knotting/Unknotting of DLO

2003-

Crawling and Jumping of Deformable Soft Robot

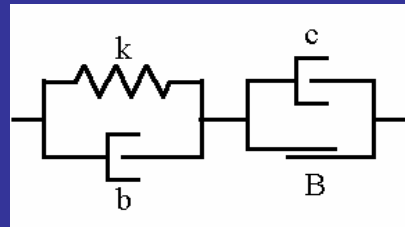
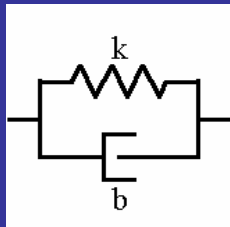
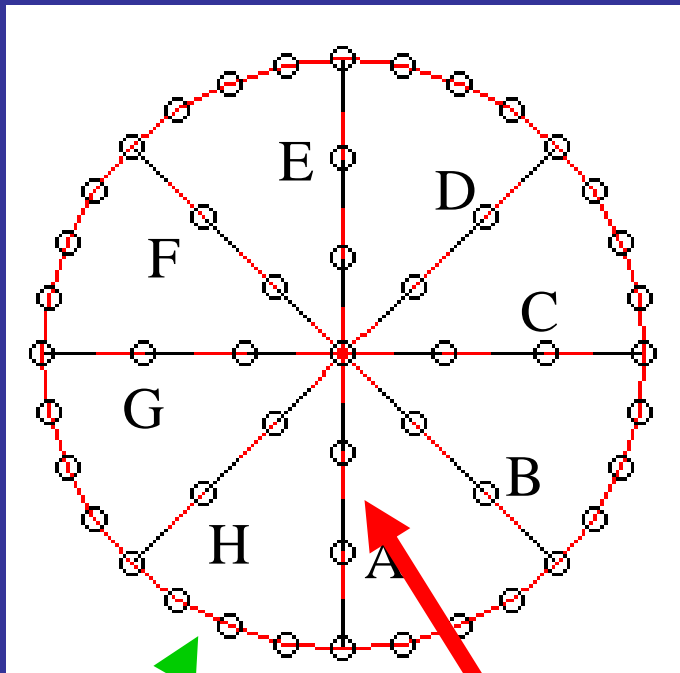


charge/discharge of
potential energy stored
in deformable body



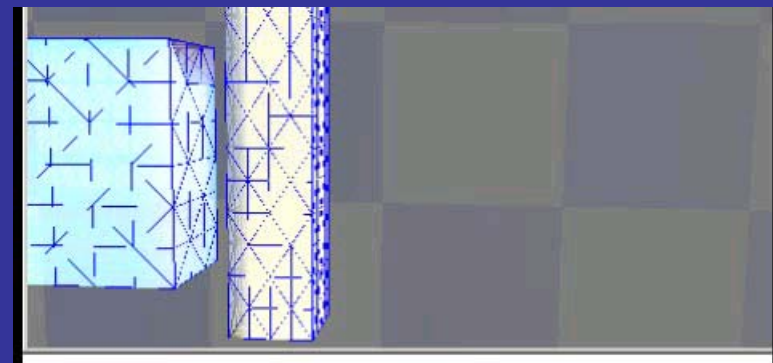
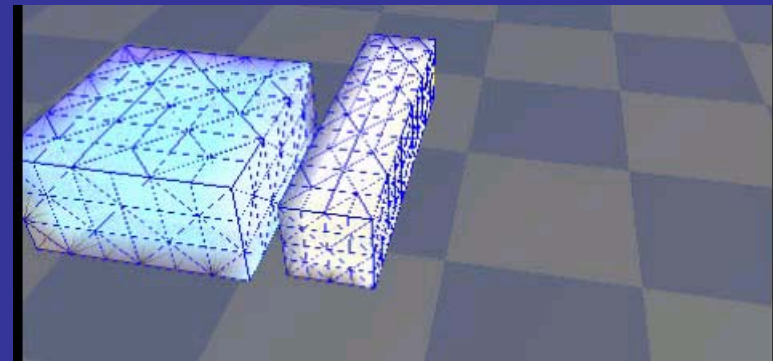
Simulation of Soft Objects

Particle-based model



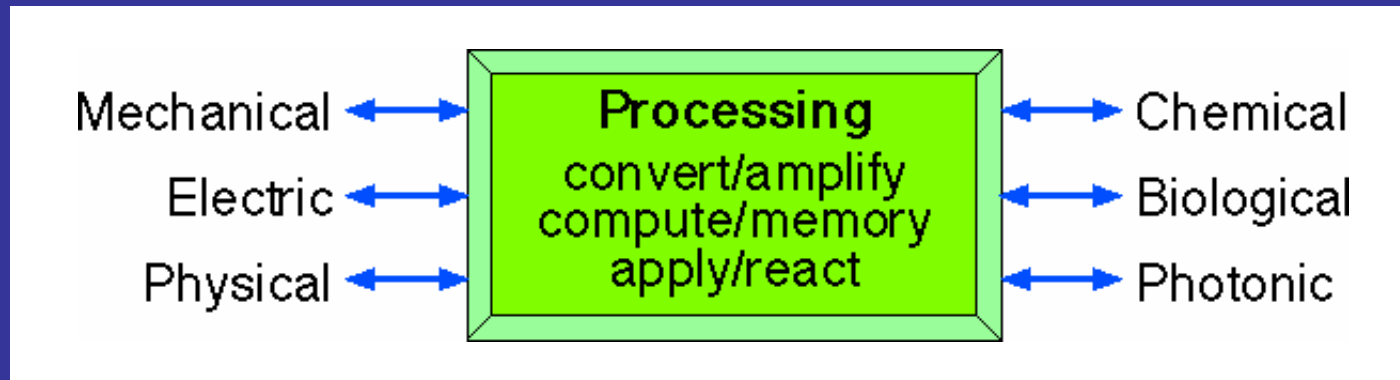
2000-

Simulation of
forming process



Toward Sensory-Motor Coordination

21st COE program Micro-Nano Science Integrated Systems



Integration of Robotics and Micro/Nano Technology

