Graduate School of Information, Production and Systems, Waseda University

Bio-Robotics & Human-Mechatronics Laboratory in Waseda-IPS, Japan

Bio-robotics and Human-mechatronics Laboratory

Graduate School of Information, Production and Systems, Waseda University

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Outline

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- Project
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    - Image-Projective Desktop Arm Trainer, IDAT
    - Projection Interface
- Closing remarks

Biographical Information

Ichiro Kato
1926-1994

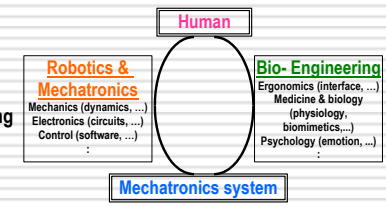
- 1985 B.S., Mechanical Engineering, Waseda University
  "Development of articulated manipulator aiming at force control"
  (Supervised by late Prof. I.Kato)
- 1987 M.S., Mechanical Engineering, Waseda University
  "Basic theory of multi d.o.f. compliance control on articulated manipulator"
  (Supervised by late Prof. I.Kato)
- 1987-99 Corporate Research & Development Center, Toshiba Corporation
  - Research on robots for specialized operations
  - Developing mechatronics systems using robotic technologies

TOSHIBA
Leading Innovation

- 1998 Ph.D., Mechanical Engineering, Waseda University
  "Research on structure and control of working robot in a little space"
  (supervised by Prof. S.Sugano)
- 1999-2010 Associated Professor, Shizuoka University
  - Education and Research on Bio-Robotics and Human-Mechatronics
  - Invited Professor (2003). LSC - CNRS, Evry France, Visiting Fellow (2002). Shizuoka Industrial Research Institute, Shizuoka Japan, etc.
- 2010- Professor, Waseda University
  - Research and Education on Bio-Robotics and Human-Mechatronics

Bio-Robotics and Human-Mechatronics Laboratory

- Various themes between human and mechatronics systems (robots and other systems)
- To make mechanical systems more friendly / useful for users
- Developing new functions and producing real-world systems
- Integrating various knowledge and technologies into systems (selection / combination are based on engineering sense)
- Work on elemental technologies by ourselves if desired



Better interaction / relationship between human and robots

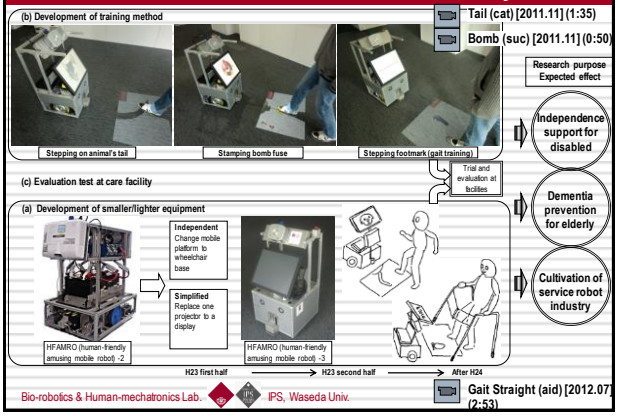
Previous subject

- Remote Operation System of Mobile Robot
  - Combination Control of Manual Operation and Autonomous Behavior
  - Environmental Map around remote robot --- Line&Hollow / Cell&Hollow
  - Operational Interface --- J/S, Eye-gaze, HMD+gaze, Voice, Touch screen
- Preliminary-Announcement of Robot's Intention
  - Method and Apparatus to indicate Direction and Speed --- 4 kinds / 2 types
  - Comparing Display Announcement with Voice Announcement
- Form and Movement of Human-Synergetic Robot
  - Informative Kinesics on Human-Machine System --- design theory
  - Informative Motion as Motion Media to incorporate information
- Interaction with Human-Symbiotic Robot
  - Step-on Interface (SOI) --- bilateral interface via projected screen
  - Friendly Amusing Mobile (FAM) --- playing "light" tag
- Measurement and Analysis of Human Movement
  - Lifting of Heavy Weight --- movement evaluation and optimal posture
- Systematic and Effective Learning Method on Mechatronics
  - Using LEGO-Mindstorm and Sony-AIBO

Recent subject

- Walking Trainer Mobile Robot System
  - Smaller/Lighter Equipment, for Trainee using Walker
  - Walking Trainer with Customizable Trajectory Design
- Image-Projective Desktop Arm Trainer, IDAT
  - (1) Reflection type, (2) Direct type, (3) Built-in type
  - Touch Event Detection --- LRF, RGB-D (Kinect), ...
- Mobile robot with human detection / following
  - Human detection
  - Human following

Method on function maintenance and recovery exercise



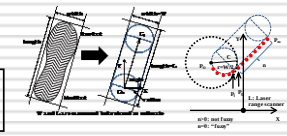
Walking trainer with customizable trajectory design

System structure

Foot Detection
Define and calculate position and direction of a foot

Robot calculation
Calculate position and direction of mobile robot

Foot model



1. **Trajectory designer** <Teaching> Use mobile robot to track and record tutor's steps and walking trajectory using laser range scanner.
2. **Trajectory viewer** Display recorded trajectory graphically and calculate data for analyzing on a computer.
3. **Mobile walking trainer** <Training> Apply data calculated along trajectory on mobile robot for trainee's steps and evaluate training status.

Features
- Actual walking feeling for trainee
- Can design trajectory suitable for different patient
  - A tutor walks and robot follows, applying into walking training

Walking training test (2) S-shape

July 2012

Teaching
- Tutor's feet sequence detected in *Trajectory Designer* while teaching

Training
- Trainee's feet sequence detected in *Mobile Walking Trainer* while training

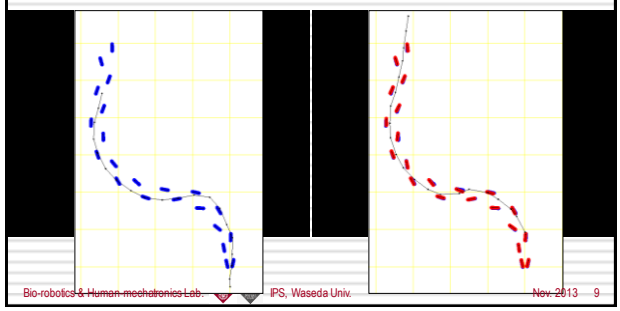
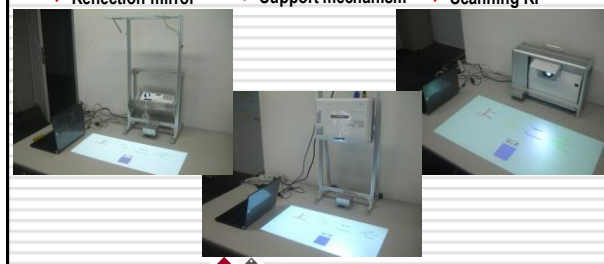


Image-projective Desktop Arm Trainer, IDAT

IDAT-1
- Reflection type
  - W365-D470-H800mm
  - 7.5kg (main body)
  - ✓ Reflection mirror

IDAT-2
- Direct type
  - W380-D380-H680mm
  - 8.5kg (main body)
  - ✓ Support mechanism

IDAT-3
- Built-in type
  - W500-D160-H360mm
  - 10.2kg (main body)
  - ✓ Scanning RF



Procedure for training

Parameter setting

Training
- To pat object

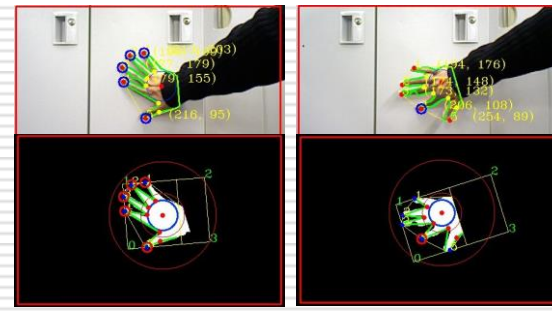
Result

Start
Welcome Screen
Game Time Setting
Object Speed Setting
Object Number Setting
Setting Confirmation
Mole Patting
Balloon Breaking
Fish Catching
Result Screen
End

By hammer [2012.06] (2:41)

Touch event Detection

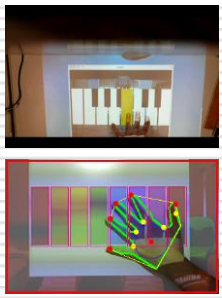
RGB-D sensor (Kinect, Xtion)



Finger touch [2013.01] (1:12)

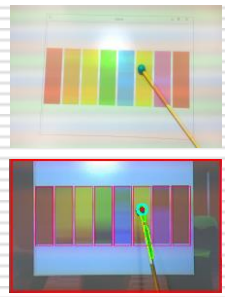
HRI based on contact/non-contact sensing

- Virtual Piano



Virtual Piano [2013.10] (0:57)

- Virtual Xylophone



Virtual Xylophone [2013.10] (0:52)

Mobile robot with human detection / following

- Human detection
  - → To solve the detection range problem
  - using laser range scanner
    - Data points clustering
    - Target human position estimation

- Human following
  - → To solve the unlimited robot speed problem
  - with adaptive acceleration of robot movement
    - Death zone
    - Speed stages: 1) increasing, 2) saturation, 3) decreasing

An interrupter goes across [2013.09] (0:19)

An interrupter walks parallel [2013.09] (0:13)

Walk parallel and turn [2013.09] (0:21)

Robotics / Humanics

- Various robots are announced in a big event and reported widely
- However, what will robots provide after losing such extra-ordinary?
- Robotics research and development lead us to consider humanity to confirm human dignity
- Learn about ourselves while implementing what we think is required and helpful for people in a robot
- We desire higher level of human nature and we cultivate enriched humanness while research and development of robots
- Robotics is humanics (from engineering point of view)

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