Bio-Robotics and Human-Mechatronics Laboratory

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Bio-Robotics and Human-Mechatronics Laboratory

- Various themes between human and robot
- To make mechanical artificial systems more friendly / useful for users
- Developing new functions, producing real-world systems
- Applying various knowledge and technologies, as a system integrator

Better interaction / relationship between human and robot

Biographical Information

- 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 on multi-dof compliance control on articulated manipulator (Supervised by late Prof. I.Kato)
- 1987–1999 R&D center, Toshiba Corporation
  Research on robots for specialized operations
  Development of mechatronic systems using robotic tech
- 1995 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 (Laboratoire Systemes Complexes) – CNRS, Evry France.
  Visiting Fellow (2002), Shizuoka Industrial Research Institute, Japan
  2010– Professor, Waseda University
  Research and Education on Bio-Robotics and Human-Mechatronics

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- Remote Operation System of Mobile Robot
  Combination Control of Manual and Autonomous
  Environmental Map around Remote Robot: Line method / Cell method
  Operational Interface: JS, Pupil mouse, HMD + gaze track, Voice, Touch display
- Pre-Announcement of Robot’s Intention
  Method and Apparatus to Display Direction and Speed: 4 kinds / 2 types
  Experiment in Simulated Interactive Situation: Human-Robot Motion Capture
  Comparing Display Announcement with Voice Announcement
- Form / Movement of Human-Synergetic Robot
  Emotional Motion: Four Basic Emotions on Teddy Bear Robot
  Informative Motion: Hand-over and Throw-over for Humanoid Robot
- Interaction with Human-Symbiotic Robot
  Step-On Interface (SOI) and Friendly Amusing Mobile (FAM) Function
  Application: Playing “Light” Tag – stepping animal tail / bomb fuse / footmark
Interaction problem

- Lack of shared knowledge / common sense
  - Human beings
    - Interact, signaling own and predicting others’ action / intention
    - Non-verbally through body language, hand gestures, facial expressions, and whole body operations
    - Acquire social and physical skills that make movement practically second nature based on sense of affinity, familiarity, and common appearance – sharing "common sense"
  - Robots
    - Cause disaffinity, unfamiliarity, and uncommon appearance – no sharing of common sense that make robot movement predictable to people
    - Avoid risk of contact and collision
- Function to preliminary-announce robot’s intention
  - Mobile robots or transport vehicles – speed / direction

Prototype Robot

- State of operation just after the present
  - Lamp
    - PMR-2R
  - Blowout
    - PMR-6R
- Operations from present to some future
  - Light ray
    - PMR-1R
  - Projection
    - PMR-5R

PMR-2R: Omni-directional Display

- "Eyeball" (gaze)
  - Friendly, familiarity
  - Operation at 1.5s-later
    - Speed – degree of eye opening
    - Direction – eye positioning

PMR-6R: Flat-panel Display

- "Arrow"
  - Commonly used, comprehensible
  - Operation at 1.5s-later
    - Speed – size / color of arrow
    - Direction – curved condition

PMR-1R: Laser Pointer

- "Scheduled route"
  - Afterimage of radiant
  - Route until 1.5s-later
    - Speed – length of route
    - Direction – direction of route

PMR-5R: Projector

- "Occupied area"
  - Color-coded / striped belt
  - Area until 1.5s-later
    - Speed – length of belt
    - Direction – curved belt
**Step-On Interface (SOI)**

- **SOI (Step-On Interface)**
  - Projected screen is used as a bilateral interface
  - Not only presents some information
  - But also delivers instructions
  - Projector displays a direction screen on a surface
  - 2-D Range scanner detects and measures the user's stepping to specify the selected button

- **Features:**
  - Hands-free – elderly, physically challenged, and users whose hands are full
  - Anywhere without disturbing others and in noisy environment
  - No special devices are needed – user's own foot or stick (cane)
  - Requires little preliminary preparation or special setup
  - Can use figures / pictures in addition to letters – language-independent, possible for beginners and non-native speakers
  - Functions are easy to design, setup and change in software

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**Human-Friendly Amusing Mobile Robot (HFAMRO-1)**

- **Omni-dir. mobile platform**
  - Omni-wheel (4)
  - HD-geared DC-motor (4)

- **Step-On Interface (SOI)**
  - **Projector**
    - Min. distance: 1200mm
    - Screen size: W730–D550mm (36°)
  - **Mirror**
    - W225–D125 mm
  - **Range scanner**
    - Area: 2460deg / 682step (0.35deg/step)
    - Distance: 20–4095mm
    - PC acquires data every 100ms

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**Basic movement from both sides**

**Functional Amusing Mobile (FAM) function**

- **FAM (Friendly Amusing Mobile)**
  - Robots interact with users
  - **Play ‘tag’**
    - Play tag, with “light”, similar to ‘shadow’ tag
    - User pursues robot and steps on button on screen
    - Robot responds by playing game, providing with information, moving to indicate ‘emotion’, etc.
  - **Game: step on animal's tail**
    - **Scenario**
      - Animal’s head and tail are displayed
      - Moves characteristically, cocking head and wagging tail
      - Stop, cry out, and show anger, when caught up / stopped
    - **Technical aspect**
      - Self-contained mobile robot, independent without movement restriction
      - Playing tag with “light” function
Human-Friendly Amusing Mobile Robot HFAMRO-2

- Two-wheel drive mobile platform
  - D200-wheel (2), DC-motor (2)
- Step-On Interface (SOI)
  - Projector
    - Min. distance: 560mm
    - Screen size: W850×H640mm
  - Range scanner
    - Area: 240deg / 682step (0.35deg/step)
    - Distance: 20–5695mm
  - PC acquires data every 100ms
- Power source
  - Battery (mobile platform / SOIs)
  - External AC100V cable

Demonstration video

- Applications
  - Stepping animal tail
  - Stamping bomb fuse
  - Stepping footprint

Stepping animal tail: Dog (fast)

Animal selection
- Dog / Cat / Pig
Start moving
- Cocking head
- Wagging tail
- Panting
Catch up with / step on tail
- Stop immediately
- Anger expression
Removed
- Start again
Kept for a while
Get away
- Call for
- Get away
- Call for
- Come close

Stepping footprint

Make user
- Strong desire to commit rehabilitation of walking
Initial screen
- Two marks of both feet
Session starts
- User puts foot
- Makes sound, move forward, display mark
Sequential presentation
- User puts foot
- Makes sound, move forward, display the other
- Gotten away
- Sound to call for

Stamping bomb fuse: failure

Fuse
- Spark at end
- Swinging
User
- Stamp on spark
Moves
- Playing
- Background music
- Showing time left / remaining num. to stamp
- Crash sound
- User hits spark
As time passes
- Moves faster
- Pick up tempo

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Message
- Let’s grow up together developing a new field as the meeting ground for people who have a new way of thinking and extraordinary abilities regardless of present areas and aspects.