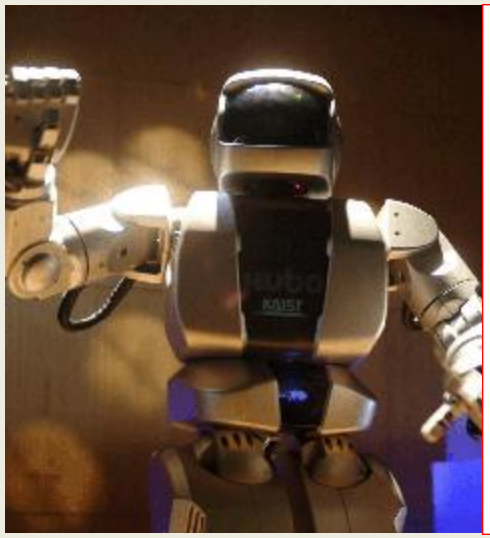
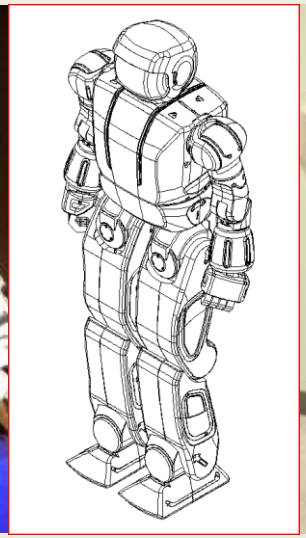
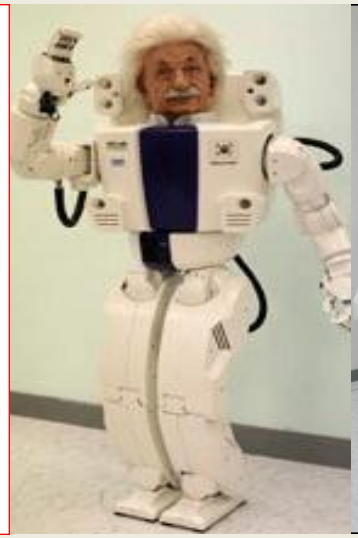
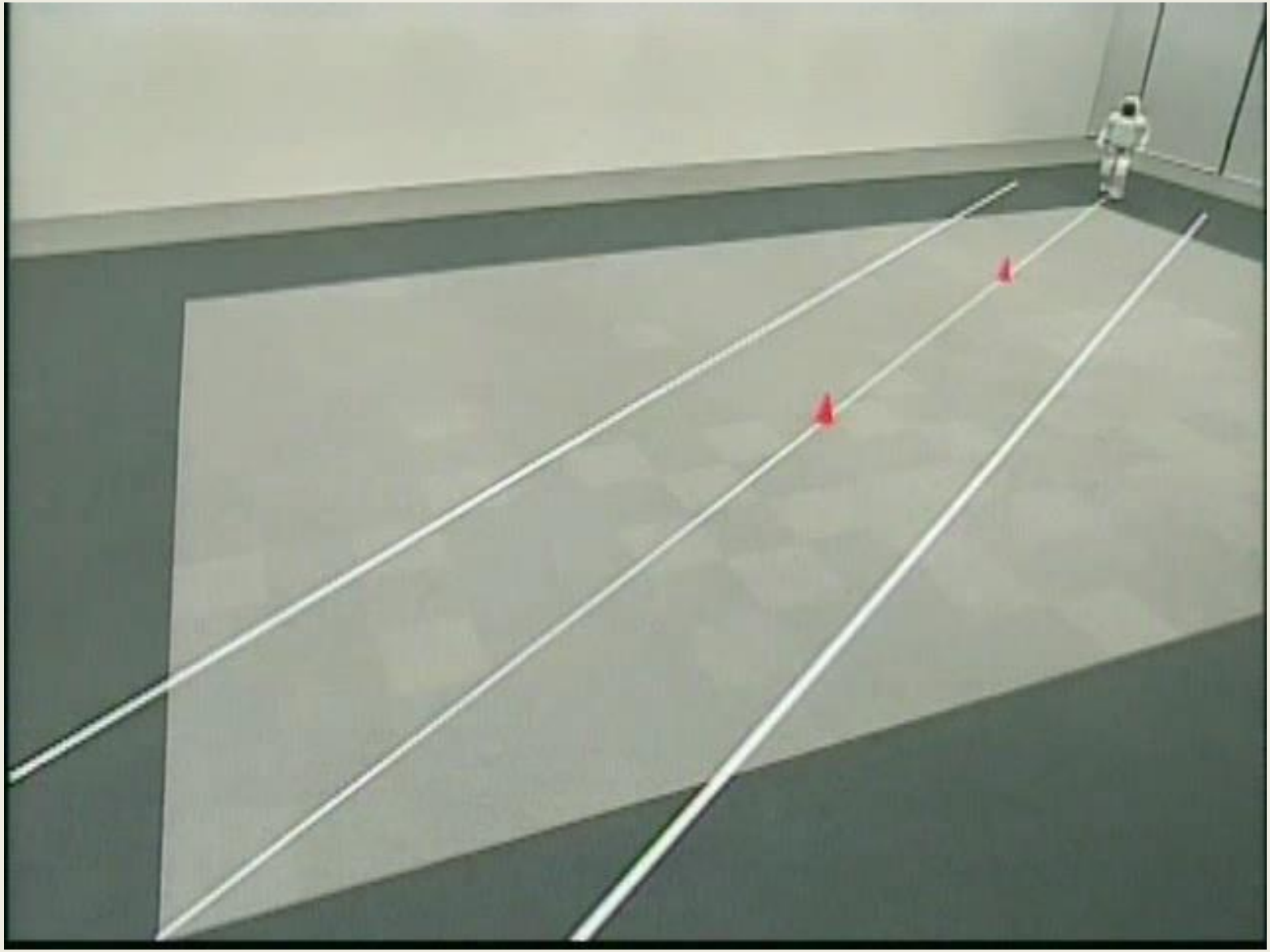





Robot Technology

HUBO LAB
Humanoid Robot Research Center
KAIST

Prof. Jun Ho Oh
Humanoid Robot Research Center,
Korea Advanced Institute of Science and Technology

Asimo, Honda



Contents

Intelligent Robot Application

- Home service robot
- Medical robot
- Military robot
- Robot in hazardous environment
- Entertainment robot
- Rehabilitation robot

Military Robot

Big Dog ,2008
USA, Boston Dynamics

Military Robot

Crusher ,*2008*
Carnegie Mellon Uni

Rescue Robot

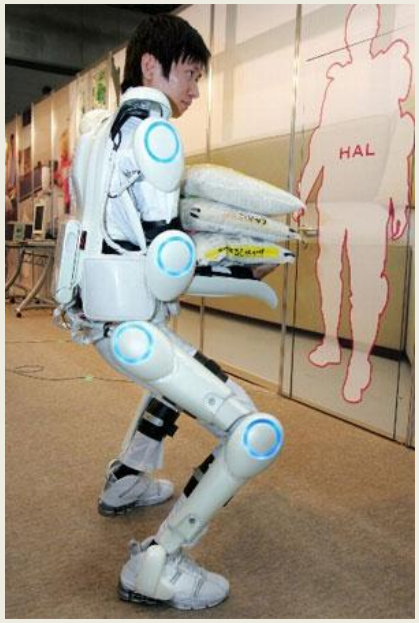
RHex
USA,Boston Dynamic

Entertainment Robot

Chroino , *2004~*
Tomotaka Takahashi.
developed by Kyoto University's RoboGarage

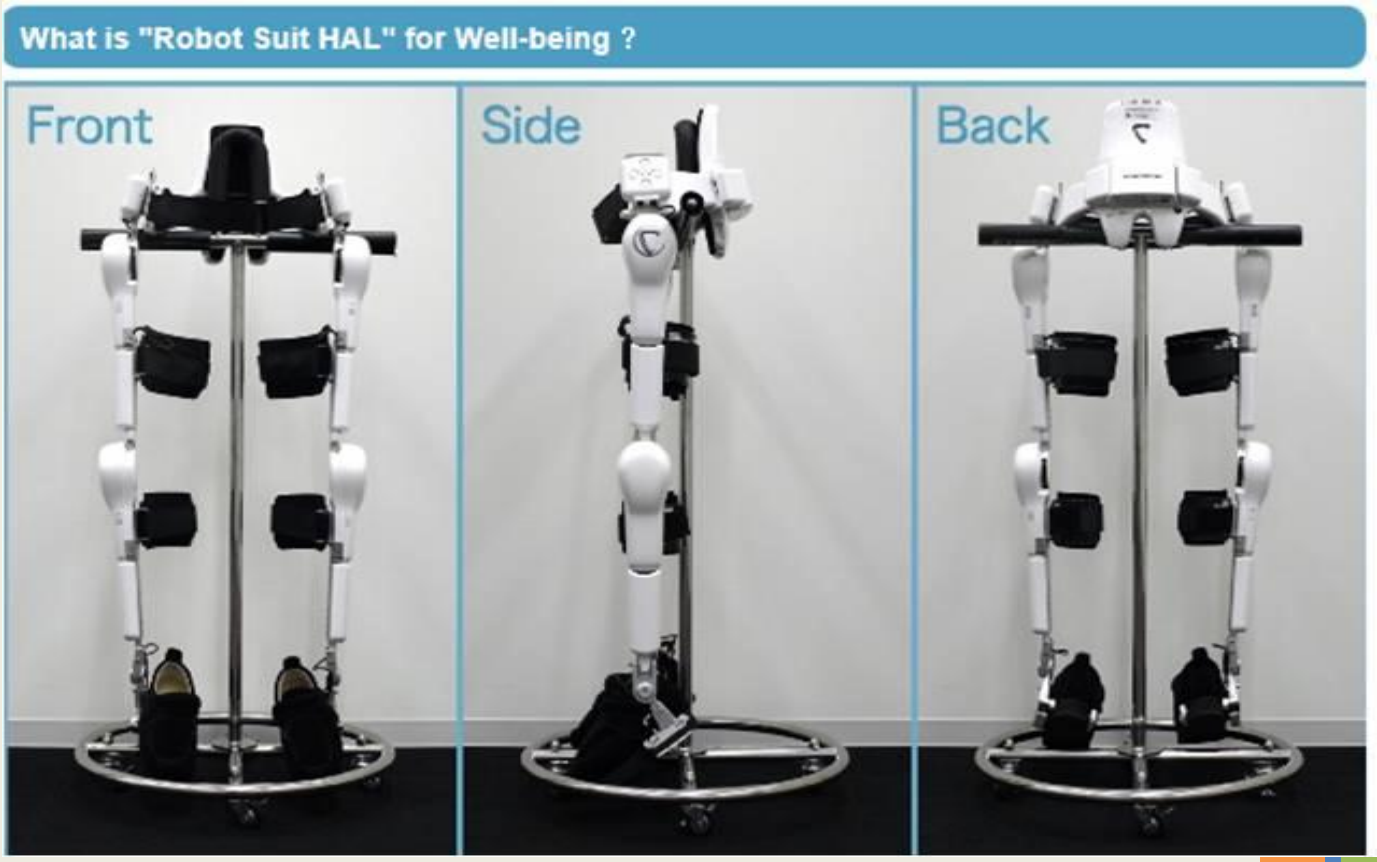
Service Robot

Pomi
Korea, ETRI



Wearable Robot

HAL, *2007*
(Hybrid Assistive Limb)
Japan, CYBERDYNE ltd. ```


What is "Robot Suit HAL" for Well-being ?
Front
Side
Back


Stride Management Assist
Bodyweight Support Assist
Walking Assist Devices Being Developed by Honda

Emotion Robot

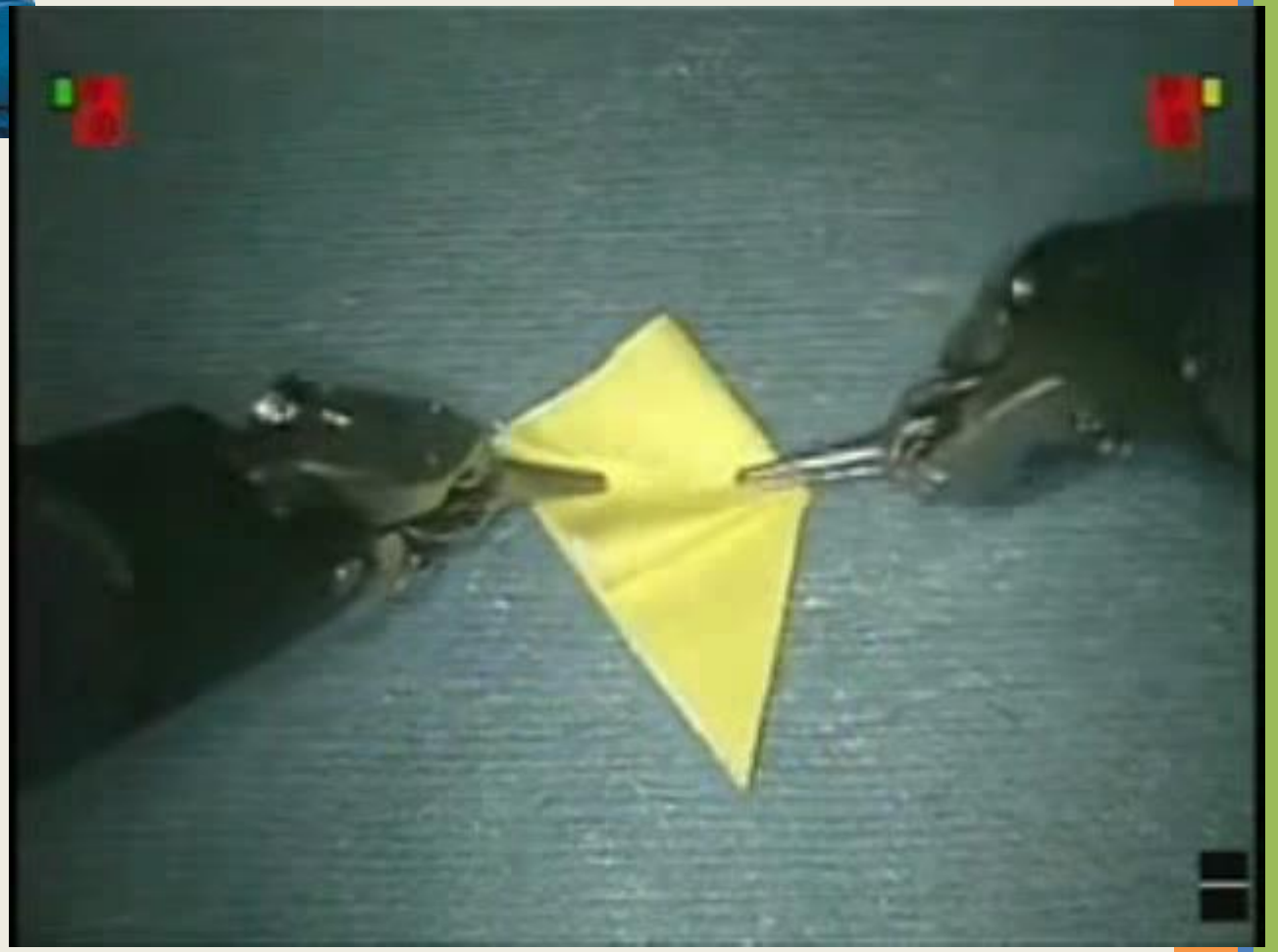
Paro, *2002*
Dr.Takanori Shibata
Japan,AIST

Bio Robots

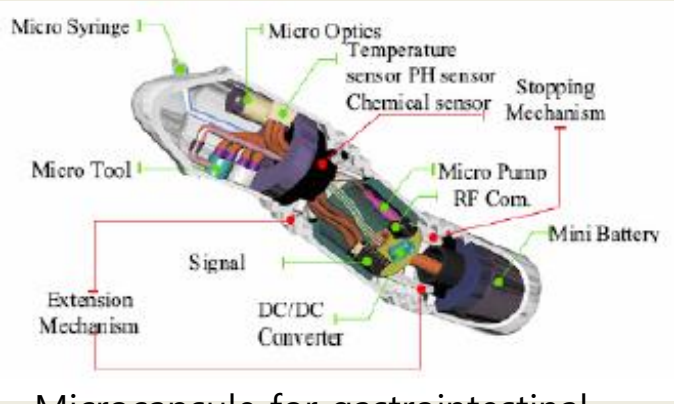
Monkeys control robots
with brain power
Univ. of Pittsburgh

Surgical Robots

Da Vici robot
USA, Intuitive Surgical Inc.



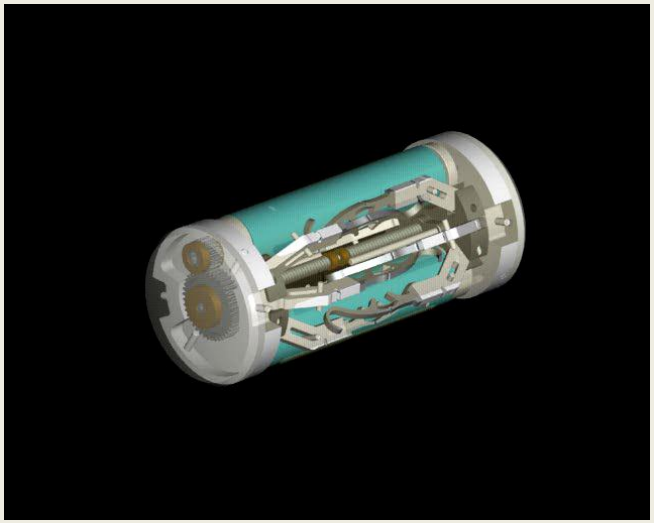
Capsule type Robots



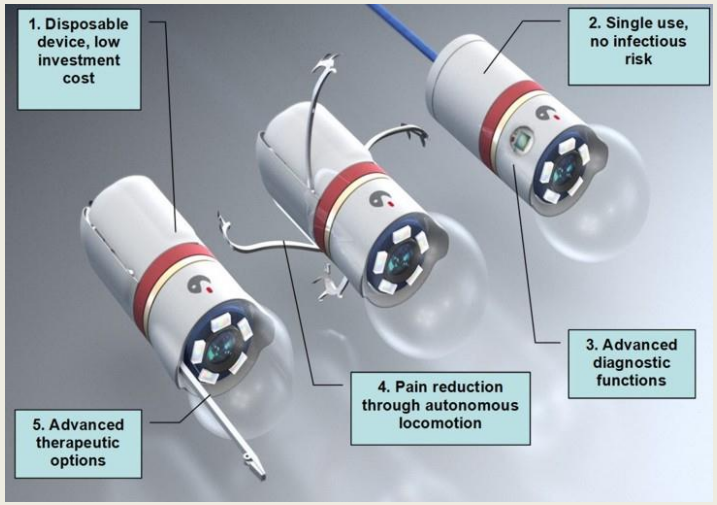
Microcapsule for gastrointestinal diagnosis and therapy (KIST, Korea)

M2A capsule endoscopy (Given Imaging, Israel)

Smart capsule endoscope (Olympus Co., Japan)

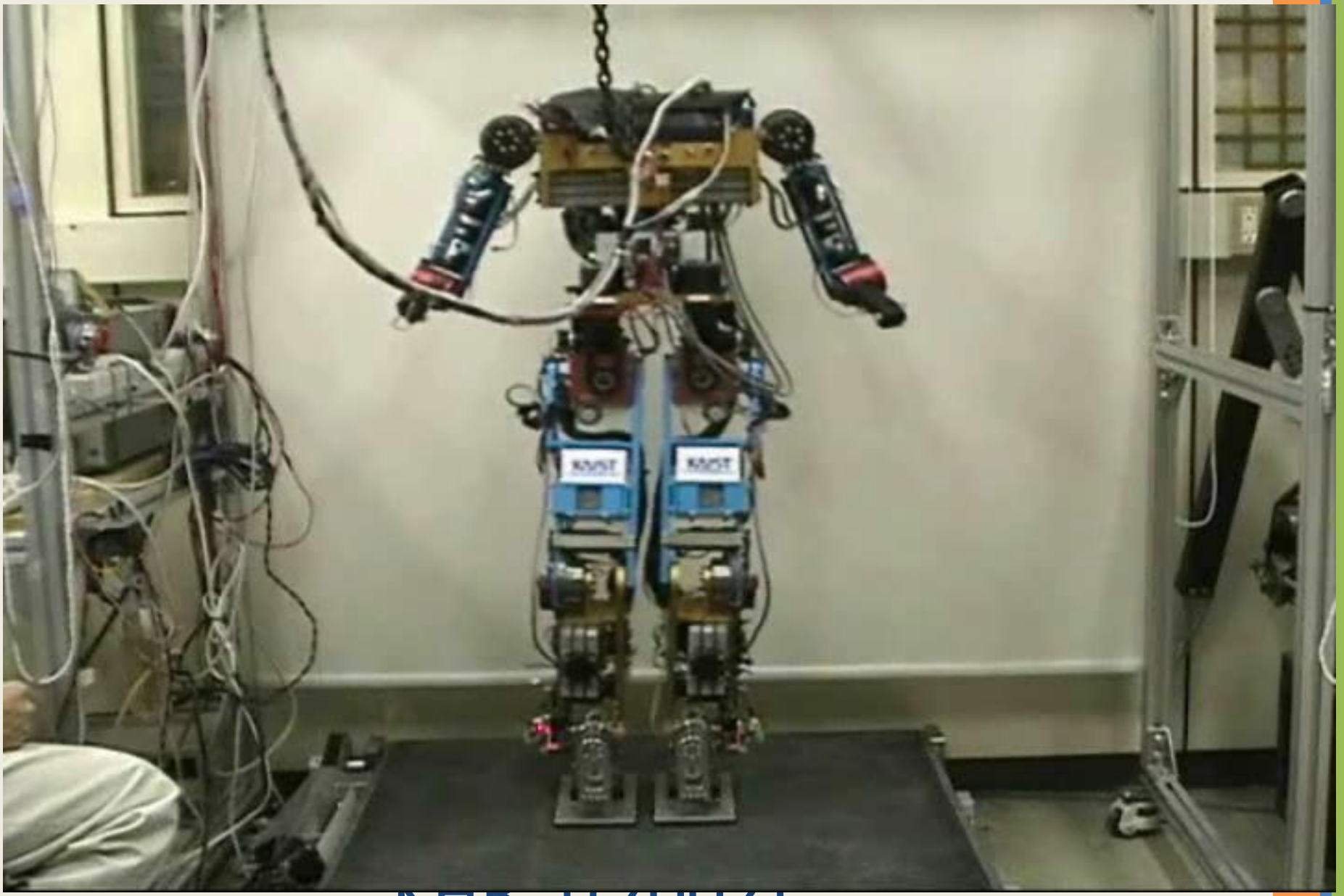


Legged Endoscopic Capsule Robots (JHU, USA)



www.vector-survey.com/surveyform.htm

Humanoid Robot: HUBO



KHR-1(2002)

KHR-2(2003)

Hubo, KAIST


로봇 휴보

Albert Hubo(2005)


KBS 1

Hubo FX-1(2006)

Humanoid Robot and DARPA Robotics Challenge

2013. 07. 30

Prof. Junho Oh
(*Vice President of KAIST*)

Humanoid Robot Research Center
Department of Mechanical Engineering
KAIST

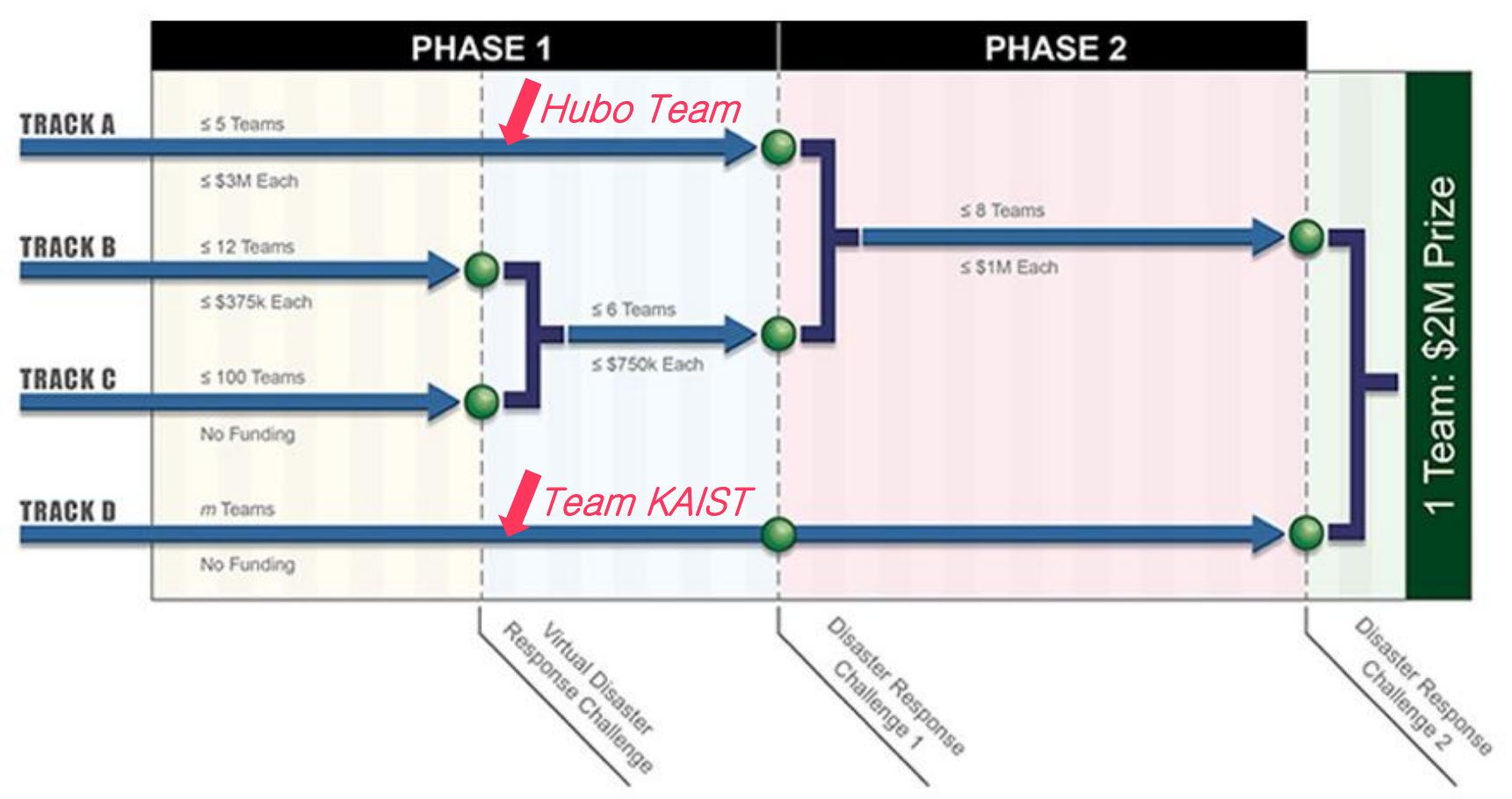
Darpa Robotics Challenge

- *Supervision*
  - Defense Advanced Research Project Agency – DARPA(미국 방위고등연구기획국)

- *Purposes*
  - To generate groundbreaking research and development so that future robotics can perform the most hazardous activities in future disaster(like Fukushima disaster) response operations, in tandem with their human counterparts, in order to reduce casualties, avoid further destruction, and save lives.

Darpa Robotics Challenge

DRC Schedule and Funding

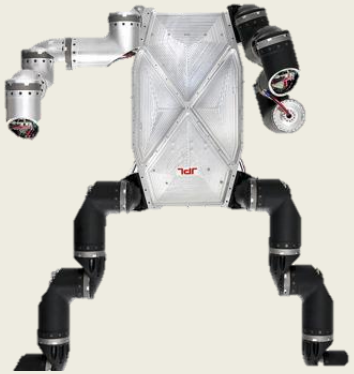


Robots in Darpa Robotics Challenge

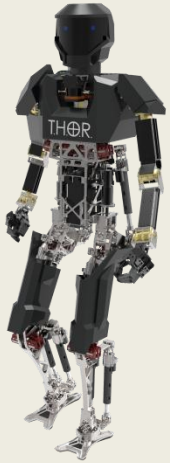
Track A

DRC-Hubo,
KAIST

CHIMP,
Carnegie Mellon University



RObosimian,
NASA JPL



THOR,
Virginia Tech

SCHAFT,
Japan

TBD,
NASA JSC

Track B

ATLAS,
Boston Dynamics

DARPA Robot Challenge

- Drive a utility vehicle at the site

- Travel dismounted across rubble.

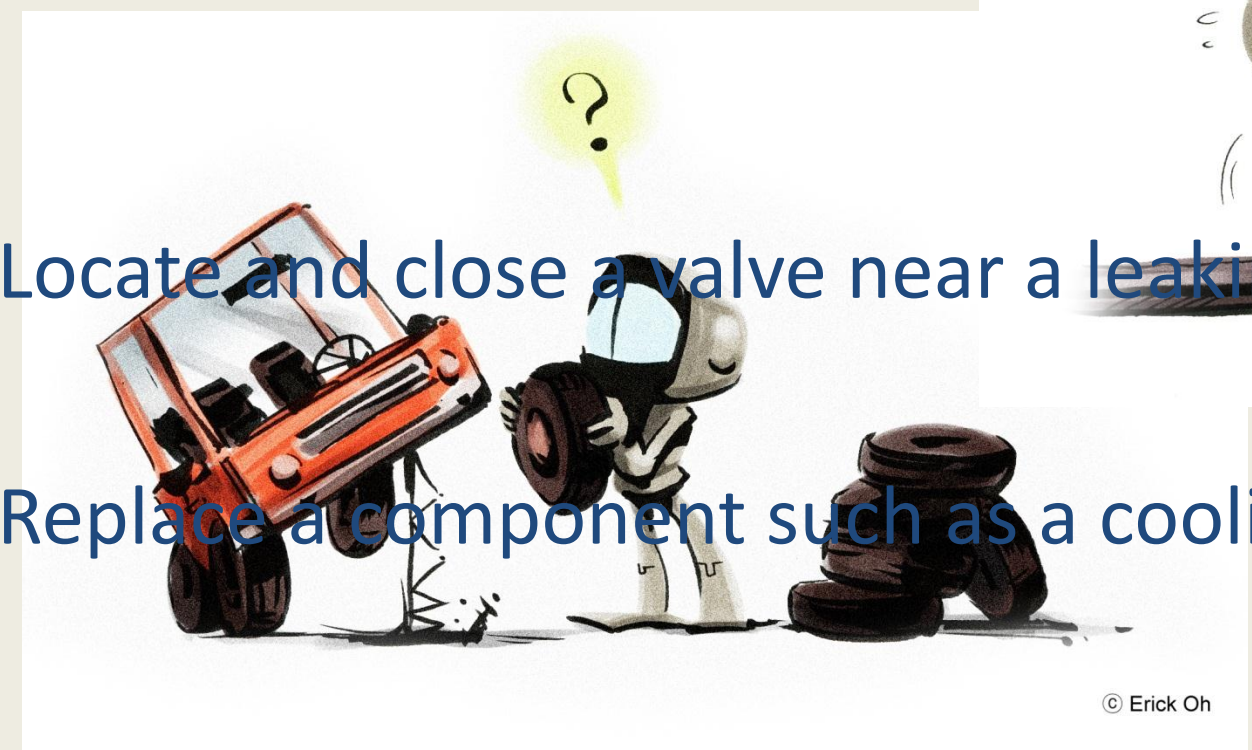
DARPA Robot Challenge

- Open a door and enter a building.

DARPA Robot Challenge

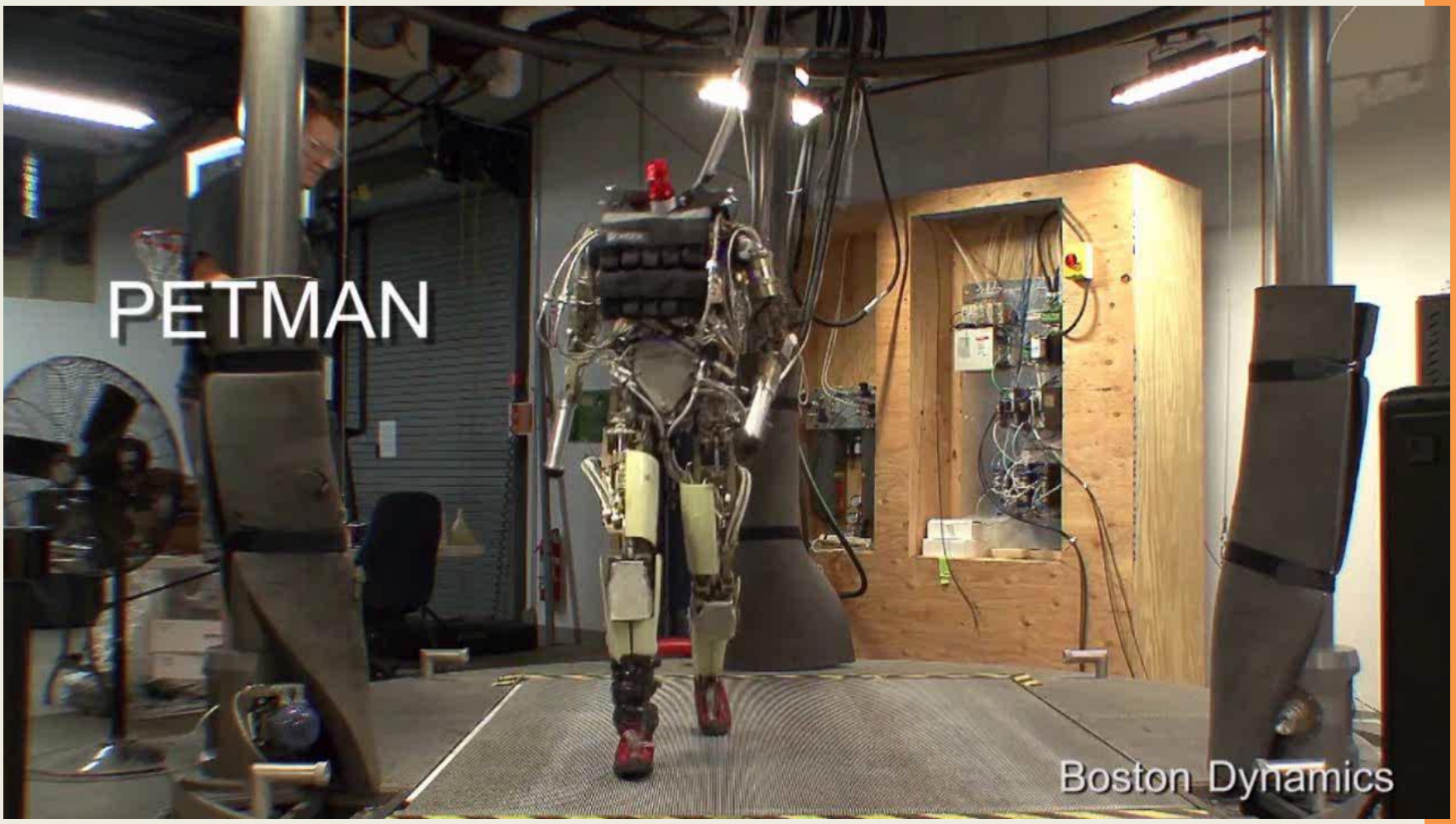
- Use a tool to break through a concrete.

- Locate and close a valve near a leaking.



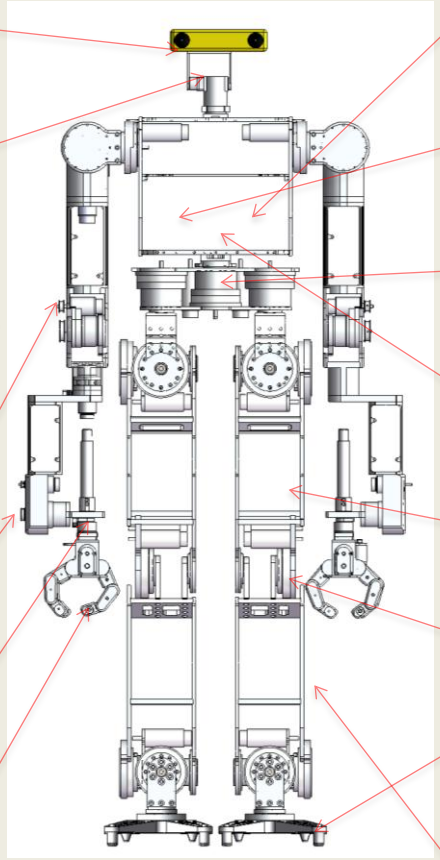
- Replace a component such as a cooling pump.

PETMAN, Boston Dynamics



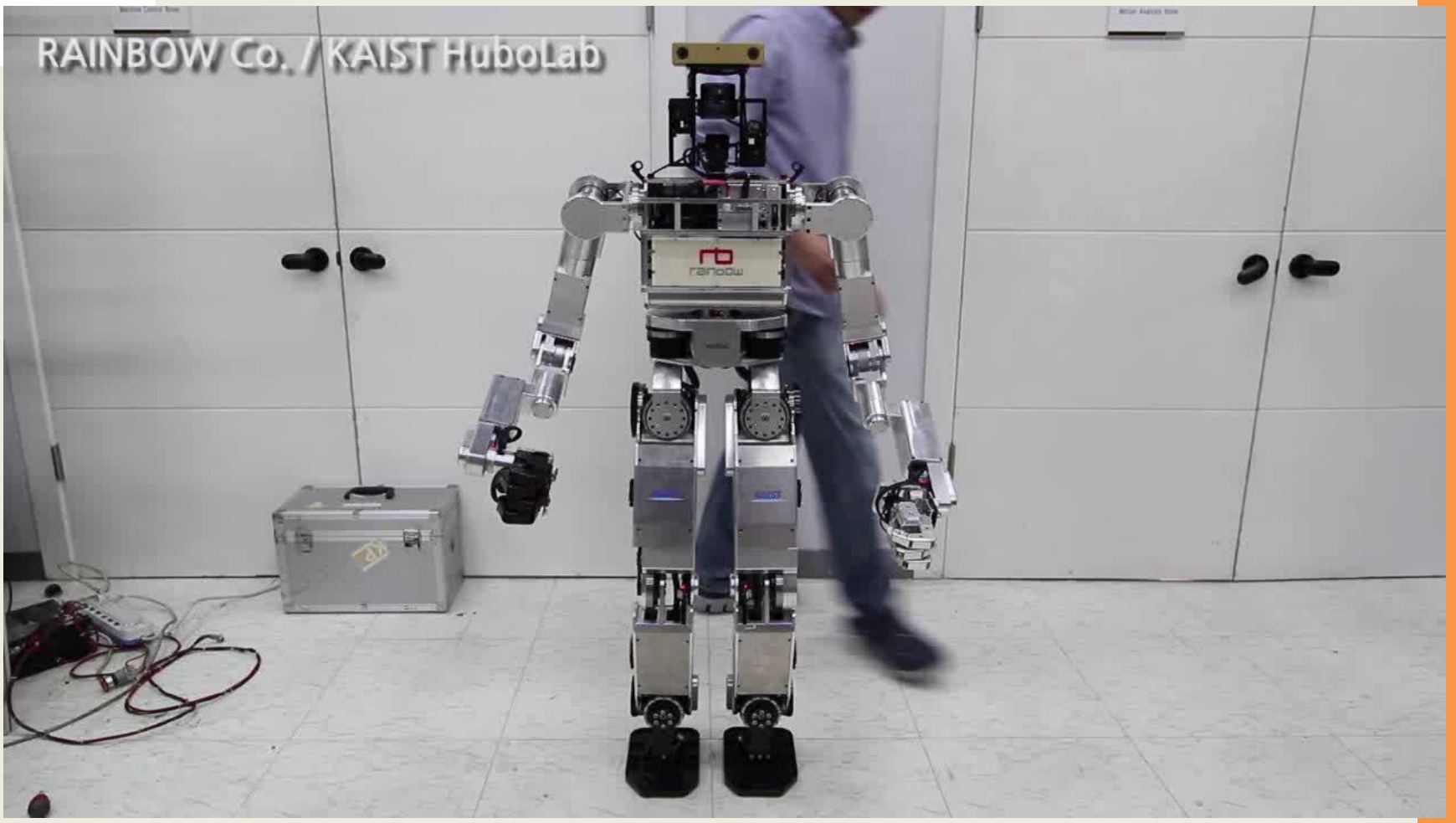
DRC Hubo Development

- Stereo vision system
- Various sensor acceptable head mechanism
- Smaller motor controller with torque control algorithm
- Powerful 7DOF arm design
- End-effector changeable mechanism
- 3-axis FT sensor with increased sensing range
- Power gripper

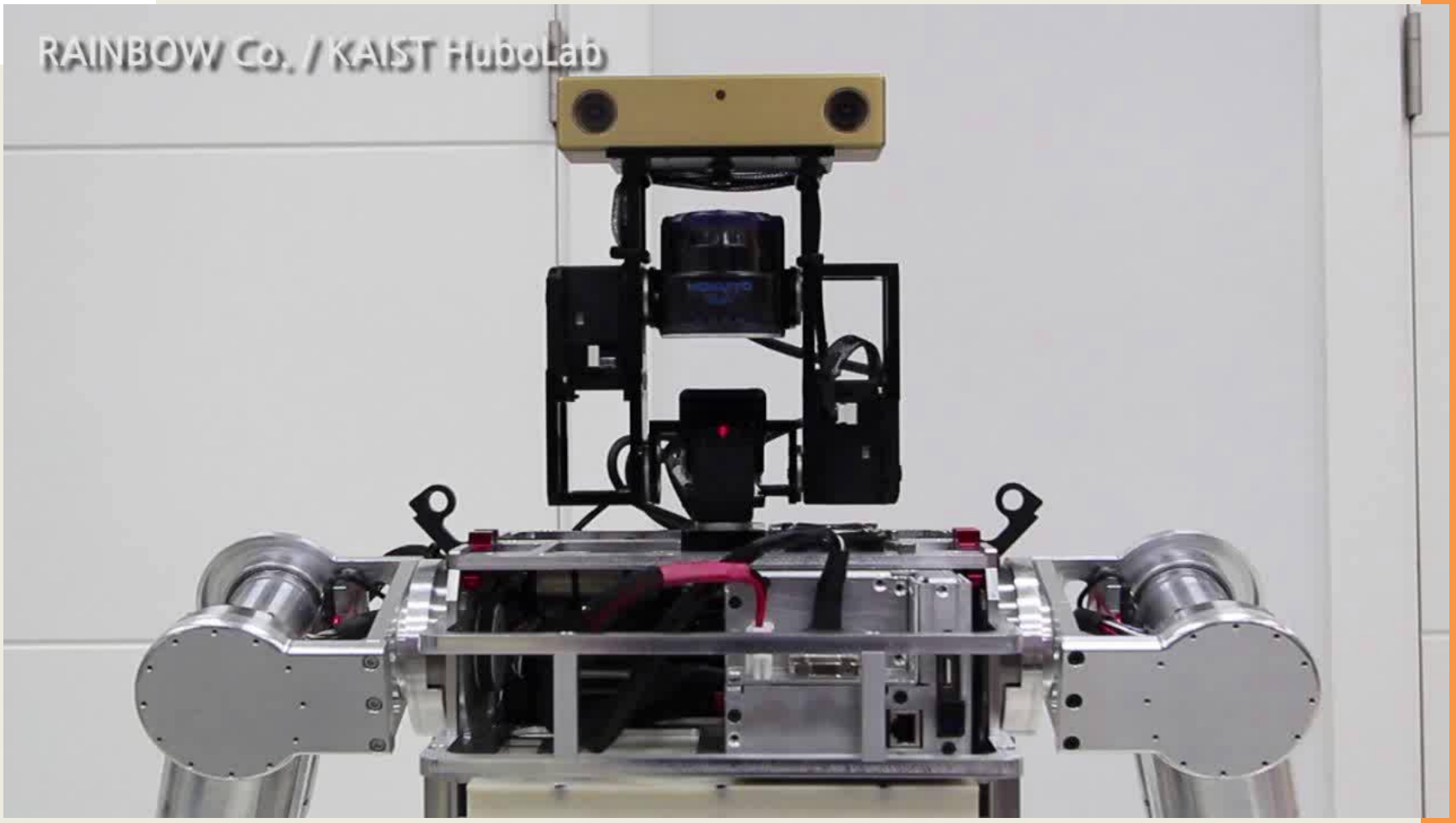


- Hard real-time linux system (xenomai)
- Increased computing power
- 3-axis IMU
- More durable battery
- Extended leg
- Powerful knee joint
- High friction material
- Protection shell (duralumin)

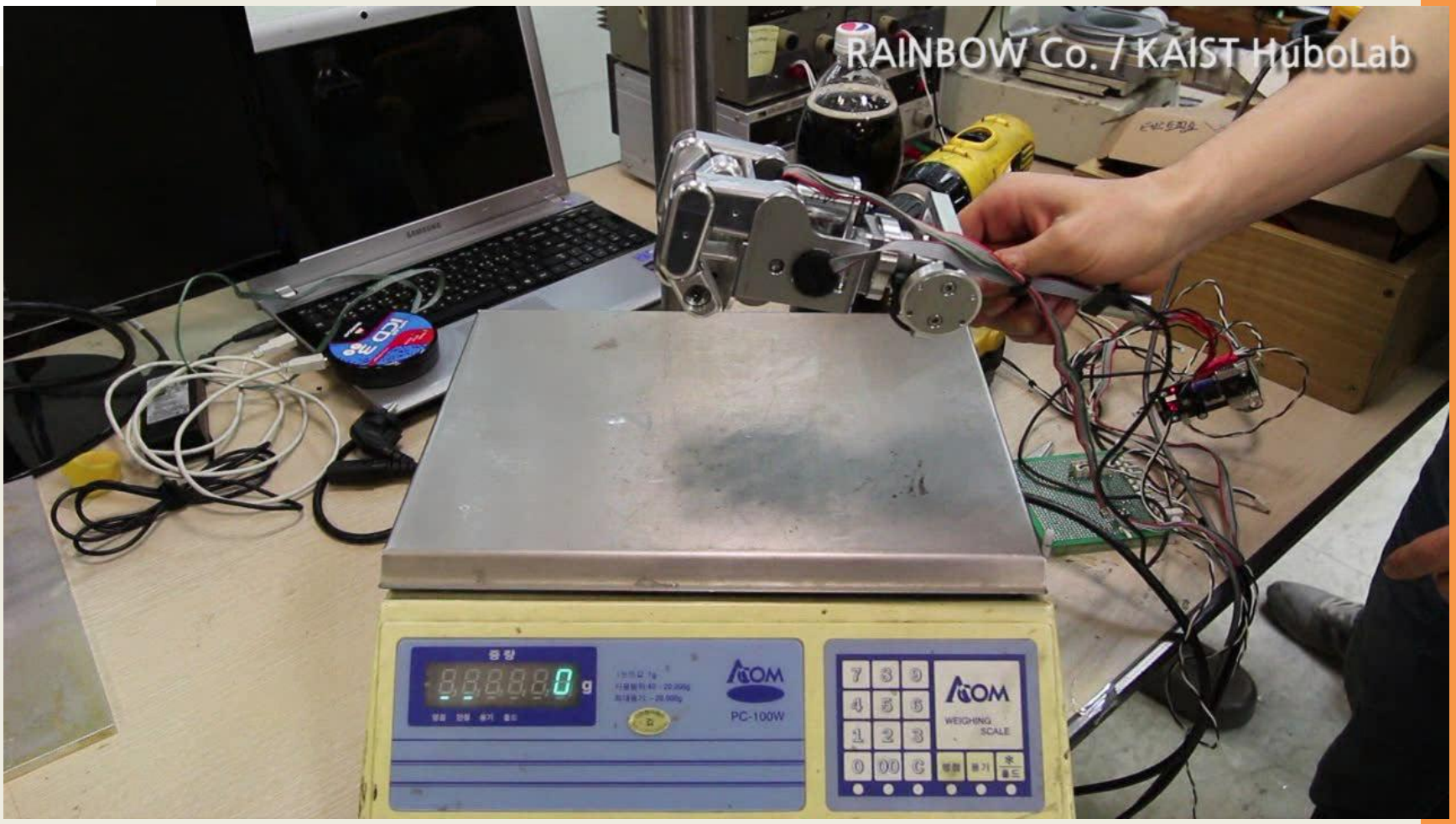
Body Operation



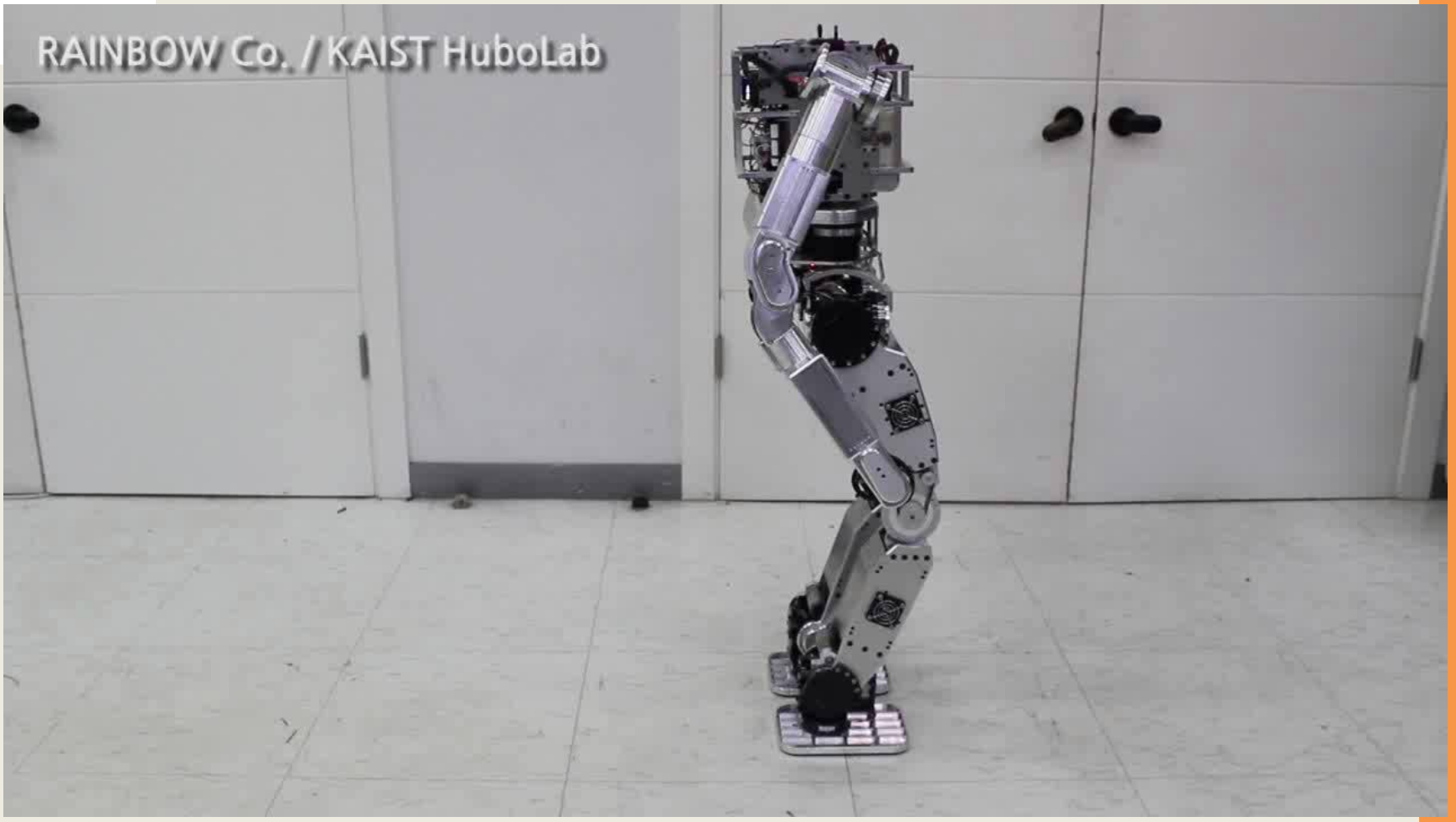
Head Operation



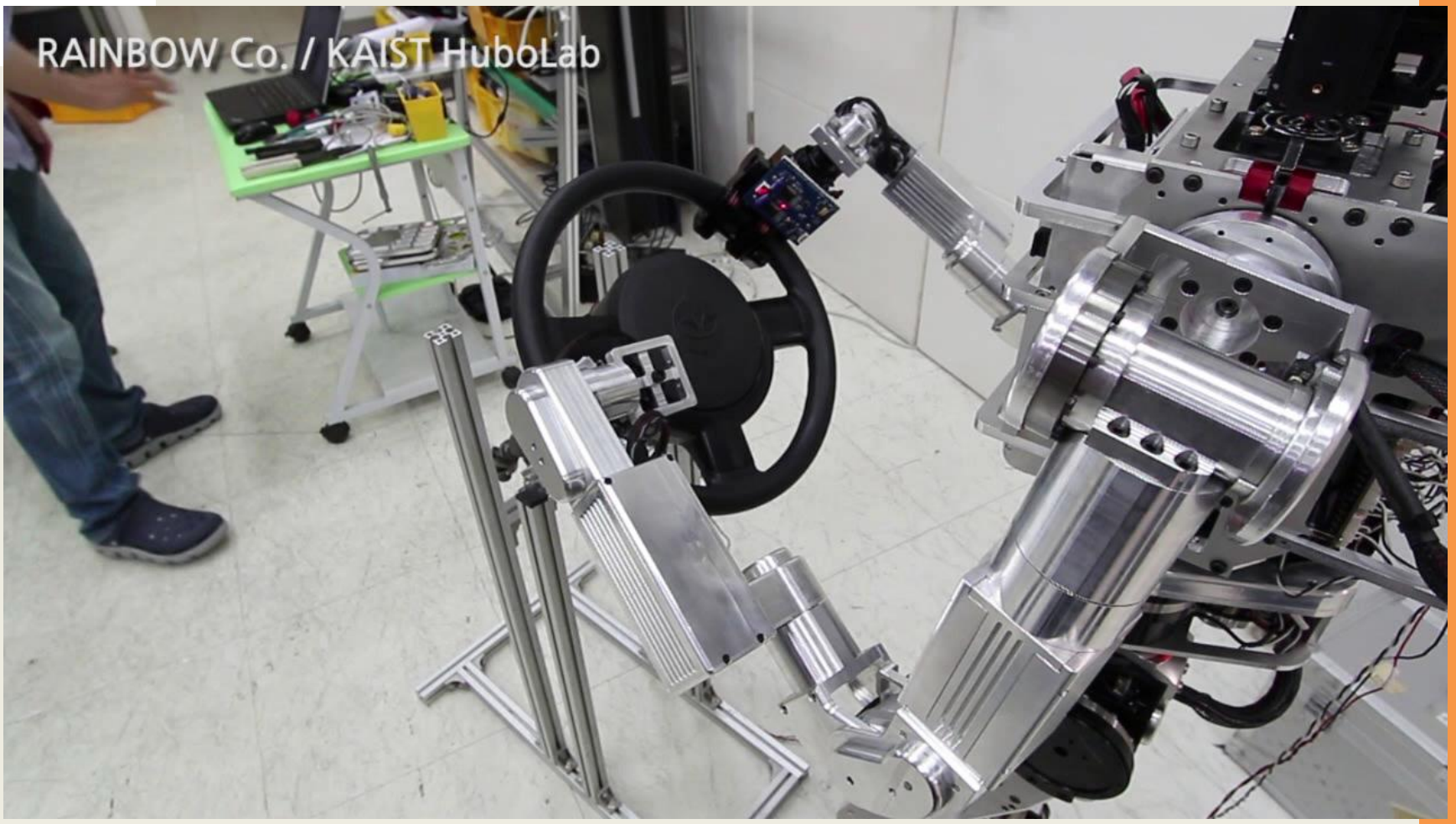
Hand Operation



Quadruped Walking Mode



Driving Utility Vehicle



Ladder Climbing

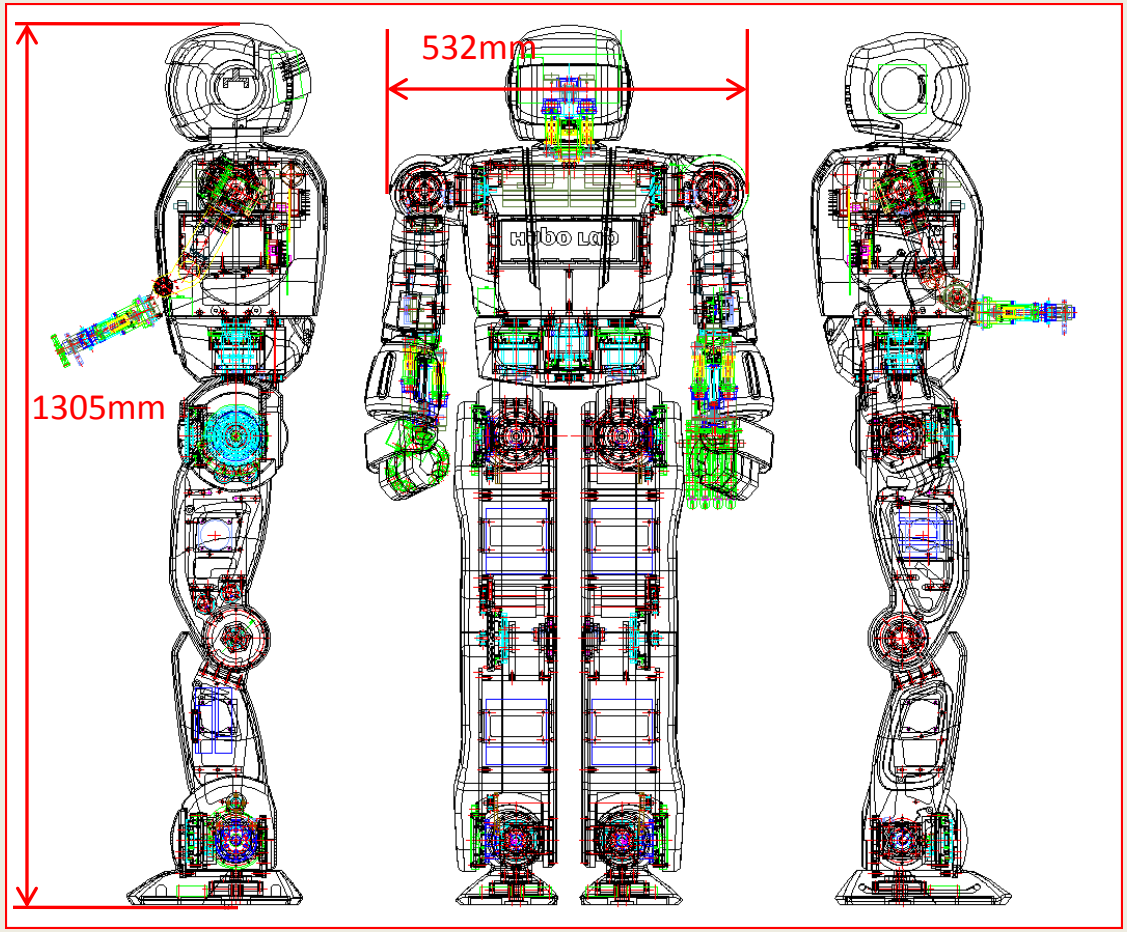
Mechanical Design – Body design

★High stiffness with light weight

★Over all weight is about 44kg including exterior case

★Avoid cantilever like structure

★40 DOF



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Humanoid Robot Research Center

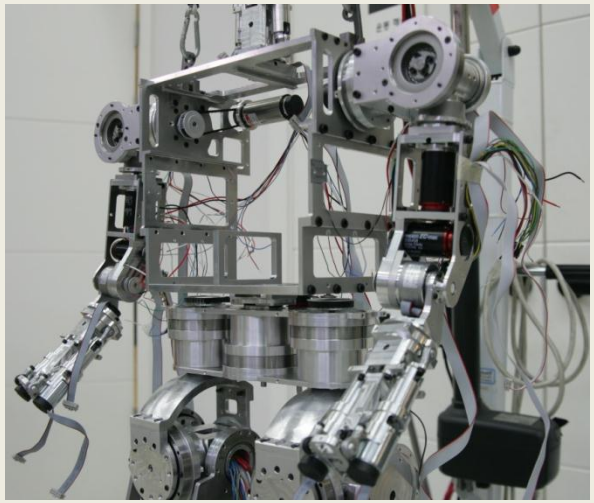
KAIST

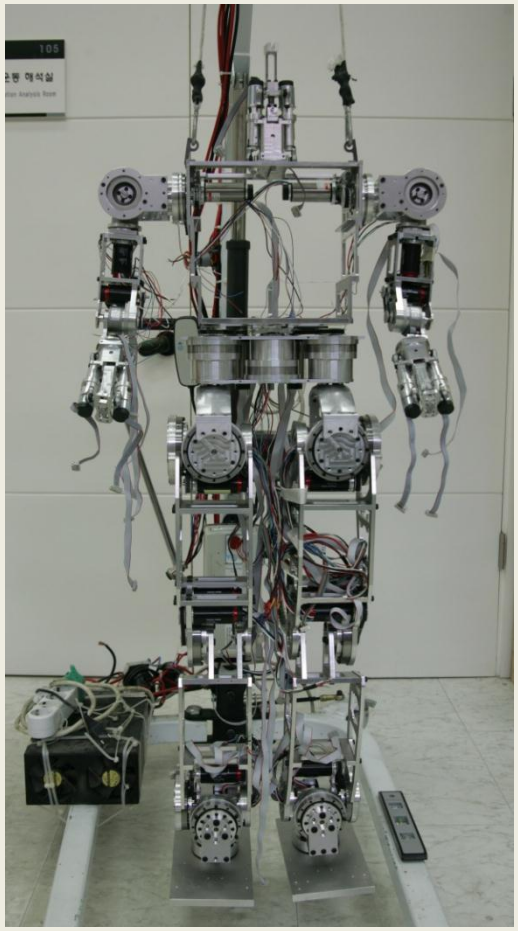
Mechanical Design – Body design

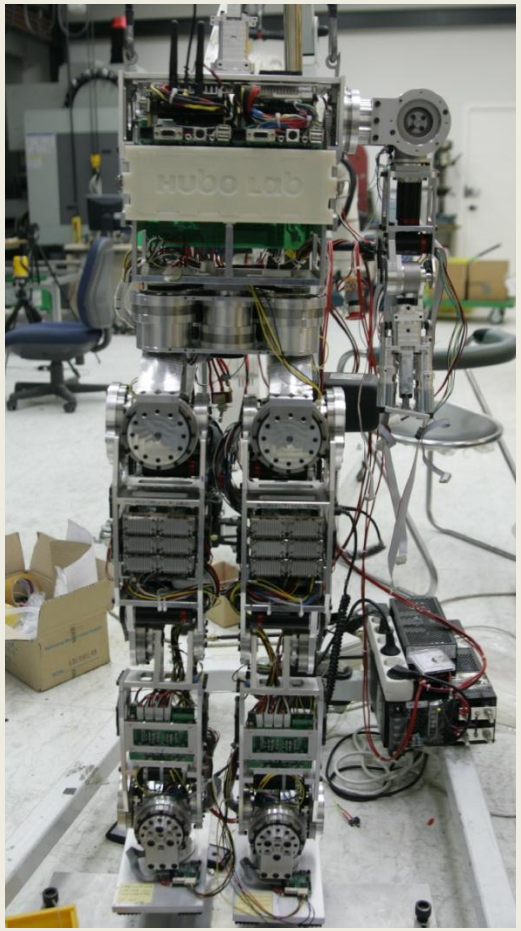
★High stiffness with light weight design

★Expected weight(include exterior case): 41kg

★30% weight reduction compare to the HUBO







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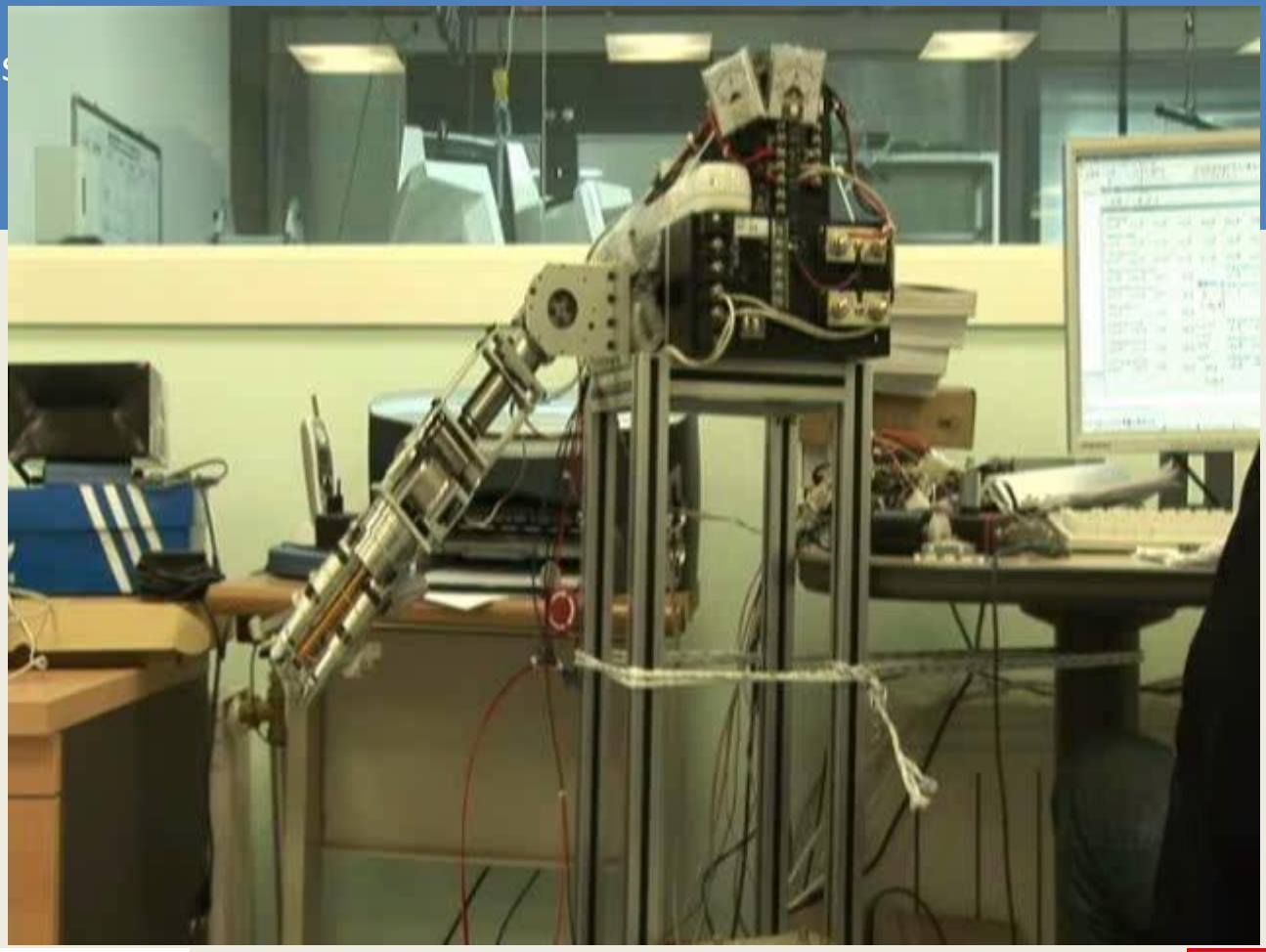
Mechanical Design – Light weight arm

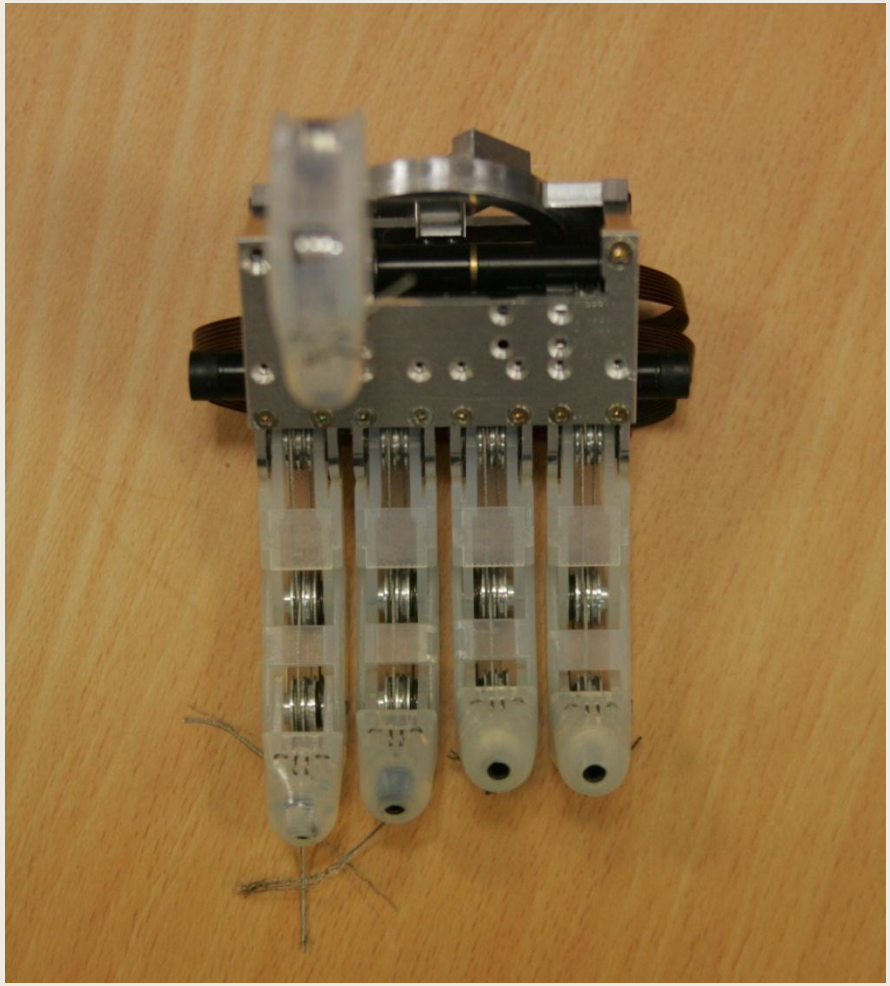
★It is pos

★7 DOF



Mechanical Design – Light weight arm

Mechanical Design – Adaptive hand



- ★Functional hand mechanism design
  - ★1 motor /finger
  - ★Tendon drive system
  - ★Shape adaptive grasping
  - ★Compact size

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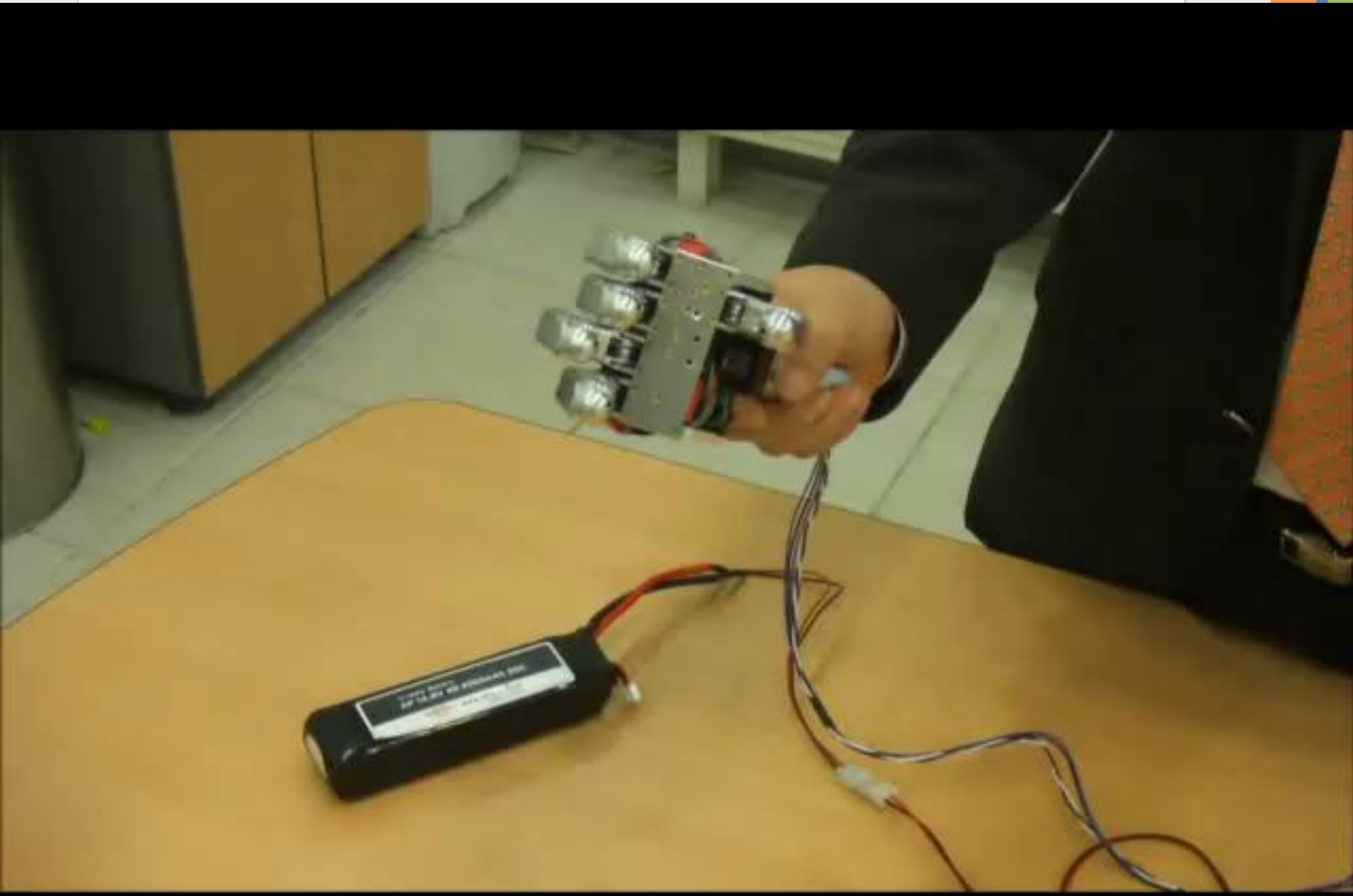
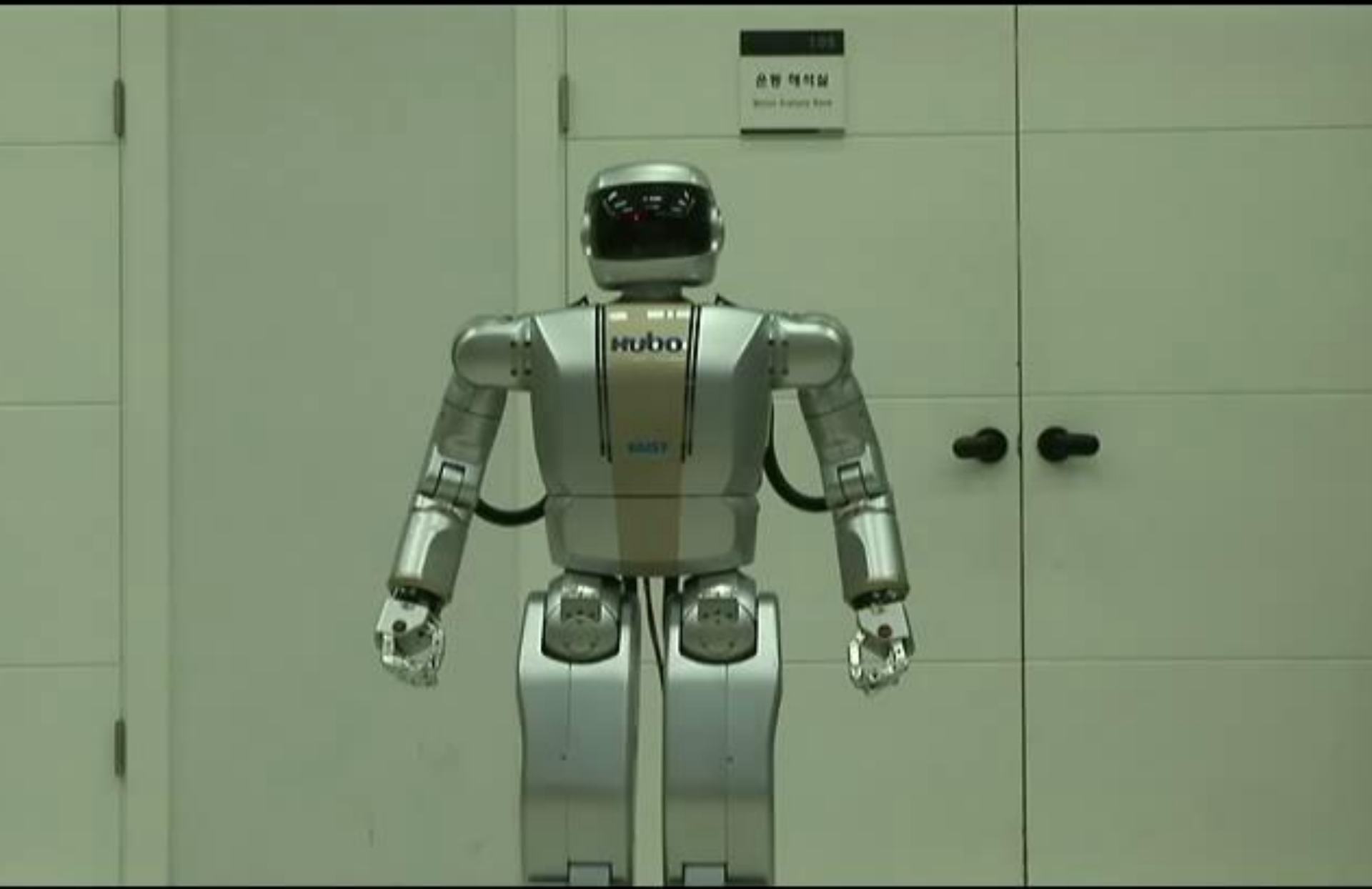
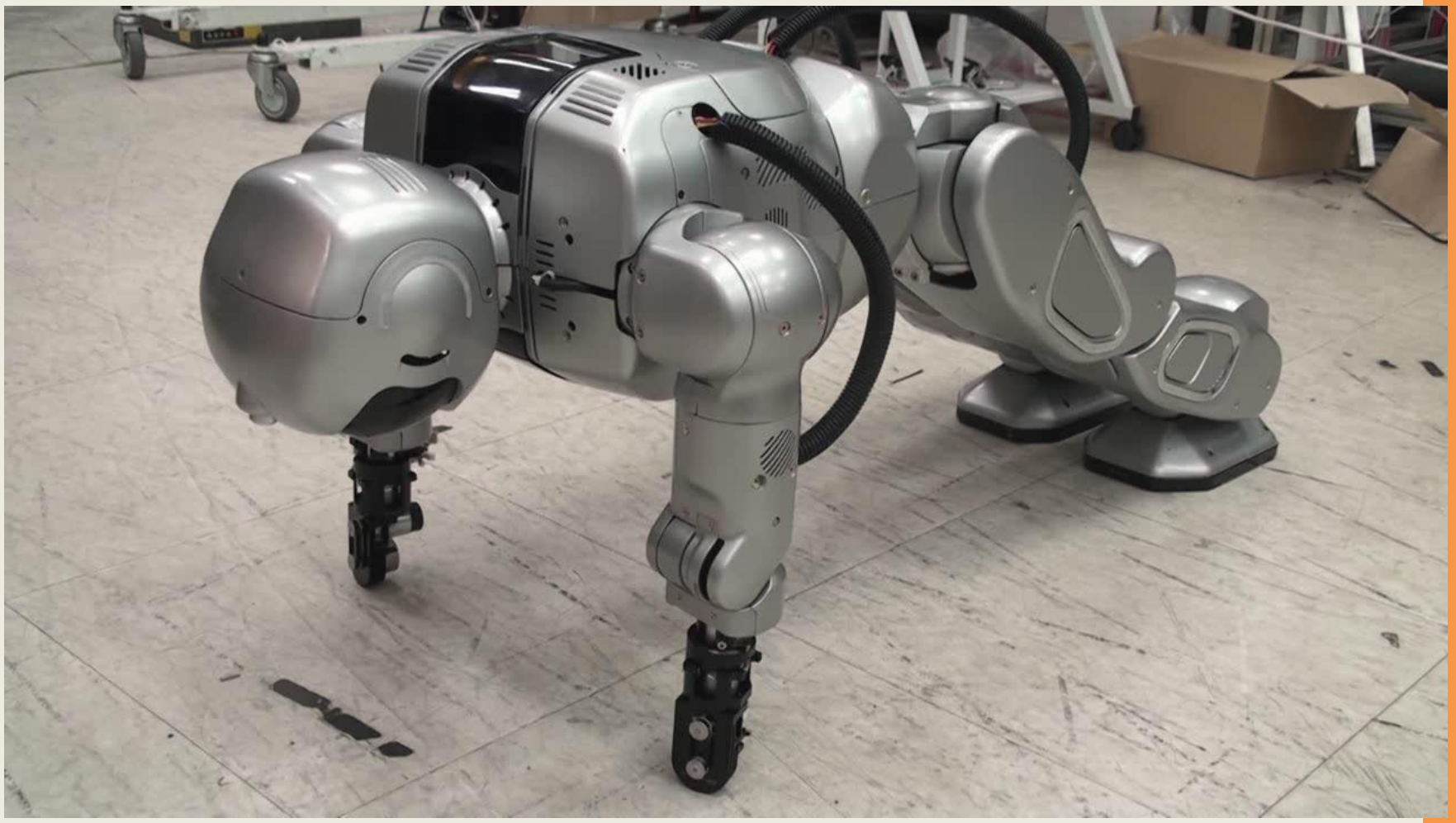


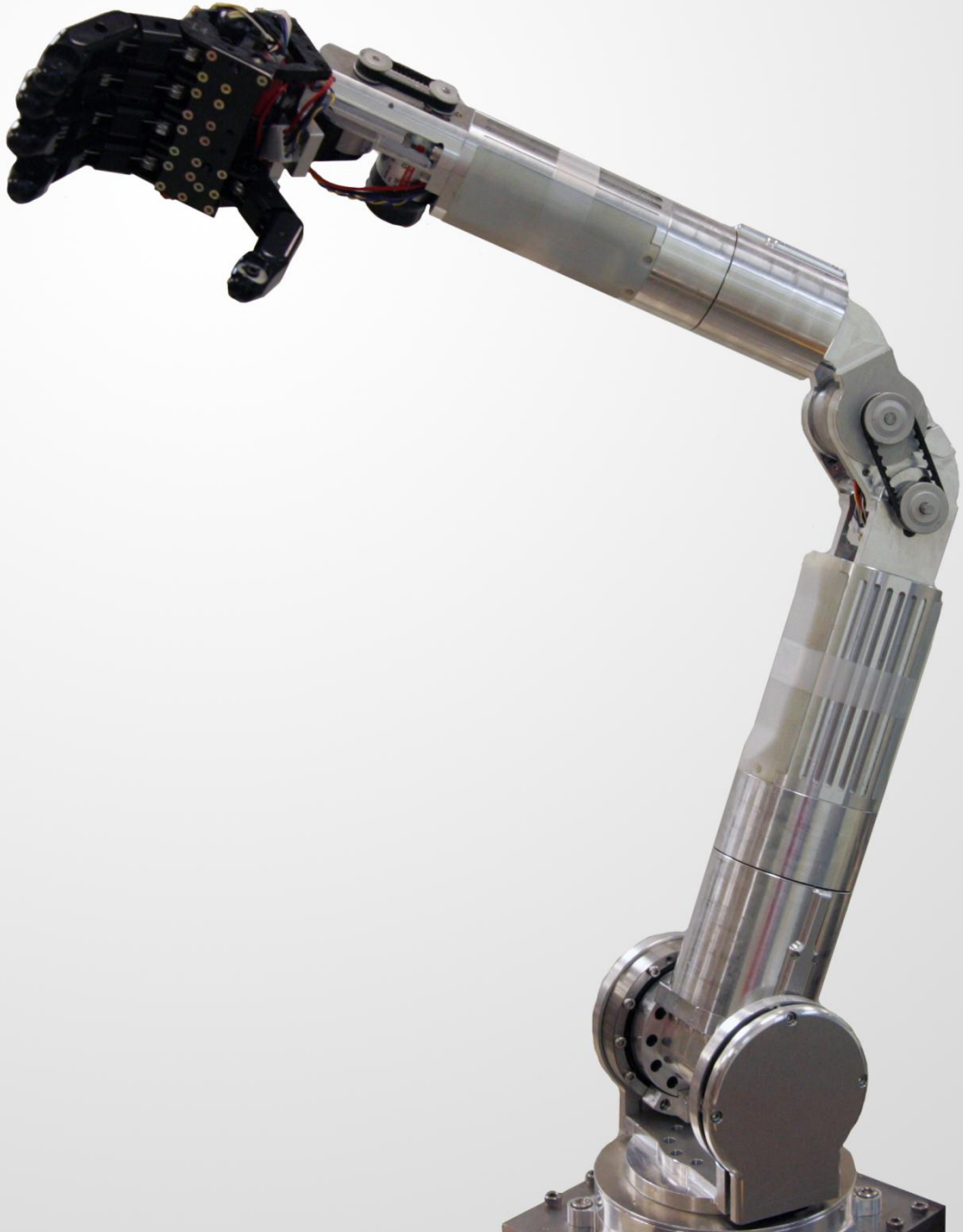

손잡 해석실
Motion Analysis Room
Hubo

Mechanical Design – Adaptive hand

★Handshake movements

Mechanical Design – Arm, Push-up



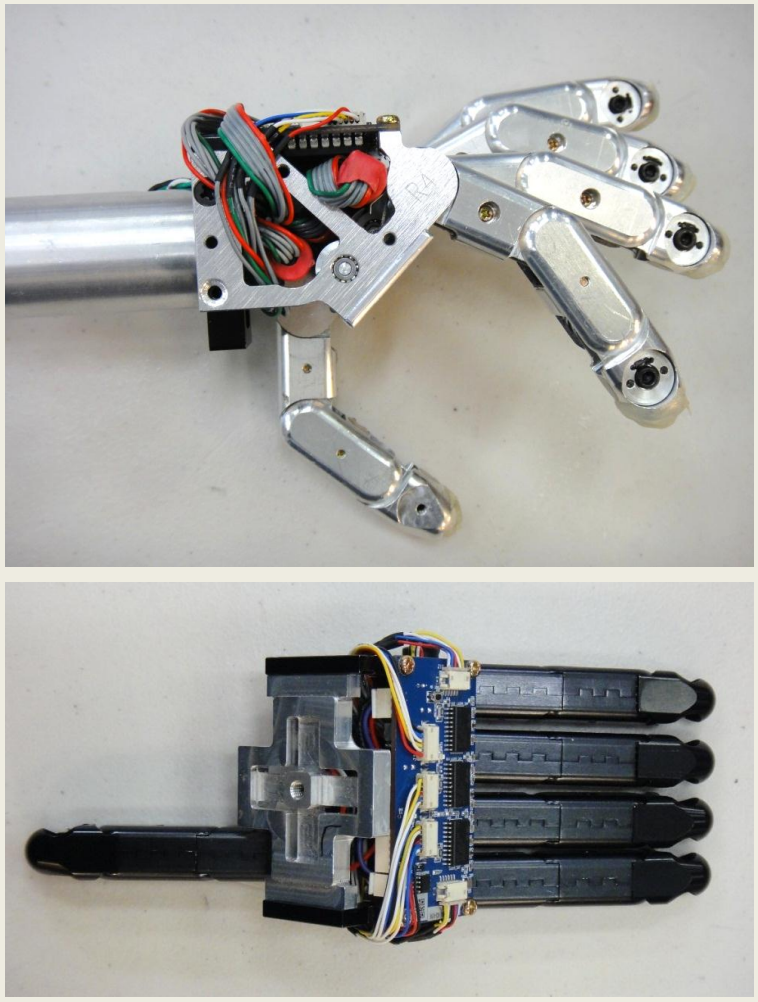


Moving Balls

Ball Batting

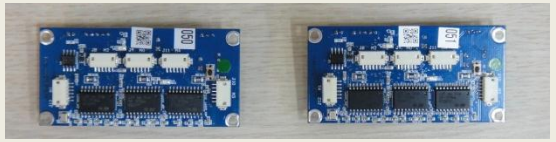
3. Hand

- Functional hand mechanism design
  - 1 motor /finger
  - Tendon drive system
  - Shape adaptive grasping
  - Compact size
  - Grasping Force : 0.2Kg/finger (5DOF/hand)
  - Holding Force : 1.75Kg/finger
  - Weight: 380g



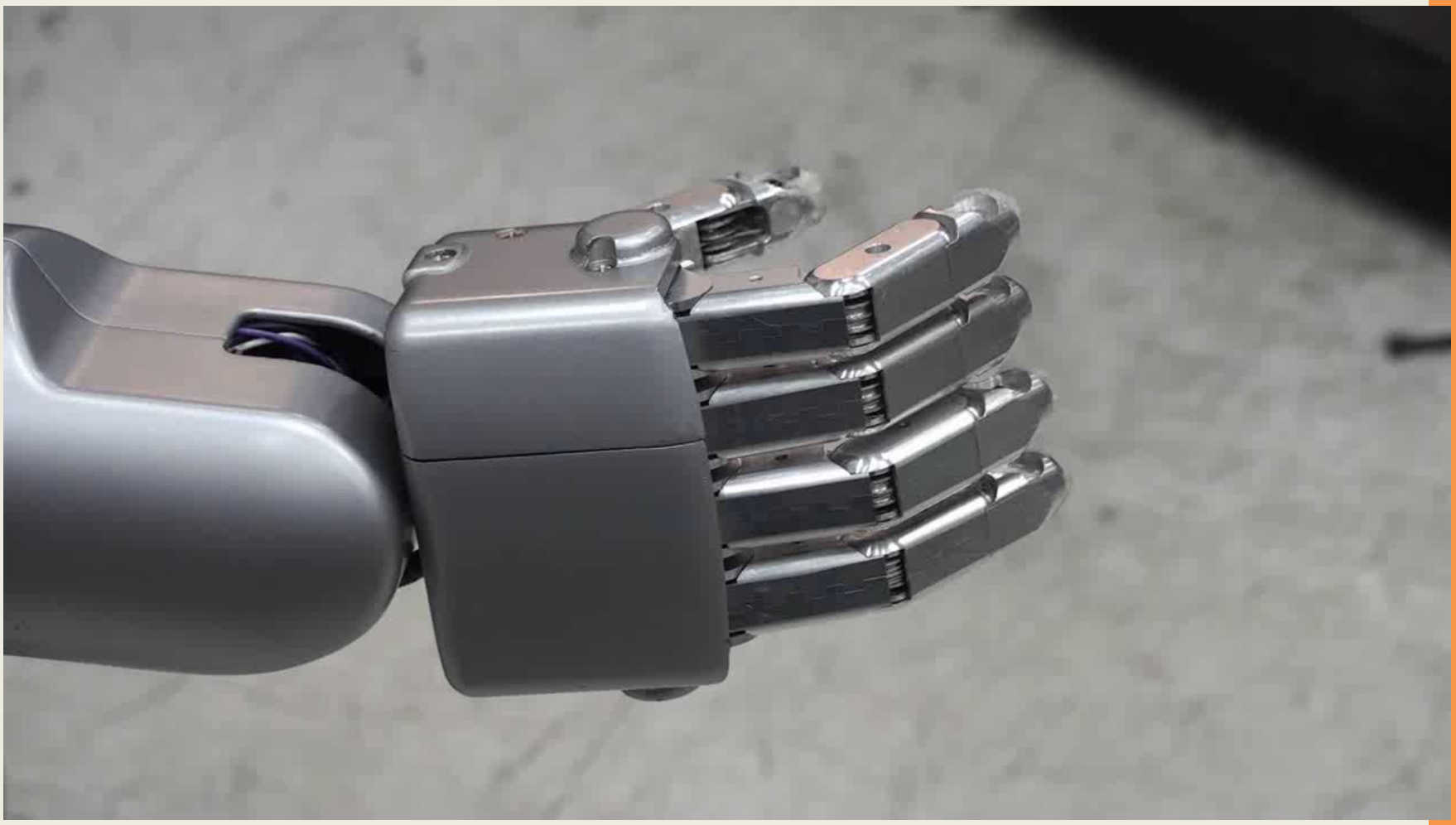
(Photograph of hand)

Mechanical Design – Adaptive Hand

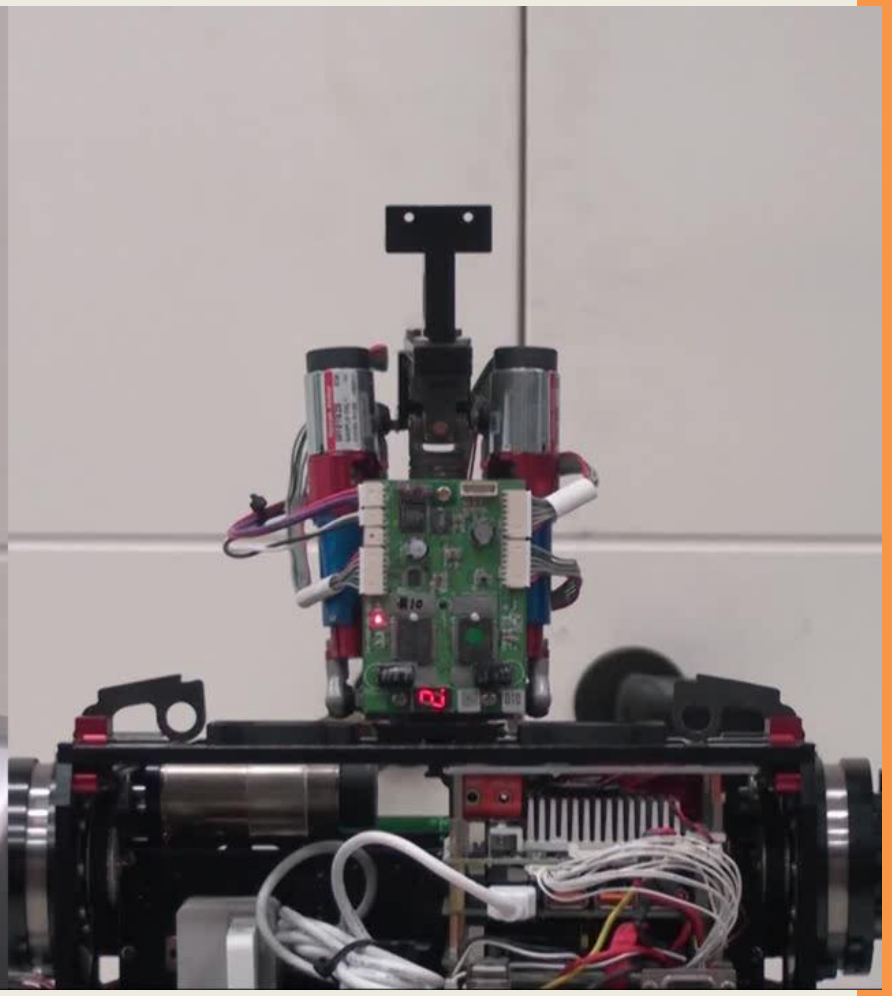


(Photograph of hand parts)

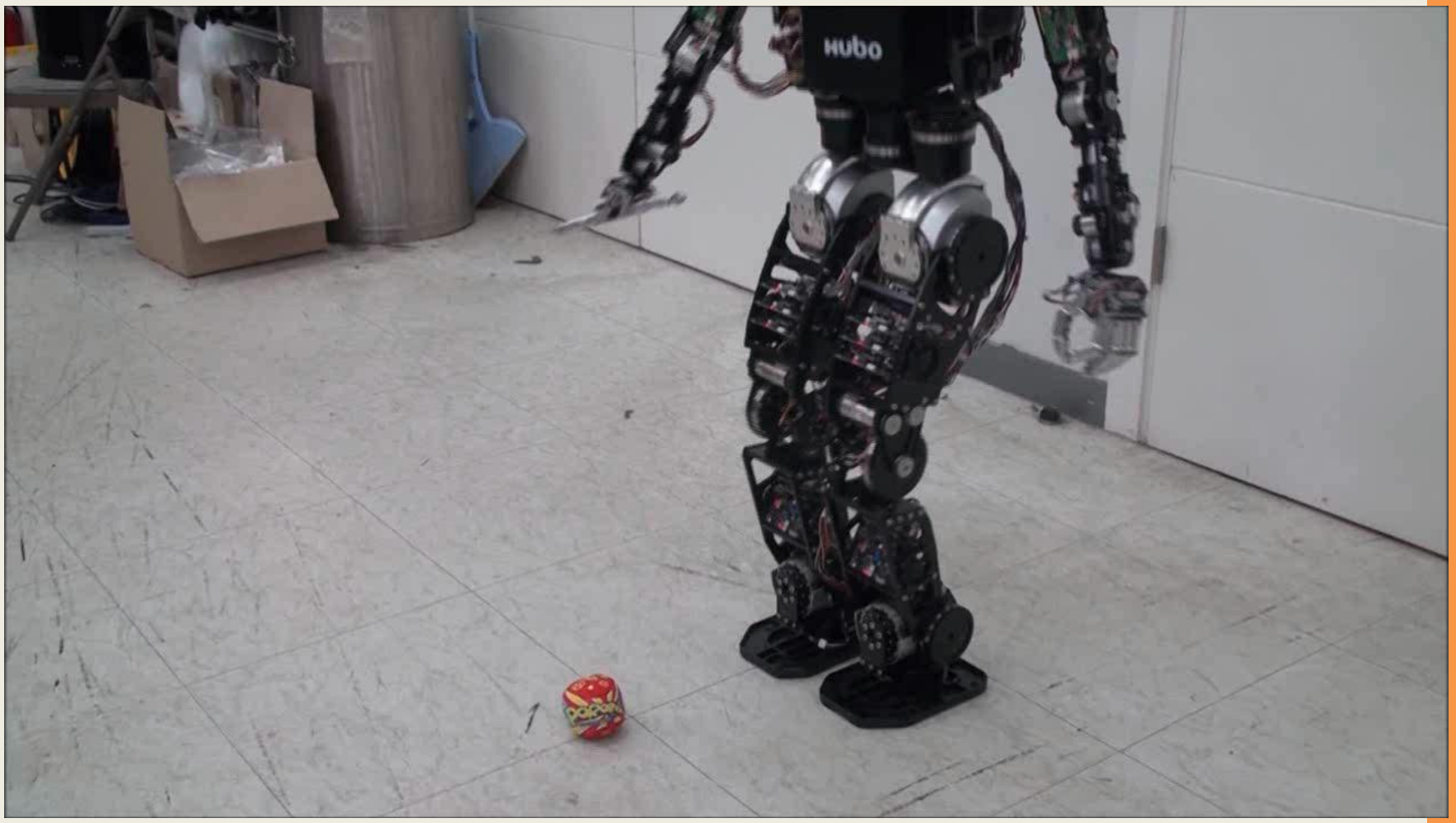
Mechanical Design – Adaptive Hand



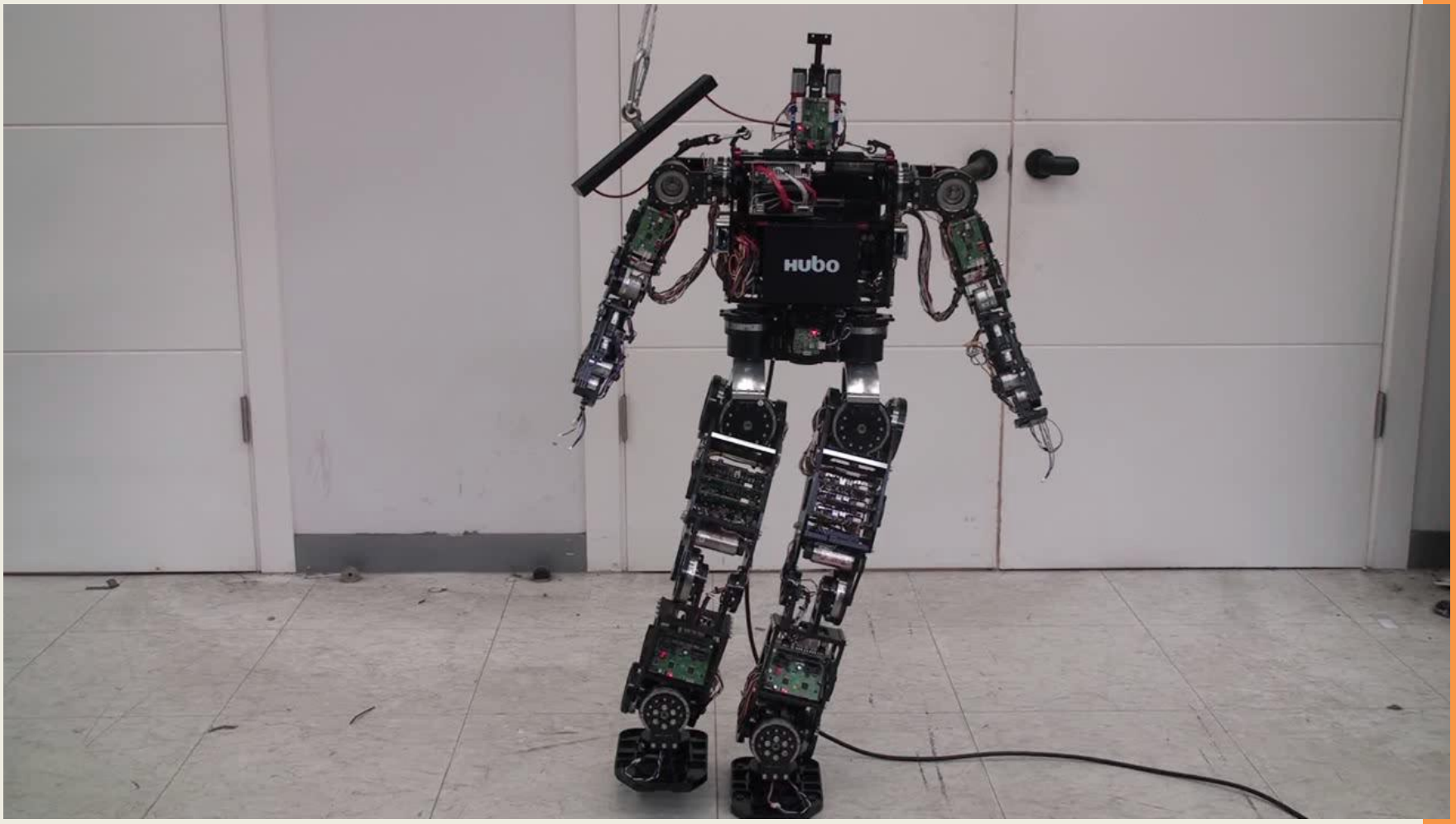
Mechanical Design – Head



Mechanical Design – Leg



Mechanical Design – Leg

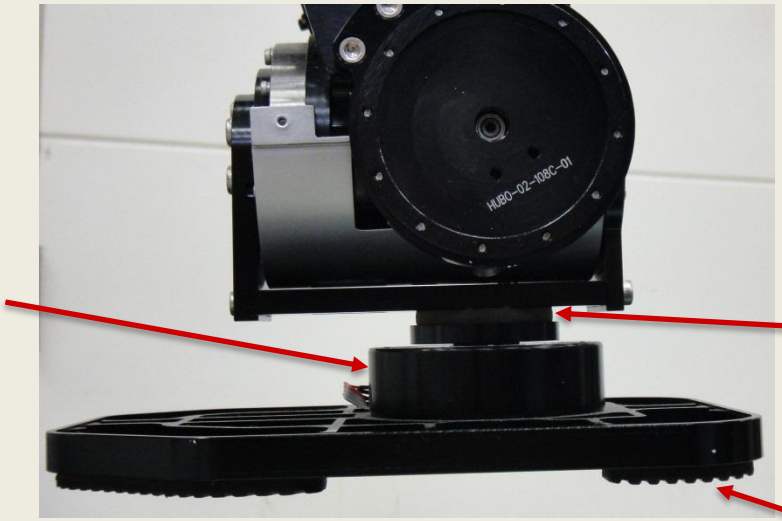


7. Foot

- Design features

  - 3-Axis Force/Torque sensor at foot : 1 Normal force and 2 Moments
  - 2-Axis Tilt sensor : measurement of ground inclination
  - 1-Axis G sensor : measurement of Z direction acceleration
  - Impact absorbing sole : 2 layer of soft & hard rubber / 4 points support of sole
  - Passive compliant : Urethane between F/T Sensor and Ankle Joint

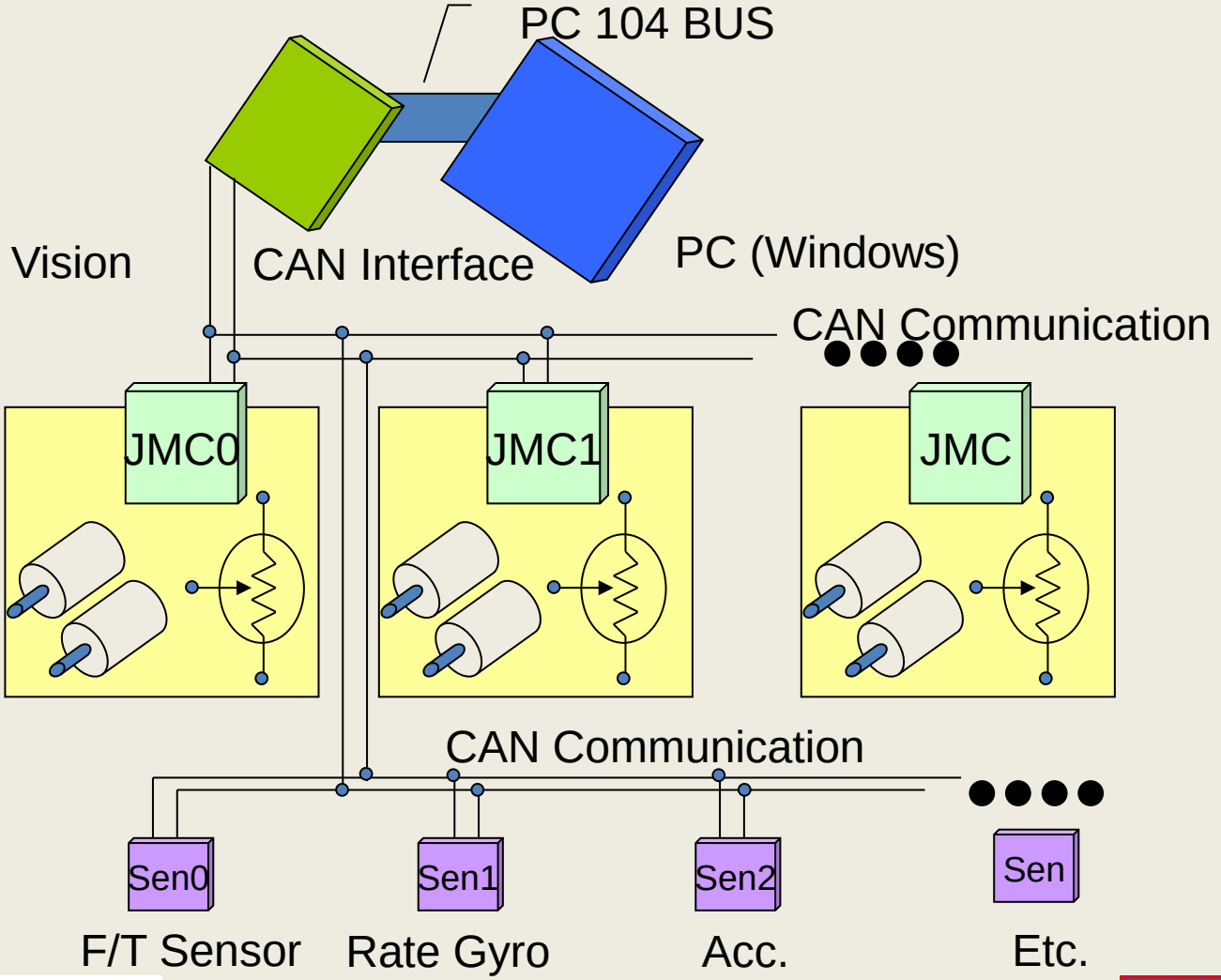
3-axis Force/Torque sensor with 2-Axis Tilt sensor and 1-Axis G sensor



(Photograph of the foot)

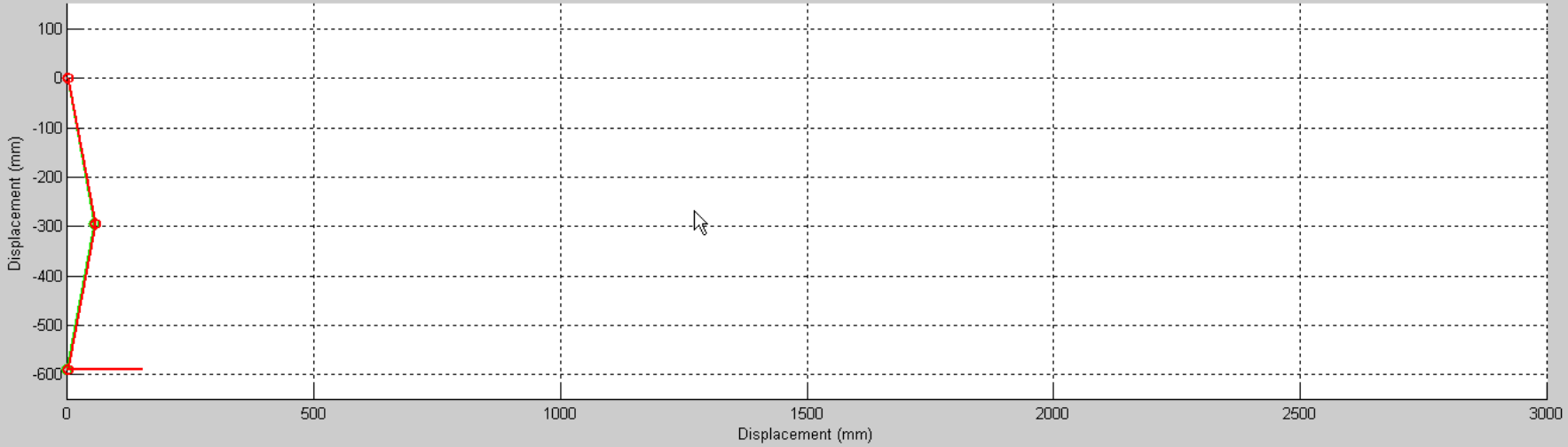
Quick Delivery Robot, HuboQ

System Integration



Stretched Leg Walking Algorithm – Walking pattern

Step time : 0.8sec
Step length : 400mm



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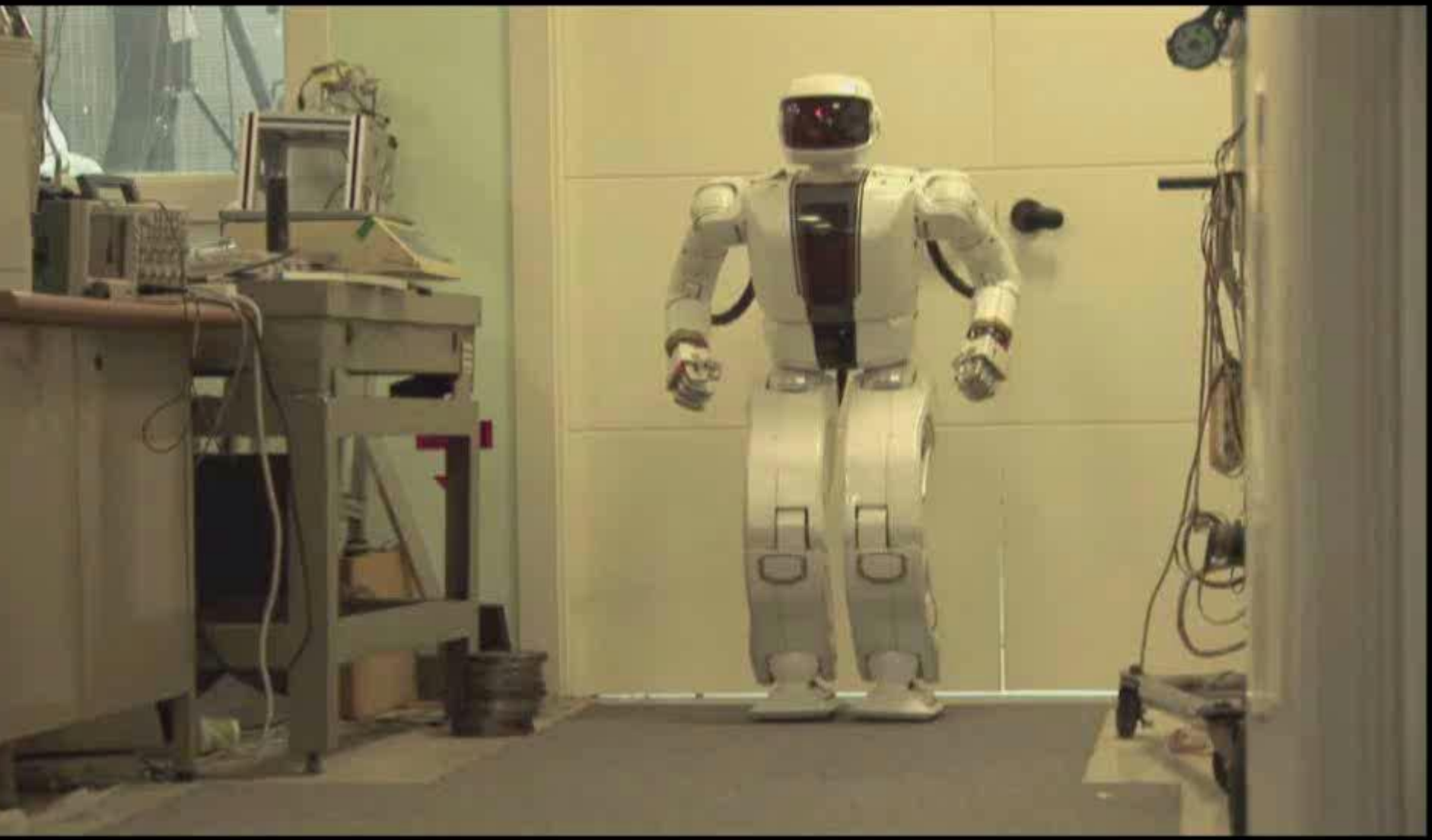
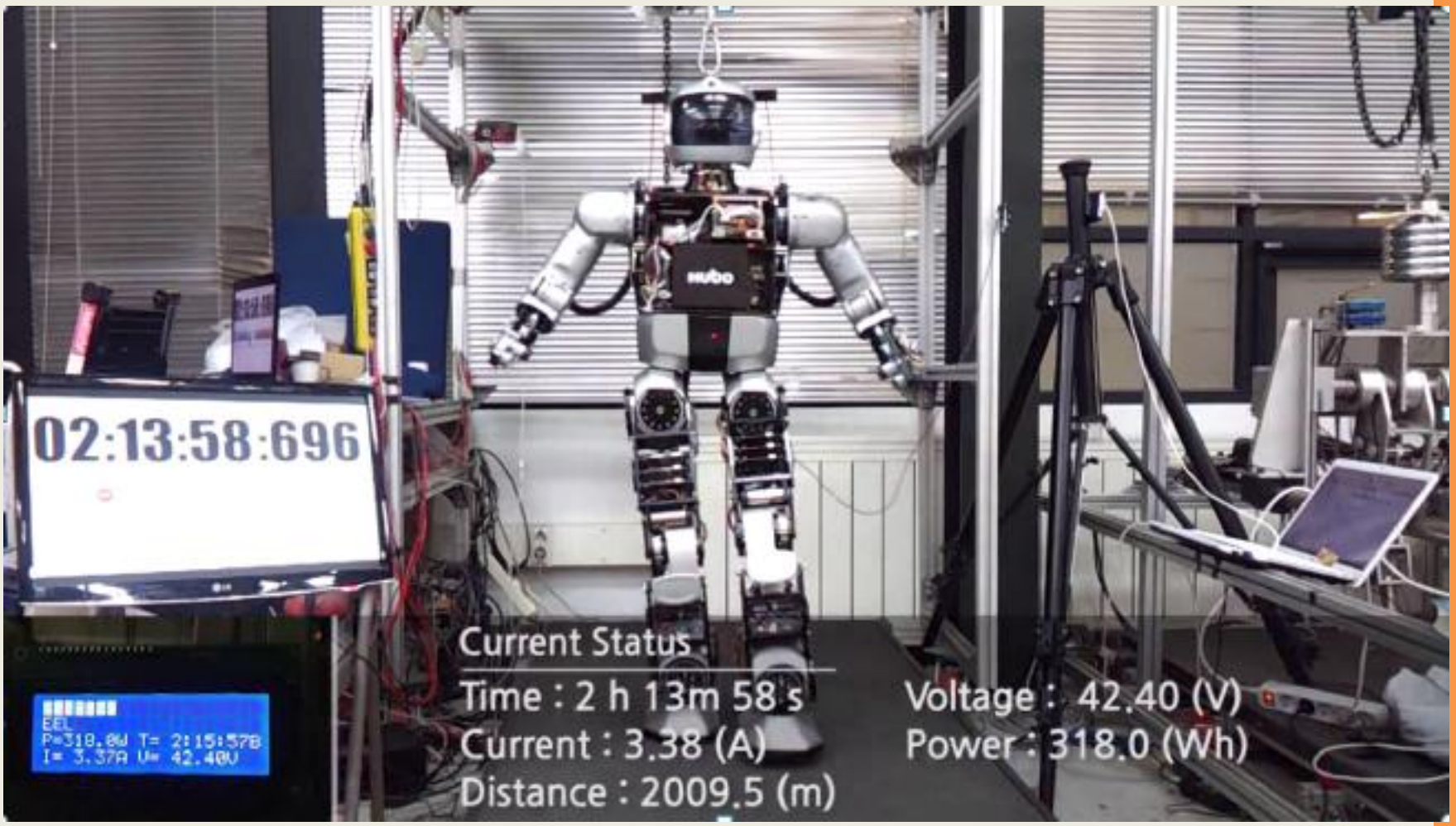
KAIST

Stretched Leg Walking Algorithm – Experiment



HUBO Power Consumption

- Step Period : 0.8 sec
- Step Length : 20 cm



Robot Technology and the Challenge

Evolution of Robot

Industrial Robot (1960's)

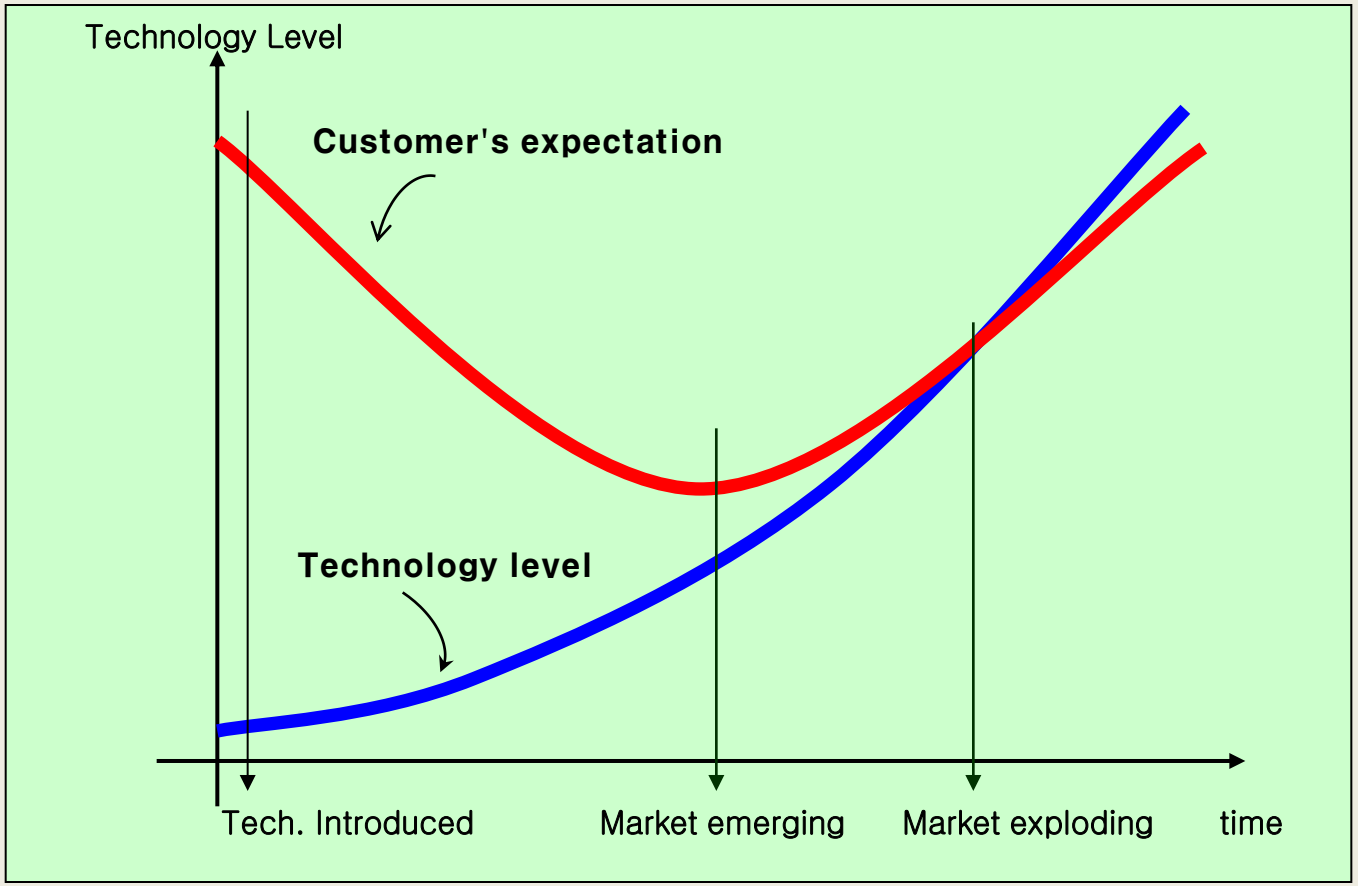
- Working in structured environment
- Pre-scheduled motion (simple & repeating)
- Machine-Robot interaction
- Simple technology

→

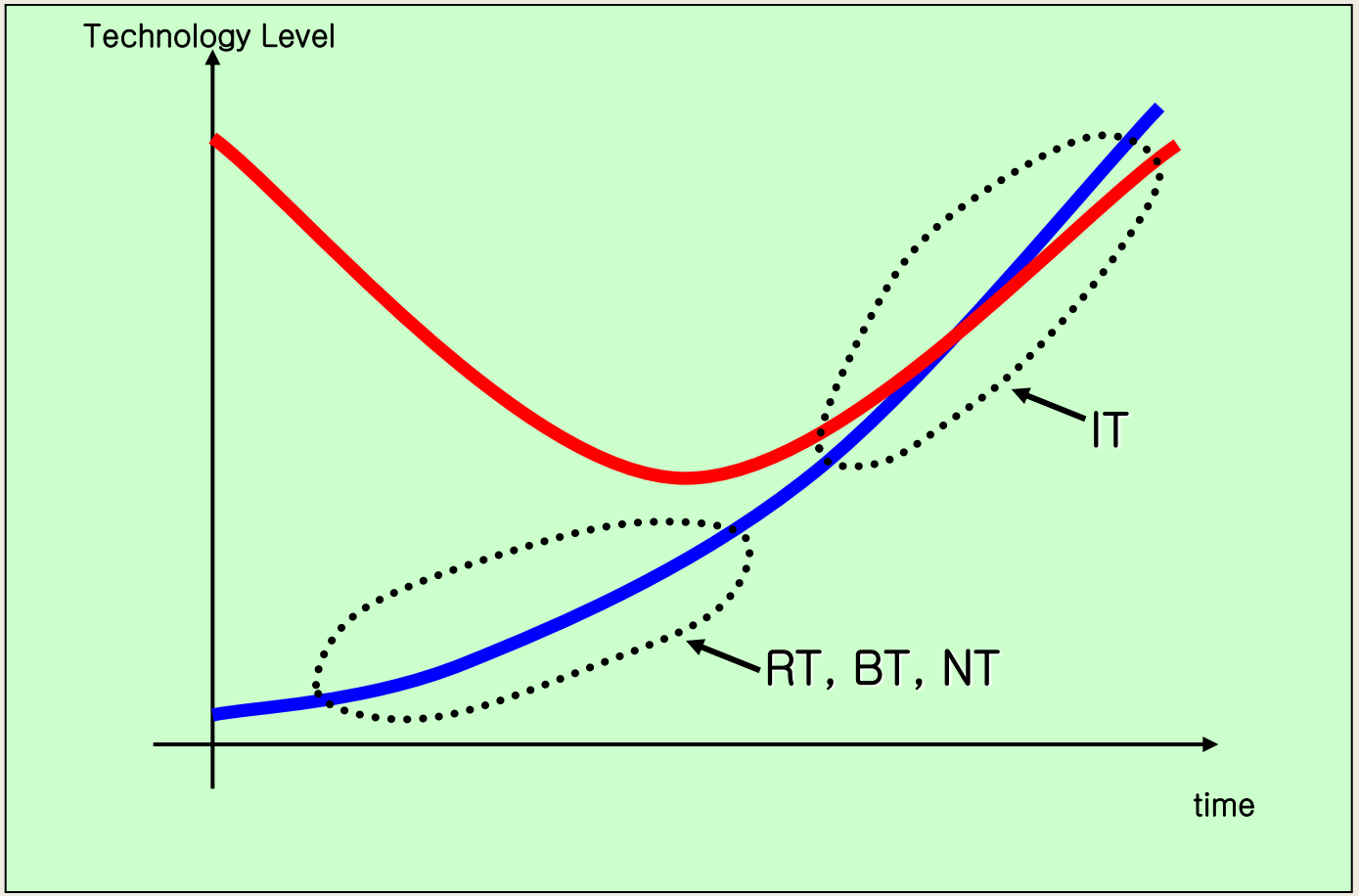
Intelligent Service Robot (21 century)

- Working in unstructured environment
- Autonomous motion
- Human-Robot interaction
- Technology convergence
  - RT+BT+NT+etc

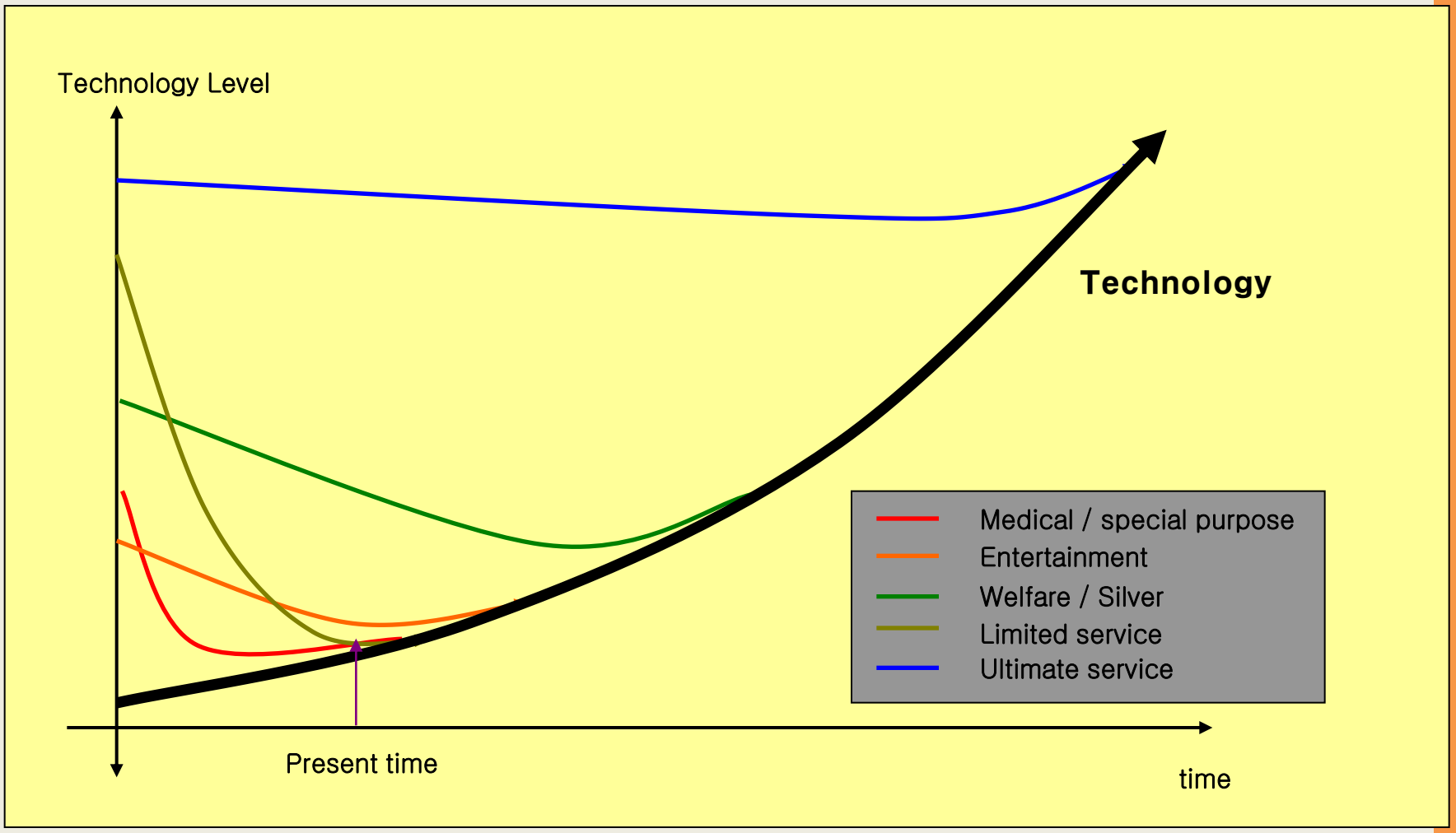
Customer's expectation Vs. Technology level



Customer's expectation Vs. Technology level



Customer's expectation in various application



Keywords for future technology application

- Networks – wireless (Ubiquitous)
- Intelligence – autonomous
- Mobility – physical contact

Robot & Related Technology

- Human friendly
- Coexisting

Robot & Robotization

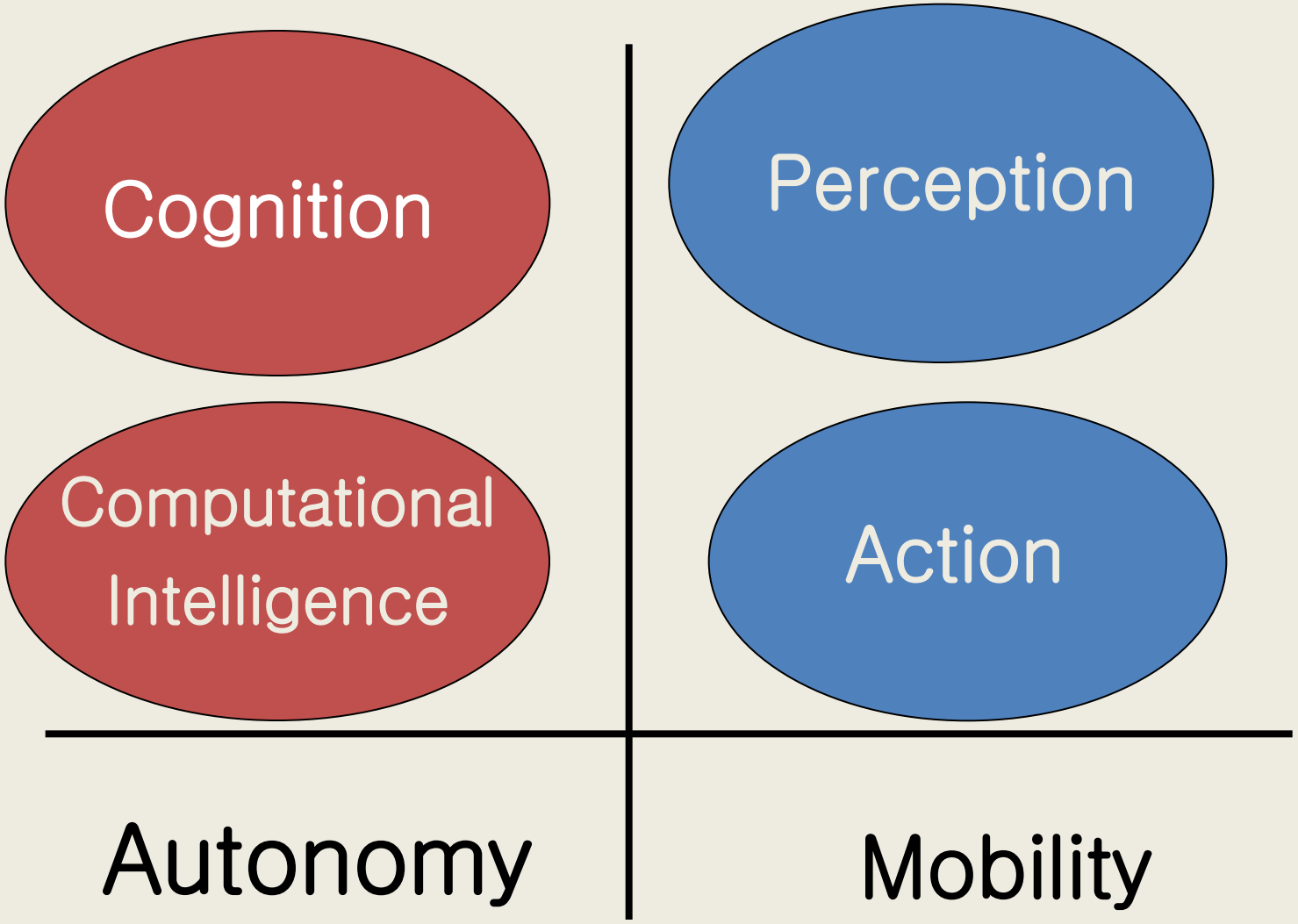
Robot : New device for specific application

Robotization : Embedding robotic function into existing device

- Flexibility
- Intelligence
- Mobility / Manipulation

[Ex]
- Robotic spacecraft
- Robotic vacuum cleaner
- Robotic automobile
- Robotic refrigerator

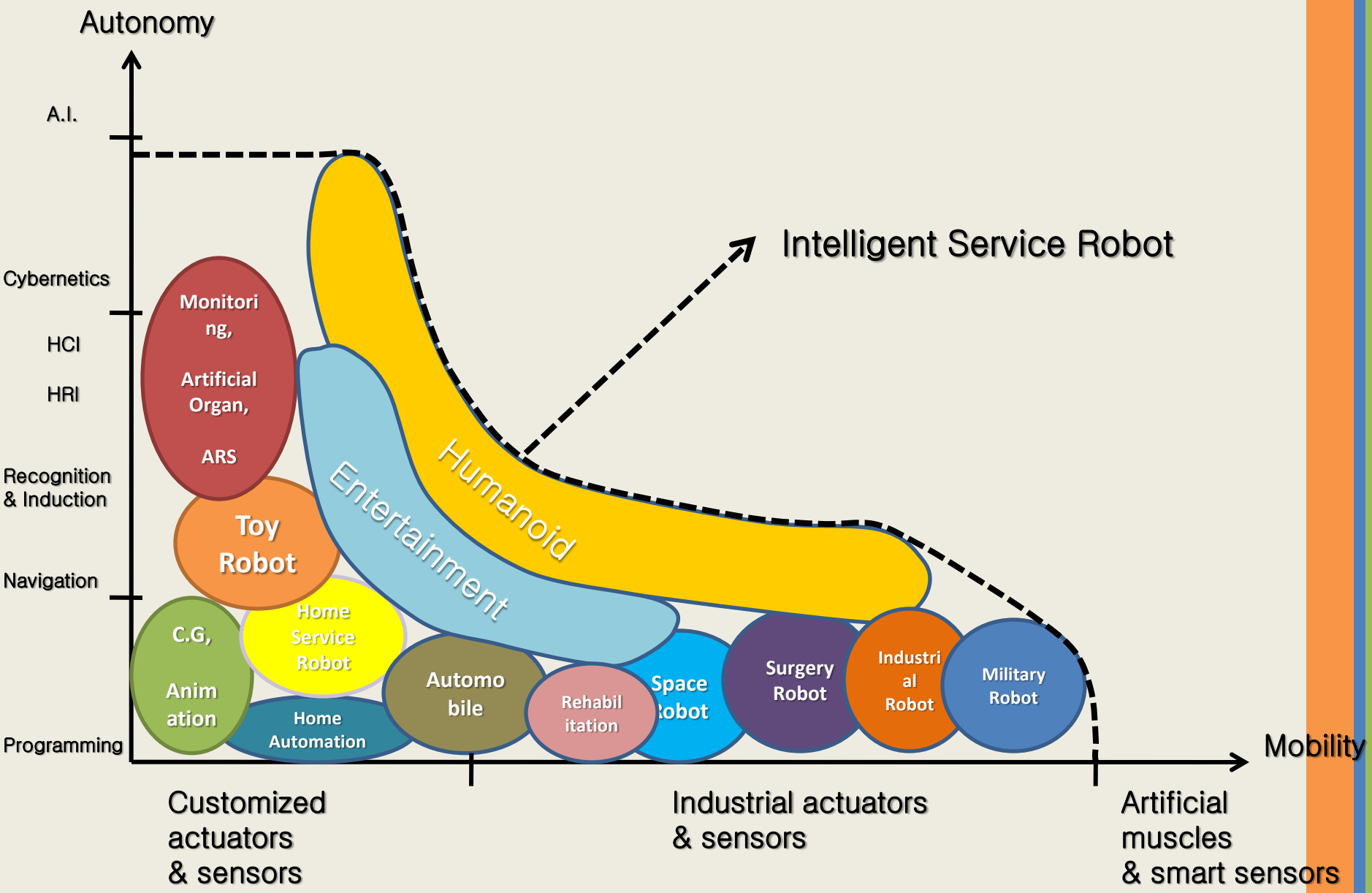
Intelligent Robots



Dilemmas

- Autonomy
- Mobility

Autonomy & Mobility



Jun Ho Oh, 2008

Summary

- Robot technology is not fully ready for market, yet.
- Service Robot -> Robotized
- Niche market
  - Entertainment, Medial, Military, Silver Industry, Rehabilitation
  - Limited Service
- Convergence with BT, NT, IT

Ending :: Hubo2 Gangnam Style Dance