Korea Humanoid Robot Projects

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Humanoid Projects(~2001)

- A few humanoid robot projects were existed.
- Most researches were on dynamic and kinematic simulations for walking by several universities.
- Most of the legged locomotion researches were for experiment.

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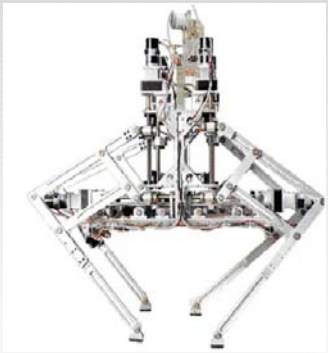
Robot Projects(~2001)

Walking Robot	Intelligent Robot	Entertainment Robot
KAISER 2 (1990) Centaur (1999)	AMI (2001)	BABYBot (2001)

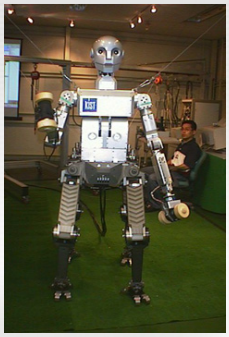
KAISER 2

- Quadruped walking robot using neural network
- Developer : System Control Lab. in KAIST
- Sponsor : MOST
- Period : 1987~1990



Centaur

- Centaur is pony style humanoid robot.
- Developer : Intelligent Robotics Research Center in KIST
- Sponsor : MOST (Ministry of Science and Technology)
- Budget : ?.0 Million USD
- Period : 1994~1999

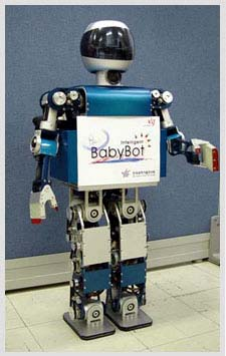


AMI

- Wheel based humanoid robot
- Developer : A.I & Media Lab. in KAIST
- Sponsor : MOCIE (Ministry Of Commerce, Industry and Energy)
- Budget : 0.? Million USD
- Period : 1999~2001

BABYBot

- Baby size humanoid robot (75cm tall)
- Developer : Intelligent Robotics Research Center in KIST
- Sponsor : MOST
- Period : 2001



KHR-1

- KAIST Humanoid Robot platform -1
- Developer : HUBO Lab. in KAIST
- Sponsor : MOST
- Budget : 0.? Million USD
- Period : 2002

KHR-2

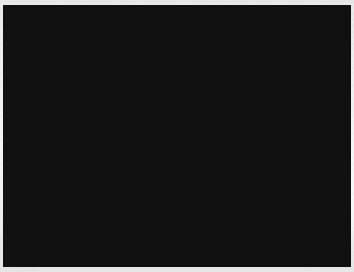
- KHR-2 has more DOF and can walk more stably than KHR-1.
- Developer : HUBO Lab. in KAIST
- Sponsor : MOST
- Budget : 0.? Million USD
- Period : 2003

RC Servo Robots

- RC servo driven humanoids are developed by universities and small venture companies.

HanSaram

- HanSaram uses RC and DC servo motors. (52cm tall)
- Developer : Robot Intelligence Tech. Lab. in KAIST
- Sponsor : MIC, MOE (Ministry Of Education)
- Budget : ?.0 Million USD
- Period : 2000~2004



HUBO

- The first Korean human size biped walking robot appeared to public.
- Developer : HUBO Lab. in KAIST
- Sponsor : MOCIE
- Budget : 0.? Million USD
- Period : 2004

MAHRU 2

- Network based intelligent robot (155.5cm tall)
- Developer : Intelligent Robotics Research Center in KIST
- Sponsor : MIC (Ministry of Information and Communication)
- Budget : ??.0 Million USD
- Period : 2004~2005

Bonobo

- Body frame and exterior are combined. (95cm tall)
- Developer : Mechatronics Lab. in Seoul National University of Technology
- Sponsor : MOCIE
- Budget : ?.? million USD
- Period : 2003~2005

Albert HUBO

- Albert HUBO is the first android robot appeared to public in Korea.
- Developer : HUBO Lab. in KAIST
- Sponsor : MOCIE
- Period : 2005

HUBO FX-1

- The first Korean human riding biped walking robot.
- Developer : HUBO Lab. in KAIST
- Sponsor : MOCIE
- Period : 2005

EveR-1

- EveR-1 can mimic human facial expressions. (160cm tall)
- Developer : KITECH
- Sponsor : MOCIE
- Budget : 0.? Million USD
- Period : 2005~2006

National Robot Projects in Korea

- 21C Frontier Technology Development
  Sponsor : MOST, MOCIE
- New Growth Engine of Korea
  Sponsor : MOCIE
- URC (Ubiquitous Robot Companion)
  Sponsor : MIC

21C Frontier Technology Development

Project	Intelligent Robot Technology Development for Human Life
Sponsor	MOST, MOCIE
Manager	KIST
Period	2003~2012
Budget	??? Million USD

New Growth Engine of Korea

Project	Intelligent Robot Development
Sponsor	MOCIE
Manager	KITECH (Korea Institute of Industrial Technology)
Period	2004~2011
Budget	??? Million USD

URC (Ubiquitous Robot Companion)

Project	IT Based Intelligent Service Robot Development
Sponsor	MIC
Manager	IITA (Institute for Information Technology Advancement)
Period	2004~
Budget	?? Million USD/Yr

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URC (Ubiquitous Robot Companion)

Project	Public Robot Development
Sponsor	MIC
Manager	KAIRA (Korea Advanced Intelligent Robot Association)
Period	2005~

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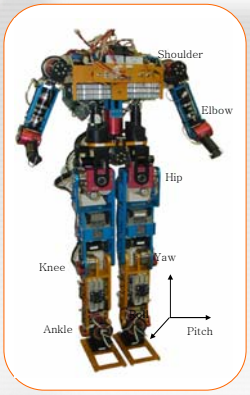
Development of HUBO robot



KHR-1
2002.1
~ 2002.12

KHR-2
2003.1
~2003.12

KHR-3 (HUBO)
2004.1
~ 2004.12

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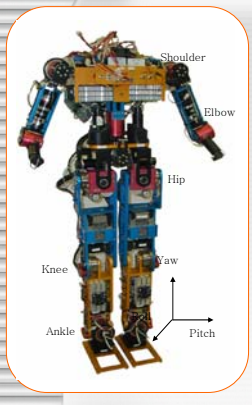
Development of HUBO robot



KHR-1
2002.1
~ 2002.12

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Development of HUBO robot

KHR-2
2003.1
~2003.12

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Development of HUBO robot

KHR-3 (HUBO)
2004.1
~ 2004.12

Humanoid Robot
HUBO

KAIST, Korea
http://mclab3.kaist.ac.kr

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Development of HUBO robot

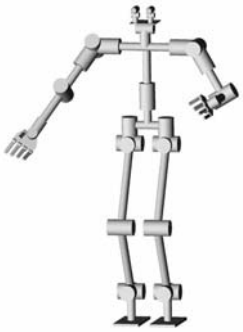
Albert HUBO
2005.1
~ 2005.11

Development of HUBO robot

HUBO FX-1
2005.1
~ 2005.11

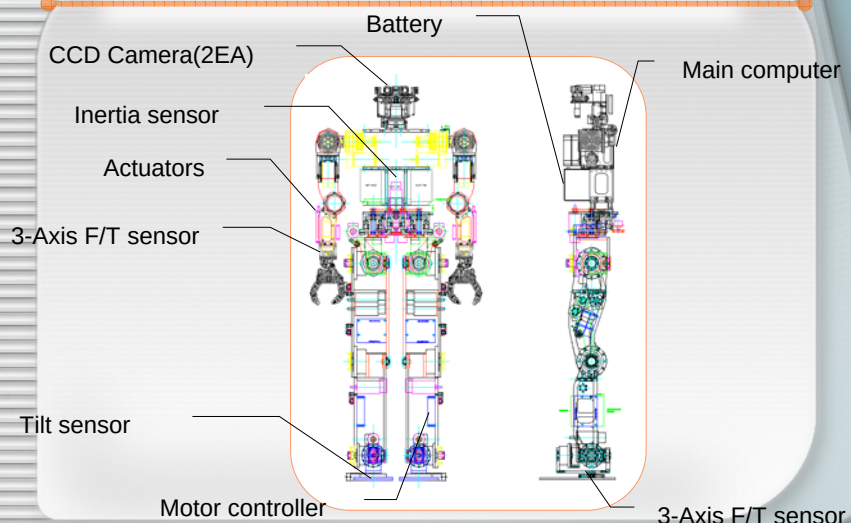
Development of HUBO Robot

- Full DOF to imitate human motion
  - Legs: 6 for each leg (2x6=12)
  - Arms: 4 for each arm (2x4=8)
  - Trunk: 1 (yaw)
  - Wrists: 2 for each wrist (2x2=4)
  - Hands: 5 (2x5=10)
  - Neck: 2
  - Eye: 2 (2x2=4)
- Total: 41 DOF

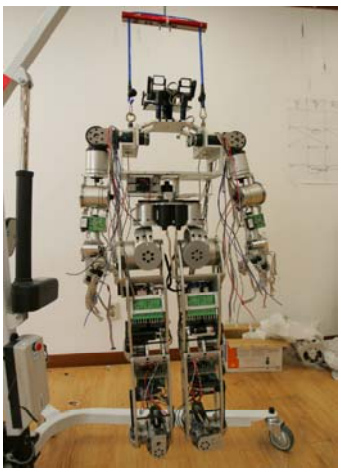


(Joint structure of Hubo)

Hardware system of HUBO



Frame of HUBO

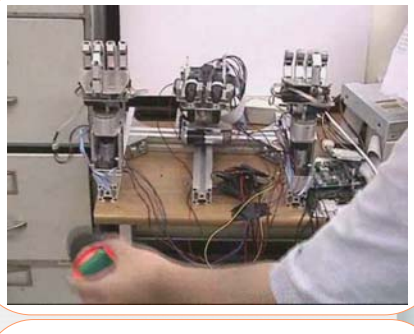


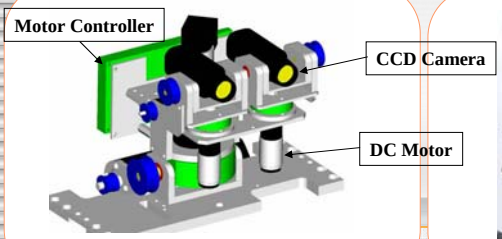
(Body Frame of HUBO)

(Photograph of HUBO)

Head

- Design features
  - Total 6 DOFs
  - Pan & Tilt mechanism of each neck and eye
  - Parallel drive by Pulley & Belt
  - Stereo CCD camera attachable



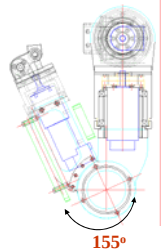


(3D CAD model of head)

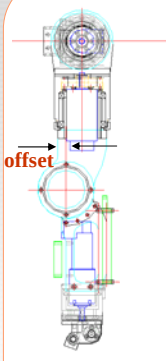
(Photograph of head)

Arm

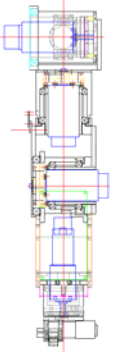
- Design features
  - Total 4DOFs
  - Backlash less: harmonic reduction gear
  - Space efficient design: frame structure as a reduction gear housing
  - Wide working range: elbow joint offset



(Folded Side)



(Side)

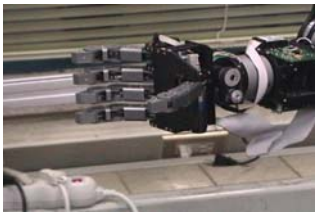


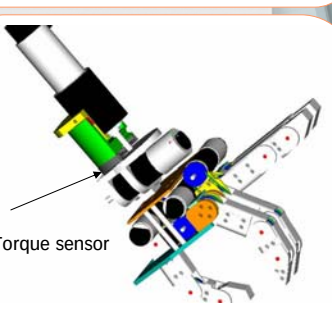
(Front)

Hand

- Design features
  - Total 7 DOFs: 1 DOF each finger, 2 DOF in wrist
  - Pulley & Belt mechanism: All joints of finger are move simultaneously by pulley & belt
  - Grasping force: 0.5 kg/finger
  - 3-Axis Force/Torque sensor at wrist: 1 Normal force and 2 Moments

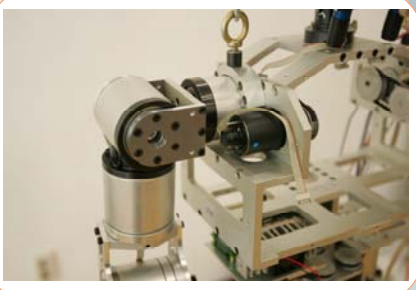
(Photograph of hand)





(3D CAD model of hand)

Mechanical Design



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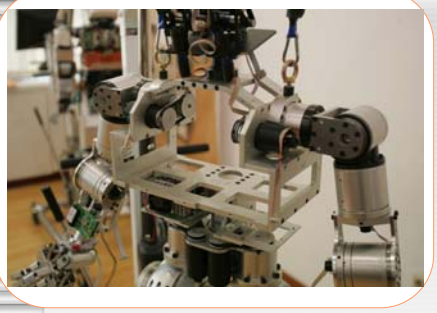
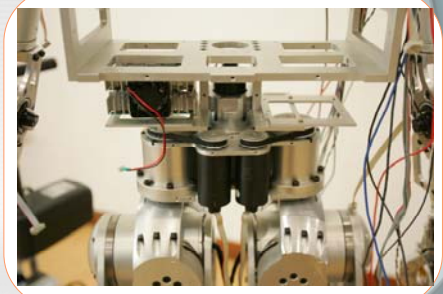
Mechanical Design





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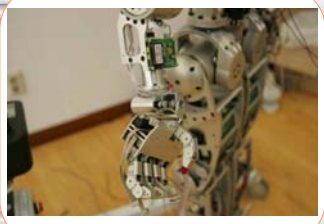
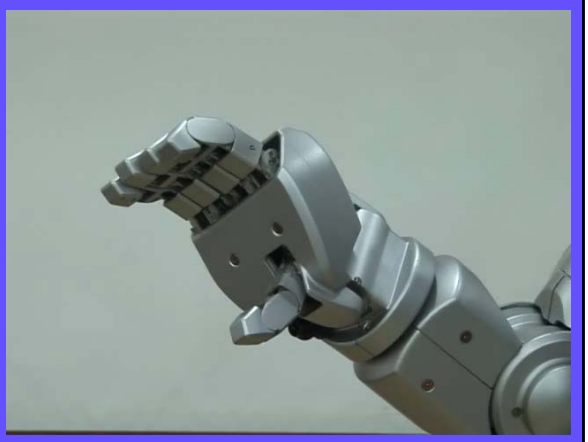
Mechanical Design





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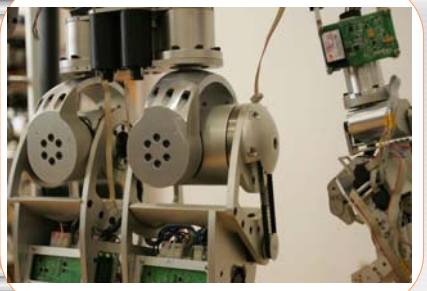
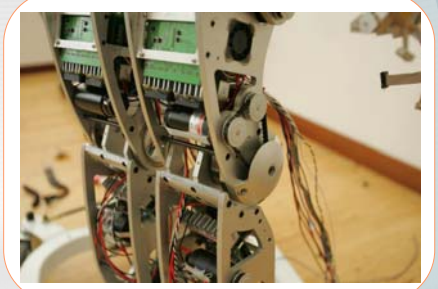
Mechanical Design





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System Integration

System Control Architecture

Distributed control system:

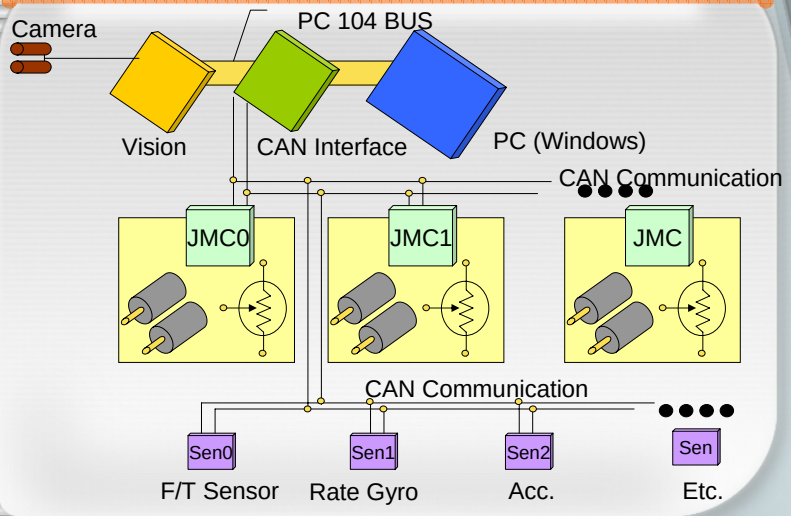
- Efficient for multi-axes control system
- Reduce the calculation burden of computer

Main Controller

Single board computer with Windows XP (PCM 3380, Advantech co.):

- Good computing ability (CPU clock : 933 MHz)
- Low power consumption (19 Watt)
- Fast development time and good GUI (Visual C++)
- Easy to install many kinds of peripherals
- Realization of real-time control ability using RTX
- CAN communication

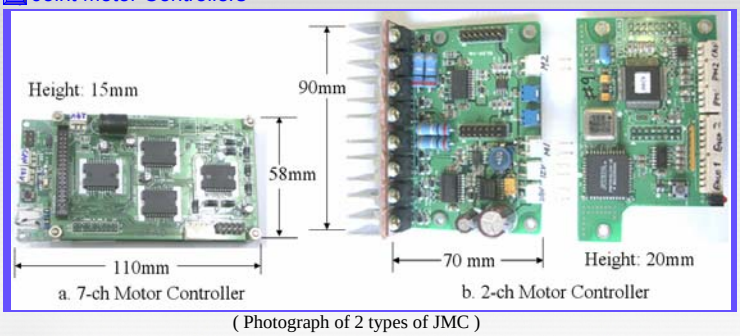
System Integration



System Integration

Sub Controllers

Joint Motor Controllers



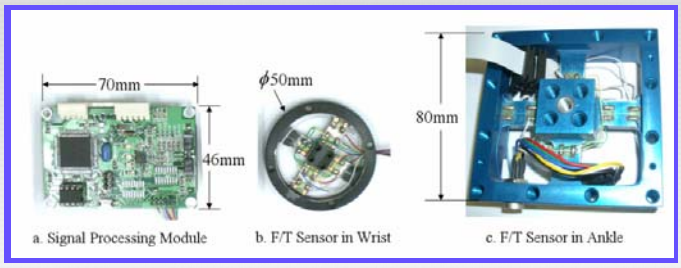
(Photograph of 2 types of JMC)

- CAN communication
- 16Bit Micom (MC9S12DG128)
- 7 ch DC motor driver (48W/ch)
- 5 ch A/D converter
- 2 ch Digital output

- CAN communication
- 16Bit Micom (MC9S12DG128)
- 2 ch DC motor driver using MOSFET (400W/ch)
- 2 ch A/D converter
- Current monitoring
- Over current protection
- CAN communication

System Integration

F/T sensor module



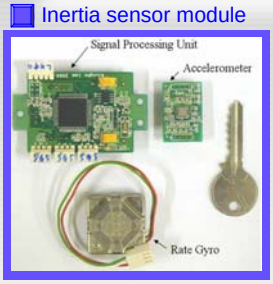
(Photograph of 2 types of F/T sensor)

- 16Bit Micom (MC9S12DG128)
- 2 Moments & 1 normal force
- Up to 10 Nm, up to 300 N
- Auto Balancing
- Strain gage amp circuit
- CAN communication

- 16Bit Micom (MC9S12DG128)
- 2 Moments & 1 normal force
- Up to 30 Nm, up to 1000 N
- Auto Balancing
- Strain gage amp circuit
- CAN communication

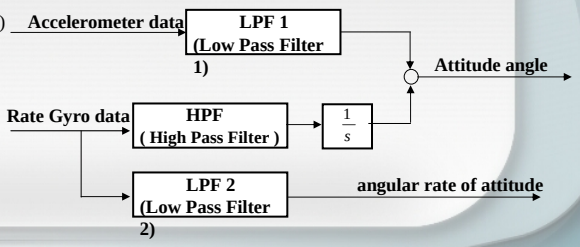
System Integration

Inertia sensor module



(Photograph of inertia sensor)

CAN communication
16bit Micom (MC9S12DG128)
2 - axis accelerometer (< 2g)
2 - axis rate gyro sensor (± 100°/s)
Measurable range : -15 ~ 15 deg in each axis



(Attitude calculation using complementary filter)

System Integration

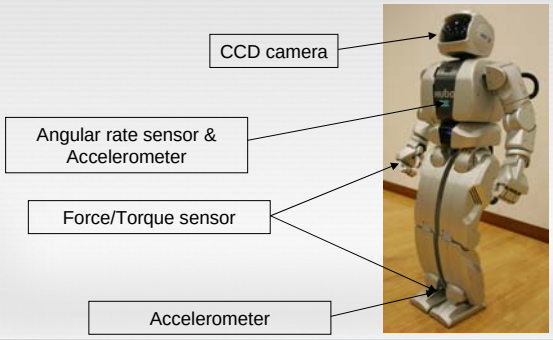
Tilt sensor

(Photograph of tilt sensor)

2 - axis accelerometer analog output (< 2g)
Measurable range : -15 ~ 15 deg in each axis

Stabilization of HUBO

Level	Sensor
1st Level	Force/Torque sensor, Pressure sensor
2nd Level	Angular rate sensor, Accelerometer
3rd Level	Vision sensor (CCD camera)



Single Support Stabilization

Double Support Stabilization

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The Ending

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The Ending