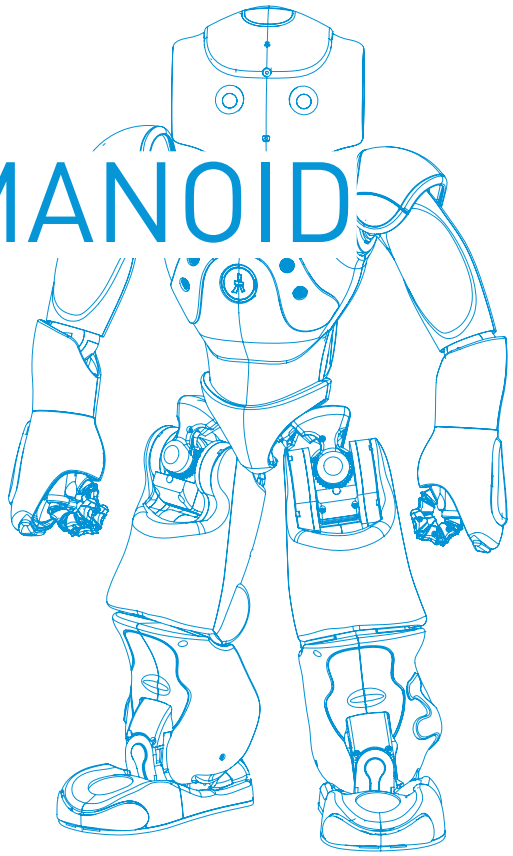
# NAO HUMANOID



## HUMANOID ROBOT PLATFORM

NAO HUMANOID Secondary Education / Higher Education & Research editions

ALL PURPOSE HUMANOID ROBOT

- INTEL ATOM PROCESSOR
- ENHANCED AUDIO AND VISUAL CAPABILITIES
- NATURAL MOTION REFLEXES

### KEY BENEFITS

- Fully programmable, open and autonomous: make the most of a full integration of state-of-the-art hardware and software
- Easy to use and understand: achieve better project results and improve learning effectiveness
- Attractive and motivating: highly increase and catch audience attention

### USE CASES

- STEM (Science, Technology, Engineering and Mathematics) training and exercises
- Scientific researches in autism, personal assistance...
- Communication tool for events such as opening house days

# NAO HUMANOID

## ENHANCED AUDIO AND VISUAL CAPABILITIES

- **Camera**
  Thanks to improved camera sensors, we provide higher sensitivity in VGA for better low light perception. For image processing work on the robot CPU, you can use up to 30 images/second in HD resolution. NAO can move the head by 239°horizontally and by 68° vertically, and his camera can see at 61° horizontally and 47°vertically. Result: NAO has a great capacity to sense his environment.

- **Object Recognition**
  NAO has the capacity to recognize a large quantity of objects. Once the object is saved thanks to Choregraphe software, if he sees it again, NAO is able to recognize and say what it is.

- **Face Detection and Recognition**
  It's one of the best known features for interaction. NAO can detect and learn a face in order to recognize it next time.

- **Text to Speech**
  NAO is able to speak up to 19 languages. With a "say box" in Choregraphe you can insert text and modify voice parameters as you wish. NAO will say the text correctly, with the right punctuation and intonation.

- **Automatic Speech Recognition**
  Speech recognition is at the heart of intuitive human-robot interaction. That's why we have chosen the best technological partner, Nuance, to develop stable and powerful speech recognition. NAO is now able to hear you from 2 meters away, recognize a complete sentence or just few words in the sentence. Result: more fluidity and natural conversations.

- **Sound Detection and Localization**
  Our environment is made of sounds that NAO, like us, is able to detect and localize in the space thanks to microphones all around his head.

## NATURAL MOTION REFLEXES

- **Smart Stiffness**
  A unique feature which automatically adapts the power needed by the motors during the movements of the robot. Result: better use of the drive components as well as energy savings for the battery.

- **Fall Manager**
  NAO may fall, but we taught him how to stand up by himself. We went even further and provided him with a fall detection system: before hitting the ground, NAO protects himself with his arms.

- **Anti Self collision**
  This motion feature prevents NAO's arms from colliding with the rest of his body. NAO always knows the position of his head, torso, legs and arms: he avoids accidental and unwanted limb collisions.

- **Resource Manager**
  NAO's biggest challenge is to merge and order conflicting commands. He's able to interrupt/stop or adjust the behavior in progress before executing a new required behavior.

# NAO HUMANOID

EXAMPLES OF APPLICATIONS

## RESEARCH

- Human Robot Interaction
- Perception & Cognition
- Object Category Recognition & Detection
- Modeling Expressive Gestures
- Localization & Navigation
- Movement Synchronization of Robot
- Structure & Motion Analysis
- Psychology & Social Robotics
- Artificial Intelligence

## EDUCATION

- Programming
- Math & Physics Concepts for Robotic Applications
- Motion Planning
- Introduction to Object/Speech Recognition & Detection
- Create Games & Stories
- Mechatronics
- Automation

REFERENCES

### EUROPE

- Paris Descartes University
- University of Bremen
- University of Hertfordshire
- University of Jaume
- Science Museum of London
- High School Tech of Nîmes

### NORTH AMERICA

- Massachusetts Institute of Technology
- Harvard University
- Carnegie Mellon University
- University of Texas, Austin
- Science Museum of Chicago
- High School Central Tech Erie

### ASIA

- University of Tokyo
- Shanghai Jiao Tong University
- National University of Seoul
- National Taiwan University
- New South Wales University
- Science Museum of Shanghai

# NAO HUMANOID

## TECHNICAL SPECIFICATIONS

### ELECTRICAL

| | |
|---|---|
| INPUT | 100 to 240 Vac - 50/60Hz - Max 1.2A |
| OUTPUT | 25.2 Vdc - 2A |

| BATTERY | | |
|---|---|---|
| | Type | Lithium-Ion |
| | Nominal voltage/capacity | 21.6V / 2.15Ah |
| | Max charge voltage | 24.9V |
| | Recommended charge current | 2A |
| | Max charge/discharge current | 3.0A / 2.0A |
| | Energy | 27.6Wh |
| | Charging duration | 5h |
| | Autonomy | 60min (Active use)<br>90min (Normal use) |

### MOTHER BOARD

| | | |
|---|---|---|
| CPU PROCESSOR | ATOM Z530 | |
| | Cache memory | 512KB |
| | Clock speed | 1.6GHZ |
| | FSB speed | 533mHz |
| RAM | 1GB | |
| FLASH MEMORY | 2GB | |
| MICRO SDHC | 8GB | |

### CONNECTION

| | |
|---|---|
| ETHERNET | 1×RJ45 - 10/100/1000 BASE T |
| WIFI | IEEE 802.11b/g/n |

### AUDIO

| | | |
|---|---|---|
| LOUD SPEAKERS | ×2 lateral | |
| | Diameter | 36mm |
| | Impedance | 8ohms |
| | Sp level | 87dB/w +/- 3dB |
| | Freq range | up to ~20kHz |
| | Input | 2W |
| MICROPHONE | ×4 on the head | |
| | Sensitivity | ~40 +/-3dB |
| | Frequency range | 20Hz-20kHz |
| | Signal/noise ratio | 58dBA |

### CONSTRUCTION

| | |
|---|---|
| DIMENSION (H×D×W) | 573×275×311mm / 22.5x10.8x12.2 inch |
| WEIGHT | 5.2kg / 11.4 lb |
| CONSTRUCTION MATERIAL | ABS-PC / PA-66 / XCF-30 |

### LANGUAGES

| | |
|---|---|
| TEXT TO SPEECH & AUTOMATIC SPEECH RECOGNITION | Arabic, Brazilian (Portuguese), Chinese, Czech, Danish, Dutch, English, Finnish, French, German, Italian, Japanese, Korean, Polish, Portuguese, Spanish, Swedish, Russian, Turkish |

### VISION

| | | |
|---|---|---|
| CAMERAS | ×2 on front | |
| Sensor model | MT9M114 | |
| Sensor type | SOC Image Sensor | |
| IMAGING ARRAY | Resolution | 1.22MP |
| | Optical format | 1/6inch |
| | Active Pixels (H×V) | 1288×968 |
| SENSITIVITY | Pixel size | 1.9µm |
| | Dynamic range | 70dB |
| | Signal/Noise ratio (max) | 37dB |
| | Responsivity | 2.24 V/lux-sec (960p)<br>8.96 V/lux-sec (VGA) |
| OUTPUT | Camera output | 960p@30fps |
| | Data Format | YUV422 |
| | Shutter type | ERS (Electronic Rolling Shutter) |
| VIEW | Field of view | 72.6°DFOV (60.9°HFOV, 47.6VFOV) |
| | Focus range | 30cm ~ infinity |
| | Focus type | Fixed focus |

FRAMERATE

| Resolution | Embedded | Gigabit Ethernet | 100Mb Ethernet | Wifi g |
|---|---|---|---|---|
| 160×120px | 30fps | 30fps | 30fps | 30fps |
| 320×240px | 30fps | 30fps | 30fps | 11fps |
| 640×480px | 30fps | 30fps | 12fps | 2.5fps |
| 1280×960px | 29fps | 10fps | 3fps | 0.5fps |

Note: using the video stream in remote highly depends on the network and the video resolution chosen. All frame rates depend on the CPU usage. Values are calculated with a CPU fully dedicated to images gathering.

# NAO HUMANOID

## TECHNICAL SPECIFICATIONS

### IR

| | |
|---|---|
| NUMBER | ×2 on front |
| WAVELENGTH | 940nm |
| EMISSION ANGLE | +/-60° |
| POWER | 8mW/sr |

### SONAR

| | |
|---|---|
| EMITTERS | ×2 on front |
| RECEIVERS | ×2 on front |
| FREQUENCY | 40kHz |
| SENSITIVITY | -86dB |
| RESOLUTION | 1cm |
| DETECTION RANGE | 0.25m to 2.55m |
| EFFECTIVE CONE | 60° |

### INERTIAL UNIT

| | | |
|---|---|---|
| GYROMETER | ×2 | |
| | Axis | 1 per gyrometer |
| | Precision | 5% |
| | Angular speed | ~500°/s |
| ACCELEROMETER | ×1 | |
| | Axis | 3 |
| | Precision | 1% |
| | Acceleration | ~2g |

### FSR ( FORCE SENSITIVE RESISTORS )

| | |
|---|---|
| RANGE | 0 to 110N |
| | ×4 per feet |

### POSITION SENSORS

| | **NAO HUMANOID** |
|---|---|
| MRE (Magnetic Rotary Encoder) | ×36 |
| | Using hall effect sensor technology |
| | Precision: 12bits / 0.1° |

### SOFTWARE

| | |
|---|---|
| OPEN NAO | Embedded GNU/Linux Distribution based on Gentoo |
| ARCHITECTURE | ×86 |
| PROGRAMMING | Embedded: C++ / Python<br>Remote: C++ / Python / .NET / Java / MatLab |

### LEDS

| PLACEMENT | QUANTITY | DESCRIPTION |
|---|---|---|
| Tactile Head | ×12 | 16 Blue levels |
| Eyes | 2×8 | RGB FullColor |
| Ears | 2×10 | 16 Blue levels |
| Chest button | ×1 | RGB FullColor |
| Feet | 2×1 | RGB FullColor |

### CONTACT SENSOR

| | **NAO HUMANOID** |
|---|---|
| Chest Button | ✓ |
| Foot Bumper | ✓ |
| Tactile Head | ✓ |
| Tactile Hand | ✓ |

### DEGREES OF FREEDOM

| | **NAO HUMANOID** |
|---|---|
| HEAD | ×2 dof |
| ARM (IN EACH) | ×5 dof |
| PELVIS | ×1 dof |
| LEG (IN EACH) | ×5 dof |
| HAND (IN EACH) | ×1 dof |

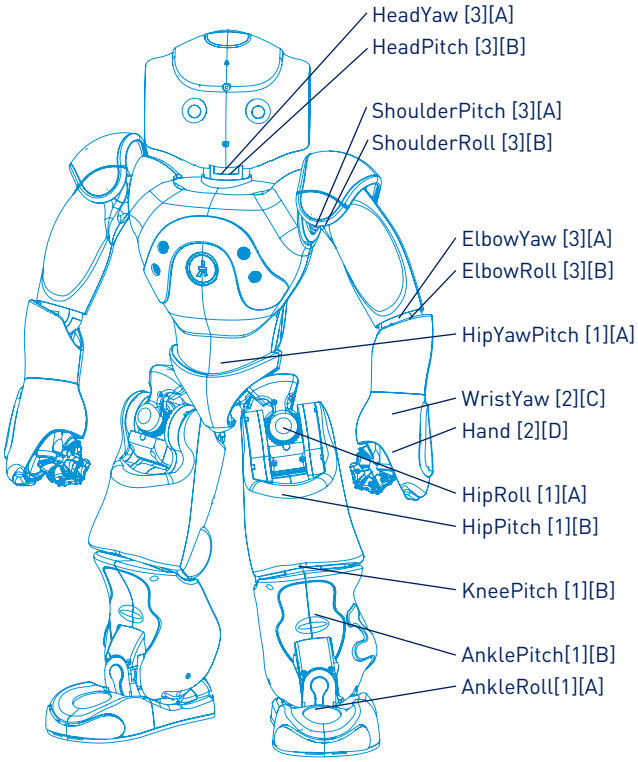
# NAO HUMANOID

## MOTOR SPECIFICATIONS

MOTOR TYPE Brush DC Coreless

### POSITION OF MOTORS

| | | MOTOR | REDUCTION RATIO |
|---|---|---|---|
| HEAD JOINTS | HeadYaw | Type 3 | **Type A** |
| | HeadPitch | Type 3 | **Type B** |
| ARM JOINTS | ShoulderPitch | Type 3 | **Type A** |
| | ShoulderRoll | Type 3 | **Type B** |
| | ElbowYaw | Type 3 | **Type A** |
| | ElbowRoll | Type 3 | **Type B** |
| | WristYaw | Type 2 | **Type C** |
| | Hand | Type 2 | **Type D** |
| LEG JOINTS | HipYawPitch | Type 1 | **Type A** |
| | HipRoll | Type 1 | **Type A** |
| | HipPitch | Type 1 | **Type B** |
| | KneePitch | Type 1 | **Type B** |
| | AnklePitch | Type 1 | **Type B** |
| | AnkleRoll | Type 1 | **Type A** |




Legend: Joint Name[Motor Type][Reductor Type]

### DESCRIPTION OF THE MOTORS

| | MOTOR TYPE 1 | MOTOR TYPE 2 | MOTOR TYPE 3 |
|---|---|---|---|
| Model | 22NT82213P | 17N88208E | 16GT83210E |
| No load speed | 8300rpm ±10% | 8400rpm ±12% | 10700rpm ±10% |
| Stall torque | 68mNm ±8% | 9.4mNm ±8% | 14.3mNm ±8% |
| Continuous torque | 16.1mNm max | 4.9mNm max | 6.2mNm max |

SPEED REDUCTION RATIO
**TYPE A**

| | MOTOR TYPE 1 | MOTOR TYPE 3 |
|---|---|---|
| Reduction ratio | 201.3 | 150.27 |

SPEED REDUCTION RATIO
**TYPE B**

| | MOTOR TYPE 1 | MOTOR TYPE 3 |
|---|---|---|
| Reduction ratio | 130.85 | 173.22 |

SPEED REDUCTION RATIO
**TYPE C**

| | MOTOR TYPE 2 |
|---|---|
| Reduction ratio | 50.61 |

SPEED REDUCTION RATIO
**TYPE D**

| | MOTOR TYPE 2 |
|---|---|
| Reduction ratio | 36.24 |

CERTIFICATIONS & APPROVALS

| REGION | CLASSIFICATION |
|---|---|
| Europe | CE (Declaration of Conformity) |
| USA | FCC |

| | |
|---|---|
| ELECTROMAGNETIC COMPATIBILITY | EN 301 489-1 / EN 301 489-17 / EN 300 328<br>EN 62311 : 2008 / FCC PART15, Class A |
| SAFETY | IEC 60950-1:2005 (2nd edition) |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Data are subject to change without notice.