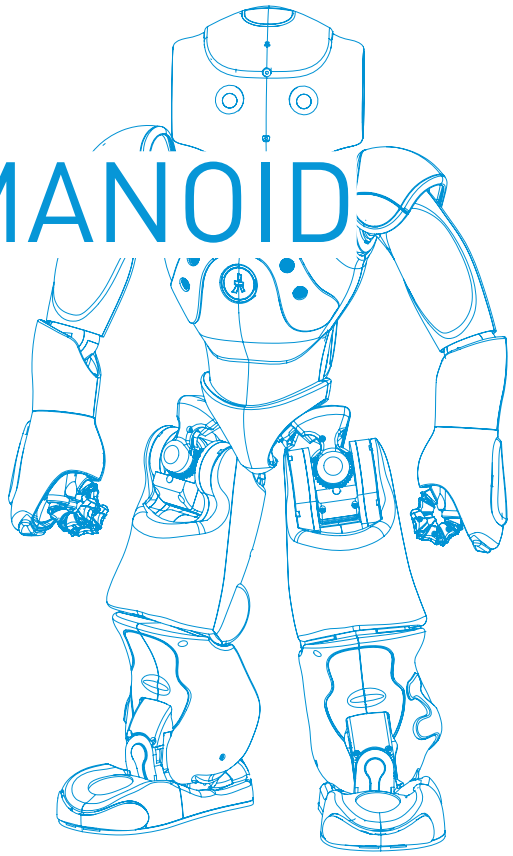
NAO HUMANOID



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) 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) 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 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

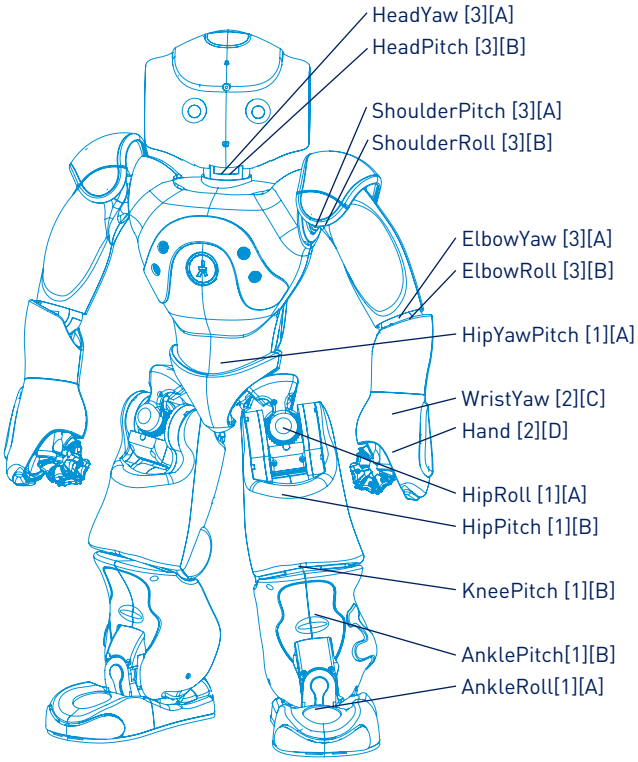
NAO HUMANOID

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 EN 62311 : 2008 / FCC PART15, Class A
SAFETY	IEC 60950-1:2005 (2nd edition)