ISTITUTO ITALIANO DI TECNOLOGIA
iCUB FACILITY

iCub

head specifications

Version	Date	Author	Comments
1.0	25 Jan 2013	A. Parmiggiani	First version
1.1	30 Jan 2013	A. Parmiggiani	Filled missing information, improved graphic layout
1.2	22 Apr 2014	A. Parmiggiani	Updated IIT's official logo
1.3	06 Dec 2016	F. Larosa – A. Derito	Updated
1.4	12 Dec 2016	M. Maggiali	Add few details

iCub head

6 DOF robotic head
with integrated vision
system and motor
control electronics
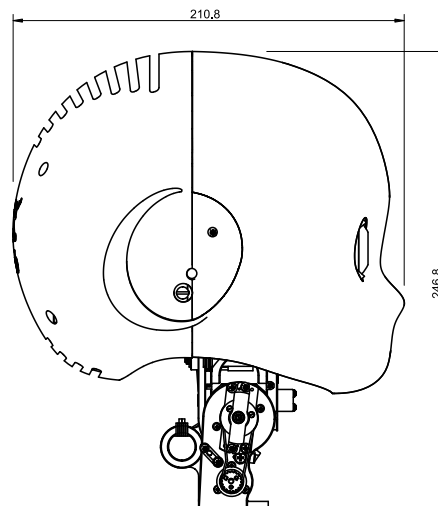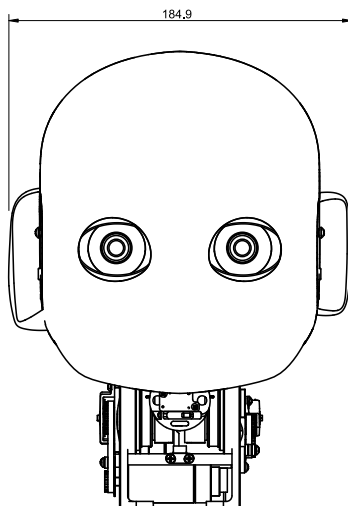
The iCub head is a compact six degrees of freedom robotic head. The system comprises several important subsystems for gathering sensory information.

More in detail the head features:

- a COM Express Type 6 Compact module embedded computer
- a fully actuated stereo video system
- an inertial sensor for the measurement of the rates of turn and angular acceleration of the head
- two microphones for stereo audio
- three LED boards for displaying facial expressions.
- motor controller boards for controlling the head joints

1.1   Dimensions and physical parameters

The overall dimension and mass of the head are reported in the following table.

Mass	1.8	[kg]
Height	246.8	[mm]
Width	184.9	[mm]
Depth	210.8	[mm]

1.2 Embedded electronics specifications

Power supply	12V (60W)
Communication	100Mbps Ethernet embedded network, 1Gbps Ethernet LAN connection.
Embedded computer	Embedded logic COM Express Type 6 Compact module (Intel® Core™ i7-4650U dual core processor with 1.7GHz, 4MB L2 cache and 1600MT/s dual channel DDR3L memory interface)
Video system	Two DR2-03S2C-EX-CS, PointGrey - Videocam Dragonfly2 color extended version, 640x480, 1/3, sampled at 30fps
Inertial sensor	Three axis gyroscopes + three axis accelerometers + three axis geomagnetic sensor based on BOSCH BNO055 chip, mounted in the head
Microphones	SoundMan High quality Stereo Omnidirectional microphone, -46 dB, 10V, 20….20 000 Hz +/- 3dB
Operating conditions	0 to 40°C, humidity <85% without condensation

1.3 DOF range of motion

The following table lists the ranges of motion of the six DOF of the iCub head measured in degrees with respect to the home position as represented in Figure 1.

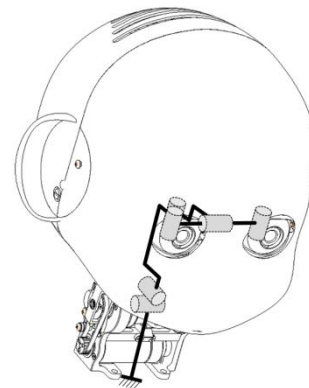| Joint	ID	Min	max	
Neck pitch	0	-30	+22	[deg]
Neck roll	1	-20	+20	[deg]
Neck yaw	2	-50	+50	[deg]
Eyes tilt	3	-30	+30	[deg]
Eyes version[1]	4	-30	+30	[deg]
Eyes vergence[1]	5	0	50	[deg]

Figure 1: Head kinematic structure (home position).

An additional degree of freedom is provided for opening and closing the eyelids.

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[1] Let us define L and R the angular positions of the left and right eye respectively with respect to the homed optical axis. The vergence angle V_g is defined as $V_g = L - R$. The version angle V_s is the angle between the axis orthogonal to the baseline and passing through the baseline's midpoint and a line connecting this midpoint and the vergence point. The version angle satisfies the nonlinear relation $\tan V_s = (\tan L + \tan R)/2$. The firmware controlling the eyes motion sends as version the value $V_s = (L - R)/2$, which holds for small angles (where $\tan x \approx x$)