ISTITUTO ITALIANO DI TECNOLOGIA
iCUB FACILITY

TECHNICAL SPECIFICATIONS OF THE ICUB PLATFORM

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Contents

1. Change Log

Revision	Date	Changes
1.0	17/05/2012	First revision
1.1	28/05/2012	Final version
2.0	30/07/2012	Updated
2.1	22/04/2014	Updated IIT's official logo
2.2	06/12/2016	Updated
2.5	05/08/2018	Added skin details. Removed useless information

2. Introduction

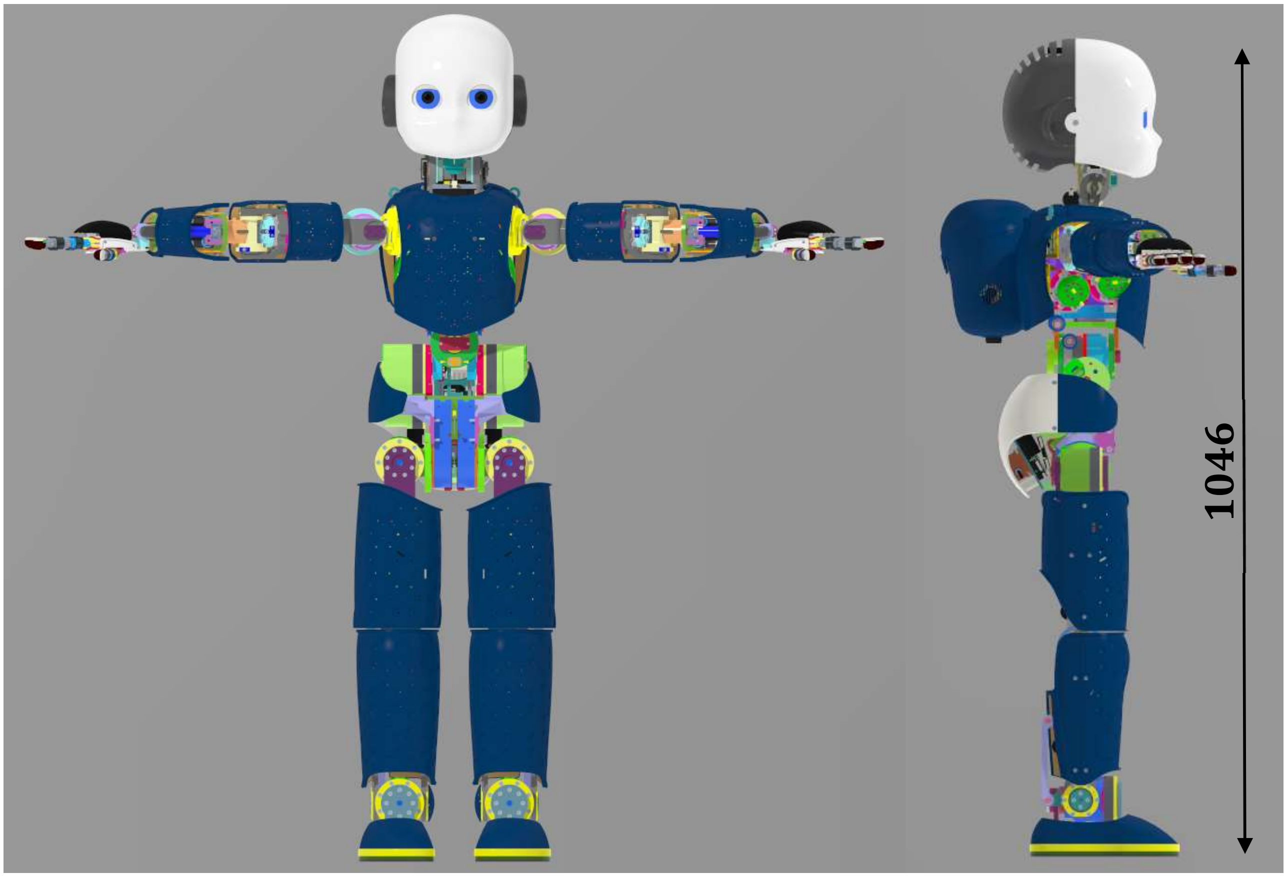
This document describes the technical specifications of the iCub platform.

3. General Specifications

The number of degrees of freedom is as follows.

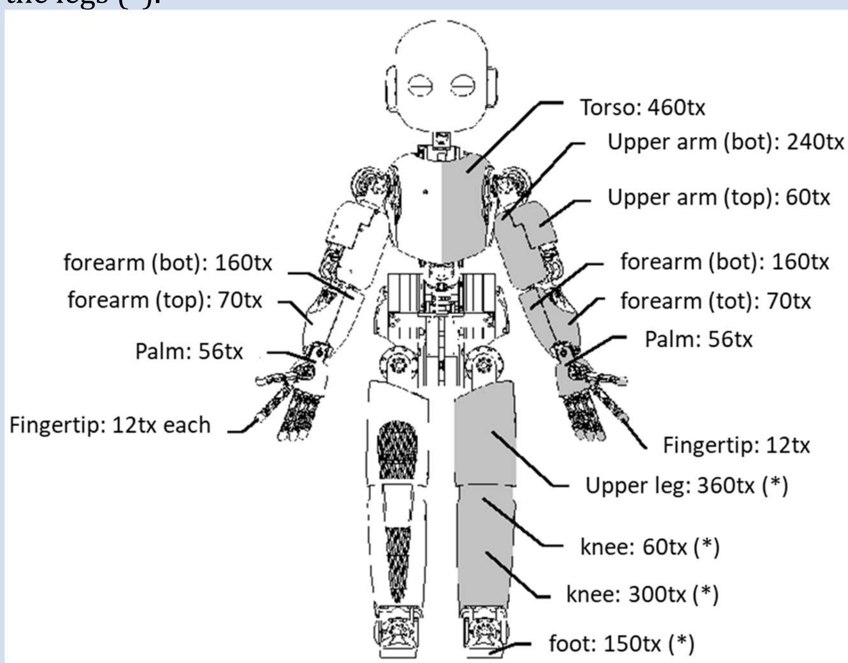
Component	# of degrees of freedom	Notes
Eyes	3	Independent vergence and common tilt
Head	3	The neck has three degrees of freedom to tilt, swing and pan
Chest	3	The torso can also tilt, swing and pan
Arms	7 (each)	The shoulder has 3 DoF, 1 in the elbow and three in the wrist
Hands	9	The hand has 19 joints coupled in various combinations: the thumb, index and middle finger are independent (coupled distal phalanxes), the ring and little finger are coupled. The thumb can additionally rotate over the palm.
Legs	6 (each)	6 DoF are sufficient to walk.

The overall size of the iCub is comparable to a four years old child as well as the general kinematics. The total number of degrees of freedom is 53. The following picture shows a CAD rendering of the full iCub. The weight of the robot is 30kg (33kg with battery pack).



The iCub sensors are summarized in the following table:

Sensor type	Number	Notes
Cameras	2	Mounted in the eyes (see above), Pointgrey Dragonfly 2 (640x480)
Microphones	2	SoundMan High quality Stereo Omnidirectional microphone, -46 dB, 10V, 20….20 000 Hz +/- 3dB
Inertial sensors	3+3	Three axis gyroscopes + three axis accelerometers + three axis geomagnetic sensor based on BOSCH BNO055 chip, mounted in the head. (100Hz)
Joint sensors	For each large joint	Absolute magnetic encoder (12bit resolution @1kHz) at the joint, high-resolution incremental encoder at the motor side, hall-effect sensors for commutation (brushless motors only)

Joint sensors	For each small joint	Absolute magnetic encoder (except the fingers which use a custom hall-effect sensor), medium-resolution incremental encoder at the motor
Force/torque sensors	6	6x6-axis force/torque sensors are mounted on the upper part of the arm and legs plus 2 additional sensors mounted closer to the ankle for higher precision ZMP estimation (100Hz)
Tactile sensors	More than 3000 (*)	Capacitive tactile sensors (8 bit resolution at 40Hz) are installed in the fingertips, palms, upper and fore-arms, chest and optionally at the legs (*). 

Technical characteristics:

Technical details are reported here:

	Specs
Body	Height ~105 cm Width 36.5 cm Weight: 33kg (30kg + 3kg battery backpack)
Connectivity	Wireless connectivity 802.11ac 2x2 Wifi Bluetooth 4.0
Electrical features	Battery 36V 9Ah (**not available yet**) Dummy battery-pack (same weight as the battery pack) for connecting the robot to the power supply.

Actuators	All main joints with zero backlash (head, arms, torso and legs). Elastic Actuator actuators in legs for human like walking.
On board Computer	CPU Intel i7 7600 RAM 4 GB SSD 32GB
Operating System	Ubuntu LTS 64 bits
Middleware	YARP 3, interface to ROS. See http://www.yarp.it YARP runs on Windows, Linux, MacOS and binary packages are provided for Windows and Linux. MacOS users can straightforwardly use HomeBrew.
Software libraries for inverse kinematics and a set of ready-to-use robot behaviors	The iCub comes with a repository of basic libraries that include: - Kinematics, Dynamics; - Force/impedance control; - Interfaces to all sensors and actuators; - Reaching and basic grasping behaviors; - Attention system; - Object learning and recognition (online); - Speech interfaces - OpenCV; - Point Cloud; - GNU scientific library; - Matlab interface; - Interfaces to various programming languages (e.g. Python, Java, C#).
Source code (as low level as possible)	All source code is available from the GIT repository (https://github.com/robotology) down to the level of the microcontroller code.
Technical documentation	All technical documentation is available from the manual (www.icub.org) and in part directly in the GIT repository.
Robot working area	Length of cables must ensure 50 m2 of working area
Demos	Arm gravity compensation Redball tracking Interactive Object Learning (IOL)

Static and Dynamic repeatability

Experiment	repeatability
Movement repeatability in Cartesian space of the palm of the robot arm excluding fingers when joints have reached their commanded set point (static)	1mm
Movement repeatability in Cartesian space of the foot of the robot leg when joints have reached their commanded set point (static)	1mm
Standard deviation of the Cartesian position movement of the palm of the robot arm excluding fingers and with fast displacement and dynamic variability of trajectories	3mm
Standard deviation of the Cartesian position movement of the foot of the robot leg and with fast displacement and dynamic variability of trajectories	3mm
Standard deviation of the movement of the palm of the robot arm with fast displacement, variability of orientation (dynamic)	1 degree
Standard deviation of the movement of the foot of the robot leg with fast displacement, variability of orientation (dynamic)	1 degree