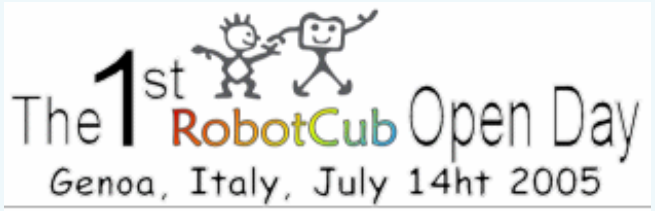
RobotCub



iCub platform design

From specs to mechanical design

F.Becchi – TELEROBOT srl – GENOVA - ITALY

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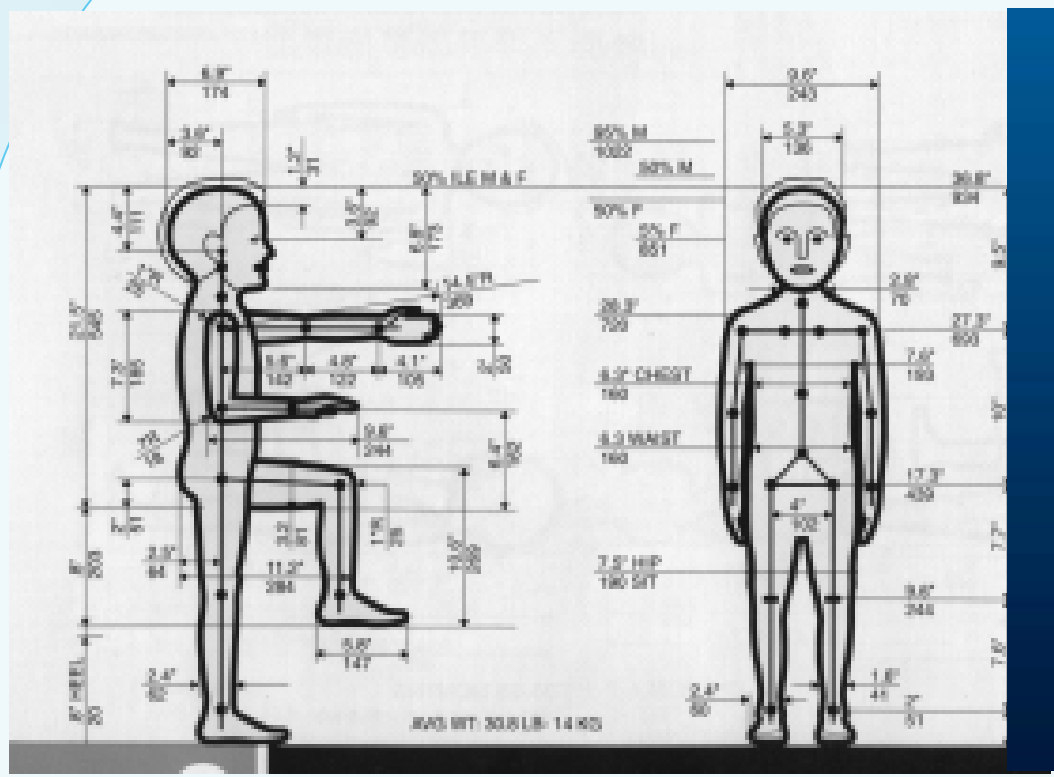
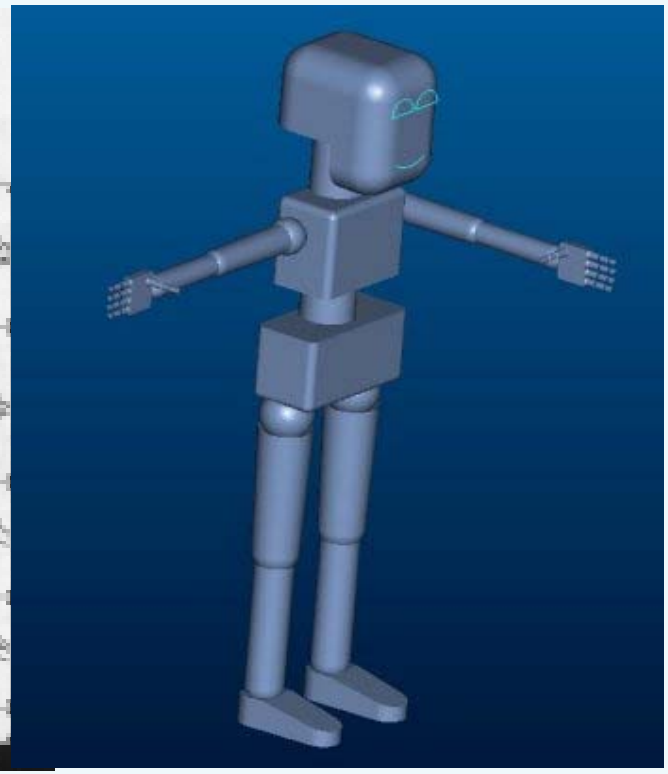
From normotype to a 3D common reference model





All must fit in the model !

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Platfom weight definition

From different experiences on robotics and common "a priori" evaluation a total weight goal with sub group weight distribution is defined

CUB weight preliminary table list	
	AVRG
HEAD	1.5
LOWER ARM+HAND left	1.25
LOWER ARM+HAND right	1.25
UPPER ARM left	1.15
UPPER ARM right	1.15
UPPER TORSO	3.75
LOWER TORSO	6.5
LEG left	3.5
LEG right	3.5
upper body	10.05
lower body	13.5
TOTAL WEIGHT	23.55

First simulations and first results

1 Hz Crawling	
DOF	Maximum Torque (N.m)
left_arm_1	48.4
left_arm_2	45.6
left_arm_3	10.9
left_elbow	29.4
torso_1	45.8
torso_2	27.2
torso_3	30.1
left_leg_1	46.3
left_leg_2	37.1
left_leg_3	36.8
left_knee	27.4
left_ankle	12.4

0.5 Hz Crawling	
DOF	Maximum Torque (N.m)
left_arm_1	40.4
left_arm_2	18.1
left_arm_3	7.9
left_elbow	18.6
torso_1	34.3
torso_2	26.5
torso_3	13.7
left_leg_1	38.5
left_leg_2	15.1
left_leg_3	23.2
left_knee	28.0
left_ankle	11.3

- Work done at EPFL gives to mechanical engineers reference performances for the actuator selection and the design task

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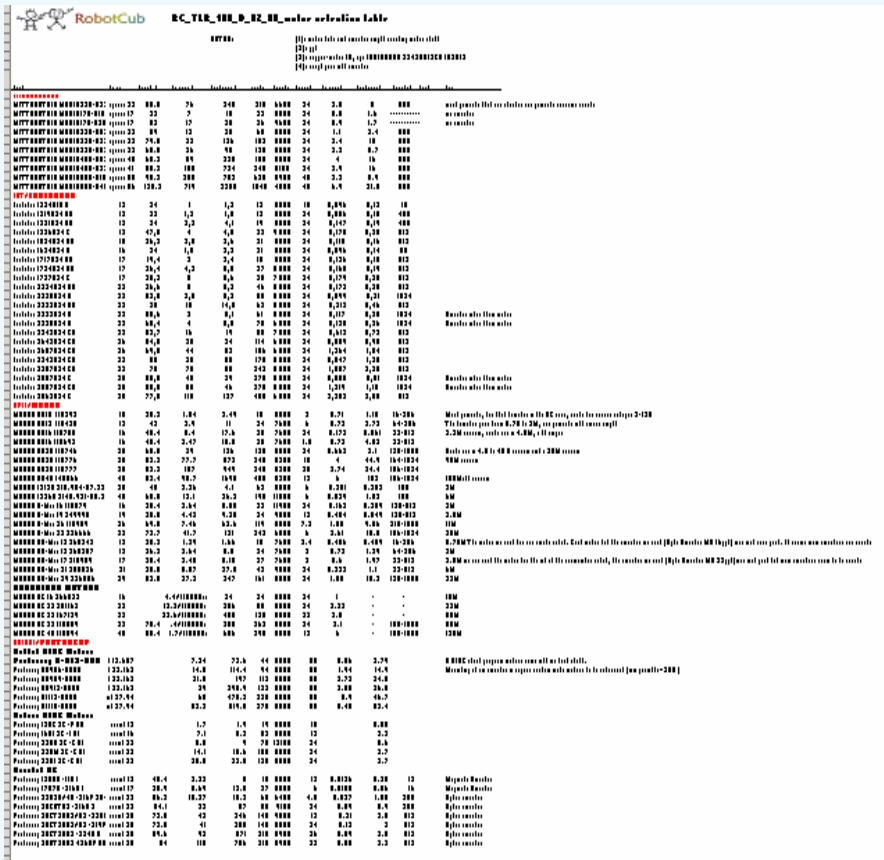
By merging each group different experience we defined a common motors and gearboxes data base:

- Faulhaber;
- Maxxon;
- Portescap;
- Wittenstein;
- Gysin;
- Harmonic drive;
- …



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- First limitation in the design is the POWER DENSITY for motors
- Second limitation in the design is the stress level in the mechanics (eg. max torques on gears…)

BOTH are phisical limits connected to the aivalable technology

BEST COMPROMISE SOLUTION NEEDS TO BE DEFINED

RobotCub

In the first discussions several possible approach were outlined in the design:

- Serial joint design;
- Pairs of toothed gears;
- Tendon driven desing;
- Parallel mechanics design;
- Underactuated design.

Each group has investigated pros and cons of different approach..

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The work team

The mechanical design of the iCub is spreaded over 4 groups:

- IST (lisbon) is responsible for the head design;
- SSSA (pisa) is responsible for the hand, arm and upper torso design;
- USAL (salford) is responsible for the waist, lower body and leg desig;
- TLR+UNIGE-LIRA (genova) is responsible for the design coordination and integration.

And the whole robotcub consortium contribute strongly to the design..

RobotCub

Reviewing some sub group at the current development state will show several different approach tailored on the application :

- The serial design of the neck (IST);
- The underactuation and tendon relocation in the finger design (SSSA);
- The cable driven waist joint on a differential design (USAL).

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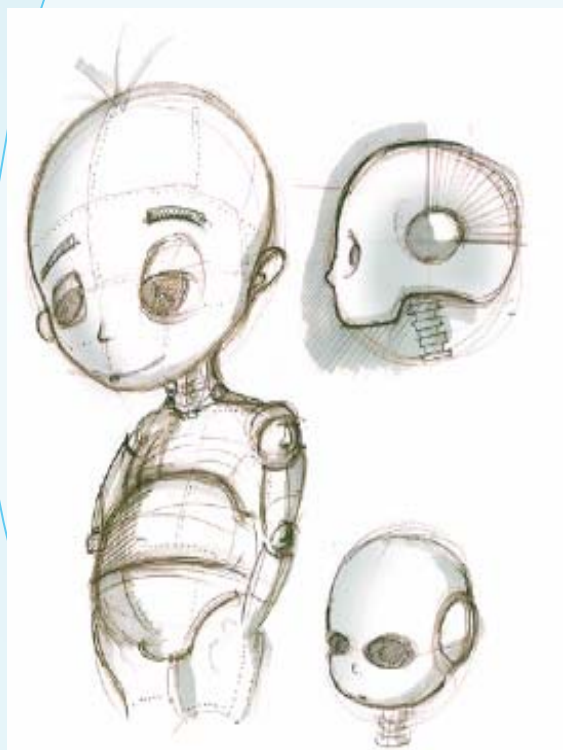
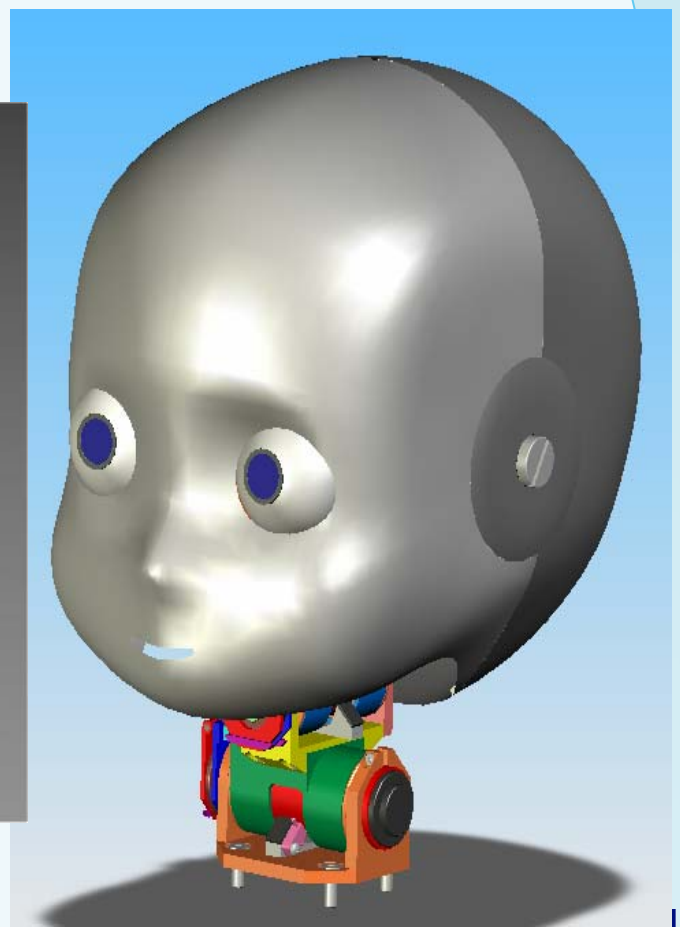
Head design (IST)

From sketch to cad





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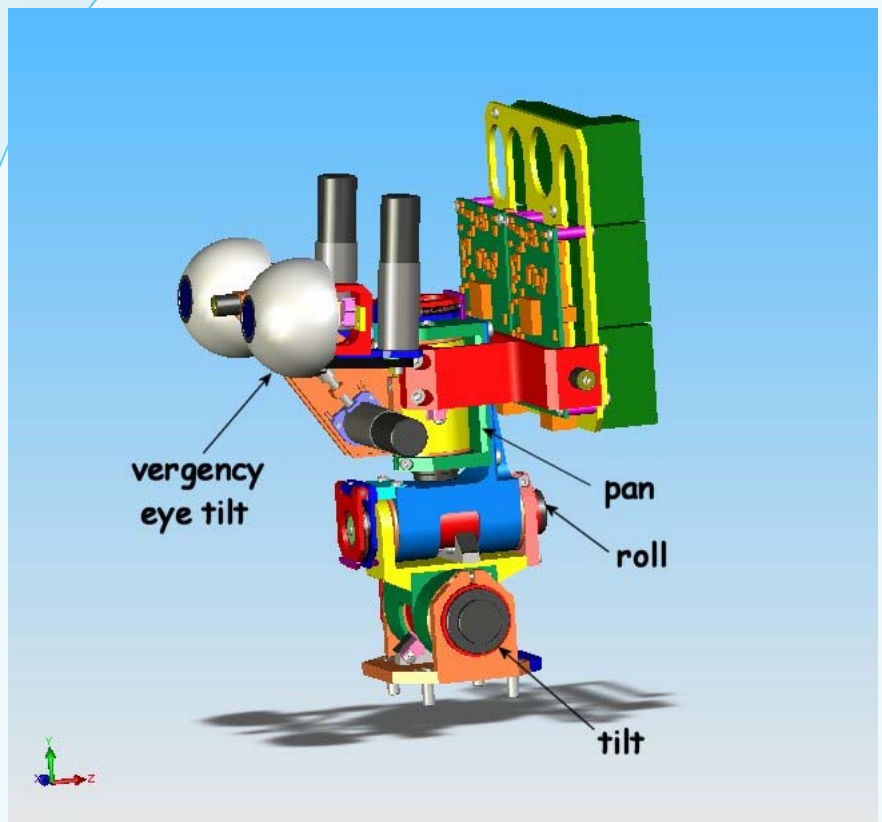
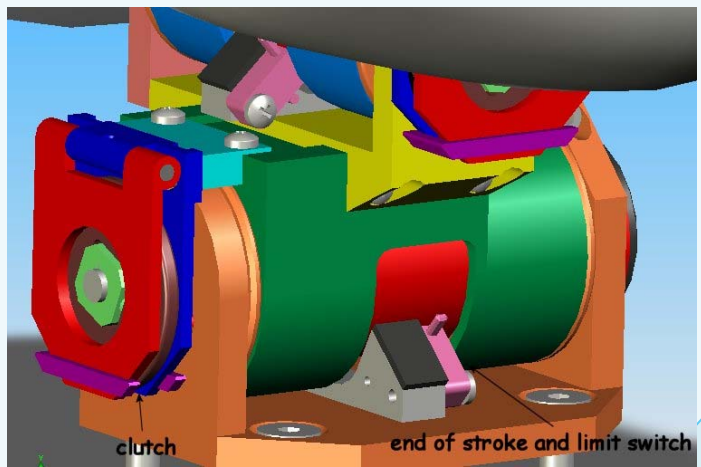
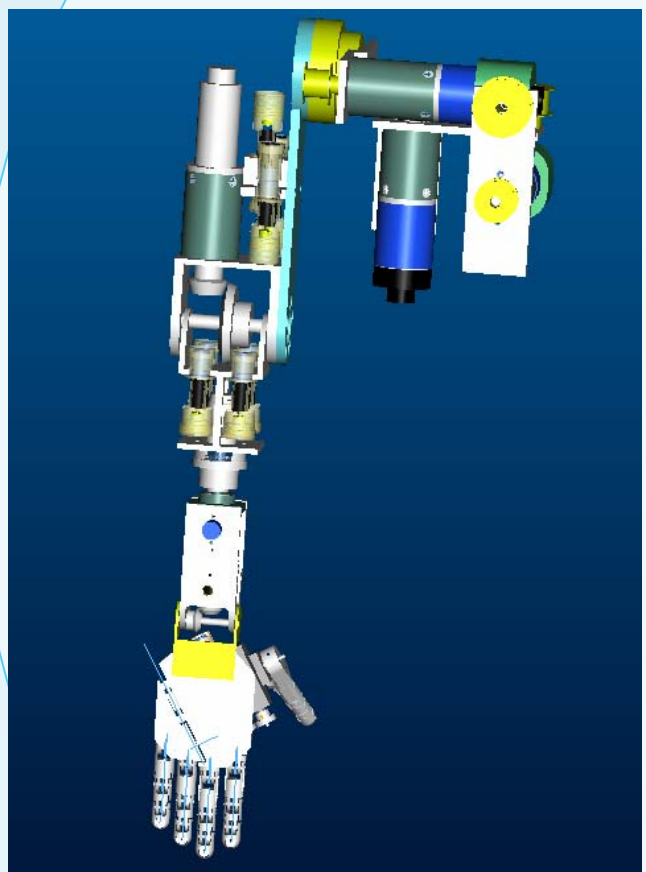
Head design (close view)



3 DOF serial neck
modular design
indipendent vergency (2dofs)
eye tilt
overload protection on neck
absolute sensors on neck
integrated sensors and electronics



Arm/Hand design (SSSA)



3 DOF shoulder timing belt driven
1 DOF elbow conical gear driven
3 DOF wrist(mixed transmission)
hand actuator relocation along the arm

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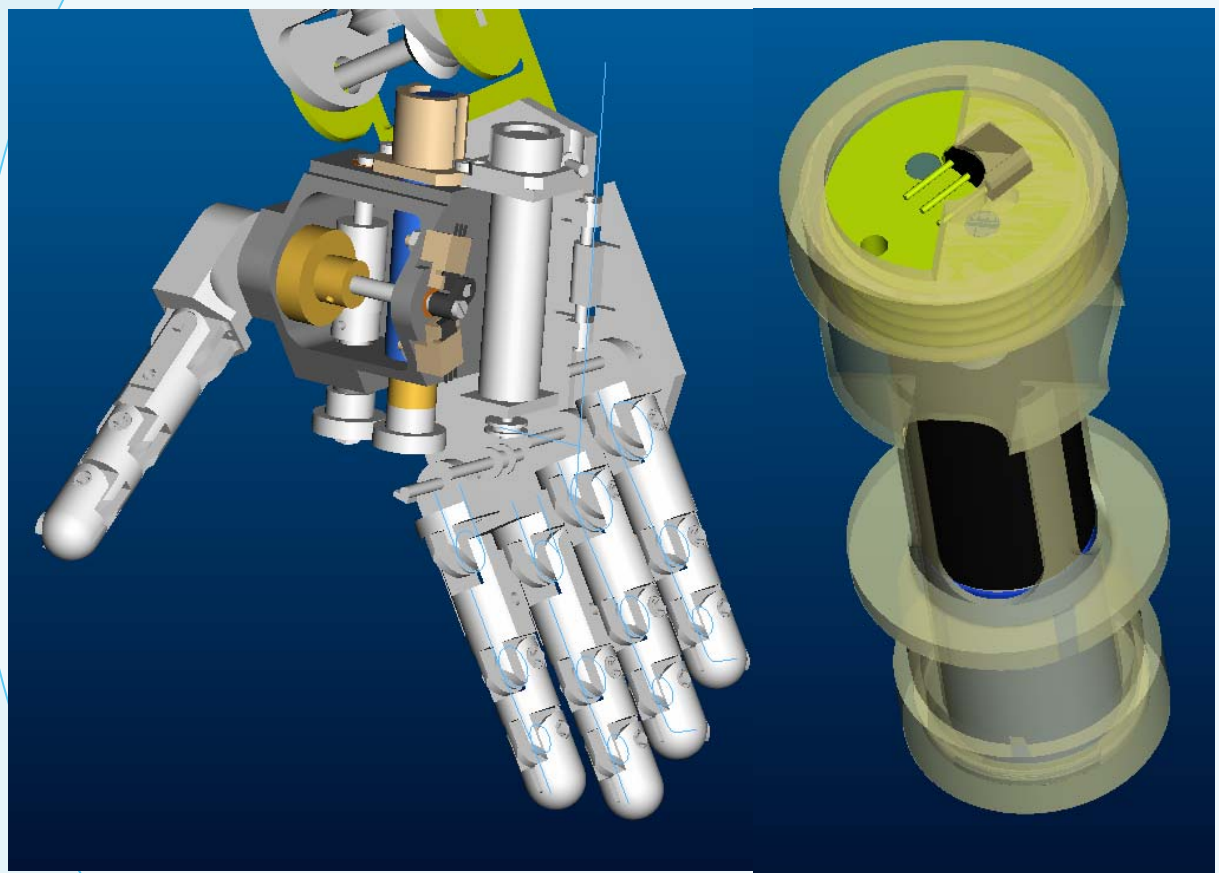
Arm/Hand design (SSSA)



9 controlled DOF on hand
finger underactuation (21 DOF in total)
absolute position sensor on finger joint
tension sensor on finger tendons
tactile sensor (still under implementation)

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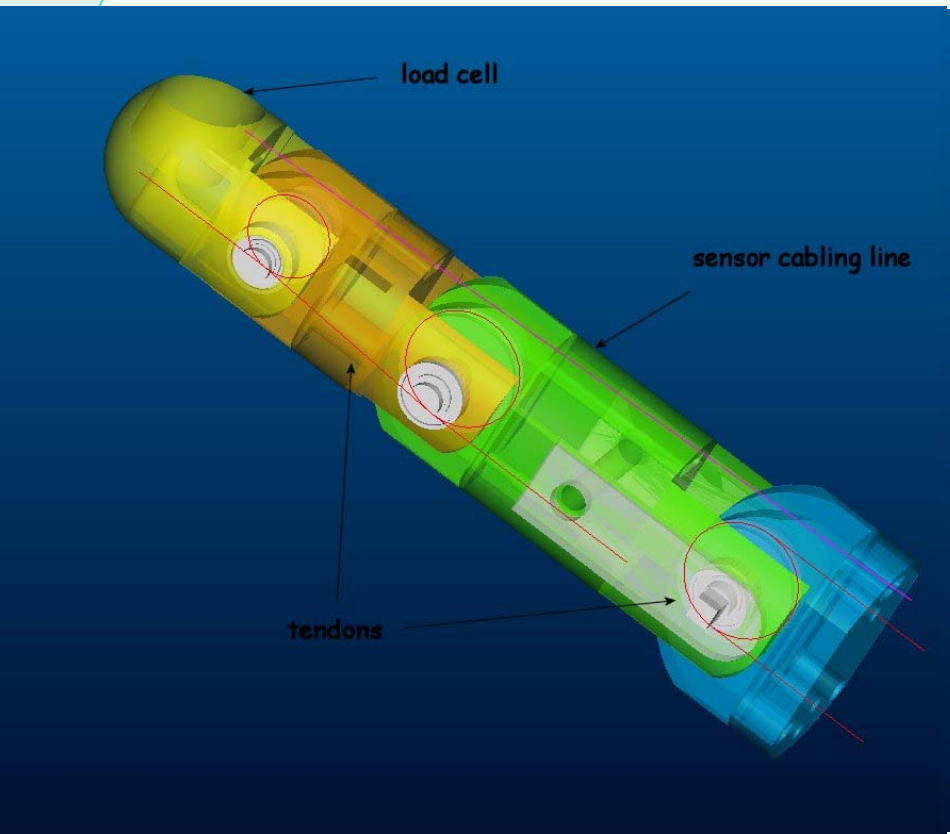
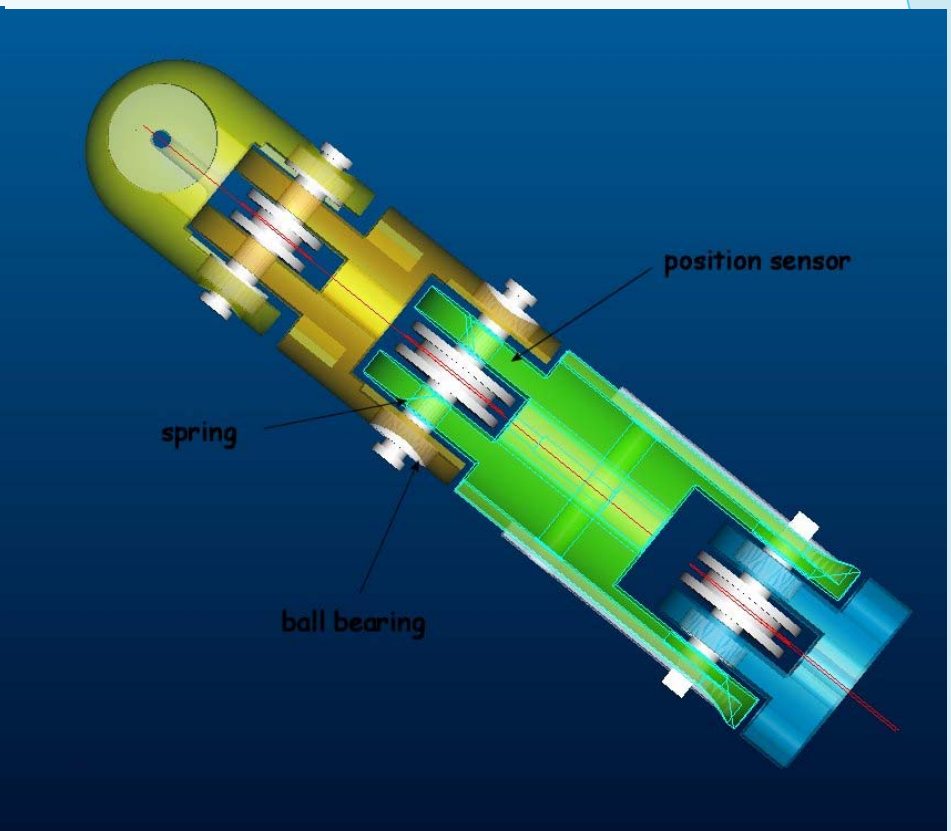
Finger design (close view)





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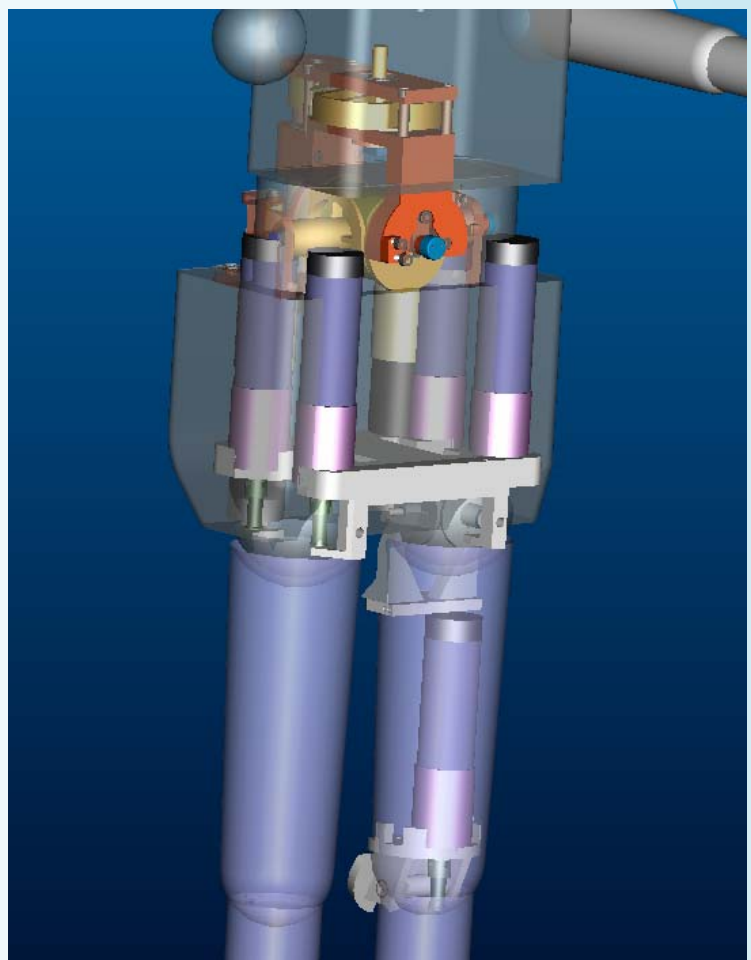
Lower body (USAL)

3 DOF waist
3 DOF hip on each leg
1 DOF knee rotation
2 DOF ankle (under development)



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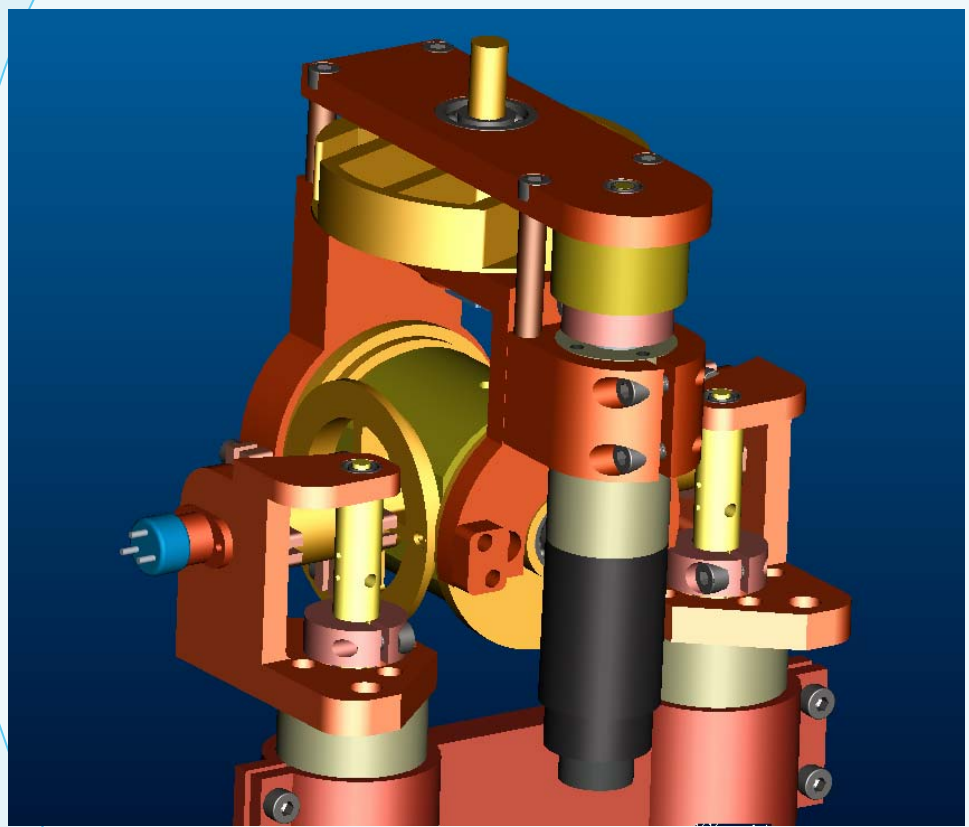
Waist design (USAL)



3 DOF central body joint
2 DOF differential tendon driven
1 DOF pan rotation
Force sensors directly integrated in wheel design
Absolute position sensors (potentiometer)

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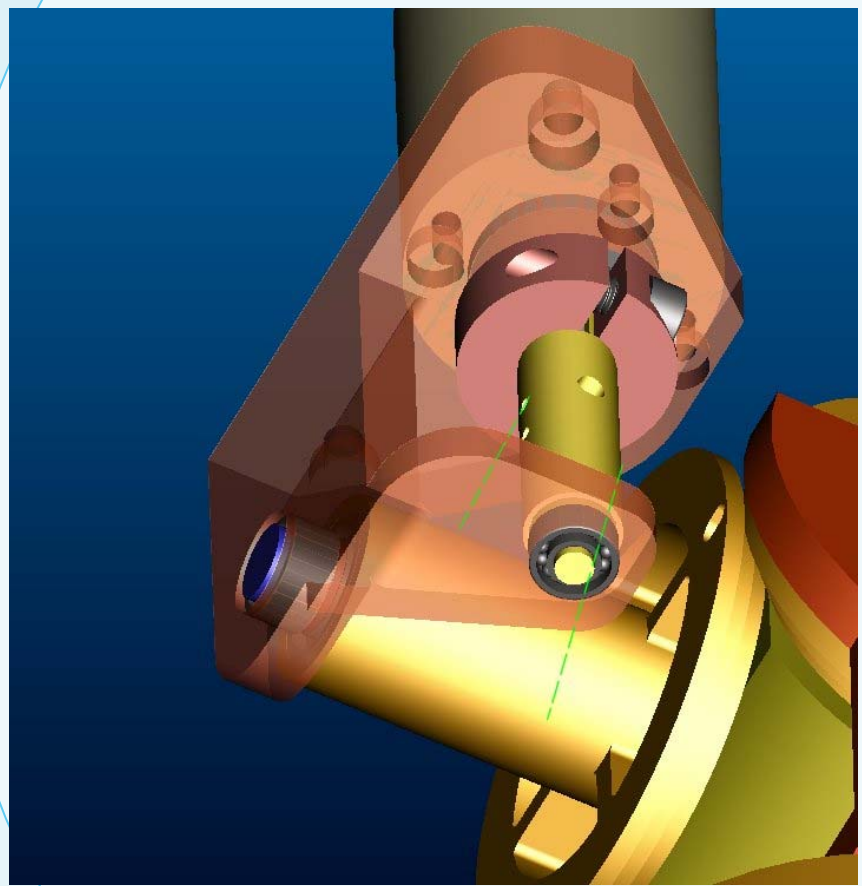
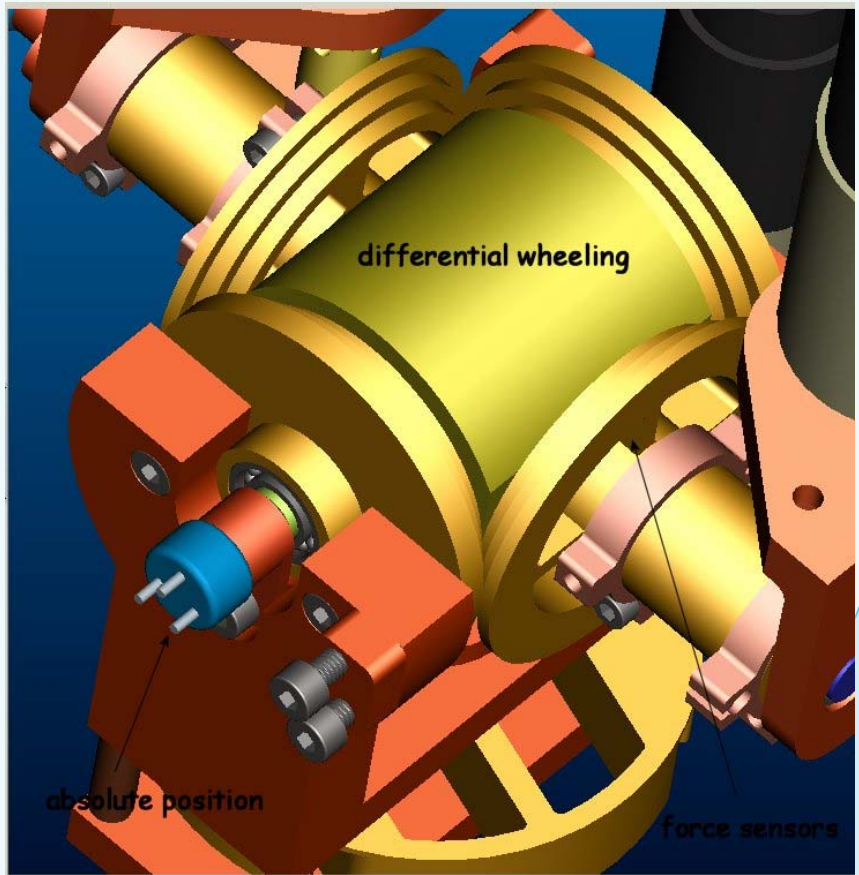
Waist design (close view)





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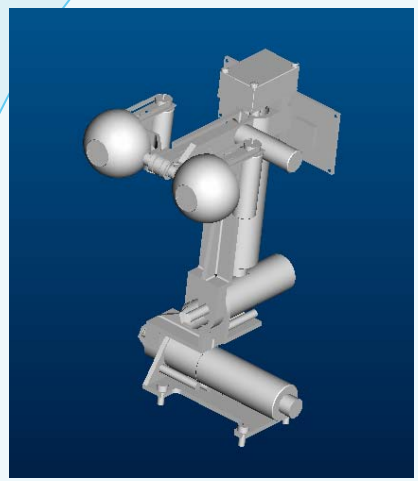
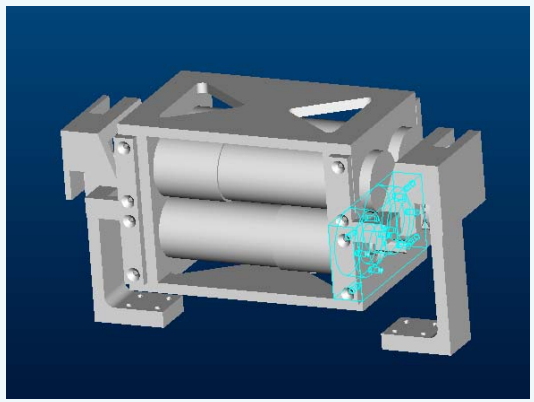
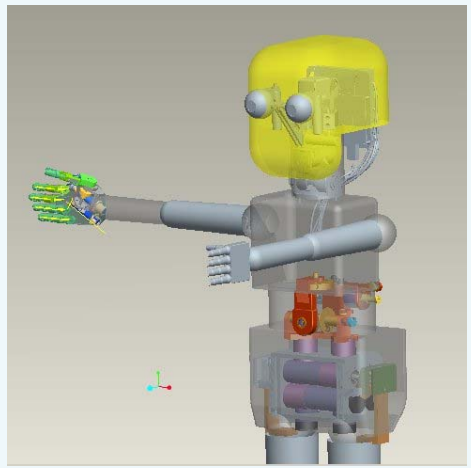
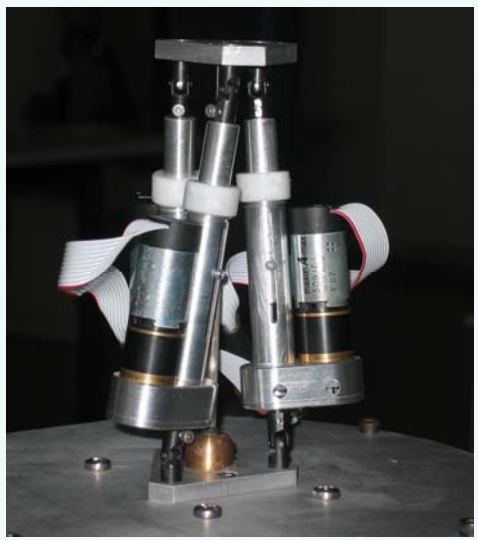
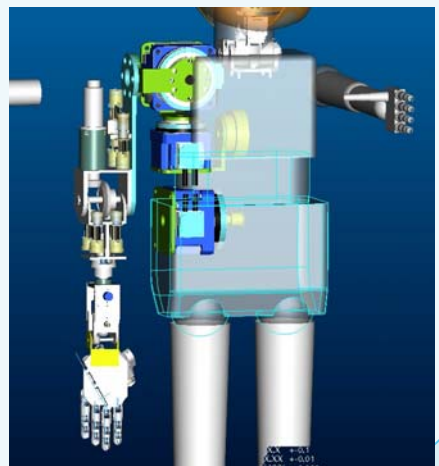
..design evolution











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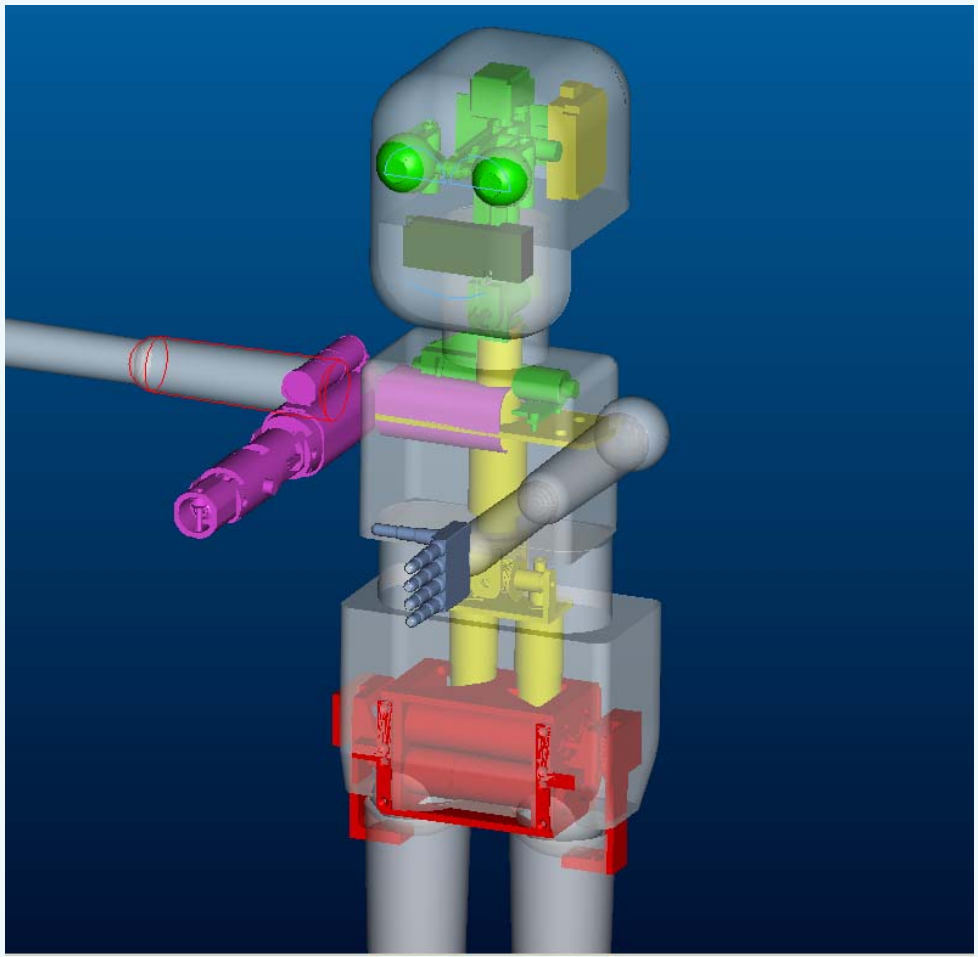
..the integration task:first attempt (march 05)



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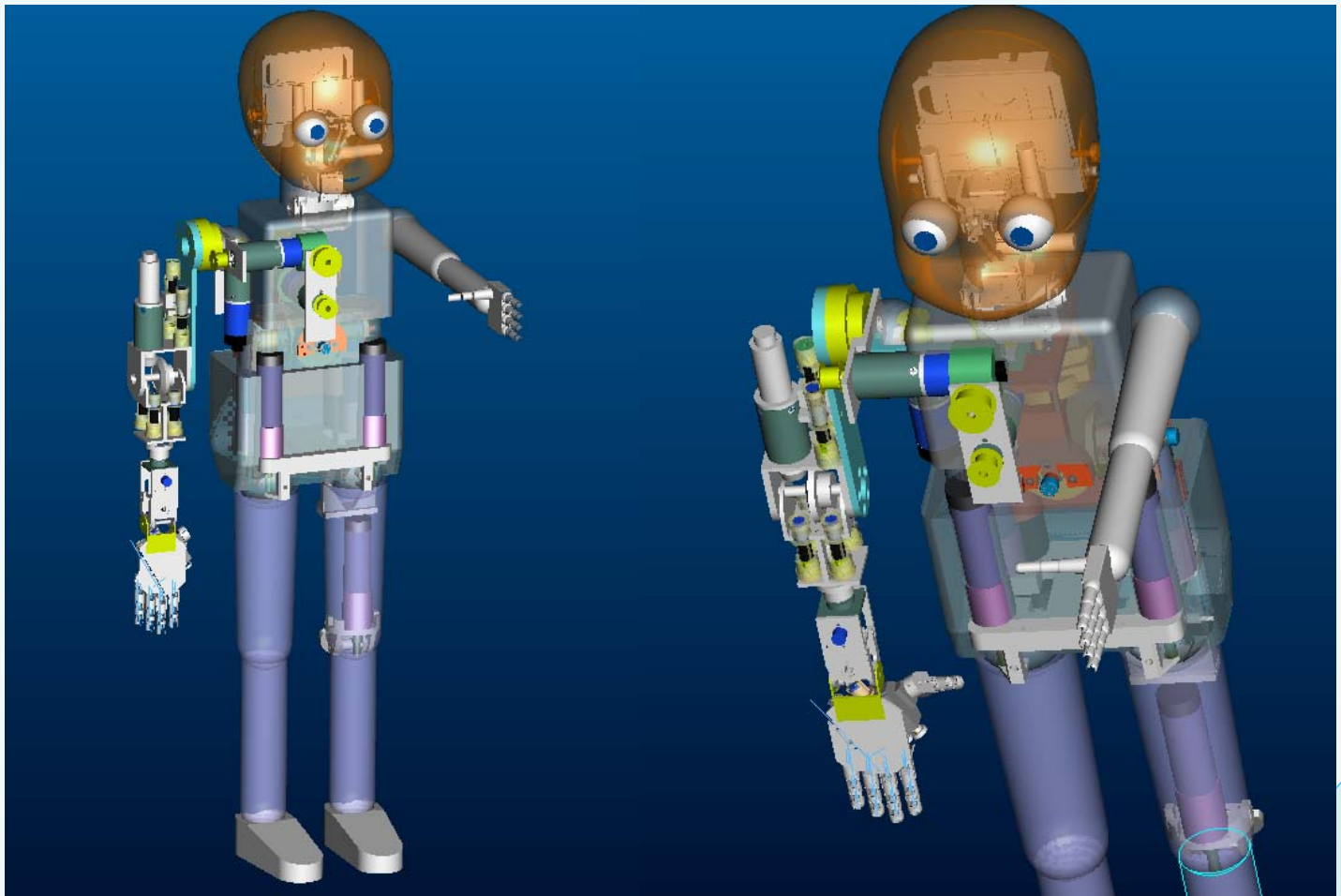
..the integration task (current status)



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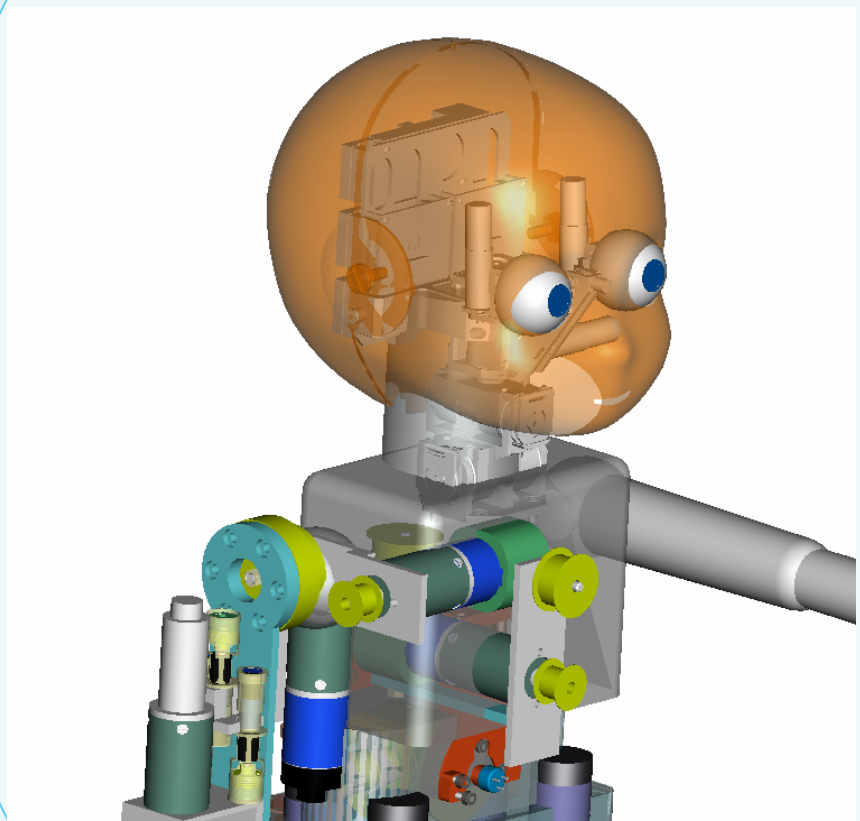
..the integration task (current status)



1. Task to be done:
solve subgroup level problems trough prototipe realization and hard test;
solve fit in and weight concerns problems;
solve internal space sharing problems;
standardization of components used and possibly of technology
..make it all work fine!

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..the integration task

..maybe next time!

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..thank-you..

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www.telerobot.it