ROBotic Open-architecture Technology for Cognition, Understanding and Behavior

Project no. 004370

RobotCub

Development of a cognitive humanoid cub

Instrument: Integrated Project
Thematic Priority: IST – Cognitive Systems

RC_IST_101_D_000_04_NECK_TESTS

Mechanical Performance of the Neck Mechanism

Internal Report

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Organisation name of lead contractor for this deliverable: IST
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Dissemination Level		
PU	Public	
PP	Restricted to other programme participants (including the Commission Service)	
RE	Restricted to a group specified by the consortium (including the Commission Service)	
CO	Confidential, only for members of the consortium (including the Commission Service)	**CO**

Objectives:

The main issues of this report are:

- Test the mechanical performance of the neck mechanism developed by IST for the iCub head, after the introduction of additional payload, with a weight similar to the electronics' weight (1 pc104+1 power supply board+ 3 DC control boards), and that was not supposed to be there, when the motors were chosen.
- Identify possible problems in the 3 DOF and explain the limitations of each dof.
- Propose different alternative solutions for the identified problems, analyzing its advantages and disadvantages.

Experiments:

In order to simulate the hardest working situations of the mechanism, its base was fixed in a vertical position, as shown on Figure 1.

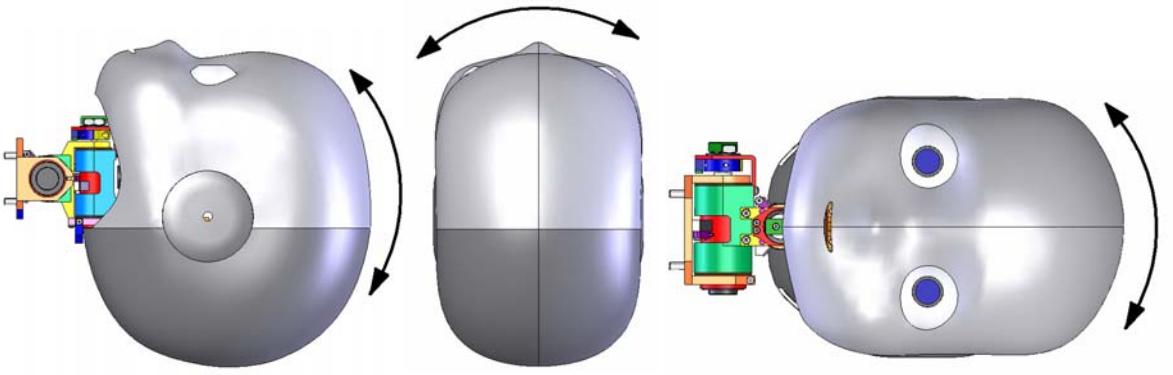

Figure 1: Movements made during the mechanical tests

The weight of the head components was measured before the realization of the mechanical tests. The values are shown on Table 1.

Table 1: Weight measurement

Component's Weight (g)	
Cover	257
Mechanism	1104
Payload (Full)	340
Total	1701

The test of each dof was made using the following procedure:

1. Fix the head on its homing position, with zero velocity, full load (payload=340g), for a short period of time (t= 5s); **static test**
2. Move the head, with its maximum velocity, along its total range of movement, with full load, for a short period of time; **dynamic test**
3. Move the head, with its maximum velocity, along its total range of movement, with full load, for 30 min, verifying the temperature of the actuator; **endurance test**

If the head weren't able to move, on 2, the velocity would be decreased until the head start moving. If the velocity reduction wasn't still enough, the payload would be decreased until the head start moving.

Table 2: Different test's Resume

Joint	Payload (g)	Vel (rad/s)	Test Period (s)	Real Range of Movement (º)	Obs
Tilt	340	0	5	+40; -50	✓
		1.3	5		✓
		1.3	1800		✓
Swing	340	0	5	+40; -40	✓
		1.2	5		×
		0.1	5		×
	210	0.0	5		✓
		1.2	5		×
		0.5	5		×
		0.1	5		×
	130	0	5		✓
		1.2	5		×
		0.1	5		×
	0	1.2	5		✓
Pan	340	0	5	+55; -55	✓
		1.6	5		✓
		1.6	1800		✓

Conclusions:

After these experimental tests, we can conclude that:

- The Tilt and Pan Actuators can handle the additional weight.
- The Swing Actuator has to be changed, since it is only able to move the head with no payload.

Although its available torque is less than the required torque, the tilt actuator was able to move the head, during 30 min, with full load. However, as it is one of the most critical actuators, especially on the crawling situations, we propose an alternative and more safety solution for it.
The different possible alternatives for both actuators are can be seen on Table 3.

Since the gear box's maximum torques of solutions 1, for the Tilt and the Swing, are less then the required ones, the best solutions are Solution 3, for the Swing, and Solution 2, for the Tilt, both using Gysin gearboxes.

Alternative Solutions								
Movement	**Alternative**	**Motor**	**Gear Box**	**Req. Torque (Nm)**	**Avai. Torque (Nm)**	**Gear Box Máx Torque**	**Advantages**	**Disadvantages**
Swing	1	Faulhaber 1524024SR	Faulhaber 16/7 GR:592	0.8	0.89	0.6	- no need to change parts - cheap solution - the avai. torque is ok	- the gear box may not be strong enough
	2	Faulhaber 2224024SR	Faulhaber 20/1 GR:246		0.74	1	- the avai. torque is ok - cheap solution	- some parts have to be changed - neck length would be increased
	3	Faulhaber 2224024SR	Gysin GPL22 GR:245		1	3	- the avai. torque is ok	- neck length would be increased - some parts have to be changed - more expensive solution
Tilt	1	Faulhaber 2224024SR	Faulhaber 20/1 GR:592	1.22	1.62	1	- no need to change parts - the avai. torque is ok - cheap solution	- the gear box may not be strong enough
	2	Faulhaber 1724024SR	Gysin GPL22 GR:343		1.23	3	- the avai. torque is ok	- more expensive solution - some parts have to be changed