



UNIVERSITY OF ROME TOR VERGATA

**LARM2: Laboratory of Robot Mechatronics
Department of Industrial Engineering**

<https://larm2.ing.uniroma2.it/>



A history of LARMbot humanoid

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historical-technical development of the LARMbot humanoid
low-cost and user-based laboratory solutions
for applications with limited operational capabilities.

since 2001 aggregating partial robotic structures
a unitary project built in 2016.

latest developments with parallel cable-actuated structures

2. Conceptual design of LARMbot humanoid

with structural modules
for the anatomical part

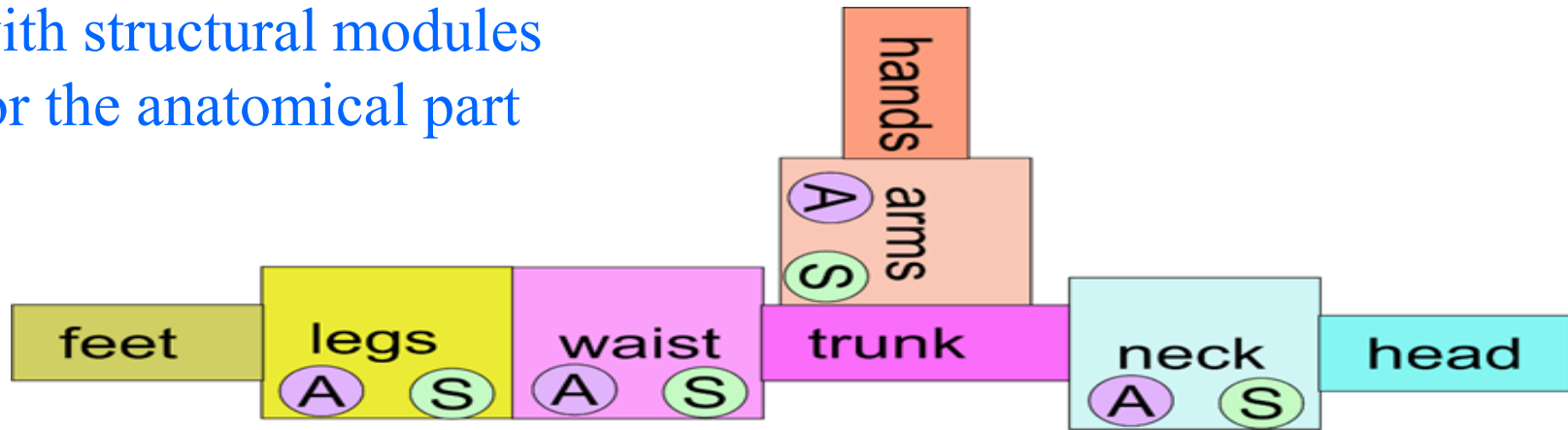


Fig. 1. A conceptual scheme for modular design of humanoids. (A is for actuator system; S is for sensing system).

LARMbot humanoid

for applications with non-high performance service tasks

and not in complicated environments

when suitable covers for a proper human-robot interaction

inspired by the human anatomy
in the musculoskeletal structure

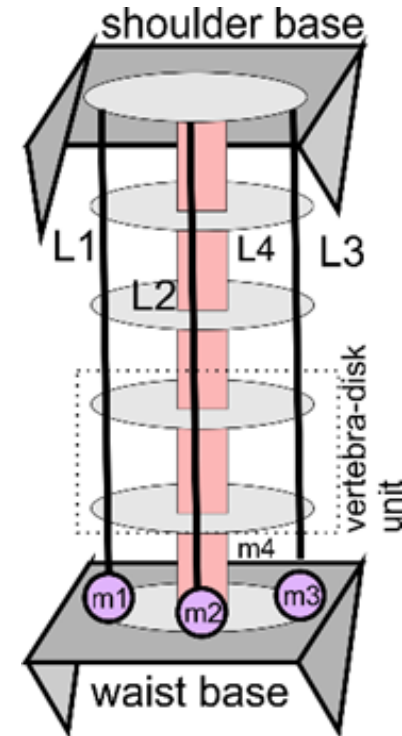
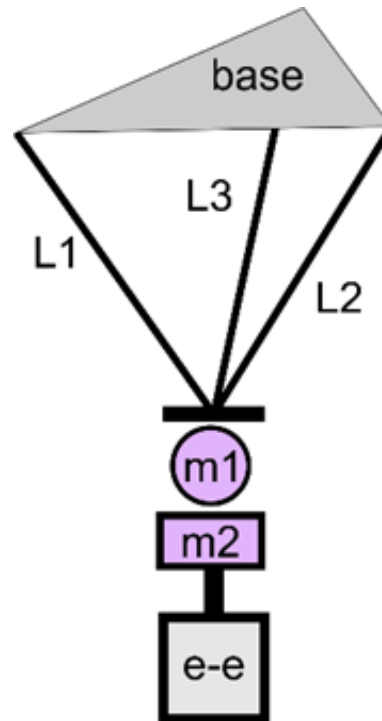
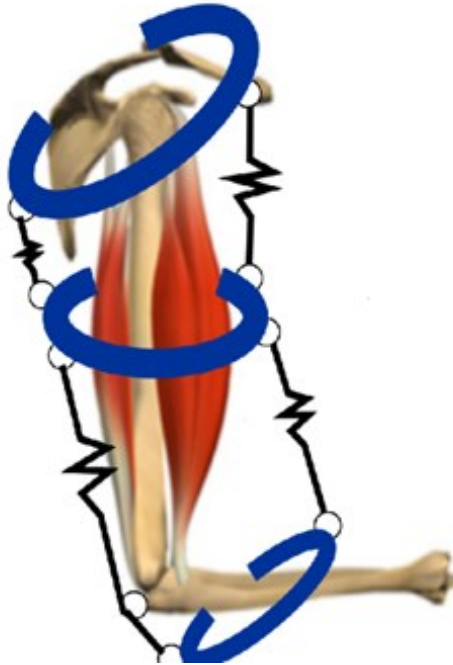


Fig. 2. Conceptual design for modular solution of LARMbot humanoid:

- a) a scheme of the inspiration from human anatomy, [10];
- b) module for legs, arms and neck-head;
- c) torso design with vertebra-disk units with cable actuation

3. LARMbot designs

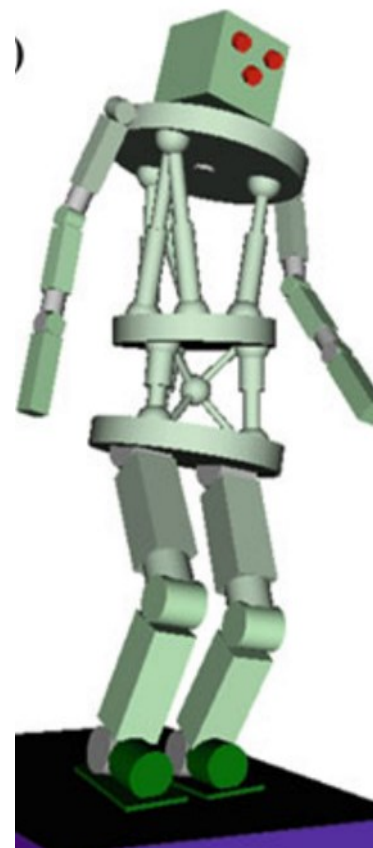
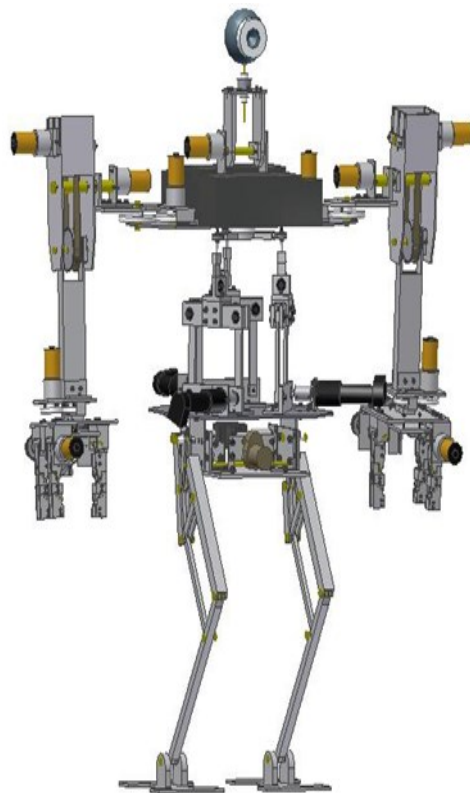
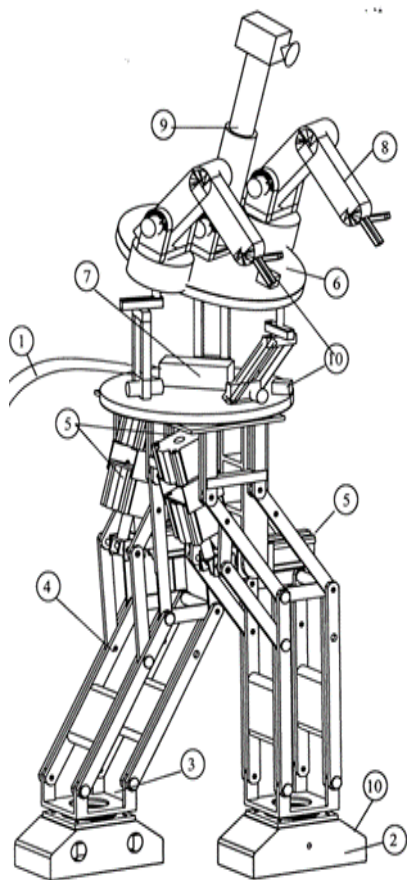


Fig. 3 Design solutions of LARM humanoid over time: a) early concept in **2001**, [12]; b) CAD design in **2006**, [13, 14]; c) waist-trunk based design in **2012**, [15]; d) locomotor-trunk based design in **2016**, [16-18].

attempt in 2010 with a different solution
inspired by particular situations in nature
such as that of the elderly or animals using their tails

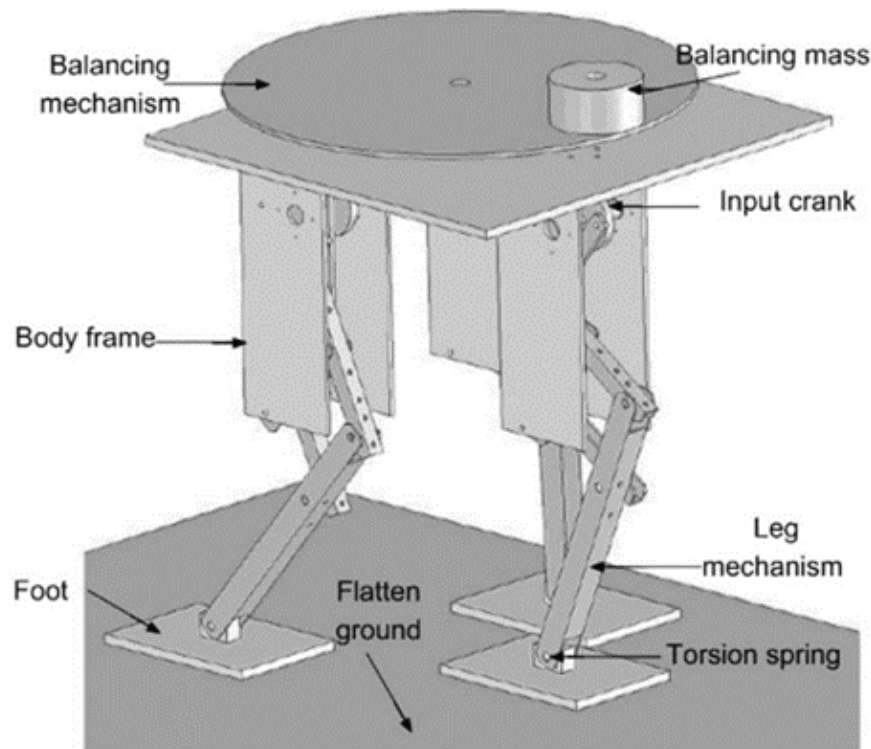
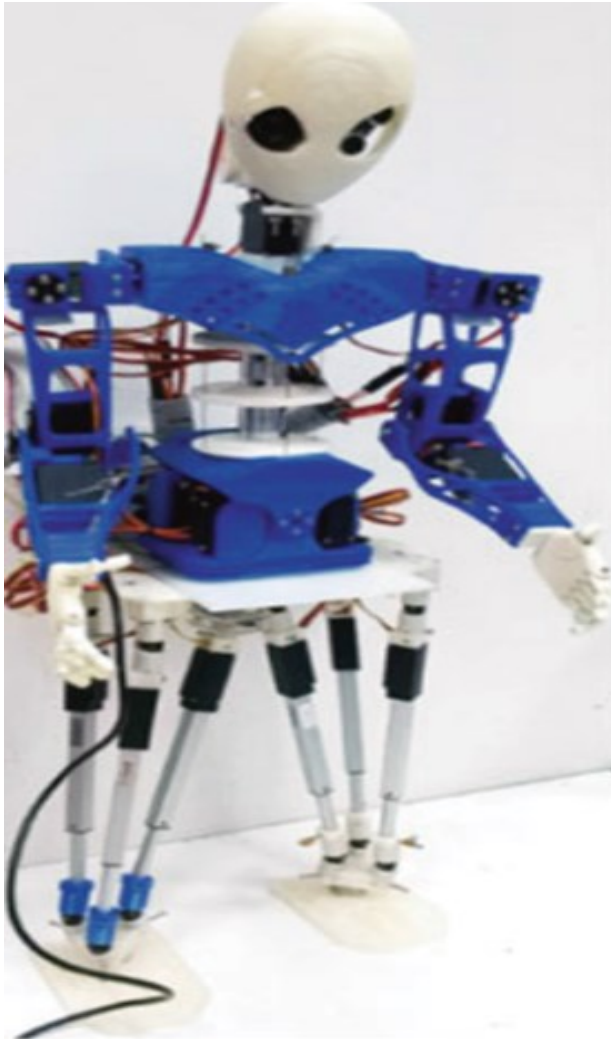


Fig. 4 A design solution for the leg module for LARMbot humanoid with three legs, [20].

4. LARMbot prototypes

starting from 2015



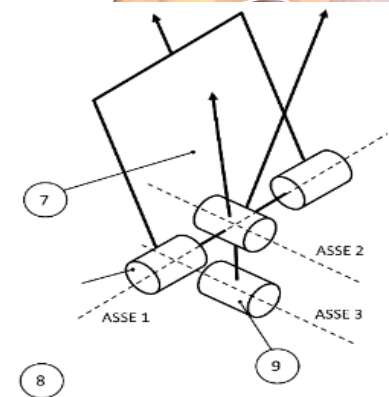
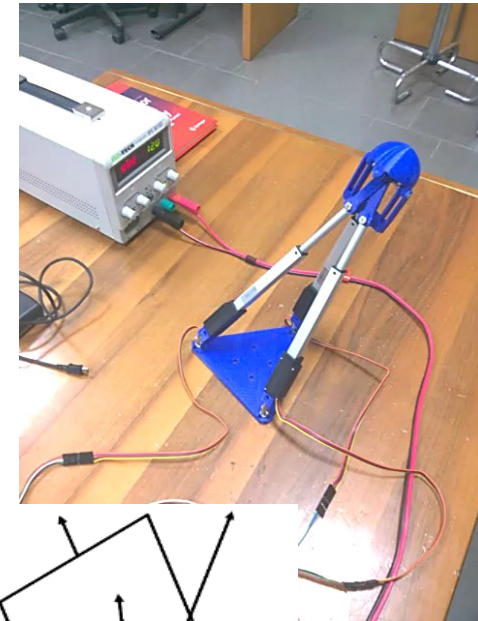
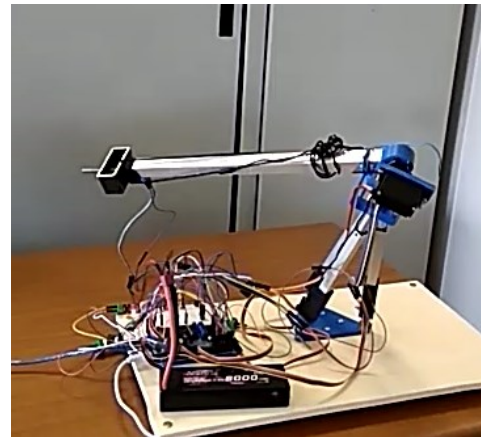
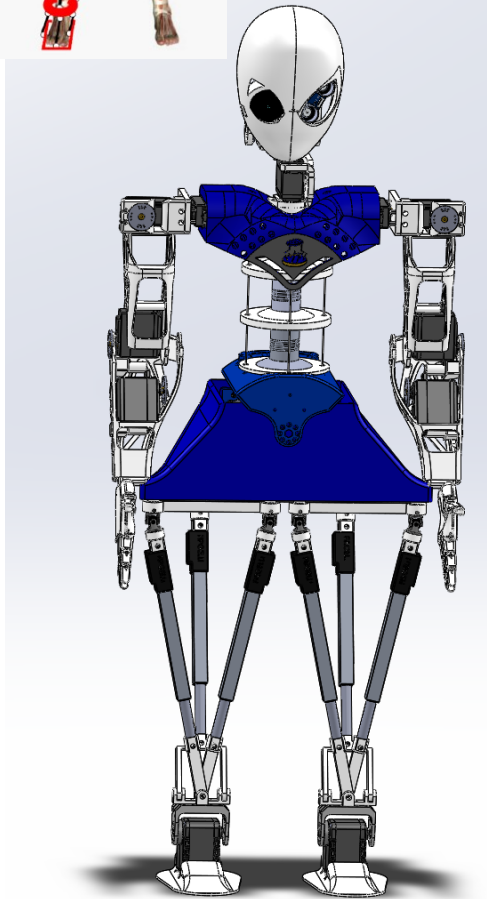
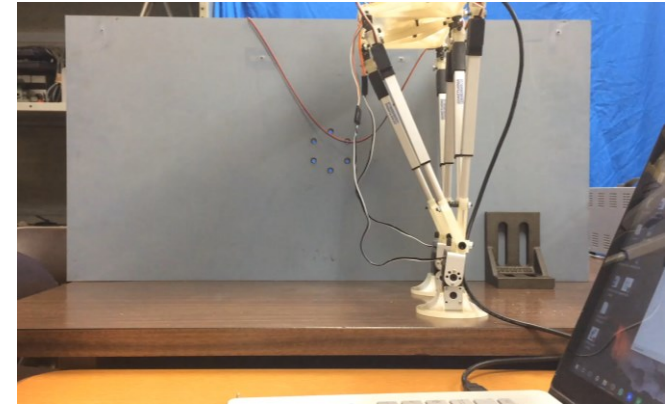
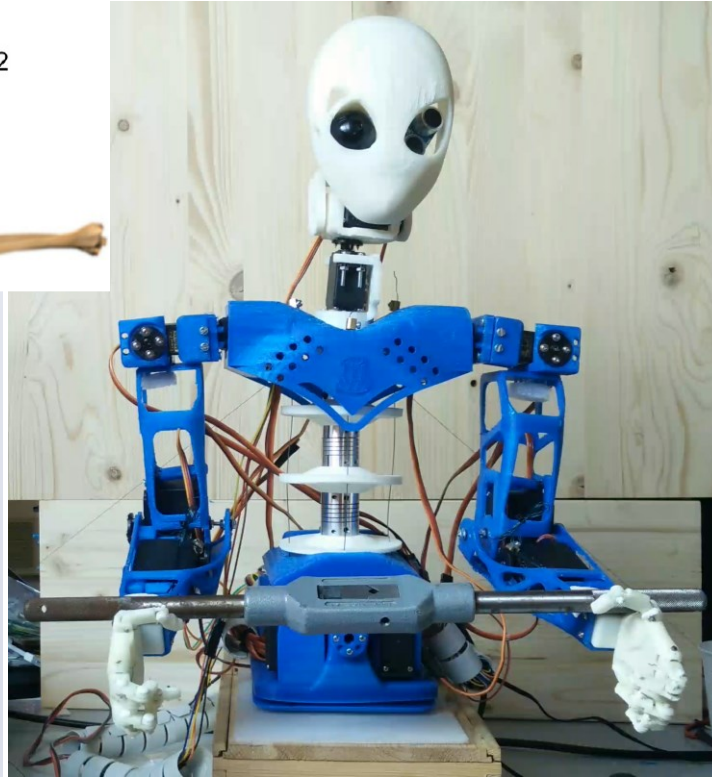
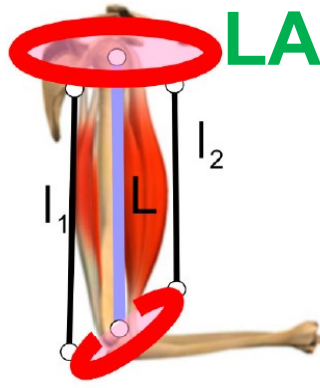
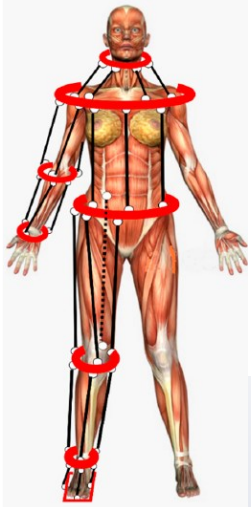
first complete prototype of the humanoid
of an overall size of about 80 cm tall and 40 cm width
with a weight of about 3 kg

no particular attention
to the structure and functionality of the arms
just with an anthropomorphic configuration

the tripod leg was not equipped with an ankle
no convergence of the three actuated links in a point
the mobile platform, which acts as a foot.

Fig. 5. The built prototype of LARMbot humanoid in 2016, [16-18].

LARMbot Humanoid



starting 2018

the leg structure
with an ankle joint
tripod new mechanism
convergence of 3 actuated links



the arm
with a tripod structure
common to leg structure

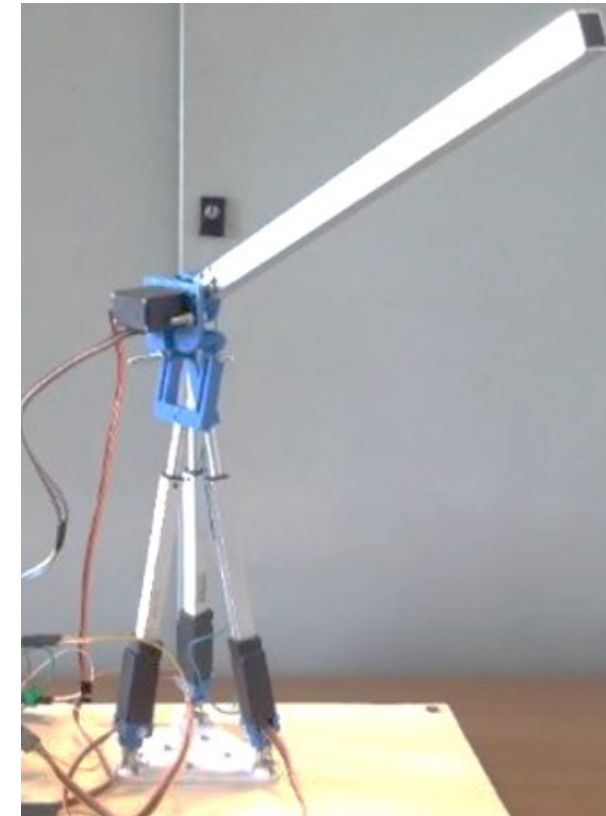


Fig. 6. Prototype modules for a new LARMbot Humanoid:
a) leg with ankle assisted foot,[21]; b) arm with elbow actuated joint, [22]

since 2020
attention also paid to the trunk

architecture with the disc-vertebra unit but
increasing the number of units up to six

Fig. 7. Prototype of the vertebra-disk unit
torso for a new LARMbot Humanoid, [23]



5. Towards new updates and novel solutions

careful consideration of the musculoskeletal human anatomy
in 2023 a revisitation of solutions

reinforced attention to parallel architectures
with muscular cables

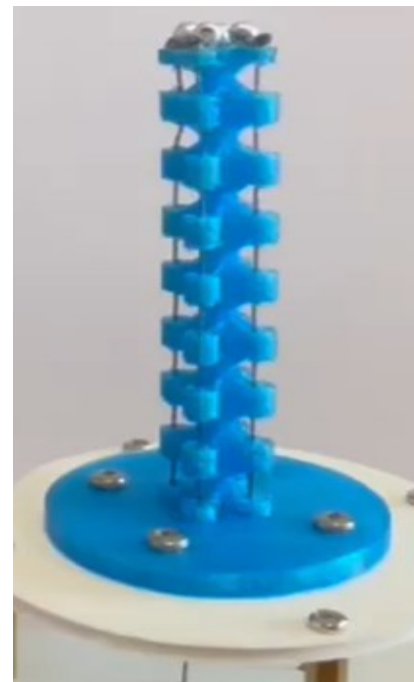
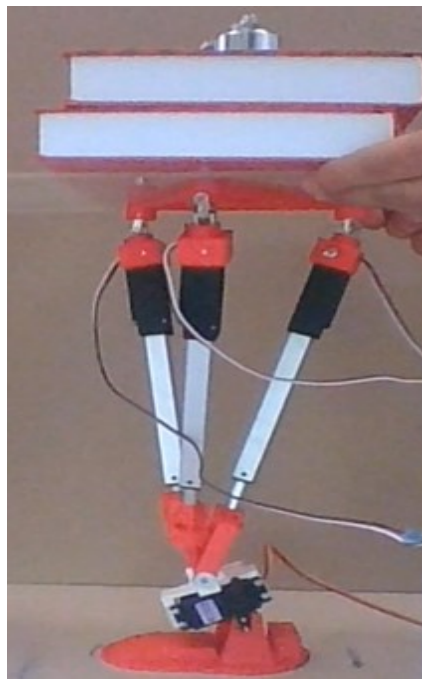
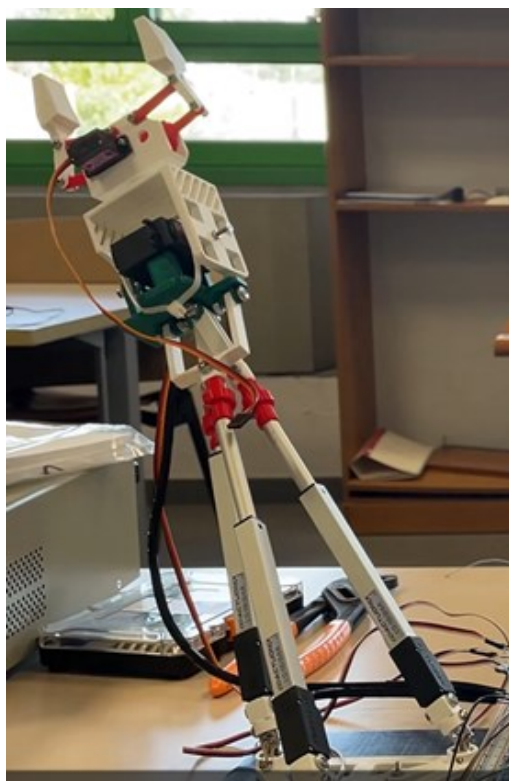


Fig. 6. Prototype modules for a new LARMbot Humanoid: a) tripod-based arm with wrist, [23]; b) tripod-based leg with ankle, [23]; c) torso design, [24].

4. Prototypes and lab test results

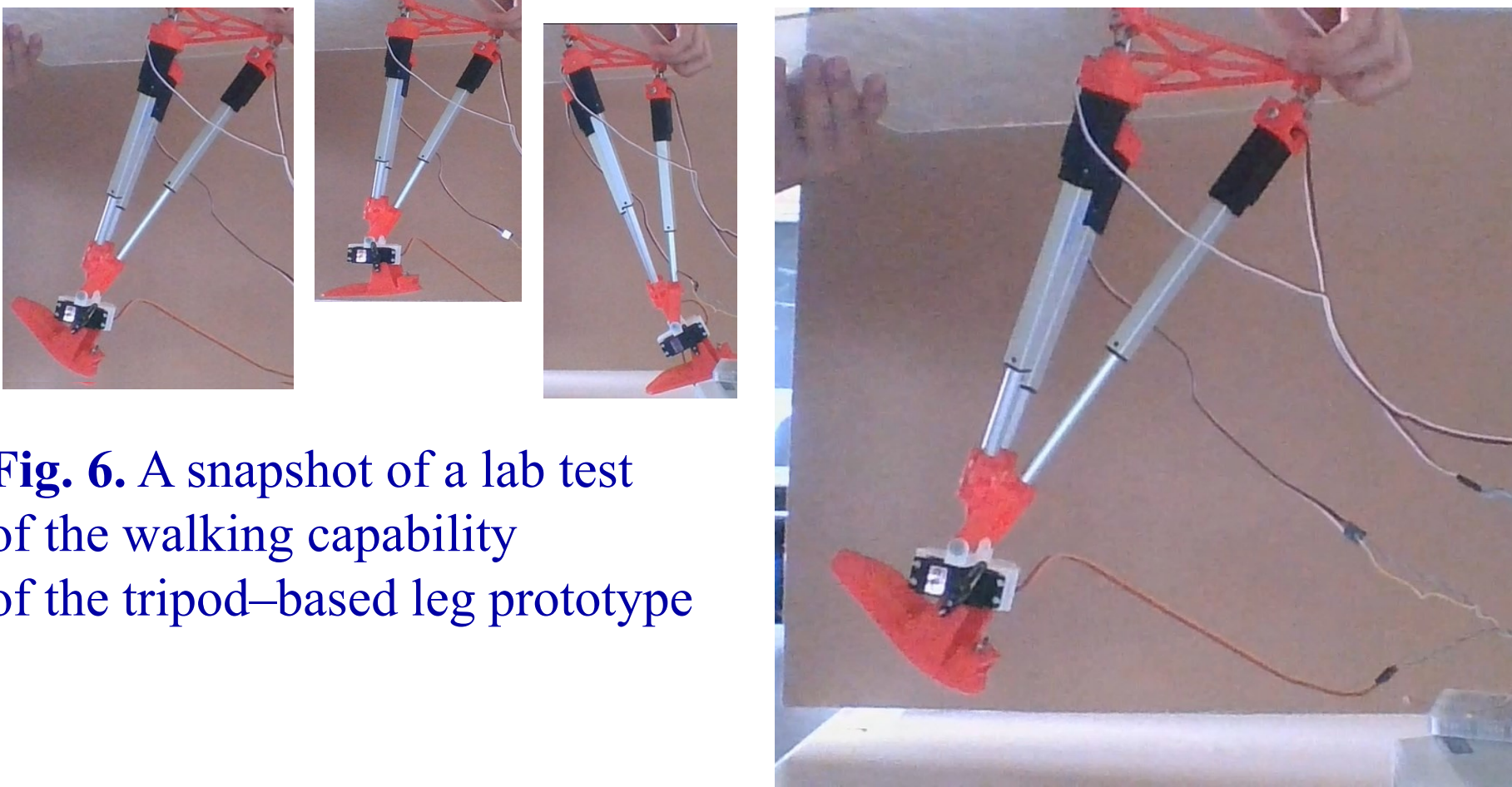


Fig. 6. A snapshot of a lab test of the walking capability of the tripod-based leg prototype

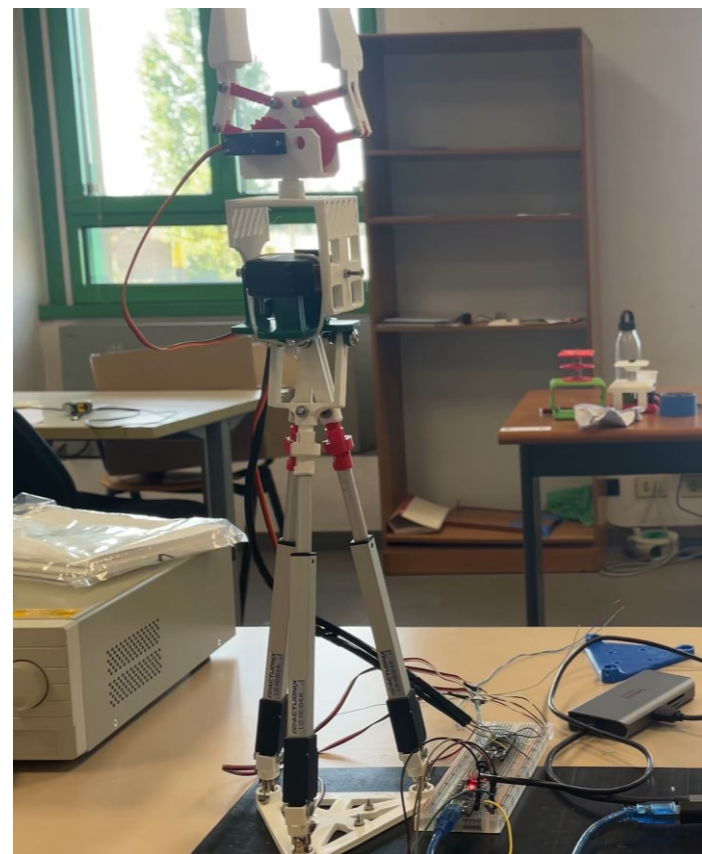
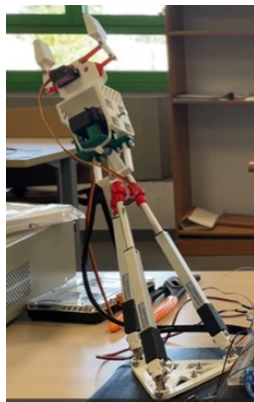


Fig. 7 A snapshot of a lab test of the manipulation capability of the tripod-based leg arm

Towards the future

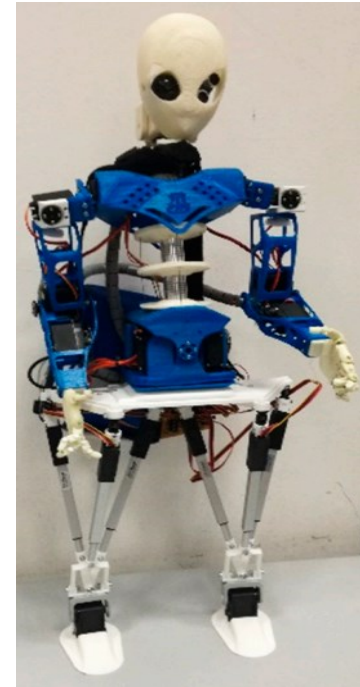
The 2023 solutions

high management complexity

low-cost for the humanoid even at less than 300 euros

in wide ranges of mobility of the limbs and torso

a high payload to be appr. 3 times the humanoid weight



a coordinated and synergistic assembly of new components

For a new laboratory prototype

As platform for investigating and testing the feasibility and performance of entire system as well as of the individual parts.

6. Conclusions

The development of the LARMbot humanoid robot
as its historical profile over twenty years
with the main characteristics of
low-cost, high load capacity, and user-friendly operation.

The initial modular characteristics
with structures developed for other specific applications
in subsequent versions

Inspiration from the human anatomy suggested parallel architecture:
**with an innovative tripod structure for the legs, and the arms
with trunk as serial-parallel structure with cable actuations**

