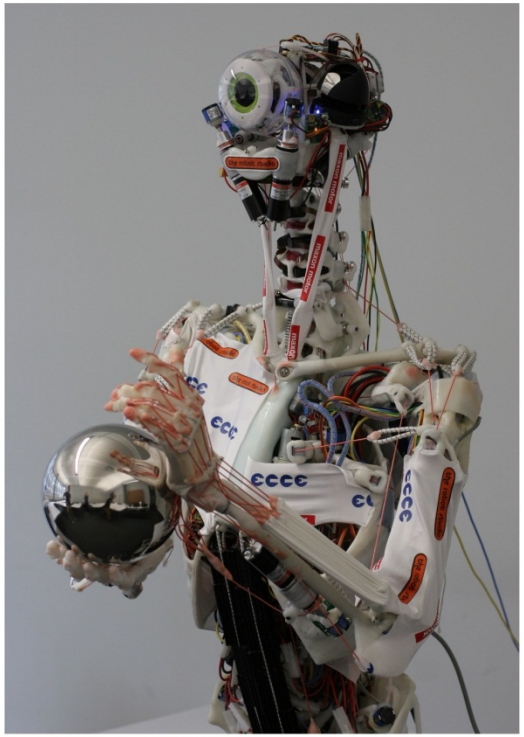
ECCEROBOT

Leader mondial de la robotique compliante & anthropomimetic



GDR Robotique
12 Décembre 2011

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The Robot Studio sarl - History

- Founded in 2008 in Divonne les Bains – 3 people.
- The Robot Studio is involved in Research and Development in the field of Robotics.
- The founder, Rob Knight, was a key member of the team at Essex University that produced “Cronos” which was the first, and also the most sophisticated, «compliant » robot in Europe.
- Compliance essentially provides non rigidity and replicates the advantages of the human structure.
- The objective is to progress research into compliant humanoid robotics, which are safe, power efficient and reproducible at a low cost.
- The compliant concept will revolutionise the exploitation of androids.

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ECCERobot Project

- Embodied Cognition in a Compliantly Engineered Robot
- Three year project 2008 – 2011
- Consortium of:
  - University of Sussex
  - University of Zurich
  - University of Munich
  - University of Belgrade
  - The Robot Studio
- Grant value 2.5 million Euros
- Three control strategies:
  - Classical control theory
  - Physics based internal models
  - Sensor-motor patterns
- Open project – maximum dissemination

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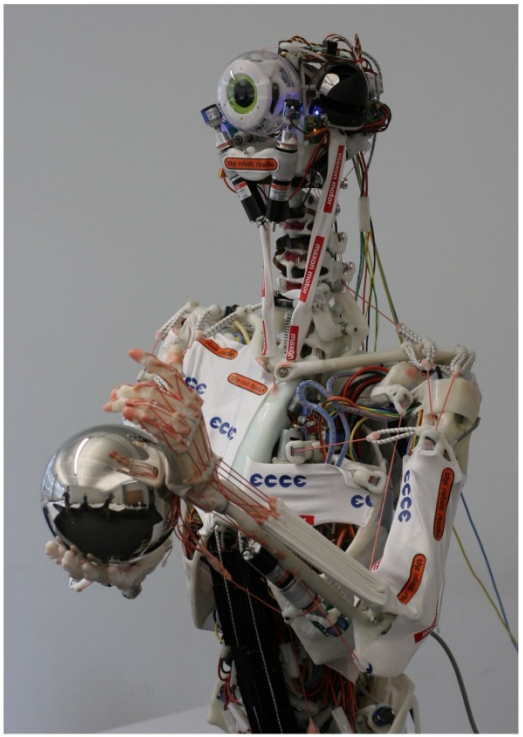
The Hardware

- Hand-built using Polymorph.
- Tendons are made of “Spectra- Kite Line”.
- Compliance provided by ultra-low compression set polyurethane.
- Muscles are DC brushed motors:
  - Cordless screw-drivers – cheap, noisy, poor control
  - MAXON servo – excellent, lot more expensive
- Teflon linings to reduce friction
- Sensors:
  - Motor position potentiometer
  - Motor position encoder
  - Motor force
  - Joint angle
  - Inertial Measurement Units (future)

The Robot



Scripted

Babbling

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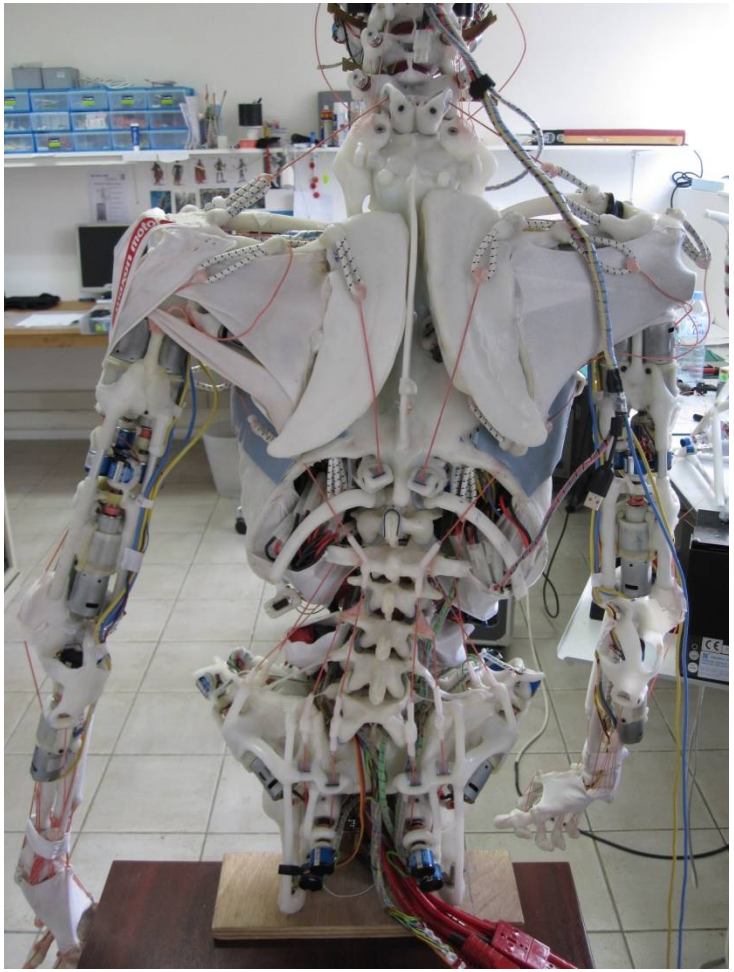
MAXON Motors

- Vastly superior power to volume, power density & precision - vastly more expensive
- Small size in hand & neck
- Medium size used in shoulders, arms and spine
- Large size used in legs
- Considerably more powerful - robot may now be capable of destroying itself – a control consideration
- Very low back torque - active postural control required

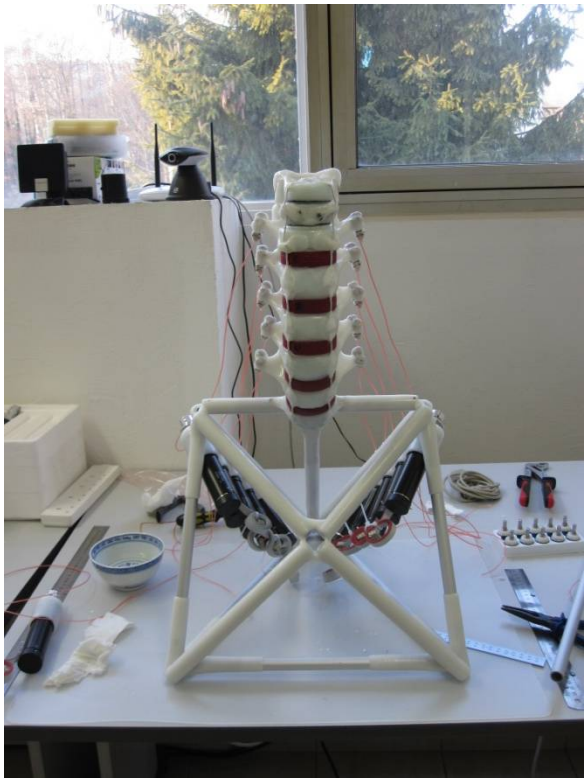
Fatigue Modes - Scoliosis

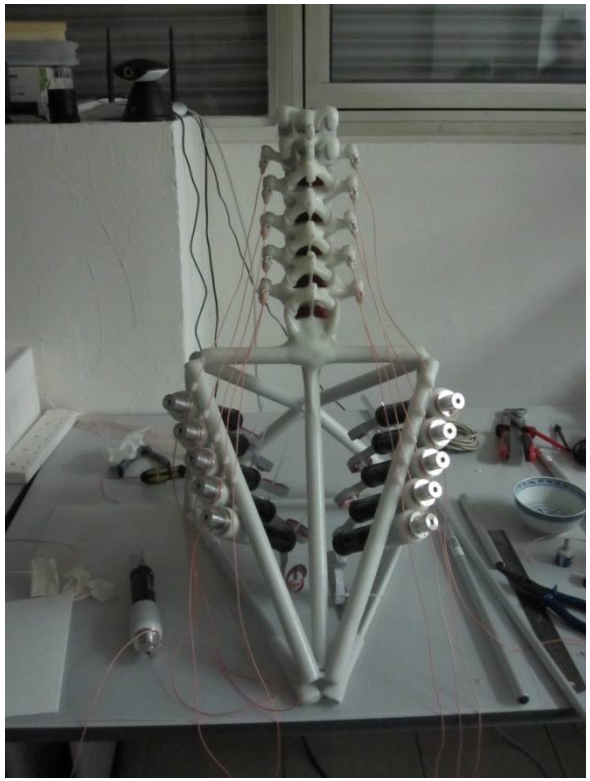
- Pronounced curvature in lumbar spine
- No definite agreed medical cause
- Probably misalignment of vertebrae leading to shifting of soft centre in the robot
- Correctable with extra motors



Assembly Precision

- Pelvis set up as a triangulated framework - more space for motors to allow full control of lumbar spine



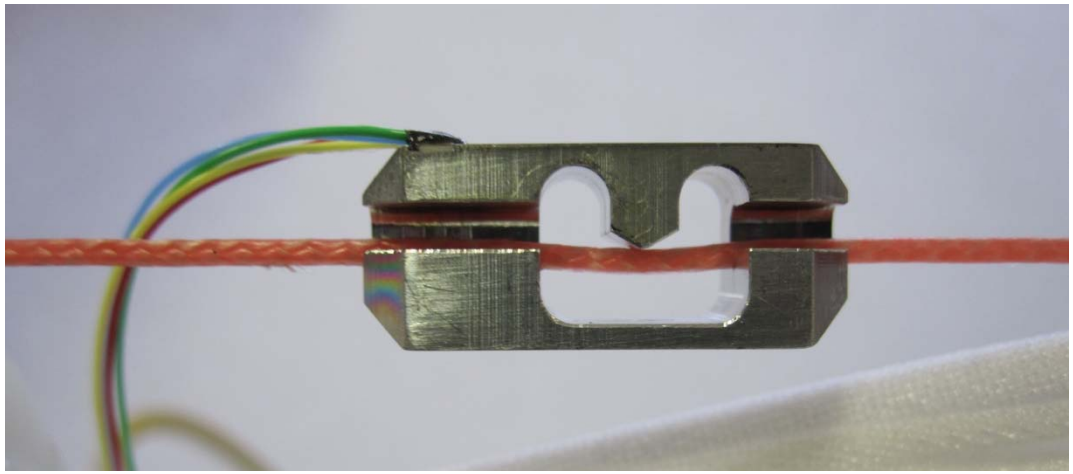


Standard Sensors

- Key sensors are:
  - Tension or force sensor for each actuated tendon
  - General purpose positional sensor for complex joints i.e. everything other than the elbow
- Force sensor - Industrial load cells
  - Minimum diameter ½”
  - Very expensive - approx €600
  - Requires a cut in tendon
  - Likely to foul
- Magnetopots considered for positional sensor
  - Good life
  - Too large

Custom Sensors

- Tendon sensor custom-designed



- Very small
- Cheaper
- Can easily be repositioned
- Will slide instead of foul

Fatigue Modes – Lumbar Spine

- Intervertebral discs:
  - Compress over the course of the day - causes change in posture
  - Have not herniated yet - lie the robot down at night to improve life - allows discs to recover shape
- Intervertebral joints:
  - Experience much higher loads than anticipated- improved bonding technique for PTFE pads

Other Fatigue Modes

Shoulder dislocation:

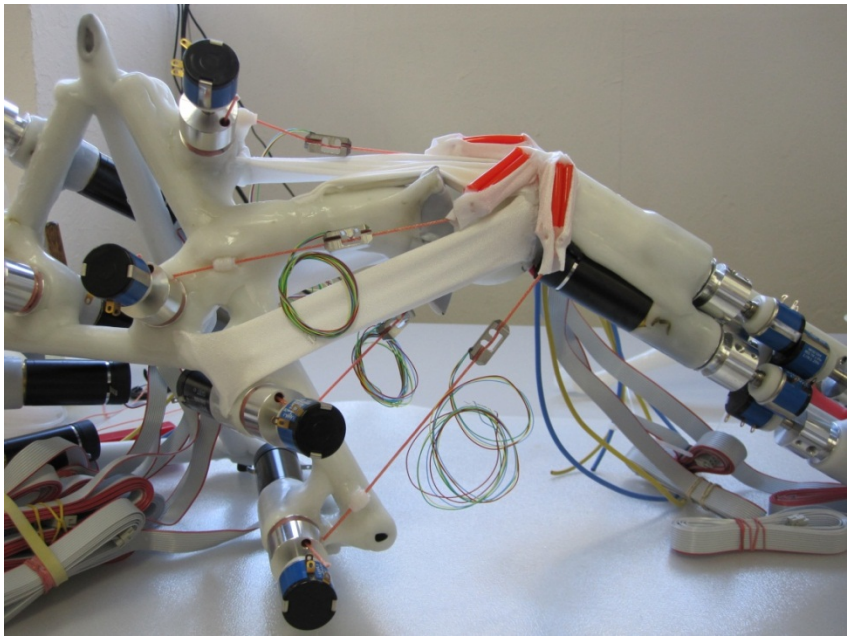
- Occurred originally due to control errors
- Getting progressively more frequent
  - Changing characteristic of joint surfaces due to contamination
  - Stabilising fabrics stretched
- Correctable in ECCE2 with better control and extra motors

Damaged motor cables:

- By pinching in joints:
  - Force control to maintain tension
- By shock loading
  - All tendons elastically terminated

Hardware Platform Manufacture

- Need to develop CAD 3D scanning and CAD printing to achieve semi-automation of the production.
- We approached all CAD companies close to Divonne – only one company would even agree to meet us – estimated the production of a CAD model at 2 man-years.
- The problem is “The body is not an engineered design”
- CAD is designed for rigid, engineered shapes, not tendons, elastomers or fabrics
- Complexity is unavoidable - many processes, lots of operations – need to focus on simplifying each operation and finding better materials.
- Manufacturing time currently 6 months per unit.
- Main function is as an integration test bed for hardware electronics and software.



Arm Elements

- Commercialise an arm element for R&D
- 15 active degrees of freedom – thumb & 2 fingers
- Optional fully dextrous hand – additional 15 degrees of freedom
- Identify manufacturing partners

Arm

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Full Android

- This is the next major project
- Currently looking for funding and partners
- Probably 2-3 year time-scale

Thank You

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