

# Herbert

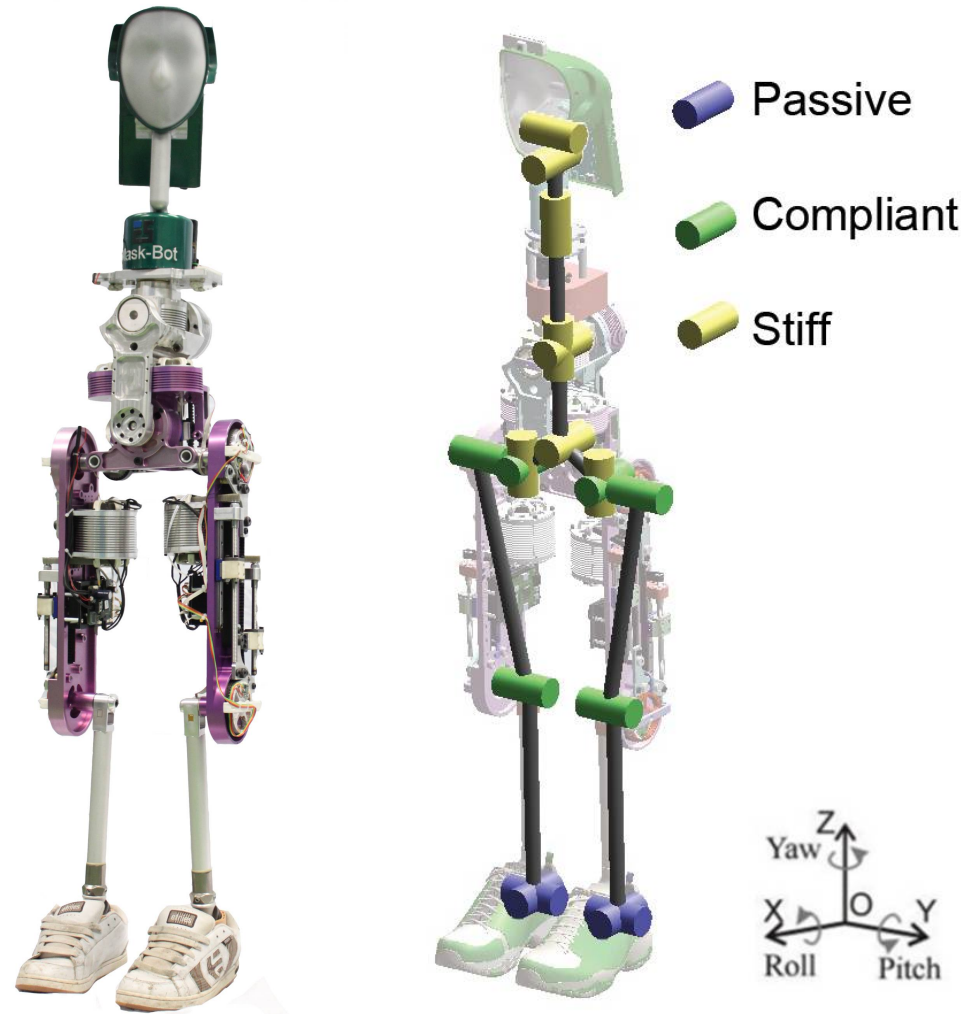
**Brennan Pierce and Gordon Cheng**

Institute for Cognitive Systems

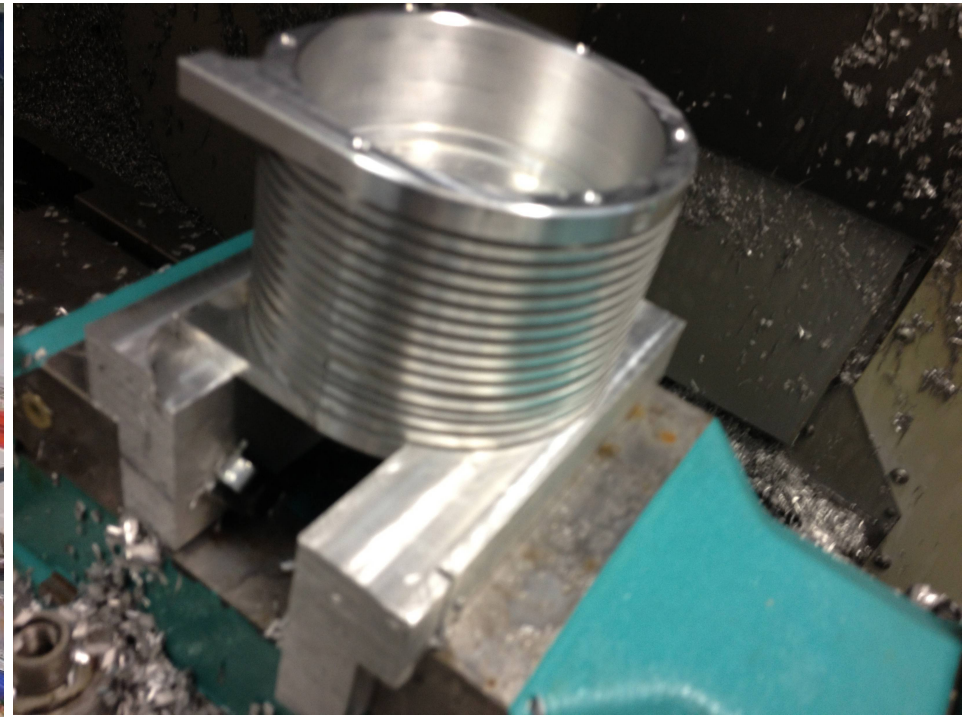
Technische Universität München

# Herbert Overview

- 14 Active DoF
  - 2 x 1 Knee
  - 2 x 3 Hips
  - 3 Waist
  - 3 Head
  
- 21.6kg
- 1.59 meters
- €21k – excluding Labour
- Rear Projected Head

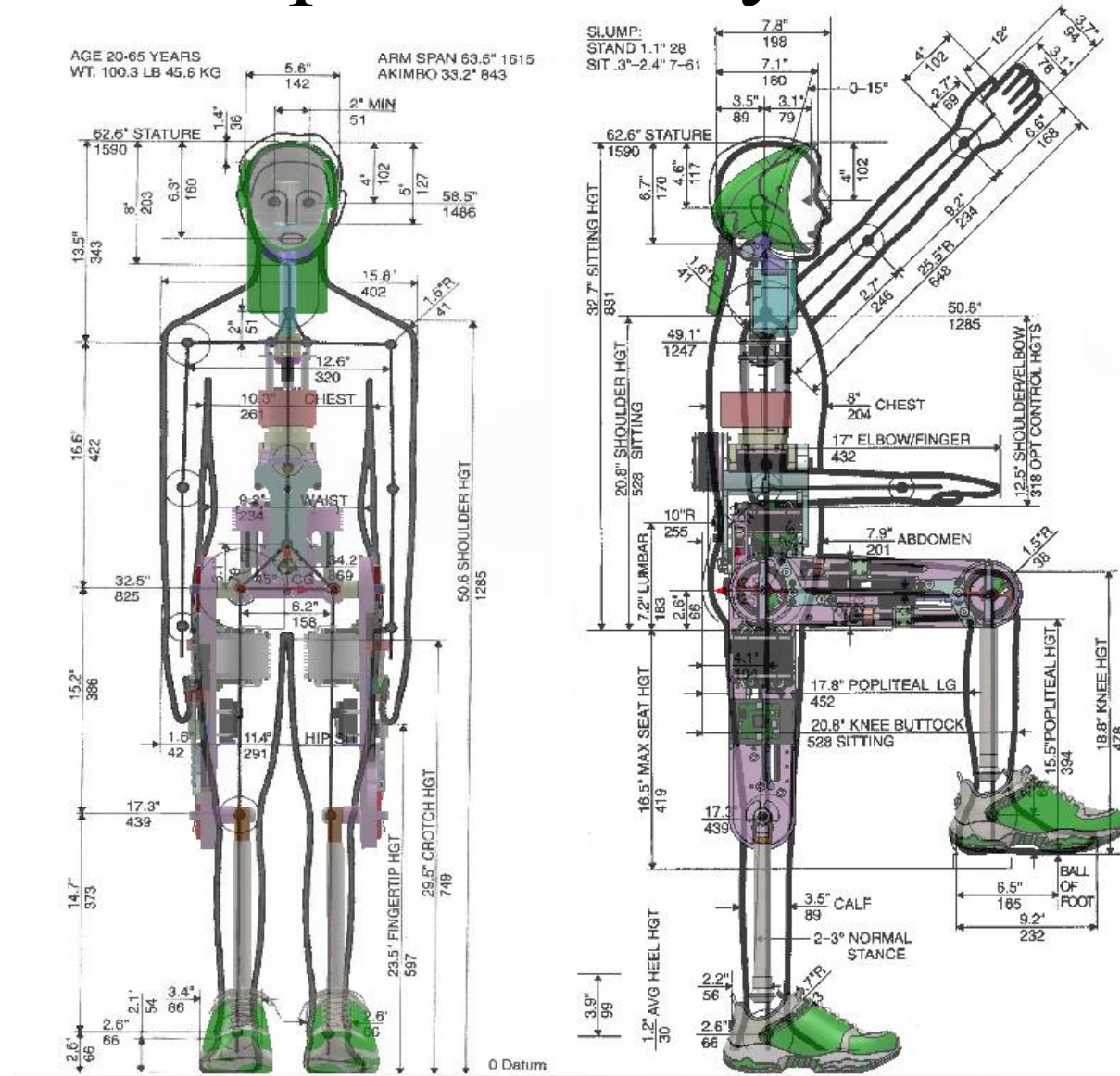


# Keep It Simple



Custom Parts < 200

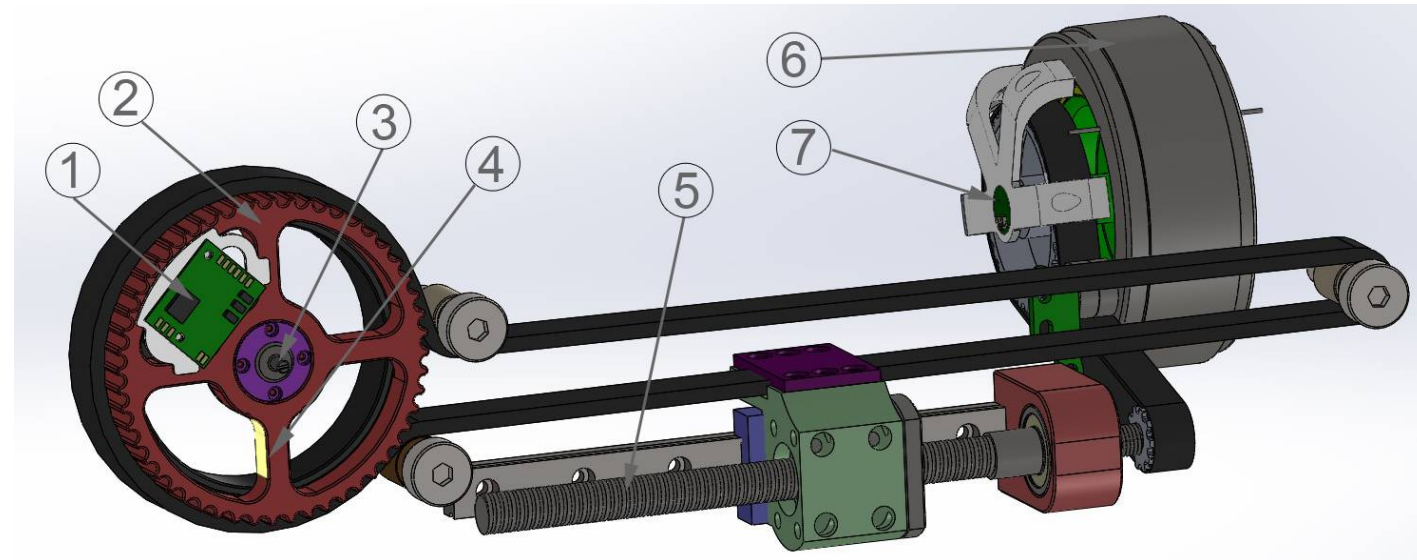
# Anthropometrically Correct



# Compliant Module

## Pro

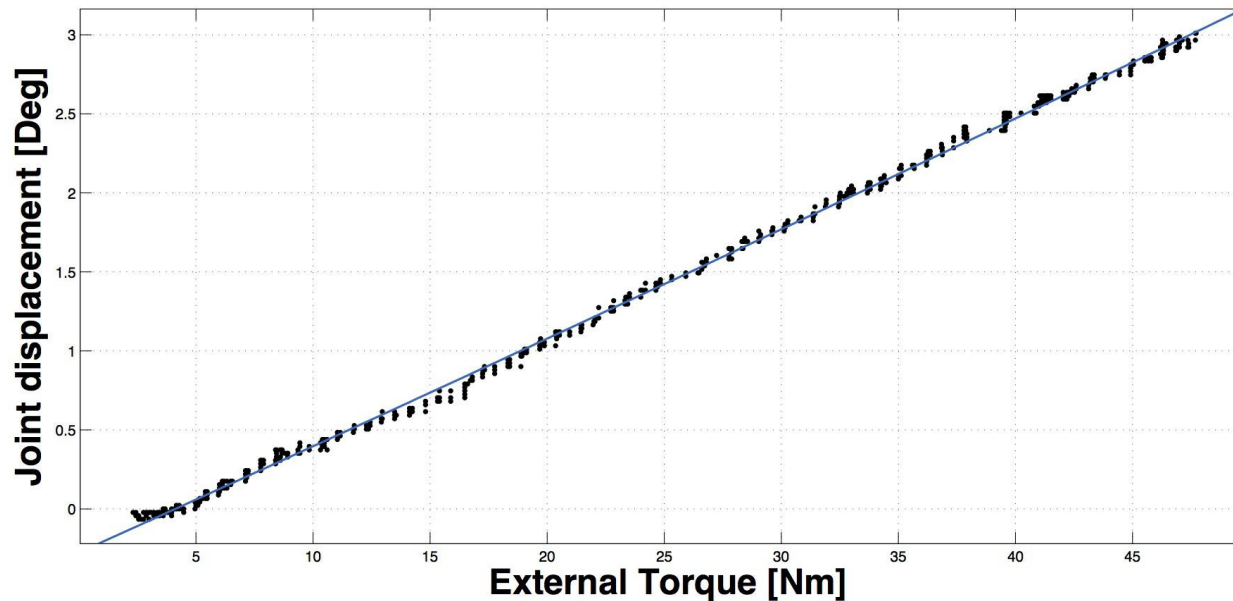
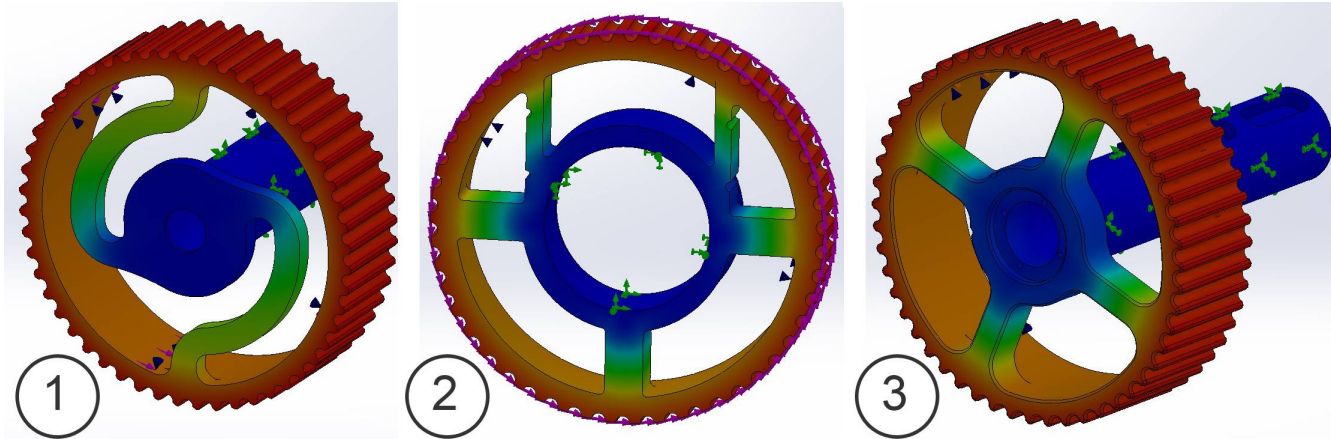
- Compliant
- Back Drivable
- Low Gear Ratio



## Con

- None Compact
- Joint Range = Size

# Compliant Module



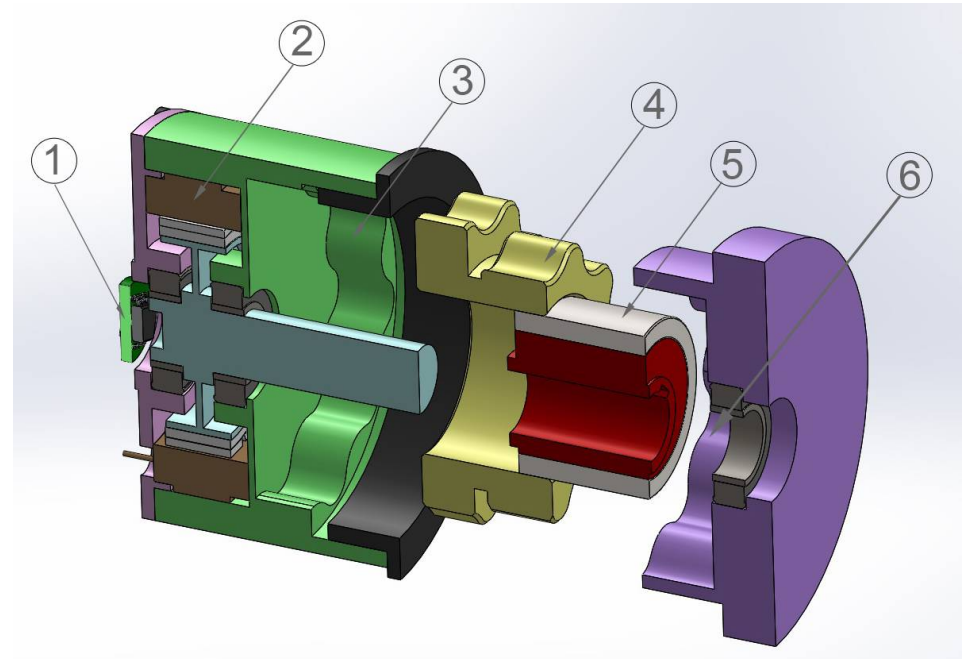
# Compact Module

Pro

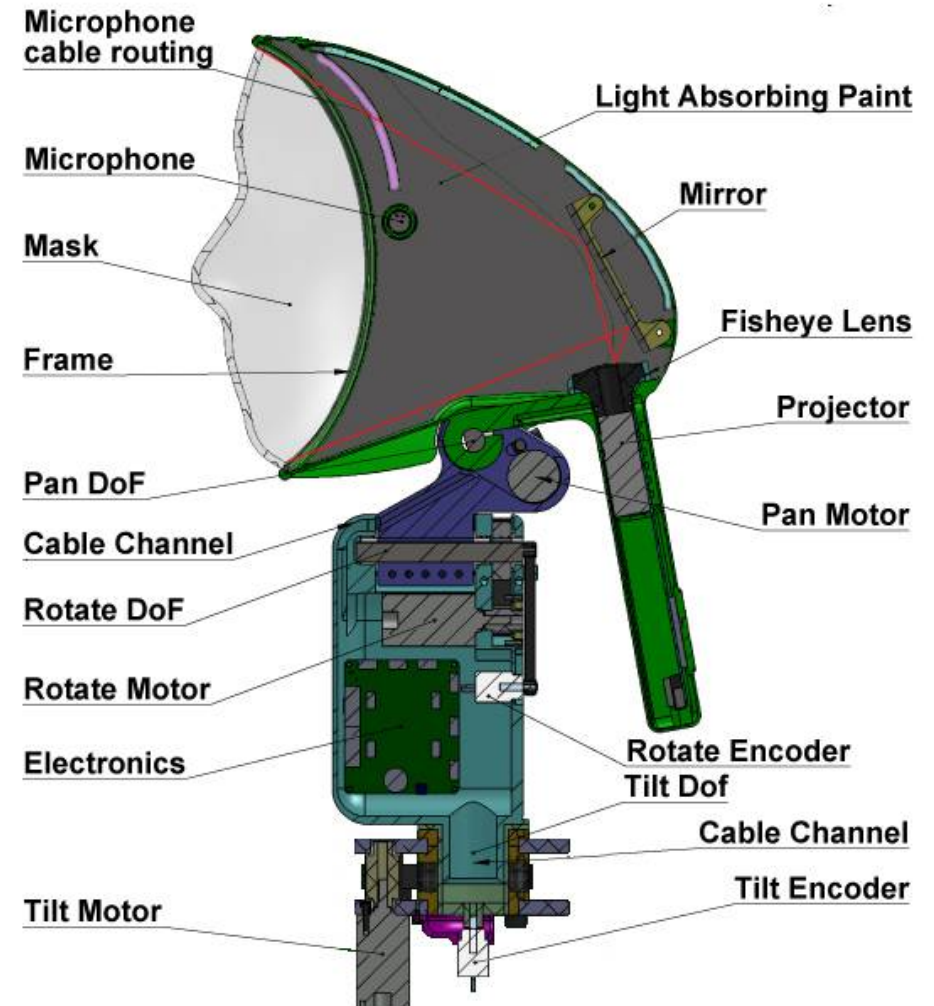
- Low Cost ~ €30 + Motor
- Compact
- Strong >150Nm

Con

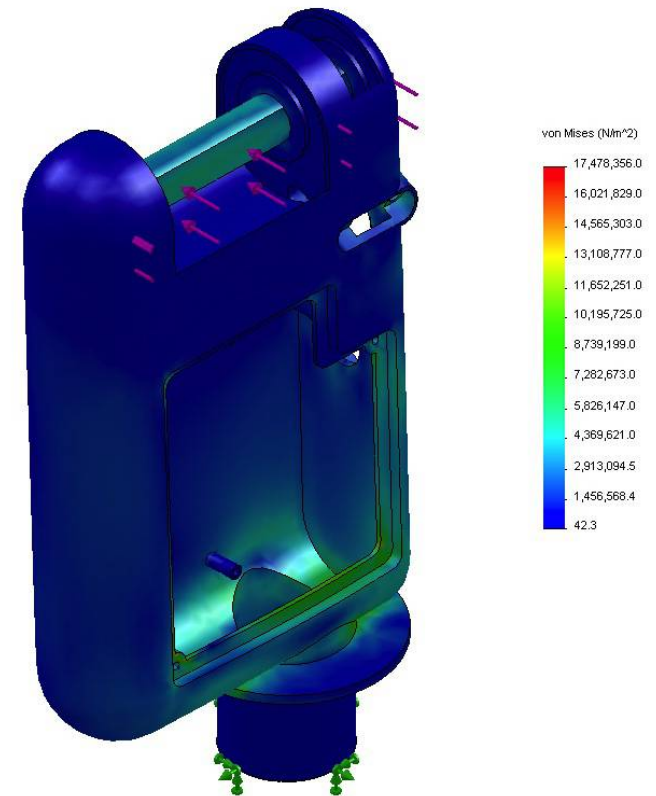
- Backlash



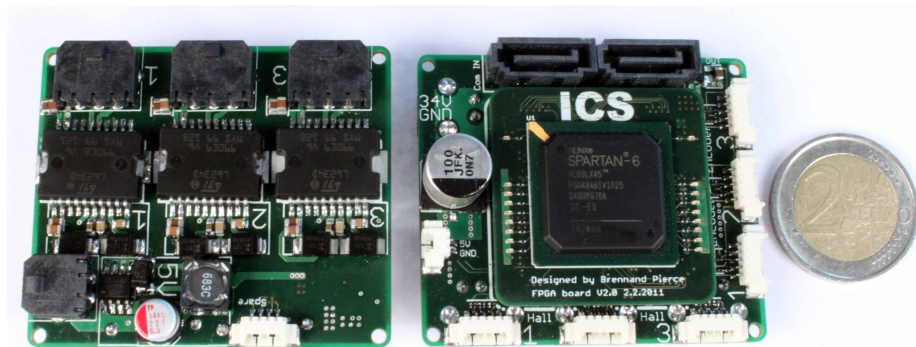
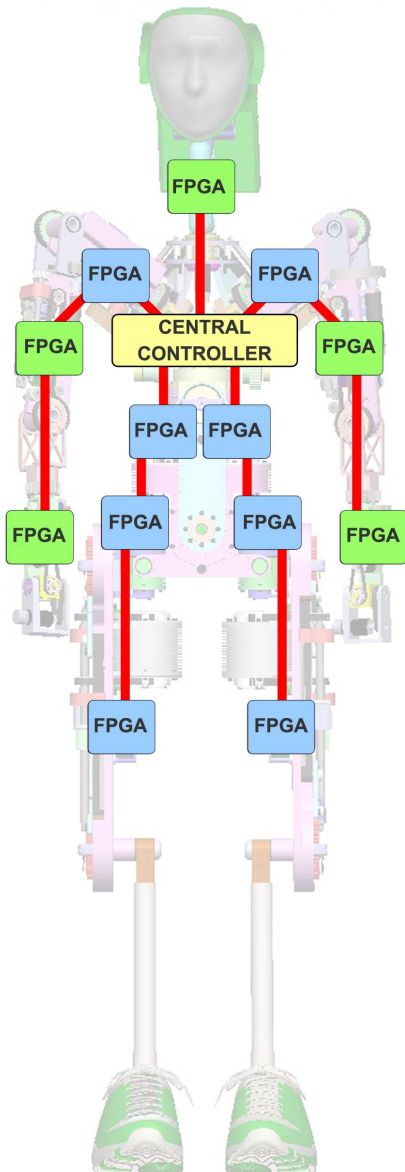
# Head



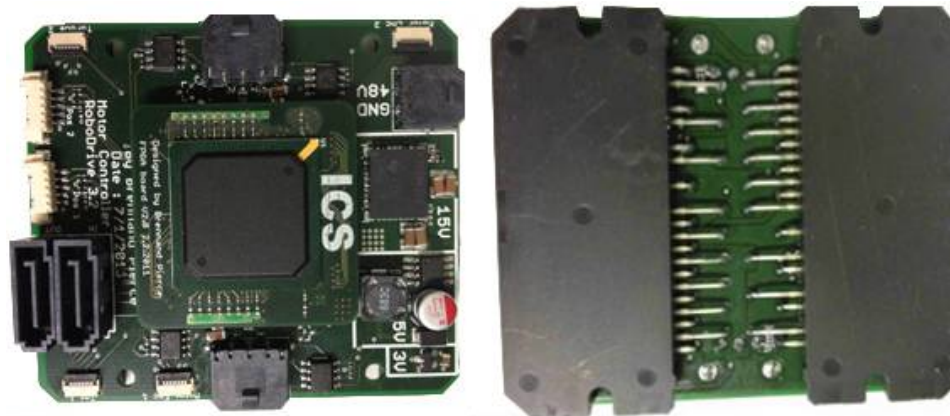
# Head



# Electronics

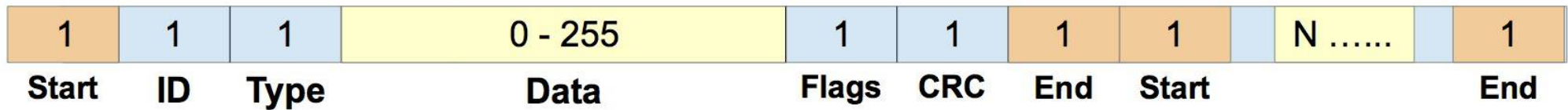
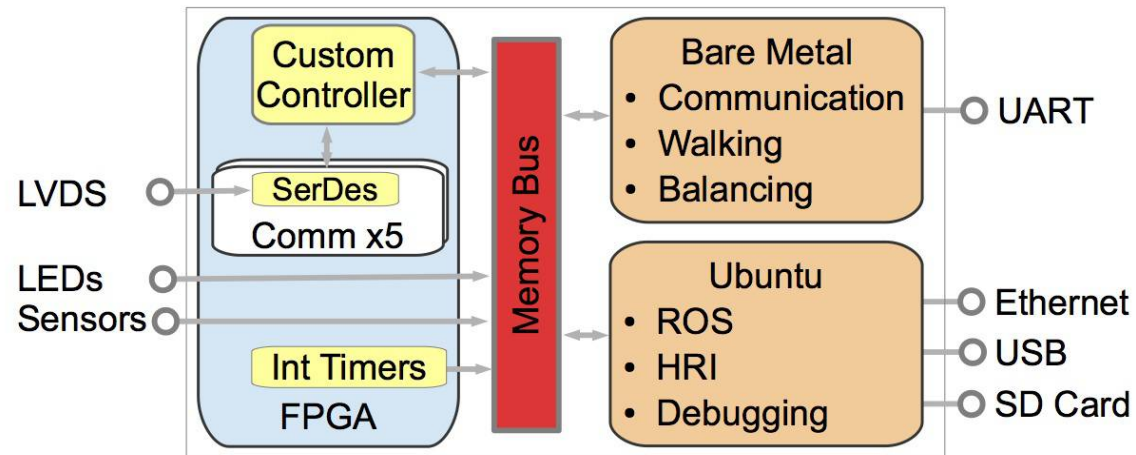
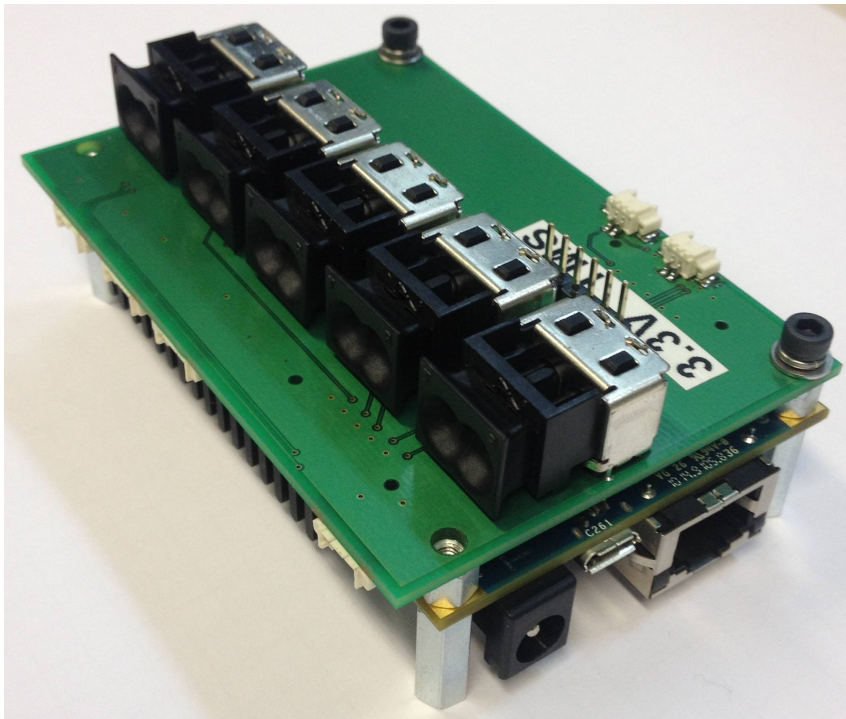


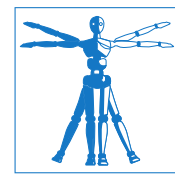
- 3 x 5A
- 3 x Hall
- 3 x Joint Encoder 15bit
- 3 x Torque sensor
- 2 x 200Mb/s Com.
- 71.0mm x 48.0mm



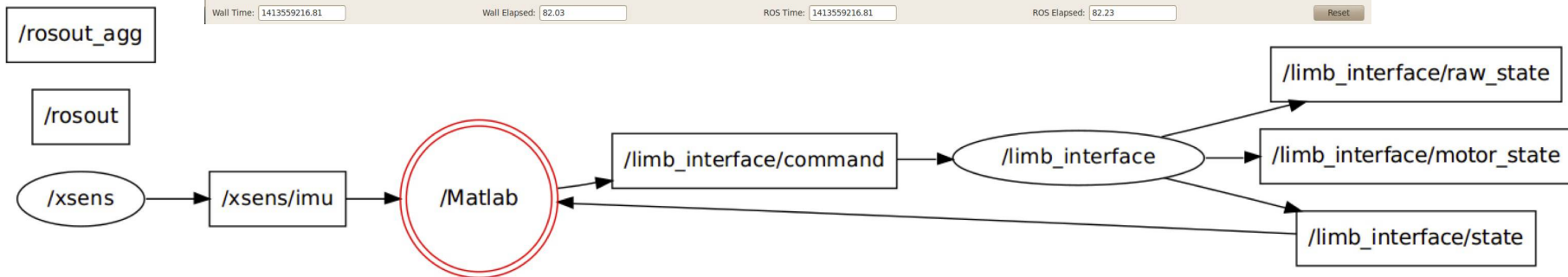
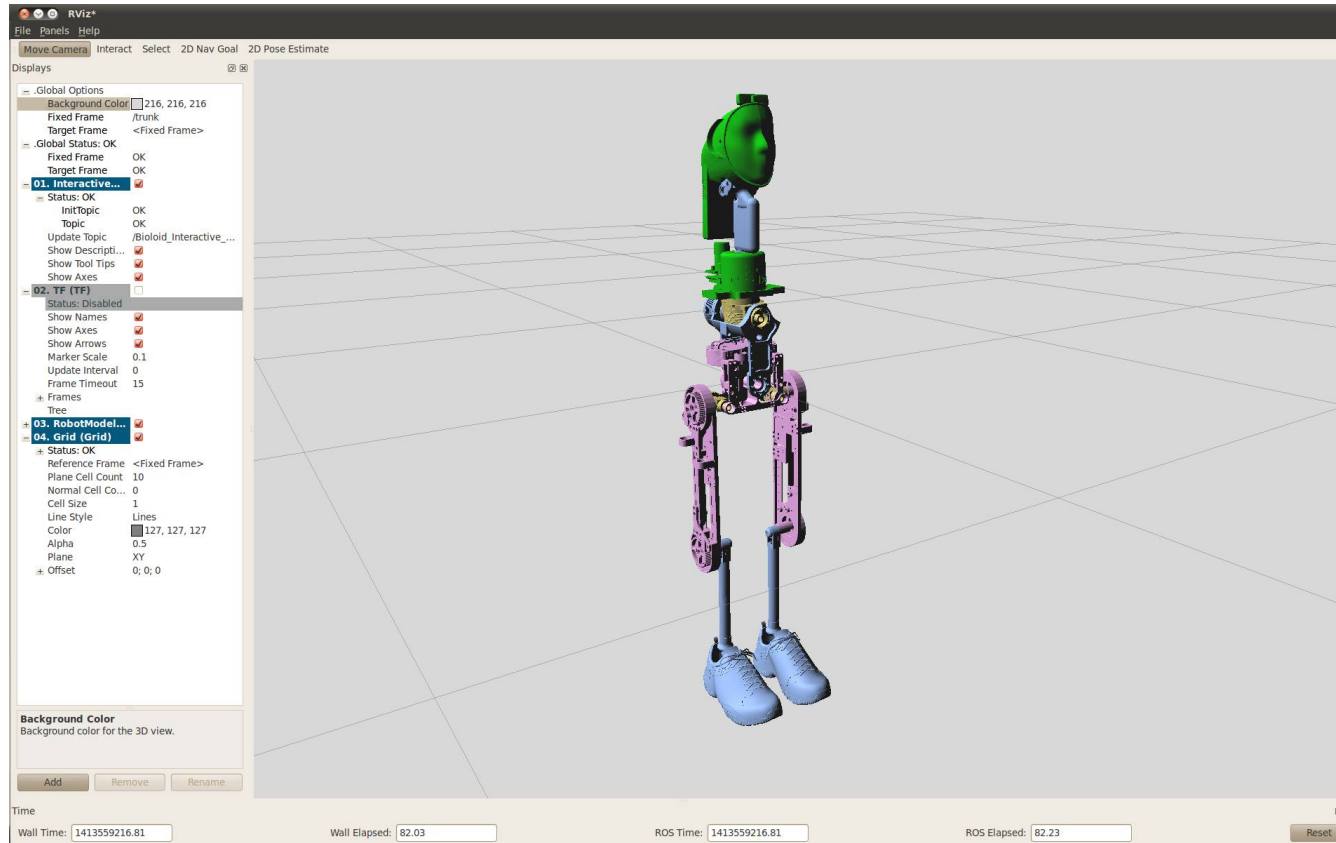
- 2 x 20A
- 2 x Motor Encoder 14bit
- 2 x Joint Encoder 15bit
- 2 x Torque sensor
- 2 x 200Mb/s Com.
- 68.0mm x 60.0mm

# Electronics



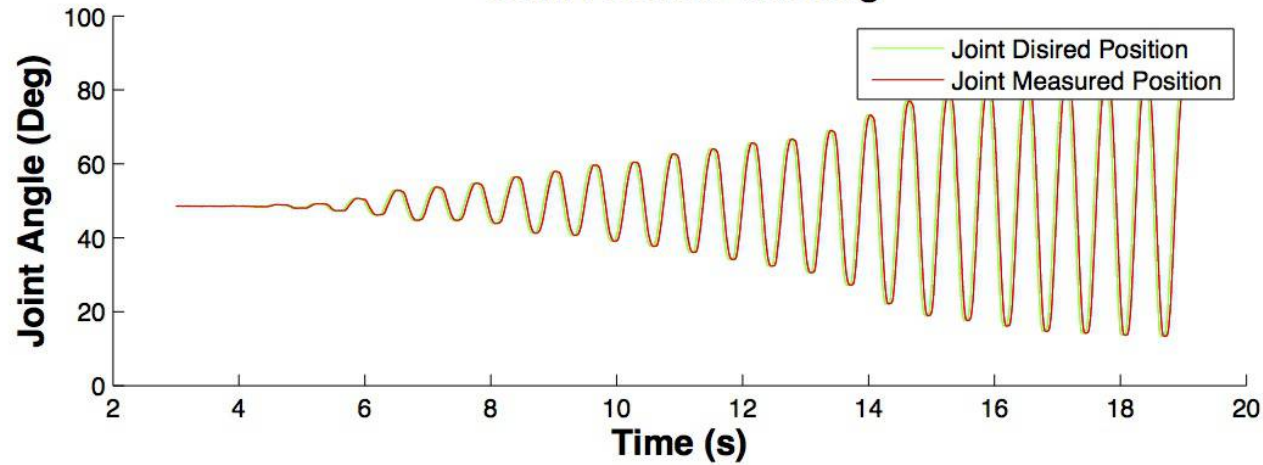


# ROS

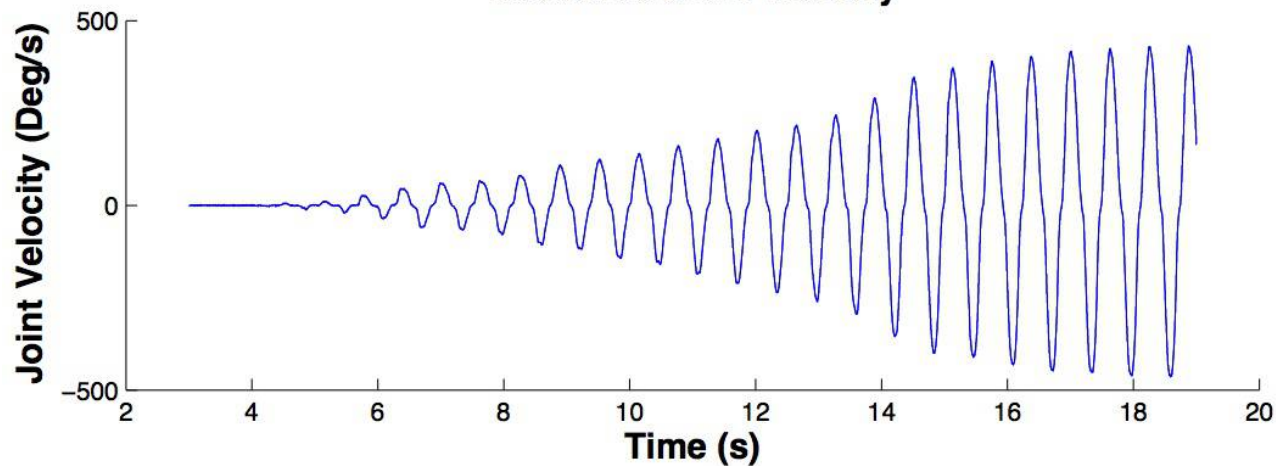


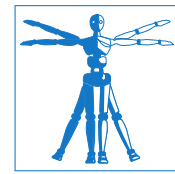
# Speed - 462.8 deg/s

**Joint Position Tracking**



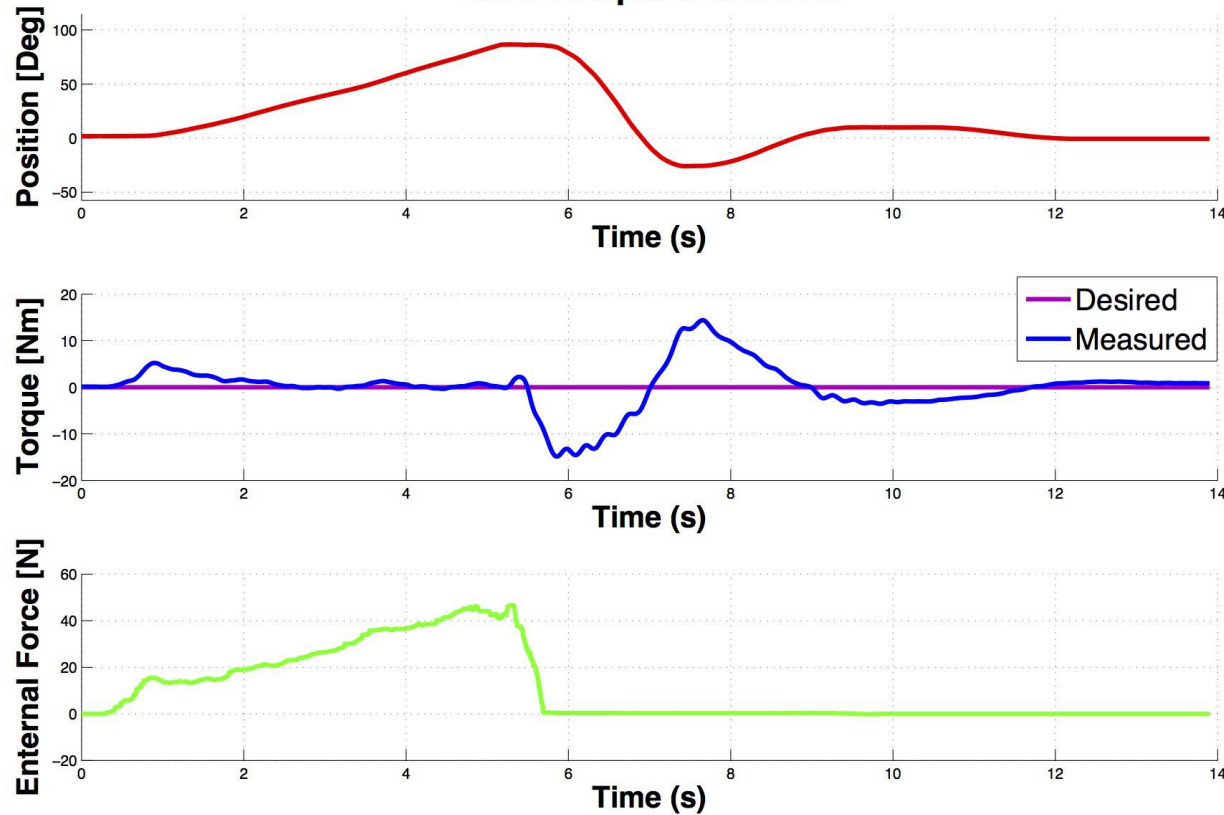
**Measured Joint Velocity**

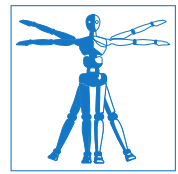




# Torque Control

Zero Torque Controller

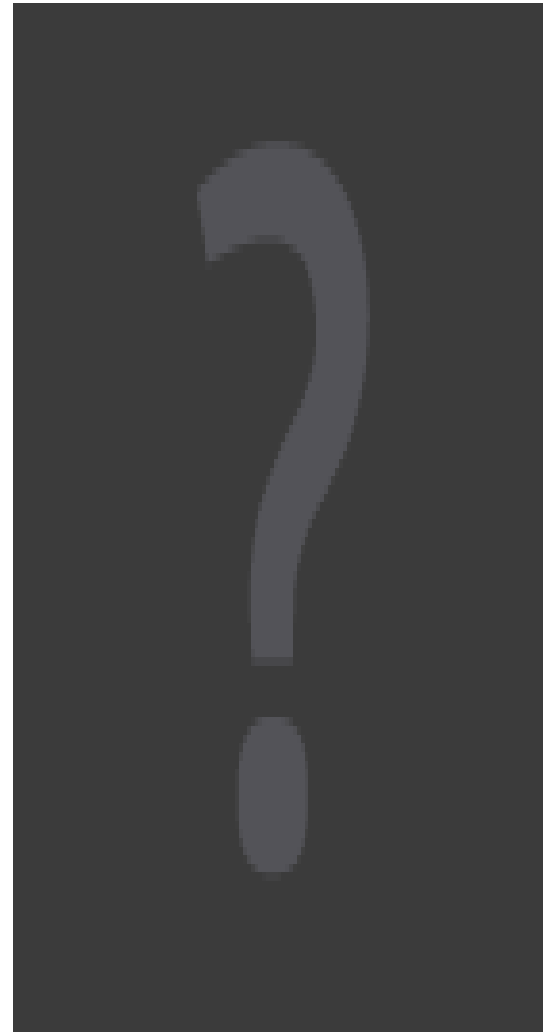




# Squatting



# Balancing



# Summary

- Conclusion
  - Low Cost
  - Light weight
  - Mechanical Compliant joints
  - Anthropometrically correct
  - Torque control
  
- Future Work
  - Adding Upper Body
  - Walking

