



The European Coordination Hub for Open Robotics Development

MODUL

Modular Drive Units for Legged Locomotion

ETH zürich ETH Zurich, Switzerland



CDD M.E.P.E., Greece

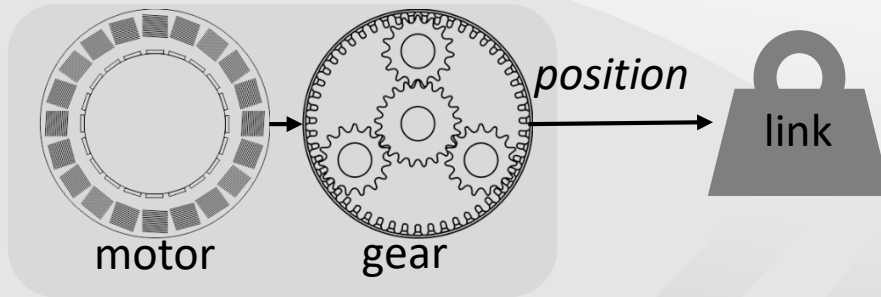
Marco Hutter, ETH Zurich

Luxemburg / 13.2.2017

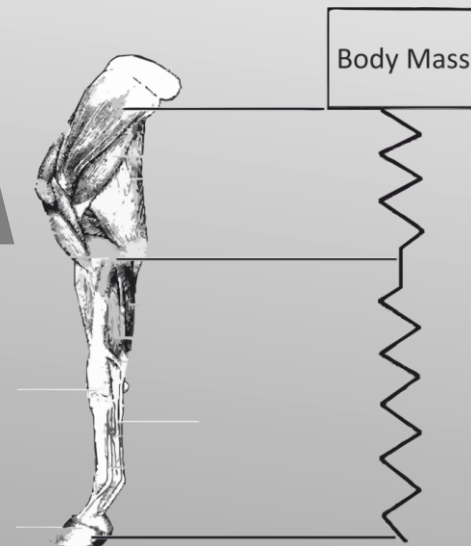
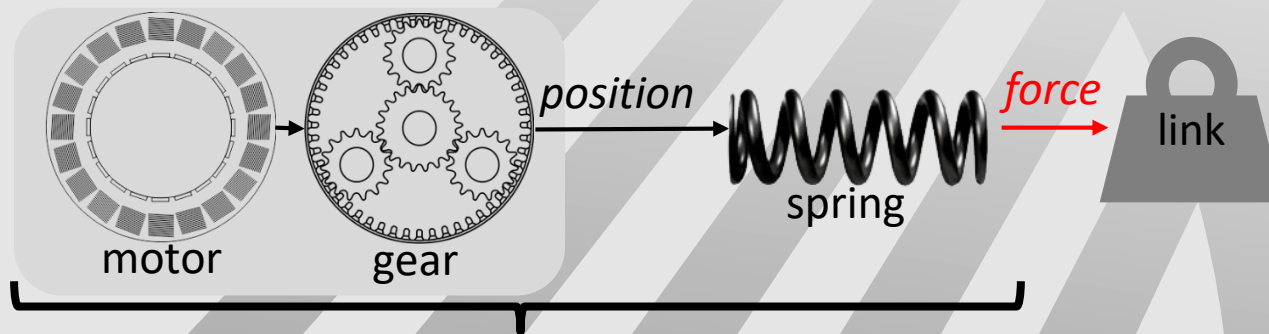


MODUL in a nutshell

- Kinematic, position control

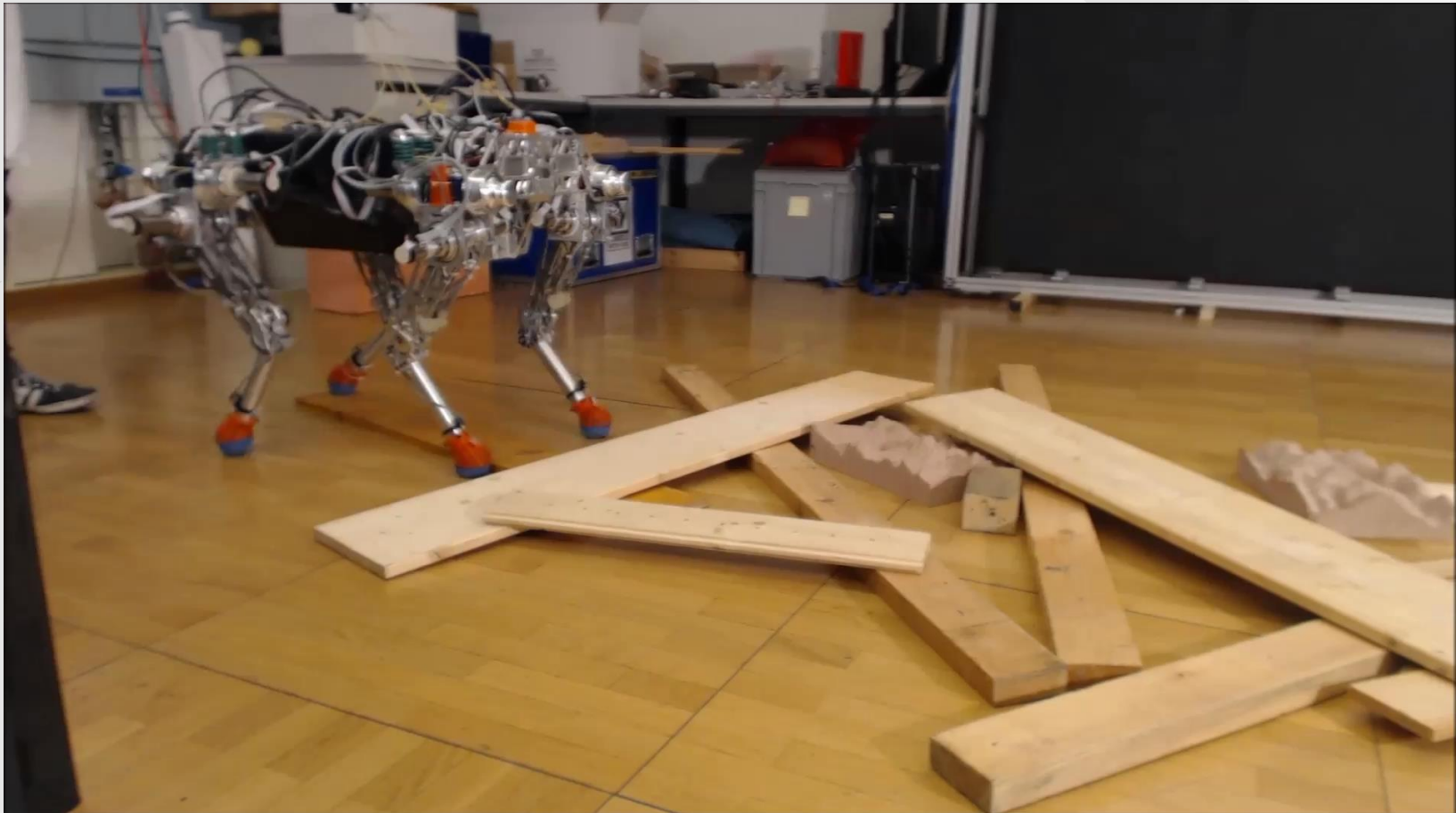


- Dynamic, **force** control



StarLETH – demonstration of elastic actuation principle

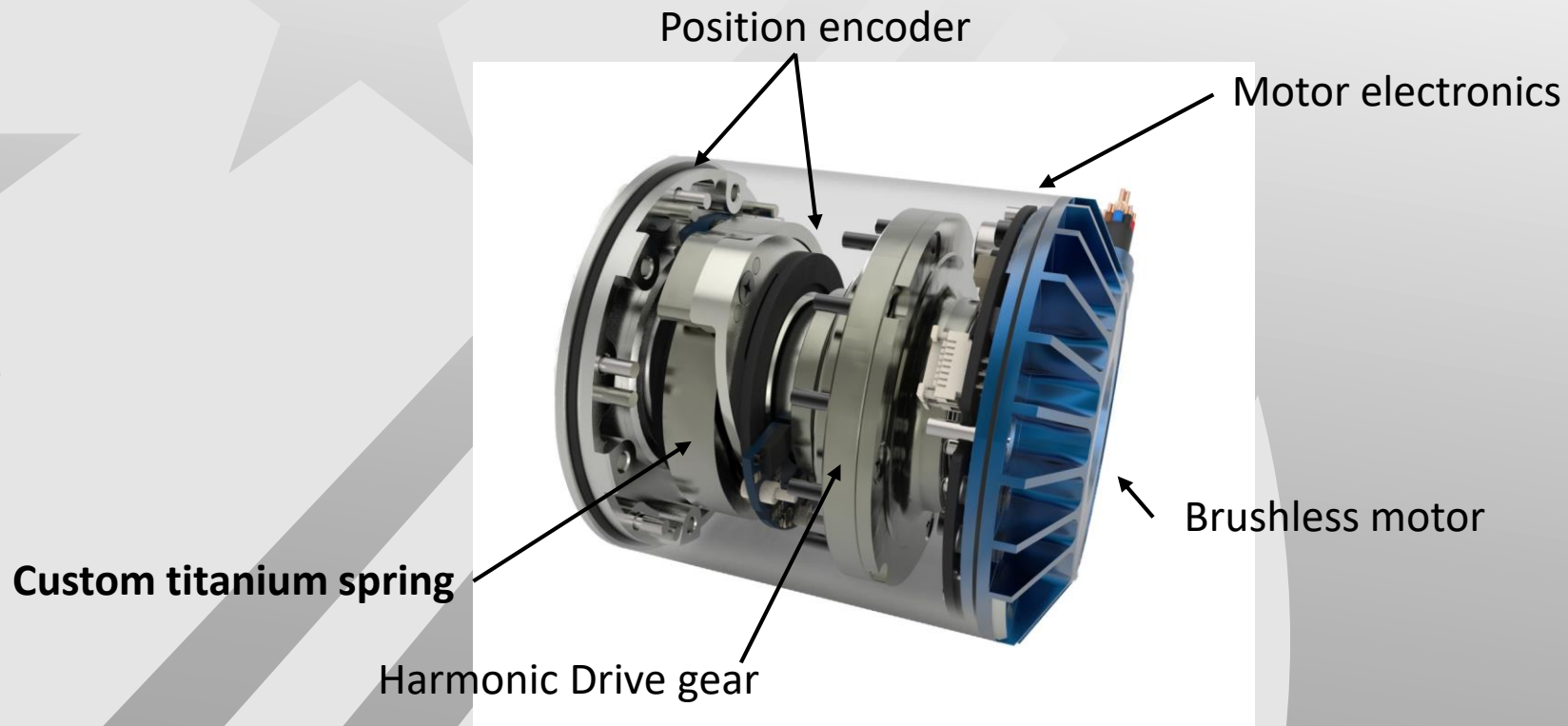
- Research 2009-2014



ANYdrive – a compliant, torque controllable robot joint

Combine motors, gears, springs, electronics

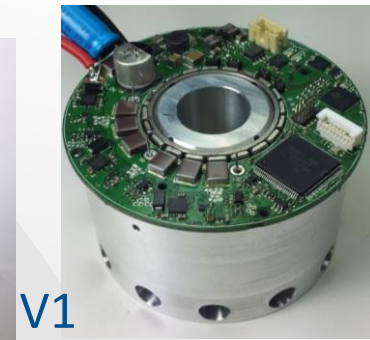
- High-tensile custom titanium grade 5 spring
- Custom electronics with advanced controls



ANYdrive – a compliant, torque controllable robot joint

Combine motors, gears, springs, electronics

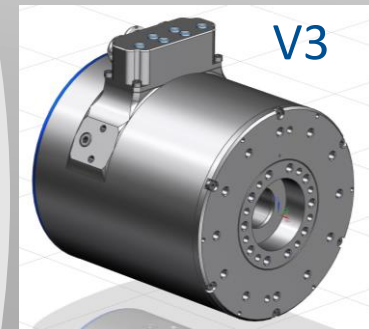
- High-tensile custom titanium grade 5 spring
- Custom electronics with advanced controls
- CAN/EtherCAT bus interface
- 17bit absolute position and torque accuracy
- High torque and speed (40Nm, 12rad/s)
- Low weight (<1kg)
- Large hollow shaft for cabling
- IP67/68 sealed



V1



V2 (V4 electronics)



V3

Hutter, M., Bodie, K., Lauber, A., & Hwangbo, J. (2016). EP16181251 - Joint unit, joint system, robot for manipulation and/or transportation, robotic exoskeleton system and method for manipulation and/or transportation. European Patent Office.

ANYdrive – a compliant, torque controllable robot joint

low-impedance
torque control



fast position
tracking



impact robustness



safe interaction



ANYmal – a ruggedized legged transporter



ANYpulator – a compliant and safe robot arm

ANYPULATOR



Market Potential



Mobile robots

Adaptability, safety

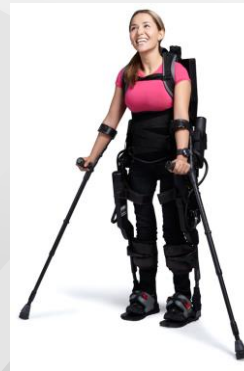
20B\$^[3] (2018)



Entertainment

Natural appearance

7.6B\$^[3] (2018)



Rehabilitation

Human support

1.8B\$^[2] (2020)



Collaborative robots

Inherent safety

1B\$^[1] (2020)

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Business Plan

- Additional startup supporting grants since April 2016 (~2MCHF)
- Foundation of ANYbotics AG with 8 people in Sept 2016 (www.anybotics.com)
 - Former CEO of ABB as Business Lead and CEO of ANYbotics
 - 12 people in 2017 and 20 end of 2018
- Expected sales (much more conservative than actual market potential)

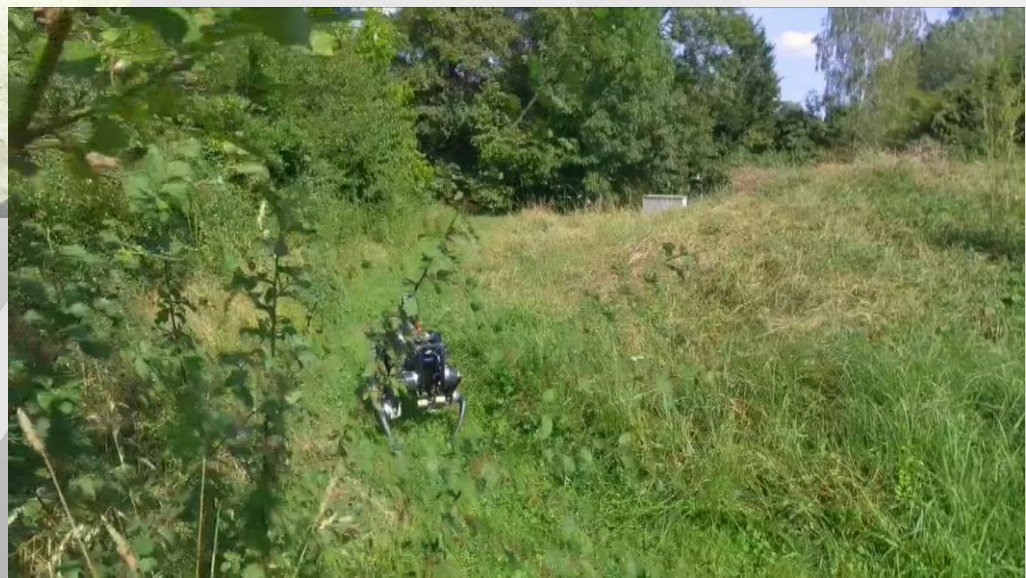
	H2 2016	2017	2018	2019	2020
No of ANYdrive	-	100	200	500	1000
No of ANYmal	-	5	10	20	30

- First ANYmal sold Q1 2017 externally, another internally for ARGOS
- Orders for >>100 ANYdrives are placed by selected customers
- Official delivery in Q2 2017

Impact from participation in ECHORD++

- Technical impact:
 - Torque controllable robot joint enables modular setup of advanced robots
“ANYdrive is the integrated, force controllable servo motor for roboticists”
 - Most advanced electrically actuated and commercially available quadruped
- Research impact
 - Cutting-edge drive technology
 - Enabling technology for new research (incl. legged robotics)
- Business impact
 - “Initial funding to make the transition from research to a product”
 - Attract more funding, initiate a company, create interest around product
- Social impact
 - Good exchange among Greek & Swiss partners
 - 1 person moved to my lab in Nov 2015

Thank you.



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Bristol Robotics Laboratory



RUROBOTS
Cognitive Science at Work

