The GummiArm

ShanghAI Lectures 2016

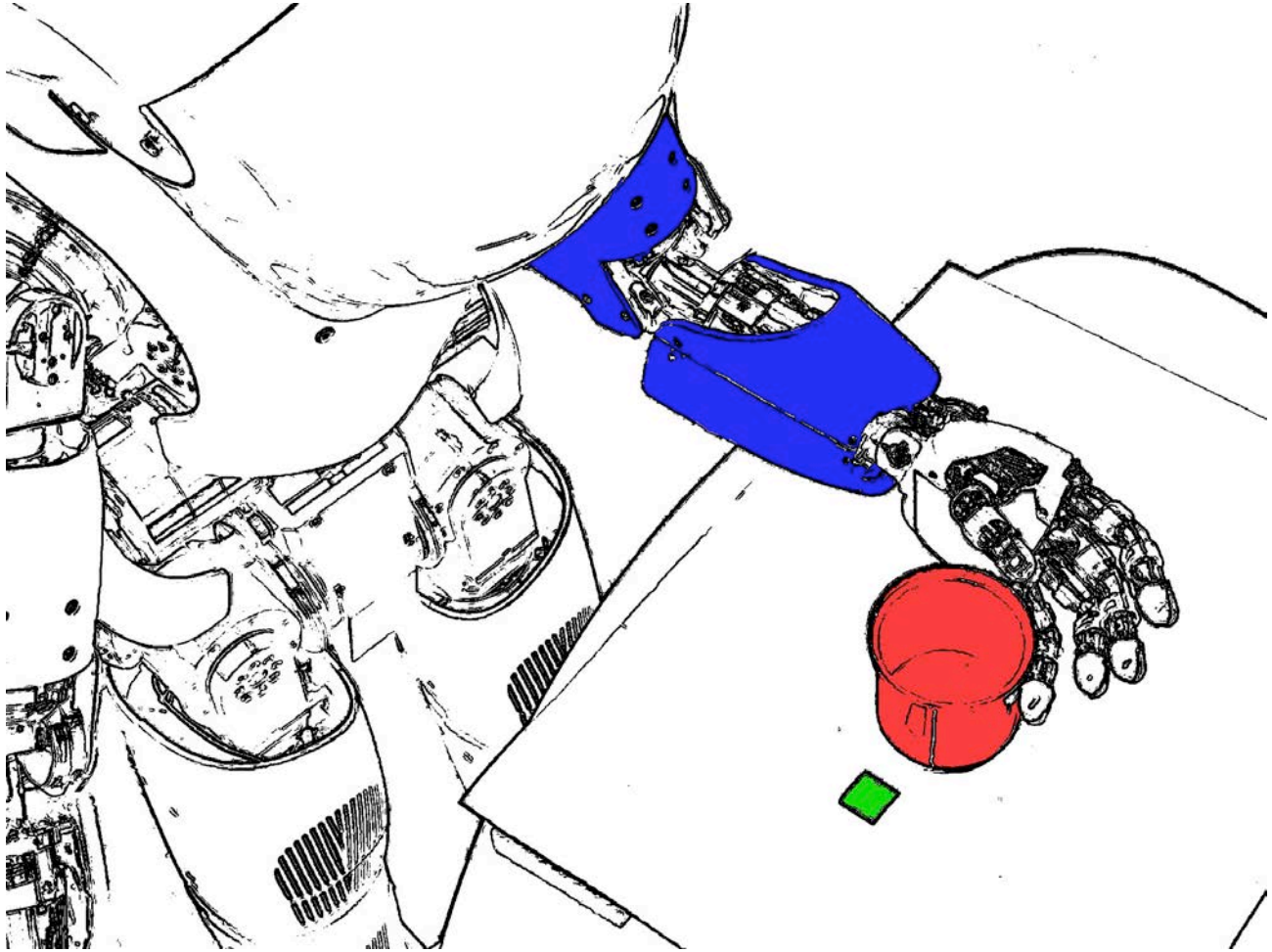
Dr Martin F. Stoelen

Plymouth University 2016

WITH PLYMOUTH UNIVERSITY

CRNS Centre for Robotics and Neural Systems

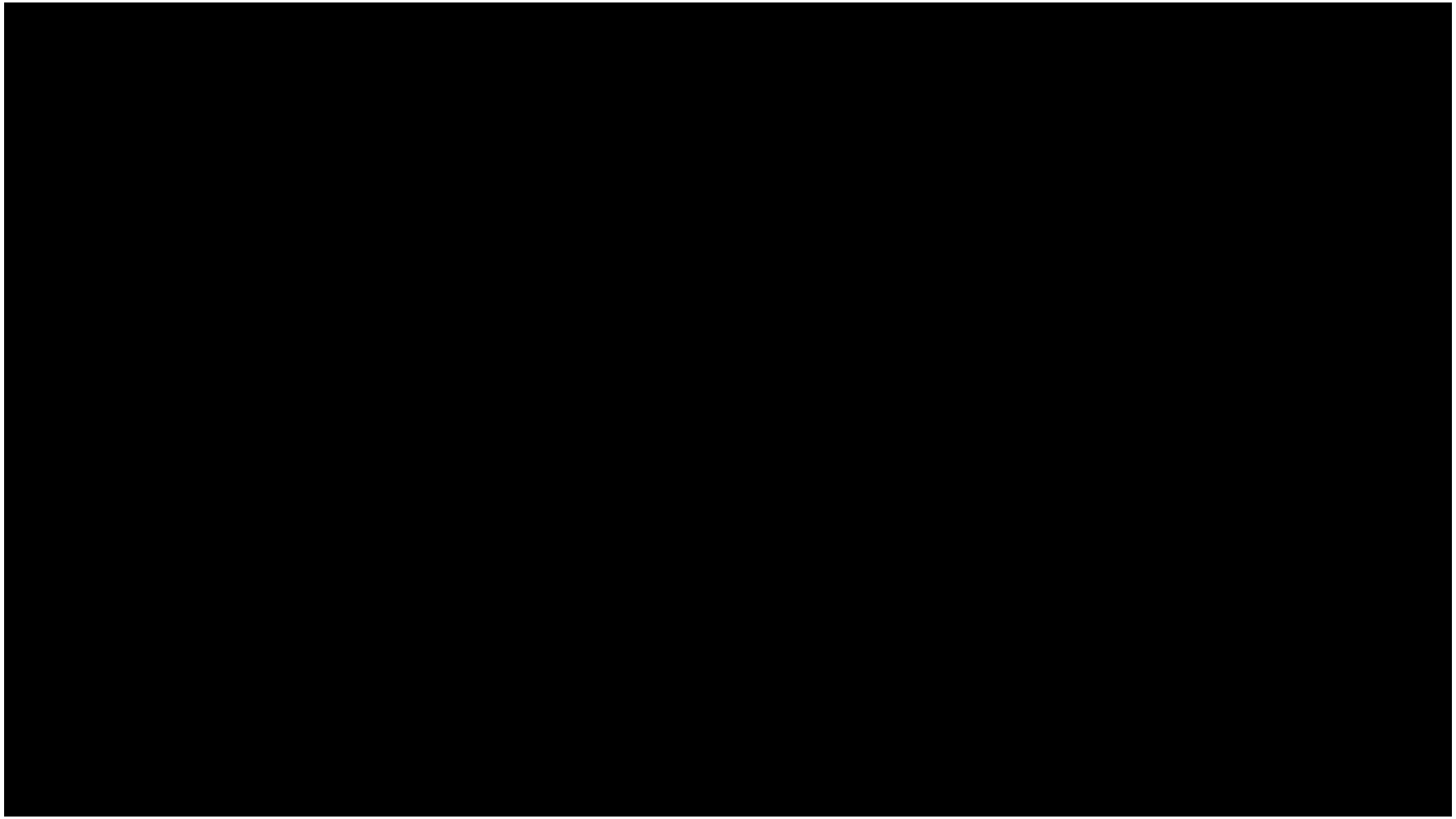
A developing mind requires a robust body…



*Part of the **DeCoRo** Marie Curie Intra-European Fellowship at Plymouth (Stoelen & Cangelosi)*

Opportunities abound for soft + precise robots (?)

The GummiArm (some months ago)



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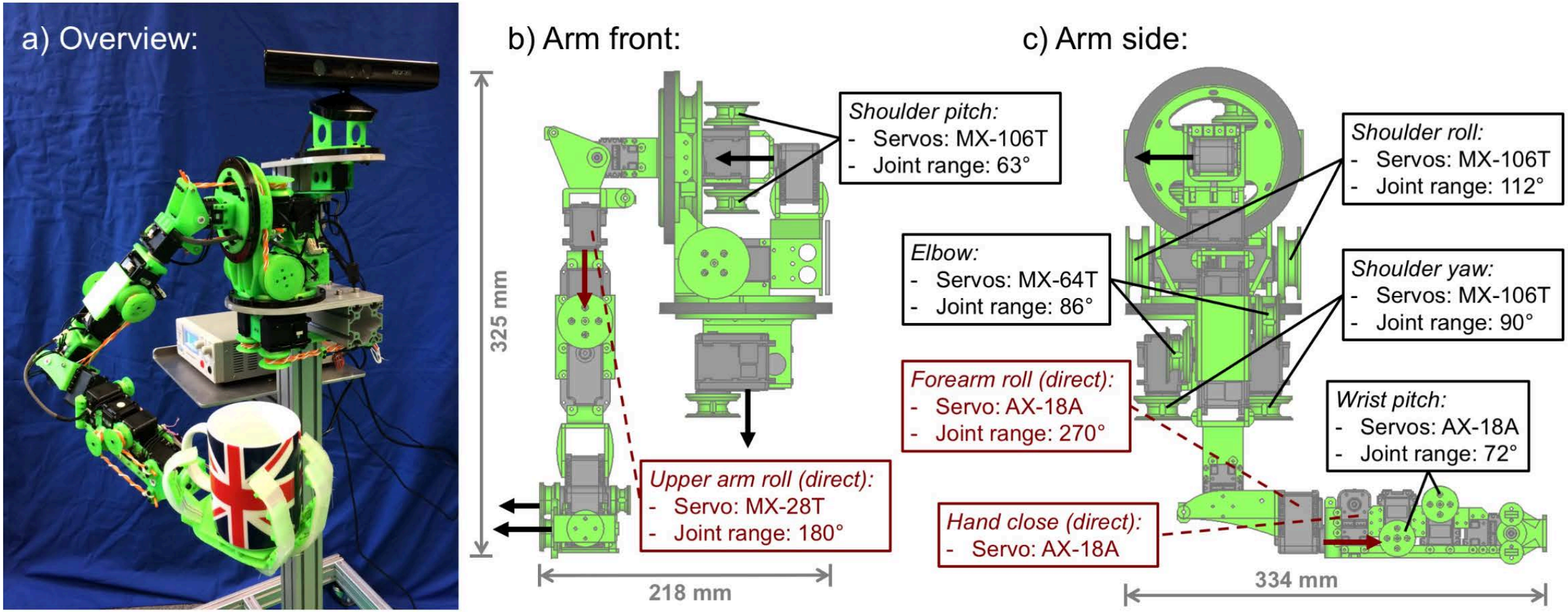

(Stoelen, Bonsignorio & Cangelosi, 2016)

Open source AND easily replicable (?)

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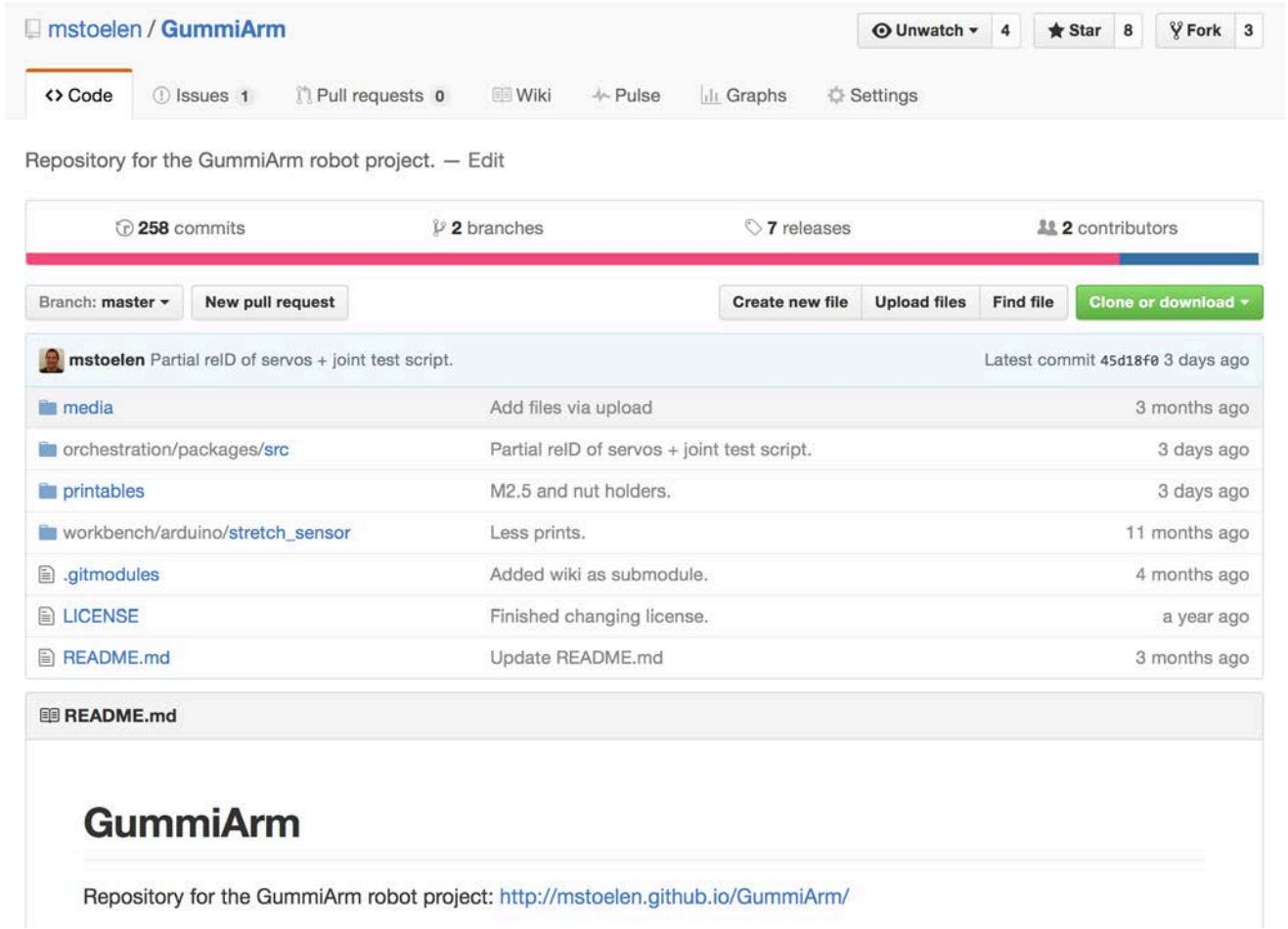

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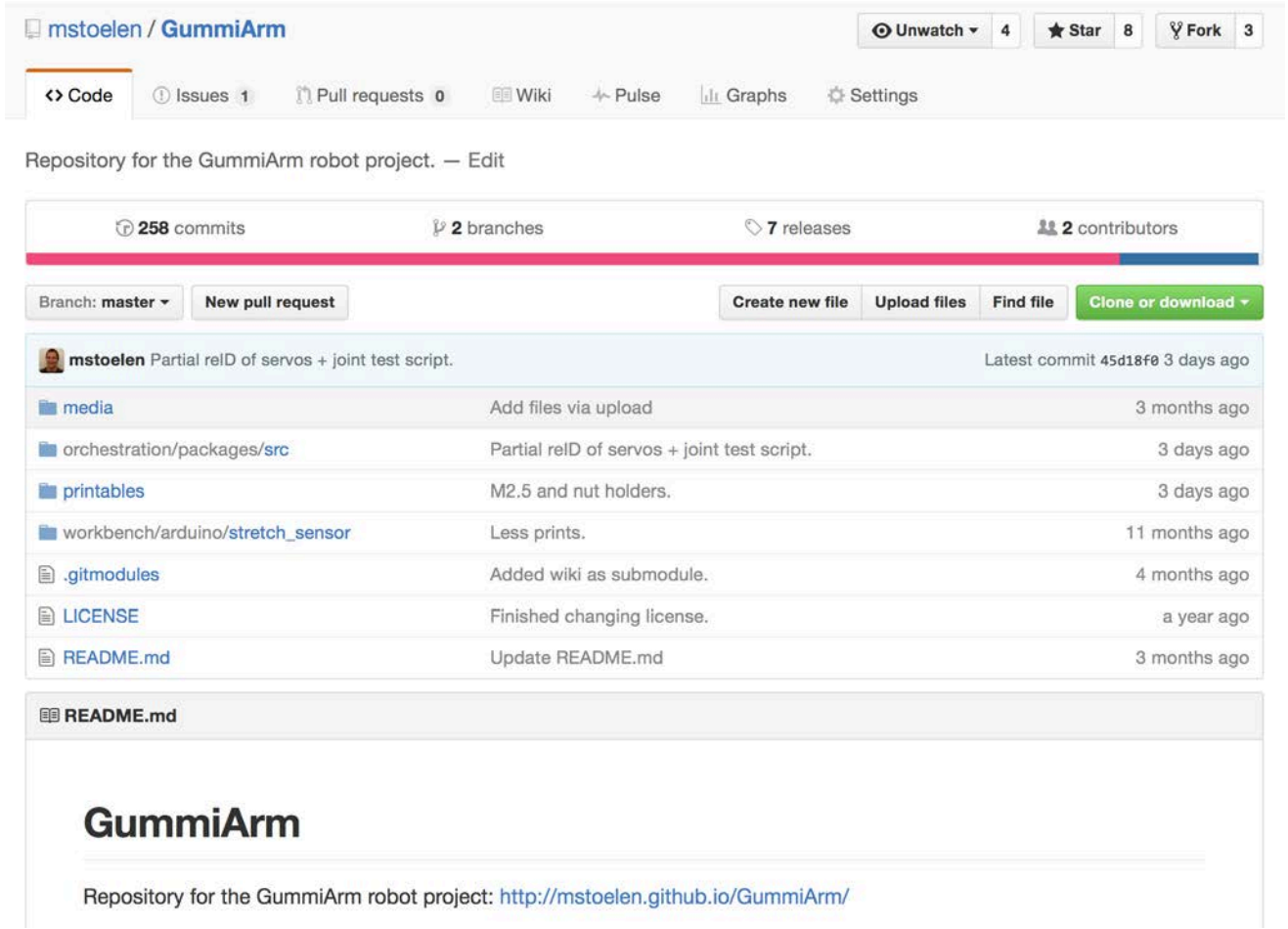

http://mstoelen.github.io/GummiArm/

Open source AND easily replicable (?)

mstoelen / **GummiArm**

Unwatch 4 | Star 8 | Fork 3

Code | Issues 1 | Pull requests 0 | Wiki | Pulse | Graphs | Settings

Repository for the GummiArm robot project. — Edit

258 commits | 2 branches | 7 releases | 2 contributors

Branch: master | New pull request | Create new file | Upload files | Find file | Clone or download

mstoelen Partial reID of servos + joint test script. Latest commit 45d18f0 3 days ago

media	Add files via upload	3 months ago
orchestration/packages/src	Partial reID of servos + joint test script.	3 days ago
printables	M2.5 and nut holders.	3 days ago
workbench/arduino/stretch_sensor	Less prints.	11 months ago
.gitmodules	Added wiki as submodule.	4 months ago
LICENSE	Finished changing license.	a year ago
README.md	Update README.md	3 months ago

README.md

GummiArm

Repository for the GummiArm robot project: http://mstoelen.github.io/GummiArm/

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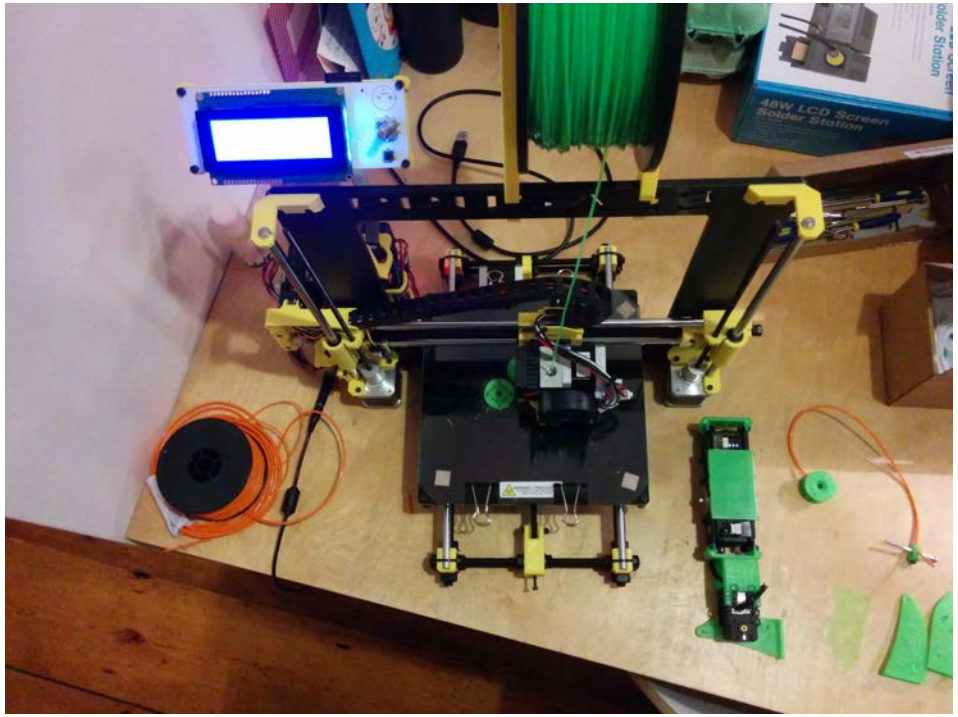

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README.md

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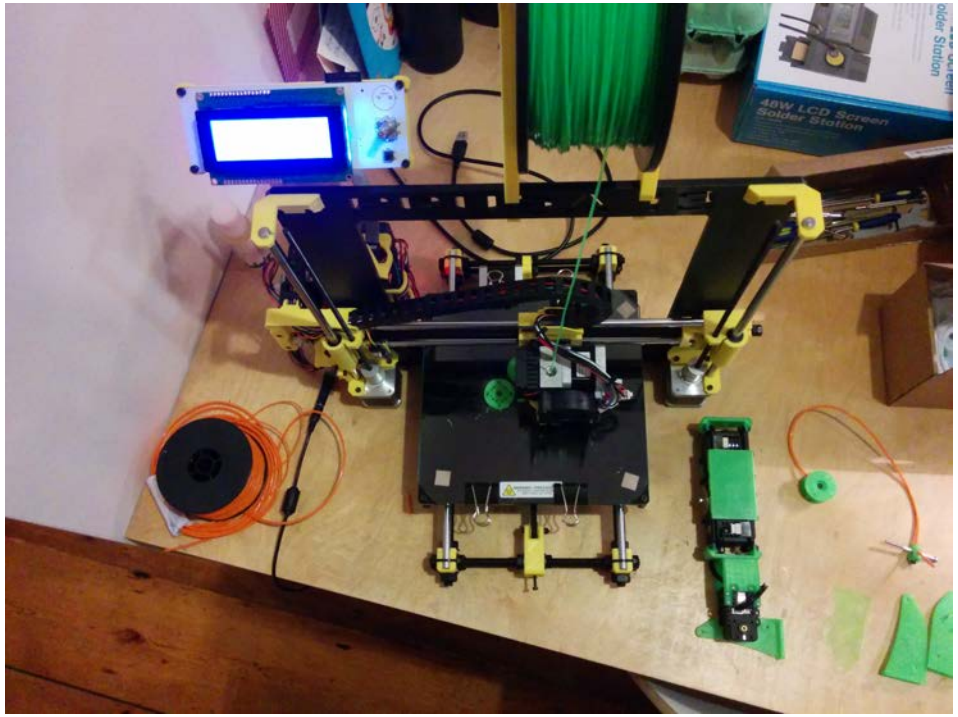


Towards replicable robot experiments?

(Bonsignorio, Hallam, del Pobil, 2007)

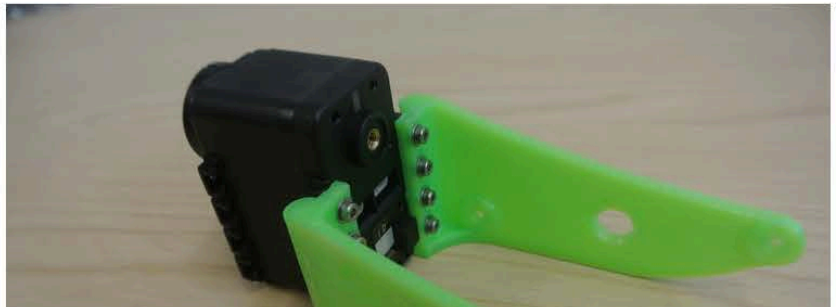
Detailed IKEA-style build instructions

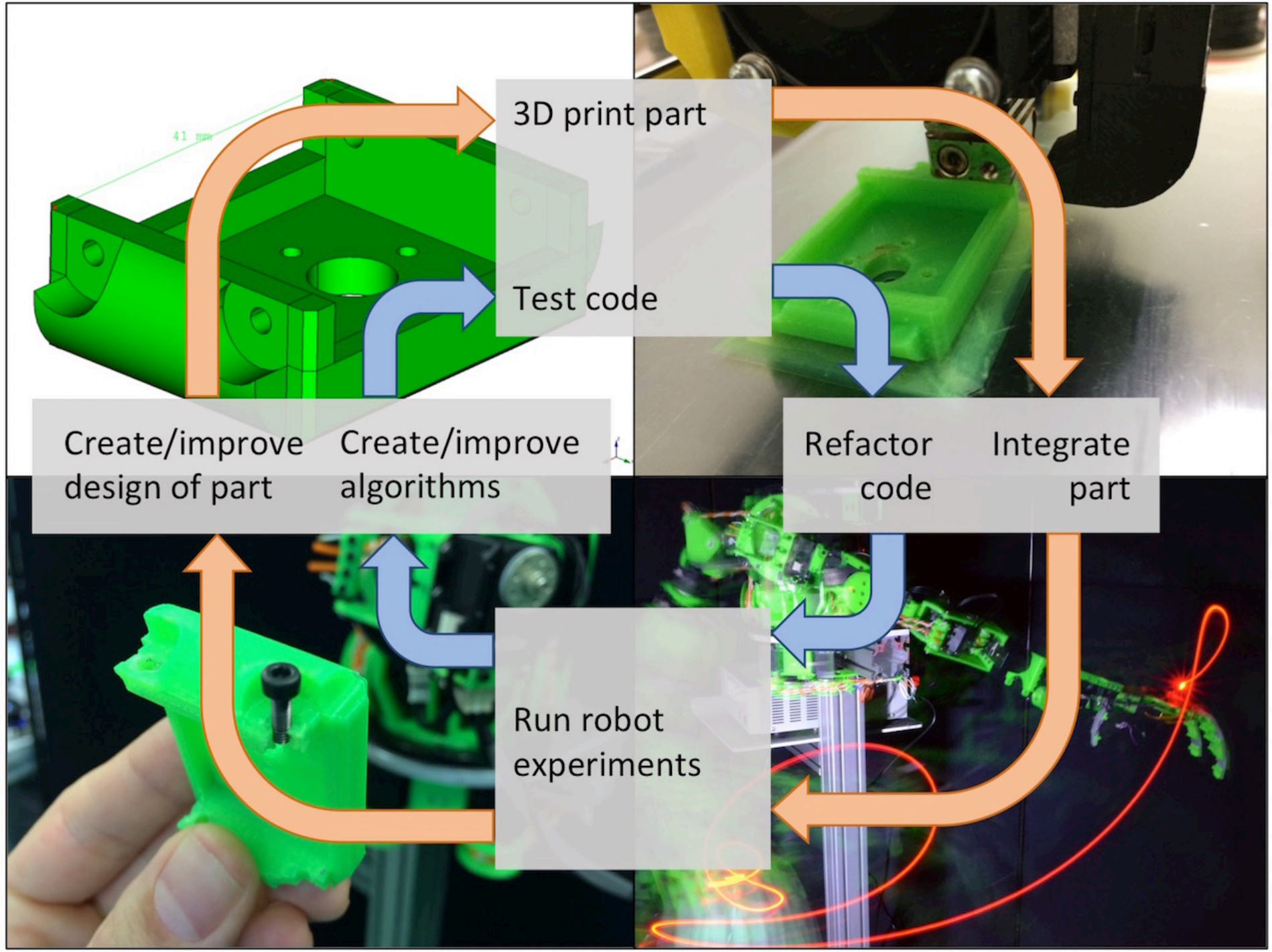
Lower arm

Required :

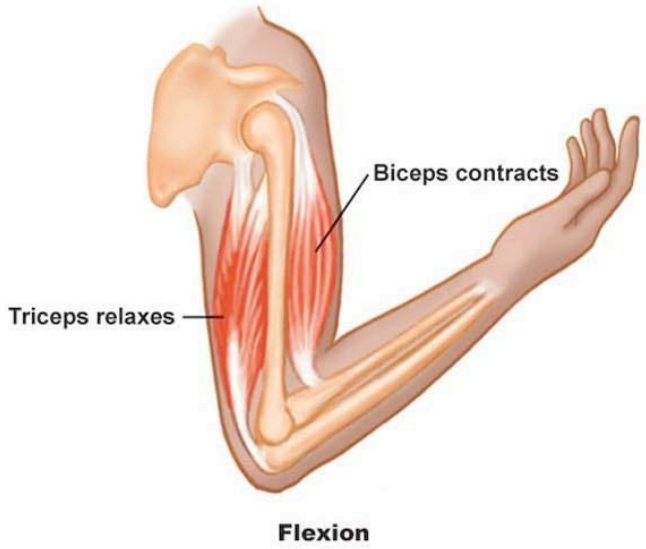
1. 82x M2x8mm screws
2. 74x M2 washers
3. 80x M2 nuts
4. 6x M2.5x12mm screws
5. 6x M2.5 nuts
6. 4x M2.5 washers
7. 1x M3x10mm with bearing bushing

1. Screw the two elbow parts on servo 21 with M2x8mm. (Figure 1)
2. Screw now the same servo to the lower plate but upside down and put a M2.5 nut in this plate. (Figure 2 and 2.5)
3. Fix all the AX-18 and the AX-12 at the end of the forearm with the reinforcement plastic parts with M2x8mm. (Figure 3 and 3.5)
4. Fix the wrist thank to the M3x10mm and M2x8mm screws. (Figure 4 and 4.5) 5. Fix the prepared wheels on the two middle servos and fix the muscles underneath the wrist's muscle fixer (M2.5x12mm). (Figure 5 and 5.5)



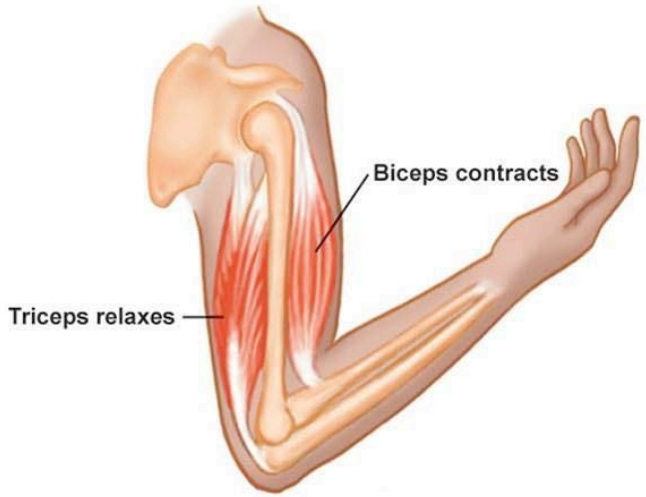

3D print part
Test code
Refactor code
Integrate part
Run robot experiments
Create/improve algorithms
Create/improve design of part

Rubbery agonist-antagonist joints



** Recreus filaments: http://recreus.com/en/*

Rubbery agonist-antagonist joints



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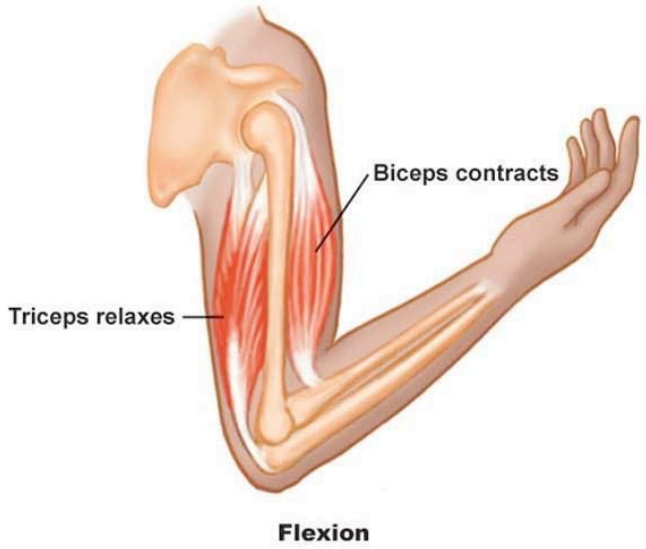

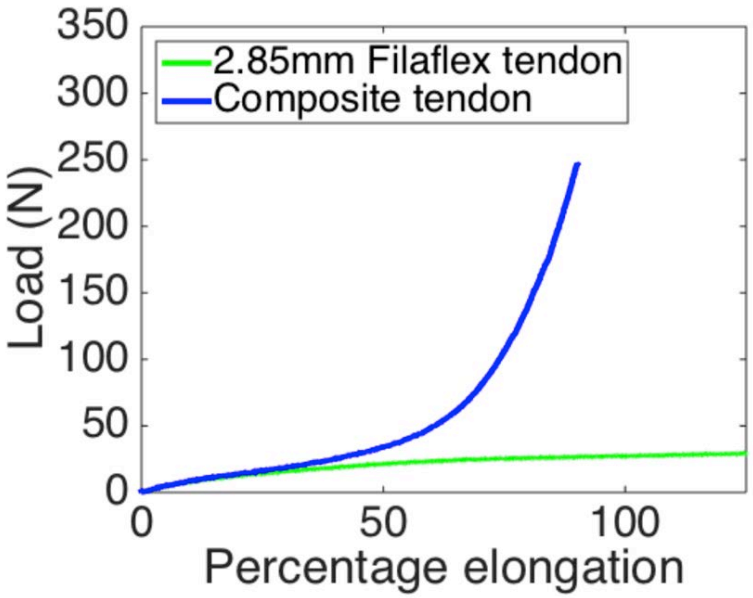

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Rubbery agonist-antagonist joints

Albu-Schäffer et al., 2008
Ham et al., 2009
Hauser, Füchslin & Pfeifer, 2014
Laschi & Cianchetti, 2014
Rus & Tolley, 2015
Vanderborght et al., 2013
++

© Pearson Education Inc., 2011

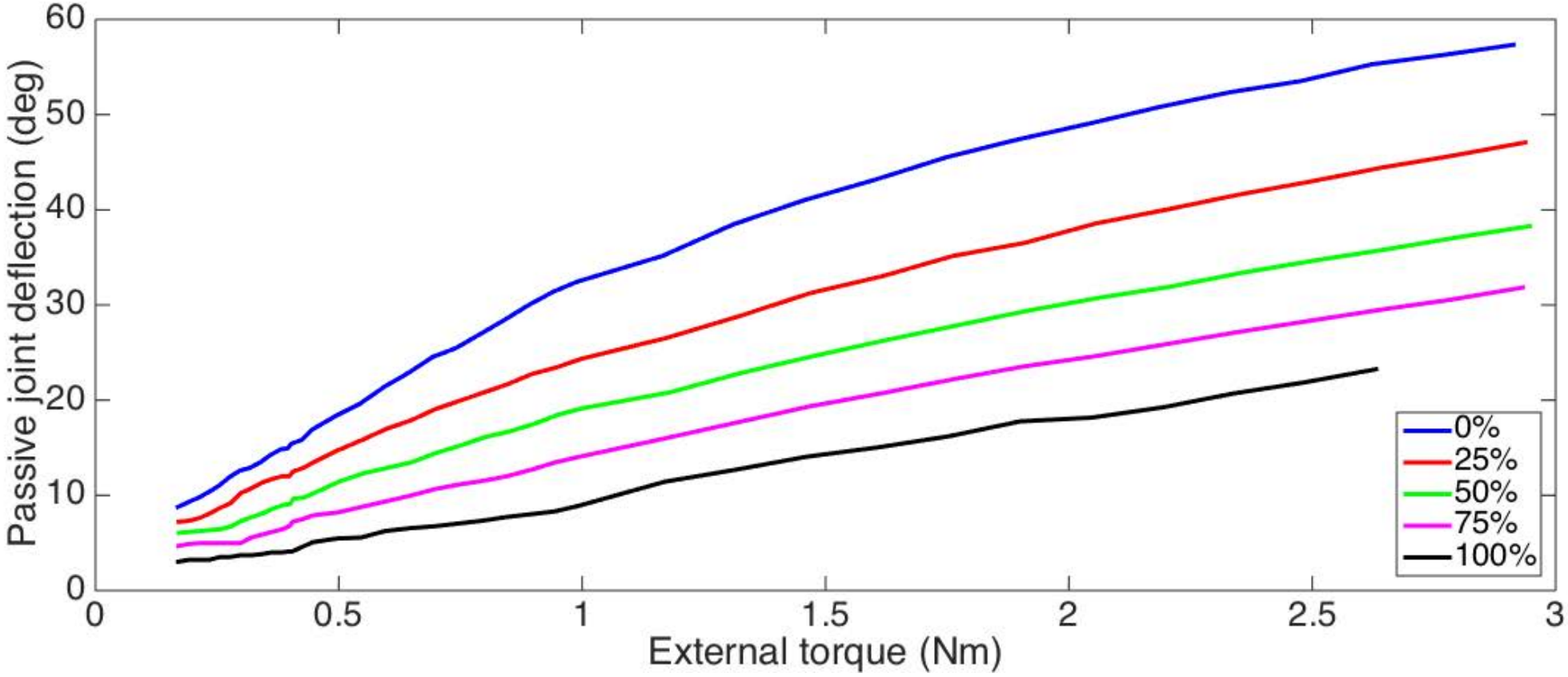
** Recreus filaments: http://recreus.com/en/*

Equilibrium point (**p**) and co-contraction (**c**)

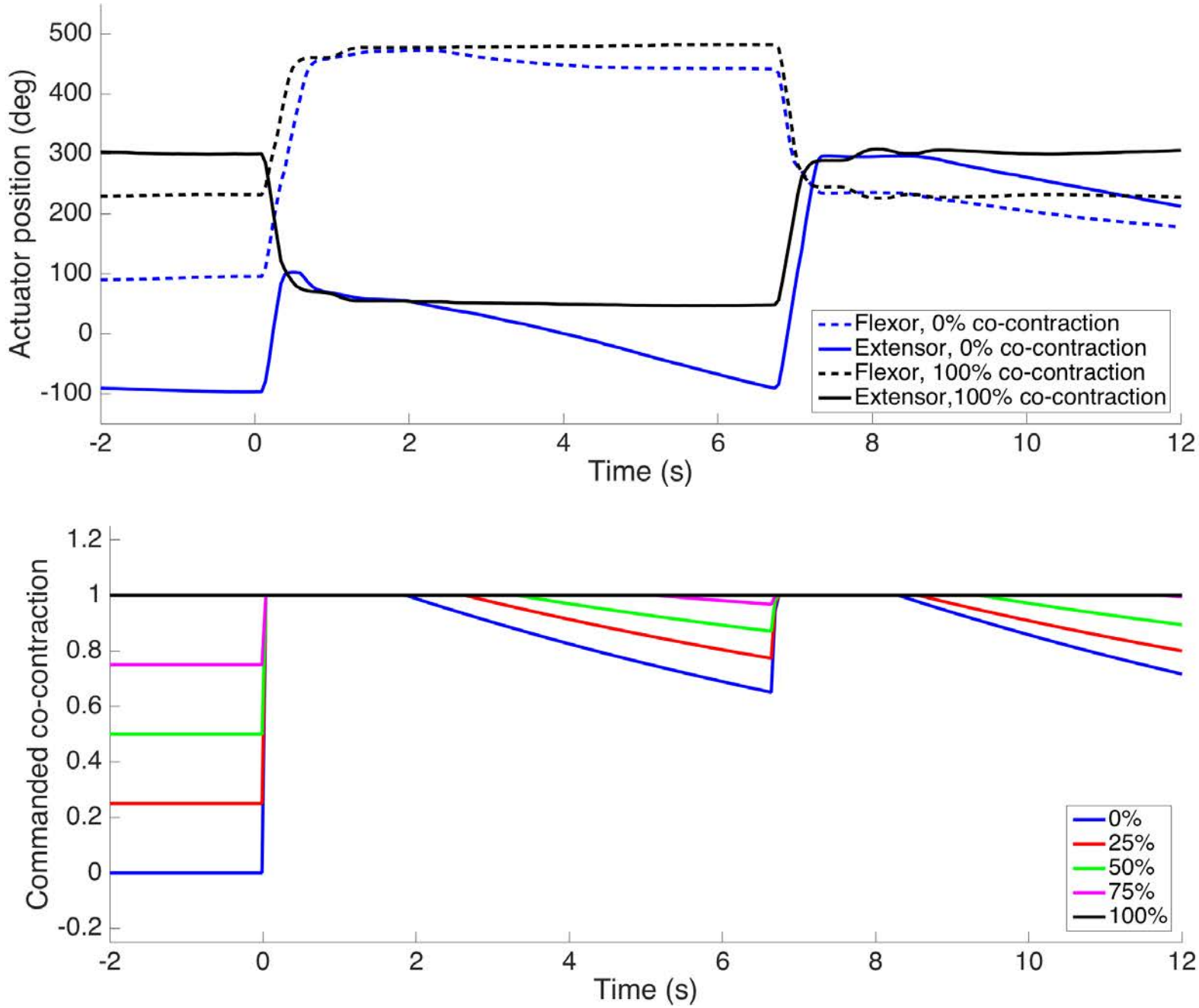
$$\alpha_{\text{flexor}} = p\frac{\gamma}{4} - c\frac{\pi}{2},$$
$$\alpha_{\text{extensor}} = p\frac{\gamma}{4} + c\frac{\pi}{2}.$$

p in range [-1,1]
c in range [0,1]

Stiffness varied through co-contraction (**c**)

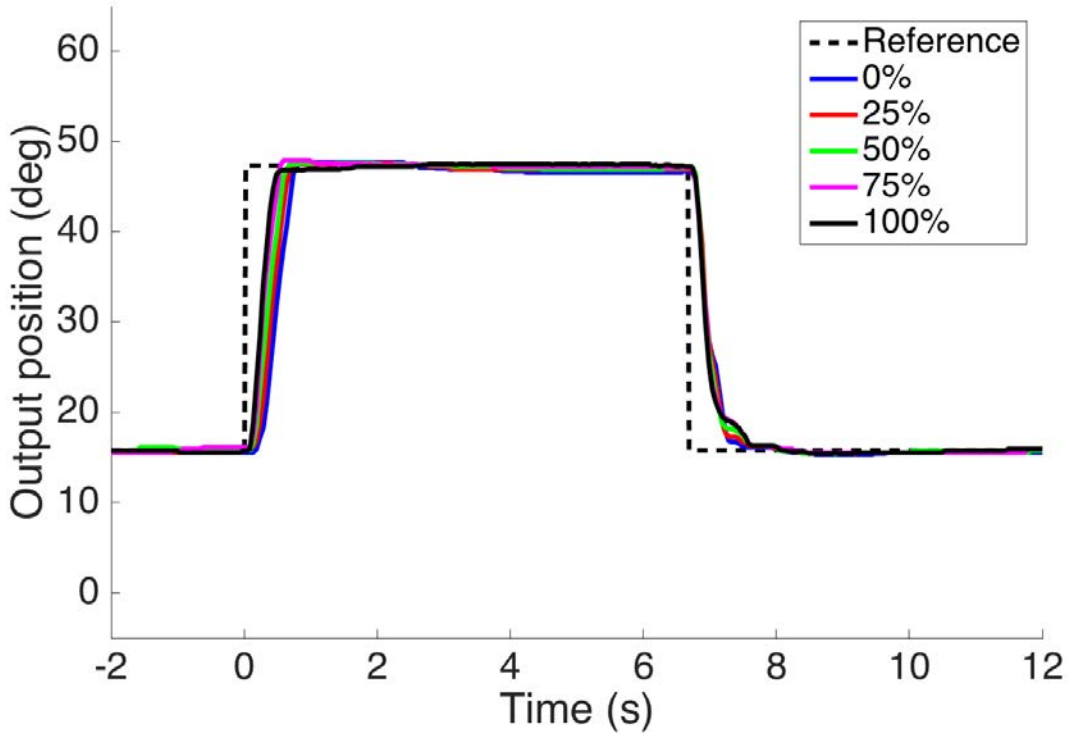



AX-12A


Actuator position (deg)
500
400
300
200
100
0
-100
-2
0
2
4
6
8
10
12
Time (s)
Flexor, 0% co-contraction
Extensor, 0% co-contraction
Flexor, 100% co-contraction
Extensor,100% co-contraction
Commanded co-contraction
1.2
1
0.8
0.6
0.4
0.2
0
-0.2
-2
0
2
4
6
8
10
12
Time (s)
0%
25%
50%
75%
100%

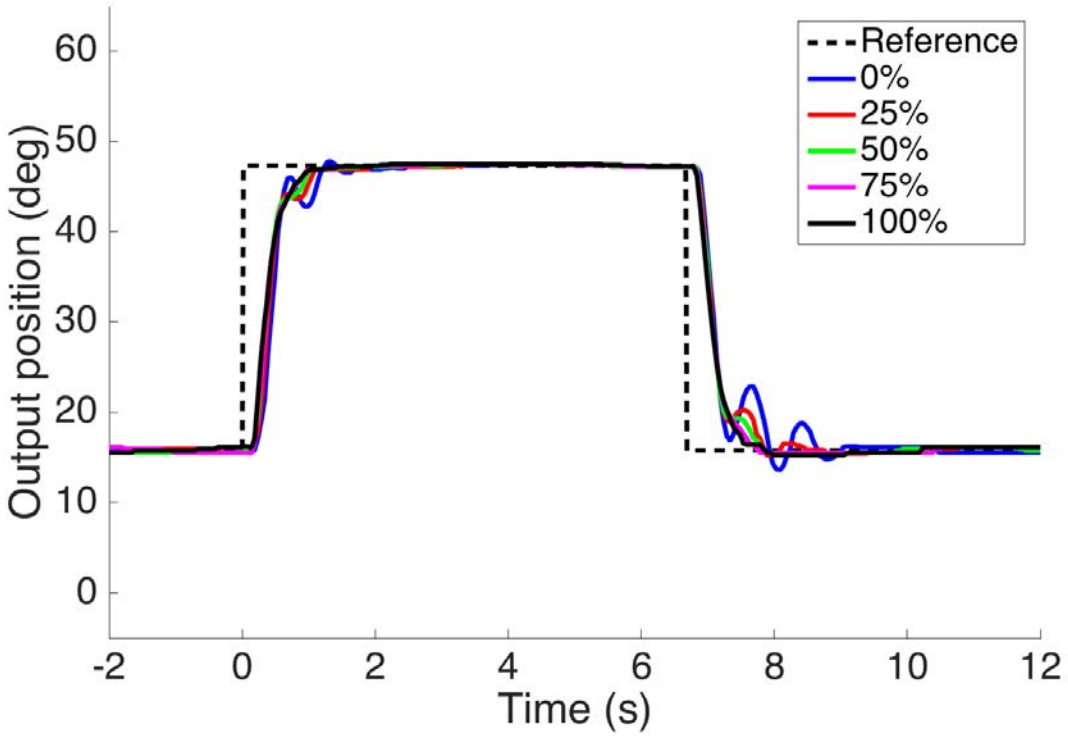
Good response even when starting “loose”

Good response even when starting “loose”

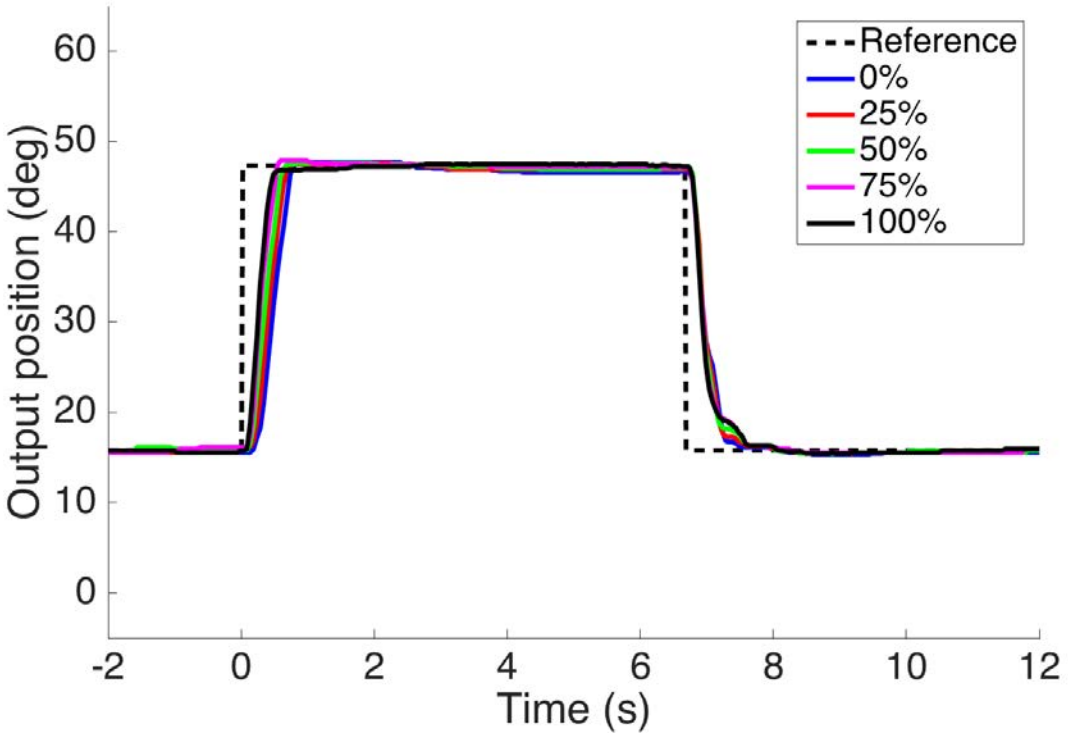


Ballistic/feedback control

Good response even when starting “loose”

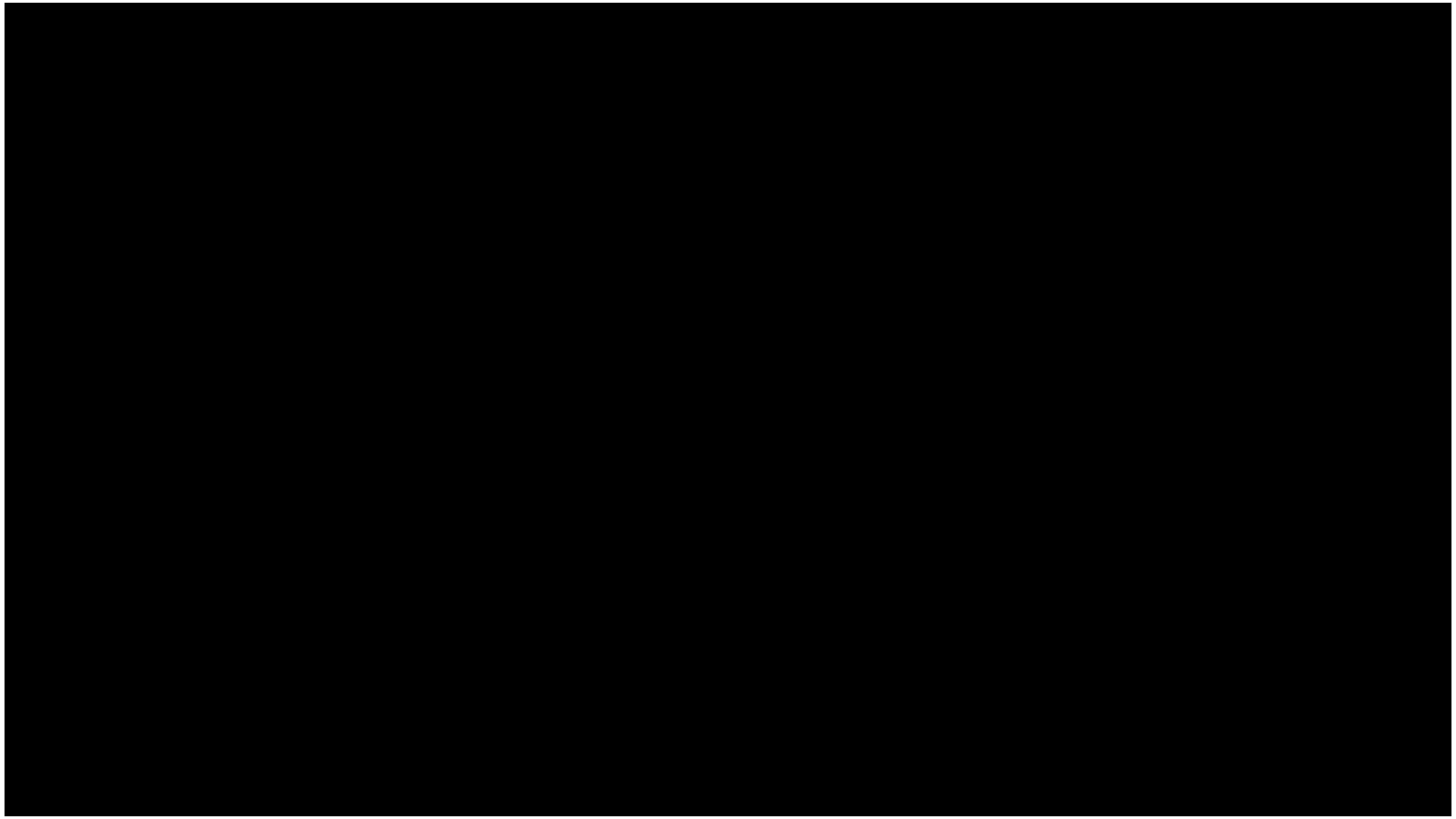


Feedback control only



Ballistic/feedback control

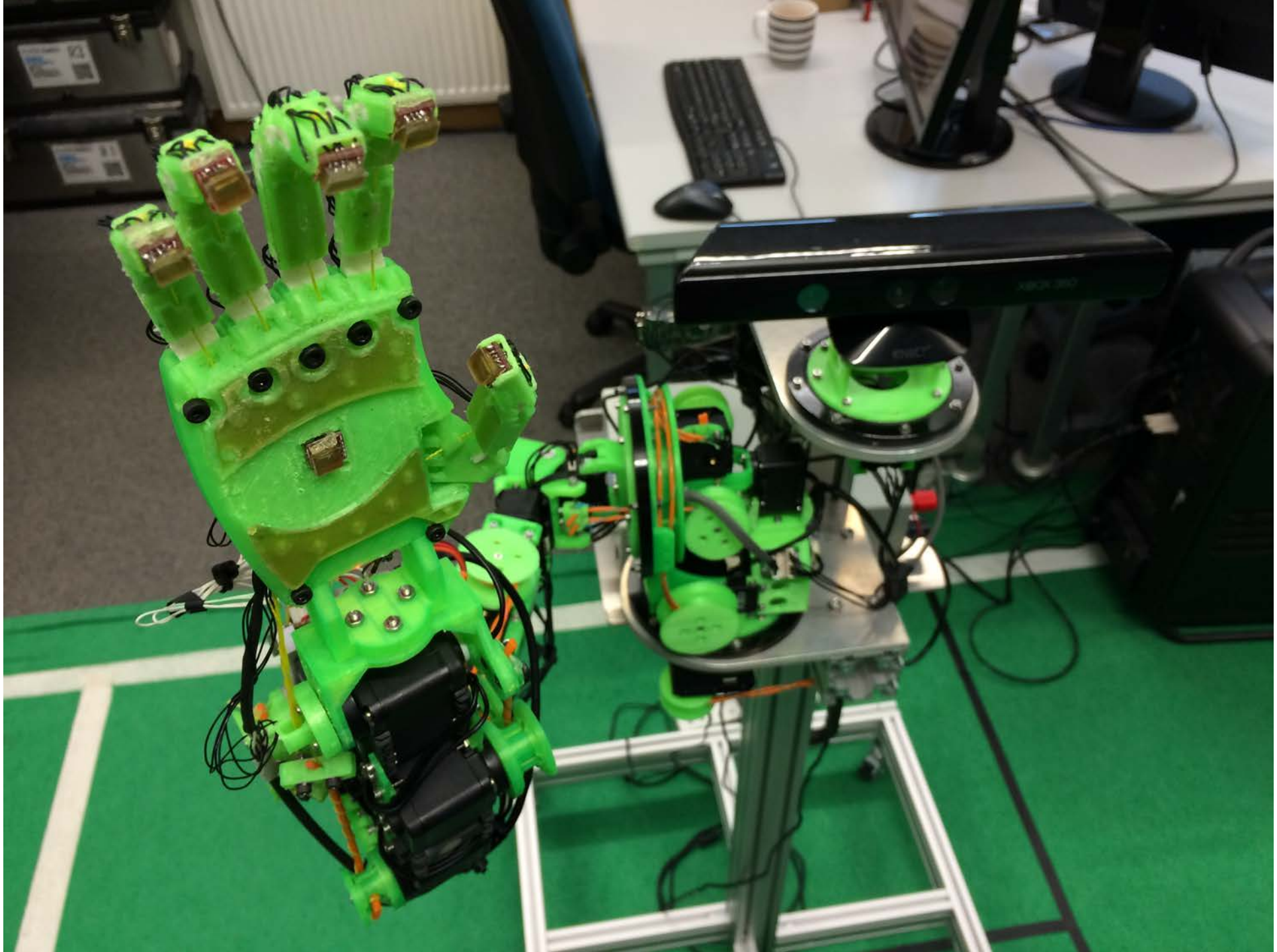
3D printed, but not necessarily fragile

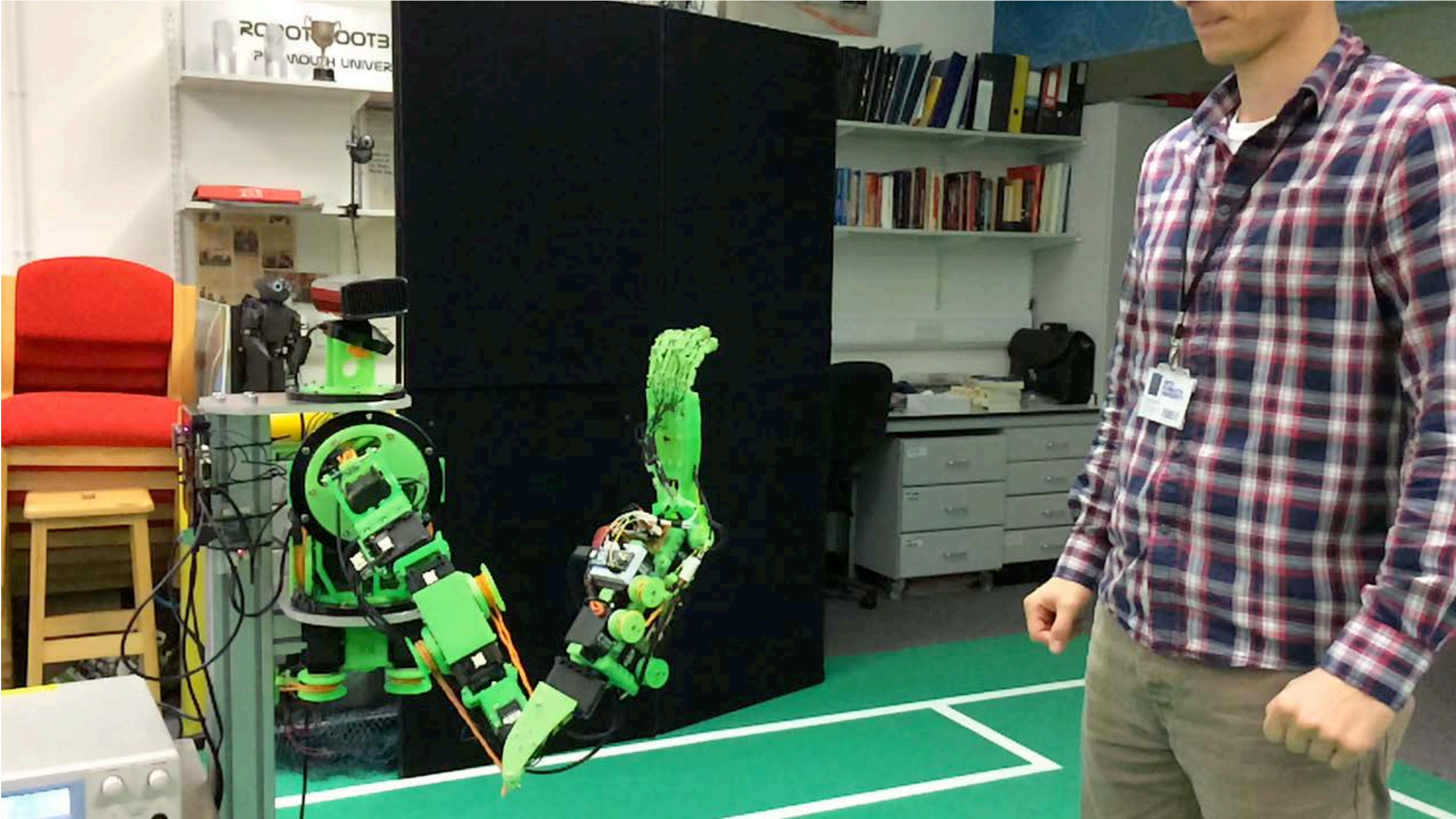


https://youtu.be/945XSTuKtAI

Varying stiffness helps physical interaction

https://youtu.be/QEHxqkwRZZE





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Neuromechanics 2016

4th – 6th October, 2016

Germany

1st UK Robot Manipulation Workshop

Birmingham:
Nicholson Building (G11)

lunch and refresh
A number of invite
and there will be p
sessions. Finally t

BEST GADGETS SHOP KITCHEN CARS MOBILE ROBOTS DESIGN

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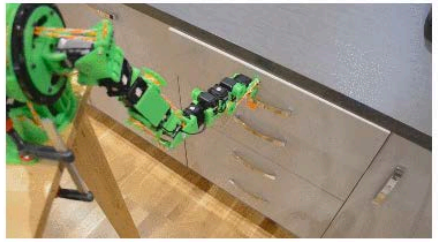
Home › 3D Printing › GummiArm: 3D Printed Robotic Arm

3D PRINTING ROBOTS

GummiArm: 3D Printed Robo

By **Gadget Junkie** - October 6 27 0



Meet the GummiArm: a 3D printed robotic arm that uses A

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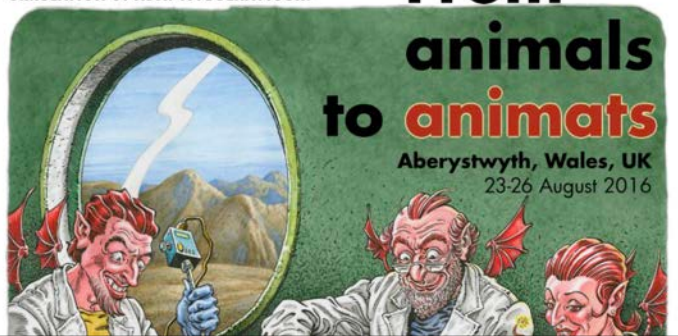

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GUMMI ARM
TECH

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