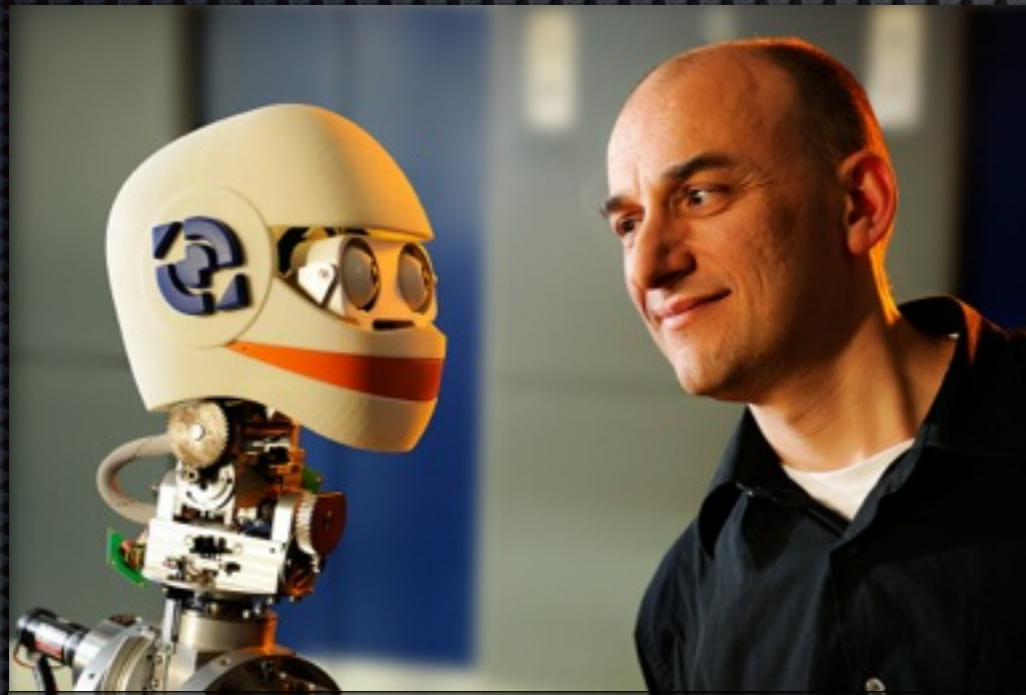


Design of Mechatronic systems in a Research Lab

Rapid prototyping, open source tools, accessible hard- and software



Stefano Stramigioli

CTIT

MIRA

BIOMEDICAL TECHNOLOGY
AND TECHNICAL MEDICINE



LEO

CENTER
FOR
SERVICE ROBOTICS

Topics

- ✦ **Novel Methodologies in Mechatronics**

- ✦ Rapid prototyping: Lasercutting and 3D printing
- ✦ Open source electronics
- ✦ Open source software tools

- ✦ **Cases**

- ✦ Pipe inspection Robot
- ✦ Novel Variable Compliant Actuator



Case: pipe inspection robot
'industrial' approach: 2006-2010

3D print

first week



second week



3 months



fully operational prototype

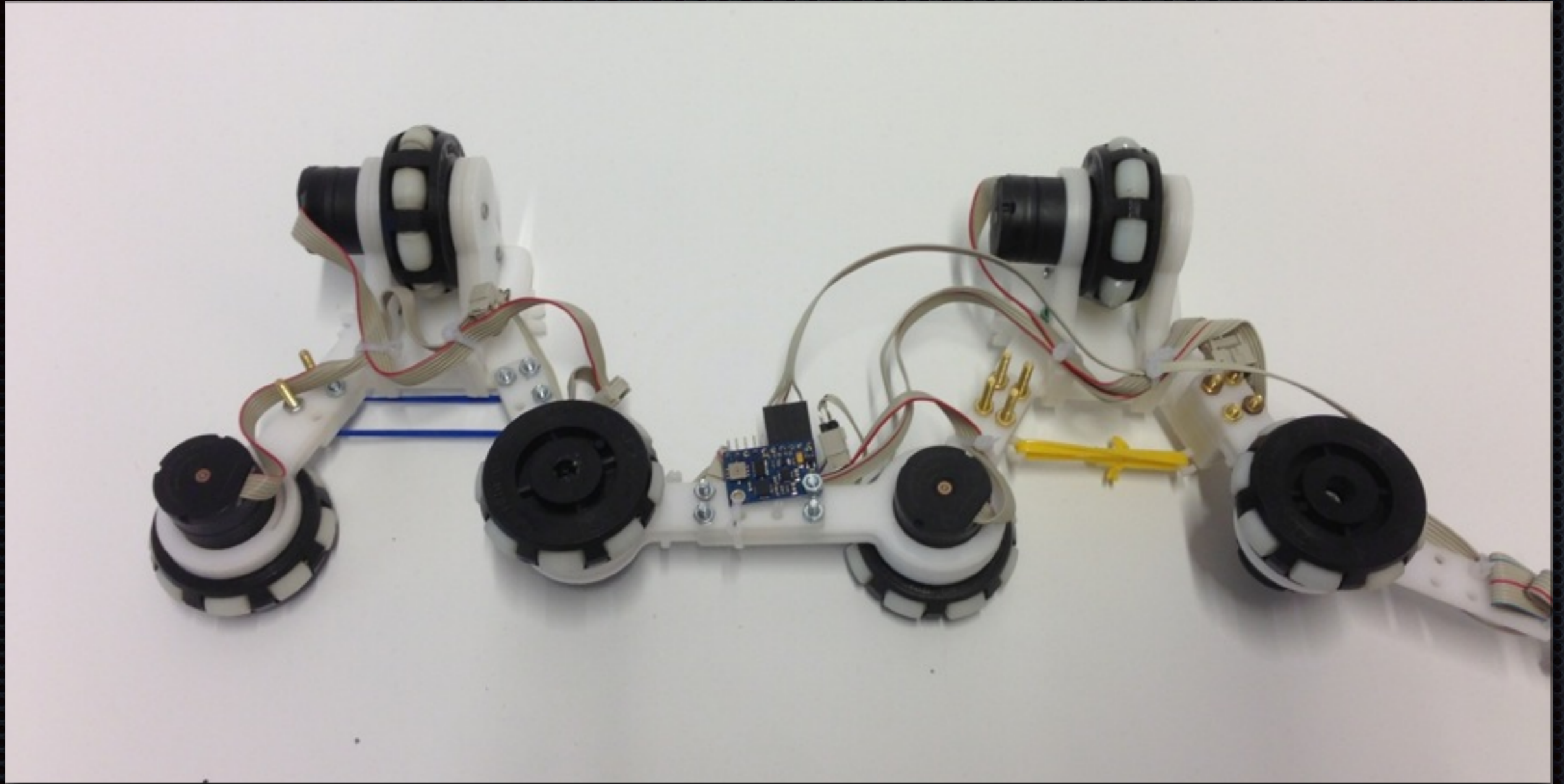
6 months



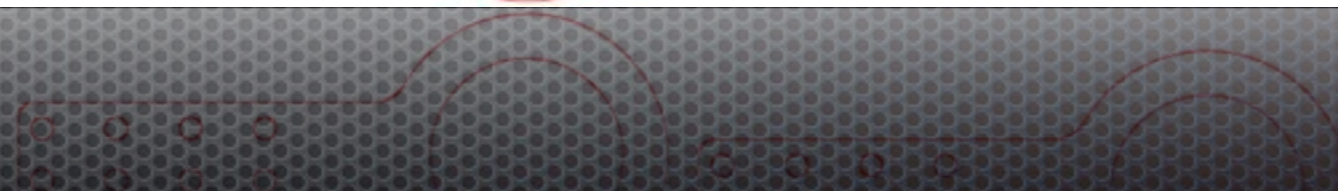
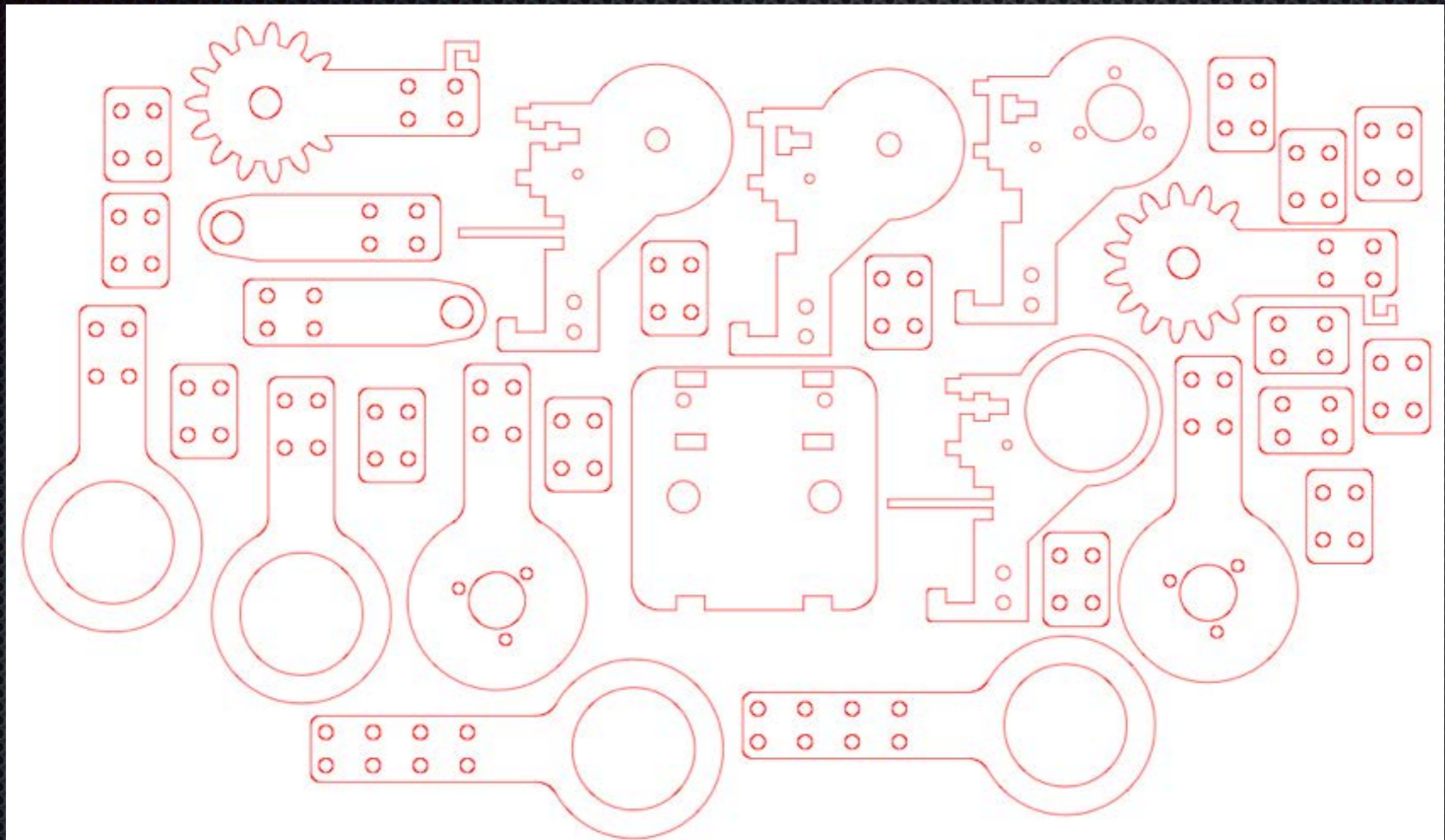
fiber reinforced nylon

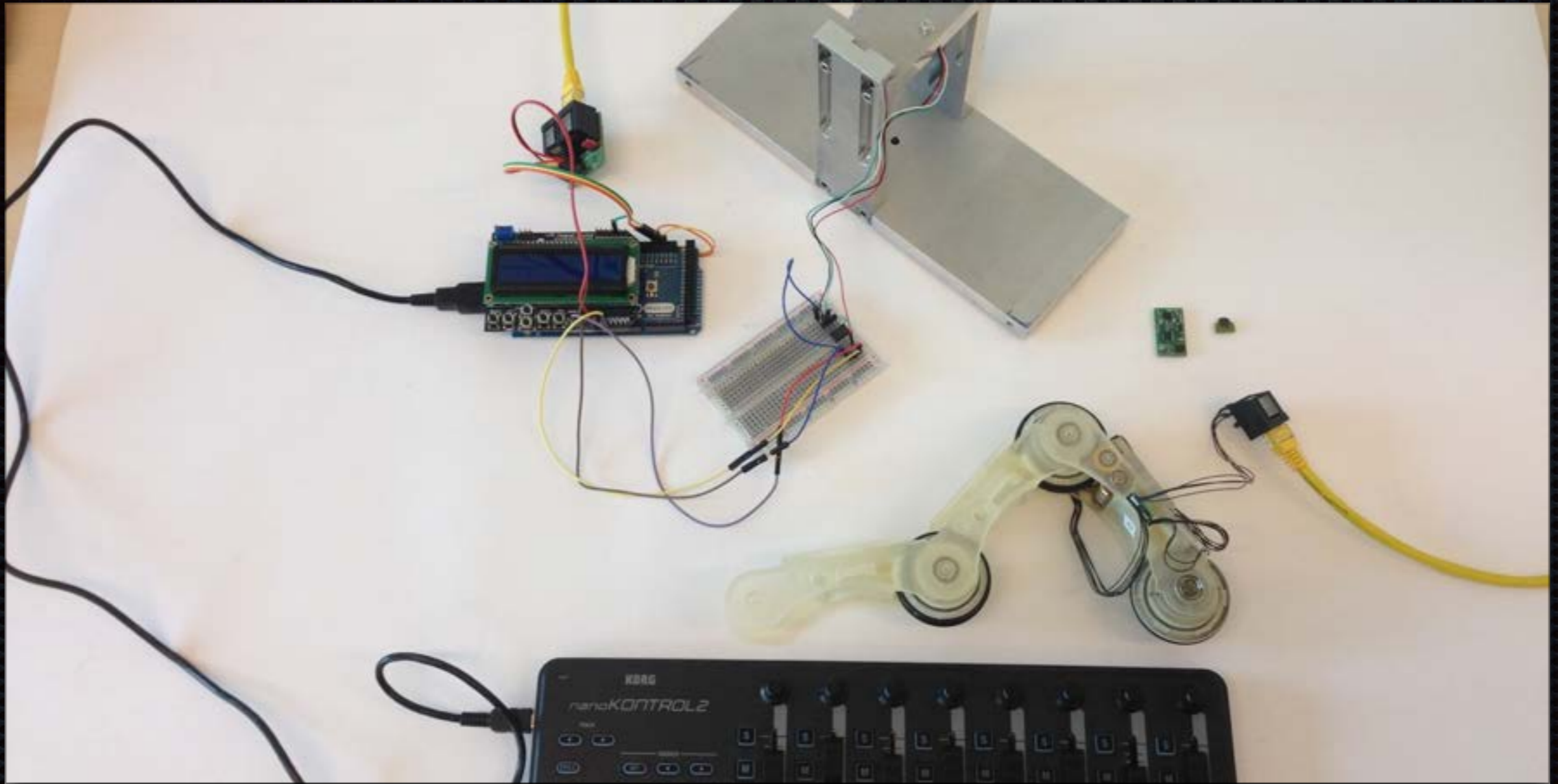
metal (drive) parts in
3D printed Stainless
Steel





Laser cutter
project in two weeks





Control Set-up

Easy and quick testing

RS485 bus

measurement bridge

lcd shield

robot control hardware

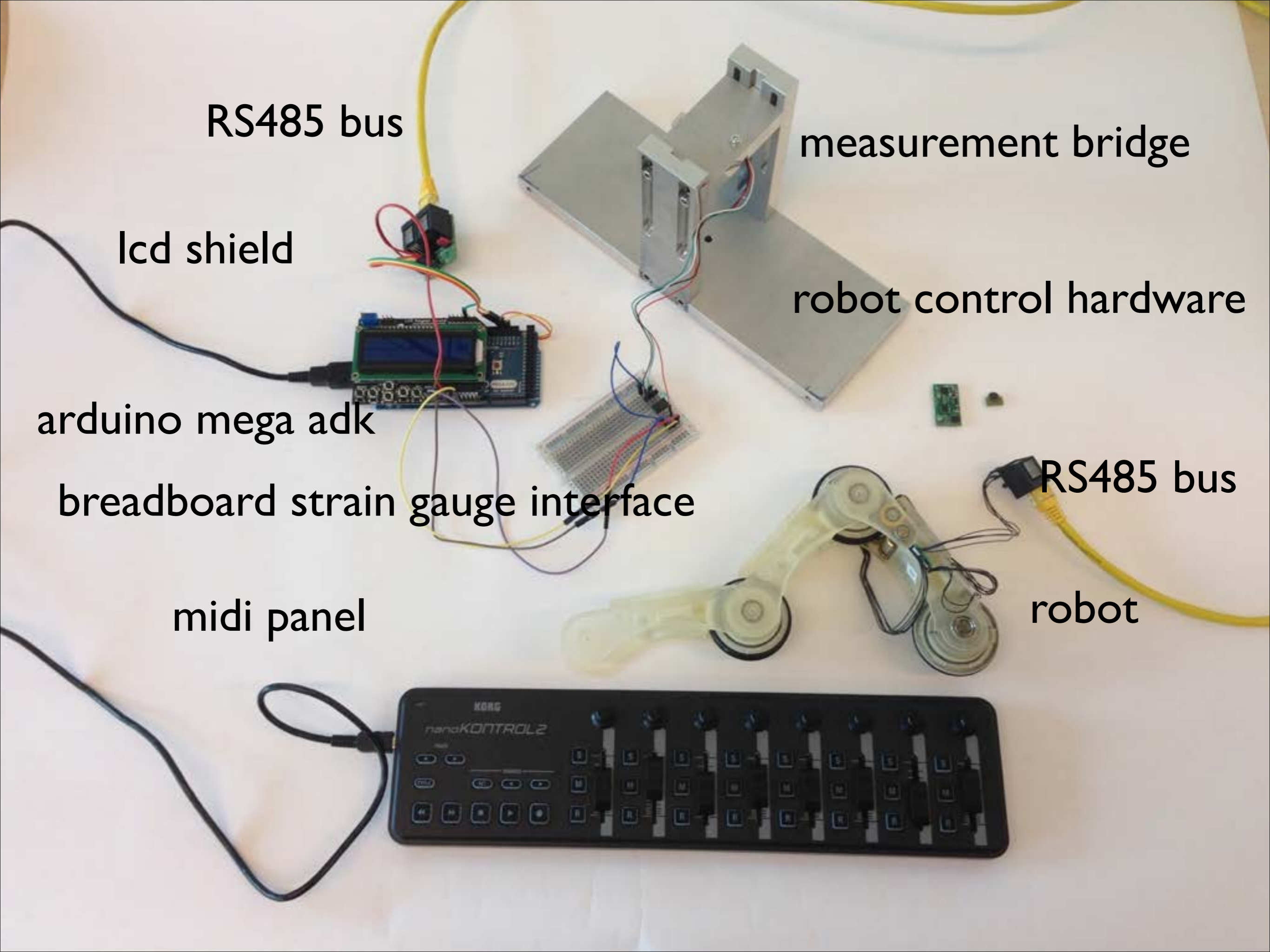
arduino mega adk

breadboard strain gauge interface

RS485 bus

midi panel

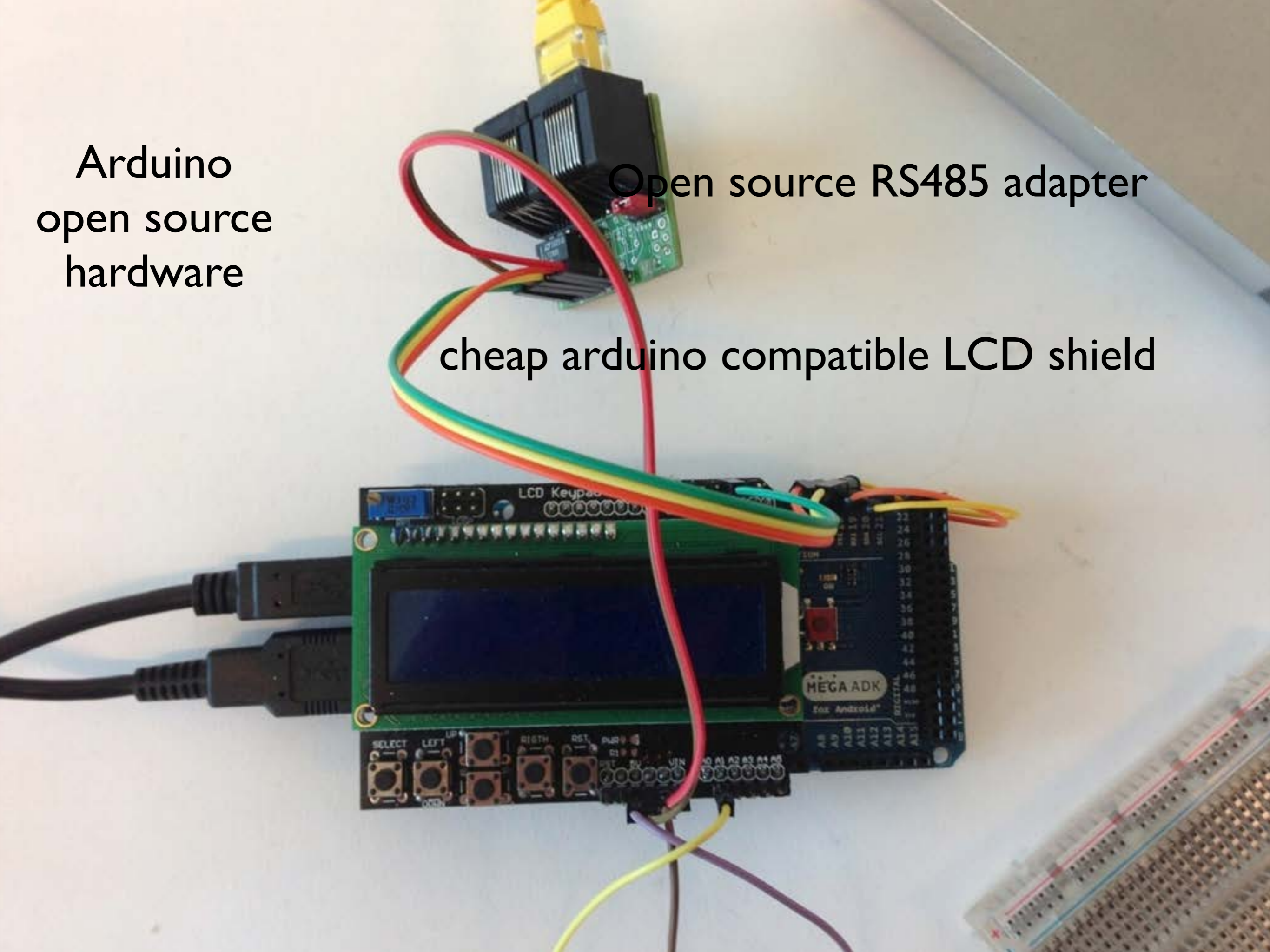
robot



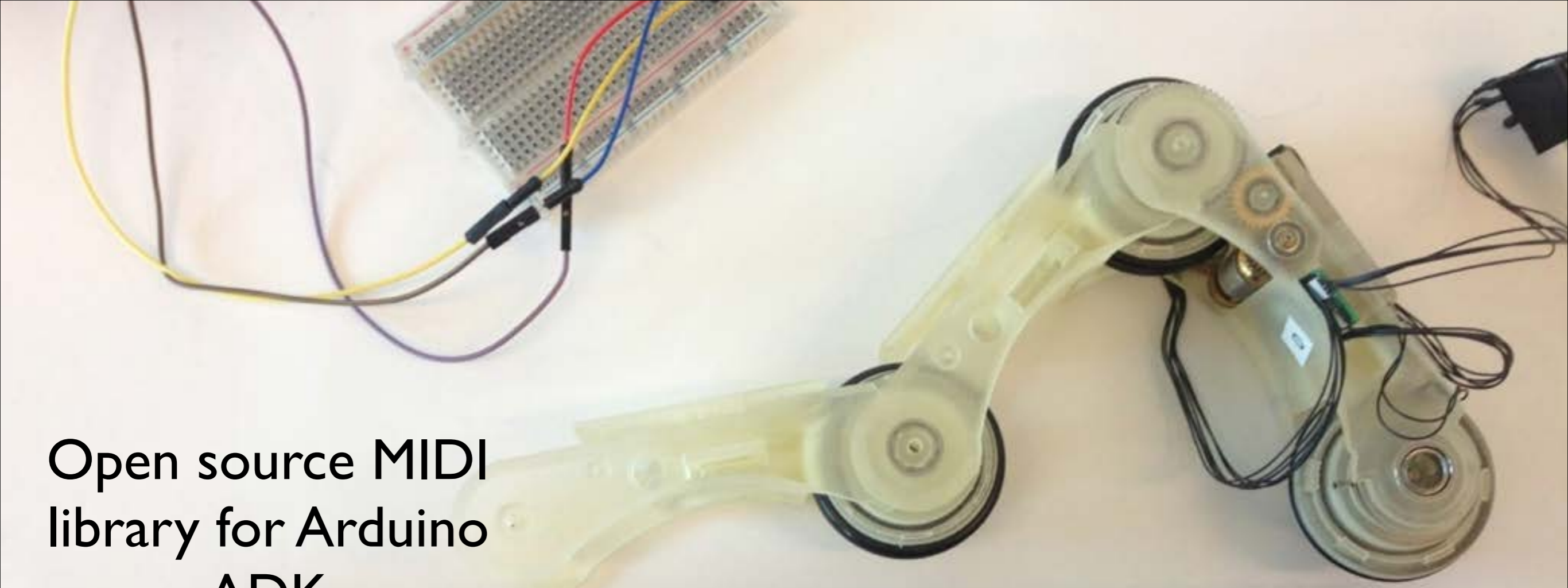
Arduino
open source
hardware

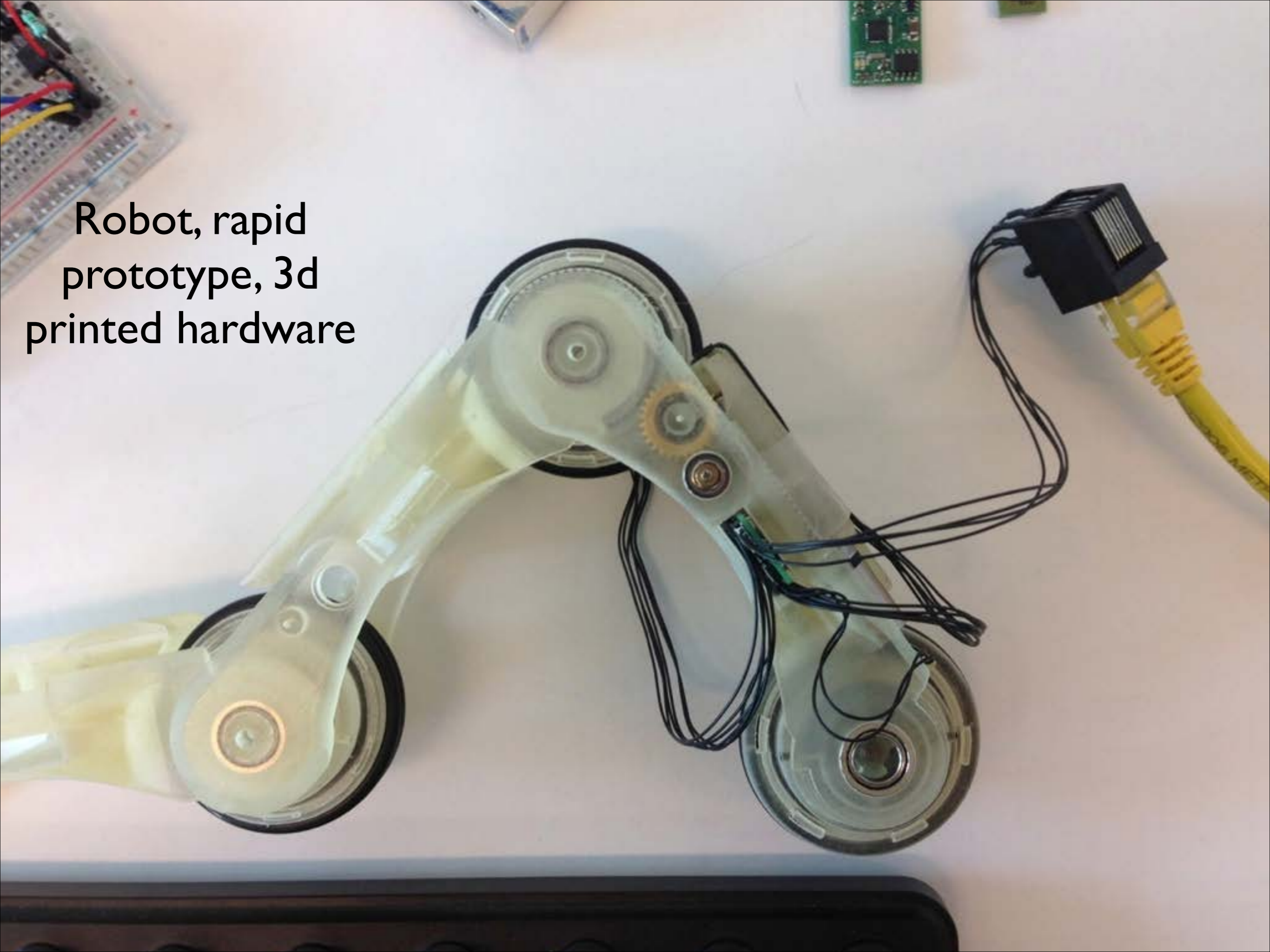
Open source RS485 adapter

cheap arduino compatible LCD shield



Open source MIDI
library for Arduino
ADK

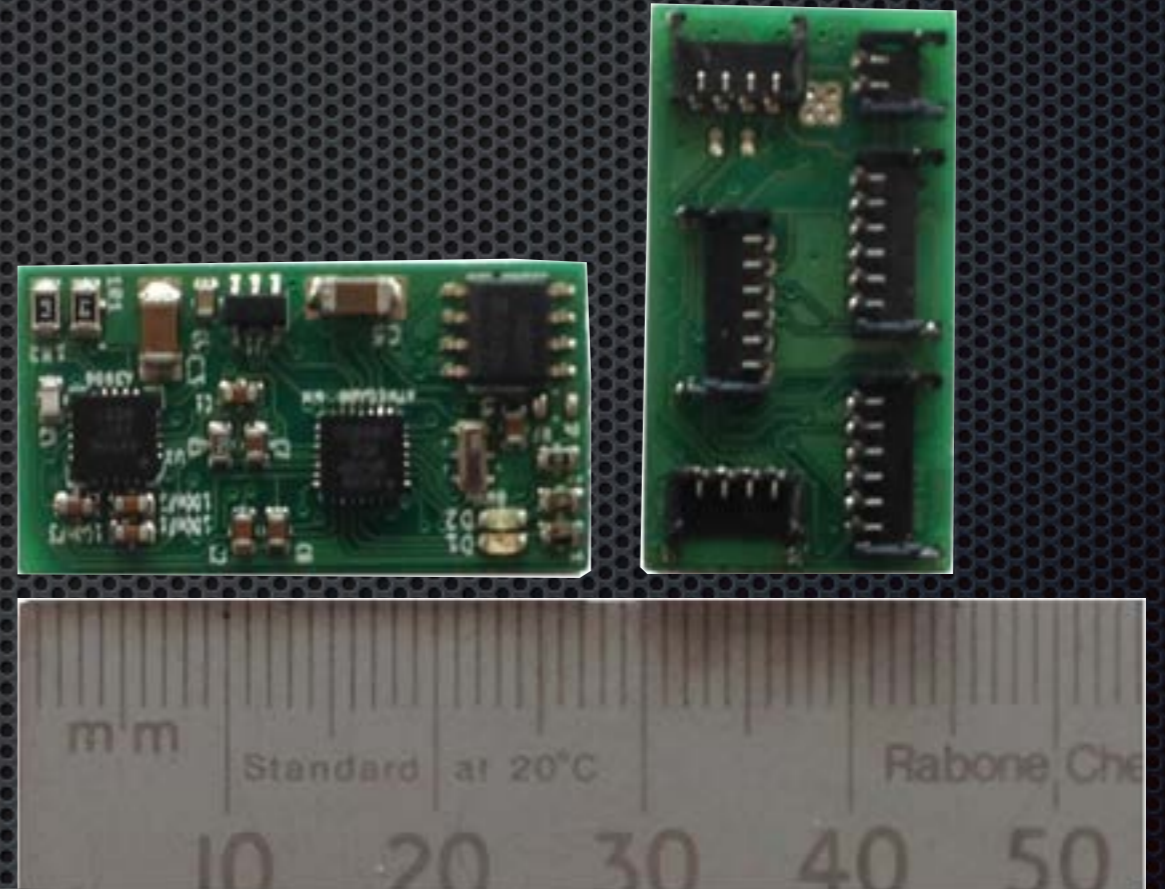




Robot, rapid
prototype, 3d
printed hardware

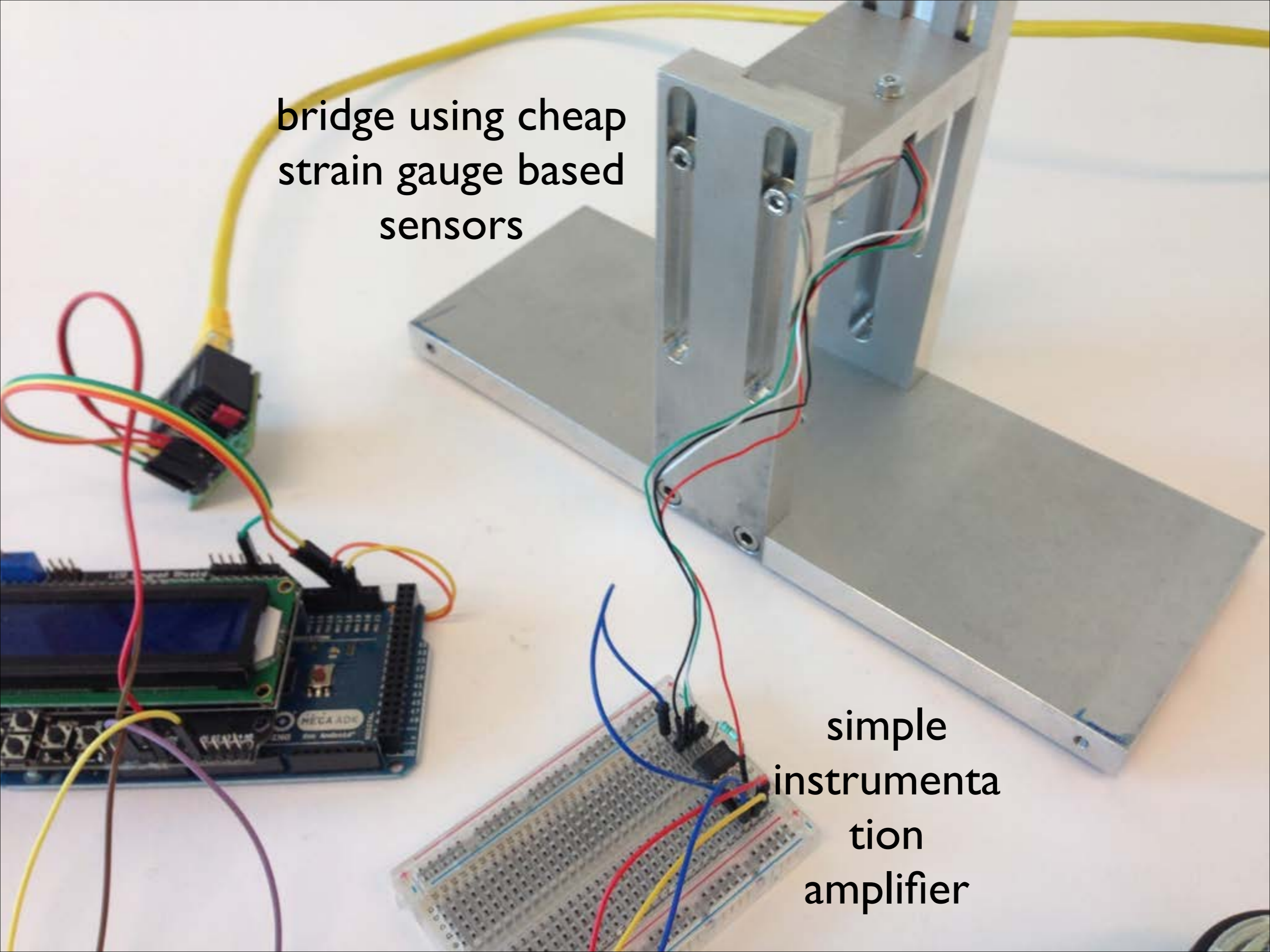
Control board

- ✦ RS485 bus motor control hardware
- ✦ fully Arduino compatible, both hardware and programming environment
- ✦ designed using open source package KiCAD



bridge using cheap
strain gauge based
sensors

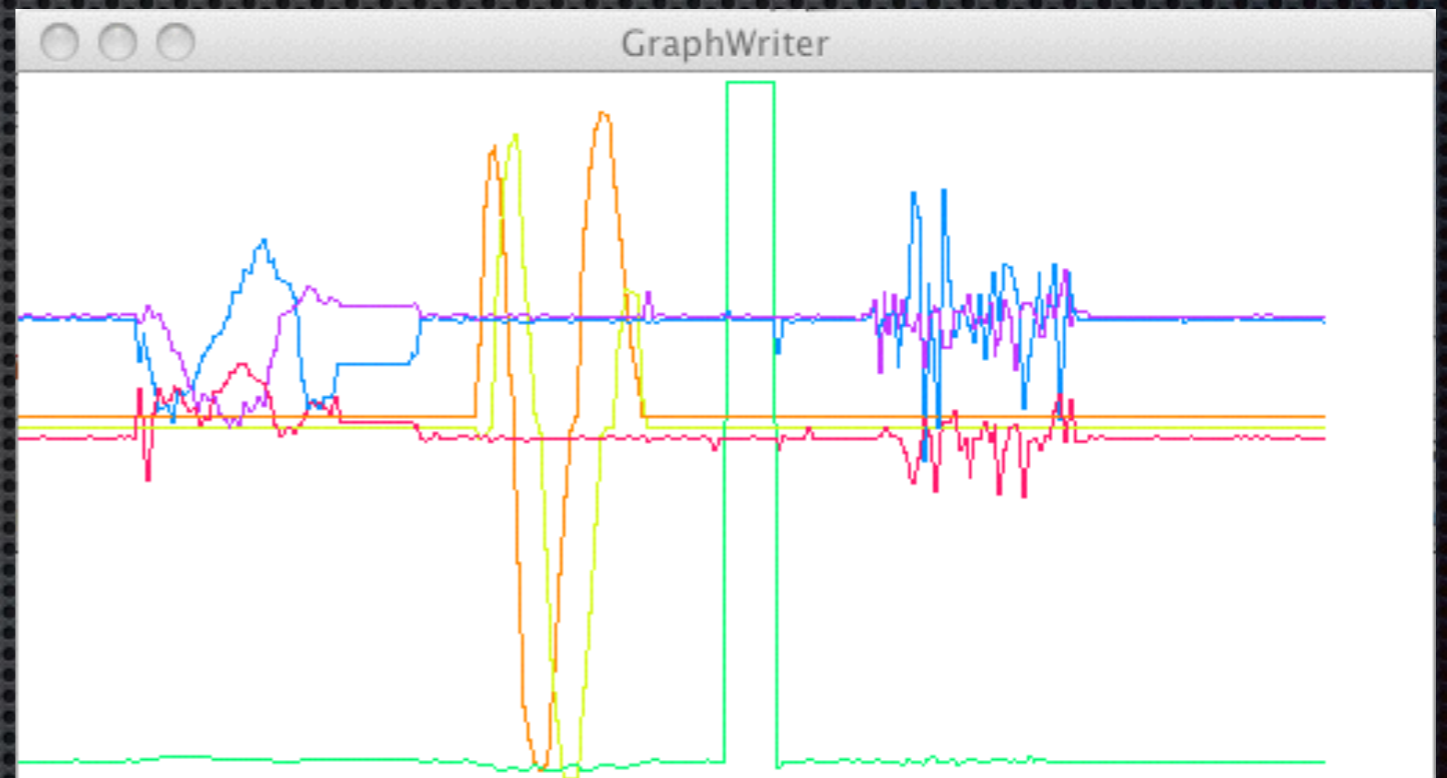
simple
instrumenta
tion
amplifier





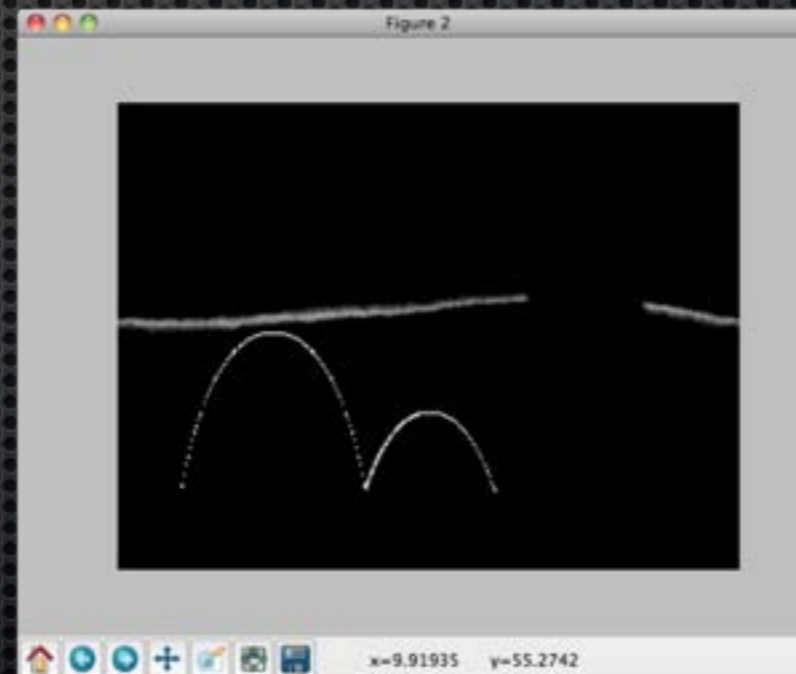
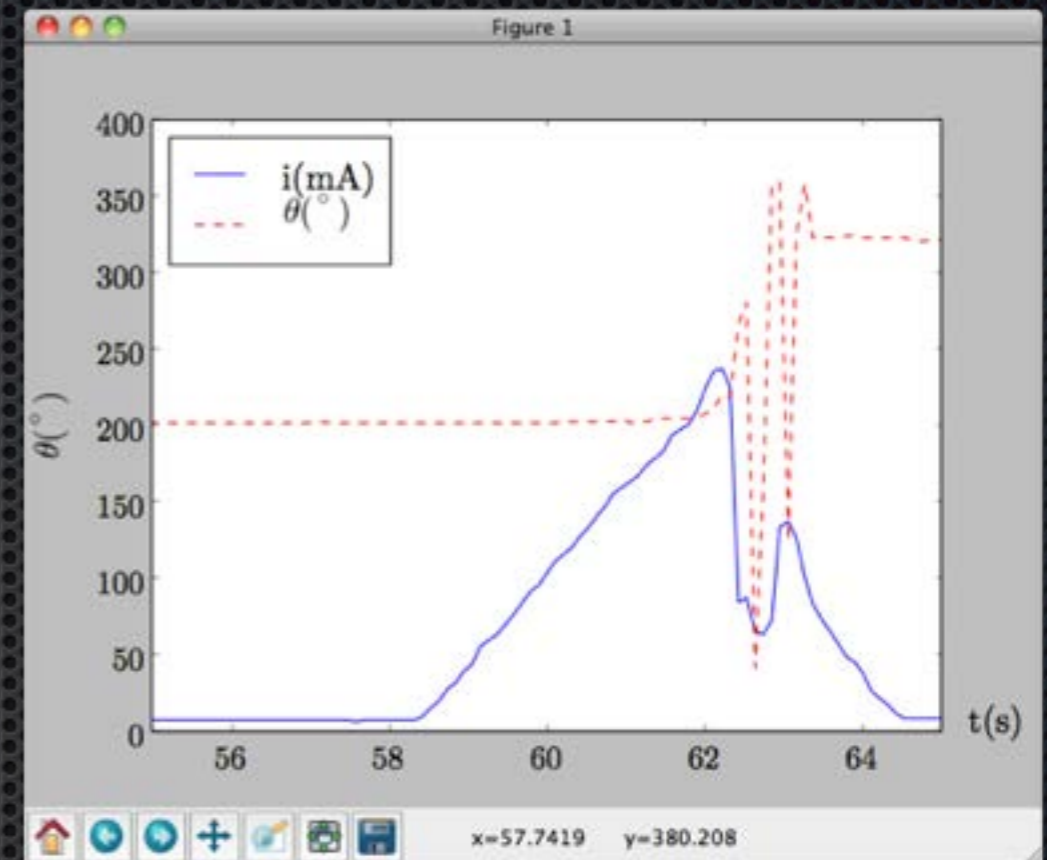
data processing and visualisation

- ✦ using processing.org
- ✦ online, realtime view
- ✦ also for control and communication, quick prototypes



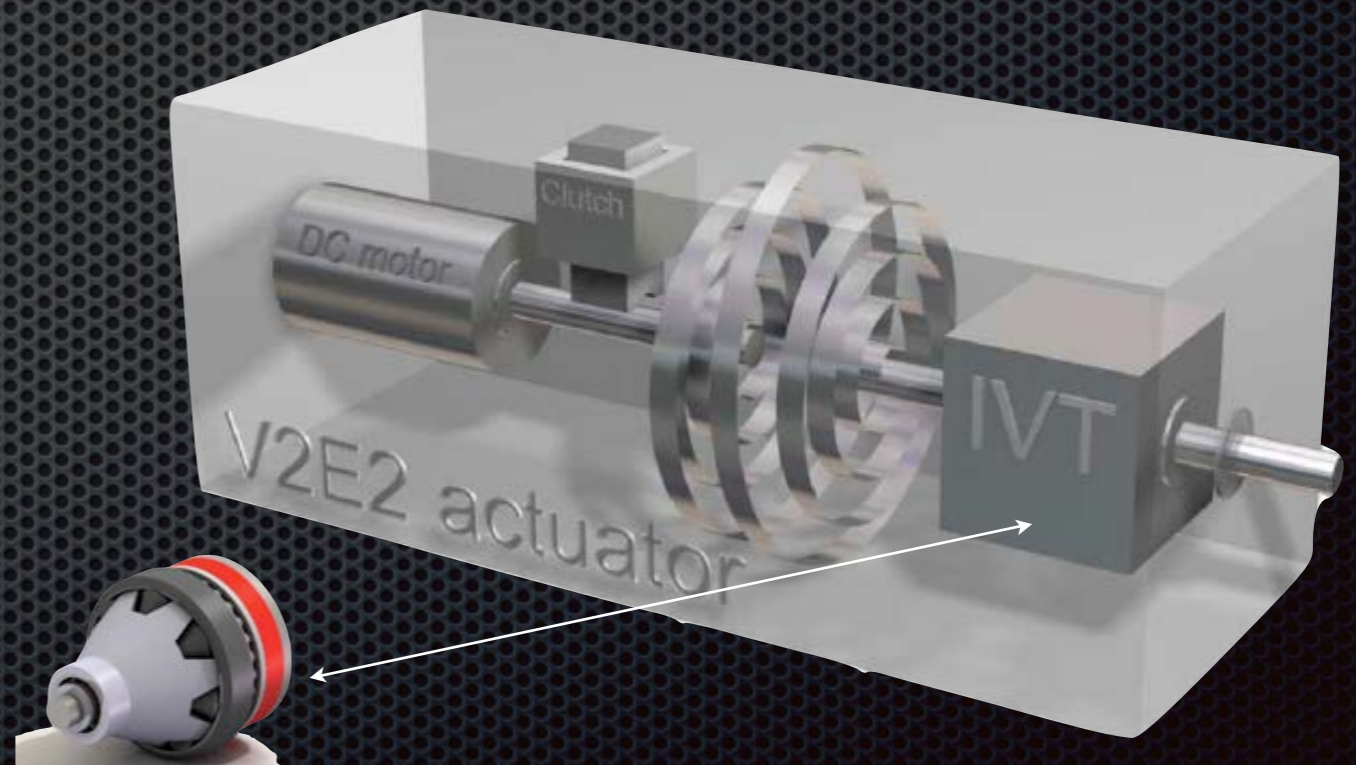
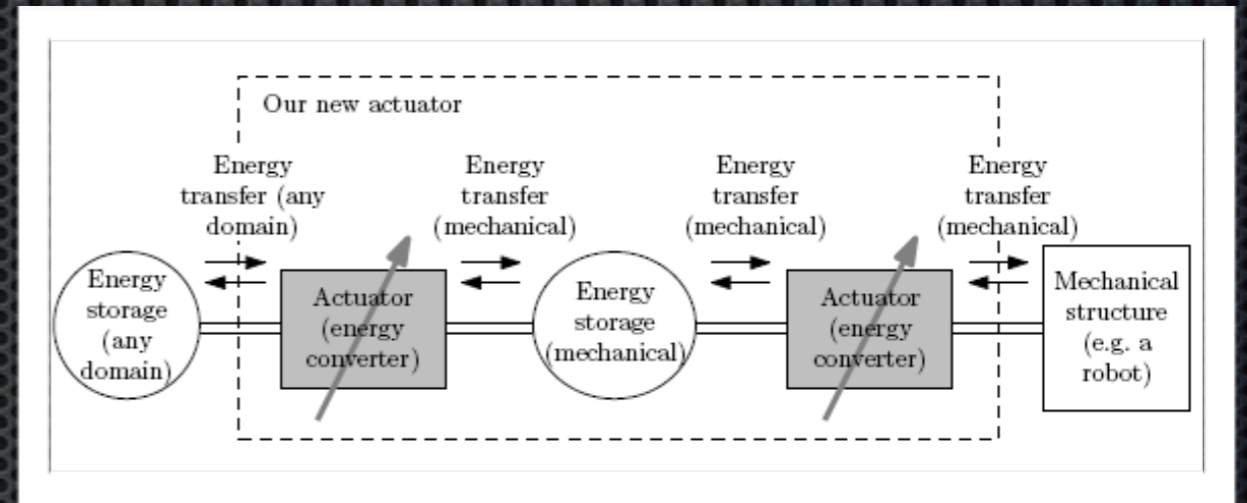
Python

- ✦ use for latex compatible graphs of measurement data
- ✦ use for vision processing

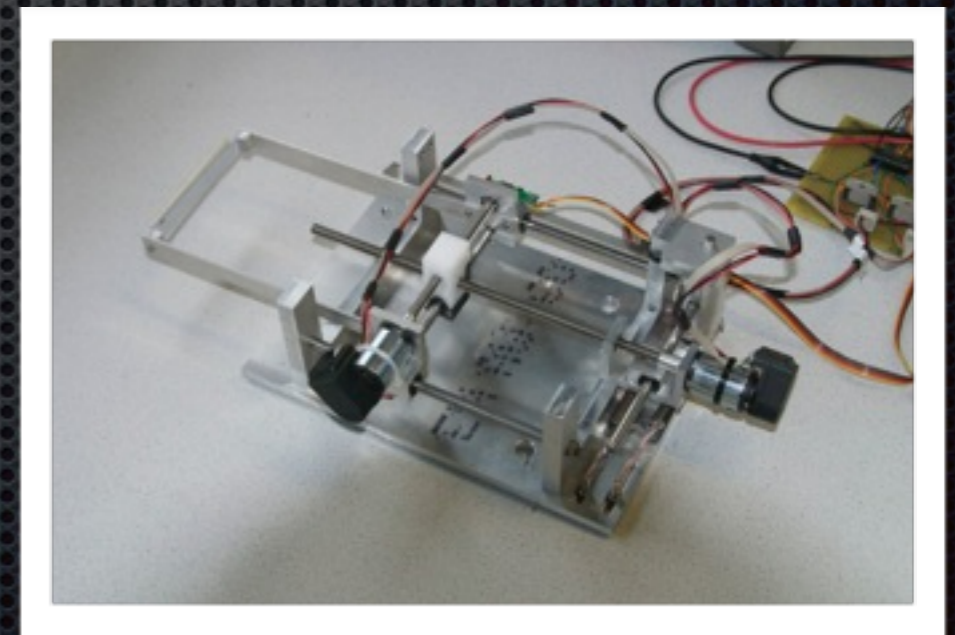
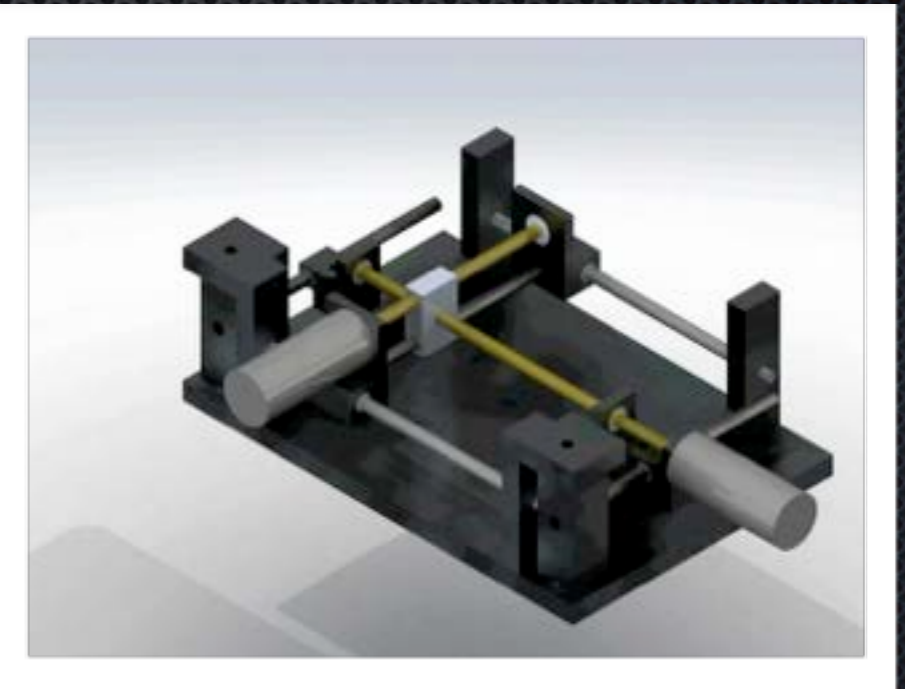
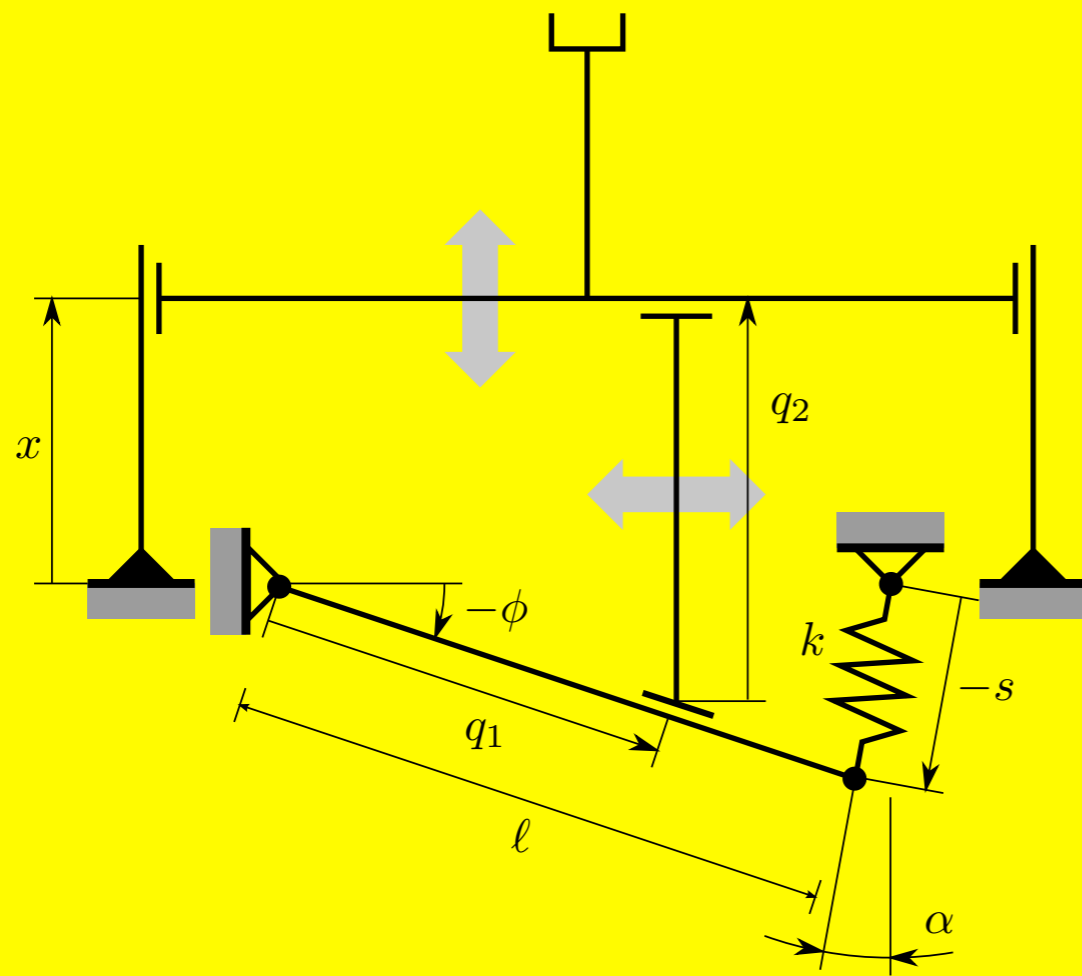


A Novel Variable Impedance Actuator

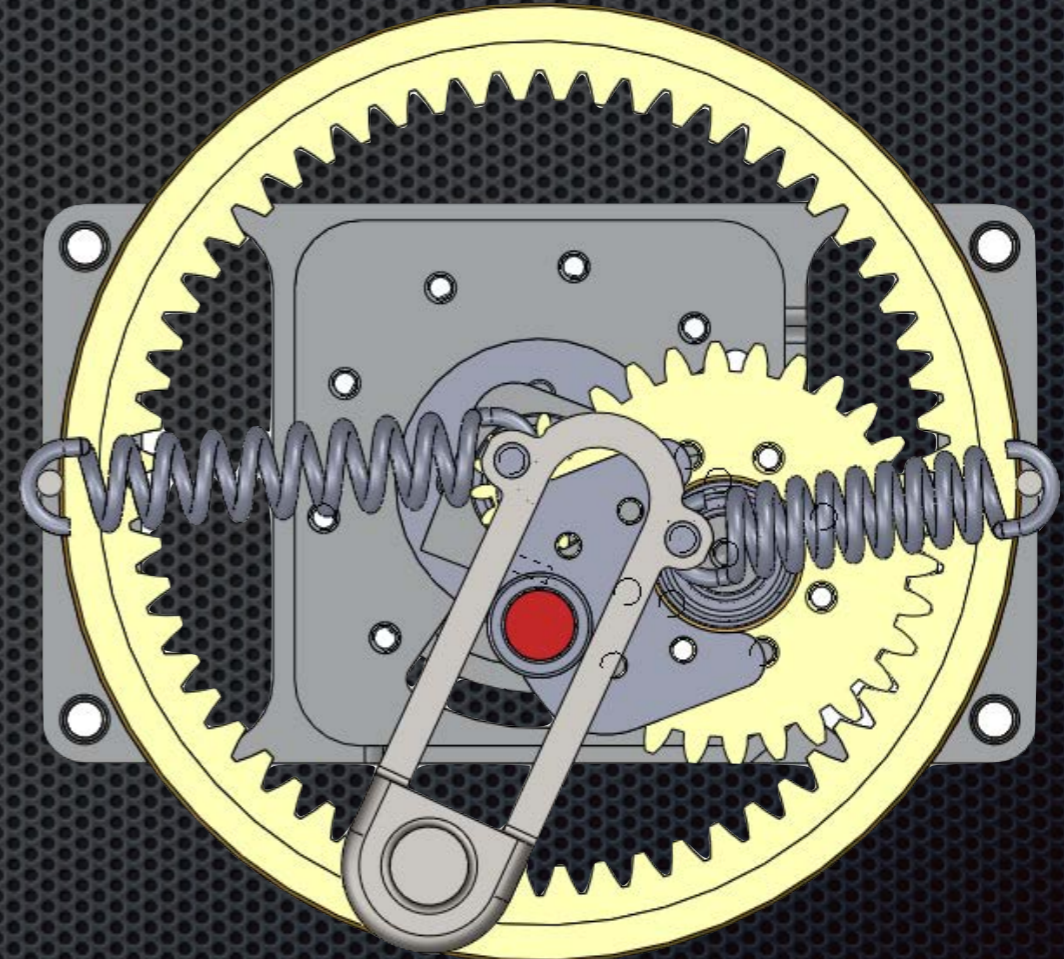
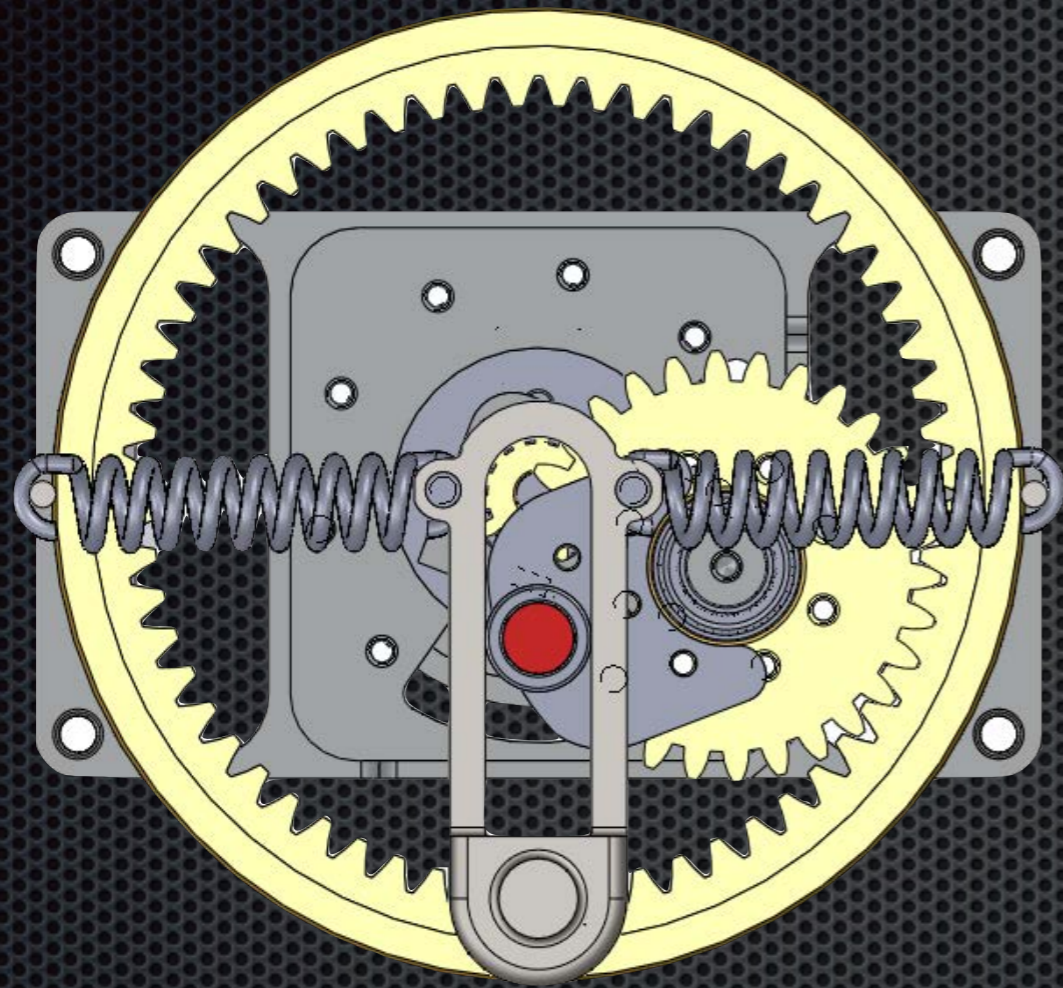
How things change in Actuators design...

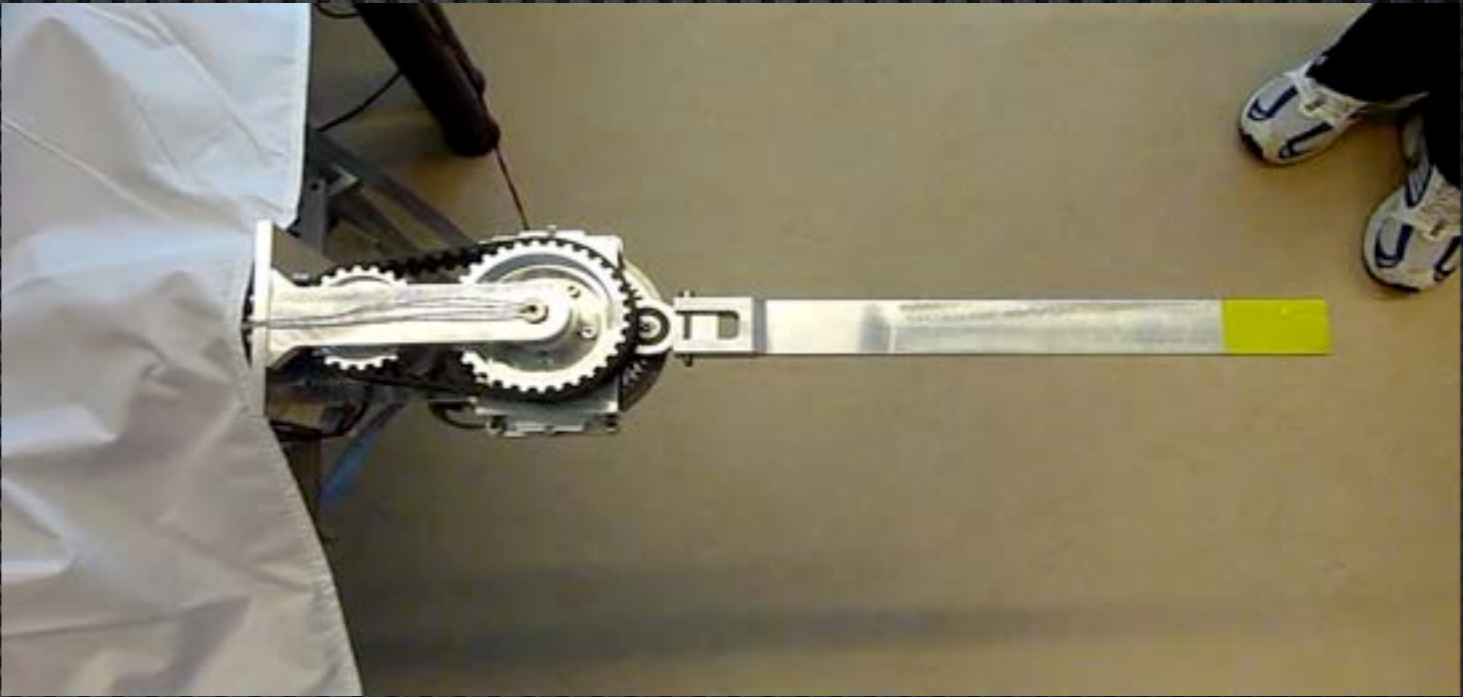
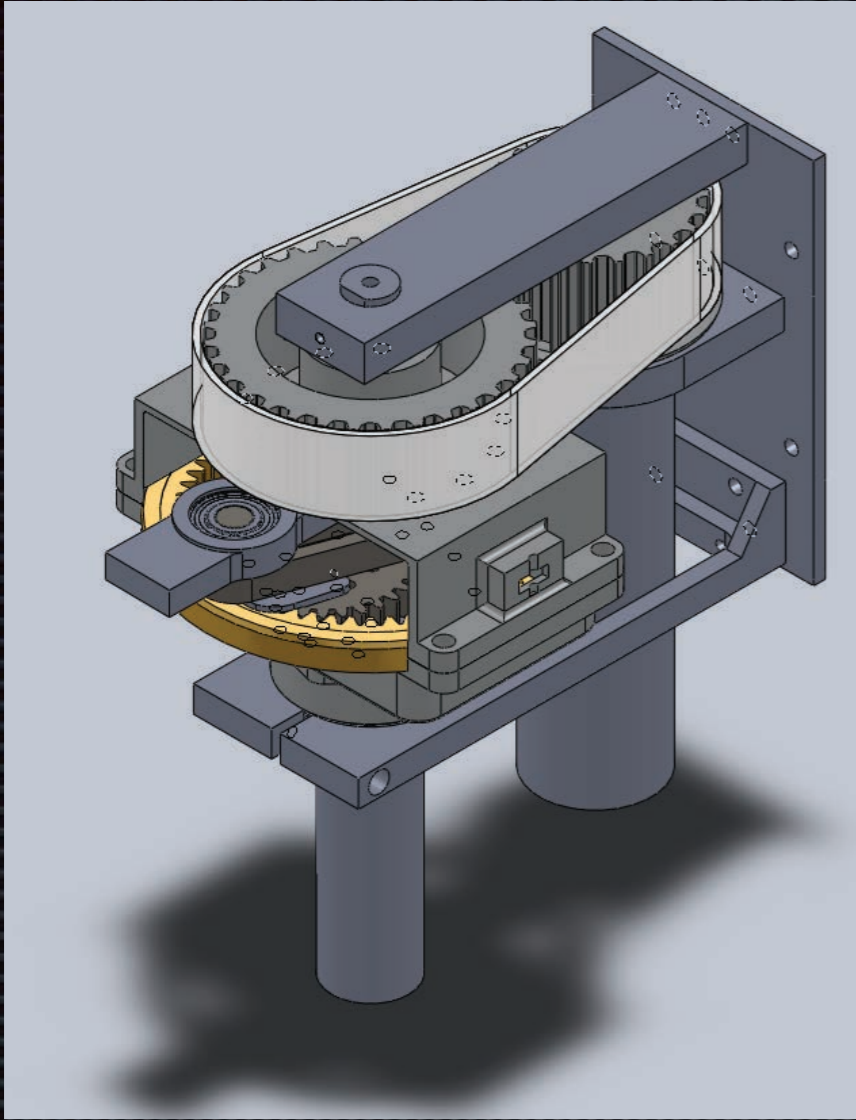


UT VIA1



UT VIA2





Limitations

✦ **Concept**

- ✦ Limited stroke in zero stiffness
- ✦ Space budget springs
- ✦ Range of springs and tenability not optimal

✦ **Production and testing**

- ✦ Long conceptualisation
- ✦ Long time for production
- ✦ All in metal

A Novel Variable Stiffness Mechanism
Capable of an Infinite Stiffness Range
and Unlimited Decoupled Output Motion

Patent Pending

THIS PART HAS BEEN EXCLUDED

Conclusions

- ✦ The way we built model and create is drastically changing
- ✦ Rapid prototyping: 3D printing laser cutting is revolutionising and changing the way we test and produce mechanical parts
- ✦ High quality electronic tools are free in open source
- ✦ Software Development Tools are available, cheap and tough more and more at schools
- ✦ Mechatronics and Robotics is evolving!