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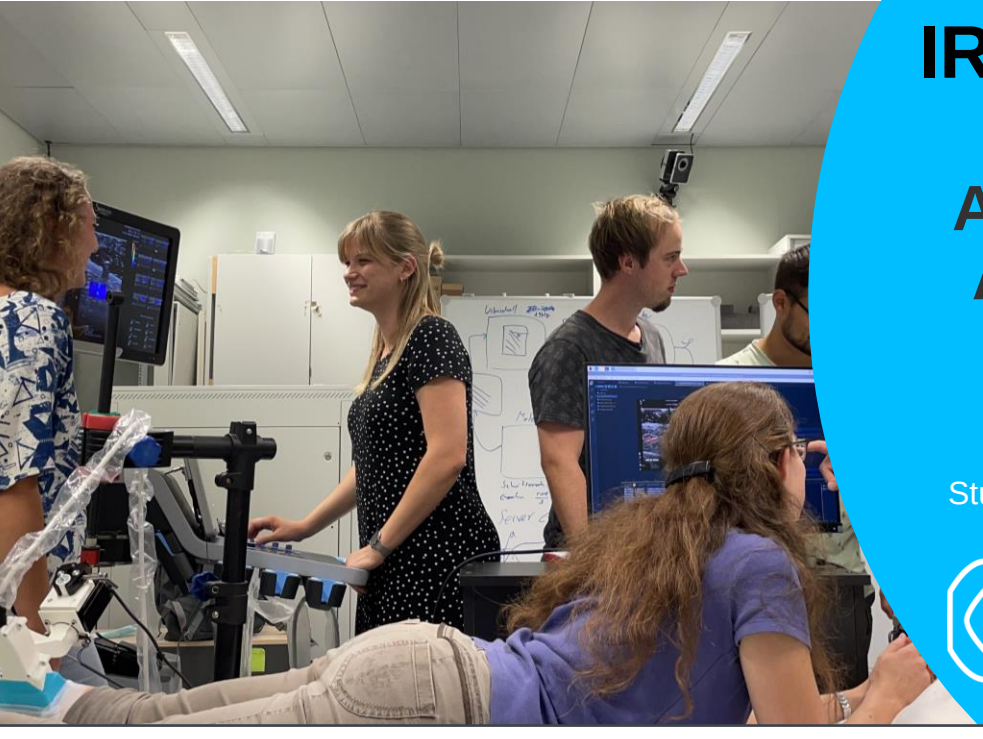


IRTG Summer School 2022

Automated Ultrasound Probe Alignment (AUPA) for Shear Wave Elastography

Stuttgart, 24 August 2022

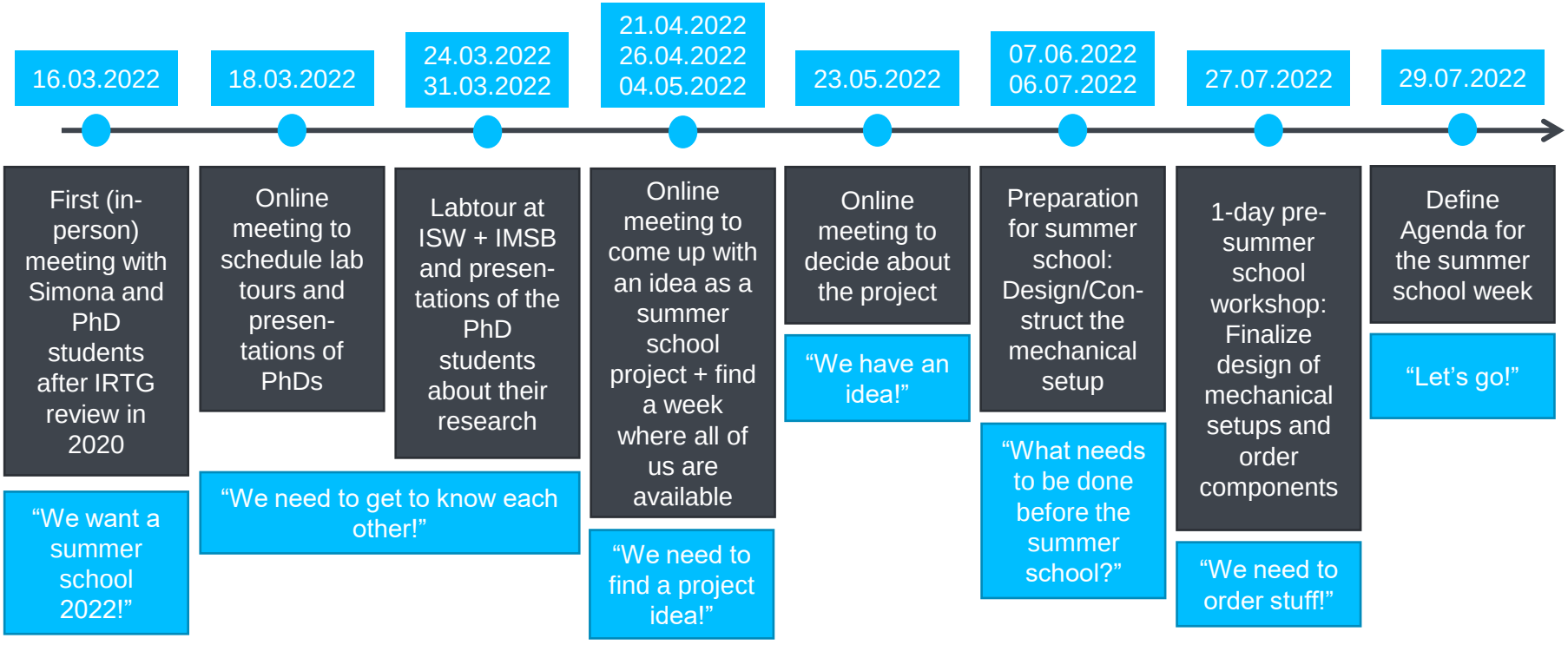
IRTG 2198/1
Soft Tissue Robotics

University of Stuttgart
Germany

THE UNIVERSITY OF AUCKLAND
NEW ZEALAND

DFG Deutsche Forschungsgemeinschaft
German Research Foundation

Timeline



Automated catheter guidance in a phantom

Automated ultrasound probe alignment for muscles

University of Stuttgart
Germany

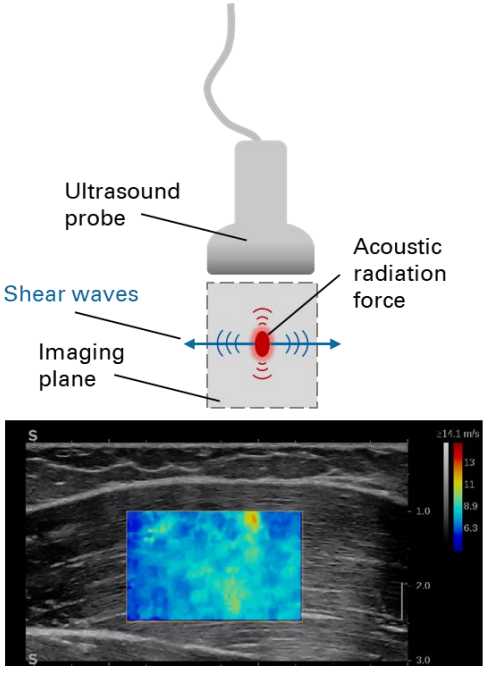
THE UNIVERSITY OF AUCKLAND
NEW ZEALAND

Motivation

Shear Wave Elastography

- … is a non-invasive measurement technique to assess **stiffness of soft tissues**:
  acoustic radiation force impulses - send by the ultrasound probe - generate a shear wave that is travelling in the imaging plane
- Necessary assumptions: homogeneous, isotropic material
- For muscles, it was shown that shear wave velocity correlates to skeletal muscles elastic modulus only if **probe is aligned with muscle fiber direction** [1]

→ Shear wave travels along muscle fibers



[1] Eby S.el al., *Validation of shear wave elastography in skeletal muscle*, 2013, Journal of Biomechanics (2013) 46:2381-2387

Project Overview

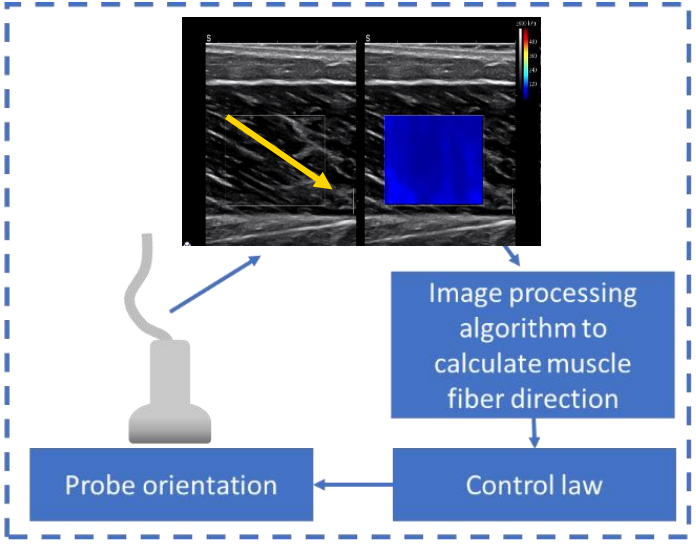
Automated probe alignment for Shear Wave Elastography

→ Automated robotic ultrasound probe alignment

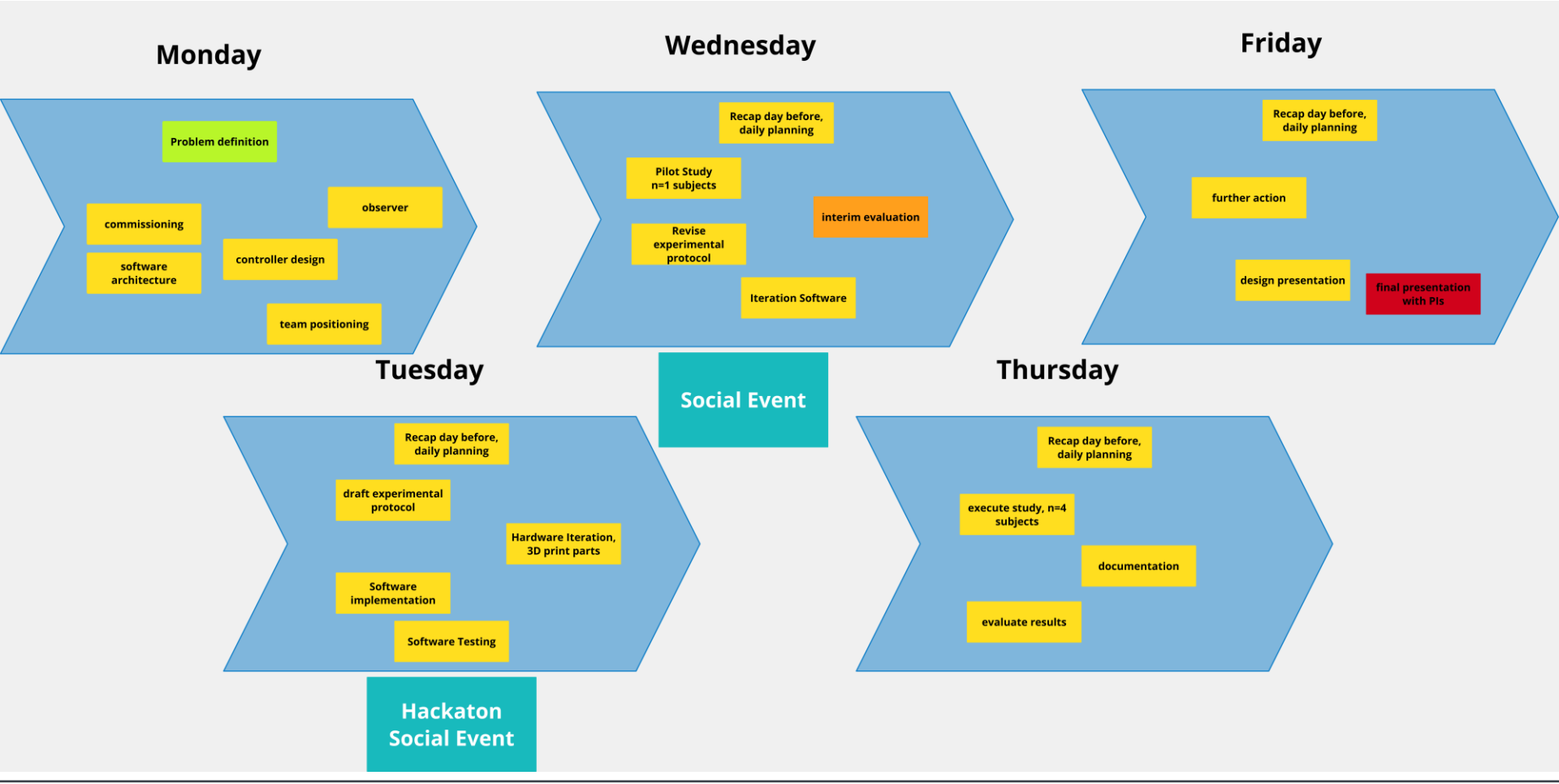
→ Evaluate SWE of pennate muscles with US probe aligned to fascicles during contraction

Our main tasks were:

1. Construct mechanical setup including actuator
2. Calculate muscle fiber direction from the B-Mode ultrasound images (image processing)
3. Design controller for probe orientation
4. Perform experimental study to evaluate the influence of the probe alignment



Agenda


Monday
Problem definition
commissioning
observer
software architecture
controller design
team positioning
Wednesday
Recap day before, daily planning
Pilot Study n=1 subjects
interim evaluation
Revise experimental protocol
Iteration Software
Friday
Recap day before, daily planning
further action
design presentation
final presentation with PIs
Tuesday
Recap day before, daily planning
draft experimental protocol
Hardware Iteration, 3D print parts
Software implementation
Software Testing
Hackaton Social Event
Social Event
Thursday
Recap day before, daily planning
execute study, n=4 subjects
documentation
evaluate results

Individual Results

Soft skills:

- Project management including scheduling, controlling and replanning
- Collaboration in individual teams with dedicated sub-presentations to update other teams
- Use of creative thinking methods (e.g. Brainstorming)
- Shifting resources (manpower) to achieve the schedule and help out each other

Hard skills:

- Ultrasound & shear wave elastography
- CAD design
- Electric design
- Image processing
- Controller design and software architecture

And who is an expert in this subdiscipline!

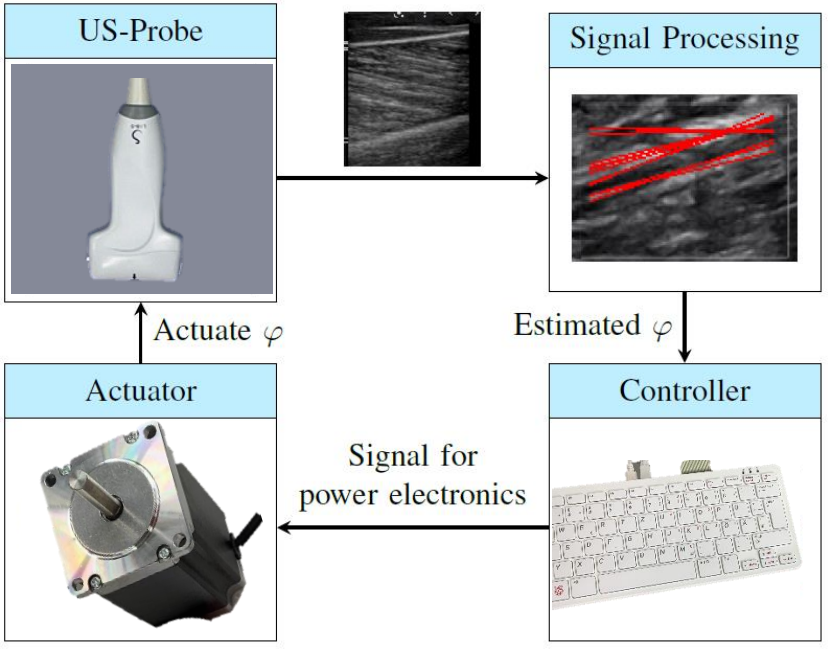
Project Results

Hardware setup:

- Ultrasound probe case
- Ultrasound probe fixture
- Gel reservoir

Stepper controller:

- Smoothing
- Angles to steps
- Reference motion



Observer:

- Capture images
- Edge detection
- Angle detection

Controller:

- Outlier detection

Impressions