ROBOT
PROGRAMMING AND CONTROL

Theory and Practice

Practice is when everything works but no one knows why

Theory is when you know everything but nothing works

After this course you should make things work and know why they work

Course Organization

- **Teachers**
- Module A: Andrea Calanca – andrea.calanca@univr.it
- Module B: Diego Dall'Alba – diego.dallalba@univr.it
- **Teaching hours**
  - Tuesday 14.30 – 16:30 – Lab. Ciberfisico
  - Thursday 13.30 – 16:30 – Lab. Ciberfisico
- **Office Hours:**
  - Appointment by e-mail
- **Assessment Methods And Criteria**

  The exam will consist of
  - Mandatory homework
  - Optional homework (2+2 points)
  - A project (26 points)

Splitting between lab and theory is not strict!

Assessment Methods And Criteria

Each module will assign homework during the lecture period which will be independently verified. Please refer to the detailed information provided by each teacher.

To pass the exam each student

- must complete the mandatory homework of each module during the lecture period (0 points)
- can complete the optional homework of each module during the lecture period (2+2 points)
- must complete a project related to only one module (26 points)

Course Prerequisites

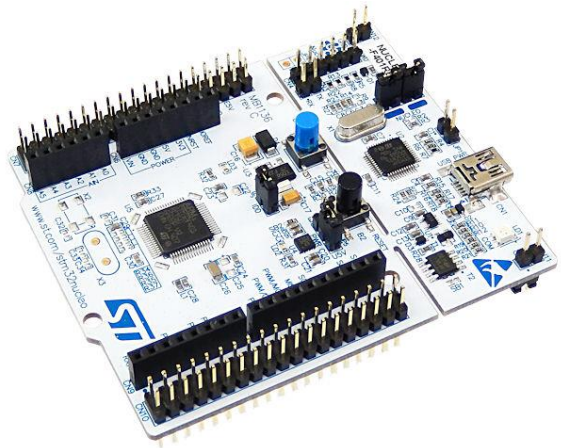
- Linear Algebra
  - Matrices, linear operators, vector spaces
- Newton Mechanics
  - Motion equations, linear and rotational
- Classic (Linear) Control Theory (Continuous systems)
  - Laplace transform, Bode diagrams
- Matlab
- Basic programming skills (c)
- Object oriented programming (c++)

Course Material

No testbook available!

- Slides and Notes provided by the teachers
- Lessons hand notes
- Shared Material on Moodle
- GitLab Repository

- Module A – Embedded programming and Control



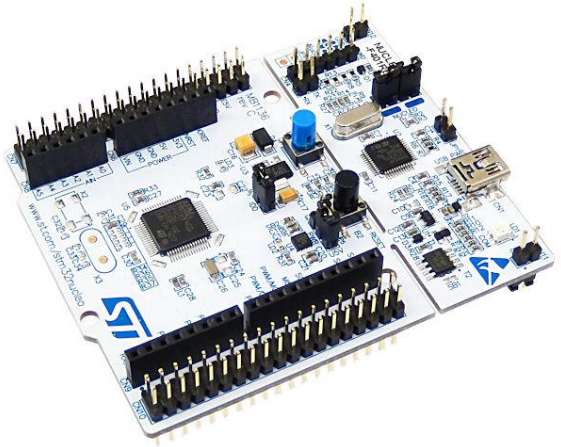
- Module B – Robot Programming with ROS

ROS

Module A - Topics

- Sensors
- Actuators
- Power Electronics
- Embedded Programming
  - Microcontroller overview
  - Peripheral management
  - Real-time execution
- Control theory in practice
  - ….
  - ….
  - ….

Everything you saw in robotics ….plus more!



Module B - Topics

Everything you saw in robotics ….plus more!

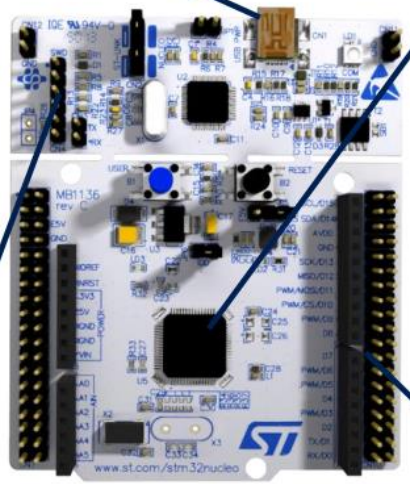
- High level robot programming, focusing on industrial manipulator task
  - Modern approach to robotics: conventions and data representation
  - Motion planning: from general concepts to real robot motions
  - Robotic system integration: EE tooling, simple work-cell design, external com, and much more
- Software engineering for robotic applications:
  - Best practice in complex robotic projects
  - Robotic middleware:
    - ROS case study: crash course + motion plan
    - ROS evolution: ROS Industrial and ROS2

ROS.org

Module A

Power supply through USB or external source

Integrated debugging and programming ST-LINK probe



STM32 microcontroller

STM32 F0 STM32 F1 STM32 F2 STM32 F3 STM32 F4 STM32 F7

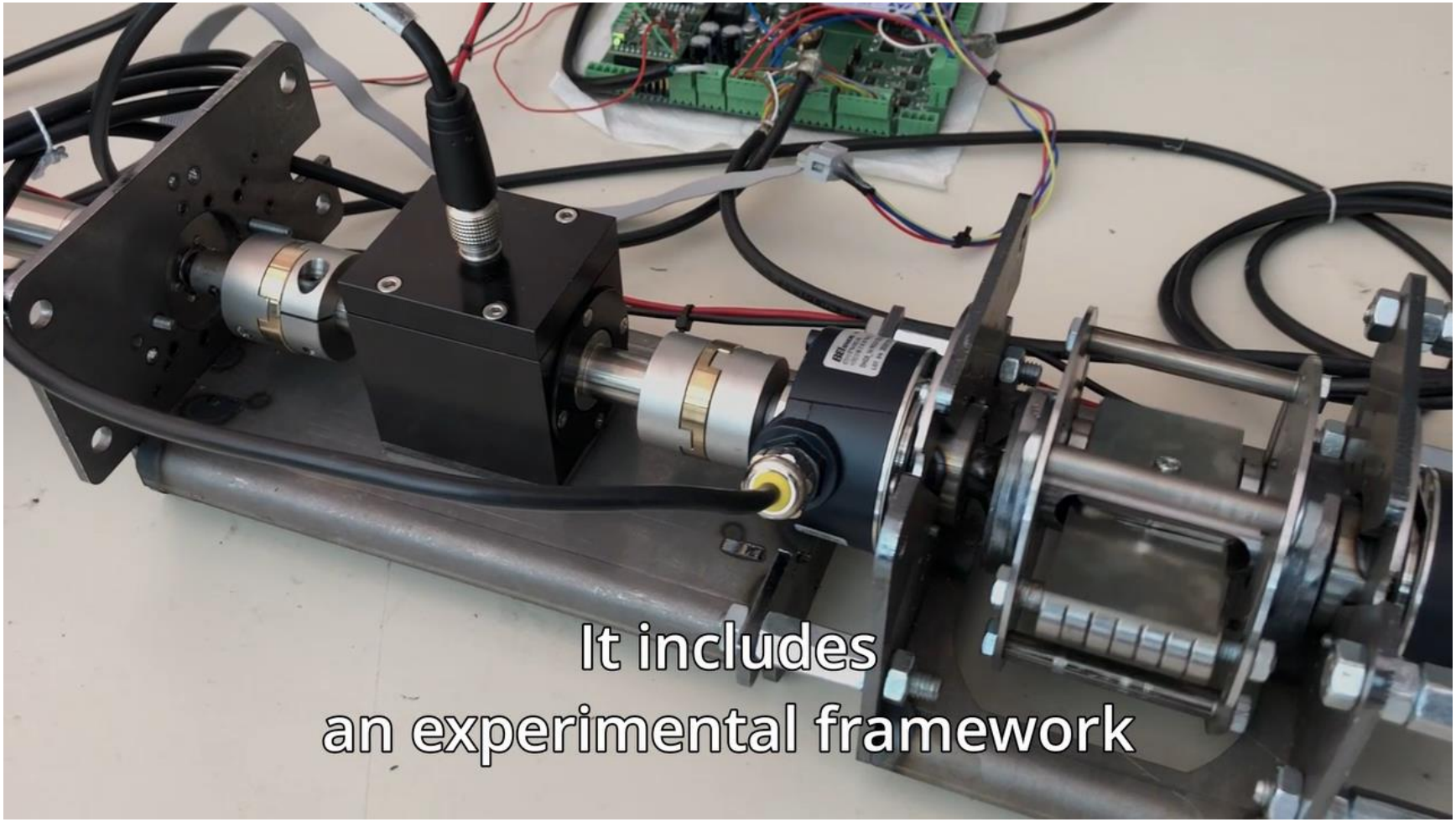
STM32 L0 STM32 L1

Complete product range
from ultra-low power to high-performance

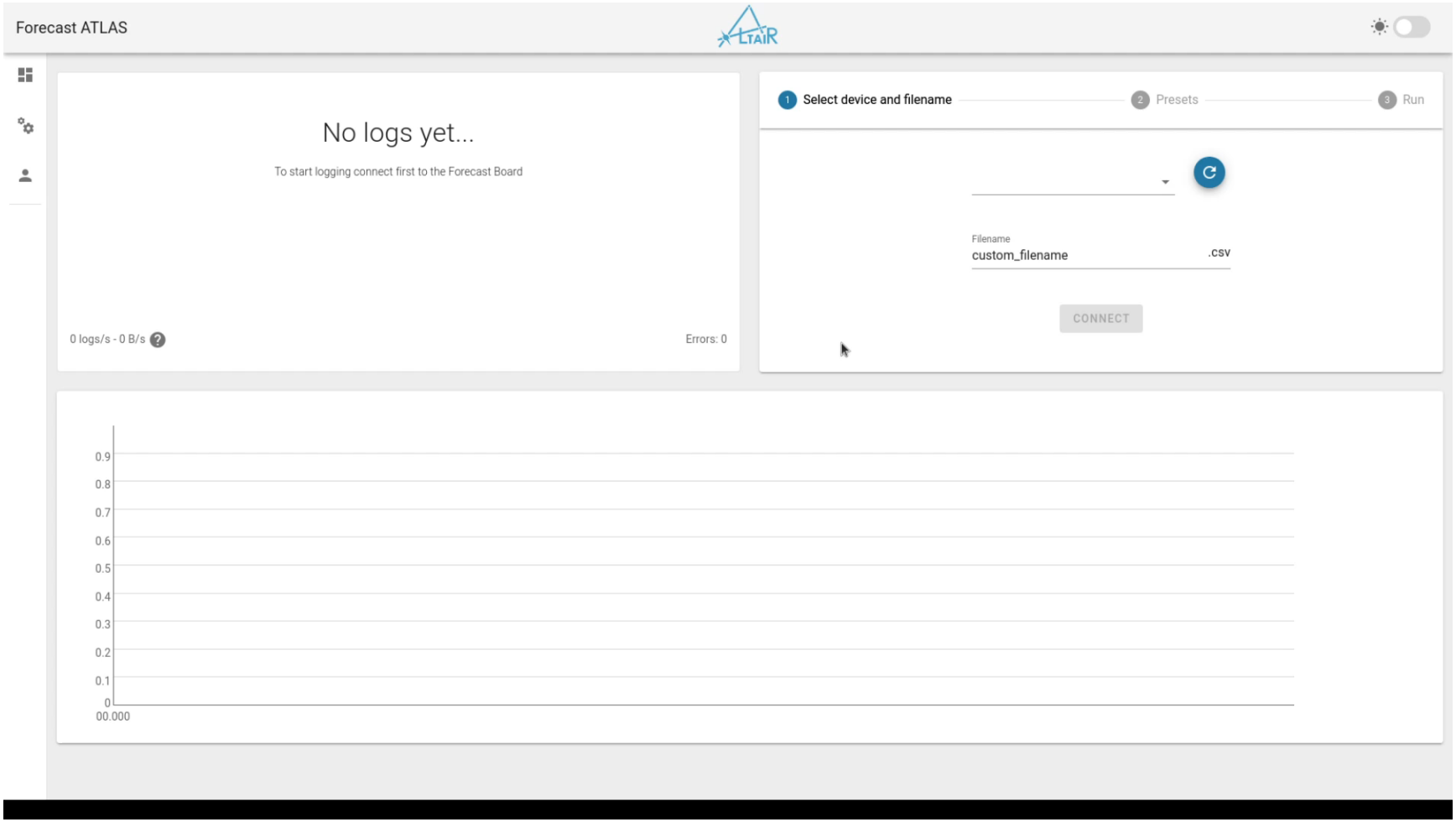
ST Morpho and Arduino™ UNO R3 extension headers

STM32 Nucleo

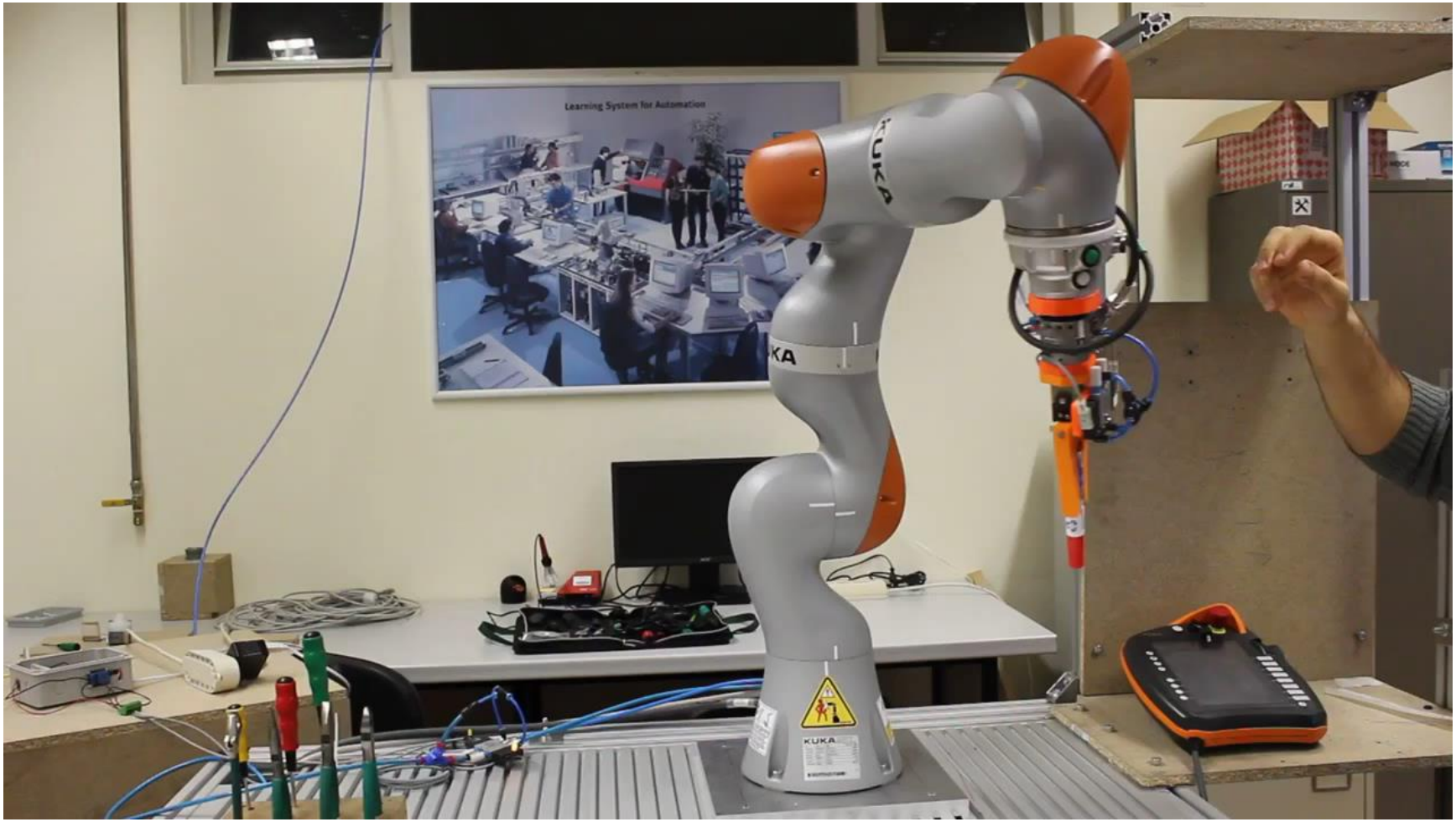
Module A



Module A


Forecast ATLAS
No logs yet...
To start logging connect first to the Forecast Board
0 logs/s - 0 B/s
Errors: 0
1 Select device and filename
2 Presets
3 Run
Filename
custom_filename
.csv
CONNECT
0.9
0.8
0.7
0.6
0.5
0.4
0.3
0.2
0.1
0
00.000

Virtual Stiffness by Force Control



Transparency by Force Control

A project done with a couple of students