University of Ljubljana
Faculty of Electrical Engineering

Modelling and simulation for automatic control design

Maja Atanasijević-Kunc
maja.atanasijevic@fe.uni-lj.si

Sofia, October 6, 2016

University of Ljubljana
Faculty of Electrical Engineering
Department of Systems, Control and Cybernetics

http://msc.fe.uni-lj.si/Index.asp

Prof. dr.
Gašper MUŠIČ

Asst. Prof. dr.
Vito LOGAR

Asst. Prof. dr.
Gorazd KARER

University of Ljubljana
Faculty of Electrical Engineering
Department of Systems, Control and Cybernetics

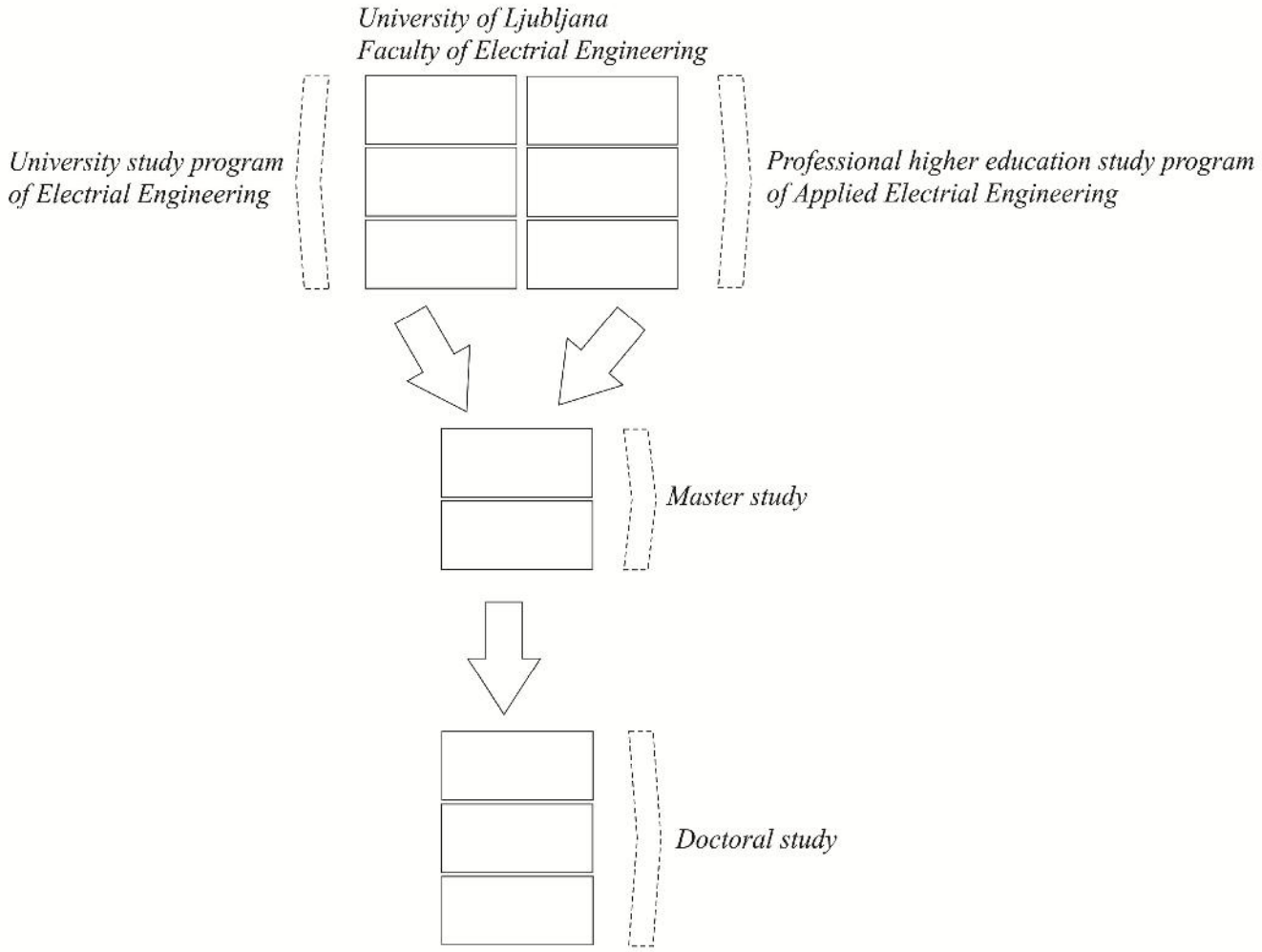
Laboratory of modelling, simulation and control

Head: prof. dr. Borut Zupančič

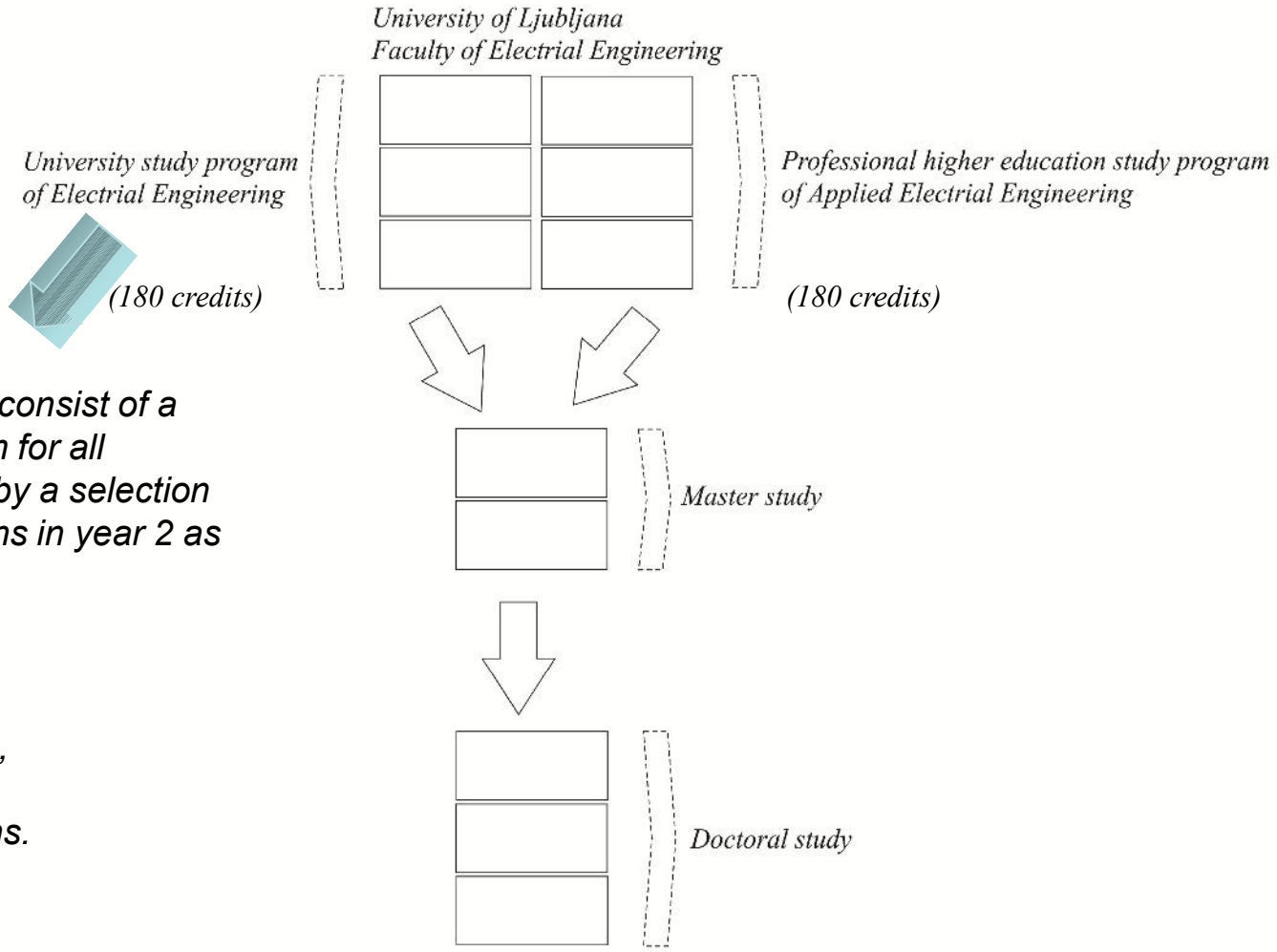
Laboratory of autonomous mobile systems

Head: prof. dr. Igor Škrjanc

Organization of Education Process



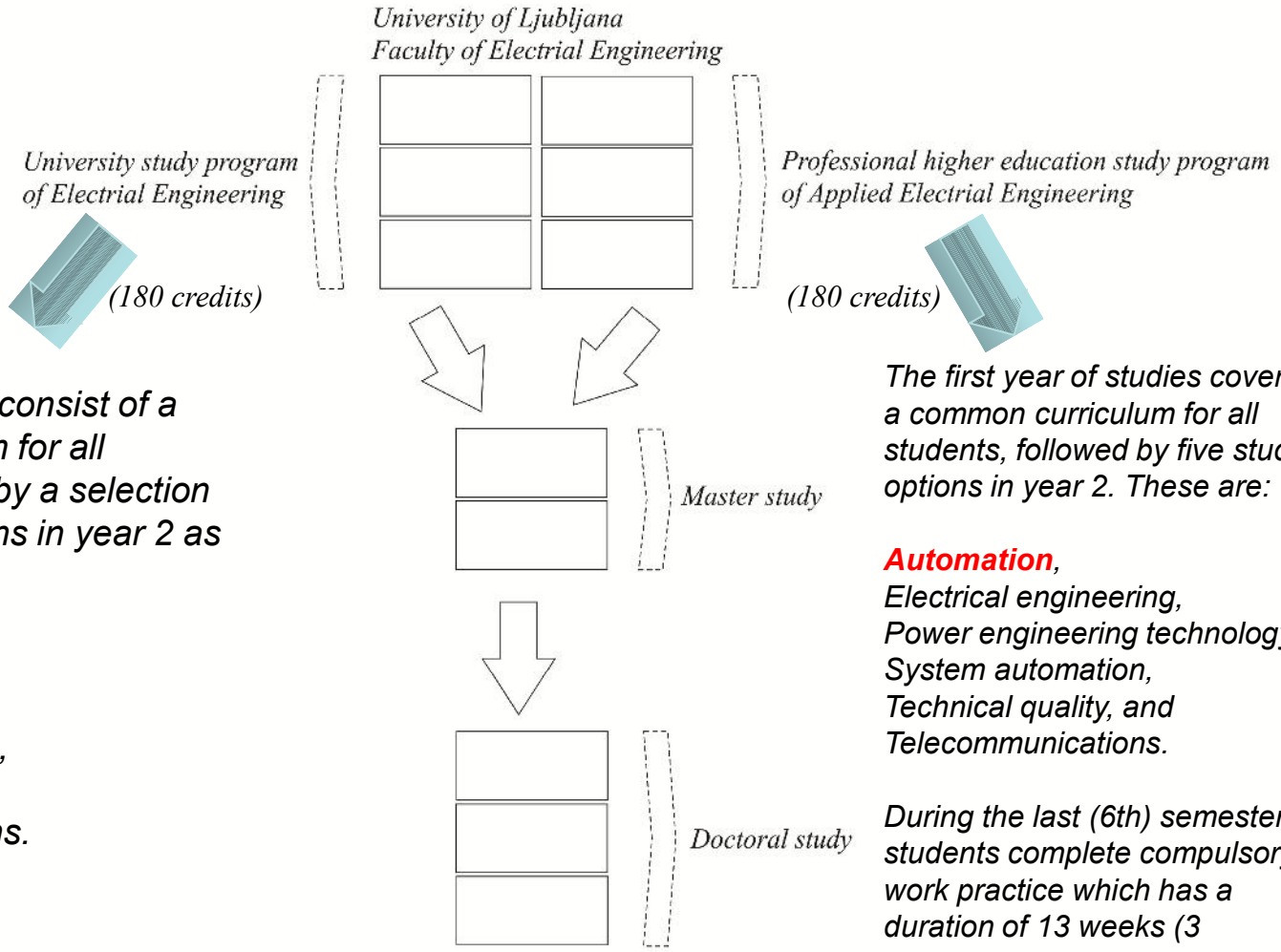
Organization of Education Process



The first two years consist of a common curriculum for all students, followed by a selection of four study options in year 2 as follows:

Automation,
Electronics,
Power Engineering,
Mechatronics, and
Telecommunications.

Organization of Education Process



The first two years consist of a common curriculum for all students, followed by a selection of four study options in year 2 as follows:

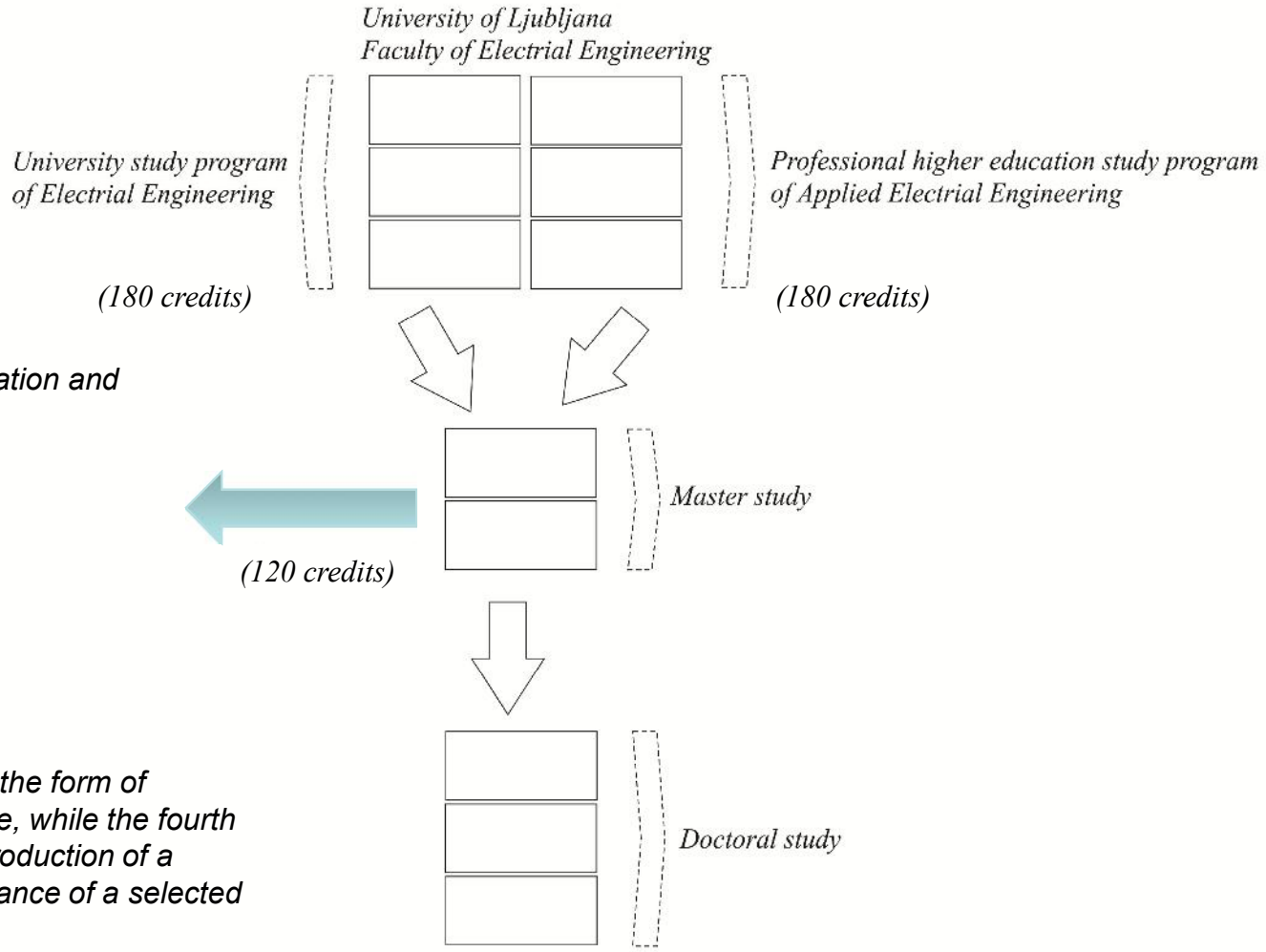
Automation,
Electronics,
Power Engineering,
Mechatronics, and
Telecommunications.

The first year of studies covers a common curriculum for all students, followed by five study options in year 2. These are:

Automation,
Electrical engineering,
Power engineering technology,
System automation,
Technical quality, and
Telecommunications.

During the last (6th) semester, students complete compulsory work practice which has a duration of 13 weeks (3 months).

Organization of Education Process

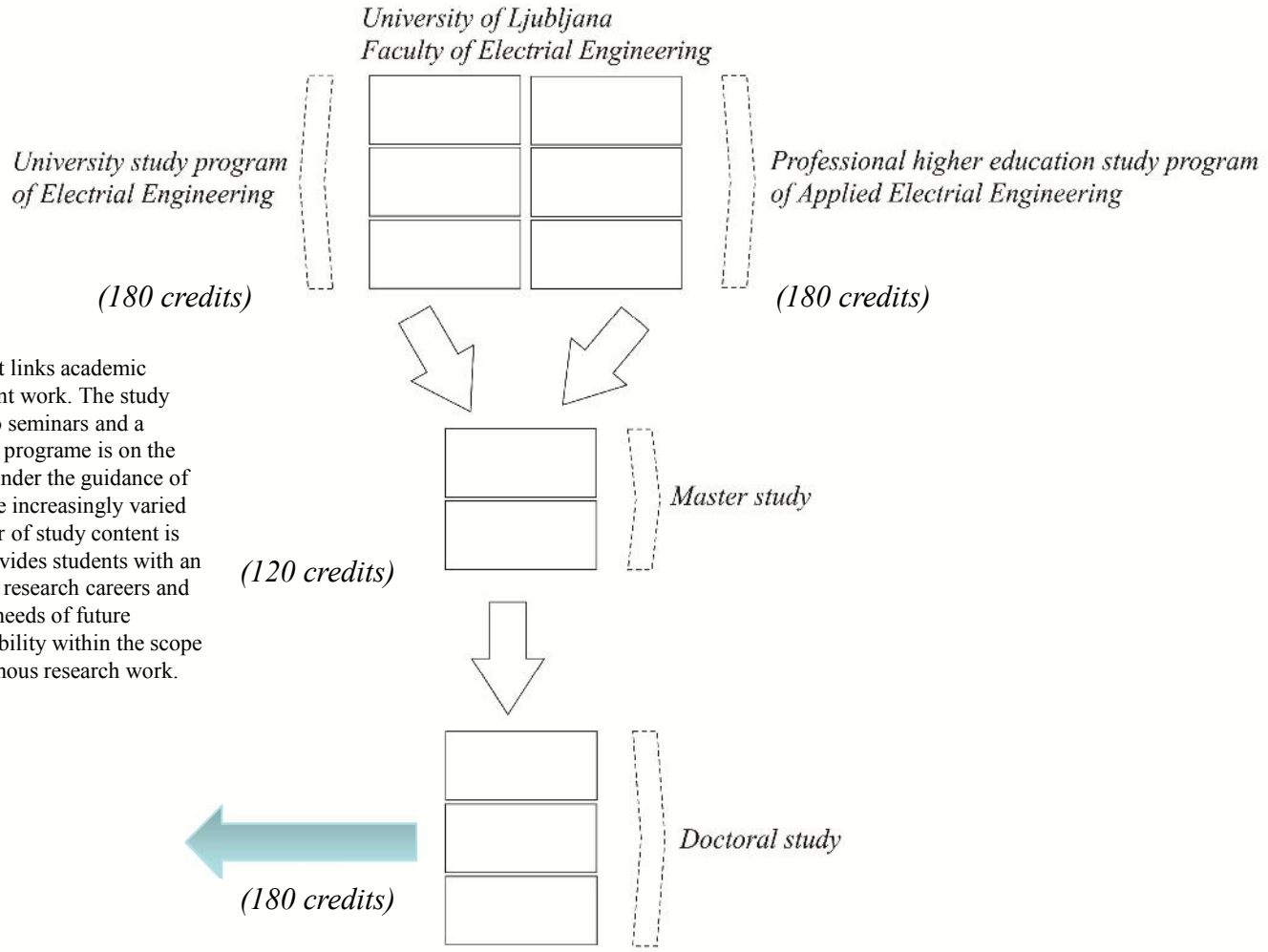


Master study is of 2 years' duration and comprises 7 study options:

***Automation**,*
Biomedical Engineering,
Power Engineering,
Electronics,
Mechatronics,
Robotics, and
Telecommunications.

The first three semesters take the form of lectures and laboratory practice, while the fourth semester is intended for the production of a master's thesis under the guidance of a selected mentor.

Organization of Education Process

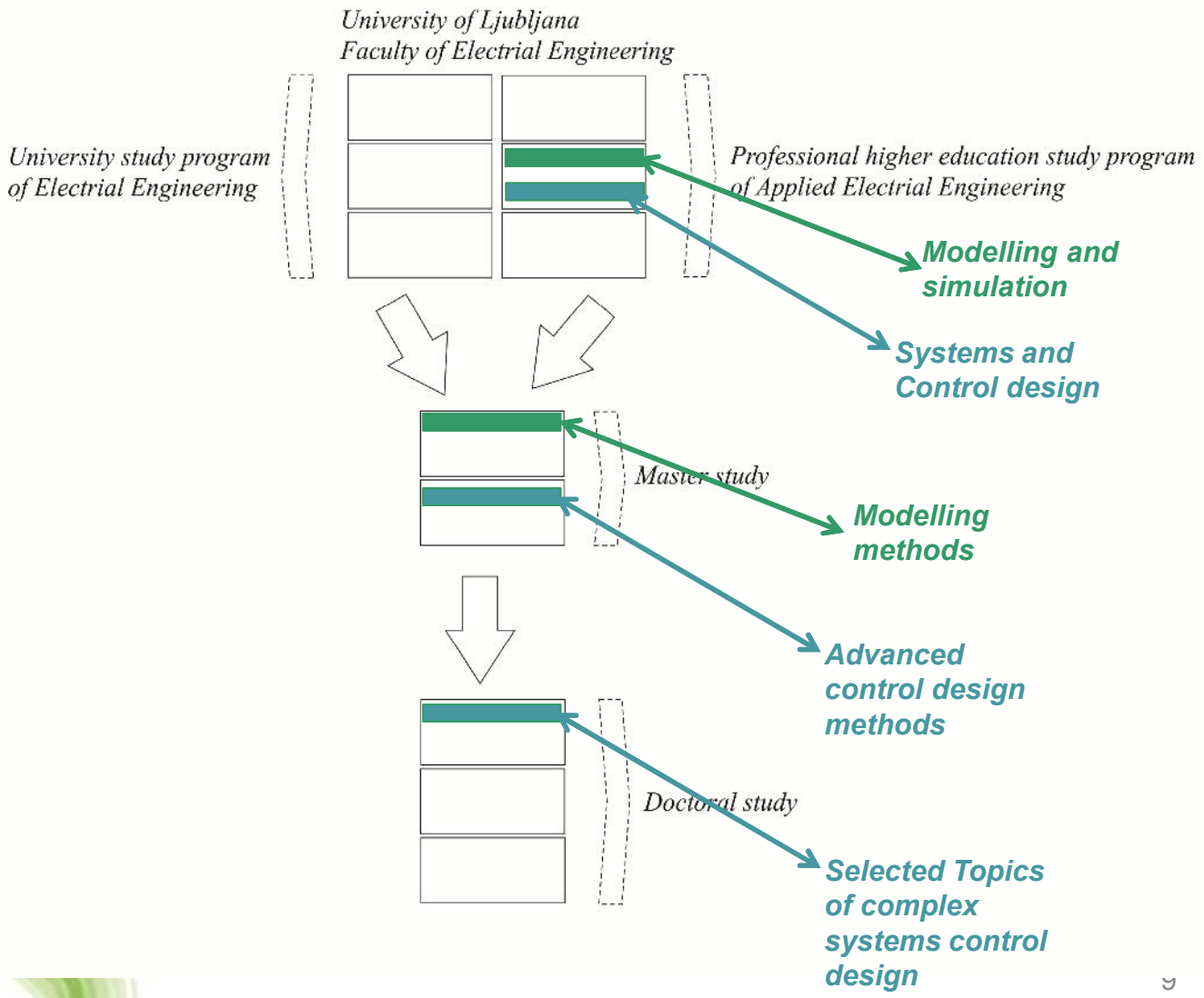


Doctorap (PhD) study is of 3 years' duration. It links academic studies with scientific research and development work. The study programe comprises four elective subjects, two seminars and a doctoral dissertation. The core emphasis of the programe is on the student's autonomous creative research work under the guidance of his/her mentor. In order to adequately cover the increasingly varied field of modern electrical engineering, the offer of study content is broad and diverse. Such freedom of choice provides students with an opportunity for the early planning of their own research careers and allows them to tailor their development to the needs of future employers. The study programe also offers mobility within the scope of organized forms of coursework and autonomous research work.

Fields:

Electrical Engineering, Intelligent Networks, Photovoltaics, Electronics, Microelectronics, Optoelectronics, Microsensorics, Nanostructures, Mechatronics, Integrated Systems, Intelligent Systems, **Automation**, Robotics, Metrology, Quality Assurance, Medical Engineering, and IT, ICT , Multimedia, Scientific Communication Skills .

Organization of Education Process



Educational programmes

1st Cycle Professional Study Programme, Applied Electrical Engineering – Control Systems

- Automatic control
- Modelling and simulation
- Control technology instrumentation
- Systems and control design
- Computer process control

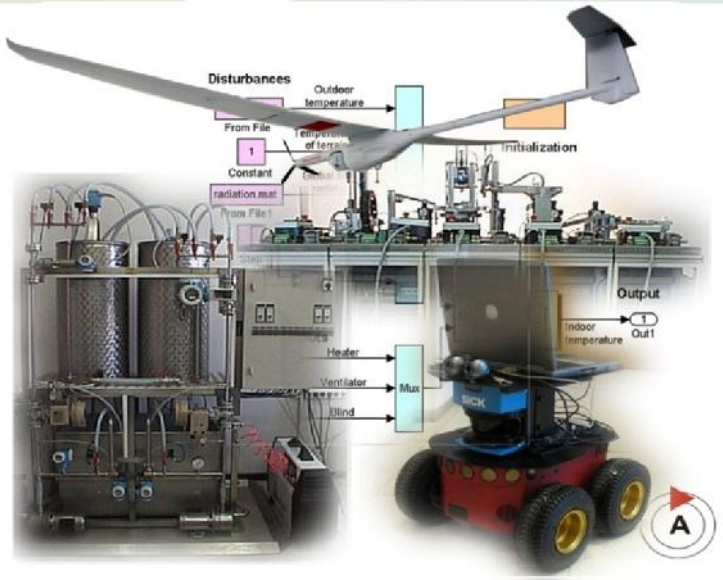
1st Cycle Academic Study Programme, Electrical Engineering – Control Systems

- Automatic control systems
- Control systems instrumentation
- Industrial control systems
- Computer simulation

Educational programmes

2nd Cycle Postgraduate Study Programme, Electrical Engineering – Control Systems and Computer Engineering

- Digital control
- Modelling methods
- Intelligent systems in decision and control
- Identification
- Autonomous mobile systems
- Production management
- Industrial informatics
- Seminar: Intelligent control
- Advanced control design methods



3rd Cycle Doctoral Study Programme

- Selected topics of complex systems control design
- Advanced control of autonomous systems
- Intelligent control in modern systems

Laboratory pilot plants

Hardware equipment:

Three-Tank-system
(Amira DTS200)

Pressure-level process - UML

Air conditioning pilot plant

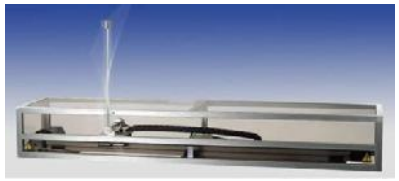
Helicopter (CE 150)

Coupled drives (TQ CE108)

Heat exchanger
(Armfield PCT13)

Level-flow
(Armfield PCT9)

Magnetic
Suspension (Amira
MA400)

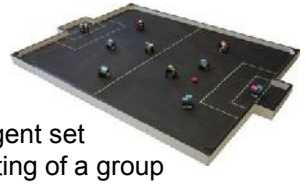


Laboratory experiment PS600

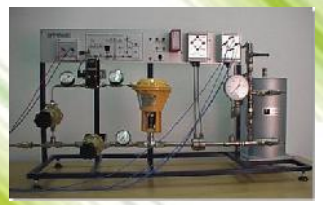
Seesaw/Inverted
pendulum
(Quanser)

Ball & Beam
(Amira BW500)

Ball & Hoop (TQ CE9)



Multiagent set
consisting of a group
of mobile robots



Pressure Control
Accessory

Speed Control with
Variable Load (Amira

Pioneer 3 AT and
Pioneer 2 Arm

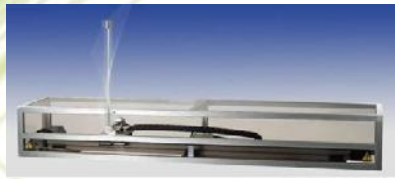
Quadrocopter
(Ascending
Technologies X-3D-BL)

SISO and MIMO systems

Speed Control with Variable Load (Amira DR300)

Magnetic Suspension (Amira MA400)

Ball & Hoop (TQ CE9)



Laboratory experiment PS600

Three-Tank-system (Amira DTS200)

Helicopter (CE 150)

Pressure-level process - UML

Coupled drives (TQ CE108)

SISO systems

MIMO systems

Electromechanical systems (fast)

Speed Control with Variable Load (Amira DR300)

Ball & Hoop (TQ CE9)

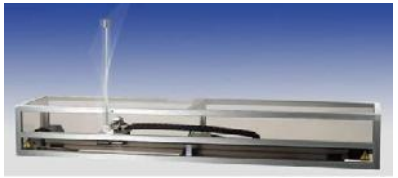
Coupled drives (TQ CE108)

Stable

Unstable

Magnetic Suspension (Amira MA400)

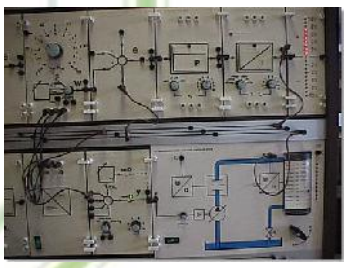
Helicopter (CE 150)



Laboratory experiment PS600

Ball & Beam (Amira BW500)

Hydraulic systems (slower)



Level-flow
(Armfield PCT9)

Three-Tank-system
(Amira DTS200)

Different order systems

combined system

Pressure-level process - UML

MIMO operation

Coupled drives (TQ CE108)

Three-Tank-system
(Amira DTS200)

Air conditioning pilot plant

Helicopter (CE 150)

Pressure-level process - UML

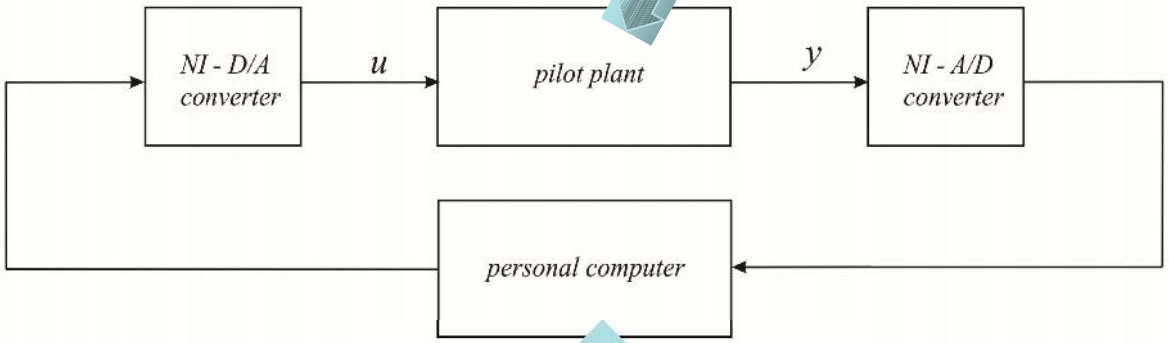
thermal systems

electromechanical systems

hydraulic systems

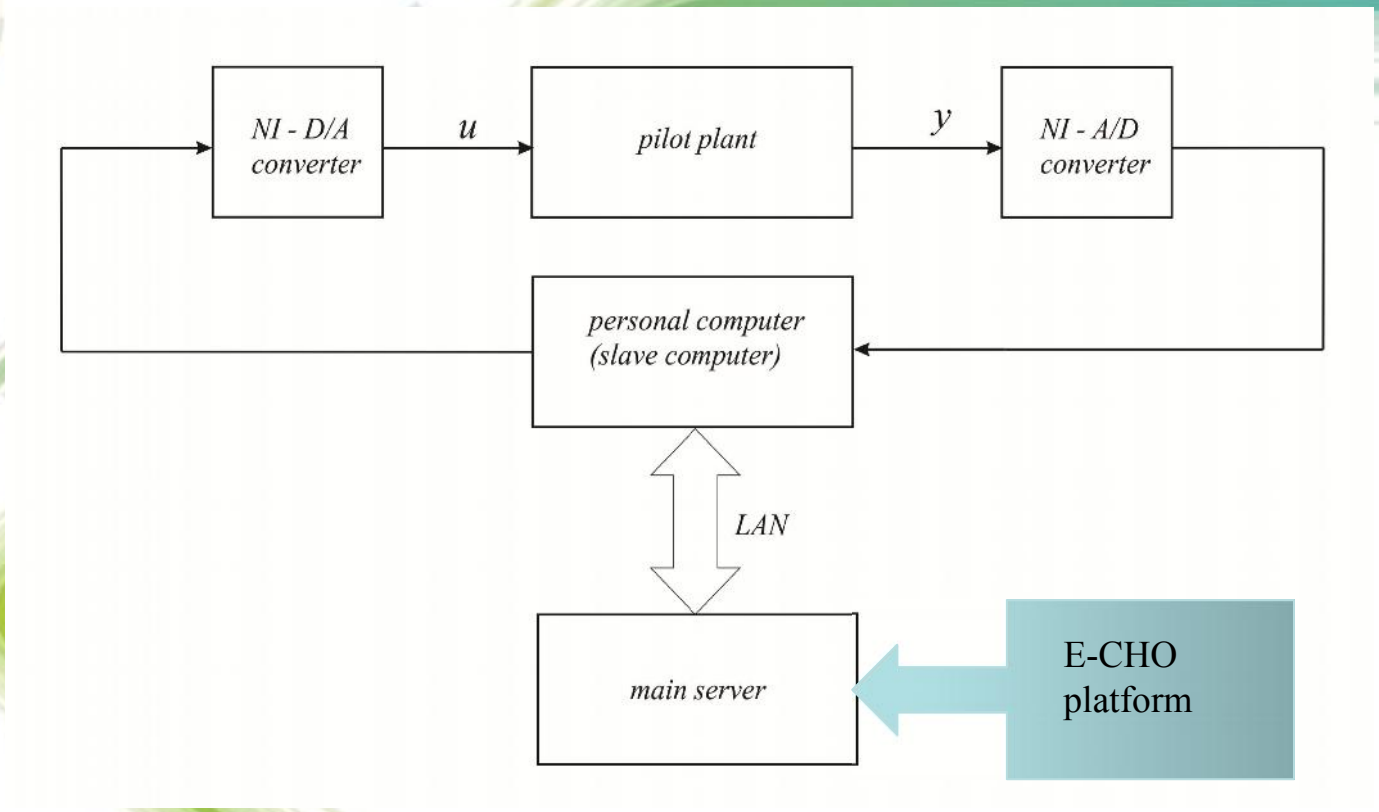
Usage of pilot plants

Coupled drives (TQ CE108)



MATLAB with Simulink (NI-PCI),
CST, ...,
LABI, ANA, ...

Remote usage and experimentation



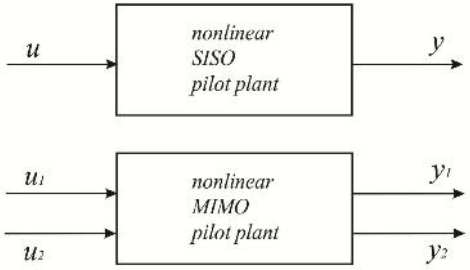
Remote usage and experimentation

Remotely used pilot plants inside the glass cases in front of our laboratory

Remote usage and experimentation

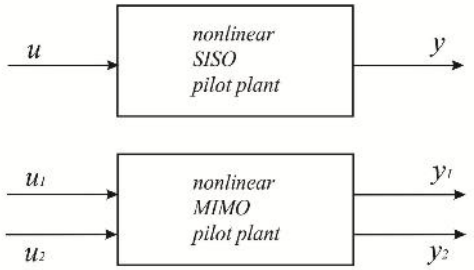
Coupled drives
(TQ CE108)

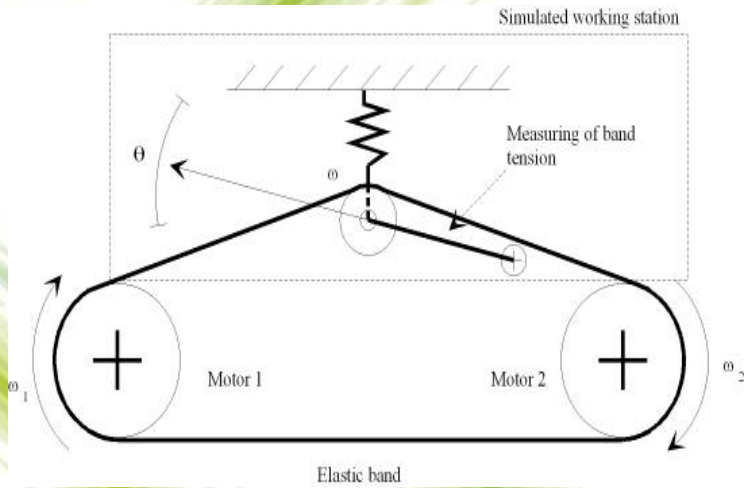
Helicopter
(CE 150)



Remote usage and experimentation

Coupled drives
(TQ CE108)

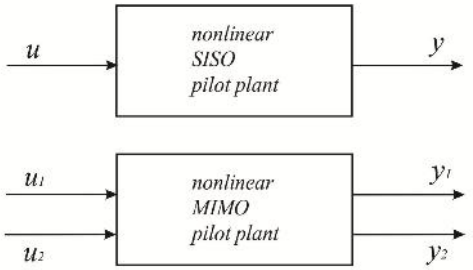


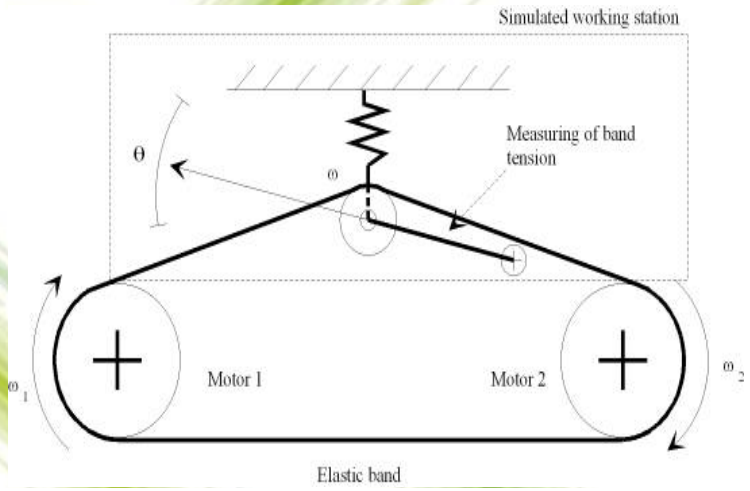


(Mimic industrial material transport problems as they occur in magnetic tape drives, textile machines, paper mills, strip metal production plants, etc..)

Remote usage and experimentation

Coupled drives
(TQ CE108)





- Robust system
- Time – constants of the system are relatively short so that time needed for one experiment can be limited to few minutes
- System observation through a video stream is also informative
- Pilot plant is flexible: complexity of the system can be adapted regarding the level of students' knowledge
- Open-loop experimentation is not problematic

Introduction of e-learning projects

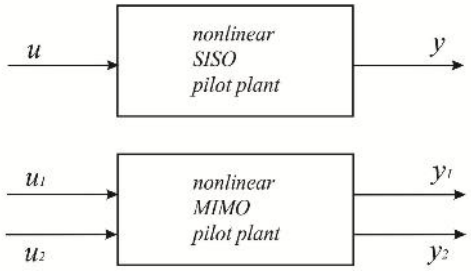
Which can be used:

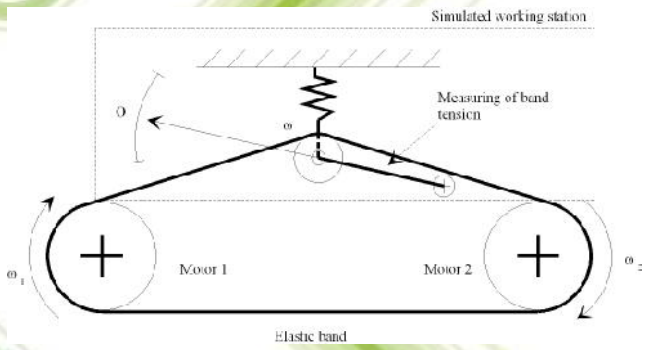
- as a students' projects,
- as a part of laboratory exercises,
- or as demonstration examples.

Goals:

- To stimulate team work,
- To motivate more intensive (on-line) study,
- To introduce some flexibility into education process regarding work organization,
- To open additional possibilities of research work and students' initiative,
- ...

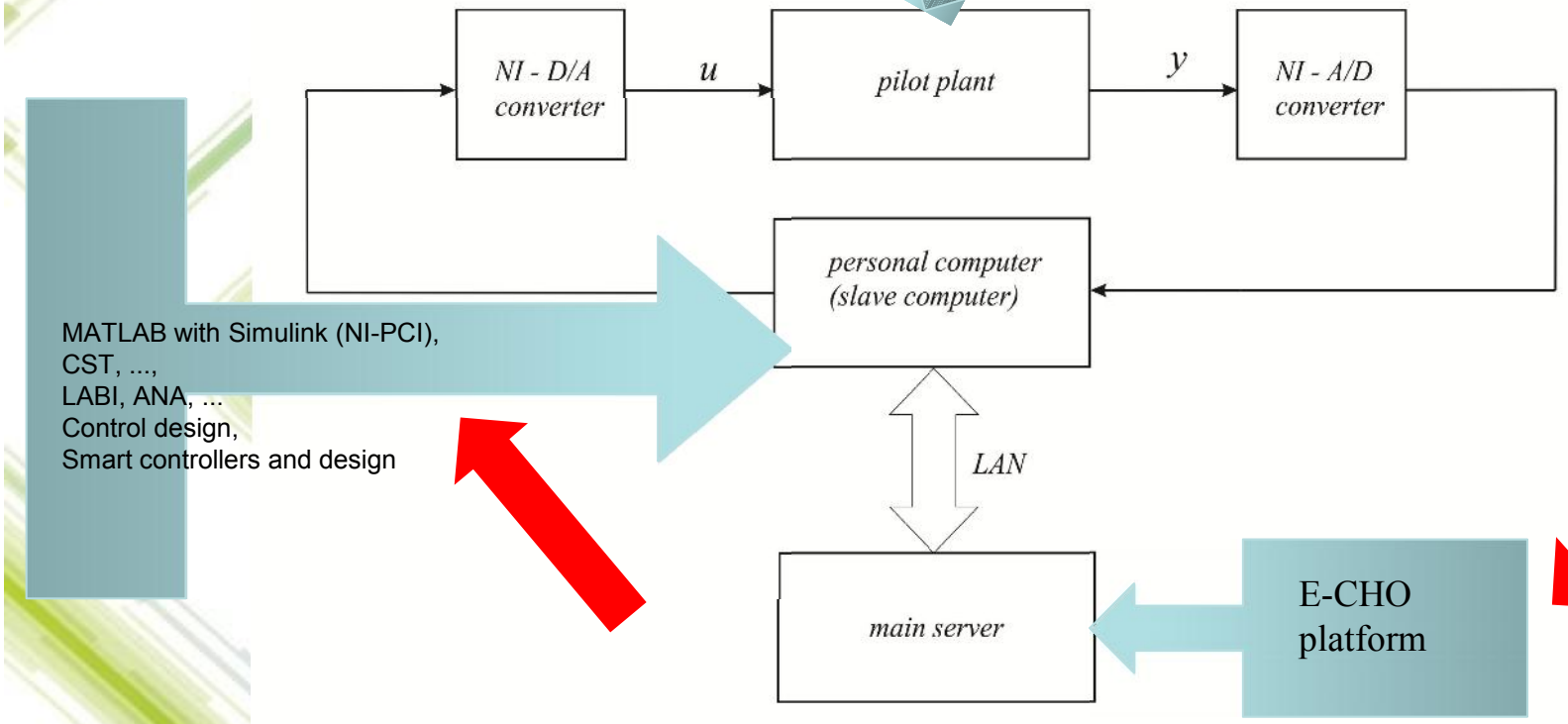
Students' Projects
Three Phase Competition Game





Possible extensions

Coupled drives (TQ CE108)



Thank you for your attention