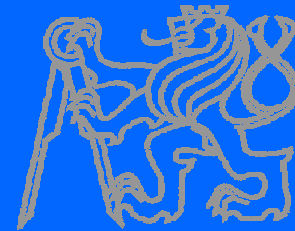


FEL
ČVUT



Department
of Control
Engineering



Where: Czech Republic - Prague / Praha



City of Prague
Czech Beer
Crystal Glass
Classical Music
Word "robot" (K. Čapek, 1920)
J. Kepler, Tycho de Brahe (16-17 cent.)
Albert Einstein (1911)



When



1707 Czech Technical University in Prague

1906 Institute of Electrical Engineering

1952 Department of Control Engineering (DCE)

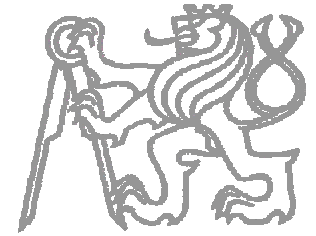


Czech Technical University in Prague

Staff: 3000 (academics 1300: professors 140)

Students: 23 000

Since 1707



6 Faculties +

Faculty of Civil Engineering

Faculty of Mechanical Engineering

Faculty of Electrical Engineering

Faculty of Nuclear Sciences
and Physical Engineering

Faculty of Architecture

Faculty of Transportation Sciences

+ services, research institutes, ...



Faculty of Electrical Engineering

Staff: 742 (academics 400, professors 40), **Students:** 5000
Program: Electrical Engineering and Informatics
Since 1920

Bachelors:

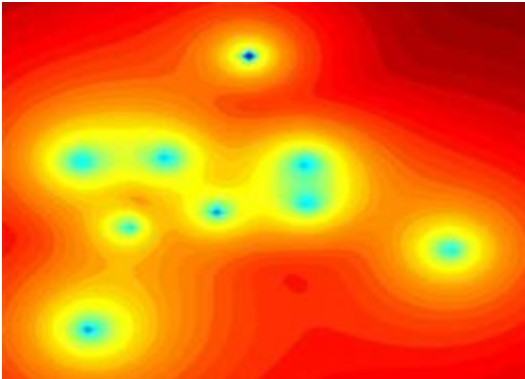
Electric Power Engineering; Electronics and Communication Technology; Cybernetics and Measurement; Computer Science and Engineering

Masters:

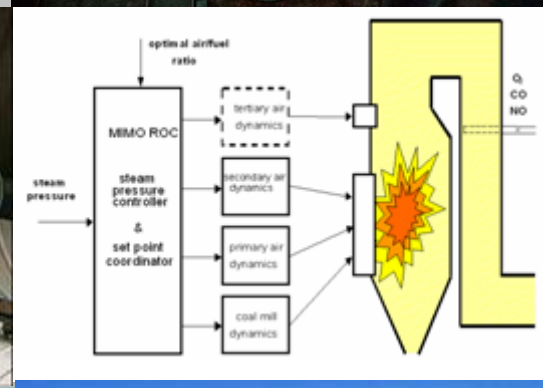
Electric Drives and Transport; Electric Power Eng; Technological Systems; Economics and Mgmt of Electrical Eng. and Energy; Electronics; Radioelectronics; Telecom. Technology; Measurement Technology; Engineering Cybernetics; Computer Science and Engineering; Biomedical Engineering; Technical Cybernetics; Aircraft Information and Control Syst.

Doctors:

Applied Math.; Plasma Physics; Electrotechnology and Materials; Electric Machines, Apparatus and Drives; Theory of Electrical Engineering; Radioelectronics; Telecom. Engineering; Acoustics; Electronics; Control Engineering and Robotics; Measurement Technology; Computer Science and Informatics; Artificial Intelligence and Bionics; Electric Power Eng.; Company Economics and Management



$$\begin{aligned} & \gg [X, Y] = axbyc(A, B, C) \\ X = & \begin{matrix} -4 + 11s + 2s^2 - 2s^3 & -2.6 \\ 3.6 + 3.2s + 5.9s^2 & -2.6 \\ -1.8 - 6.6s + 7.5s^2 & -2.6 \end{matrix} \\ Y = & \begin{matrix} 6.9 - 11s - 14s^2 & 4 - \\ -2.5 - 15s - 6.7s^2 & -3.1 \\ 4.2 + 11s - 1.4s^2 & 4.6 \end{matrix} \\ & \gg \det(X) \\ \text{ans} = & -2 + 6.6s - 4.3s^2 - 2.3s^3 \end{aligned}$$



DCE

Department of Control Engineering (DCE)

Automatic control of engineering, physical, biological, medical, transport, economical and other systems **in the broadest sense** from theory, modeling, and design, through algorithms, software and hardware, networks and communication, automata, embedded systems and robotics, to practical applications, industrial realizations and their impact to society

Mission

- Education of Bachelors, Masters and Doctors in Cont. Eng.
- Top level theoretical and applied research
- Technology and science promotion in industry and society



Data

- **Staff:** 59 (4 professors, 10 docents, 10 assistants, 25 researchers)
PhD students: 32
- **Budget:** 1.3 M Euro
(1/3 governmental subvention for teaching + 2/3 projects)

SIEMENS

**Rockwell
Automation**

Honeywell



Contribution to SpaceMaster

Engineering Track 5: Space Automation and Control (30 ECTS)

3rd semester modules:

Space Systems, Modeling and Identification (7.5 ECTS)

Optimal and Robust Control Design (7.5 ECTS)

Estimation, Filtering and Fault Detection (7.5 ECTS)

Project (7.5 ECTS)

4th semester: Master Thesis

30 ECTS

Double degree:

MSc in Electrical Engineering and Informatics ([Ing](#))

~10 Students





Space Systems, Modeling and Identification

Prof. V. Kučera:

*introduce to **systems theory and properties**, models building and identification methods*

various types of systems: CT and DT, LTI, LTV, nonlinear, MIMO
properties of space systems: stability, controllability, observ., realiz.
input-output and state-space models, model reduction and data sampling
deterministic and stochastic identification, FF and FB control structures
modern software tools for systems analysis, mod/sim. - Matlab and tbxs



Optimal and Robust Control Design

Prof. M. Šebek

*introduce and train classical and modern **optimal and robust control design methods, algorithms and tool***

LQ and LQG optimal controllers, time-optimal and finite impulse response
uncertain systems: parametric, interval, unstructured, ...
robust stability and performance, optimization tech. for robust cont. design
(e.g. semi definite programming, LMI, ...)
H-2 and H-infinity optimal robust controllers



Estimation, Filtering and Fault Detection

Prof. V. Havlena

*provide an introduction to problems of **estimation, filtering and fault detection** in space born systems*

estimation, filtering and fault detection in space born systems

estimates of various types: mean squares, maximum likelihood and Bayesian
Wiener and Kalman filtering

deterministic and stochastic fault detection, fault isolation techniques



Software for Space Control, Embedded Systems

Prof. Z. Hanzálek

*critical, autonomous, robust space applications,
reliable processors and real-time operating systems*

computer aided real-time measurement and control

real-time computer systems for space control

basic structures of RTOS: scheduler, inter-task communication primitives

structure of RTOS VxWorks from WindRiver systems, environ.Tornado II

basic knowledge of RTOS VxWorks

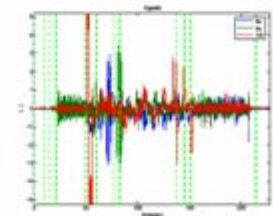
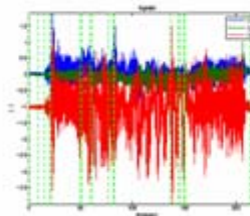
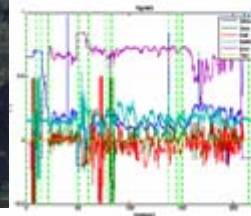
Current R&D aerospace projects at DCE

- Fly-by-wire system for a subsonic combat aircraft
- Stabilized platform for UAV aircraft
- Active control for new generation flexible passenger aircraft
- UAV helicopter
- X-ray pixel sensors for orbital observations



FBW for a light combat aircraft

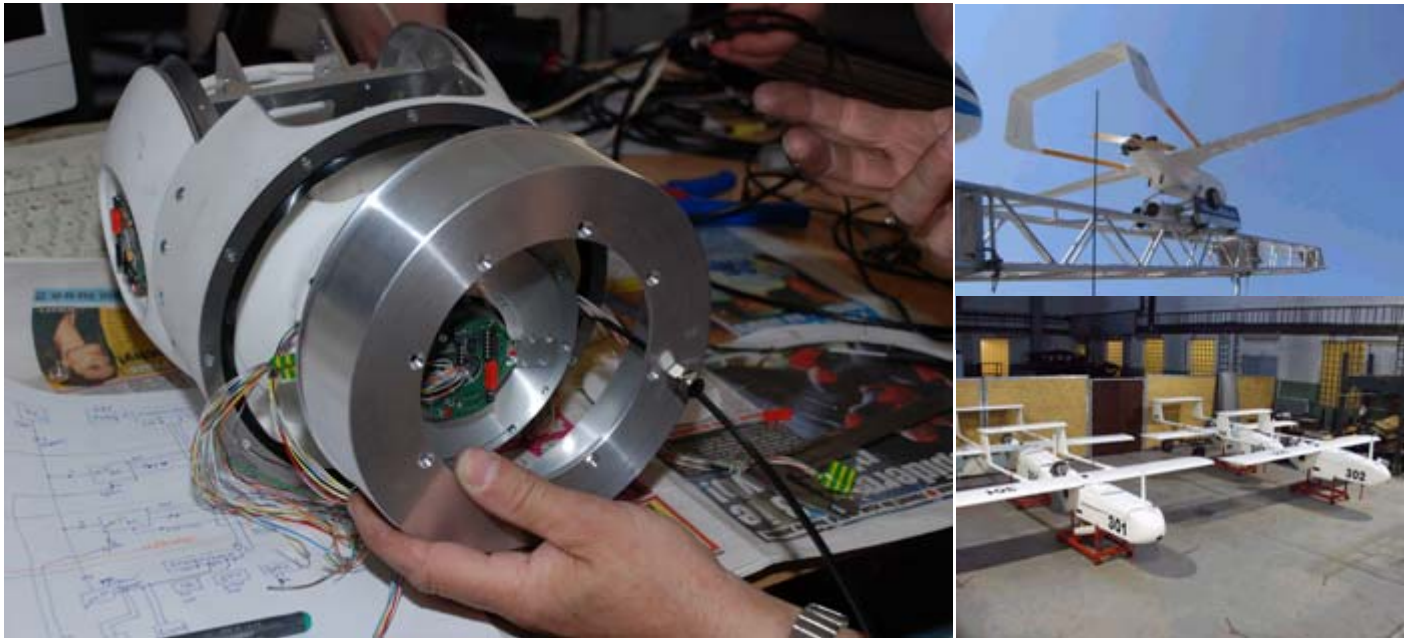
- **Government supported** project, 2007-2011
- Cooperation with **Aero Vodochody**, Czech producer and developer of training and light combat jet aircraft
- Intended for the new generation aircraft to replace current hydro-mechanical linkages, augment its maneuverability and increase flight comfort and performance
- **DCE** responsible for **HIL simulator** (hardware-in-the-loop) and development of **control algorithms** and schemes for particular configurations of the flight control system



- **Project leader:** Zdenek Hanzalek, hanzalek@fel.cvut.cz
- **References:** www.aero.cz

UAV stabilized platform

- Cooperation with [VTUL PVO Prague \(Air Force Research Institute\)](#), developer and supplier of UAVs for the [Czech Army](#)
- Optical and infrared cameras and a laser rangefinder as payload
- [Control goals](#): wind & turbulence attenuation and target tracking
- DCE responsible for [on-board control system](#): HW & SW development, control system design



- [Project leader](#): Zdenek Hurak, z.hurak@c-a-k.cz
- [References](#): www.vtul.cz

Active control for a flexible aircraft

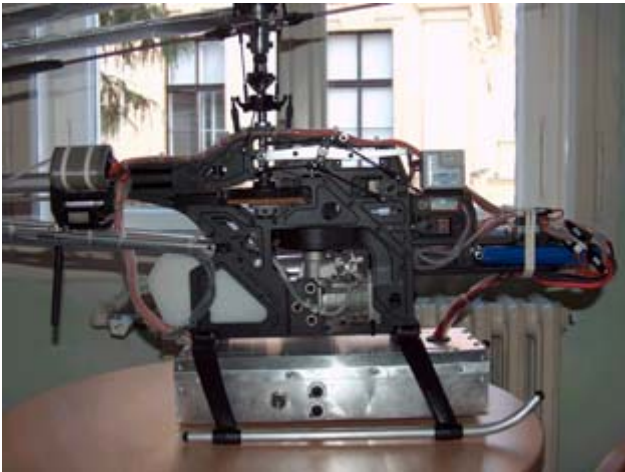
- EU funded project proposal, 2008-2012, FP6
- Consortium includes EADS, Airbus, DLR, ONERA, Alenia and others
- Development of control systems for upcoming high-capacity passenger aircraft, to increase passenger comfort and reduce weight and fuel consumption
- DCE involved in optimal and robust control algorithms and command shaping



- Project leader: Martin Hromcik, m.hromcik@c-a-k.cz

UAV helicopter

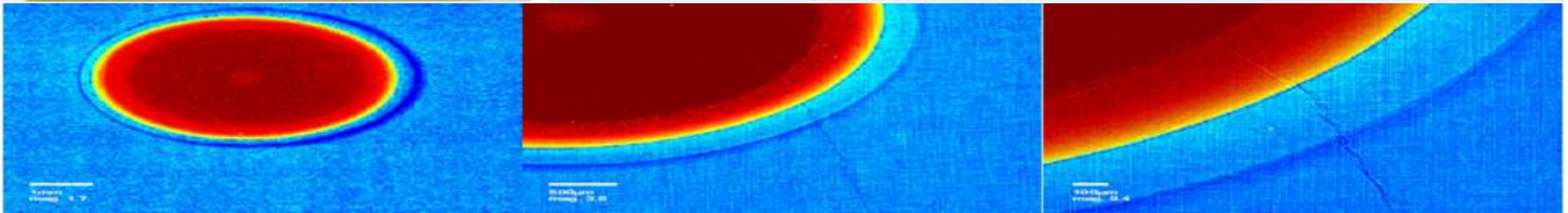
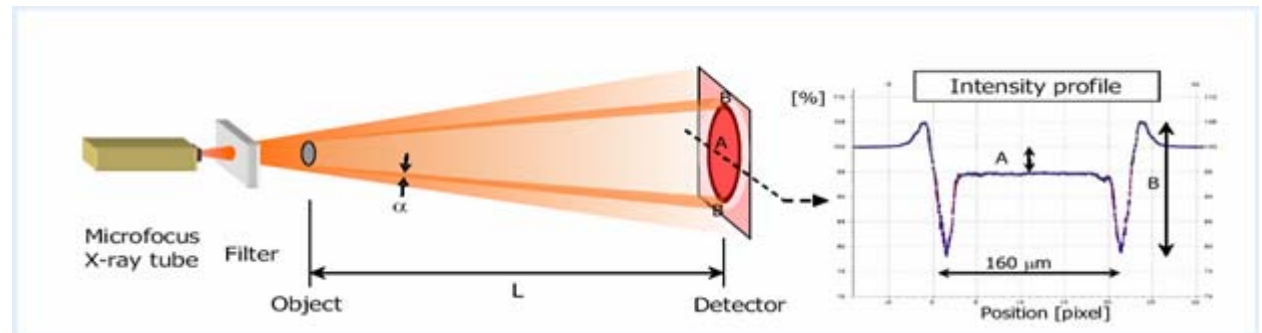
- DCE project on development of small UAV, based on a 7kg RC kit helicopter
- HW: aircraft construction and maintenance, control electronics,
- SW: control routines, measurement pre-processing, servo control, mission programming, ...



- Project leader: Zdenek Hanzalek, hanzalek@fel.cvut.cz
- Reference: <http://rttime.felk.cvut.cz/helicopter>

X-ray pixel sensors for orbital observations

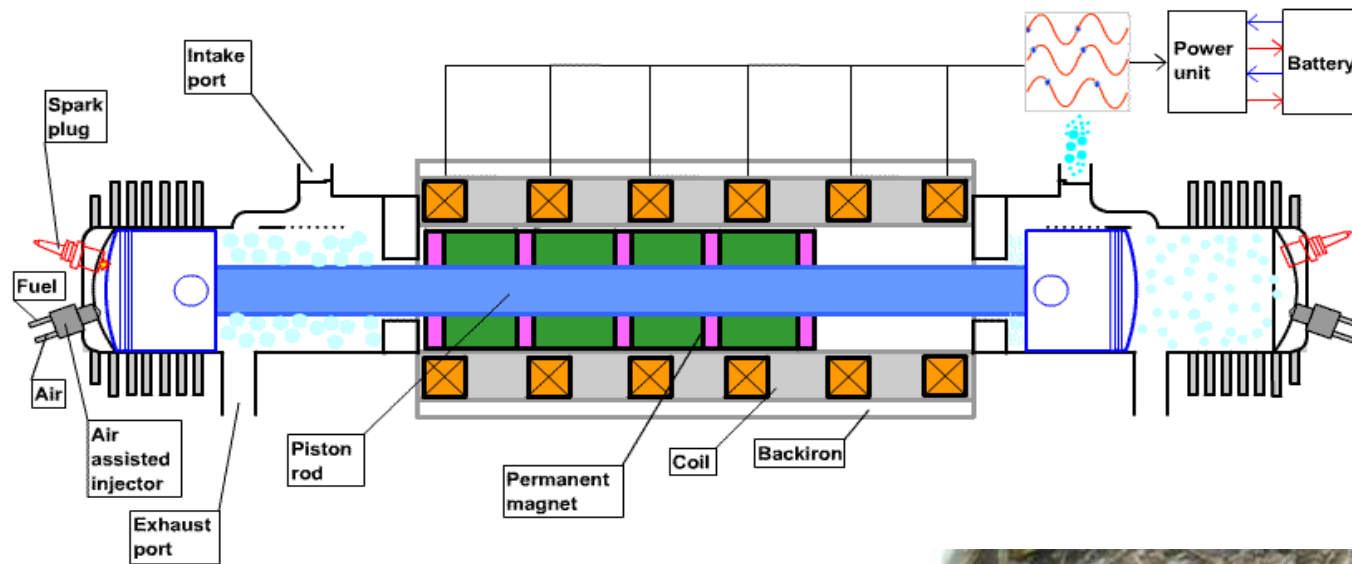
- Utilization of special **pixel X-ray sensors** for space **on-orbit** observations
- Small-size: suitable for microsattellites
- Cooperation with the **Czech Astronomical Institute** (X-ray optics developer) and **Inst. of Experimental and Applied Physics** (sensor provider)



- **Project leader:** Martin Hromcik, m.hromcik@c-a-k.cz
- **References:** www.utef.cvut.cz, www.asu.cas.cz

Application Research

■ Linear combustion engine / generator

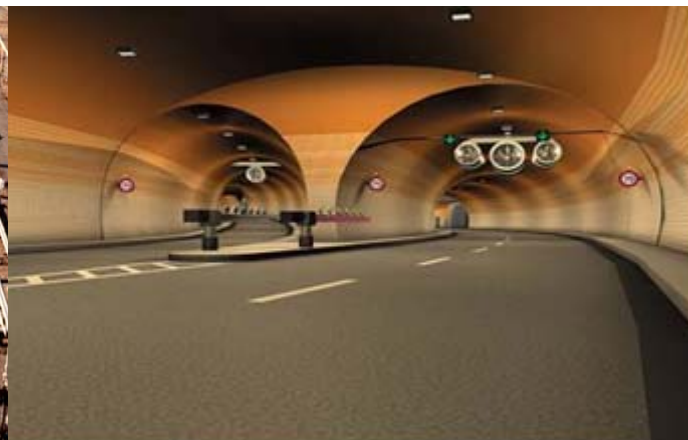
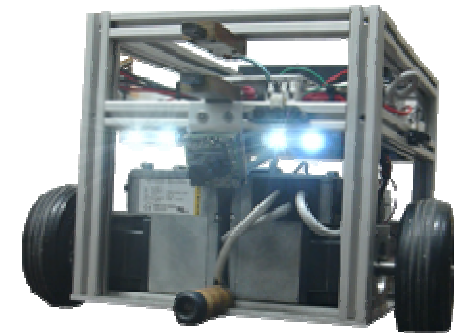


■ Automated Fish Production



Application Research

- active car suspension
- solar power plant control
- astronomic VLT telescopes positioning
- aircraft computer
- real-time operating systems
- embedded systems
- Prague tunnel modeling
- remotely programmable mobile robot
- bio control (human muscles)
- nano control
- ...



Industrial Implementations

- Optimization of a combustion process in Otrkovice heating plant
 - V. Havlena: Combustion Optimization with Inferential Sensor. Patent Office US, 6,622,645 B2. 2003-09-23.
 - V. Havlena: Communication for Water Distribution Networks. Patent Office US, 6,626,042 B2. 2003-09-30

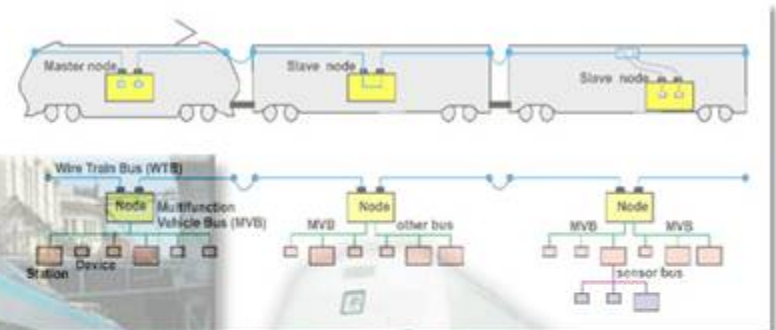


- Steam plant optimization in SASOL (South Africa Synthetic Oil)

- Communication protocol for trains

implemented in

- Prague metro
- Pendolino



Contact info

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fax: +420-224 916 648
e-mail: m.hromcik@c-a-k.cz