Open Day for Applicants for Doctoral Studies at CTU FEE

Prague
March 23, 2023
Programme

1. Introduction - Petr Páta, Dean of FEE
2. Scientific Activities and Doctoral Study at CTU FEE - M. Polívka, Vice-Dean for DS&S
3. PhD Success Stories
4. Discussion with participation of supervisors, chairs of scientific boards, heads of departments and graduates, ..
Scientific Activities
at CTU FEE
FEE Mission & CTU Ranking

Mission – to provide education and conduct world-class research in the fields of electrical engineering (EE) and computer science (CS) with overlap into the natural, medical, economic and human sciences: air and space, biomedical, and power engineering; acoustics, applied physics, automation control; cybernetics; computer science; graphics; history of science, management and energy economics; mathematics; material science, microelectronics; radioengineering; robotics; telecommunication,..

QS WORLD UNIVERSITY RANKINGS

FEE, 2022: EE #201-250, CS #151-200

Government evaluation of research organization 2020, methodology M17+, with international evaluation panel

FEE evaluated „Excellent“ in Eng. & Techn.
252/267 points,
1st of 13 parts CTU.
A Brief Look at Science at FEE

Strength

- High-quality publication standards (IF journals, conferences CORE A*, A)
- High-end laboratory equipment (HW, SW)
- International collaborations (projects, common teams, internships)
- Prizes & awards (individual, team)
- Results commercialized (licences sold, start-ups)

Results

<table>
<thead>
<tr>
<th>Result type / year</th>
<th>2022</th>
<th>2021</th>
<th>2020</th>
<th>2019</th>
<th>2018</th>
<th>2017</th>
</tr>
</thead>
<tbody>
<tr>
<td>WoS IF journal papers¹)</td>
<td>345</td>
<td>350</td>
<td>344</td>
<td>323</td>
<td>317</td>
<td>305</td>
</tr>
<tr>
<td>WoS citations¹,²)</td>
<td>10 588</td>
<td>11 390</td>
<td>9 502</td>
<td>10 392</td>
<td>8 790</td>
<td>7 917</td>
</tr>
<tr>
<td>Patents US+Jap+EU / totally</td>
<td>5 / 18</td>
<td>1 / 12</td>
<td>9 / 15</td>
<td>12 / 20</td>
<td>6 / 10</td>
<td>4 / 12</td>
</tr>
</tbody>
</table>

¹) According to V3S, February 2023, ²) heterocitations

~ \( \frac{1}{3} \) scientific results of the CTU, 2022 (V3S)

Publikace Jimp:  30 % absolutely, 34 % considering author's shares
Citace:  41 % absolutely, 43 % considering author's shares
Selection of the best R&D results and achievements

5 examples demonstrating:

- support from domestic/foreign grant agencies or foundations,
- involvement in international collaborations/transnational projects,
  - presentation and publication of results, social impact,
  - patent protection and commercialisation of results,
    - awards received.

28 more in the Appendix
Multi-robot Systems group, Dr. Martin Saska, Dept. of Cybernetics

2nd challenge: 1st place US$ 250,000, 1st challenge: 2nd place, TOTAL: 1st place

- 1. challenge: to capture and neutralize intruder UAVs
- 2. challenge: to autonomously locate, pick, transport and assemble different types of brick shaped objects to build pre-defined structures
- 3. challenge: to autonomously extinguish a series of simulated fires in an urban high rise building

Congratulations
Method for accurate automated non-invasive measurement of blood pressure waveform  Dept. of Physics, Vratislav Fabián

- Very sensitive, non-invasive assessment of hemodynamic parameters of human cardiovascular system (Pulse Wave Velocity - PWV etc.)
- Unique technology for measuring blood pressure in LVAD (Left Ventricular Assist Device)
- The work is based on our US Patent US10251567 “Method for an accurate automated non-invasive measurement of blood pressure waveform” (2019)
- Research cooperation with Human Integrative and Environmental Physiology Laboratory MAYO Clinic, Rochester, USA
- Support from Technology Agency of the Czech Rep. Grant No. TH04010173 Apparatus for non-invasive automatic analysis of hemodynamic parameters
- The work has been cited in respected journals: Nano Energy, Heart Failure Reviews

Validated against the gold standard of PWV measurement. https://v3s.cvut.cz/results/detail/332373

sensors
AToM – Antenna Toolbox for MATLAB
Dept. of Electromagnetic Field, Miloslav Čapek

- antenna analysis and design with unique novel features
- based on fundamental research*), ongoing support&development
- licences sold worldwide (Sandia Labs., Kathrein, Futurewei, ...)
- free demo version available (452 users within 30 months)
- almost 20k downloads of corresponding white papers
- project has opened collaboration with, e.g., ESI Group
- developed & owned by CTU, see antennatoolbox.com

*)
10.1049/iet-map.2010.0269
10.2528/PIERB11060209
10.1109/LAWP.2011.2158050
10.1109/LAWP.2011.2178811
10.1155/2012/490327
10.1109/TAP.2012.2207329
10.1109/MAP.2013.6529342
10.1109/TAP.2013.2287519
10.1109/MAP.2014.6867702
10.1109/LAWP.2014.2329421
10.1049/iet-map.2013.0473
10.1049/iet-map.2014.0302
10.1109/TAP.2016.2617779
10.1109/TAP.2016.2624735
10.1109/TAP.2016.2632725
10.1109/TAP.2017.2717478
10.1109/TAP.2018.2870492
10.1109/TAP.2018.2869642
SIMToolbox – Live cell microscopy beyond the diffraction limit

Dept. of Radioelectronics, MMTG, Miloš Klíma
Karel Fliegel, Tomáš Lukeš, Jakub Pospíšil

MATLAB open-source project for fluorescence structured illumination microscopy (SIM)

Twofold increase in resolution – breaking the diffraction barrier

Currently more than 400 users

Developed and supported by CTU (simtoolbox.github.io)

International collaboration:
EPFL, Switzerland
UCCS, Colorado, USA
UNI Bielefeld, Germany

Associated publications:
Opt. Express 2014 (Q1)
Bioinformatics 2016 (Q1)
GigaScience 2019 (Q1)

Received grants/projects:
Jakub Pospíšil (2018-2021, ESR) – project DeLIVER
H2020 Innovative Training Network, No. 766181

SIM setup built and operated at UCCS
Example-based Stylization of Images and Videos
Dept. of Computer Graphics & Interaction (DCGI), prof. Daniel Sýkora’s group

- 8 SIGGRAPH papers
- 6 US patents
- 4 free Software Tools (EbSynth, StyleBLIT, FaceStyle, StyLit)
- 2 companies have included results (Adobe, Snap)
Doctoral Studies at CTU FEE
I'M A PHD STUDENT

WHAT MY FRIENDS THINK I DO

WHAT MY MOTHER THINKS I DO

WHAT SOCIETY THINKS I DO

WHAT MY ADVISOR THINKS I DO

WHAT I THINK I DO

WHAT I ACTUALLY DO
Essential Information

- **Ph.D.** - “Doctor of Philosophy”, the highest level of higher education „philosophiae“ – from Latin, Greek „love of wisdom“

- **Content**: scientific research on a "dissertable" topic under the supervision of a supervisor (having the potential of finding original results surpassing the current state of knowledge; to make a contribution to the state of the art)

- **Forms**: full-time/combined

- **Standard length**: 3-4 years

- **Evaluation and study checks**: Doctoral Study Code & dean’s directives

- **Prerequisite for admission**: completed university education, knowledge of EN language

- **Commencement of studies**: February 1/ September 1

- **Applications before**: April 30 / October 31

https://intranet.fel.cvut.cz/en/education/phd/study
Standard Timeline I.

- **Selection of the framework topic** [https://fel.cvut.cz/cz/education/phd/phdtopics](https://fel.cvut.cz/cz/education/phd/phdtopics)
- **Agreement** with a potential **supervisor**
- **Application** submission, admission procedure
- **Scientific work** under the guidance of a **supervisor** according to **Individual Study Plan**
  - presentation of results at international conferences, scientific journals
  - short-term internships ([financial support](https://www.phdcomics.com/)), summer schools, scientific consortia meetings, ..
- **Study stage**: 2/3 years, min. 2 **profess. courses** (Scientific Writing, ..), 1 **scientific artical**
Standard Timeline II.

- Optional **pedagogical practice**
- **Defence** of a **progress study** („minimum“) - preparation for a dissertation; **EN exam**
- **State Doctoral Exam** (given by law), **seamless merging** of SDE and „minimum“
- Compulsory **foreign experience** (internship, min. 1 month, preferably 6 months, ERASMUS+)
- **Thesis defence**: 3 **scientific articles**, min. 1 IF journal paper / conf. paper **CORE A*, A / MathSciNet**
- **Dean’s Award** for an excellent dissertation 😊
Doctoral Study Programmes

- Acoustics (together with FSv, FS)
- Aerospace and Space Technology
- Applied Physics
- Bioengineering
- Cybernetics and Robotics
- Electrotechnics and Communication (4 spec.)
- Economics of Energy and Electrical Engineering
- History of Science and Engineering
- Informatics (3 spec.)
- Mathematical Engineering

**Doctoral students & supervisors (2022)**

Totally: **360** (~ 10 % of all FEE students)

Graduates: **26**

Accepted (from FEE, outside of FEL\ of which foreign): **64** (26, 38\ 20)

Supervisors (prof., assoc. prof. + approved by Scientific Council FEE): **217**

~ 1.7 doctoral students/supervisor
Tips & Hints for the Beginning of Your PhD Study

• **Read** (scientific) **papers**: 30-40 per 1st year
• **Consult** regularly with your **supervisor** (and also with your PhD classmates)
• Be **curious** and **critical** (of what your supervisor tells you),
• Set up proper **time management** (especially for writing articles/papers, reviews!),
• Improve your **scientific writing skills** & English
Last but not Least: Money

• **Scholarship + (Project) Income**: net income 35-52 thousand CZK/month (20\textsuperscript{th} - 80\textsuperscript{th} percentile), corresponds to a gross income of 44 - 67 thousand CZK/month

• You can **concentrate** on your work and stay in the lab as long as you want 😊
PhD Success Stories
Questions:

1. Where do you currently work and what is the scope of your work?
   
   **Industry**: senior R&D engineer, chief scientist, head of research lab, patent examiner (EPO), CEO in world-wide international companies.

   **Academia**: postdoc, researcher, vice-dean - international universities, Academy of Science CR.

2. What have your doctoral studies given you for your current career?

   Analytical & critical thinking, detailed analysis of problems, and ability to find the state of the art for a given problem and assess its relevance, .., meet the best scientists and researchers in the field, hard-working people who aim to push the boundaries of the state-of-the-art as much as you do, opportunity to travel the world, gain knowledge and experience that would be otherwise very hard or even impossible to get.

3. Where have you been during your doctoral studies and where have you been at postdoc?

   Several months spent at international universities (incl. EPFL, MIT, ..) and/or world-wide companies.
Milan Polívka
Vice-dean for Doctoral Studies and Science

science@fel.cvut.cz,
studyphd@fel.cvut.cz,
Selection of the best R&D results and achievements

Appendix
From Ground to Space
Dept. of Radioelectronics, O. Nentvich\textsuperscript{1}, M. Urban\textsuperscript{2}, R. Hudec

Nanosatellite VZLUSAT-1

- Three years of successful operation in Low Earth Orbit (since June 23, 2017)
- Verification of newly developed materials and technologies in/for space
  - Carbon-fibre reinforced plastics testing
  - X-ray Lobster-eye optics and Timepix detector
  - Photovoltaic panels
  - Ground station in Pilsen
- Collaboration of two universities (UWB and CTU) and several companies (VZLU, RITE, ADVACAM, ...)

Rocket experiment (REX)

- Two payloads (CZ - REX and US - WRXR) as a part of NASA's sounding rocket launched on April 4, 2018
- Two X-ray Lobster-eye optics with Timepix detectors, visible camera, MEMS and IR sensors driven by the autonomous Robot Operating System
- International collaboration: Penn State Uni. (US), UWB (CZ) universities; other parts of CTU (Cyber. & Physics. Dept., IEAP); research center PANTER MPE (DE), VZLU (CZ); companies RITE, ADVACAM (CZ)

\textsuperscript{1}ondrej.nentvich@fel.cvut.cz, \textsuperscript{2}martin-urban@fel.cvut.cz

Left: REX launch
Middle: Two payloads placed on the sounding rocket during the embedding phase
Right: Testing after rocket sea recovery and after launch testing at Penn State University, US

URBAN, M., NENTVICH O., et al., 2017. VZLUSAT-1: Nanosatellite with miniature lobster eye X-ray telescope and qualification of the radiation shielding composite for space application. \textit{Acta Astronautica}. (Q1, JIF Percentile = 88.710)

Visual Recognition Group, prof. Jiří Matas, Dept. of Cybernetics publishes at the most prestigious journals and conferences. The most impacted publications include:

Iscen, Tolias, Avrithis, Chum: *Label propagation for deep semi-supervised learning*, CVPR 2019
100 citations in Google Scholar (in 1 year), CVPR is the fifth best publication source according to Google Metrics

Radenović, Tolias, Chum: *Fine-tuning CNN image retrieval with no human annotation*, TPAMI 2018
IF 17.861, 254 citations, extension of ECCV 2016 paper – 429 citations

447 citations

Lukezic, et al.: *Discriminative correlation filter with channel and spatial reliability*, CVPR 2017
595 citations

Mishchuk, et al.: *Working hard to know your neighbor's margins: Local descriptor learning loss*, NIPS 2017
190 citations

**Prizes awarded to the group members:**

Honorable Mention for Outstanding Contribution Award at GCPR 2019
Saburo Tsuji Best Paper Award at ACCV 2018
Longuet-Higgins Prize at CVPR 2017
Best Science Paper Honorable Mention at BMVC 2017
Winner of ICDAR Robust Reading Multi-language - Script identification 2017
Identification of speech disorder in prodromal Parkinson’s disease

SAMI research group (http://sami.fel.cvut.cz), Dept. of Circuit Theory
Jan Rusz, Jan Hlavnička, Tereza Tykalová, and Michal Novotný

We were first worldwide to develop a unique methodology on how to objectively detect preclinical Parkinson’s disease via acoustic speech signal.

Pilot results were continuously published in respected peer-reviewed journals:


The findings raised international recognition, and thus we received for the continuation of the project prestigious USA funding by Michael J Fox Foundation (PI: Jan Rusz) in collaboration with 7 centers of excellence in sleep and parkinsonian research across Europe and North America.
Physical field-controlled manipulation of small robots
Dept. of Control Engineering, AA4CC group, Zdeněk Hurák

micro/milli-meter size „robots“: up to 10 manipulated independently
planar arrays of generators of magnetic, acoustic and electric fields
shaping the physical fields in real time by solving nonconvex optimization
feedback by real-time visual tracking

Unique and unified approach to real-time feedback manipulation with several small objects in plane independently by shaping force fields through arrays of actuators
Applications: bioanalysis (cell manipulation) and intelligent materials (assembly)
Collaboration: FEMTO-ST, Besancon, F and IACH AV, Brno, CZ

papers in IEEE/ASME Trans on Mechatronics – Lab on a Chip
Example-based Stylization of Images and Videos
Prof. Daniel Sýkora - Dept. of Comp. Graph. & Interaction (DCGI)

A series of algorithms, patented methods (U.S.), and top-level publications (ACM Transactions on Graphics, SIGGRAPH) represents the unique achievements, currently the best in the area in the world scale.

Several solutions already implemented in the Adobe company products, enthusiastically welcome by creators from movie and imaging industry.

https://dcgi.fel.cvut.cz/home/sykorad/
Smooth Analysis in Banach Spaces
Petr Hajek, Dept. of Mathematics

- The book is the first systematic treatment of smooth analysis in real Banach spaces.
- It brings new views of the role of polynomials in approximation nonlinear theory.
- The results stem from original research of the authors who have significantly contributed to the development of this area.
- Chosen as a significant result of research in mathematics by the Research, Development and Innovation Council, Government of the Czech Republic.
- Rector’s Award for prestigious publication.
High-yield fabrication and properties of 1.4 nm nanodiamonds with narrow size distribution

By analyzing thermal annealing process we achieved controllable size reduction of NDs down to 1.4 nm (mode size), narrow distribution (±0.7 nm) with high yield while keeping diamond character and pushing the science and technology down to the fundamental stability limit of nanodiamonds (1 nm).
Ion acceleration mechanism to 60 MeV in mega-ampere plasma column

Fast increase of impedance with a sub-nanosecond e-folding time leads to ion acceleration and neutron production in terawatt pulsed-power generator (GIT-12 in Tomsk, Russia)

Increased neutron yields above $10^{13}$ at the current of 2.7 MA; deuterons reach 60 MeV

Significant contribution to solution of one of the long-lasting problems in plasma


- 60 MeV: highest ion energies in pulsed-power devices & comparable with state-of-the-art lasers
- Mechanism helps also explain production of energetic particles in space and solar plasmas
- Work resulted in collaboration, joint project and publications with US Naval Research Laboratory

Novel SiC Power Device Technologies
Dept. of Microelectronics, Electron Device Group, Pavel Hazdra

- Novel technique of Local Lifetime Control by proton irradiation was developed for high-voltage silicon carbide bipolar devices (Hazdra et al., *IEEE Transaction on Electron Devices*, 2018, DOI: 10.1109/TED.2018.2866763)

- The technique was applied in collaboration with ASCATRON AB (S) in production of 10 kV SiC power PiN diodes. It allows a significant reduction of turn-off losses and increase of the diode switching speed

- The research was conducted within 7 FP EU project SPEED (Silicon Carbide Power Technology for Energy Efficient Devices) supporting innovation in new power electronic technologies for energy applications – development of European silicon carbide power electronics
Spreading spark discharge via mutual action of acoustic and magnetic fields

- Spark discharge is principally very localized and uncontrolled event, thus difficult to make use of
- We showed that magnetic field can scan discharge filaments across the cross-section of a cylindrical tube while the acoustic field can spread the discharge along the length of the tube
- The technology and physics behind can help to advance the development of various plasma sources and reactors, i.e. for decontamination
- The work is based on our European Patent EP3113582 “Stabilized and homogenized source of non-thermal plasma” (2017)
- The Journal of Applied Physics selected the work as the lead cover article in its 8th issue (vol. 126)

https://v3s.cvut.cz/results/detail/332610
https://v3s.cvut.cz/results/detail/315075
Influence of advective heat transport on acoustic streaming structure – Rayleigh revisited

- **Acoustic streaming** = net mean fluid flow that is generated by and superimposed on acoustic field
- **Lord Rayleigh** (1883) theoretically predicted sinusoidal-like pattern of acoustic streaming
- Modern measurements showed **deviation** from the Rayleigh’s prediction in strong acoustic fields
- **We have revealed** its strong sensitivity on lateral temperature gradients and **universal mechanism** limiting the streaming velocities
- Unlike prior efforts, the proposed mechanism is consistent with experimentally obtained data
- The mechanism is highly important for various thermoacoustic and microfluidic **applications**
- Published in a series of two papers in JASA
- Cited in respected journals e.g. J. Fluid Mechanics

**J. Acoust. Soc. Am.** 2017 & 2018

[https://v3s.cvut.cz/results/detail/312111](https://v3s.cvut.cz/results/detail/312111)
[https://v3s.cvut.cz/results/detail/319375](https://v3s.cvut.cz/results/detail/319375)
Inhibiting bacteria growth by carbon nanomaterials dispersed in cell culture media

Colony forming units after 5 and 24 h in MH medium: H-nanodiamonds the most effective.

Inhibition of E. Coli growth by nanodiamond and graphene oxide enhanced by Luria-Bertani medium, Nanomaterials 8 (2018) 140, >1900 downloads and 14 citations in 2 years

Bacterial response to nanodiamonds and graphene oxide sheets, Physica status solidi B 253 (2016) 2481, 13 citations in 4 years
Acoustic source distance determined from the spherical harmonics

- Processing of signals measured by a spherical microphone array utilizing its **near-field information**.
- The processing, based on the spherical harmonics decomposition, was performed in order to investigate the radial dependent spherical functions and extract their argument – distance to the source.
- Using the **low-frequency approximation** of these functions, the source distance is explicitly expressed.
- Method was **tested for real data**: measured by a rigid spherical microphone array of radius 0.15 m consisting of 36 microphones and a small speaker as a point source.
- Published in D1 journal (2017) and also cited there: *Mechanical Systems and Signal Processing*

[Image of spherical microphone array and spherical functions]

[Link to publication: https://v3s.cvut.cz/results/detail/307534]
Electrical discharges for energy efficient generation of active molecular species

- Attention is focused on corona, and dielectric barrier discharges for the generation of ozone and nitrogen oxides to kill bacteria, viruses (Covid-19) and for wound healing.

- Increased generation efficiency of these species: usage of non-traditional materials, energization, optimization of electrode systems and air supply mode, application of photocatalysts.

- Support from Technology Agency of the Czech Republic. TH03030432: Advanced oxidation technology for water, disinfectants and environmental applications.

- Czech patent No. 308279 (2020): Method of ozone and other active particles generation and the apparatus for this purpose.

- Since 2016 the research was published in 8 scientific articles that received > 20 citations.

- Research collaboration with Czech companies (Lifetech, Chemcomex) and the Czech Academy of Sciences.
Eye-tracking and testing learning disabilities
M. Dobiáš, Department of economics, management and humanities

We have our own eye tracking technology which includes hardware and software. We have created a battery of oculometric tests for children in cooperation with the University of South Bohemia. We have verified the methodology of eye movement tested on a sample of approximately 1000 children. As a result, we are already able to identify eye movement problems, although we continue working on the more complex data analysis. Only then we will be able to state, whether a child needs assistance to improve e.g. his/her reading skills or not.
Virtual reality and eye-tracking for testing competencies in HR
M. Dobiáš, Department of economics, management and humanities

We have created several games in VR and we can identify selected competencies from eye tracking in relation to work safety. These include reliability, resilience, attention and flexibility. The created mathematical model is now being validated. The achieved results will be applied through the established personnel agency Motiv P on the Czech and Slovak market.
Microwave Ablation: Device Development and Treatment Planning

Department of Circuit Theory
Jan Šebek, Radoslav Bortel

Objective of our research is 2-fold. First, applicators for minimally invasive image guided treatment of tumors in lung, and liver with control of radiation pattern to prevent unnecessary thermal damage to surrounding healthy tissue.

Sebek et al. Int. J. of Hypothermia 2017; 33.1: 51-60,
Sebek et al. Journal of Medical Devices 2017; 11.3,
Sebek et al. ERJ Open Research; 2020; 6.4.

Our second goal is to develop the patient-specific probabilistic treatment planning framework for guiding treatment parameters like applicator position, and energy dose to mitigate current challenges like local tumor recurrence.

Sebek et al. Medical Physics 2016; 43.5: 2649-2661,
Forecasting of epileptic seizures

SAMI research group (http://sami.fel.cvut.cz), the member of EpiReC (http://epirec.cz), Department of Circuit Theory, and Department of Cybernetics
Jan Kudlacek, Jan Chvojka, Vojtech Kumpost, Radek Janca, et al.

The mechanism of seizure emergence and the role of brief interictal epileptiform discharges in seizure generation are two of the most important unresolved issues in modern epilepsy research. We found that the transition to seizure is not a sudden phenomenon, but is instead a slow process that is characterized by the progressive loss of neuronal network resilience. The external neuronal stimulation can prevent the loss of resilience and delay seizure incoming.


Stable system:

- potential valley
- perturbation

Unstable system:

- Oscillation around equilibrium (impuls response)

 fast oscillation
 slow oscillation
 low amplitude
 high amplitude
 fast damping
 slow damping
Hierarchical scheduling for Cloud-Radio Access Network (C-RAN)

Z. Becvar, Department of Telecommunication Engineering

US patent + IEEE papers - 5Gmobile research lab (http://5gmobile.fel.cvut.cz)

C-RAN reduces cost and energy consumption of mobile networks

- Communication functionalities split between centralized baseband unit and distributed remote radio heads
- **Problem**: Additional delay (centralized↔distributed) \(\Rightarrow\) performance degradation

**Solution**

- Allocate resources at two tiers – *hierarchical scheduling*
  - Centralized scheduler (C-Sc)
  - Distributed scheduler (D-Sc)
- Dynamic allocation of computing resources for scheduling

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Prediction of direct channel among devices (D2D communication)
Z. Becvar, Department of Telecommunication Engineering
US patent + IEEE papers - 5Gmobile research lab (http://5gmobile.fel.cvut.cz)

Direct communication among devices (vehicles, IoT, machines,...)
- **Knowledge of all channels** among all devices \( N \times (N - 1) \) channels
- **Significant overhead** to measure and report quality of all channels
- **Limited number of communicating devices**

Solution

- **Predict direct channels** among devices from channels to few base stations
- **Deep neural networks** for regression
- **Close-to-optimal performance** of radio resource management

Direct communication of (almost) any number of devices enabled

DARPA SubTerranean Challenge

prof. Tomáš Svoboda group, Dept. of Cybernetics

Tracked, wheeled and flying robots (semi)autonomously exploring unknown underground

winning twice among self-funded teams
(twice 3rd overall)

Dept. of Cybernetics and Dept. of Computer Science, and Uni LAVAL
60 min mission, go, explore, find, locate objects. No GPS, no Wifi ...
http://robotics.fel.cvut.cz/cras/darpa-subt/
MEMS sensors with optical scanning
Microsystems Group (Janíček, Husák), Department of Microelectronics

• Within the ESO MEMS project CTU developed a layout of data processing circuit for MEMS system with optical scanning.
• It uses a X-Fab 180 nm technology.
• The result will be applied at Honeywell, Inc.
Ink-jet printed sensors
Electron Device Group, J. Voves, Department of Microelectronics


This basic research is funded by EU OP RDE project Centre of Advanced Applied Sciences (CAAS) and results have been presented in top scientific journals Physica E, IEEE Sensors.
Large Core Optical Planar Splitters
Opto Electronics Group, Václav Prajzler, Department of Microelectronics

• Development of Large Core Optical Planar Splitters by 3D print technology
• Large Core Optical Planar Splitters are used together Plastic Optical Fibers (POF) as a simple solution for data transmission in short-range data communications such as home or office networks, automotive or locomotives optical communications.

Published papers:

Smart Access Control for Smart Buildings
Microsystems group (Janíček, Husák), Department of Microelectronics

• Within the SACON project CTU developed a system integrateable into regular door handle with energy harvester for powering the smart lock.

• It uses gear with high ratio which is driven by the door handle itself. Just one turn can generate enough energy for generating enough energy for powering the integrated power management circuit which stores the energy in supercapacitors or batteries.

• The hardware will be compatible with industry standards of our project partners (EVALAN, IMA), the hardware is intended for commercial use.
Wireless sensor nodes powered by energy harvesting
Microsystems Group (Bouřa, Husák), Department of Microelectronics

- Within the EnSO EU project CTU developed wireless sensor nodes that can be powered just using the energy from the surroundings.
- Successfully tested with small photovoltaic panels at indoor illumination, piezoelectric transducer for harvesting the vibrations and Peltier cells for powering by heat (human body, waste heat, sun, etc.).
- Hardware part of the energy harvester occupies just $6 \times 10 \text{ mm}^2$ on PCB and price of the components is 30 times lower than price of the commercially available equivalent module ($2.2 \text{ € vs. } 67 \text{ €}$) which allows mass applicability e.g. in the IoT smart grids and ubiquitous sensors.

Developed sensor node with energy harvesting circuit and the receiver.

Energy harvester on sensor node PCB
Revolutionary certification methodology for flight control systems
Dept. of Control Engineering - Martin Hromčík group

Collaboration with Honeywell Aerospace in the years 2015-2020
→ BendixKing AeroCruz 230 product released Summer 2020

For the first time ever, AML STC (Approved Model List – Supplement Type Certificate) was received for an autopilot unit

The system certified for more than 60 aircraft types while full certification flights for only three types were done

Accompanying analysis developed by CVUT convinced certification authorities (FAA, EASA) that heavily reduced number of flight tests is sufficient

Reduced development costs and rapid marketing of new autopilots

Reported by Avionics News, Sept 2020
From atoms to fighters: revolutionary solid lubricants
Dept. of Control Engineering - Tomáš Polcar group

Key papers:
Nature Comm 2020
Phys Rev B 2019, 2020
ACS Appl Mat Int 2019
Nanoscale 2018

Material Fabrication

Lab Testing

Process Up-scale

Deposition on real part

Application: solid lubricant on actuator for L39 NG

Industrial testing

Advanced Materials Group
nano.cvut.cz
Wireless Physical Layer Network Coding
Department of Radioelectronics, DiRaC, Jan Sýkora
(Jan.Sykora@fel.cvut.cz)

https://doi.org/10.1017/9781316156162

• Comprehensive theoretical monograph – mathematical grounds for physical layer network coding and signal processing

• Novel research results, e.g., capacity coding theorems (achievability, converse) for hierarchical decode and forward strategy (chapter 5.7), design of Network Coded Modulation for imperfect hierarchical side-information (chapter 8), Joint Hierarchical Interference processing (chapter 9.4), and WPNC coding for complex stochastic networks (chapter 10), ...

• FP7-ICT DIWINE - Dense Cooperative Wireless Cloud Network (2013-2015)

• CTU in Prague Rector’s Award for Prestigious Publication
Fluxgate magnetometer with 1 pT noise
Mattia Butta and Michal Janošek, Department of Measurement

Novel type of fluxgate sensors based on amorphous wire achieved noise of 1 pT/√Hz at 1 Hz, which is the lowest noise reported for this type of room temperature vectorial magnetic sensor


Multimedia transmission quality subjective testing with parallel task
Jan Holub, Hakob Avetisyan, Dept. of Measurement

Novel subjective testing methodology designed to mimic multi-tasking environment. The resulting international recommendation is the first methodology for multimedia transmission quality subjective testing that deploys paralell task world-wide.


Lightdrum: A portable device for texture measurement (BTF, BRDF)  
prof. V. Havran – Dept. of Comp. Graph. & Interaction (DCGI)