



# ANNUAL REPORT / 2020

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**T** BRNO FACULTY  
UNIVERSITY OF INFORMATION  
OF TECHNOLOGY TECHNOLOGY



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## Foreword

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The year 2020 was rather challenging. It taught us a lot, brought a lot, but also took a lot away. All in all, we cannot really call it a successful year.

In March 2020, the campus suddenly emptied out with what incidentally was the first general close-down of Czech universities since World War II. Classes went online due to the pandemic and students did not return to the campus for the rest of the year. Our first-year Bachelor's students were at least lucky enough to meet at the Start@FIT event in September 2020. Various regulations and measures also restricted the staff on campus. However, despite all these problems and limitations, we never stopped teaching and pursuing our research, the faculty continued with its activities and achieved some very good results. I would like to thank everyone involved for their tremendous efforts.

It is clear that the gaps that opened in 2020 will be difficult to bridge. We can see in our students that online learning cannot replace face-to-face classes in the long run, despite all our efforts. It is clear that students would be better motivated by interactions with fellow students – some of whom they did not even meet in person so far – with teachers and the faculty in general. Despite some satisfactory results, the pandemic also caused complications for science and

research and nearly severed most international contacts. We are prepared to start paying off this debt towards ourselves as soon as the pandemic subsides, supporting student activities, reintroducing face-to-face teaching and especially renewing international relations and contacts as much as possible.

The situation we had to face in the past year brought about many losses, countless complications and constant change. We pride ourselves in being IT professionals who should be trained to adapt and respond quickly to new situations and I believe that we ultimately succeeded in these challenging times although it was not without setbacks and that we learned many valuable lessons, including the bare fact that human contact is irreplaceable, despite all advances in IT and technology in general.

That is also why I believe that most of the solutions that we had to adopt in 2020 were viable only in the short term. I hope we will get 'back on track' soon. The world, however, will not go back to pre-pandemic conditions and it is my hope that we will be able to keep the lessons of 2020 close to the heart.

Pavel Zemčík, Dean of FIT BUT



# FIT profile

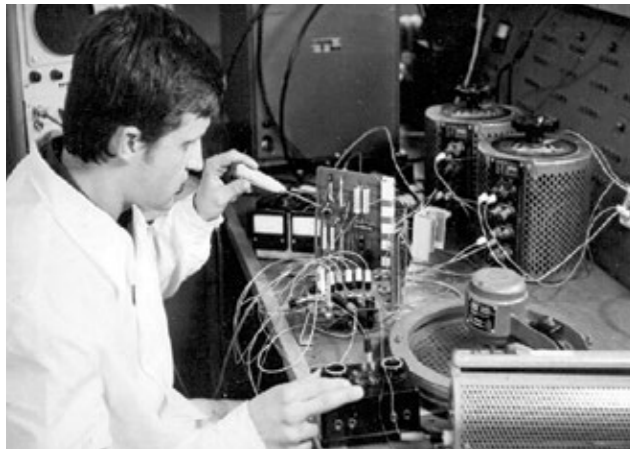
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The Faculty of Information Technology is a modern, internationally renowned university institution, and a centre of top quality research in various areas of IT – from hardware, through intelligent systems to multimedia. At its modern and uniquely equipped campus, the faculty offers to its students highly valued education in IT at all levels of studies: the three-year Bachelor's programmes, the two-year follow-up Master's programmes, and the four-year Doctoral studies.



## Tradition

The faculty's tradition of teaching information technology started in 1964, when the Department of Automatic Computers was established at the Faculty of Electrical Engineering of the Brno University of Technology. The department grew gradually, and became a faculty in 2002. Today, almost 2,500 students attend.



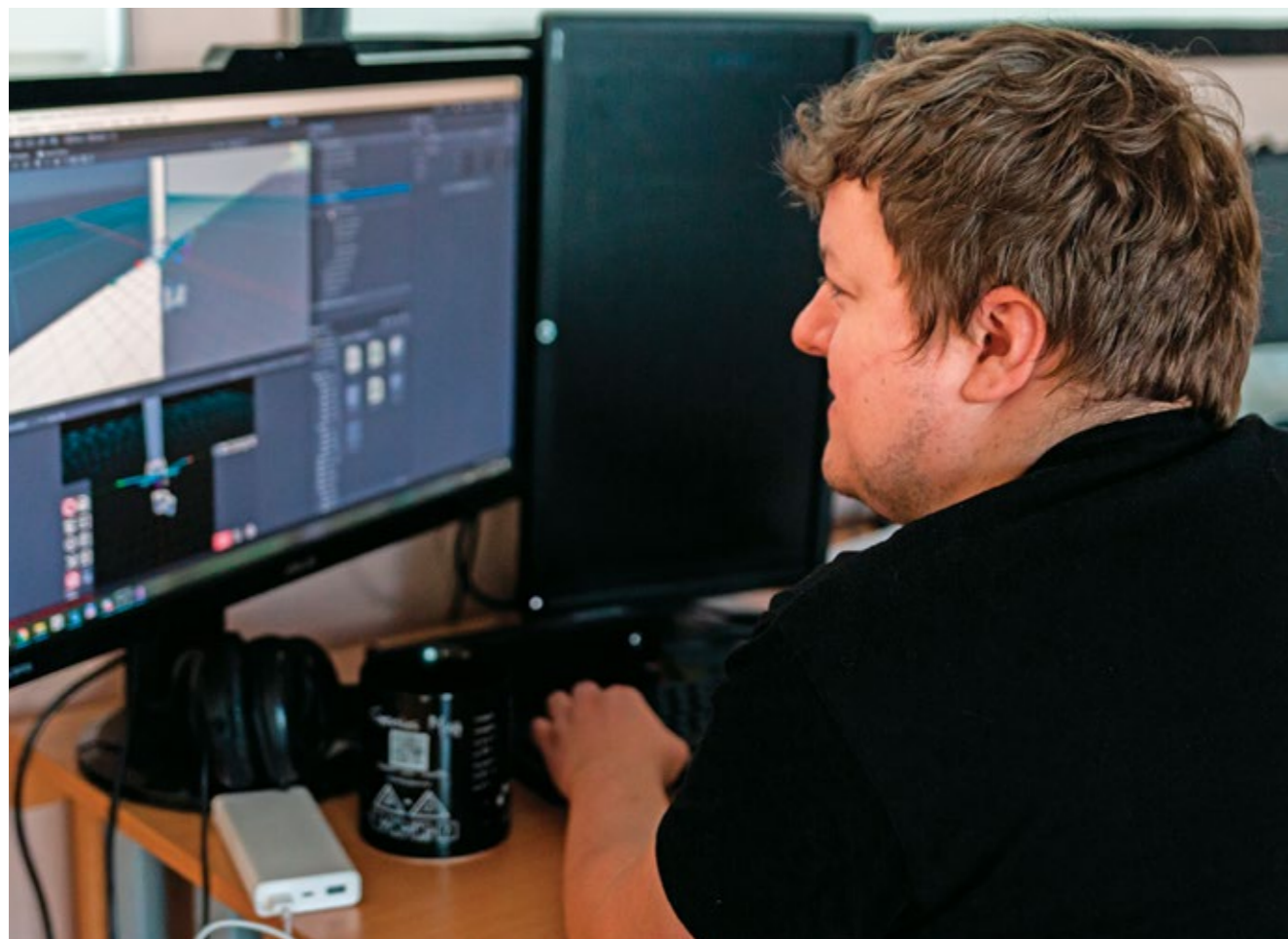
## Teaching and practice

The faculty emphasises high quality theoretical preparation corresponding to university studies in the field of technology. However, we realise the importance of the studies being interconnected with practical experience. The faculty has its own Industrial Board through which it maintains regular contact with the industry leaders. That allows the faculty to bring the latest findings from practice into its study programmes. As a result, FIT graduates are highly demanded at the labour market, and have the highest starting salaries from all BUT graduates.



## Science and research

There are over twenty research groups working at the faculty, many of them being successful not only in the Czech Republic, but also abroad. FIT is participating in both national and international projects – whether on its own or in co-operation with other universities, research centres, or renowned companies and institutions. The faculty also operates its own Research Centre of Information Technology. The centre is part of the IT4Innovations centre of excellence, the owner of the national supercomputing centre.



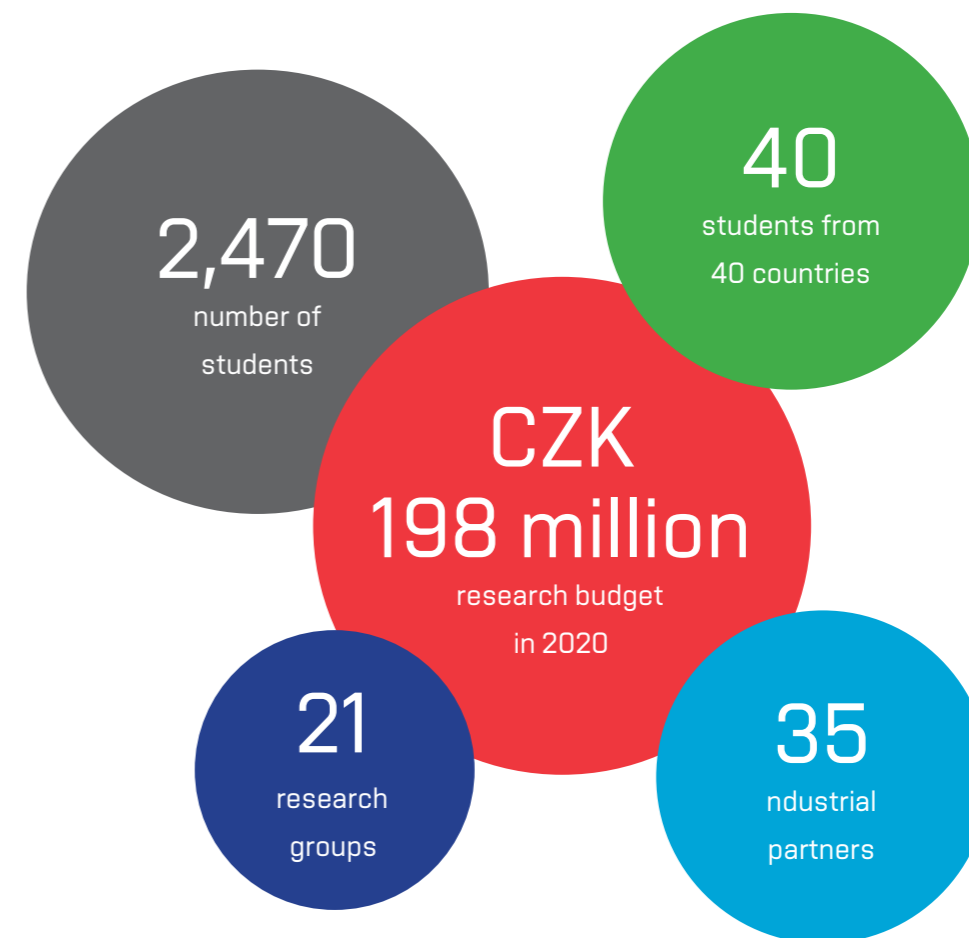
## Campus

The faculty's campus is a unique combination of carefully renovated historic premises of the former Carthusian monastery from the 14th century and new and modern buildings. The renovation and construction works were carried out between 2006 and 2013, giving the leading Brno architects an opportunity to utilise the most recent findings on creating university teaching areas. The premises consist not only of lecture rooms and laboratories equipped with state-of-the-art technology, but also provide space to relax and rest in, dining areas, and a space for cultural and leisure activities.





## 2020 at FIT in numbers





# People

## Faculty management



**prof. Dr. Ing. Pavel Zemčík**  
dean



**Ing. Bohuslav Křena, Ph.D.**  
Vice-dean for Efficiency  
and Academic Affairs



**Ing. Vítězslav Beran, Ph.D.**  
Vice-dean for External Relations



**Ing. Jaroslav Dytrych, Ph.D.**  
Vice-dean for Bc. Study



**doc. Ing. Richard Růžička, Ph.D., MBA**  
Vice-dean for MSc. Study



**prof. Ing. Tomáš Vojnar, Ph.D.**  
Vice-dean for Science and Research



**Ing. Petr Hajduk**  
Secretary

## Heads of departments and centres



**doc. Dr. Ing. Dušan Kolář**  
Department of Information Systems



**doc. Dr. Ing. Petr Hanáček**  
Department of Intelligent Systems



**doc. Dr. Ing. Jan Černocký**  
Department of Computer Graphics  
and Multimedia



**prof. Ing. Lukáš Sekanina, Ph.D.**  
Department of Computer Systems



**prof. Ing. Tomáš Hruška, Csc.**  
Research Centre of Information Technology



**Ing. Petr Lampa**  
Computer Centre

## Number of employees

<b>total number</b>	<b>316</b>
number of academics and researchers	103
other employees	213



# FIT in 2020

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The global Covid-19 pandemic strongly affected the Faculty of Information Technology. In March, the campus had to close down for students and the public and the faculty had to start teaching online practically overnight. This regime lasted virtually throughout the entire 2020 with most of the events moved to the virtual environment. This challenging year was nonetheless still rich in events and successes, and the faculty and students were always ready to extend a helping hand where it was needed.

FIT in 2020



## FIT helps



### The faculty donated laptops and tablets to a children's home

Nine laptops, five tablets and two mobile phones were handed over by representatives of the Faculty of Information Technology to the director of the Dagmar children's home in Brno. The devices were collected in a donation drive at FIT and prepared by the Computer Centre technicians. The children then used them for online classes.



### BUT joined the nationwide chcipomoc.cz and Folding@home initiatives

BUT students joined the nationwide initiative chcipomoc.cz (I want to help). It was launched under the auspices of the Academic Centre for Student Activities, run by FIT graduate Jaroslav Švec. The website was used to register and categorise volunteers. BUT students used the platform to offer help, e.g., in the field of IT, sewing face masks and distance tutoring.

The faculty also participated in the Folding@home initiative, providing its computational resources to simulate protein folding to help scientists develop a Covid-19 vaccine.



### Student support

The faculty also did its best to help and support the students from sending them the necessary library books and hardware sets that allowed them to at least partially compensate for their absence from the laboratories, to lending them faculty laptops. We also sent a bus for Slovak students who found it difficult to travel to Brno when international transport was interrupted.



### Light against the virus

A red cross was lit up at the Faculty of Information Technology to pay tribute to medical professionals, rescue workers, firefighters, police officers, volunteers and everyone who lent a helping hand to fight the pandemic. The Light Against the Virus initiative was inspired by VISUALOVE group, symbolically illuminating buildings that had to close down during the pandemic.

# Life at FIT

## Charles University and Brno University of Technology belong to the prestigious network of European laboratories for AI

Two Czech laboratories working in automatic speech and language processing have achieved significant international success. The results of the European programme supporting the creation of artificial intelligence centres were announced in March. The institutions involved in the HumanE-AI-Net project also include the Faculty of Mathematics and Physics, Charles University in Prague and the Faculty of Information Technology (BUT).

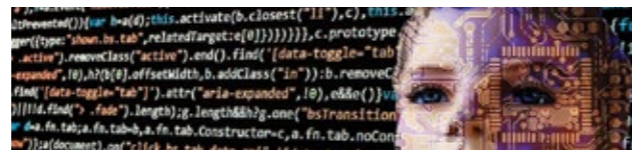
The HumanE-AI-Net project brings together leading European research centres, universities and industrial enterprises into a network of centres of excellence that goes beyond the narrow definition of artificial intelligence (hereinafter referred to as AI) and combines leading global AI laboratories with key players in related areas such as human-computer interaction science, cognitive science, social science and complexity science. This is linked to a European strategy that focuses on human-centred artificial intelligence.

“We have been involved in international projects dealing with natural language processing and spoken language since the early 1990s. The mandate of representing this area in HumanE-AI-Net is a success, but also a commitment to continue our top research in this area, while extending it in a multidisciplinary way, as the project assumes,” said Jan Hajič from the Faculty of Mathematics and Physics, Charles University. The project is led by the German Artificial Intelligence Research Centre (DFKI) in Saarbrücken, with which Charles University has long-term cooperation in the EU Framework Programmes and the Horizon 2020 Programme. “AI and language technology research will be conducted in HumanE-AI-Net through joint microprojects, which aim to achieve completely new results and new research questions through unconventional experiments, which will at the same time force participants to leave the ‘comfort bubble’ in which they usually operate with their research. HumanE-AI-Net is also a networking project aimed at pre-

paring major AI projects in the planned Horizon Europe programme,” explained Hajič, who is also chairman of the pan-European association META-NET (Multilingual Europe Technology Alliance Network).

Experts from Charles University will cooperate closely with colleagues from Brno; these colleagues are speech recognition experts working at the Faculty of Information Technology of the Brno University of Technology, who are among the world leaders in their field. “Participation in the HumanE-AI-Net project is a reward for our more than 20 years of work in the field of speech information mining, one of the cornerstones of modern AI. We look forward to using ‘HumanE-AI-Net’ to drive out of our narrowly focused field and connect with people exploring AI on a much wider scale,” commented Jan Černocký, the Head of the Speech@FIT research group. “Throughout our existence, we have been trying not only to produce top research results, but also to be valid members of the international research community, whether by participating in international technology evaluations or organising international workshops,” Černocký added, remembering the American projects DARPA and IARPA obtained by his group and the fact that the biggest speech conference, Interspeech, will be held in Brno in 2021 thanks to BUT.

Under the HumanE-AI-Net project, 53 partner organisations will receive a total of nearly 12 million EUR. According to Hajič and Černocký, however, this is not about finance itself, but rather about prestigious European cooperation, which helps to connect key players in the field of AI. In addition to the European Commission, the Czech government is now focussing more closely on AI and plans to establish a European Centre of Excellence in AI as a part of the National Artificial Intelligence Strategy. In addition to CU and BUT, the Czech Institute of Informatics, Robotics and Cybernetics of CTU, which is involved in three other projects funded from the same call to support the creation of AI Centers of Excellence, should participate in this initiative.



## Masaryk University, together with CTU and BUT, established a new institute focused on cybersecurity

Three leading Czech higher education institutions – Masaryk University, Czech Technical University in Prague and Brno University of Technology – agreed to strengthen their existing co-operation in the area of cybersecurity and established a registered institute called the CyberSecurity Hub. Apart from strengthening joint professional activities, they will also focus on supporting industry, companies and European certification of state-of-the-art technologies in the area of cybersecurity. Representatives of the higher education institutions signed the foundation deed of the institute on 18 November.

“This one-of-a-kind co-operation of three higher education institutions, who are leaders in the field of cyber security research both on national and international levels, will significantly strengthen the position and competitiveness of Czech research and education, as well as co-operation with the industry in the area of cyber security,” says Radim Polčák, Vice-Rector of the Masaryk University for Development, Legislation and IT.

The new institute will continue joint activities of its founders at the National Competence Centre for Cybersecurity, which hosts co-operation between leading Czech research institutions and private companies. First activities of the institute include establishing of a European digital innovation hub or creation of a special certification authority in the area of cyber security.

“As a part of the European Digital Innovation Hub, a network of European hubs for digital innovation, the institute intends to co-operate with

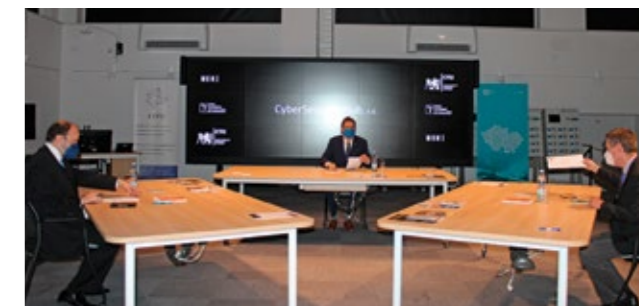


its partners on providing support for safe development of digitalisation and implementation of innovations in Czech industry by creating a comprehensive system for sharing information and experience, ensuring availability of know-how, technologies and infrastructure, education and supporting investments,” states Radek Holý, Vice-Rector of CTU for the Information System.

Another goal of the institute will be to evaluate compliance of new state-of-the-art technologies with security requirements and certify them. The CyberSecurity Hub will thus become a certification authority under the control of independent public higher education institutions which will have the required accreditation and will be responsible for the entire certification process. Certification authority will operate under the new European legal regulation, meaning that its certificates will be valid in the entire European Economic Area. Thanks to co-operation of leading experts from the participating higher education institutions, the institute wants to compete against certification authorities from large member states of the European Union.

“Close co-operation with Czech companies in the area of cybersecurity will lead to improvement of utility properties of their products and services and hence to improving competitiveness of Czech industry at an international level,” adds Pavel Zemčik, Dean of the Faculty of Information Technology of BUT.

The institute will achieve these ambitious goals through its activities which will be strategically managed by an administrative board comprised of representatives of the founding institutions as well as the expert community. It will co-operate with external research institutions, public administration, private companies, expert associations, industry clusters and other organisation both in the Czech Republic and abroad.



## FIT contributes to the creation of Brno.AI, Brno's new artificial intelligence platform

**Autonomous cars and receptionists, applications for the visually impaired, voice recognition, virtual power stations or developing a cure for Covid – all this could be achieved by employing artificial intelligence. Brno's experts on artificial intelligence set themselves a goal to achieve its greater practical use and, on Thursday, introduced a common platform – Brno.ai. It was created not only by professionals from FIT BUT and Masaryk University, but also by representatives of IT companies, the South Moravian Region and the City of Brno as well as the JIC innovation agency.**

"Brno is the perfect fertile ground for internationally successful artificial intelligence projects," says Petr Chládek, director of the JIC innovation agency, which is responsible for the platform's launch, and adds: "In Brno, high-quality IT departments of local universities meet successful start-ups and established companies, such as Phonexia or Artin, as well as large corporations like Honeywell and Red Hat." The platform's coordinator Jan Bárta thinks that the platform will allow closer cooperation of these institutions and companies on the currently needed projects. He says that the platform is planning to organise regular events where experts and company managers can meet, present their work and network with potential partners. "We started with these meet-ups already at the end of the last year in a trial online regime. The demand was huge – more than a hundred experts from Brno's companies and universities signed up for the first event," Bárta adds.

Brno already has several leading companies that won recognition in the area of artificial intelligence. A BUT spin-off company Phonexia, for example, is an internationally successful company specialising in innovative speech analytics and voice biometrics. Bringauto, an autonomous vehicle constructed by Artin in cooperation with FIT's specialists, has recently passed its first test drives. And there is also Kinalisoft, a supplier of an AI-based production quality control systems. "We believe that the platform where experts can meet will give a boost to similar companies and put Brno – and not only Brno – on the world AI map. It certainly has the potential to do so," says Bárta, adding that the platform is counting on cooperation with other regions, including Prague and its prg.ai platform.

The dean of the Faculty of Information Technology of BUT, Pavel Zemčák, finds the platform helpful for the development of AI in Brno: "Our researchers have years of experience in putting artificial intelligence into real world applications and have worked together with the industry on a number of research and innovation projects. The new common platform is very important for the whole region – I believe that sharing the know-how, real world experience and opportunities can help Brno and the South Moravian Region find its place on the world map of artificial intelligence." Professor Antonín Kučera from the Faculty of Informatics of Masaryk University has a similar view on the creation of the platform: "AI has been gradually finding its way into all science fields. At Masaryk University, many research groups are actively using or developing AI-based tools. The platform could help us make all of that more efficient and bring scientific research closer to industrial practice."

The city of Brno and the South Moravian Region also support creation of the platform. "Artificial intelligence is one of the most promising fields of science, research and business. We would not want to miss this opportunity to efficiently connect these areas and start intensive communication among individual participants, who otherwise often seem to focus only on their own thing and share very little with others. Most importantly, our objective is to debunk the myths surrounding AI in the eyes of the public and showcase its numerous benefits, not only threats," says Jiří Hlavenka, Member of the Regional Council. Deputy Mayor Tomáš Kolář agrees: "Artificial intelligence is widely used not only in futuristic scientific areas, but also in every-day situations – it helps with automation of routine activities, provides for cybernetic security in the sense of intelligent supervision over city infrastructure and personal security in the form of intelligent management and optimisation of transport in the city. I think it is likely that artificial intelligence is about to become the next pillar of Brno's prospering IT sector."

Some of the multinational corporations with workplaces located in Brno also contributed to the creation of the platform. Honeywell is one of them. Its representative Tomáš Szaszi points out that many similar platforms exist around the world. However, not many of them can profit from a successfully working ecosystem that meets the requirements for long-term stability, such as the one that exists in South Moravia. "Brno.AI interconnects the principal components of the local ecosystem, including universities, municipalities, start-ups and industry, with the objective of mutual cooperation and faster application of the given technology in practice," concludes Szaszi.

## 2020th Ceremonial Academic Assembly of BUT Rector awarded 8 people associated with FIT

Eight individuals associated with FIT chosen from among its students, employees, or co-workers, have been awarded by the Rector Petr Štěpánek at the Ceremonial Academic Assembly of BUT. The annual ceremony, announcing the Best Teachers Award winner and honouring selected individuals associated with the university, was scheduled for 24 November, but was cancelled due to the current situation. On these grounds, students and academics who took part in the "VUT pomáhá" (BUT Helps) project and contributed to the fight against the coronavirus pandemic, symbolically received the awards and a thank you from the Rector in a video message and a booklet, which can be found [HERE](#).

### FIT BUT Awardees:

#### Silver Medal

- prof. RNDr. Alexandr Meduna, CSc. – for outstanding academic achievement in teaching, research and scientific work.
- doc. RNDr. Jitka Kreslíková, CSc. – for significant contribution in the area of teaching.

#### Memorial Medal

- prof. Hao Liu, Ph.D. – for fostering co-operation between FIT BUT and Beihang University, Beijing University of Technology, and Xihua University
- Ing. Marcela Oravcová – for long-term exceptional achievement in organisational activities.

### BUT Helps – honourable mention

- Ing. Radek Hranický



### Award of the Rector for students of BUT

- Ing. Roman Andriushchenko – for outstanding academic achievement in the Master's programme.

### Best teacher according to BUT students

- doc. RNDr. Dana Hliněná, Ph.D. – best teacher as selected by BUT students in the Bachelor's studies category, BUT Faculty of Information Technology
- doc. Ing. Jiří Jaroš, Ph.D. – best teacher as selected by BUT students in the Master's studies category, BUT Faculty of Information Technology

# Events

## 'Offline' events

### DevConf

(24 to 26 January) The largest event for Linux and open source developers, administrators and users in Central Europe once again took place at the FIT campus with the Faculty of Information Technology as one of the organisers. The twelfth edition of the conference welcomed over 1,500 participants and more than 300 speakers from all over the world. The conference addressed a variety of topics ranging from the development of cloud applications to machine learning, artificial intelligence and infrastructure administration tools.



### High Visual Computing

(24 to 26 January) The 7th gathering of Czech and Slovak experts in computer graphics and vision. The event was organised by the Faculty of Information Technology together with the Faculty of Mathematics and Physics of Charles University. The event aims to promote the exchange of knowledge and experience between researchers and experts.



### Balls

- Representative Ball of FIT and FEEC (24 January)
- FIT Students' Ball (14 February)



### (F)IT Summer School for Girls

(24 to 28 August) LEGO robots, basics of programming, a photography course or hacking using a gummy bear. That were just a few of the activities offered at the (F)IT Summer School for Girls, whose participants also got to see a specially adapted FabLab Experience trailer – the first digital mobile laboratory that was created with FIT support. (F)IT Summer School is the oldest event of its kind in the Czech Republic; this year, it was held already for the fourteenth time. With the project, the faculty strives to encourage young girls not to be intimidated by computer science.



### Start@FIT

(17 to 20 September) The traditional Start@FIT event for freshmen was held in a limited scope due to the epidemiological situation, but it was still designed to introduce students to university life, show them around the campus, help them meet their fellow students and the faculty and find their way about the city.



### VGS-IT: Invited Talks on Vision, Graphics, and Speech

- Lecture by Jan Chorowski (10 January) on neural representations for speech and handwriting recognition.
- Lecture by Jan Ullrich (27 February) from the Language Conservancy on research into concentric languages and on classical and new theories for natural language processing and natural language understanding.

### Exhibition at the Technical Museum: FIT robots watch theatre and explore collaboration with humans

An interactive exhibition on robotics was prepared by the Technical Museum in Brno for the 100th anniversary of the first edition of Karel Čapek's drama R. U. R., in which the author first made use of the new word robot'. The exhibition presents the importance of robotics in industry, science and technology, as well as in culture and art. Visitors will also find robots from FIT among the one hundred exhibits.

The main exhibition space on the third floor of the museum has been transformed into a laboratory, which shows the results of mutual cooperation between the museum and individual faculties of BUT on an area of more than 600 m<sup>2</sup>. Visitors will also find an exhibit of L&K Robotics - a start-up from the Faculty of Information Technology, which manufactures semi-professional robots.



"They bring Čapek's vision of available universal machines from R.U.R. closer to reality. When Karel Čapek imagined robots one hundred years ago, it was an affordable and versatile machine that performs any kind of labour. Since the time of Karel Čapek, technology has advanced at an incredible pace. In the digital age, everyone has a computer with an internet connection. So far, we only encounter robots in factories and warehouses, but they do not help us at home yet," explains Martin Kolář, a researcher from FIT who participated in the development of the robot.

"Our exhibit at the Technical Museum shows how a robot can tirelessly repeat any task. You can also see how a robot with a camera observes Čapek's play in which it was created, and think about the possibilities and implications of expanding artificial intelligence," he adds.

The exhibition features a rescue robot called Ruda, which was developed at the Department of Intelligent Systems and designed to search for people in cave-ins and avalanches. "The former winner in the category for automation, measurement and control technology, sensors and robotics can find a living person up to 20 metres below the surface thanks to its bio-radar. During the development process, which took more than four years, the team worked with the military and firefighters in particular to define the robot's capabilities and equipment requirements. It is a modular device whose equipment can be added and changed according to the current situation," said Martin Drahanský from FIT, head of team that developed the robot.

Some of the other main exhibits also come from BUT faculties including a pair of humanoid robots that will lead a "dialogue between centuries".

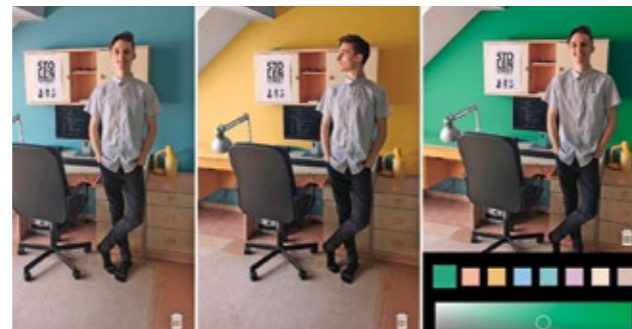
## 'Online' events

### Students presented the best IT ideas at this year's Excel@Fit conference hosted online

**The sixth year of the annual Excel@FIT student conference focusing on innovations, technology and research in the IT field was held at the Faculty of Information Technology. The conference presents the best ideas of the students of information technology. Due to the extraordinary situation, the presentations of students' works were held online.**

An expert panel comprising professionals from both the academic and commercial sectors chose over 30 works for the final presentations at the Excel@FIT 2020 conference. The aim of the conference is to show practical solutions developed by students of IT; examples of the works presented by the students this year include an application that helps its users to pick a colour before painting their room, a tool detecting errors in programmes, and a platform that is used for exposing criminals using cryptocurrencies for their illegal activities.

Dominik Vagala presented his Android application that enables its users to try out different wall colours in real time. "I wanted to paint my room about two years ago and I just couldn't pick the right colour. It is not that easy to imagine which colour would be best suited for one's room. I tried existing applications, but they were mostly incompatible with my mobile device. That is why I had to use a graphic editor on my computer to change the colours there. This process took too much time and I especially lacked the ability to walk around the room and look at walls with different colours from various angles," Vagala describes his motivation. He managed to finish his application, named 'Paint my Room', and publish it on the Google Play store.



Vladislav Bambuch created a functional platform that can help expose criminals using cryptocurrencies for their illegal activities. His work is using data mining from publicly available websites. "The data-mining process can take months so I primarily focused on its acceleration. I came by this topic during a work on a university project. I found this issue, which could help increase the security on the Internet, quite fascinating and saw an opportunity to build something with a practical use as part of my diploma thesis project," Bambuch says. The result of his work is a functional platform that serves as a basis for the future connection of other web-based tools and their integration with other projects undertaken at FIT BUT.

Roman Bártil designed a device capable of displaying various notifications from telephones similarly to what smart watches do. Incoming calls, text messages or notifications from other applications are shown as icons on a matrix display built from LEDs. "I have created a functional prototype so far. The work also included development of an application that manages the pairing of the phone with the device and where the user can set which notifications he/she wants to be displayed and what icon should represent them," Bártil describes.

Michal Ormoš co-operates with Brno-based company, Sewio on the development of a system enabling localisation of people in buildings. "We



are all used to using our phones to help us with navigation, we can use GPS to 'find' each other anywhere in the open space and choose the right direction. However, this does not work once we enter a building because our phones need an unobstructed connection with the satellites in the sky," he notes. Technology for localisation inside buildings, based on ultra-wideband radio transmission using specialised hardware, is gradually becoming embedded in the newest smart phones and, unlike GPS, it enables to localise devices even in places where it was not possible before. "With this technology, for example, during the current pandemic, building managers would be able to monitor the movement of people in a building, check that they observe proper social distancing and, in case of confirmed infection, find out who the infected person was in contact with in the past 24 hours," Michal Ormoš explains. His year-long work on the project yielded a test kit enabling automated validation of this technology across its development.

Monika Mužíková was also one of the presenters at the conference. She managed to expand the ANaConDA framework to enable detection of errors in concurrent programmes. "These errors may be very serious and actually caused deaths in the past – for example, in the infamous case of Therac-25 radiation therapy machine, an error in parallel programming caused massive overdose of radiation in several patients. ANaConDA and other similar tools can detect errors in parallel programmes using fibres to achieve concurrency. However, there is another large group of multi-process programmes that the existing tools cannot analyse," Mužíková explains.

### FIT students were not the only ones to present their work at the conference

Lukáš Dobiš, a student of biomedical engineering at FEEC BUT, presented his fast, robust and modular solution for detection of persons and recognition of their features on the basis of visual data. "First, we detect the position of the person's face and then we can determine the sex, emotional state or age of the person. We used a combination of several convolutional neural networks for the detection of faces and analysis of their features. A single network was used for each sub-task," says Dobiš. He adds that he had always been interested in artificial intelligence and as the impact of neural networks on our everyday lives increases, he wanted to analyse the technology and find its limits.

Panel of experts awarded prizes to a total of 20 students' works. The Jiří Kunovský Award was awarded to six projects based on over 900 votes cast by public in an online voting. Another twenty prizes were awarded by the industrial partners. The award-winning authors received stipends in the total value exceeding 180 thousand Czech crowns. "The Excel@FIT conference enables students to present their ideas and results of their work. Unfortunately, the extraordinary measures adopted in response to the current situation prevented us from hosting the conference as we were used to in the past. We had to cancel some parts of the programme altogether and other parts were moved to the digital world. Despite the various restrictions, majority of the students worked really hard on their projects and we are very happy with the extent and quality of our students' results," notes Vítězslav Beran, Vice-dean for External Relations at FIT BUT and Executive Chairman of the Excel@FIT conference board.

## Other events

### Online Science Night

The Science Night focused on the cooperation between humans and robots. BUT researchers prepared over two dozen videos for the event, which had to take place online this year. The Faculty of Information Technology took this opportunity to present its numerous facilities used to research human-computer interaction. The faculty representatives explained their use of augmented reality for robot programming, presented some results in the area of machine learning and guided the listeners through the research into a new concept of programming robots in their own 3D working environment.



### Introduction to Quantum Computing (online lecture)

Jean-Michel Torres, a technical expert from IBM, talked about the main concepts of quantum programming and working with actual quantum devices.

### Artificial Intelligence: A Gentle Introduction (online lecture)

Brainchild of IBM experts Matthias Biniok, who created the original lecture, and Ondřej Szekély, who introduced the participants to artificial intelligence and its deployment in production.

### Series of lectures and workshops within the Star(t)up@FIT programme

- more on page 77

### Open Day

The open day for prospective students also had to be moved online. The faculty presented a series of videos, which took the applicants on a virtual walk through the campus and answered important questions about their studies, life at FIT, employment and science. The videos are available here:

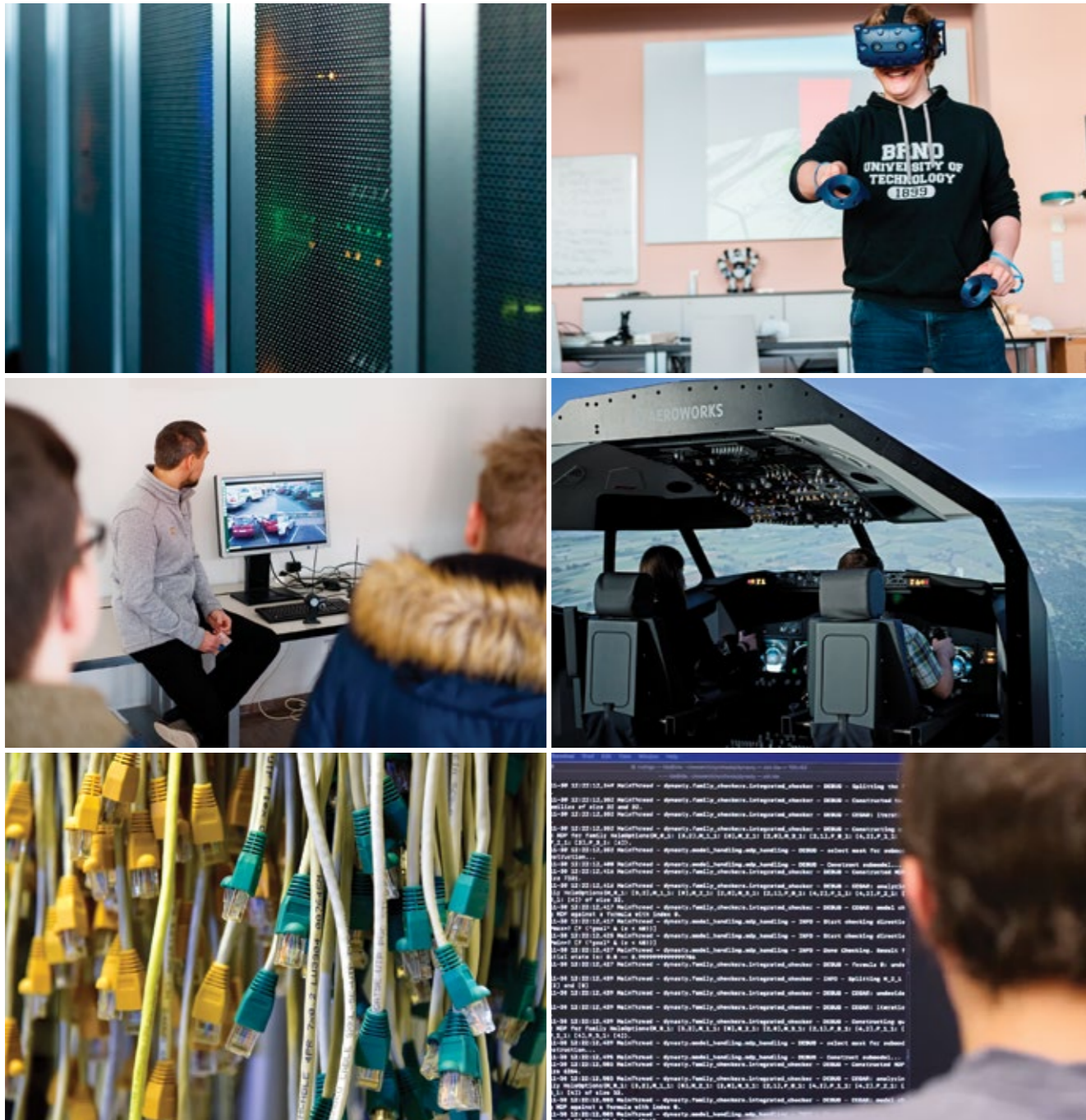


# Research, development and innovation

There are over twenty research groups working at the faculty, many of them being successful not only in the Czech Republic, but also abroad. FIT is participating in both national and international projects – whether on its own or in co-operation with other universities, research centres, or renowned companies and institutions. The faculty also operates its own Research Centre of Information Technology. The centre is part of the IT4Innovations centre of excellence, the owner of the national supercomputing centre. FIT BUT's strategic mission comprises research into information technologies, cyber-physical systems and artificial intelligence, including their security, reliability and efficiency.







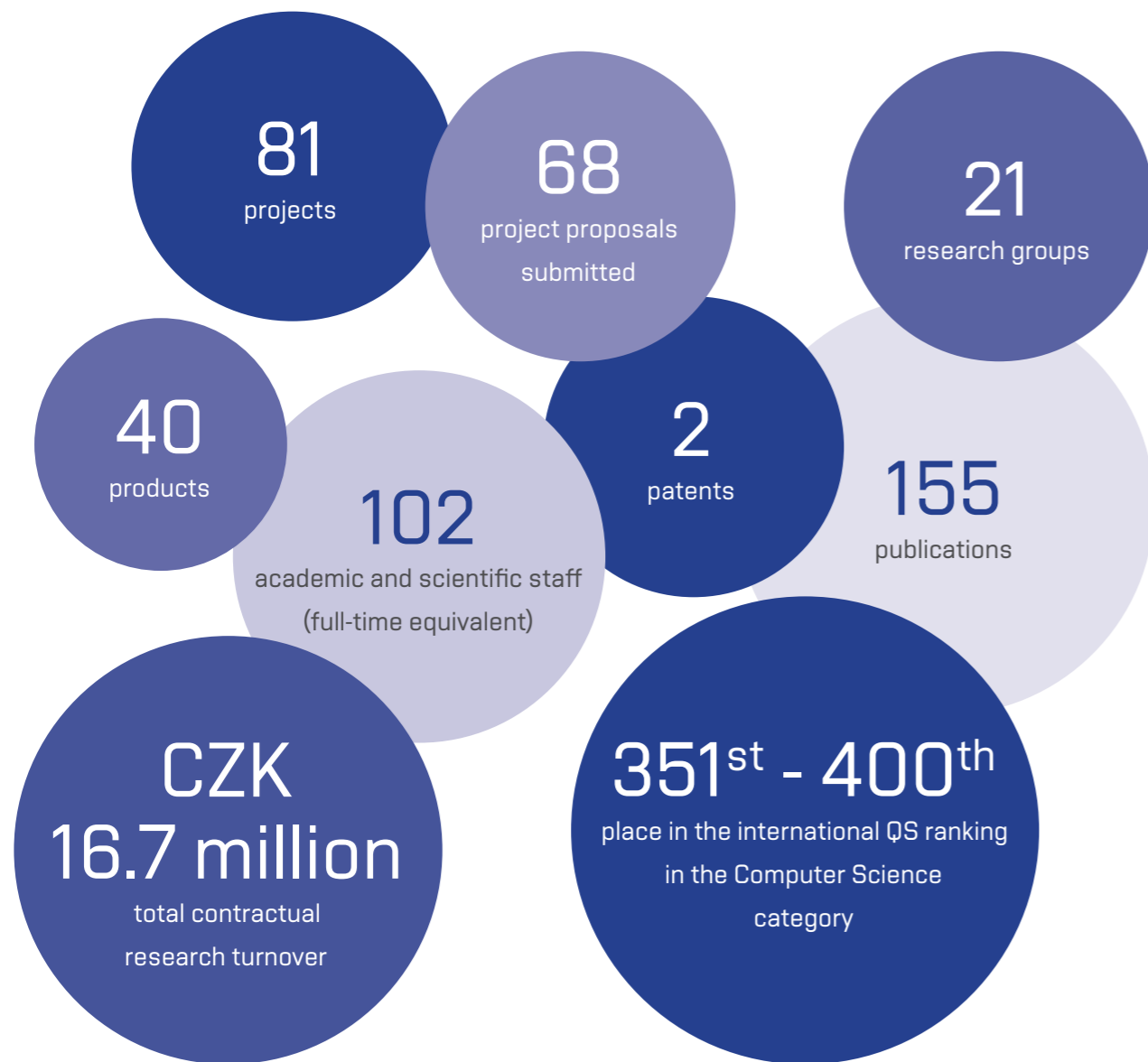
## Key areas of science and research at FIT

- Network security
- Artificial intelligence and machine learning
- Verification, synthesis, automata and logic
- Embedded computing and supercomputing technologies
- Evolutionary hardware
- Robotic and cyber-physical systems
- Knowledge acquisition, automation of information linking, smart device cooperation, document digitisation
- Theoretical foundations of computer science

The faculty further builds on these fields in its various other important activities in the area of infrastructure and applications, including their use in the industry (Industry 4.0, Internet of Things), in transport (smart cities, autonomous vehicles), and even in healthcare (challenges posed by an ageing population, personalised healthcare), in services for the society (digitisation of cultural heritage) and also in sustainable development of humanity (carbon footprint, smart agriculture) and other human activities where information technology plays a role (eGovernment, GDPR).



## Research at FIT in numbers



## Departments, centres and research groups

### Department of Information Systems FIT BUT

is responsible for teaching the courses within the Information Systems Master's study programme. Scientific and research activities of the Department focus on security, computer networks and the internet, database technology, implementation of information systems, management of software projects, and the theory of formal languages and compilers.

#### Research groups:

- Networks and Distributed Systems Research Group (NES@FIT)
- Hardware-Software Codesign research group (LISSOM@FIT)
- Formal Model Research Group (FM@FIT)
- Information and Database Systems Research Group (IS@FIT)
- Management of Software Engineering Research Group (MSWI@FIT)

#### Publications in 2020:

- Academic monographs 1
- Conference papers 12
- Journal papers 14
- Technical reports 4

All publications of the department are available here:



## Department of Intelligent Systems FIT BUT

is responsible for teaching the courses comprising three Master's specialisations: the Information Technology Security, Intelligent Systems, and Mathematical Methods in Information Technology. The research activity of the Department is focused primarily on intelligent systems, especially the biometric systems and robotics, but attention is also paid to systems for specific applications, communication systems and sensor networks.

### Research groups:

- Brno University Security Laboratory (BUSLAB@FIT)
- Security Technology Research and Development (STRaDe@FIT)
- Automated Analysis and Verification Research Group (VeriFIT@FIT)
- Intelligent Systems Research Group (INTSYS@FIT)
- System Modelling and Optimization Research Group (MODSIM@FIT)
- High Performance Computing Research Group (HPC@FIT)

### Publications in 2020:

- Conference proceedings 1
- Lecture 3
- Presentation, poster 1
- Summary article 1
- Conference papers 22
- Journal papers 13
- Technical reports 1

All publications of the department are available here:



## Department of Computer Graphics and Multimedia FIT BUT

deals with research and education in human-computer interaction, multimedia and multimodal data mining, image and video processing, computer graphics, speech data mining, advanced approaches to automatic control, knowledge technologies and big data processing. It builds on the solid foundations of mathematics, physics, theoretical informatics, signal processing, automation, and machine learning.

### Research groups:

- Speech Data Mining Research Group (SPEECH@FIT)
- Computer Graphics Research Group (GRAPH@FIT)
- Knowledge Technology Research Group (KNOT@FIT)
- Computational Photography Group (CPHOTO@FIT)

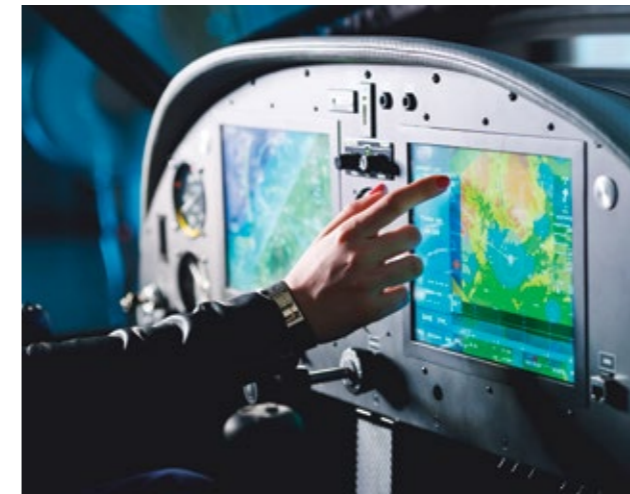
### Interdepartmental:

- Robotic research group (ROBO@FIT)

### Publications in 2020:

- Conference papers 29
- Journal papers 17
- Technical reports 1

All publications of the department are available here:



## Department of Computer Systems FIT BUT

is mainly responsible for teaching hardware-oriented courses in all study programmes accredited at FIT. The Department serves as a guarantor of the specialisations Bioinformatics and Biocomputing, Embedded Systems, and High Performance Computing within the newly accredited follow-up Master's study programme of Information Technology and Artificial Intelligence. Scientific and research activities of the Department are focused on HW/SW architecture of computer systems at the levels of digital circuits, single- and multi-core processors (including GPUs), embedded systems, application-specific integrated circuits, reconfigurable systems based on field-programmable gate arrays (FPGA), computer clusters and supercomputers.

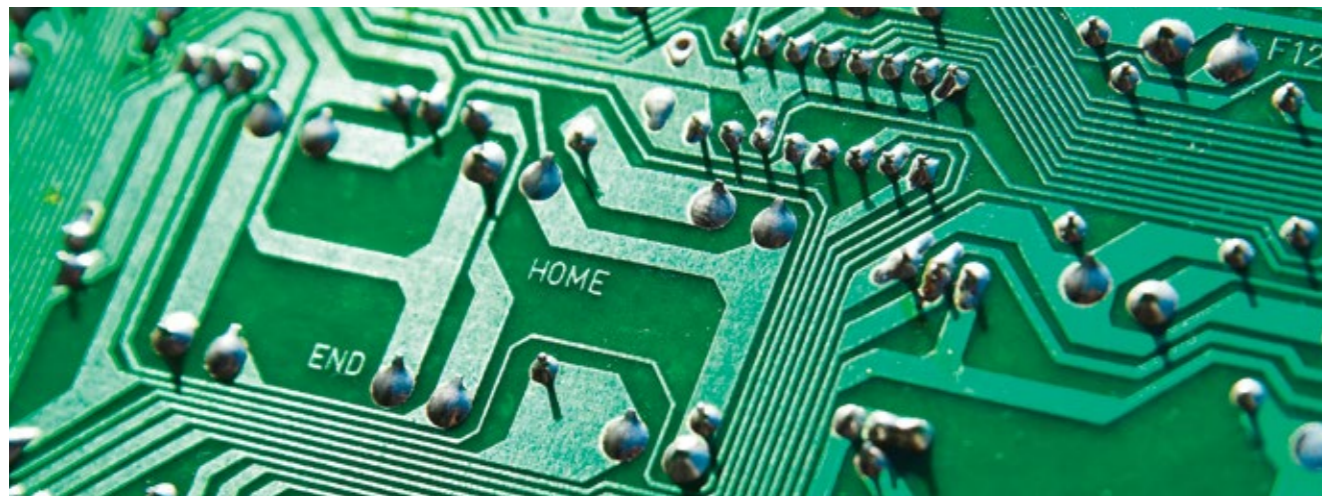
### Research groups:

- Evolvable Hardware Research Group (EHW@FIT)
- Unconventional Digital Circuits Research Group (POLY@FIT)
- Dependable Systems Research Group (DIAG@FIT)
- Supercomputing Technologies Research Group (SC@FIT)
- Accelerated Network Technologies Research Group (ANT SC@FIT)

### Publications in 2020:

- Abstracts 1
- Editorial article 1
- Conference papers 32
- Journal papers 13

All publications of the department are available here:



## Centres

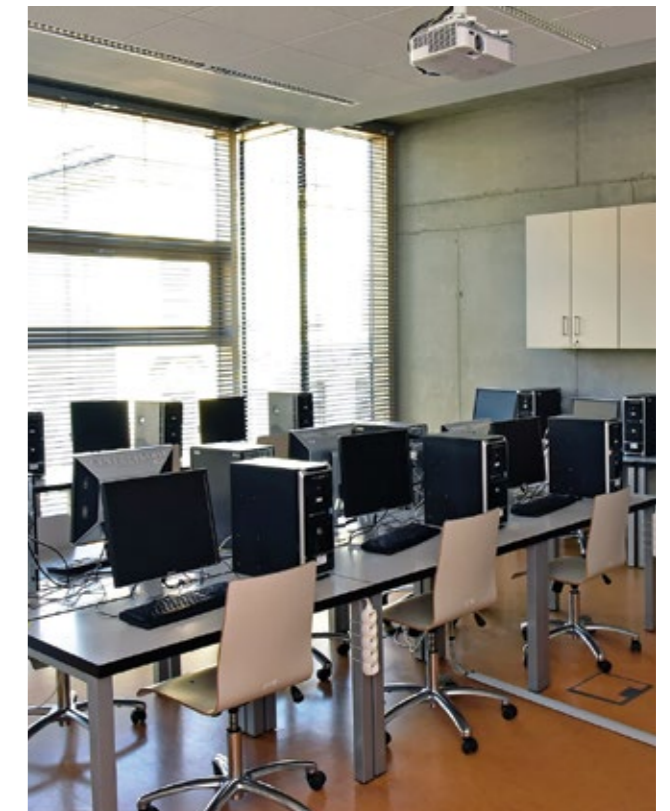
### IT4I Research Centre

is a unique project combining the function of a research centre for academic purposes, with research for the purposes of the industry and co-operation with business subjects by the means of contractual co-operation. The main areas of research are the identification and presentation of information from multimedia data, and safe and reliable architectures, networks and protocols. The centre offers some excellent opportunities for the students — they can acquaint themselves with top projects, and also with how the work is done outside the academia.



### Computer Centre

provides for the operation of computer laboratories, computer technology, the faculty computer network, servers and information systems. Computer laboratories located in the centre are used both for scheduled teaching and for working on projects, theses and research tasks. Outside scheduled teaching, the laboratories are freely available to all students of the Faculty of Information Technology.



# Awards

## Joseph Fourier Prize awarded to Kateřina Žmolíková for her work in the area of speech separation

**Kateřina Žmolíková, a doctoral student at the Faculty of Information Technology of BUT, has been awarded the prestigious Joseph Fourier Prize today. She ranked third for her work in the area of speech separation. The prize, which is awarded to doctoral students for successful work in the area of computer science and information technology, was presented to her at the French Institute in Prague by French ambassador Roland Galharague.**



In her work, Kateřina focuses on extraction of a single speaker from a speech mixture. “We are trying to extract speech of a single specific speaker from a recording in which multiple people speak at once and remove the other speakers. This can be used as a pre-processing step for various other technologies, such as speech-to-text conversion the ac-

curacy of which is otherwise markedly decreased if there are multiple speakers speaking in a recording,” Kateřina explains and further adds that the work was done largely in co-operation with the NTT research laboratory in Japan.

The technology Kateřina is working on is widely used today. Digital personal assistants like Alexa or Google Home are very popular nowadays, but the technology can also be used in applications for people with hearing impairment or for automated subtitling.

The Joseph Fourier Prize is an annual competition organised by the French Embassy in Prague in co-operation with Atos. Each year, authors of the best works go head-to-head in the competition focusing especially on design and use of compute-intensive algorithms and methods, simulations and modelling and on processing of large data volumes. More than a dozen of contestants from the top Czech universities participated in this year’s competition. The winners receive financial support and are presented with the opportunity to travel to a research laboratory in France for scholarship. In 2019 Vojtěch Mrázek was awarded the first place for his work focusing on the use of machine learning for optimisation and approximation of numerical circuits.

## System for answering human questions developed at FIT succeeded in a trivia quiz. It competed against both machines and humans

**It was a close call, but team of researchers from the KNOT@FIT group – Martin Fajčík, Martin Dočekal, Karel Ondřej and Pavel Smrž – managed to come in third at the EfficientQA competition held as part of the NeurIPS 2020 conference. Their system called BUT R2-D2 succeeded alongside such big names as Facebook or Microsoft and triumphed in the “machine competition” where it also competed against humans in a trivia quiz.**



How well can machines understand questions asked by humans and answer them correctly? Are they better at it than humans themselves? That is what the EfficientQA competition wanted to find out; the competition was organised by the GoogleAI research group as a part of the NeurIPS 2020 conference at the end of the last year. With their system called BUT R2-D2, the team of researchers from FIT managed to place at the top of the ladder in the category of systems under 6 GiB as the only university team.

“It is a neural system for answering human questions. All you need to do is ask it something and it will search a huge library, find relevant books, read them and give you an answer,” explains Martin Fajčík from the KNOT@FIT group which won third place at the competition. In effect, BUT R2-D2 had to learn over 21 million text passages.

The system contains two subsystems which gradually browse the document library and pick a small subset of the documents and another pair of subsystems which read through them and extract the answer. This is why we named it R2-D2 (Rank twice, read twice) which was inspired by the Star Wars robot who always helped where needed.

“Similar system see a wide range of applications today – for example as conversation agents, in customer support or in gathering information from virtually any field. Systems for answering questions will probably be a part of the future of gathering information, just as web searching is today. As the amount of information available on the Internet increases, web search can find us a huge number of relevant websites, but finding the correct answer we are looking for may be exhausting and sometimes even impossible,” notes Martin Fajčík.

BUT R2-D2 and other top systems faced tough competitors in the competition – humans. After the initial round, machines competed against a team of university professors and trivia quiz champions. They lost 51:73, but they showed great potential!přibližuje Martin Fajčík.

Proti BUT R2-D2 a dalším nejlepším systémům se v soutěži postavila těžká konkurence - lidé. Po úvodním kole se stroje utkaly s týmem složených z univerzitních profesorů a kvízových šampionů. V něm sice prohrály 51:73, ale ukázaly velký potenciál!

## Medals for the VeriFIT research group from the SV-COMP competition

**Tools, the development of which involved researchers from FIT won two gold, two silver and one bronze medal at an international competition on software verification SV-COMP. The competition is part of the TACAS conference.**

The Predator tool developed by Petr Peringer, Veronika Šoková and Tomáš Vojnar won a gold medal in the competition. The bronze medal was awarded to the 2LS tool, which is being developed primarily by DiffBlue in collaboration with Viktor Malík and Tomáš Vojnar. In addition, Tomáš Vojnar, together with Martin Hruška and Veronika Šoková, works on combining the Predator tool with the Symbiotic tool, which is being developed primarily at FI MU and which has won one gold and two silver medals.

## Anna Silnova’s article won an award at the Odyssey 2020 international conference

Anna Silnova from FIT and her colleagues wrote the best expert student article. They won the Jack Godfrey’s Best Student Paper Award at the Odyssey conference - the most prestigious event in the field of automatic speaker and language recognition. Their award-winning article is on probabilistic embeddings for speaker diarization.

## FIT doctoral student looks for bugs causing apps to “freeze”

Every day, we rely on the flawless functioning of dozens, if not hundreds, of applications and programs running on our computers, be they web browsers, information systems, communications software, or a multitude of hidden programs running in the background. We have come to expect applications not only not to crash suddenly, but also to respond very quickly to our commands. However, every user has experienced a situation where a new update to an important app caused it to slow down noticeably or even freeze up completely. This is exactly what Jiří Pavela, a doctoral student from the Faculty of Information Technology of Brno University of Technology, who is also one of the awardees in the Brno Ph.D. Talent competition, wants to prevent.



In his research project, Jiří Pavela is designing and developing new techniques and approaches for application developers to help them effectively detect errors that deteriorate application performance. “Although many tools already exist for this purpose, using them for very large projects with millions of lines of source code is often very time-consuming. So my aim is to achieve a noticeable acceleration and refinement of similar tools. This should be another step towards fewer and fewer annoyingly slow or unresponsive applications in the future,” explained Pavela, who has been doing research practically since his Bachelor’s degree studies.

Today he pursues the same topic as a doctoral student at the Department of Intelligent Systems under the supervision of Tomáš Vojnar and Tomáš Fiedor. He has received feedback for his tool from RedHat, a company with which he has already discussed cooperation. The Excel@FIT conference, where representatives of commercial partners evaluate individual IT projects, also helped him significantly. “We received very

helpful feedback, for example from companies like Honeywell, telling us whether the solution was actually applicable in practice and we know what we need to do to deploy it in a real company,” said Pavela.

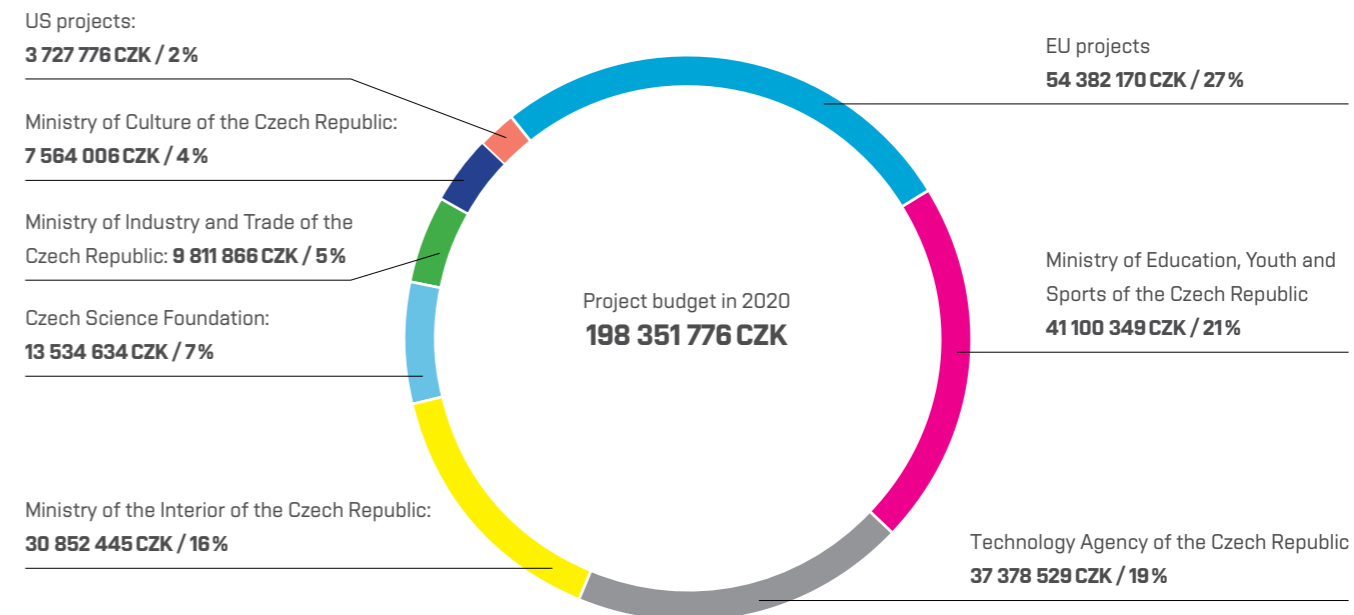
His bug detection tool is designed for large-scale software, for example cloud solutions from Microsoft or Amazon, applications like Facebook, etc., where developers are faced with millions or tens of millions of lines of code in which they have to look for a problem that slows down or crashes the application completely. “We want developers to be able to detect bugs faster and more accurately whenever possible. The tools available cannot be used in such complex and complicated projects. Moreover, the fact that my research was among the winners of the Brno Ph.D. Talent competition proves to me that my dissertation is meaningful and can have a positive impact in real life and influence the work of many other people,” said Pavela, who is now in the first year of his doctoral studies and the award will allow him to receive a scholarship for three years so that he can devote more time to his research.

The beta version of the program is now available on GitHub, where users can test the tool for free and provide feedback to its author. “I dare say that after three years of development, my solution should actually be usable in practice, and hopefully others will try to implement it further, get it up and running and start using it in their companies,” concludes the successful FIT student.



He received valuable feedback on his work also at the Excel@FIT conference  
Author: Jan Prokopius

## Survey of projects



Name of the project	Agency	Research leader
Security monitoring of ICS communication in the smart grid	MI CR	doc. Ryšavý
Information mining in speech acquired by distant microphones	MI CR	prof. Černocký
Flexible probe for lawful interceptions	MI CR	doc. Kořenek
Integrated platform for analysis of digital data from security incidents	MI CR	dr. Matoušek
Development of Decoder for IP Traffic	MI CR	dr. Veselý
Tools and methods for video and image processing to improve effectivity of rescue and security services operations	MI CR	prof. Zemčík
Robust processing of recordings for operations and security	MI CR	dr. Karafiát
Employment of artificial intelligence into an emergency call reception	MI CR	prof. Černocký

Name of the project	Agency	Research leader
AuFoVer - Automated Formal Verification	TA CR	prof. Vojnar
Colour Image in "Realtime Embedded Computing"	TA CR	prof. Zemčík
Decentralized collection, analysis, visualization and interpretation of extensive data in art practice	TA CR	Ing. Jeřábek
Deep learning in psychotherapy: Machine learning applied on therapeutic session recordings	TA CR	dr. Matějka
EmlC - Embedded Intelligence for Smart Cameras with Traffic and Industrial Computer Vision Applications	TA CR	doc. Smrž
Possibilities for creation of communité genealogical database with semantic information and uncertainty	TA CR	dr. Rozman
Next Generation of Integrated Atomic Force and Scanning Electron Microscopy	TA CR	prof. Herout
Computer-Aided Analysis and Prediction of the Child Growth and Development	TA CR	prof. Zemčík
Progressive Image Processing Algorithms	TA CR	prof. Zemčík
Survey and education of citizens of the Czech Republic in the field of biometrics	TA CR	prof. Dražanský
SMARTCarPark - Surveillance Monitoring, Analysis and Re-identification of Traffic for Enhanced Car Parking	TA CR	prof. Herout
Flight Training Evaluation Software	TA CR	doc. Chudý
AI for Traffic and Industry Vision	TA CR	dr. Bařina
Embedded Intelligence Based on Advanced Methods of Machine Learning for Edge-Computing Systems with an Application in Livestock Management	TA CR	doc. Smrž
Artificial Intelligence Driven Autonomy	TA CR	doc. Chudý
KYPO4Industry	TA CR	dr. Smřčka
Conformity Assessment Body	TA CR	doc. Ryřavý
SECURE SENSORS and data	TA CR	prof. Zemčík
TRACTOR: TRAFFIC Analysis and seCURITY OpeRations for ICS/SCADA	TA CR	doc. Ryřavý
Efficient Finite Automata for Automated Reasoning	MEYS CR	dr. Holík
Infrastructure for modern studium of IT	MEYS CR	doc. Růžička
IT4Innovations excellence in science	MEYS CR	prof. Hruřka
International mobility of researchers at the Brno University of Technology	MEYS CR	prof. Zemčík
MuSiC - Multi-level Security for Critical Services	MEYS CR	prof. Zemčík
MOST (Modern and open studies in technology)	MEYS CR	doc. Růžička
Multi-linguality in speech technologies	MEYS CR	prof. Černocký
Advanced Methods of Nature-Inspired Optimisation and HPC Implementation for the Real-Life Applicationsreálných aplikací	MEYS CR	prof. Sekanina

Name of the project	Agency	Research leader
Distant Reading for European Literary History	MEYS CR	doc. Smrž
Large-Scale Information Extraction and Gamification for Crowdsourced Language Learning	MEYS CR	doc. Smrž
Deep-Learning Approach to Topographical Image Analysis	MEYS CR	doc. Čadík
BUT Opportunity	MEYS CR	dr. Sadovský
Quality internal grants at BUT	MEYS CR	prof. Zemčík
International mobility of researchers at the Brno University of Technology II	MEYS CR	prof. Zemčík
Intelligent irrigation system	MIT CR	Ing. Podivínský
Industrial Research and Experimental Development in the Company Platební instituce Roger a.s.	MIT CR	dr. Bartík
Test-it-off: Robotic offline product testing	MIT CR	dr. Materna
Validated Data Storage	MIT CR	dr. Rychlý
Development of indoor software for cycling - Rouvy AR	MIT CR	prof. Herout
Research and development of the monitoring part of forging presses	MIT CR	doc. Smrž
CPK - Using Semantic Technologies to Access Cultural Heritage Through The Central Portal of Czech Libraries	MC CR	doc. Smrž
Advanced content extraction and recognition for printed and handwritten documents for better accessibility and usability	MC CR	doc. Smrž
Automata for Decision Procedures and Verification	GA CR	dr. Holík
Computer-Aided Quantitative Synthesis	GA CR	dr. Čeřka
Designing and exploiting libraries of approximate circuits	GA CR	prof. Sekanina
Neural Representations in multi-modal and multi-lingual modeling GAČR doc. Burget	GA CR	doc. Burget
Scalable Techniques for Analysis of Complex Properties of Computer Systems	GA CR	prof. Vojnar
Assessing and Enhancing Emotional Competence for Well-Being (ECoWeB) in the Young: A principled, evidence-based, mobile-health approach to prevent mental disorders and promote mental well-being	EC EU	doc. Smrž
Automatic collection and processing of voice data from air-traffic communications	EC EU	prof. Černocký
Cross-CPP - Ecosystem for Services based on integrated Cross-sectorial Data Streams from multiple Cyber Physical Products and Open Data Sources	EC EU	doc. Smrž
HAAWAIL - Highly Automated Air Traffic Controller Workstations with Artificial Intelligence Integration	EC EU	doc. Smrž
HumanE AI Network	EC EU	prof. Černocký
Multiple Intelligent Conversation Agent Sevicees for Reception, Management and Integration of Third Country Nationals	EC EU	prof. Černocký

Name of the project	Agency	Research leader
OCR, Classification & Machine Translation	EC EU	doc. Smrž
Photoacoustic/Ultrasound Mammography for evaluating screening-detected lesions in the breast	EC EU	doc. Jaroš
Real time network, text, and speaker analytics for combating organized crime	EC EU	prof. Černocký
Robust End-To-End SPEAKER recognition based on deep learning and attention models	EC EU	dr. Lozano
SAUCE - Smart Asset re-Use in Creative Environments	EC EU	doc. Smrž
TEchnology TRAnsfer via Multinational Application eXperiments	EC EU	dr. Palkovič
Alliance for developing, teaching and training Digital Forensics and Incident Response students and practitioners	EU	doc. Ryšavý
AQUAS: Aggregated Quality Assurance for Systems	ECSEL JU	prof. Vojnar
Arrowhead Tools for Engineering of Digitalisation Solutions	ECSEL JU	prof. Vojnar
Framework of key enabling technologies for safe and autonomous drones' applications	ECSEL JU	prof. Zemčík
From the cloud to the edge - smart Integration and OPTimisation Technologies for highly efficient Image and Video processing Systems	ECSEL JU	prof. Zemčík
MegaModelling at Runtime - scalable model-based framework for continuous development and runtime validation of complex systems.	ECSEL JU	doc. Smrž
Next Perception	ECSEL JU	prof. Zemčík
Product Security for Cross Domain Reliable Dependable Automated Systems	ECSEL JU	doc. Smrž
Verification and Validation of Automated Systems' Safety and Security	ECSEL JU	dr. Smrčka
Low Resource Languages for Emergent Incidents (LORELEI)	University of Southern California, USA	doc. Burget
Machine Translation for English Retrieval of Information in Any Language (MATERIAL)	Intelligence Advanced Research Projects Activity, USA	dr. Karafiát
Application of AI methods to cyber security and control systems	BUT	dr. Matoušek
Modern methods of processing, analysis and display of multimedia and 3D data	BUT	prof. Zemčík
Design, Optimization and Evaluation of Application Specific Computer Systems	BUT	prof. Sekanina
Reliable, Secure, and Efficient Computer Systems	BUT	prof. Vojnar

## Selected projects

### Researchers at FIT BUT in cooperation with Adobe Research developed a new augmented reality method

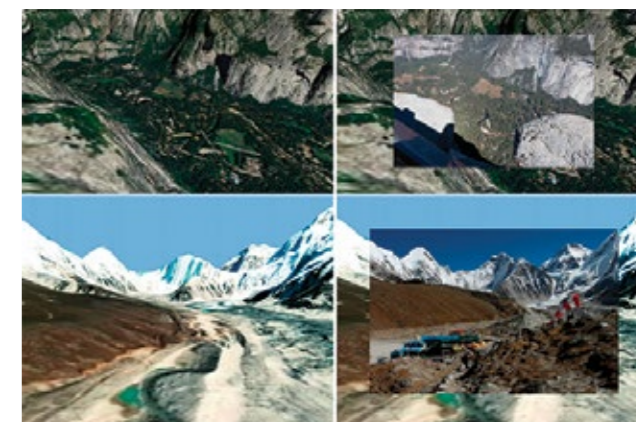
Imagine yourself pulling out your phone to take a picture of a beautiful view. You point the camera towards the landscape and your device tells you, in augmented reality, the names of surrounding hills, their elevation, tourist paths in the area and can even show you the terrain contours. The new software tool created by researchers of the CPhoto@FIT BUT group is able to recognise the photographer's location and the photographed object and knows what the surrounding area looks like under different weather conditions. This allows you to edit the picture at home, e.g. make it sharper or adjust the shadows. On top of that, it can take you back to the place where the picture was taken using virtual reality.

The new software developed by a team of members of the Computational Photography research group at the Faculty of Information Technology of Brno University of Technology in cooperation with Adobe Research can do all of that. It was presented at the prestigious ECCV conference and its authors are currently waiting to have it patented.

"Our software is designed to give more accuracy to the position and direction of a camera in the outdoor environment. The mobile application uses virtual reality to provide information on the surrounding area, such as names of mountains and rivers. It can also show isolines or distances to a mountain lodge or, simply put, any piece of topographic information about the actual terrain," says Martin Čadík, head of the CPhoto@FIT research group.

The phone uses GPS location to generate a synthetic view of the landscape, similarly to how Google Earth works. It then detects significant points in the picture or the screen, such as skyline of hills and shape of rivers or forests, and compares them to terrain models. It can thus determine the location and direction of the camera with an accuracy within metres. The comparison of points in the photograph and the 3D model is automatic thanks to a neural network, which was trained on thousands of landscape pictures from the researchers' own sources, as well as photos available on the Internet.

"At first, we used these pictures to compare individual points. That is, we were comparing photographs to photographs. There was a number



of disadvantages. For one, we were unable to perform the localisation in places from where we had no pictures. Now we compare the photographs to 3D terrain models. These models cover the whole planet, even remote areas where people cannot go, and also include data with textures specific for different seasons. That helps with the localisation if the landscape changes over the year," explains Martin Čadík. This is a great success in the field of computational photography, which was made possible especially thanks to the development of neural networks and improved access to accurate terrain models with textures.

The algorithms will then help users especially at home when using a computer. Thanks to the software, it already knows perfectly the location from which the picture was taken and the orientation of the camera, i.e. the place the photographer wanted to capture. This enables for the photographs to be edited in all sorts of ways that would otherwise be very complicated – the users can, for example, move the point of focus to a different peak, add shadows or adjust the lighting of the photograph. The software can also fit the picture directly into the landscape and bring the photographer back to the same spot from where the picture was taken through virtual reality. Using a special pair of glasses, the photographer's friends and family have the chance to take a look at the same spot where the photographer stood when taking the photo and to see its surroundings beyond the frame of the original picture.

The tool was created as a part of the Deep-Learning Approach to Topographical Image Analysis, a project of the Czech Ministry of Education. The FIT's scientists intend to follow up with further research in order to teach the software to determine the location and direction of the camera on a larger scale using neural networks and terrain models without the previous rough location estimate from GPS.



## Thanks to developers from Vimperk, people can ride through famous alpine passes in the comfort of their homes

**VirtualTraining, a company based in South Bohemia, co-operates with experts from FIT BUT on the development of an application that simulates training on real-world cycling routes. Specialists from Brno University of Technology helped the company with research and development of a prototype for the reconstruction of 3D scenery on the basis of 2D video. Rouvy provides a training solution based on augmented reality for everyone who wants to have fun, but also break a sweat.**

The application simulates a real outdoor ride using state-of-the-art videos incorporating the GPS profile of the route section. The routes combine animated 3D riders with a real video using augmented reality, so cyclists can enjoy the diversity and fun of cycling at home. All they need is a smartphone, computer or tablet, bike and a cycling trainer.

With Rouvy, users do not cycle for hours at a monotonous speed, as is usual for other indoor cycling trainers, but they can navigate famous routes from all over the world, even during winter. One can easily find a route to incorporate in one's training plan at any time, just connect the cycling trainer to the app and choose from more than three thousand routes according to their length or elevation profile. Furthermore, the data of the activities can be synchronised with other popular applications such as Strava or TrainingPeaks.

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"The main benefit for us was the transfer of know-how in the area of augmented reality and video post-processing. The specialists from BUT helped us with the research and development of a prototype for the reconstruction of 3D scenery based on 2D video. This resulted in the creation of a unique technology for combining real videos from attractive places with 3D objects of cyclists or advertising banners," explains Petr Samek, director of VirtualTraining, a company which is currently strengthening its development team by recruiting new developers.

Researchers from BUT are generally not against co-operation with innovative companies from the Czech Republic creating top-quality products penetrating on the global market. Quite the contrary. "It is great if we manage to co-operate together in a mutually beneficial way. We can contribute to companies with our knowledge that would otherwise be difficult to find and adopt. We, as a technical university, are interested in applying our knowledge on specific assignments and looking for a solution to a new, original problem," says Adam Herout from the Department of Computer Graphics and Multimedia at FIT BUT.

VirtualTraining implemented the developed prototype into its own product, Rouvy, which made the Vimperk-based company successful on a global scale. The company will co-operate, for example, with Tour de Suisse, a prestigious race which takes place annually in mid-June. Their task will be to record and digitise the individual sections of the race.



Archive of Rouvy

## New project of FIT BUT and FSS MUNI will provide feedback to psychotherapists

Deep learning, automatic speech recognition technology, natural language computer processing and expert coding will help with feedback for psychotherapists. "Speech researchers" from the Speech@FIT group, together with researchers from the Department of Psychology of the Faculty of Social Studies of Masaryk University have received a grant from the Technology Agency of the Czech Republic for their project of machine analysis of therapeutic sessions recordings. "Psychotherapy requires continuous decision-making and constant evaluation of the course of the psychotherapeutic process by the psychotherapist. In practice, however, psychotherapists burdened by a lack of immediate feedback to support this decision-making process. The aim of the project is to create a software that will enable automated analysis of audio recordings from psychotherapeutic sessions and thus provide psychotherapists with feedback on the course of these sessions in a short time," explains Pavel Matějka, leader of the project at FIT.

## FIT scientists develop acceleration technologies for high-speed networks. Their probe also helps with lawful interception

**The ANT@FIT research team from BUT has created one of the world's first acceleration cards with a bandwidth of 100 Gb/s. In contrast to other devices available, the new card is much more powerful, allowing deployment in high-speed networks. Working on acceleration of time-critical operations used in network infrastructure equipment and in network monitoring and security, the research group also participated in several other commercially successful projects.**

It all started thanks to our co-operation with the CESNET association. In 2003, Jan Kořenek, then still a Master's student of BUT, joined one of the research projects, which aimed at creating a high-speed IPv6 router based on a commodity computer and an acceleration card. Together with his colleagues, he accepted the challenge to create a 10Gb adapter, which even the renowned companies participating in the European Scampi project would not attempt to make. Two years later, the team managed to construct the adapter and the outcome was so good that

its authors later started to market through a new, very successful spin-off company INVEA-TECH.

"It was already at that time I felt the need to establish a research group at the FIT BUT which would bring together excellent researchers and PhD students with the aim to focus on problems that arise from the trend of the constantly increasing speed of backbone networks. The thing is that increasing the speed of the network lines is closely related to the need to increase the performance of the network devices," explains Jan Kořenek, head researcher of the ANT@FIT team. Nowadays, the bandwidth of hundreds of gigabits is naturally not the concern of end users, but rather operators of data centres and high-speed telecommunication networks. These have high demands on security.

Security is therefore of key importance and this is why one of the first 100Gb acceleration cards was created. After being introduced on the market, the card attracted great attention and this may perhaps be one of the reasons why a large manufacturer of network testing equipment subsequently used it in its products. The team also received several awards, such as the first place in the award Česká hlava 2016 within the Industrie category.



The Research Group was also awarded by the Minister of the Interior  
Author: archive of Jan Kořenek

The co-operation between the BUT researchers and the Police of the Czech Republic in the area of lawful interception can serve as a good example of the use of theoretical knowledge in the area of acceleration in practice. Not only police officers, but also other State security forces can now use the BUT probe, which helps them fight cybercrime every day. In 2018, the BUT team received the Price of the Minister of the Interior for outstanding results in the area of security research.

However, their work does not end here. "We are always pursuing a new goal. Our next ambition is to create a 400Gb card. However, it would

be incorrect to think that our only objective is to increase the speed. We must also improve the flexibility of the entire system,” emphasised Kořenek. The team members gained experience in the area of computer networks mainly by participating in European and locally financed projects, but also by actively communicating with commercial partners and users from among the State security forces.

In recent years, the research group has also been dealing with the issue of security of the Internet of Things, i.e. technologies for modern devices that can be controlled remotely via the Internet. With the help of devices such as smart thermostats, locks or air quality monitoring and control devices, our everyday life can be much easier. While the number of devices connected to the Internet is constantly increasing, manufacturers and customers often do not consider their safety. This is yet another task for the researchers from ANT@FIT. “Naturally, manufacturers are trying to market smart devices as quickly as possible, regardless of whether those devices are resistant to possible attacks. Our aim is to be able to detect attacks and provide suitable security solutions which will not significantly increase the consumption of the devices,” explained the head of the team.



Jan Kořenek, head of the ANT@FIT team, received a co-operation of the year award (second from the right) | Author: Jan Kořenek's archive

The ANT@FIT research team is headed by Associate Professor Jan Kořenek from the FIT BUT. He co-operates not only with the CESNET or CZ.NIC associations, but also provides contract research to a number of commercial companies. Jan Kořenek also co-founded spin-off companies FlowMon Networks, Netcope Technologies and RhiveTech. Members of the research team go on regular internships at the co-operating Cambridge University and Queen Mary University of London.

(fra)

## Scientists from several institutions are opening new ways of material microscopy analysis

**Further advancement of material microscopy analysis using the innovative LiteScope device, developed and manufactured by Brno-based NenoVision; that is the goal of a new project launched this April in co-operation with the Technology Agency of the Czech Republic. Apart from NenoVision, historically the first spin-off company of the project's other participant CEITEC BUT research centre, the other participants also include the Faculty of Information Technology of Brno University of Technology (FIT BUT), Regional Centre of Advanced Technologies and Materials (RCPTM) of the Palacký University in Olomouc and Institute of Physics of Materials (ÚFM) of the Czech Academy of Sciences.**

“We have high hopes for the project consortium to significantly help us launch our products on the global market. At this time, almost no starting company producing scientific devices has sufficient capacity and necessary know-how to be able to approach customers all over the world with application designs on its own. It is therefore logical to co-operate with university partners who can provide long-term assistance with the development of suitable solutions for specific research areas. This co-operation is mutually beneficial. Our partners are the first to use our new measurement techniques and they can use them to gain deeper understanding of the analysed phenomena, material qualities and the new techniques,” says NenoVision's Jan Neuman, principal investigator of the project.

The partners' ambition is for the Czech Republic to become not only the leader in electron microscopy, but also in ground-breaking correlative techniques enabling combining information from various types of microscopes, e.g., atomic force microscope with scanning electron microscope.

LiteScope, a microscope developed in 2016, is the only microscope in the world able to simultaneously connect 2D image from electron microscope with 3D image from atomic force microscope with high precision. Thanks to these properties, it can be used for sample analyses in the areas of nanotechnology, material research, semiconductor industry and solar cell research. The objective of the Next Generation of Integrated Atomic Force and Scanning Electron Microscopy (GEFSEM) project is to add new functions to the device, which are currently available only in a limited way or not at all.

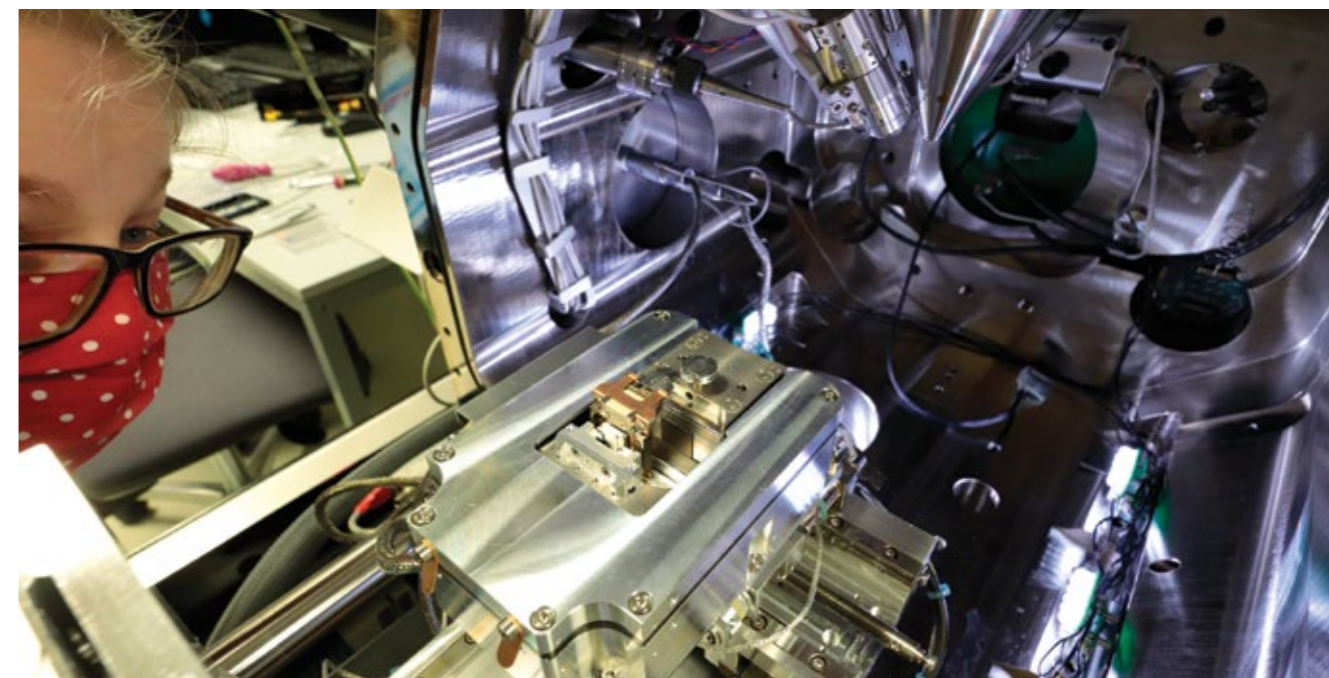
“Within the project, we plan to develop new modules that are highly attractive for the current research even at our workplace. We have really high hopes for the strong consortium we were able to put together for this project. Our group will participate in the development and application testing of advanced methods of scanning probe microscopy. Integration of these methods into electron microscope will yield a unique experimental set for research and development of 2D material-based electronic and optoelectronic components,” says Miroslav Kolíbal of CEITEC BUT.

Researchers from the Faculty of Information Technology (FIT) of BUT were also interested in participating in interdisciplinary research. “Our research group has long been dealing with image processing and computer vision. Pictures from electron microscope and other scanning devices are somewhat ‘exotic’ and we are interested in finding out what we are able to view and recognise in such images. It is interesting to see how experience from processing of one type of images can enrich a completely different discipline,” adds Adam Herout from FIT BUT.

ÚFM has already co-operated with NenoVisio, they participated in three joint projects in the past with a view to improving and extending certain functional properties of the LiteScope microscope. “We see

mutual benefits in the continuation of our co-operation. From the viewpoint of ÚFM, this includes, in particular, the expansion of the portfolio of characterisation methods to include correlated measurements of structures and electrical properties of surfaces of semiconductor films. We find the possibility of combining direct measurements on LiteScope with theoretical and computer models of defects in solid substances very interesting and it is one of the main research directions of our group,” Roman Gröger of ÚFM explains the reasons for participation in the project.

Olomouc-based RCPTM will test the methods developed in the project on its two-dimensional materials which it develops within a project focusing on 2D chemistry. “We will be enriched by new possibilities for analysis of 2D materials and provide feedback to NenoVision and help it identify interesting issues that are being addressed in the area of chemistry and properties of 2D materials. For us, correlative methods open new perspectives on the nano-world and allow us to study properties that we had previously obtained only with great difficulties,” explains Michal Dtyepka, deputy director of RCPTM. He appreciates the joint project not only for the possibility of extending the amount of analytical methods used, but also for th



## FIT works together with Microsoft Research on protection against DoS attacks

Members of the VeriFIT group (Lenka Turoňová, Lukáš Holík, Ondřej Lengál, and Tomáš Vojnar) and their colleague Margus Veenes from Microsoft Research (Redmond, USA) found an innovative approach to protection against a class of DoS attacks. DoS attacks overwhelm the target service with such amount of traffic that it depletes its resources and makes the service unavailable for legitimate users. VeriFIT focuses primarily on ReDoS attacks, i.e. attacks against services using regular expressions.

Regular expressions are supported in all common programming languages. They allow searching for patterns, replace text and also validate user input. If a regular expression is used, for example, to look for patterns in network traffic (e.g. within an intrusion detection system (IDS)) or to validate user input to a network service, hackers can attack it and, for instance, shut down the target service or the intrusion detection system (and then do whatever they want on the network without running the risk of being detected).

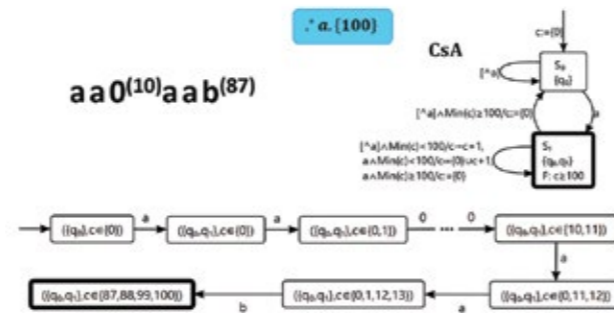
First, the hacker tries to create an input string so that it takes a disproportionately long time to validate against the regular expression. This is because validators based on backtracking and non-deterministic finite automata will search through all possibilities to split the input string into 10 to 30 substrings before rejecting it. This type of attack shut down Stack Overflow for several days, for example.

Validators based on deterministic finite automata do not suffer from this problem, but they have another issue: deterministic finite automata can be huge.

Developed as part of basic research into automata theory in collaboration between VeriFIT and Microsoft Research, the method can verify input efficiently using a newly introduced formal model called counting-set automaton. It is a special type of deterministic automaton, in which the configuration of the automaton contains the status and also certain counting sets, which can effectively represent limited repetition in regular expressions. Thanks to

these counting sets, a compact automaton can be created even for regular expressions that contain large repetition values, which can then be used for pattern searching or validation. For a certain class of regular expressions, this method provides a more robust pattern-searching algorithm than, for example, the well-known grep tool or Google's optimised RE2 library.

This innovation by the VeriFIT group shows that the theory of finite automata, which was conceived 70 years ago and is often considered to be an unchanging fundamental pillar of theoretical computer science, is still subject to rapid developments with many practical applications.



A video presentation by Lenka Turoňová, who was able to spend her summer at an internship in Microsoft thanks to the co-operation, is available here and the paper on the method is provided at this link.



## Technology from FIT can be used to convey personal testimony from the First World War

Diaries, memories and correspondence from the First World War will be conveyed to researchers as well as the public by the EGO-DOK, a new project of the Military History Institute Prague. After over a century, personal testimonies of both participants in and observers of the war will come to life in a digital world also thanks to technology in development at the Faculty of Information Technology.

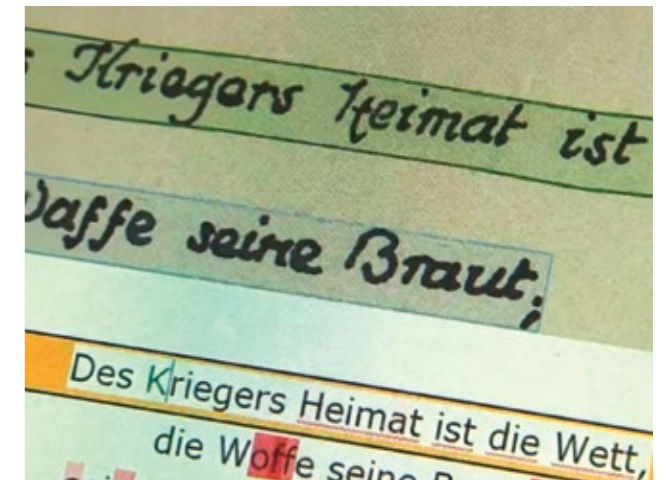
It is the goal of the EGO-DOK project for the coming years to digitise historical documents from the First World War, especially documents of a personal nature, and concentrate them under a common search engine. The aim is to gather as many sources, which are currently scattered over many institutions, private collections and families, as possible, and preserve them for the future or make them available for researchers. The Military History Institute will now offer institutions and private individuals to process their documents into a digital form free of charge.

After scanning the documents, it will be a time for tools developed by FIT researchers within the PERO project. They use a unique technology for reading manuscripts utilising artificial intelligence and machine learning. "Our tools then completely process the document. They can locate lines, create an accurate transcription of texts written in both the Latin and Kurrent script and subsequently allow for full-text searching, including a function for highlighting

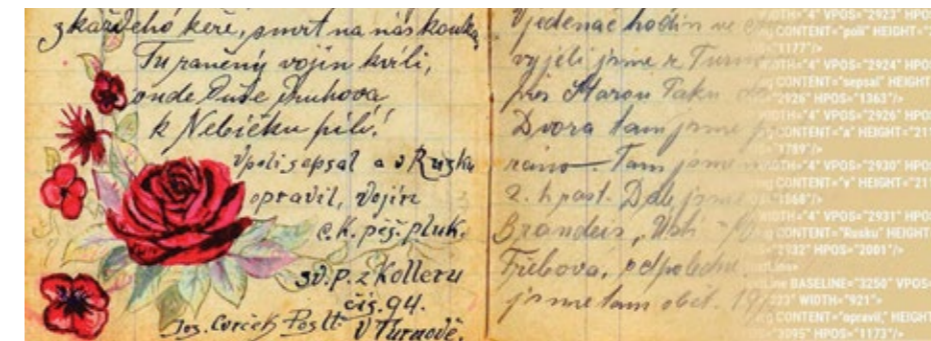
the searched expression in the text," explains Martin Kišš from FIT who personally participated in the development of the technology.

The Military History Institute then hands the results of processing to the document's owner and publishes them in the Digital Reading Room of the Ministry of Defence of the Czech Republic. Even now the reading room offers the first fruits of yielded by the co-operation between the Military History Institute and FIT BUT – an example of a processed diary from the First World War period.

Tools from the PERO project will also be used for example to refine searching of the contents of old newspapers, Czech cantastoria written in Fraktur and to transcribe a large amount of handwritten chronicles from the 20th century.



The first result of cooperation between the Military History Institute and FIT BUT is already available for inspection in the Digital Study Room of the Ministry of the Interior:



Algorithms developed at FIT help photographers. The new function can automatically straighten lines

Zoner Photo Studio can now recognise lines in the photo and straighten the photo according to these lines thanks to a new feature developed at the Faculty of Information Technology. It will be especially useful for architecture photographers.

“They often want the vertical lines to be actually vertical and the photo not to “fall”. The new feature detects lines that converge in the photo and automatically selects the appropriate ones for comparison. This makes it possible to correct the perspective of the image, but, at the same time, the software makes sure that the degree of deformation is not too significant,” explains Roman Juránek, the author of the library, which Zoner has newly integrated into its product. You can see how intelligent line straightening works in the video.

The solution is part of the TAČR (Technology Agency of the Czech Republic) project. The computer graphics research group has also developed a solution for anonymising faces and vehicle license plates and is working on smart noise reduction in photographs or horizon detection.



FIT participates in a new pan-European project dealing with monitoring of human health and transport automation

A new European project called NextPerception, which was launched this May, focuses on two interesting areas: intelligent monitoring of patients’ health and the development of automated driving. Participants from European institutions include researchers from BUT, specifically from the Faculty of Information Technology, CEITEC BUT and from the Department of Biomedical Engineering of FEEC.

The project financial aid in the amount of EUR 30 million should advance the science of early diagnostics of patients with deteriorating medical condition. At the same time, the project aims at opening new pathways leading to improved safety of pedestrians and cyclists as part of the automated transport of the future.

The researchers from FIT BUT are focusing on this specific part of the project. “We want to focus on the detection of road users as well as the research into monitoring of vital signs using the millimetre-wave radar technology,” says Lukáš Maršík who participates in the project. The task of our colleagues from CEITEC BUT who co-operate with the Department of Biomedical Engineering of FEEC, is to develop wearable systems (wearable devices). These systems will enable not only evaluation of people’s sporting activities but also user’s vital signs and health.

Sensing technology has become an important part of our everyday life. People are increasingly relying on complex intelligent systems in their decision-making processes. This is evident not only in the health-care sector, where these systems monitor even the smallest changes of patient’s medical condition, but also in the area of road transport, where autonomous driving systems take over the control of vehicles. “Decision-making is being increasingly passed over from people to the machines. Even potentially risky areas, such as healthcare or road transport, are not exempted from this trend. It is therefore crucial to make sure that sensing and decision-taking technologies are safe and reliable,” says Johan Plomp, project manager from Finnish VTT Technical Research Centre, who is the main project co-ordinator and defends the importance of the NextPerception project.

A total of 43 institutions and companies participate in the NextPerception project.

## Products and patents

### Products

- A Tool for Creating Test Scenarios for Industry Applications, software. Authors: Fiedor Tomáš, Hruška Martin, Panov Sergey, Pospíšil Luboš, Rozsival Michal, Smrčka Aleš, Tureček Dominik
- Adaptive OCR for older printed documents, software. Authors: Hradiš Michal, Kišš Martin, Kodym Oldřich, Kohút Jan, Beneš Karel, Buchal Petr
- ANaConDA: A Framework for Analysing Multi-threaded C/C++ Programs on the Binary Level, Version 0.4, software. Authors: Fiedor Jan, Vašíček Ondřej, Mužikovská Monika, Smrčka Aleš, Vojnar Tomáš, Křena Bohuslav
- Anesthesiologic Model of Patient, software. Author: Hrubý Martin
- Atomer: Atomicity Violations Analyser, Version 1.0, software. Authors: Harmim Dominik, Vojnar Tomáš
- Autonomous agent behavior model, software. Authors: Chudý Peter, Gamba Ivo, Pomikálek Jiří, Ruta Dominik, Vlk Jan, Prustoměřský Milan, Mitaš Matěj, Kašpárek Tomáš, Borůvka Michael
- Bayesian HMM based x-vector clustering - VBx, software. Authors: Diez Sánchez Mireia, Landini Federico Nicolás, Burget Lukáš
- C++ implementation of acoustic field calculation in k-Wave 1.3, software. Authors: Budiský Jakub, Treeby Bradley E., Jaroš Jiří
- C++ implementation of the k-Wave Toolbox version 1.3, software. Authors: Jaroš Jiří, Treeby Bradley E., Cox Ben T., Kukliš Filip
- Control board for EYRINA device manipulator, specimen. Authors: Malaník Petr, Drahanský Martin
- CUDA implementation of the k-Wave Toolbox version 1.3, software. Authors: Jaroš Jiří, Treeby Bradley E.

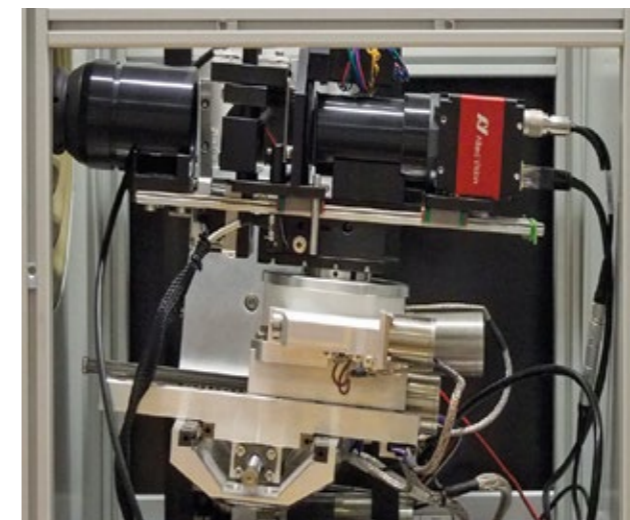
- Device for acquisition of biometric characteristics of the human hand, specimen. Authors: Dvořák Michal, Goldmann Tomáš, Dvořák Radim, Drahanský Martin, Kanich Ondřej, Sakin Martin, Meister Torsten, Nezhyba Ondřej
- Device for online real-time video processing, specimen. Authors: Bambušek Daniel, Bartík Vladimír, Bartl Vojtěch, Beran Vítězslav, Drahanský Martin, Goldmann Tomáš, Herout Adam, Kanich Ondřej, Kocman Radim, Malaník Petr, Nosko Svetozár, Plascencia Alfredo C., Volf Tomáš, Zemčík Pavel, Zendulka Jaroslav
- DiamondSpace package for Python, software. Authors: Juránek Roman, Juránková Markéta
- Digital forensic platform, specimen. Authors: Burget Radek, Jeřábek Kamil, Matoušek Petr, Polčák Libor, Rychlý Marek, Ryšavý Ondřej, Veselý Vladimír, Hynek Jiří
- DroCo - Multi-Drone Control Vizualization Tool, software. Authors: Beran Vítězslav, Bambušek Daniel, Hubinák Róbert, Sedlmajer Kamil
- Electronic pen for recording of dynamic properties of handwriting, specimen. Authors: Müller Dominik, Drahanský Martin
- EnzymeMiner: automated mining of soluble enzymes with diverse structures, catalytic properties and stabilities, software. Authors: Bednář David, Borko Simeon, Damborský Jiří, Hon Jiří, Martínek Tomáš, Prokop Zbyněk, Štourač Jan, Zendulka Jaroslav
- HDR tone-mapping software, software. Authors: Nosko Svetozár, Zemčík Pavel
- Chipmunk: The tool allows one to match patterns using counting-set automata., software. Authors: Holík Lukáš, Lengál Ondřej, Turoňová Lenka, Veanes Margus, Vojnar Tomáš

- Image Denoising Software, software. Author: Bařina David
- Immersive Trip Reports, software. Authors: Brejcha Jan, Āadık Martin
- INET 4: EIGRP, software. Authors: Veselý Vladimír, Zavřel Jan
- Infrastructure for camera sensor security management, software. Authors: Karam Singh, Musil Petr, ZemĀık Pavel
- JavaScript Restrictor, software. Authors: PolĀák Libor, Timko Martin, Pohner Pavel, Horňák Peter, Āervinka Zbyněk, Bednáf Martin
- L2D2: A Low Level Deadlock Detector, Version 1.0, software. Authors: Marcin Vladimír, Vojnar Tomáš
- LandscapeAR, software. Authors: Brejcha Jan, Āadık Martin
- Library of ICS Protocol Analysers, software. Authors: Ryřavý Ondřej, Lichtner Ondrej, Koláf Duřan, Matoušek Petr
- librectify - library for automatic perspective correction, software. Author: Juránek Roman
- Looper: A Worst Case Cost Analyser, Version 1.0, software. Authors: Pavla Ondřej, Vojnar Tomáš, Fiedor Tomáš, Rogalewicz Adam
- Official implementation of BUT-FIT's solution from SemEval-2020 Task 5: Counterfactual Recognition, software. Authors: DoĀekal Martin, FajĀík Martin, Jon Josef, Smrř Pavel
- OSLC ANaConDA Adapter, Version 1.0, software. Authors: VaříĀek Ondřej, Fiedor Jan, SmrĀka Aleř, Vojnar Tomáš, Křena Bohuslav
- Packaging quality assessment using 2D-3D matching, software. Author: Klíma Ondřej
- PCLines package for Python, software. Authors: Juránek Roman, Juránková Markéta
- Perun: Lightweight Performance Version System, Version 0.18.3, software. Authors: Fiedor Tomáš, Pavla Jiří, Podola Radim, Stupinský řimon, LiřĀinský Matúř, Rogalewicz Adam, Vojnar Tomáš
- Scanner for damaged documents, specimen. Author: Hradiř Michal
- Software for evaluation of pilot techniques, software. Authors: Chudý Peter, Gamba Ivo, Mitař Matěj, Blařková Barbora, Vlk Jan, Prustoměřský Milan
- SYDAGenerator 2 - Advanced tool for generating datasets using a 3D object, software. Authors: Goldmann Tomáš, Drahanský Martin
- Testos-Spectra: A tool for verification of ptLTL on C/C++ programs, software. Authors: SmrĀka Aleř, SeĀkařová Petra
- The secure intelligent camera sensor, specimen. Authors: Karam Singh, Musil Petr, ZemĀık Pavel
- Tool for mobile app fingerprinting, software. Author: Matoušek Petr
- Toreator, software. Author: PolĀák Libor

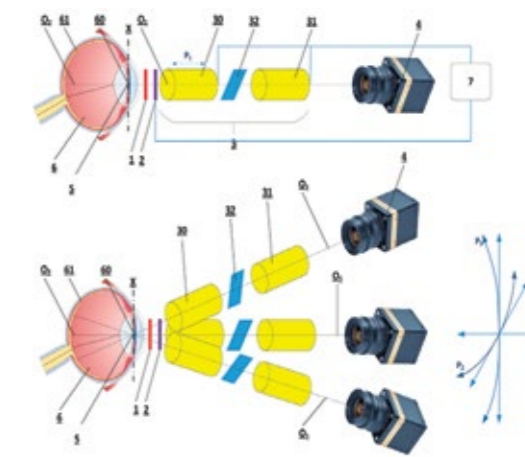
## Patent

### Device for scanning the ocular background and the method of its operation

Authors: Martin Drahanský (FIT BUT), Josef Hájek (FIT BUT)



The invention relates to a device for sensing the ocular background, which comprises means of illumination, an adaptive optical system, a sensing unit and an electronic unit, where the illumination means, the optical unit and the sensing unit are mounted on positioning means for accurately positioning the optical axis of the device on the optical axis of the scanned eye. The adaptive optical system and the sensor unit are further mounted within a positioning means for precise positioning of the optical axis on a common spherical positioning system, where the centre of rotation is the intersection of the optical axis of the device with the pupil plane of the scanned eye. The common spherical positioning system of the optical system and the sensor unit is reversibly pivotally adjustable around the centre in circular directions and the adaptive optical system is arranged in a pair of coaxial tubes arranged one behind the other in the optical axis, the front tube being independently reversibly adjustable in the optical axis direction of the scanned eye. Furthermore, the solution relates to a method of scanning the ocular background with this device.



### Generating immersive trip photograph visualisations

Authors: Jan Brejcha (FIT BUT), Martin Āadık (FIT BUT), Zhili Chen (Adobe), Michal LukáĀ (Adobe)

This US patent deals with the presentation of photograph sequences in a new, attractive and unconventional way using geo-referenced 3D terrain models. Photos supplied by the user are automatically placed (registered) in the 3D terrain model. The photographs' registration with the terrain model makes it possible to view parts that were not captured in the photographs, enhancing the user's experience with context and making it possible to view the route the photographer took. The visualisation can also take the form of virtual and/or augmented reality.

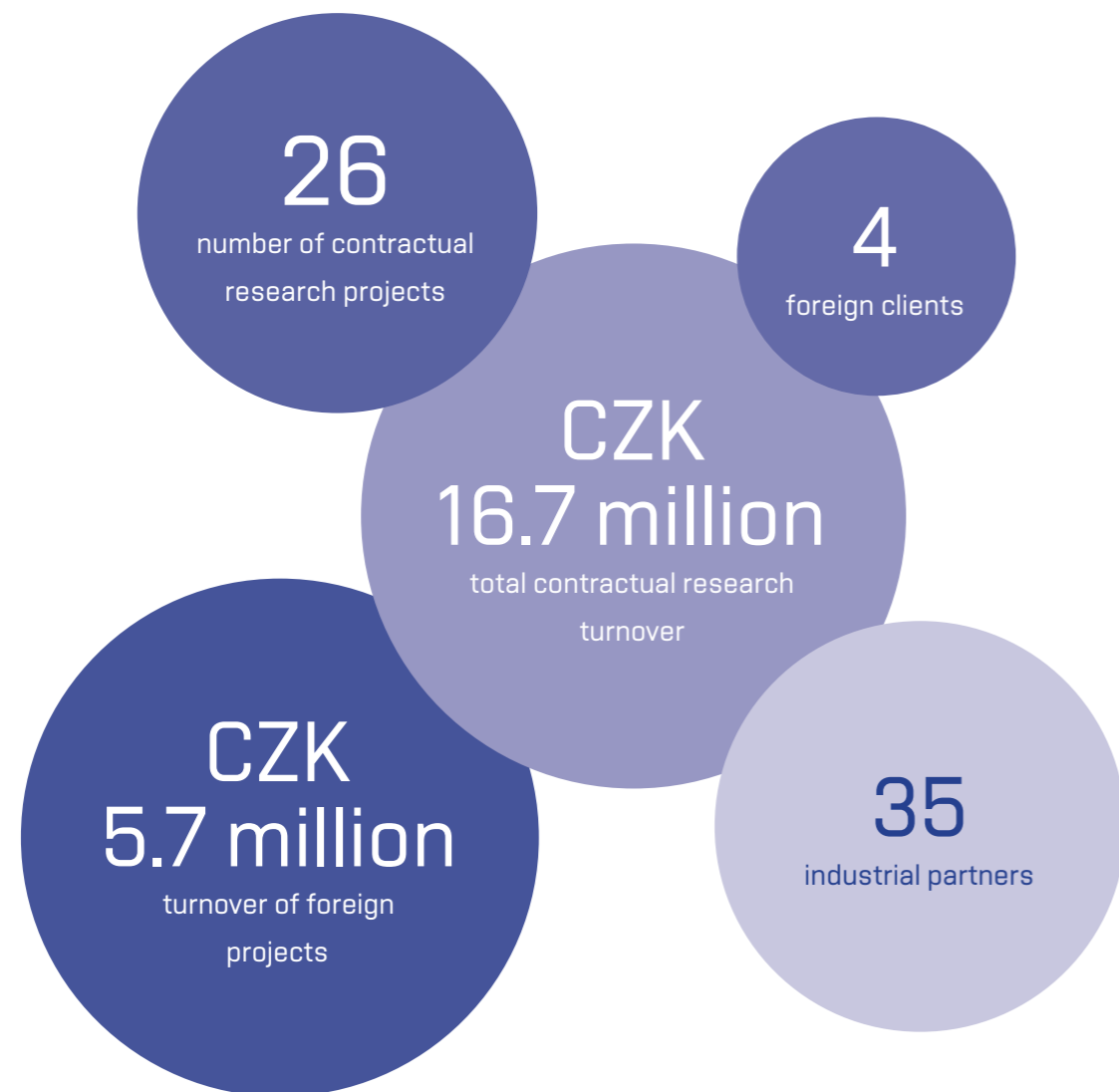
More on page 47

### Utility designs:

- 3D face sensor: Tomáš Goldman (FIT BUT), Martin Drahanský (FIT BUT)
- Medical device for localisation of solitary pulmonary nodules in lung tissue: Jiří Votruba (VFN), Martin Drahanský (FIT BUT), Tomáš Goldmann (FIT BUT), Radim Koláf (FECC BUT), Tomáš Brůha (M-Task).

# Contractual research

## Contractual research at FIT in numbers



## Researchers from the FIT are working on a new platform that will help analyse space data

The technology that is being developed at the FIT within the BLENDED project helps the European Space Agency (ESA) process images of Earth. The project connects scientists across Europe in an effort to create a revolutionary platform for distributed and, most importantly, secure data processing using artificial intelligence that processes and analyses space data.



How can we share results from space-based observation and maintain the integrity and security of such data? In the following year, researchers from the Department of Information Systems of the Faculty of Information Technology of BUT will help the European Space Agency answer this question as part of the international research project named Blockchain Enabled Deep Learning Data Analysis (or BLENDED in short). Apart from the FIT BUT, the project participants include Belgian company SpaceApplications, IT4Innovations National Supercomputer Centre in Ostrava, as well as Greek partners Forth (Foundation for Research and Technology Hellas research centre) and Geosystem Hellas (company specialised in processing of geodetic data).

Together, the institutions will be working on solving one of the long-term scientific projects of the European Space Agency which focuses on the creation of a platform that will use machine learning for analysis of space data. Over the years of its existence, ESA has used its satellites to gather vast amounts of data and images of different places on Earth. This data is freely available for universities and companies to subsequently analyse, process and use to reach interesting

conclusions - for example the rates of drying out of soil, the rate of urbanisation or the fertility farmlands.

Processing of these terabytes of data in real time is very difficult, therefore, artificial intelligence is nowadays used to facilitate this task. It is quite easy to create an algorithm solving a certain problem with respect to one specific dataset; however, to adapt and successfully use such algorithm on thousands of different datasets requires the use of AI. The research team from the Department of Information Systems of the FIT BUT will take up the challenge of finding the best way to share the results of such analyses, e.g. normalised data, extracted photometric layers or trained AI models. Together, they have designed and are implementing a platform that would make it possible to do just that. The platform is based on two complementary technologies - InterPlanetary File System (IPFS) and Ethereum.

The NES@FIT research group participates in the project. Members of the group are Vladimír Veselý, Dušan Kolář, Ondřej Lichtner, Michal Koutenský, Dominika Regéciová and Matúš Múčka. They have vast experience with cryptocurrencies, blockchain technology, smart contracts, and distributed systems in general and they are developing a platform that has significantly larger potential than just the required use within the ESA project. The platform can work as a sort of undercarriage for any completely distributed system (in terms of data storage, computing, and system management). So we are very much looking forward to seeing how the know-how and experience acquired by the NES@FIT team pay out in other grant opportunities or different contractual research projects.

The co-operation with the research partners within the project will continue until mid-2021 when the deployment of the platform prototype should be completed which will enable the following:

- upload and (securely) share any data within a potentially unlimited storage;
- run series of highly demanding AI calculations (both third-party and the participants' own) using the data stored in datacentres participating in the project;
- subsequently publish (in the IPFS) the results of such calculations, algorithms used and the AI models trained, as data for which it is possible to verify the origin and authorship (via Ethereum blockchain) so that the integrity (and confidentiality, if needed) of such data is maintained in the entire chain of custody.

## ŠKODA AUTO – Design Framework for Highly Integrated Advanced AP3 Systems

A unique system that enables ŠKODA AUTO's technical development staff to design and validate various user interfaces for future cars with greater ease has been developed by researchers from the BUT Faculty of Information Technology in co-operation with the carmaker. The system gives them the possibility to design more attractive, user-friendly and safe interfaces not only for the dashboard, but also for the infotainment module and the head-up display. The system also enables the implementation of clinical studies for qualitative and quantitative analysis of the set design goals. The proposed system shortens the development cycle and enables agile response to the latest trends in the fields of human-machine interfaces, specifically the human-automotive interfaces.



## NTT – Speech Enhancement Front-end for Robust Automatic Speech Recognition with Large Amount of Training Data

The purpose of the joint research is to develop speech enhancement front-end for robust automatic speech recognition with large amount of training data through the cooperation of NTT and BUT. The work is relying on embeddings produced by neural networks in various places of the processing chain.

## IARPA – Machine Translation for English Retrieval of Information in Any Language (MATERIAL)

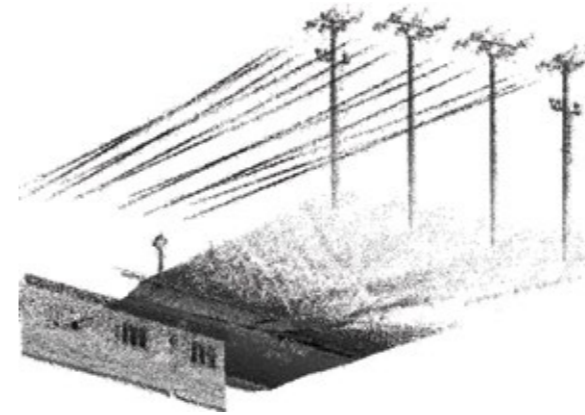
Foreign Language Automatic Information Retrieval (FLAIR). MATERIAL aims to develop an "English-in, English-out" information retrieval system. The system will search for relevant data in a large multilingual data store based on an English domain-dependent query and present it as a summary (again domain-dependent) in English.

## New backpack for 3D mapping developed by FIT researchers. It is bound to be popular especially with land surveyors

**The device developed at the Faculty of Information Technology of BUT could, in the future, help land surveyors all over the world create 3D models. The backpack with a laser scanner and sensors scans the walk-through area and the software subsequently creates a model. The experts from BUT are now planning to work on a solution for cars.**

In co-operation with Geodrom, a surveyor company, researchers from the Faculty of Information Technology of BUT developed a special backpack for 3D mapping. "When we were approached by the company's representatives, we had the basic odometry algorithms in our hands. We then created the hardware solution and refined the algorithms, and now have a prototype. It is still in the process of fine-tuning, being developed at the faculty at one moment and at the surveyor company at the next," said Martin Vefas from FIT BUT, who participates in the project.

Weighing approximately eight kilograms, the backpack includes laser scanners, GPS and multiple sensors. In the future, surveyors should be able to monitor an area by simply walking through it with the backpacks on their backs. "After coming into the office, they only need to download the data and have a computer process it and create a 3D model" describes Vefas.



*In contrast to other solutions, the backpack can scan e.g. power lines or various bends | Author: archive of Martin Vefas*



*Author: archive of Martin Vefas*

Compared to the classic method of surveying using a total station, the backpack has several advantages. "It is very difficult to measure some objects, such as power lines bends and masts, with a total station - or the process simply takes too long. Our device will help not only with this, but it will also facilitate surveying inside of buildings," confirmed Martin Vefas. For scanning of the internal parts of the buildings, the experts from the FIT BUT used the SLAM methods, which enable them to calculate trajectories even in areas without a GPS signal. "In order to create a 3D model, one must have the trajectory data available. When calculated in exteriors, the GPS signal is usually used. To obtain the data indoors, we used the SLAM methods," added Vefas. According to Martin Vefas, the accuracy of both methods is comparable. But it is still one of the areas which experts want to improve. "Since we would like to reach the accuracy of five centimetres, the system has to be even more robust so that it can resist difficult conditions, such as enclosed spaces, long corridors or situations when the GPS signal is unstable or weak," said Vefas.

Experts are now trying to adapt the device so that it can be used on cars, which would, according to Martin Vefas, offer more possibilities of use. Moreover, this would allow them to take advantage of other technological solutions and refine their measurements. "In addition to the fact that everything in the backpack can be placed on the car, we can also make use of the odometer, a device used to determine how the wheels are rotating, which helps us calculate the trajectory. Furthermore, the movement of cars is steadier, which improves the quality of scanning," added Vefas.

However, experts must resolve the problem with speed because the scanner often cannot keep up during a ride. "We therefore plan to obtain a scanner with a wider viewing angle. Moreover, a multi-directional camera will be placed on the car, allowing to capture the surroundings," said Martin Vefas.

Although similar devices already exist, the FIT BUT team is trying to come up with a solution which will be more affordable and universal when it comes to its use. It might be offered to customers as a service with additional assistance.

## Industrial partners

Brno is sometimes referred to as the Czech Silicon Valley. And the Faculty of Information Technology is in the very centre of it. One cannot be closer to the renowned global companies, promising start-ups and excellent research teams.

We co-operate with the partners with whom we share professional interests in following areas:

- joint preparation of both national and international research projects
- orders, services and licences in IT
- hosting in labs and research workplaces
- research topics with possible participation of students
- co-operation in teaching
- support of faculty events, conferences and competitions
- promotions of the partner at the faculty

## Partners of the faculty

### Golden

- Avast Software
- Honeywell



### Silver

- Espressif Systems
- Red Hat Czech
- ROI Hunter
- ŠKODA AUTO
- Thermo Fisher Scientific



### Bronze

- |   |                      |                           |
|---|----------------------|---------------------------|
| ▪ 24iMedia CZ   | ▪ Innovatrics        | ▪ Solitea Česká republika |
| ▪ ARTIN   | ▪ Kinalisoft         | ▪ TESCOAN ORSAY HOLDING   |
| ▪ Cadwork   | ▪ KOMIX              | ▪ TESCOAN 3DIM            |
| ▪ CAMEA   | ▪ Master Internet    | ▪ UNIS                    |
| ▪ CAMVISION   | ▪ Mavenir            | ▪ Webnode CZ              |
| ▪ CESNET  | ▪ NXP Semiconductors | ▪ Y Soft Corporation      |
| ▪ Codasip   | ▪ Phonexia           | ▪ ZONER software          |
| ▪ Edhouse   | ▪ SAP ČR             |                           |
| ▪ Flowmon Networks                                      | ▪ SEACOMP            |                           |
| ▪ IBM Global Services Delivery Center<br>Czech Republic | ▪ Sewio Networks     |                           |
|   | ▪ SolarWinds Czech   |                           |



# Spin-offs

## American company Kemp buys a spin-off of the Brno University of Technology, Flowmon Networks

**Kemp Technologies, a technology company, has announced its acquisition of Brno company Flowmon Networks. The founding team of the university spin-off, which is currently one of the global leaders in network traffic monitoring and analysis also included researchers from FIT BUT. The acquisition of Flowmon Networks is the first successful exit of a BUT's technology spin-off.**

Flowmon Networks, originally known as Invea-Tech, was founded 13 years ago around the Libero router research group of the CESNET association. At that time, many members of academic staff and students from FIT BUT and the Masaryk University were involved in the spin-off. Products of the newly established company were based on the results of their academic research.

"When members of academic staff of both institutions founded a company, both universities gained an equity interest and, together with the CESNET association, continued to support the development of new technology. The result of this was, for example, one of the first 100Gb Netflow probes," recalls Jan Kořenek from FIT BUT, one of the co-founders of the company.

Thanks to co-operation with academic entities and focus of development on new technology, Flowmon Networks received a number of awards and is currently one of the fastest-growing technology companies in the area of network traffic monitoring and analysis.

"Partnering up with Kemp is a great opportunity to bring our solutions closer to more customers all over the world," says Jiří Tobola, CEO of the company, who was the co-founder of Flowmon Network when he was still studying at FIT. You can read more about the foundation of this spin-off in an interview with Jiří Tobola on page 89.

Acquisition of Flowmon Network is a proof that it is possible to turn academic research into a very successful company. Of course, this is not

the end of co-operation with the academic sphere. To the contrary, both CESNET and the Brno University of Technology plan to continue their co-operation with Flowmon Networks. Furthermore, thanks to the acquisition, technology created by the company will be in better position to establish itself on foreign markets.

## FIT academic project from secures fast connection for the university

**Brno University of Technology prides itself on having produced yet another successful spin-off company. At the end of the last year, NetX Networks, a project developing a platform for high-speed networks, officially became a stand-alone company. The project, led by Matěj Grégr from FIT BUT, was originally intended mainly for the needs of the university, but now various commercial network providers and datacentres show interest in its products.**

NetX offers a platform for high-speed networks which is tailor-made to the customers' needs and provides sufficient capacity, which prevents loss of performance. Until now, there was no such solution on the market according to the co-founder Matěj Grégr. "There are several 'out-of-the-box' solutions that are suitable for large service providers. However, there weren't any solutions for medium-sized and larger enterprises offering them solution to problems, which may occur when they exceed specific network speed, and, simultaneously, also providing sufficient flexibility. A solution that could be comfortably connected to their other systems without any losses of performance," Grégr explains.

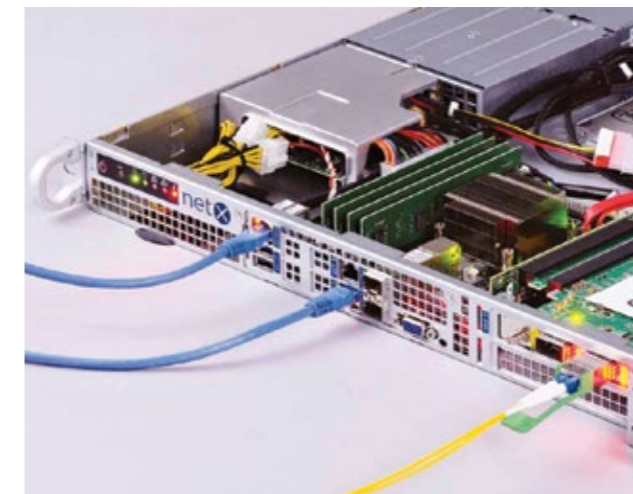
Although the clients of the spin-off include primarily Internet service providers and datacentre operators, the solution was originally intended for the needs of BUT. "We existed as an association for several years during which we worked in co-operation with the faculty and CESNET on several projects with participation of students of FIT BUT. We had started the development of the solution some ten, maybe fifteen years ago and origi-

nally, we were building it for BUT which, after all, is a large Internet service provider. Just the university dormitories have a network connecting approximately six thousand users," Grégr specifies.

He adds that it had become gradually evident that even customers from the commercial sector were interested in the product. "The original form of an association was not very suitable for various negotiations and new co-operations. That was one of the reasons why, after consulting the matter with the Technology Transfer Office of BUT, we decided to transform the association into a joint-stock company," Grégr says, adding that now he is focusing on building a stable position on the Czech market. However, he does not rule out a possible expansion of the company's operations abroad.

For most of his team, this is not their first encounter with the business sector. "Since BUT has many commercial customers, we already have some experience in this regard. But it is true that this is the first time we are completely on our own and it is our responsibility to run the business," he admits. In his opinion, in the company's short term of existence, they achieved more than they originally anticipated. "We have finished a number of projects for our customers and launched research activities in co-operation with the Technology Agency of the Czech Republic," Grégr explains, noting that he tries to invest as much of the company's profits as possible back into the further technology development and expansion of the platform.

"In our development, we focus on advanced algorithms for network traffic management enabling, for example, to prioritise TV broadcasting



over other network traffic. There are also requirements for improved protection against heavy DDoS attacks," Grégr says. The NetX platform already enables to detect such attacks and filter them out so that the customer's traffic is not affected. "This solution is especially interesting for medium-sized customers because it enables them to protect both the network and clients and the company does not have to get any additional technologies," Grégr adds.

The first year of the new spin-off company's existence was significantly affected by the spring coronavirus pandemic. "From the company point of view, we managed to deal with the restrictions because all our testing and development can be done remotely from home. On the other hand, cancellation of mass events was more problematic because we were supposed to give presentations and have exhibition stands at professional conferences where we usually get useful insights and obtain valuable customer contact information. Since these events were cancelled, the presentation of the platform, as well as installations, had to be done remotely which is of course a little limiting," Grégr describes the impacts of the coronavirus pandemic on the fledgling company.

At the same time, he adds that some customers actually praised this manner of co-operation because they did not have to travel and were able to try out the solution remotely. "The Covid-19 crisis is also showing the importance of communication technology in our modern society and their management and security. This also includes an increased focus on the use of technology and solutions that we are dealing with at NetX Networks," Grégr concludes.





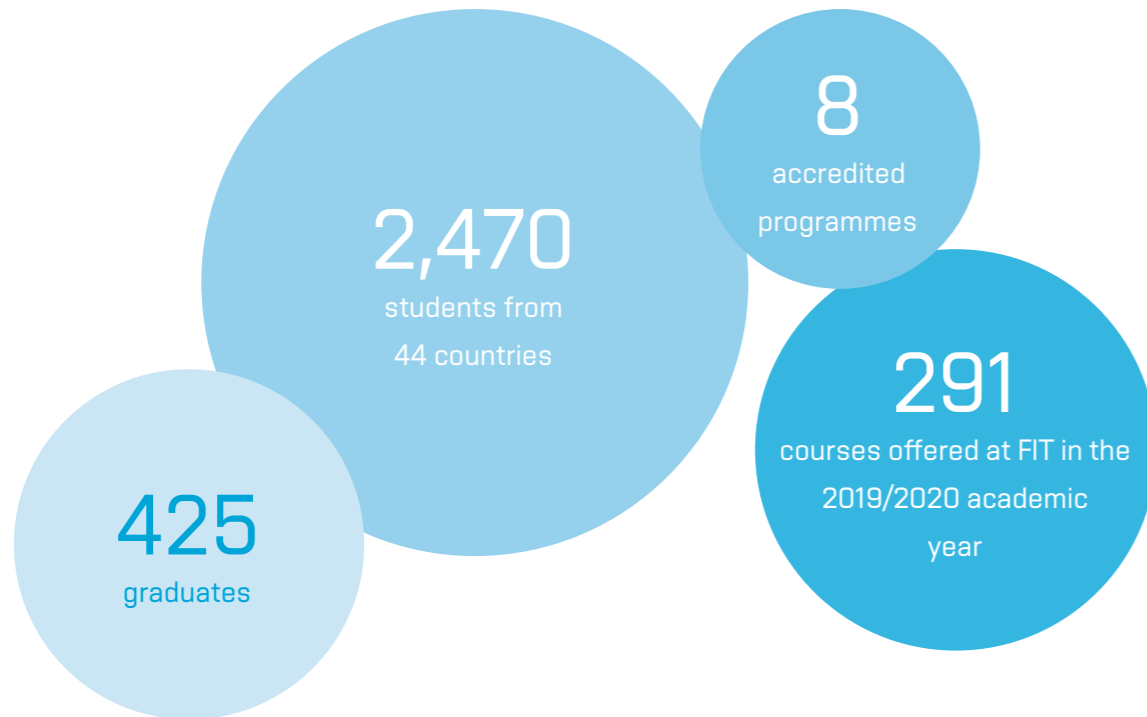
# Education and students

Currently, the Faculty of Information Technology offers the following degree programmes: three-year Bachelor's degree programme, Engineer (Bc.), two-year follow-up Master's degree programme (Ing.) and four-year doctoral programme (PhD).

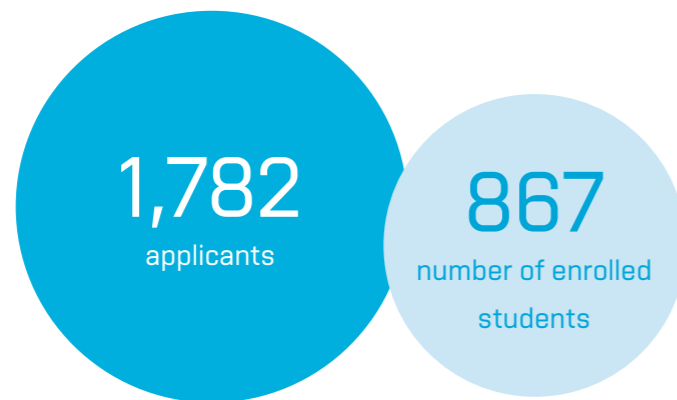
The faculty has a total of eight accredited programmes. In 2020, it received accreditation for new Bachelor's and doctoral programmes in English and a new Czech doctoral programme in Information Technology.

Teaching was conducted mainly online in 2020. All courses had to go online in March, when universities had to shut down due to the Covid-19 pandemic. Teachers had to move their lectures and practical classes to platforms such as YouTube, Zoom or MS Teams practically overnight. Their commitment and effort, as well as of the FIT Student Union, which was very active on social media and tried to engage and inform other students at least in the online space, should be recognized. Last but not least, we should also recognise the efforts of the students themselves, who coped with the difficult study conditions that lasted practically until the end of 2020.

## Study at FIT in 2020 in numbers



## Popularity of the Bachelor's programme



## Student Awards

### The Josef Hlávka Award for talented students was presented to Simeon Borko from FIT

One of this year's winners presented with the Josef Hlávka Award for talented students was Simeon Borko from FIT. He received the award for his work on the EnzymeMiner project which he described in his Bachelor's thesis and in a publication in the international journal Nucleic Acids Research. EnzymeMiner is a computational tool that enables automated mining and annotation of diverse enzyme sequences and thus serves as an aid in finding suitable enzymes for research and industry. The prestigious award of the Nadání Josefa, Marie a Zdeňky Hlávkových (Foundation of Josef, Marie and Zdeňka Hlávka) is presented annually to talented students and graduates or young researchers under the age of 33. The award is regularly presented on the eve of the Velvet Revolution anniversary at Josef Hlávka Chateau in Lužany u Přeštic, but this year the ceremony did not take place due to the epidemic.



### The Neplanikař application won the Gratias Tibi Award

The Neplanikař (Don't Panic) application, developed by Veronika Kamenská from FEEC and Tomáš Chlubna and Aleš Řezáč from FIT, won first place in the Gratias Tibi competition on Monday, 21 September 2020. In the category under 30 years of age, students of BUT beat other nominated projects. The award is given for the civic engagement of young people who impact the life of Czech society in a positive way.

The Neplanikař mobile app has been helping people suffering from mental illnesses, such as depression, anxiety, self-harm, suicidal thoughts or eating disorders, for over a year. It also provides contacts for professional help. In the first 10 months of its operation, the application was downloaded by over 45,000 users and saved at least 30 lives. The competition jury appreciated that the project deals with a very current topic at a time when human experience strongly influences the way of life and interpersonal communication. According to the jurors, the Neplanikař application contributes to the destigmatisation of mental issues. An important part of the project is also that it has professional guarantors from among psychiatrists, which ensures its relevancy.



Photo: Gratias Tibi

## The Prize of Zdena Rábová was awarded to Aneta Helešicová and Jan Vlk

The Prize of Zdena Rábová which is given to prominent personalities from among the faculty students for their active participation in science and research and for their overall contribution to the faculty's prestige, was presented by the Dean to Aneta Helešicová and Jan Vlk on Friday. The faculty thus appreciated their work to date – in previous years, Aneta Helešicová made a significant contribution to the activities of the Student Union, which she also led in 2019. In the summer semester of the academic year 2019/2020, during her studies and in a confusing “covid” situation, she also selflessly discharge duties of FIT Study Advisor.

Jan Vlk received an award for his research work, which has long been used in solutions of both national and international projects, contractual research for national and international industrial partners and, last but not least, in a series of publications presented at prestigious aerospace conferences in Europe and the USA. He is also a co-author of a Czech patent. Congratulations!



## IT Spy:Thesis from FIT in TOP 10 of the Czech Republic and Slovakia

The split 4th–10th place of the IT Spy competition went to Roman Andriushchenko from FIT. His diploma thesis, supervised by Milan Češka Jr., deals with computer-aided synthesis of probabilistic models. The work significantly increases the speed and accuracy of probability programs. These play a significant part in various areas of engineering and in fact represent the design of programs whose goal is to determine unknown parameters in order to achieve a given result. These programs can be used, for example, to design a communication protocol capable of transferring a specified amount of data, or to find optimal strategies for areas such as energy consumption management. The expert jury, made up of leading academics and business representatives, selected the best works out of over 1,400 diploma theses in the field of computer science from Czech and Slovak universities.

## Students from Brno have won gold at the iGEM competition with their solution for cleaning water from blue-green algae

**A team of students from the Masaryk University and Brno University of Technology called Generation Mendel has won gold medal and was nominated for Best Environment Project at the International Genetically Engineered Machine (iGEM) global competition. Students from FIT, twins Petr and Pavel Kohout and Gabriela Chmelařová as an advisor, are also part of the winning team who came up with the design for a solution for cleaning water from blue-green algae.**

Their project succeeded among international competition of nearly 250 teams and almost five thousand competitors from 36 countries all over the world. The organisers published the results of the competition, which were decided by 304 members of a jury from all over the world, on Sunday 22 November. “We are so happy to have succeeded and we are glad we participated. Winning a gold medal assured us that our works is going in the right direction and it also supported our idea of creating a functional marketable product,” says Petr Kohout.

He and his brother got into the project through their friend who, at that time, was finishing research for her Bachelor's thesis at the Loschmidt Laboratories where they are currently both working on their diploma theses.

They were tasked with all technical aspects of the project, from creating a website to working on a water filtering device. “Over this summer, we focused on designing the device and its model along with creating a basic simulation. Next year, we will focus on creating a more detailed fluid simulation and simulation of our target proteins and their mutations in order to increase effectiveness. Our plan for the next global jamboree, which will be held in Paris this time, is to present a functional prototype with supporting software. Within the scope of the competition, we have also participated in development of the iGEM community by creating an internal search tool,” explains Pavel Kohout.

The team's motivation was to work on something that would be of interest to people from around Brno but would also be relevant on a global scale. “We got an idea about how Brno dam struggles with blue-green algae. In order to effectively remove blue-green algae from water, we must remove their cells, but also their toxins. So, we

started developing a system based on cells of *Bacillus subtilis*, soil bacteria,” notes Barbora Hrnčířová from the Faculty of Science of the Masaryk University.

In order for the bacteria to serve the given purpose, they must be modified using methods of synthetic biology. Synthetic biology makes use of combining various genetic components to functional units with new or better properties than those naturally occurring. “We modified our cells with a protein scaffolding on their surface; this scaffolding will then be used for attaching enzymes which will destroy blue-green algae cells and their toxins,” student specifies.

However, in order to succeed in the iGEM competition, the team not only had to come up with a solution of the issue itself, but also to finish a number of additional tasks, such as creating a scientific poster, a website or a video, which replaced presentation before the jury in Boston due to the ongoing pandemic. Apart from all this, students also had to think about future implementation of the entire research. In order to gain high-quality input data, they communicated with many experts as well as the public and they co-operated with other teams from all over the world.



# Creative activities of students

## Platform developed at FIT is searching for the owners of cryptocurrency addresses. It is able to connect them to illegal activities

The platform, which helps identify people buying illegal services on the Internet, has been created by Vladislav Bambuch from FIT BUT. He first encountered the topic of processing of publicly available data and linking them to cryptocurrency addresses in one of his university courses. Subsequently, he expanded upon the topic in his diploma thesis. The result of his work is a functional platform linking past projects undertaken at FIT BUT and serving as a basis for the connection of other web-based tools in the future.

Vladislav Bambuch has long been interested in the topic of increasing security on the Internet. That is one of the reasons why he decided to study, and, at the same time, join a project undertaken as a part of the Data Communications, Computer Networks and Protocols course, taught at FIT BUT by Vladimír Veselý. "Within the project, my task was to gather data from one website. Specifically, I was collecting cryptocurrency addresses. When the project ended and I was thinking about the topic of my diploma thesis, I got the idea to approach Vladimír Veselý. We agreed that I will work on a platform that will connect various student and diploma projects gathering data from websites," explains Bambuch.

According to him, publicly available data are gathered so it would be possible to use them to identify people in the future. "If there will be enough data, it will be possible to tell that a specific person bought illegal services on the Internet," he specifies. It concerns gathering of information on specific cryptocurrency addresses. "Cryptocurrency addresses are pseudonymous. That means full anonymity during payments cannot be guaranteed. Our goal is to find out who an address belongs to. That person may make a mistake and accidentally reveal that the address belongs to them. For example, they may post in some Internet forum. If we have information from the dark web that this particular account was used for illegal activities

and we have publicly available information on who logged into that account, we will then connect all data to find an intersection," describes Bambuch.



Author: unsplash

A wide range of student works and projects on the same topic had already been created at FIT BUT. However, most of the time, they differed in their approach and often also in the programming language used. Therefore, Vladislav Bambuch's goal was to create a platform that will integrate individual projects and create a common basis for further work. He also added his own modules. "Specifically, it concerns processing of two different websites and data that can be used to detect persons," he adds. He processed for example the bitcointalk.org forum which is frequented by many people interested in cryptocurrencies. "It is a very interesting source of information. On top of that, we can guess who is the owner of the cryptocurrency addresses we find there based on the context," notes Bambuch. Users can use the platform for example to find matching addresses from a dark web blackmail e-mail sample and from some of the discussion forums or social networks.

Apart from this, Vladislav Bambuch also added other things to his platform; for example, a project which can create complete copies of websites and archive them. "It prevents us from losing data and evidence, for example when someone deletes his post," he explains.

Although its aim within the diploma thesis was primarily to demonstrate certain abilities, Vladislav Bambuch continues the development of the platform and, under the auspices of a commercial company, shaped it into a product which can be used for example by prosecuting bodies. "Organisations interested in assessment of the given cryptocurrency address can also make use of the information. We are able to tell, whether it belongs to an ordinary person who uses bitcoin to pay for bread or a hired assassin," adds Bambuch.

However, he himself was not able to identify specific people during the development of the platform. "It was not my goal. A large amount of data is required in order to identify someone. That is why I focused more on demonstrating certain knowledge and creation of a tool than on searching for murderers or drug dealers," clarifies Vladislav Bambuch.

The only issue he had to tackle during the development of the platform was rate limiting. "There is a limit on requests sent to the given server. You cannot view a website without any limitations. If you send too many requests too fast, the server will block you. I was aware of this and I had to take this into account while creating platform's architecture. If I waited and sent requests gradually, the process would take about 103 days. But I was sending requests from seven computers simultaneously, so I managed to convince the server it wasn't just me. Thanks to that, I managed to reduce the length of the process to around nineteen days. That, of course, is still a lot, but I still managed to save plenty of time," noted Bambuch.

## He needed to paint his room but he just could not pick the right colour so he created an app that is becoming globally popular

Three years ago, Dominik Vagala, a student of the Faculty of Information Technology at BUT, wanted to paint his room. However, he was not sure which colour would look best on his walls. He wanted to solve this conundrum using modern technology but could not find any suitable application that would work on his phone and help him choose the colour. Although he eventually had to use a graphic editor to pick the colour, the idea for a new mobile application was conceived during the process. The app called 'Paint my Room' is now available on Google Play store and has already been downloaded by almost thirty thousand people. Dominik Vagala chose the development of the app as the topic of his Bachelor's thesis and presented his project at this year's Excel@FIT conference.

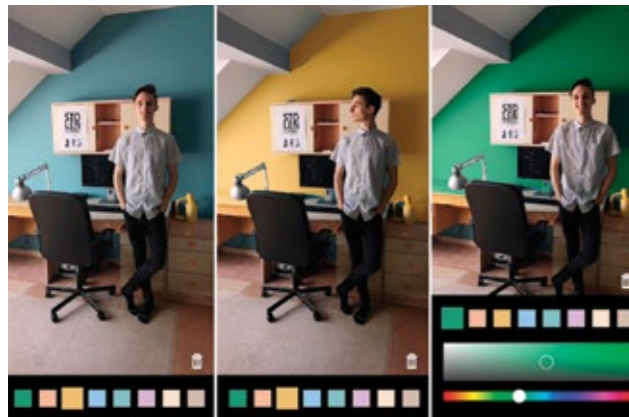
An application for smartphones that enables users to walk around in a room and try out different virtual wall colours in real time is based on personal experience of its author, Dominik Vagala. "Three years ago, I wanted to redecorate my room and I just couldn't choose the colour. After all, it is not easy to imagine which colour would go best with the furnishing of the room. At that time, I had to use a computer graphic software where I was changing different wall colours in a photo of the room. However, this entire process was quite lengthy," Vagala describes.



Although his room has been redecorated for quite some time now, he later remembered the problem when he was choosing the topic for his Bachelor's thesis. "I thought that other people may be dealing with the same problem as I had been back then. So I wanted to help them," Vagala explains, adding that at that time he had only very limited experience with the development of mobile applications.

His app called Paint my Room, which is available on Google Play, works in real time. "User can freely walk around the room and see the wall colours from different angles," Vagala describes. He says that it took him eight months to create and launch the application on the market. "It was quite challenging, but I enjoyed it very much. That's one of the reasons why I recommend people to work on their own ideas for their Bachelor's theses. In such a case, you don't see the hundreds of hours invested in the project as work, but rather as fun," he adds.

Of course, he is not the only one with a similar idea. "There are multiple similar applications on the market. However, the ones working in real time are all depending on a single library that is supported by only about 20% of Android devices. Therefore, vast majority of people cannot run such applications at all," Vagala explains. He also thinks that, in general, the user interfaces of the competing apps, as well as the manner in which the user selects the colour to be applied on the wall, needed some finishing touches.



Author: archive of Dominik Vagala

Twenty-seven thousand people from all over the world has already downloaded his application. That is despite the author's lack of any promotion or investments in marketing. Given the interest of people, he plans to further develop Paint my Room. "I want to create a version of the app for iOS devices and add some new functionalities. Later on, I would like to approach companies dealing with paints and discuss possible co-operation. One company has actually already contacted me," Vagala specifies his plans for the future.

He also presented his project at the recent Excel@FIT conference. "My thesis supervisor, professor Adam Herout, suggested that I should participate in the conference for which I am very grateful as I would not have thought about that myself. But it was an amazing experience," concludes the student of FIT BUT.

## Searching for owners is now easier. Web search engine created by a FIT student helps returning lost dogs to their homes

**A law stipulating that owners need to get their dogs tagged with an identification chip has been in force for nearly a year. That should help finding lost dogs and fighting illegal breeders. But a central register that would serve for this purpose is still missing. FIT student, Kristýna Zaklová, introduced a solution which can partially replace uniform register. Within her Bachelor's thesis, she created a web search engine called Komu patřím (Who do I belong to).**

It can make the job easier especially for animal control, veterinarians, police and other people who need to identify a dog and its owner. The thing is, even if they manage to find out the chip number by using a reader, the battle is far from over – there is no central register in the Czech Republic, in its stead, there is about fifteen registers operated by private companies, so they have to search every one of them.

A solution was brought by a student of FIT who created a web search engine called Komu patřím. "The person who found a dog does not need to manually search individual registers. They only need to enter the microchip number in the search form and the search engine will find out whether the supported registers contain information on this

entry on its own," explains Kristýna Zaklová. Her application also supports searching using tattoo numbers, pet passports, municipality-issued tags and Lysset tags. This makes her work unique.

Kristýna Zaklová worked on the solution for nearly a year. "I spent a lot of time surveying the current situation. Based on suggestion of my thesis supervisor, I also ascertained the situation in other countries. I always contacted someone living in the country to also learn the perspective of local inhabitants. I also wanted to specify users' requests as well as I could so that the final application would make their work easier and they would like using it," she describes.

Cynology is her hobby, dogs have accompanied her on her journey through life for over ten years. "So I was interested in the issue of tagging dogs for a long time. I took interest in Czech registers as soon as the amendment stipulating mandatory microchipping of dogs was approved. To this day there is no central register of animal owners, not even any official list of available private registers," she explains. On top of that, current legislation does not stipulate the obligation for owners to register the chips which makes the situation even more complicated. Therefore, the goal of Kristýna Zaklová's project is also to spread awareness of individual registers and the most popular manners of tagging animals.

The hardest part was to keep pace with the changes that were gradually coming. "The largest number of new registers appeared in late 2019 and early 2020. Some existing registers had undergone implementation changes so it happened a couple of times that some of the finished parts just stopped working overnight," FIT student recalls some of the difficulties she had to face during the development.

But today, her website is fully functional and gradually finds its users. It is visited by several hundreds of people each week. "I am glad to

receive any feedback and, most of all, I am glad when the search engine fulfils its purpose. For example, I was recently informed by a veterinarian from a local clinic that she used the search engine while treating a found dog. Thanks to a registered chip and my search engine, the dog could be quickly returned home to its owners," describes Kristýna Zaklová.

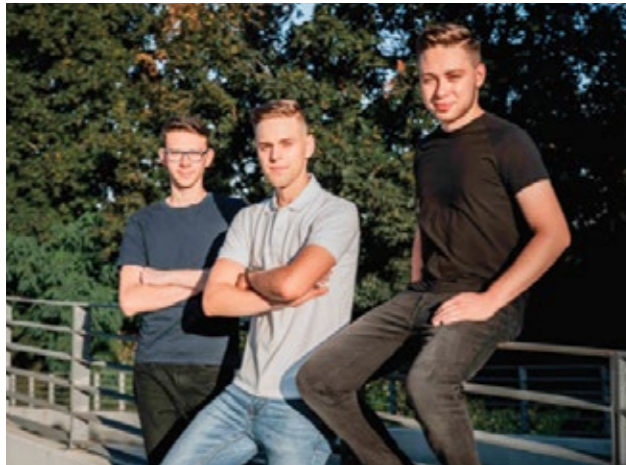
She would like to establish co-operation with the two missing registers in the near future. The promised State central register for dog microchips should be created in 2022. "The question is whether it actually happens and how will the current registers react. But even if this project should serve the public for less than two years, I think the energy I invested in its development was worth it for every found dog who was or will be able to soon return home thanks to it," concludes Kristýna Zaklová with a smile.



Author: archive of Kristýna Zaklová

## They fight bullying with technology. A company founded by a FIT student and his grammar school classmates is the best Czech start-up

**How does it feel to be a CTO sooner than you are of legal age? Pavel Ihm knows. He founded the company with two of his grammar school classmates when he was sixteen. Currently, he is a student at FIT and the application he developed is helping pupils and schools all over the world. At the end of September, the project of a Brno-based start-up FaceUp Technology won the national finals of the Creative Business Cup international competition.**



Author: archive of FaceUp Technology

The expert jury of the competition, which is organised by Czech Invest and which selects the most innovative start-ups, was most interested in the Nenech to být (Don't let it be) application Pavel Ihm started to develop the application with his grammar school classmates four years ago. Today they lead the FaceUp Technology start-up which is developing a web system and a mobile application to fight against bullying.

"Our system is currently used by almost two thousand schools and institutions and during its existence the pupils used the application to send nearly six thousand reports," describes Pavel Ihm, who is currently in the second year of his studies at FIT. The system, the

technological aspects of which he devised, is simple – pupils may share their feelings that something happens in their class, completely anonymously and outside the school environment, directly through the app or website. Information is then relayed to a teacher, psychologist or anyone else who can address the issue at the school. At the same time, this person also receives a professional guidance on how to deal with the report.

"This is no snitching. Unfortunately, bullying is fairly common in schools and even we faced the issue of silent majority during our school years, nobody was brave enough to get up and go to our class teacher, or we did not know if, how and with whom to address the issue," Pavel Ihm explains the original motivation behind the project.

The friends got the idea to develop a mobile application which would help solving similar situation when they were only sixteen. They discussed their idea with teachers and experts and they managed to get the support of the Ministry of Education, the South Moravian Innovation Centre and finally even an investor, Jiří Hlavenka.

"We introduced the application in spring 2017 at a press conference held by the Ministry of Education, Youth and Sports. We said it would be nice if one hundred schools joined by the end of the year. In the end, we reached one hundred within a week," recalls Pavel Ihm.

In order to kickstart and operate their business, his classmates had to be emancipated. After succeeding in the Czech Republic, they decided to transform the NGO into a company called FaceUp and expand abroad. Today, they operate under this name for example in the USA, Mexico or the Republic of South Africa where the app is used also at the school which Elon Musk attended and left due to bullying.

Unfortunately, the pandemic which 'forced' pupils out of their classrooms in the last couple of months did not put an end to school bullying, it only moved it to the online environment even more than before. "We are definitely not done with schools; we want to keep working and helping in that area. But we start to focus on a new segment, companies. Even workplaces give rise to an environment where unethical behaviour or mistrust preventing people from confiding their issues occur. We created a business platform during this summer, so far we are just starting its operation but we see it has potential," Pavel Ihm describes further goals of the promising start-up.

# Promoting student entrepreneurship

FIT opened a new Creative Showroom and Open Space for creative students, and held the third edition of the Star(t)up@FIT programme in 2020 for the first time with two new FIT Innovation and Entrepreneurship Consultants. With their help, a number of exciting events took place at FIT, although mostly online, and a number of interesting ideas were launched.

The Star(t)up@FIT programme helps all students who have an idea but are not sure how to develop it, as well as those who have already started and want to take the next step towards commercial applications, and also those who still "don't know how to go about it".

## Events

### Events in 2020

- Idea Market
- online workshop on Business projects
- online seminar From idea to product
- The Digital Innovation Game
- Student turned CEO/CTO

For more information about the Star(t)up@FIT programme, see <https://www.fit.vut.cz/study/startup@fit/en#startup>



## Good idea, bravery, decency and enthusiasm. Personages of IT described their road to success in a debate held at FIT

Nearly 250 participants virtually came to listen to a panel discussion of four personages of IT named **Od studenta k CEO/CTO (From Student to CEO/CTO)**. During the discussion, **Martin Cígler, Jan Najvárek, Jan Kořenek a Zbyněk Pouliček** shared their experience not only from the beginnings of their businesses with the audience.

One of them started as a programmer at a research veterinary institute, the second one started as a student of FIT, the third one started his business as a scientist at FIT and the fourth one started his business following a chance meeting with a classmate. All the guests of the Thursday discussion had one thing in common: they all managed to start a business which currently represents the "South Moravian Silicon Valley". Also, they all agree that this might be the best time to start a business with your ideas.



"If you are students or fresh graduates, it is likely you do not have your own families or mortgages yet, so no serious obligations. We, the IT nerds, have a tremendous advantage in that in order for use to start creating a product, we only need a laptop and we are good to go," says Zbyněk Pouliček from GINA Software. He founded the company while he was still a FIT student when he was looking for a topic of his diploma thesis. Today, his company is developing a map system used by fire brigades, rescue workers and international organisations all over the world to co-ordinate their teams out in the field.

"But even the best vision is not enough by itself. It is important to have a good idea, but it is equally important to see how to get it on the market," described Martin Cígler from Solitea, which grew under his

leadership from small Brno-based company to an international holding with 1,300 employees and a turnover in the amount of two billion Czech crowns. As he adds, at the beginning, it is important to earn good reputation. "New companies usually do not have large sums of money for marketing. Therefore, the beginning is about a couple of satisfied customers, which means that your work has to be very good and honest from the very start," he adds.

Jan Kořenek agrees with both points. Together with a group of enthusiasts and other FIT researchers, he created a spin-off company Invea Tech which gave rise to two internationally successful companies, Flowmon Networks and Netcope Technologies, which are among the industry leaders and deliver solutions to industry giants such as Intel. "At the beginning, there was technology which nobody knew. We came to market which was practically non-existent. On top of that, technology does not equal product and certainly not successful product. We had to focus on communication with customers – so that they learned about our technology and also so that we received feedback on what the product should look like. The start was rough, it is important to be brave and step outside your comfort zone," recalls Jan Kořenek.

As says the last guest participating in the discussion, Jan Najvárek, it is also important to be lucky. "But you also need a great passion. It is important to do what you enjoy. If you succeed, it is great; if you do not succeed, then you spent couple of years doing something you enjoyed and that is not a loss. It is also important to be persistent, because it sometimes take a while until you succeed, and to be ready to take some risks," says the co-founder of ARTIN, one of the most innovative Czech companies, who also participates in the development of RoboAuto and BringAuto autonomous vehicles.

The guests agreed that at the beginning, it is not easy being 'the idea guy' as well as a technician, manager and a salesperson. "Technical knowledge is the key. Start-up with only a salesperson would not work," believes Jan Najvárek. As noted by Jan Kořenek, future start-up owners should be ready to address everything. "For technology companies, it is not bad to ideally have future CEO and CTO who can complement each other's missing competences. But it is important for them to share the same mindset," he stresses. According to Zbyněk Pouliček, the composition of characteristics and skills within the team is also important, as is authenticity. "We were three IT guys, but, as we were advised by a consultant from the South Moravian Innovation Centre, nobody makes better first sales pitch than you, the guys with the idea," said Zbyněk Pouliček. At the same time, Martin Cígler encourages decency and honesty and not just in terms of promises made to potential customers or investors. "Bravery is a must. But decency is just as important, your reputation will be with you the entire time. In short, as you sow, so shall you reap," he said.

## Projects

### Smart greenhouse of FIT students saves water and extends harvest season until Christmas

**Not just hoes and shears – even mobile phones, computers or tablets can be used for gardening. Smart greenhouse created by FIT students David Bažout and Daniel Kolínek can be controlled remotely, will extend harvest season until Christmas and saves water at the same time. This was one of the reasons why their Sensorie project ranked among the best project at the SDGs Awards 2020, unique awards for meeting the UN Sustainable Development Goals.**

Controlling of opening of greenhouse windows and irrigation using rainwater or recognising one of over thirty diseases through symptoms manifesting on leaves, the smart greenhouse project created by FIT classmates David Bažout and Daniel Kolínek can do it all. The Faculty incubator Star(t)up@FIT also helps them to start their company Sensorie.

"The idea came to us last summer – it was just a spontaneous idea we got while sitting on a park bench. We immediately started working on it, in fact, we have gone almost without any sleep for two weeks," laughs David Bažout. Soon after that they created a website and a questionnaire which the students sent out to several gardening groups. "It was nice to see others support us and it motivated to us to actually build a smart greenhouse," recalls Daniel Kolínek.



An old greenhouse belonging to David's parents became the place where they conducted their early experiments. "Most of the parts were very old and were just taking up space in our attic. We used a decommissioned convector heater for heating and for example the fan was older than both of us combined. It was not perfect, but in a couple of weeks, the world's first smart greenhouse was born," describes David Bažout.

Today, they have their own supplier of electronics and you can see their project in practice at the Open Gardens. "This year we offered our solution just to a couple of people at the acquisition price. In essence, it was a test operation; we needed to receive feedback and finalise the product so we could obtain certification. That should happen in the near future; we are accepting pre-orders for next year," explains David Bažout.

How does it all work? The cornerstone is the control unit to which all the other components are connected – soil and air temperature and humidity sensors and other auxiliary equipment such as night-vision camera or electric window opening. The control unit can be connected to a WiFi network and controlled over a phone, computer or tablet from anywhere in the world.





"You can set the exact conditions you want to maintain inside the greenhouse using a simple setting. In case the user has no experience with growing plants or is unsure, the user interface contains a help feature which can give them advice for growing usual plants such as tomatoes, cucumbers or peppers. You can select between an economic or turbo growing mode, but it is also possible to switch to manual control which allows the user to customise the conditions," describes Daniel Kolínek.

The gardener selects or sets the temperature and humidity ranges and the control unit will then maintain said conditions by opening and closing the window or starting and stopping the fan, electric heating or irrigation system. The system can also recognise over thirty different plant diseases based on a picture of the plant.

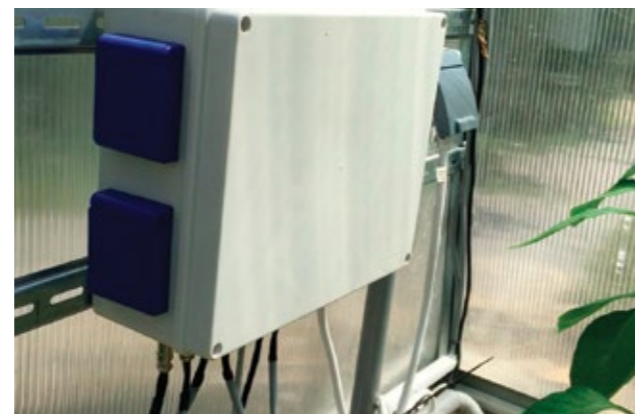
"We focused on vegetables most frequently grown in Czech greenhouses. After studying diseases and their symptoms in detail, we proceeded to download a large number of photographs from the Internet. All photographs had to be carefully cropped, sorted and processed by a neural network. Currently, we want to improve the neural network and increase the number of detectable diseases on the basis of photographs we will receive from users," Daniel Kolínek laid out his plans. People can also watch the ripening crops via camera which also watches out for thieves and other pests.

This project of Sensorie founders aims mainly on gardening enthusiasts, who can then extend the harvest season well into winter, but also to those who cannot attend to growing plants every day. "For example, one of our clients is a cottage-owner who lives in Prague and cannot attend his greenhouse regularly. Now he always knows what is happening inside of the greenhouse and the crops will be taken care of even if temperature starts dropping below zero," describes David Bažout.

As he pointed out, based on their own experiments, they learned that thanks to controlled conditions inside the smart greenhouse, the growing season was extended by three months and the plants were more resistant against various diseases. Furthermore, smart greenhouse also saves water – thanks to soil humidity sensors it only irrigates when needed and it can make do with rainwater.

"The future lies in green technology and investments in long-term sustainable solutions," says David Bažout. Consultants from the Star(t)up@FIT programme also help them grow their business. "For me, personally, the biggest contribution was especially at the very beginning – just the realisation that I can work on something of my own, but also the basic information on what you need to do to start your own business. I never thought about that. Now the programme's consultants help us with specific things, such as how to negotiate with business partners, and they also arranged consultations with a neural network expert from FIT for us," describes David Bažout.

Currently, the founders of the new Sensorie company focus on sales. Sales should begin in a couple of months. In the future, they plan to improve the neural network for plant disease detection and automation and offer a solution for example to market-gardeners.

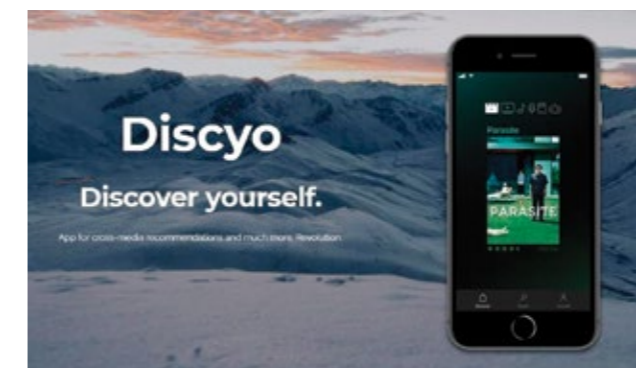


## The BUT Student Entrepreneurial Spirit Award was won by Discyo, an app that can tell what you like

**The BUT Student Entrepreneurial Spirit Award competition, which was held by BUT for the very first time this year, was won by the Discyo application, a project of four students from the Faculty of Information Technology. Their solution can give the user advice on what film to watch, what podcast to listen to or what videogame to play. The algorithm can tell what are the user's preferences across various media and what the user might like. The competition of student ideas is held by the Brno University of Technology in co-operation with the South Moravian Innovation Centre.**

"Discyo provides information across different media. For example, if someone liked the Iron Man film, the application may recommend a podcast with the leading actor," says Petr Buchal, highlighting the interconnection between various media. Furthermore, the selection of films and series is not limited to a single provider such as Netflix, HBO GO or Apple TV+. The user will receive recommendations across all platforms and the application will give him recommendations on which source offers the most content that aligns with the user's preferences.

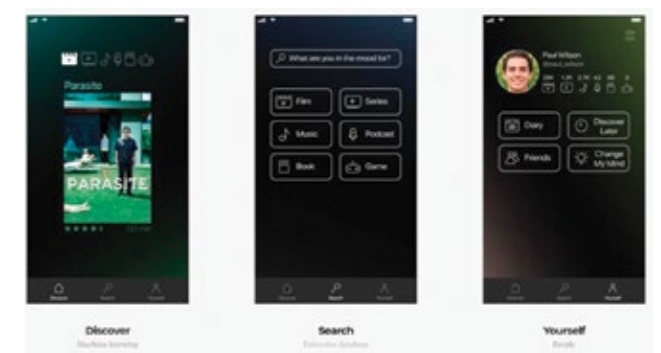
"So far, the application was only available for the first couple dozen users who helped us to test things and provided feedback. In January, Discyo will be made publicly available for free in Google Play and App Store. Discyo will provide users with recommendations on films,



series or interesting audio podcasts," Buchal describes the planned launch. In the future, the media offer will be expanded to also include books, videogames and an option to select content suitable for multiple users. "If, for example, someone plans to watch a film with their girlfriend or some friends, it will be possible to set films or series suitable for multiple viewers as one of the parameters," explains Buchal, who have worked on the project for over a year along with two of his classmates and one fresh FIT BUT graduate.

After the user downloads the application, all they need to do is input the content they liked recently, which should not take more than a minute. Furthermore, the students plan to connect Discyo with Facebook or the Spotify music player, where it will be possible to download data on user's preferences to date in order to customise the offer even more. The application itself will be available for free, but some functions will only be available with a premium account which should cost under two euros. In the following year, the students will also introduce the Discyo application at the Innovation Leaders Summit virtual fair, which will be organised by Tokyo, Japan.

Students tuned up their entrepreneurial idea thanks to the university Pojd' podnikat! (Start a business!) programme in which they were led by lecturers from the South Moravian Innovation Centre and regularly received feedback regarding their project. In the finals of the Student Entrepreneurial Spirit Award, the expert jury consisting of representatives of BUT and the South Moravian Innovation Centre divided a total of 400,000 Czech crowns among the students' projects; as the winner, Discyo received over 130,000 Czech crowns to help kick start the business.





Author: archive of Julia Rudnitckaia

## Student mobility

The year 2020 and the Covid-19 pandemic also had a great impact on student mobility. There was a significant drop in the number of outgoing FIT students as well as in the number of incoming foreign students. The second year of the Brno International Summer School of Information Technology FIT (BISSIT 2020) had to be cancelled. Most of the capacities of the Foreign and External Relations Departments of FIT and BUT had to be relocated overnight to support students both foreign students in the Czech Republic and FIT students abroad. This included communication with students and relevant institutions, information on current restrictions and the possibility of returning home, and on other forms of study. Although the situation partially stabilised in the second half of 2020, study in most countries in Europe and beyond remained online and it is already clear that there will be a significant decline in mobility especially in the academic year 2020/2021.





### FIT students' mobility abroad in the academic year 2019/2020

Total: 43

#### Programmes

▪ Erasmus+	39
▪ Erasmus+ – credit mobility (to non-EU countries)	1
▪ Ministry of Education, Youth and Sports Development Programme	3

#### Destination:

▪ Finlando	8	▪ Austria	2
▪ Great Britain	5	▪ Denmark	1
▪ Belgium	4	▪ Ireland	1
▪ Portugal	4	▪ Kenya	1
▪ Greece	4	▪ Latvia	1
▪ Estonia	3	▪ Malta	1
▪ Germany	3	▪ Russia	1
▪ Norway	3	▪ Spain	1

### Incoming foreign students in the academic year 2019/2020

Total: 83

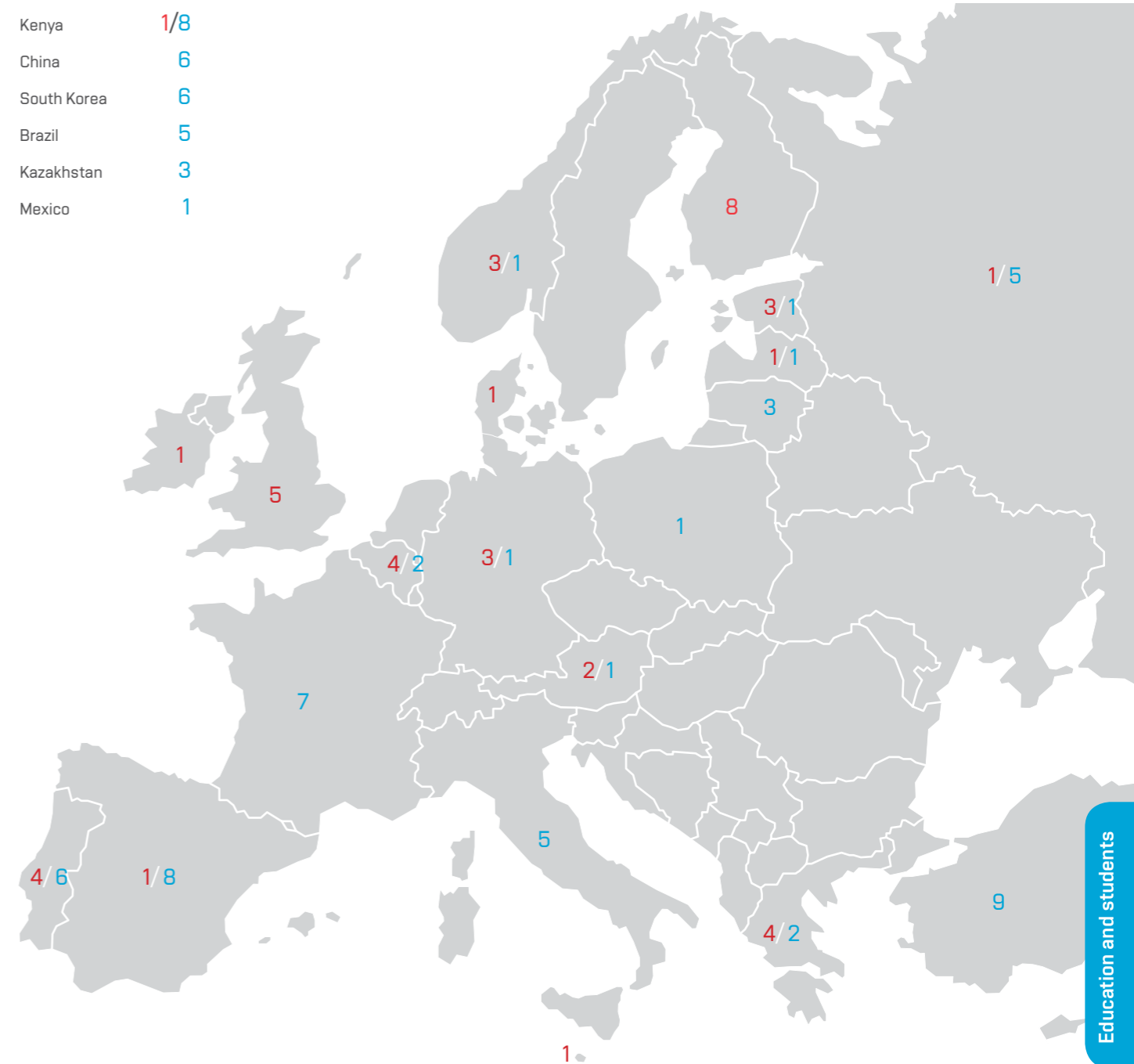
#### Programmes

▪ Erasmus+	53
▪ Intergovernmental agreements	4
▪ Co-operation agreement, Freemovers	26

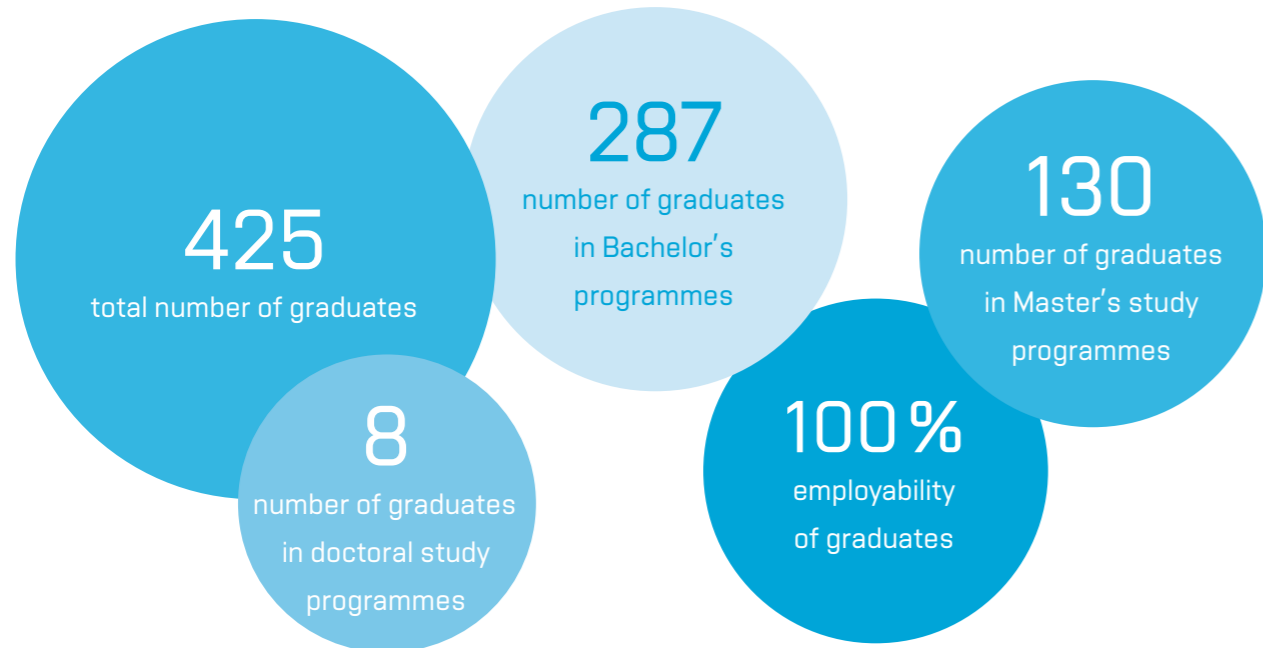
#### From these countries:

▪ Turkey	9	▪ Lithuania	3
▪ Spain	8	▪ Belgium	2
▪ Kenya	8	▪ Greece	2
▪ France	7	▪ Austria	1
▪ China	6	▪ Germany	1
▪ South Korea	6	▪ Estonia	1
▪ Portugal	6	▪ Latvia	1
▪ Brazil	5	▪ Mexico	1
▪ Italy	5	▪ Norway	1
▪ Russia	5	▪ Poland	1
▪ Kazakhstan	3		

Kenya	1/8
China	6
South Korea	6
Brazil	5
Kazakhstan	3
Mexico	1



## Graduates



## Our research changes the world and leads to important discoveries

If the words of Jaroslav Kadlec, a FIT graduate are anything to go by, microscopy is a fascinating discipline. Kadlec works as software manager for Thermo Fisher Scientific, one of the world leading producers of electron microscopes, where he is in charge of development of both talented people as well as new technologies.

### What is the role of IT specialists in the development of a microscope?

Modern electron microscopes are extremely complex and their development would not be even possible without the use of software solutions. A large number of developers participates in the development of new modules or new SW functionality. They are in charge of software architecture design, as well as prototyping, implementation and modernisation of the technology used. Development of SW involves various other areas from communication with HW modules to the design of application user interface. People often assume that this work mainly focuses on the development of firmware, but that is incorrect; in fact, 99% of our work consists of application development.

### Why are you interested in microscopy in particular?

Microscopes are fascinating. I had no idea about all the things involved in microscopy. They are not used for just viewing things, they can create, build, machine and even print products. They are used in all areas and play a key role in all major scientific discoveries as well as in ordinary industry production. Our microscopes are used in the research focusing on the ZIKA and HIV viruses, they are enabling the development of new materials, as well as miniaturisation of modern mobile phones. We can see that our research changes the world and leads to important discoveries. That is a huge motivation for me as well as for my colleagues.

### You work as a software manager. What exactly do you do in your job?

My role is quite versatile. I lead a team of people who work on different software solutions and I am trying to help them grow and improve and to overcome any and all problems that occur or may



occur. It is not just about supporting their work, but also about their professional development and education. I am also in charge of technical solution of several projects. We are currently working on the development of a new generation of the Scios microscopes. This is a mid-range microscope that is being frequently used in material sciences and in companies developing and producing semiconductor components. And finally, what is especially important to me is that I am still involved in the SW development and I am actively programming.

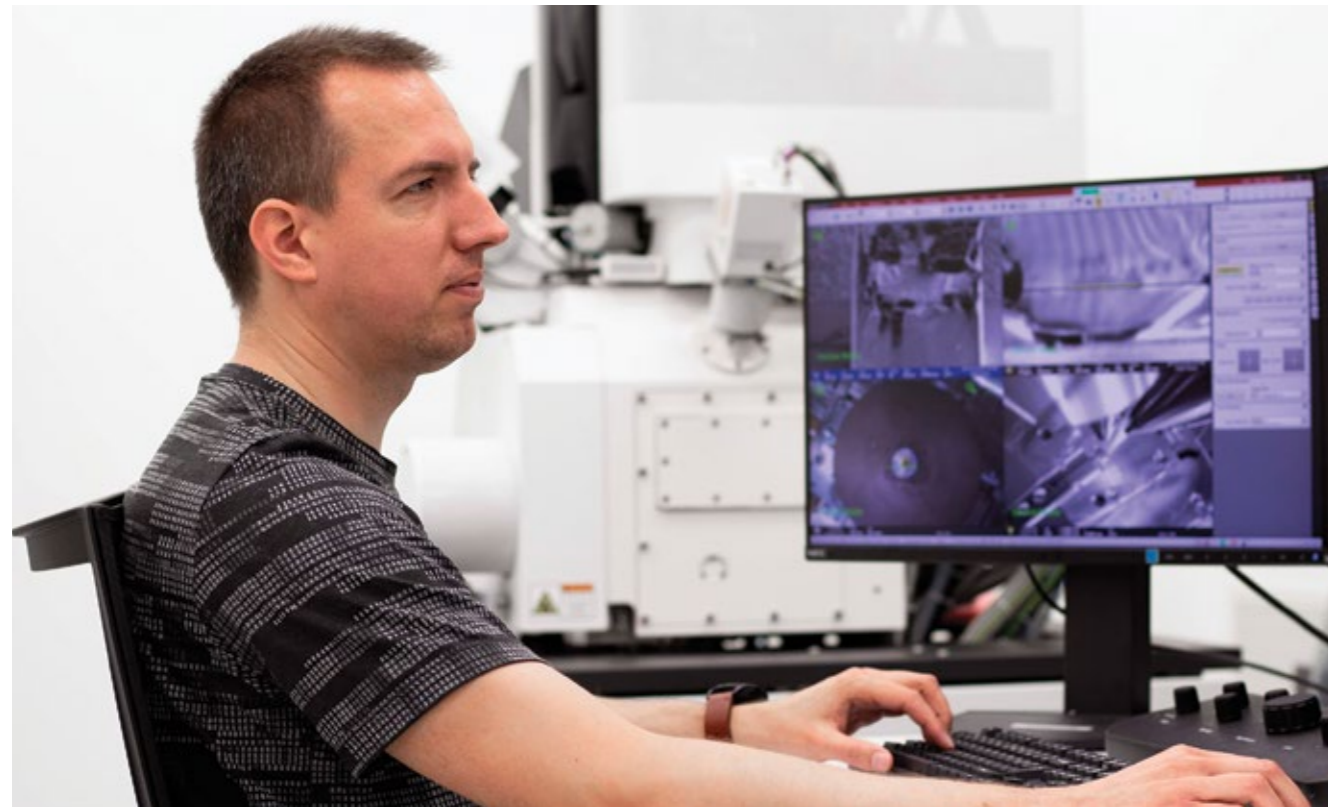
### What do you use in your job from what you learned during your studies?

I learned a lot in my doctoral studies. First, I am grateful to the great team at the Department of Computer Graphics and Multimedia, I

learned a lot from them. Then there is teaching and being in contact with students – there is a difference in thinking when you are learning or doing something yourself and when you are supposed to pass your knowledge to others. Both these experiences taught me lessons I am still benefitting from today.

**You still often work with students. Why do you find co-operation with universities so important?**

In SW development, we need skilled people who like to learn new stuff and think. At FIT, there is plenty of such people we can choose from. Students working at our company can learn a lot and get their hands on some truly advanced technology. The downside, at least for some, is that this process takes some time; it takes months to really understand how these microscopes function. In my team, students work on software development as part of some quite difficult tasks.



**So what qualities are important for people working in your field?**

When I am meeting people for job interviews, I always prefer people with a great deal of interest and enthusiasm. It is often even more important than the fact that they can apply perfectly a skill they were developing for past X years. We are looking for people who want to grow and learn.

**And in what areas do you yourself need to “grow” and learn?**

Every day brings many challenges and interesting moments and I try to deal with them as best as I can. So I am in fact learning new stuff or learning from my previous mistakes every day. I really enjoy trying out new technologies and helping people grow. Technology is a vast area and it is a lot of hard work to keep oneself in the loop with the latest developments. And seeing the advancement and growth of people I can influence is also a great joy. And I can, in turn, learn something new from them.

**From academic research through spin-off company to becoming a global leader**

**operating from a single room. Today, Jiří Tobola leads a company that belongs among the industry leaders in the area of network traffic monitoring and analysis and employs 130 people. “This is a great success story showing where an academic research can lead,” says the current CEO of Flowmon Networks. The company was founded three years ago as a university spin-off company and, today, it has more than a thousand customers all over the world.**

**You started as a “garage company”, today you are one of the industry leaders. How did you manage that?**

It has been a long and winding road. It started with our academic research project in which we wanted to compete with Cisco’s products. Although an ambitious plan, in the end it was not a very good idea. We had to start again from scratch and find our own path. That is when we turned our attention to computer network monitoring and security. Our unique prototypes were lauded even by the European Commission which suggested that we should commercialise them.

**That was the beginning. The technology was created by a group of researchers from the CESNET association; Flowmon Networks was then founded as a spin-off company with the universities being its shareholders. What are the advantages of the connection to the academic world?**

First and foremost, it enables a long-term co-operation with the university. It is easier for us to agree on joint research projects or discuss student diploma thesis topics. This is a great advantage that helps us with the innovation of our products. Nowadays, regular co-operation with universities is an integral part of the development and innovation process at Flowmon Networks. We are working together on a number of research and development projects. Our customers can see the results of our co-operation every day.

**You too started in the university environment. What did you learn from it?**



This is a great success story showing where an academic research can lead. I started at FIT in 2002 and back then, it was new and a bit unorthodox to work on projects in groups. However, it was the right preparation for the real-world company environment. It is great that there are multiple research groups at the school and they work on a large number of projects. From my second semester, I was able to work on a research in the Liberouter project. Apart from the welcome scholarship, this also enabled me to work on a Bachelor’s and diploma theses which had a real-life practical impact and were not just an academic exercise. In the end, the Liberouter project evolved into Flowmon. I only regret that I was not able to conclude my academic stint as a graduate from doctoral studies; unfortunately, it soon became

evident that combining research work with commercialisation of its results is extremely time-consuming.

**Thirteen years ago, Czech universities did not have many experiences with commercialisation. Neither did you with business, right?**

Yes, that is the area where we were most lacking experience. The support provided by the South Moravian Innovation Centre was therefore very important; they provided us with not just facilities, but also valuable consultations, seminars, legal services and contacts from the very beginning. The appointment of Rostislav Vocilka as the managing director was also crucial. He brought the necessary experience from his previous employments at ICT companies. Specifically, he had experience with building up sales, launching brands on the market, team leadership and creation and transformation of company structures.

**So is that the formula for achieving success – a great technology supported by capable management?**

Hundreds of pieces need to fall into place to reach success. And it might have never happened without a number of seemingly less important decisions. For me, the success is based on having a team of the right people, motivation to make something great and a strong technology. The product itself has changed over the time and will further change in the future, but if you are surrounded by the right team, you can achieve unexpected and unplanned success. Looking back I have to admit that we came at the right time with the right technology and were very lucky in choosing our acquisitions. From the technology side, Flowmon's success went hand in hand with the change of companies' approach to the security of their IT infrastructures.

**What has changed?**

At the time when we founded Flowmon, it was evident on the global market of security solutions that the existing manners of IT infrastructure security based on the protection of the network perimeter and end stations were no longer sufficient. The traditional tools can only defend a company against certain types of attacks. Therefore, a

technology was required that would enable monitoring of the network traffic and analysing anomalous behaviours. In other words, a technology that would cover the blind spots in the company's protection.

**So the beginning revolved around the development of a unique technology. Is development still important for you today?**

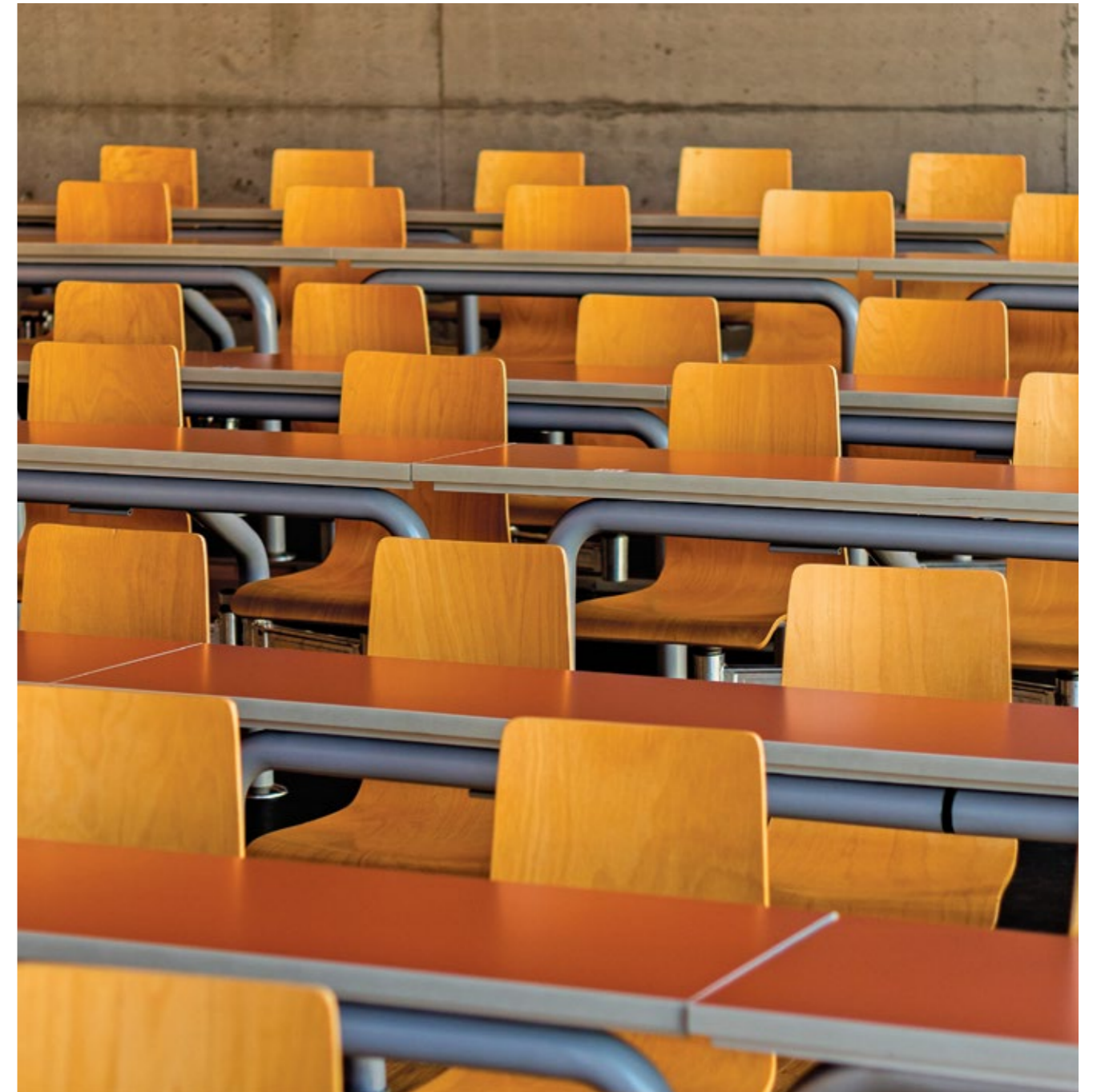
We would not be where we are today without the development of our technology. And if we want to remain one of the industry leaders, the innovation and development processes are absolutely crucial. That is why this year we are participating in the largest number of research and development projects in the company's history and we allocate more and more of our capacities to these projects.

**When you became the CEO of the company in 2018, you set some ambitious goals. Were they changed in any way due to the current crisis?**

Our long-term objective remains unchanged. We want to build a global technology company that provides attractive jobs to more than 800 people and is the global industry leader in the area of network traffic monitoring and security. However, we had to review our short-term goals. In January, we started another round of our expansion to the U.S. and we wanted to strengthen our branch office with new faces for sales and marketing departments. But we had to suspend and postpone these activities after two months.

**Do you see any positives about the current situation?**

We all know that some sectors, such as tourism, hospitality industry and airlines, are facing very severe problems and another economic recession is coming to hit us in the near future. On the other hand, there are some positive signs – it is now acceptable to organise online meetings with partners from Japan or America, which used to be widely rejected in the past. A number of tasks are being transferred to the digital form and I believe that looking back five or ten years from now, we will see that the current crisis significantly accelerated digitalisation, after all, it forced even our mothers and grandmothers to learn how to Skype.





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