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RESEARCH DEPARTMENTS

CYPHY Cyber-Physical Systems, Head Prof. Ing. Michael Šebek, DrSc.
INTSYS Intelligent Systems, Head Prof. Ing. Vladimír Mařík, DrSc., Ph.D.
IID Industrial Informatics, Prof. Dr. Ing. Zdeněk Hanzálek
RMP Robotics and Machine Perception, Head Prof. Ing. Václav Hlaváč, CSc.
IPA Industrial Production and Automation, Head Prof. Ing. Michael Valášek, DrSc.
COSYS Cognitive Systems and Neurosciences, Head Doc. Ing. Lenka Lhotská, CSc.
BEAT Biomedical Engineering and Assistive Technology, Head Prof. Ing. Eva Důkolinská, CSc.
PLAT Scientific Management of Platforms, Head Prof. Ing. Vladimír Kučera, DrSc., Ph.D.
By creating fusions of research disciplines, CIIRC turns ideas into breakthrough technologies for industry, health and society. It serves as a broadly open cooperation platform enabling collaboration, exchange and knowledge transfer on both national and international levels.

One of the main objectives of the CIIRC CTU is to integrate information and cybernetic research and education at the CTU building on partnerships with out-of-city centers as well as close collaboration with international research centers. CIIRC CTU creates research opportunities as well as provides educational workplaces in a scientific atmosphere, pleasant work conditions in a number of specializations, and achieving note-worthy results at the highest international level.

The Institute opens its doors to experts from both the Czech Republic and abroad providing a forum for individuals to become part of the CIIRC CTU team or cooperate with it. A very significant part of the cooperation is also in the area of interdisciplinary collaboration with universities as well as with the Academy of Sciences of the Czech Republic, with the industrial sector and similarly oriented foreign institutions.

MISSION

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VISION

“CIIRC is a modern research and educational institute bringing together the best research teams, young talent and unique know-how to move the boundaries of technology, providing motivation to produce world-class results and raising a future generation of researchers of an international calibre.”

Since its inception CIIRC CTU has experienced constant growth with the goal of recruiting up to 350 employees by 2020, namely in research positions and PhD students. All of them will work in the new CIIRC building built at the CTU premises in Prague, Dejvice (in operation since April 2017). One of the key tasks is to train research results not only with university teaching, but also to attract students to research primarily from the master’s and doctoral study programs, but also with a focus on the needs of the industrial sector and clinical practice.

CIIRC CTU has become a place of interdisciplinary cooperation, a natural fit for the fields of informatics, robotics and cybernetics. The cooperation opens the gates of opportunity and greatly supports knowledge transfer into industry whereby it serves to provide guidance to staff members.

HISTORY

CIIRC CTU was established by the Academic Senate of the Czech Technical University in Prague on April 22nd, 2013, whereby it came into effect on July 1st, 2013. The main task in the first phase of this establishment of CIIRC CTU has been to prepare a high-quality project in the area of the Research and Development for Innovation to revitalize the existing premises in the building that housed the Technical menza canteen and to provide adequate physical facilities for the work of CIIRC. The other major task is to gradually build CIIRC up into a national scientific and teaching workplace on a European and international level.
The National Center for Industry 4.0 (NCP4.0 – www.ncp40.cz) was established on 4 September, 2017 through collaboration with academic and industrial partners and professional organizations. The founding partners are CIIRC CTU, Brno University of Technology, VŠB – the Technical University of Ostrava, Siemens, ŠKODA Auto, the Czech Chamber of Commerce, JIC - South Moravian Innovation Center, SIC - Central Bohemia Innovation Centre, the Confederation of Industry of the Czech Republic, ABRA Software, DEL, Festo, KUKA Roboter CEE, SAP ČR, and SIDAT. Subsequently, other partners have also joined.

Our vision is to “Inspire & Make the Czech Industry 4.0”. The NCP4.0 is charged with assisting in the implementation of the National Initiative Industry 4.0 at the national level by providing the research potential and knowledge transfer to Czech industry supporting mainly SMEs in implementing Industry 4.0 compatible solutions in the field of manufacturing. The main goals are implementing Industry 4.0 principles, increasing awareness of Industry 4.0 and Society 4.0 solutions, and forging cooperation between academic organisations and industrial partners by sharing best practices and technologies. Our international activities are also very important as this initiative is part of the EU RICAIP project (Research and Innovation Centre on Advanced Industrial Production) and has become one of the 30 new EU Digital Innovation Hubs.

The new CIIRC Testbed for Industry 4.0, comprised of research, experimentation, and the demonstration facility, is based on state-of-the-art technology with a future outlook toward further development. It is well suited for prototyping, process improvement, product development and testing in order to investigate new concepts and methods that would improve the manufacturing processes and optimize manufacturing.

Lab Automotive R&D 4.0 is a specialized laboratory that was established as a result of cooperation with Škoda Auto in response to specific requirements of modern research and development in the automotive industry. The laboratory is focused on HMI, UI, user requirements, acceptance tests, quality in product development (QFD) requirements and on functional testing of vehicle systems, with key emphasis in user interaction. The other CIIRC CTU labs fall in two categories: –joint labs with different external partners (AVRAR - Association of Virtual and Augmented Reality, Eaton, Facto Systems Solutions, PMHE, EoP, Pocket Visually, and SmartFlat), and our internal labs (DVE MediaLab, Intelligent and mobile robotics, Robotic perception, and Robotics Development labs). The 3D printers (plastic and metal) are also available.

The grand-opening of the CIIRC CTU building
The grand-opening of the CIIRC CTU building was held on Tuesday, May 2, 2017. The President of the Czech-Republic Mr. Miloš Zeman and the Prime Minister of the Czech Republic Mr. Bohuslav Sobotka opened the new building, designated by Petřín Hospice.

The First Lady of the Sultanate of Oman visit
On 16 May, CIIRC CTU welcomed the Sultan Qaboos University delegation led by Her Majesty Dr. Mona al Said, a prominent member of the Sultanate of Oman and the executive rector Professor Ali Al Bemani. The aim of the meeting was to lay the foundation of a cooperative atmosphere in the areas of research and pedagogical activities, to present the future development priorities, and to discuss possibilities of joint projects personally with ČVUT representatives in order to facilitate professor and student exchange in selected fields.

Visit by the Minister of Economy, Technology and Industry of Japan
On 21 August, 2017, CIIRC CTU was visited by Japan’s Minister of Economy, Technology and Industry, Mr. Hiroshige Seko who has expressed key interest in Industry 4.0 and related research and development, especially in robotics, computer vision, and industrial automation. The Minister also spoke with Mr. Yutaka Nagashima, an employee of CIIRC CTU.

Engineering forum
Digitalization and correlating topics of Industry 4.0 (also called the 4th industrial revolution) are trends which, in the last couple of years, have significantly changed the world of mature industry having advanced production automation which corresponds to changes in the labour market. Presentations were given by Dr. Petr Kořínek (CIIRC) as well as by representatives of other industrial partners.
2017 Longuet-Higgins Prize for fundamental contributions to computer vision. The award recognizes papers from the Conference on Computer Vision and Pattern Recognition, held ten years ago, which have had a significant impact on computer vision research. Awarded for (Philbin, Chum, Isard, Šivic, Zisserman, CVPR 2007).

2x 2017 Helmholtz Prize for fundamental contributions to computer vision. The award recognizes papers from the International Conference on Computer Vision held ten or more years ago which have had a significant impact on computer vision research. Awarded for (Šivic, Zisserman, ICCV 2003) and (Šivic, Russell, Efros, Freeman, Zisserman, ICCV 2005).


https://www.kaggle.com/c/youtube8m

Annual Competition of Automated Theorem Proving Systems, the higher-order (THF) category, won by Ch. Brown for his system Satallax (CASC26 – http://tptp.org/CASC)

Google Faculty Research Award for J. Urban for collaboration with Google Research on topics combining Machine Learning and Automated Reasoning.

https://research.googleblog.com/2017/02/google-research-awards-2016.html

The Amazon Alexa Prize 2017 award for the second best social bot in competition with over one hundred university teams. The CTU team made up of five students led by Jan Šedivý developed a conversational social bot named Alquist for Alexa intelligent speakers. The way humans interact with machines is at an inflection point, and Alquist is an advanced example of the latest Conversational Artificial Intelligence (AI). It is designed to converse coherently and engagingly with humans about popular topics such as sports, politics, news, movies, etc. The Conversational AI is leveraging several research areas including knowledge acquisition, natural language understanding, natural language generation, context modeling, commonsense reasoning and dialog planning. Alquist uses original algorithms researched in the CIIRC department of Intelligent Systems.

Medal of Merit was awarded by the President of the Czech Republic Miloš Zeman to Vladimír Mařík in October 2017.
SELECTED RESULTS

...excellence and applicability
The paper details the official published account of the formal verification of the oldest problem in discrete geometry - the problem of congruent balls in a Euclidean three-space has density 1. This large collaborative project took over ten years combining formalizations in the HOL Light and Isabelle proof assistants.

The presented theory furnishes a new framework for formulating and solving important problems for camera models with image distortion. The theory of distortion varieties is useful to solve such systems by first eliminating parameters that are studied using tropical geometry. The distortion varieties of a given projective variety are parametrized by duplicating coordinates and multiplying them with monomials. This study has explored their degrees and defining equations. Exact formulas have been obtained for the case of one-parameter distortions. These formulas are based on Chow polytopes and Gröbner bases. Multiple-parameter distortions are studied using tropical geometry.

Decision variables and clear elimination

The Distances between objects of a given projective variety are parametrized by duplicating coordinates and multiplexing them with monomials. This study has explored their degrees and defining equations. Exact formulas have been obtained for the case of one-parameter distortions. These formulas are based on Chow polytopes and Gröbner bases. Multiple-parameter distortions are studied using tropical geometry.

Energy optimization of robotic cells

Energy optimization of industrial robotic cells is undoubtedly essential for long-term, sustainable development. As a result, the institute decided to extend the robot programming tools followed in 1967. A solution for the general case, appeared in 1964, and a solution for square and invertible systems followed in 1967. The static-state feedback, however, was not previously known. It also generates new and interesting constraints on the permissible transformations. One of the solutions has been evaluated by a detailed scenario-based approximation-based nonlinear predictive control and commercial products on an industrial framework of face car motor control is in the institute. The simulation has been carried out in a real-time system with a processor core.
Solving and stress resistance. with an emphasis on flexibility, decision making, problem solving and stress resistance.

A test environment has been developed for the subsystems for recording, visualization and evaluation. The developed software consists of several applications (diagnostics and therapy - nystagmus, disabled (control of a PC or other devices); and in medical design (websites, store shelves, promotional materials); can be used in many different applications: marketing, research, education, and entertainment).

Eye movement monitoring
Eye tracking is the measurement of eye activity that can be used in many different applications: marketing (product testing, store shelves, promotional materials), transport safety (driver, passenger, pedestrian), help to the disabled (control of a PC or other devices); and in medical applications (diagnostics and therapy - ophthalmology, cardiology, diabetes, etc.).

Two hardware settings are used: head-mounted and distance tracker. The developed software supports the recording of several subsets for recording, visualization and evaluation.

Tracking performance in the mm-scale is the main advantage of the distance tracker setting. These data can be used for the assessment of visual and cognitive skills and competencies, with an emphasis on flexibility, decision making, problem solving and stress resistance.

NetVLAD: Architecture for weakly supervised place recognition
The NetVLAD architecture is a new approach that significantly outperforms non-learnt image representations in large-scale, weekly-labelled tasks. Finally, researchers have proposed a new approach to address the task of place recognition. The example result shows that our trained image descriptor significantly outperforms non-learnt image representations in place recognition and image retrieval benchmarks.

Semantic Big Data Historian
A functional prototype of Semantic Big Data Historian was developed within the framework of Rockwell Automation – Distributed Intelligence Control Laboratory (RA-DIC). The tool aims to reduce semantic heterogeneity of data gathered from industrial processes as well as integrate with external data resources. The solution is built upon the semantic web (OWL ontologies) and Big Data technologies (Apache Spark, Apache Cassandra). The first step of the solution is data ingestion. The data is subsequently extracted and cleaned using real-life production datasets. The next step is data transformation. The transformed data is subsequently annotated and linked using OWL ontologies. The next step is distributed data processing. The solution is then ready to be consumed using semantic web technologies such as SPARQL.
RESEARCH PROJECTS
...on track to achieving excellence
ESIF – European Structural and Investment Funds

OP RDE – Operational Programme Research, Development and Education

Despite strong proposals from competing applicants, the CIIRC CTU succeeded in three exceptional projects in the “Support to Excellent Research Teams” Call of the OP RDE. The projects with total eligible costs over 400 million CZK (€15M) will provide leading experts with facilities at the RDE. The projects with total eligible costs of over 400 million CZK (€15M) will provide leading experts with facilities at the RDE. The purpose of the 4Horizon project is to develop automated methods for performing computer monitoring and assessing the state of advanced knowledge bases. These methods are necessary to perform computational verification of large mathematical theories, software and hardware, and other advanced knowledge-based systems and technologies.

RICAIP: Research and Innovation Centre on Advanced Industrial Production

Project Title Agency / Call Ref. No. Implementation Period

LADIO: Project Live Action Data Input/Output EU H2020 731970 12/2017 – 05/2018

Supply Chains

RadioRoSo: Radioactive Waste Robotic Sorter EU FP7 ECHORD++ 601116 09/2016 – 02/2018

Industrial Production

SafeLog: Safe human-robot interaction in logistic applications for highly flexible warehouses EU Horizon 2020-IND-CE 723336 10/2016 – 09/2019

Assisted Disaster Response

UP-Drive: Automated Urban Parking and Driving EU Horizon 2020-ICT 888111 01/2016 – 12/2019

Competence Centres Programme

CAK: Centre for applied cybernetics
Project No. TE01020197, Technology Agency of the Czech Republic, 01/2012 – 12/2019
Principal investigator: Prof. Ing. Vladimír Kučera, DrSc., dr. h. c.

The program is focused on the development of long-term collaboration between the public and the private sectors. The project operates nationwide, involving 16 partners, of which are 4 public universities, 3 large-size enterprises, 2 medium-size and 7 small-size companies. The research and development activities include:

- Modeling and control of production, distribution and conversion of electric power
- Intelligent man-machine interaction
- Machine perception and image analysis
- Optimization tools for industrial informatics.

List of Other Research Projects

<table>
<thead>
<tr>
<th>Project Title</th>
<th>Agency / Call</th>
<th>Ref. No.</th>
<th>Implementation Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>GenomKit</td>
<td>MPO TRIO II</td>
<td>FV30421</td>
<td>01/2018 – 12/2021</td>
</tr>
<tr>
<td>Predictive modeling of student performance using learning resources</td>
<td>CAK</td>
<td>18-04150Y</td>
<td>01/2018 – 12/2020</td>
</tr>
<tr>
<td>Development of a modern modular system for teaching mechatronics in line with the Industry 4.0</td>
<td>TACR Epsilon</td>
<td>1405010448</td>
<td>01/2018 – 12/2020</td>
</tr>
<tr>
<td>TACR-OISBOT: Research and realization of prototype of a breakthrough solution of multifunctional autonomous modular robot for transport and manipulation in sophisticated manufacturing and assembly operations</td>
<td>TACR Epsilon</td>
<td>1405010848</td>
<td>01/2018 – 12/2020</td>
</tr>
<tr>
<td>DPMAS: Data-driven Asset Management in Automobile Industry Based on Semantic Modelling</td>
<td>TACR Delta IV</td>
<td>V14000054</td>
<td>01/2018 – 12/2019</td>
</tr>
<tr>
<td>PMPharmASIA: database extension of drug substances and the PMPharm models to East Asian population and development of NGS diagnostic panel and algorithm for predicting statin pharmacokinetics/dynamics</td>
<td>TACR Delta V</td>
<td>V150000320</td>
<td>01/2018 – 06/2022</td>
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<tr>
<td>IMitRob: Imitation learning supported by language for industrial robotics</td>
<td>TACR Delta IV</td>
<td>V150000040</td>
<td>01/2017 – 06/2018</td>
</tr>
<tr>
<td>QUICKSAFE: Time-delay control laws for upcoming transportation UAV systems</td>
<td>HDP, INTER-EXCELLENCE</td>
<td>L14-041713</td>
<td>09/2017 – 12/2018</td>
</tr>
<tr>
<td>GERL: Personal Health Assistance Systems</td>
<td>MPO TRIO II</td>
<td>L1500006</td>
<td>01/2017 – 06/2021</td>
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<tr>
<td>CODA: Control Platform for High-Accuracy Micromanipulation Assembly</td>
<td>MPO TRIO II</td>
<td>L1500003</td>
<td>01/2017 – 06/2021</td>
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<tr>
<td>Research and project concept of a multifunctional robotic effector of an underground multibot for storage of disposal casks in a deep geological repository, and the realization of a prototype of dual robotic effector module and its master control system</td>
<td>MPO TRIO II</td>
<td>L14000167</td>
<td>06/2017 – 12/2018</td>
</tr>
<tr>
<td>Institutional support of the Czech Technical University in Prague</td>
<td>HGMT</td>
<td>C22.2.20/000/15/0_0_015/0002382</td>
<td>06/2017 – 12/2022</td>
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<tr>
<td>Project Title</td>
<td>Agency / Call</td>
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<tr>
<td>KnowDrift: Knowledge-Driven Industrial Robotics for Flexible Production</td>
<td>Die Öster. Forschungsförderungsgesellschaft mbH (FFG), Produktion der Zukunft 2016</td>
<td>8A4707</td>
<td>03/2017 – 08/2019</td>
</tr>
<tr>
<td>NaoSkin: Robot self-calibration and safe physical human-robot interaction inspired by body representations in the primate brain.</td>
<td>GAČR</td>
<td>GA17-15697Y</td>
<td>02/2017 – 12/2019</td>
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<tr>
<td>Kassandra - multi-camera vehicles' undercarriage security scanner</td>
<td>Ministry of the Interior</td>
<td>VI20172020080</td>
<td>01/2017 – 04/2020</td>
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<tr>
<td>Smart Camera - New Generation Monitoring Center</td>
<td>Ministry of the Interior</td>
<td>VI20172016082</td>
<td>01/2017 – 12/2019</td>
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<tr>
<td>Temporal context in analysis of long-term non-stationary multidimensional signal</td>
<td>GAČR</td>
<td>GA17-20480S</td>
<td>01/2017 – 01/2019</td>
</tr>
<tr>
<td>KONPOLA: A robotic cell for inspection of painted parts in industrial manufacturing</td>
<td>OP EIC - Operational Programme Enterprise and Innovation for Competitiveness</td>
<td>CZ.01.1.02/0.0/0.0/15_019/0004939</td>
<td>10/2016 – 09/2019</td>
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<tr>
<td>Technology for industrial robots integration into production systems based on Industry 4.0</td>
<td>MPO</td>
<td>FV10299</td>
<td>09/2016 – 08/2019</td>
</tr>
<tr>
<td>Sounds: Processing of complex sounds in the central auditory system under normal and pathological conditions</td>
<td>GAČR</td>
<td>GA16-09086J</td>
<td>02/2016 – 12/2018</td>
</tr>
<tr>
<td>ERRA_CZ: The involvement of Czech research organizations in the ERRA Energy Research Alliance</td>
<td>MŠMT</td>
<td>EUPRO LE 15024</td>
<td>01/2016 – 12/2017</td>
</tr>
<tr>
<td>FLOPP: The factory of the future – FLexible, Optimized and Controllable Production Platforms.</td>
<td>OP EIC - Operational Programme Enterprise and Innovation for Competitiveness</td>
<td>CZ.01.1.02/0.0/0.0/15_019/0004688</td>
<td>01/2016 – 09/2019</td>
</tr>
<tr>
<td>FOREST: Flexible Scheduling and Optimization Algorithms for Distributed Real-time Embedded Systems</td>
<td>GAČR</td>
<td>GA16-23009S</td>
<td>01/2016 – 12/2018</td>
</tr>
<tr>
<td>TDS: Time delay compensators for flexible systems</td>
<td>GAČR</td>
<td>GA16-17398S</td>
<td>01/2016 – 12/2018</td>
</tr>
<tr>
<td>ADV DIABETES: Individual dynamics of glycemia excursions identification in diabetic patients to improve well-managing procedures influencing health outcomes</td>
<td>KDO Ö,</td>
<td>IVIS-25710A</td>
<td>05/2015 – 12/2018</td>
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<tr>
<td>CRT: Features of Electromechanical Dyssynchrony that Predict Effect of Cardiac Resynchronization Therapy</td>
<td>KDO Ö</td>
<td>IVIS-23386A</td>
<td>05/2015 – 12/2018</td>
</tr>
<tr>
<td>SeLaC: Structures, Learning, Cognition</td>
<td>GAČR</td>
<td>GA16-04682S</td>
<td>01/2015 – 12/2017</td>
</tr>
<tr>
<td>Symbolic Regression for Reinforcement Learning in Continuous Spaces</td>
<td>GAČR</td>
<td>GA16-22731S</td>
<td>01/2015 – 12/2017</td>
</tr>
</tbody>
</table>

**Note:**
- TD - Technology Agency of the Czech Republic
- GAČR - Grant Agency of the Czech Republic
- MPO – Ministry of Industry and Trade of the Czech Republic
- MŠMT – Ministry of Education, Youth and Sports of the Czech Republic
- Ph.D. Education

There were 54 Ph.D. students enrolled in different Ph.D. study programs at CTU who were supervised by the CIIRC staff members and participated in the CIIRC research projects in 2017.
SELECTED PUBLICATIONS

...publish and flourish
Journal Articles


