



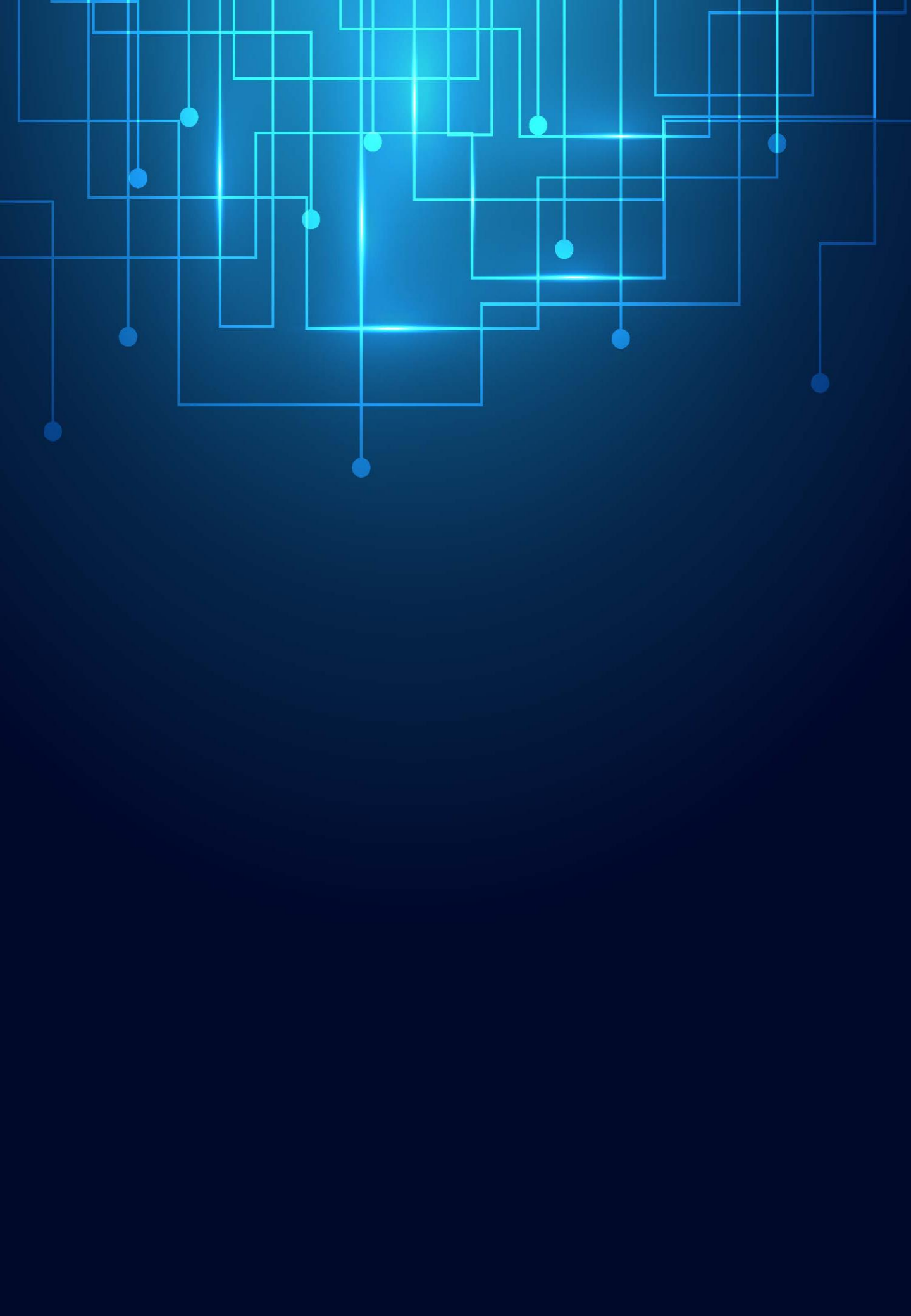
Tallinn University of Technology: Department of Computer Systems

PROMOTION CATALOGUE

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The TUTORIAL project has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No **692152**



Welcome to the promotion guide of the Department of Computer Systems at Tallinn University of Technology (TUT)

As one of the four departments within the School of Information Technologies, this catalogue presents descriptions of the divisions within the Department of Computer Systems, their research and innovation activities, as well as their ongoing achievements. It has been produced within the framework of the TUTORIAL project, funded by the European Commission's Horizon 2020 Research and Innovation Programme (Grant Agreement No. 692152)



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FOREWORD

Tallinn University of Technology (TUT) is the flagship of Estonian engineering and technology education and the only technological university in Estonia. Here the synergy between different fields (technological, natural, exact, economic and health sciences) is created and new ideas are born. TUT is becoming one of the leading technological universities in the Baltic Sea region.

As the most international university and the biggest international community in Estonia, they have more than 1400 students from over 90 countries and 11% foreign staff members. The emphasis on international cooperation is also a priority for joint curriculum development, student and employee exchange programs and joint research development programs.

Study and teaching is based on internationally recognized research and the graduates are highly rated on the labour market. The University's approximately 70,000 alumni have shaped the economic landscape of present-day Estonia. The TTÜ campus is also a home to more than 200 high-tech companies (e.g. Skype).

TUT is in charge of nurturing the next generation of engineers and advancing engineering culture in Estonia, contributing to the sustainable development of the society and increased national prosperity with its innovative services. Our vision is innovative Estonia in a sustainable world.

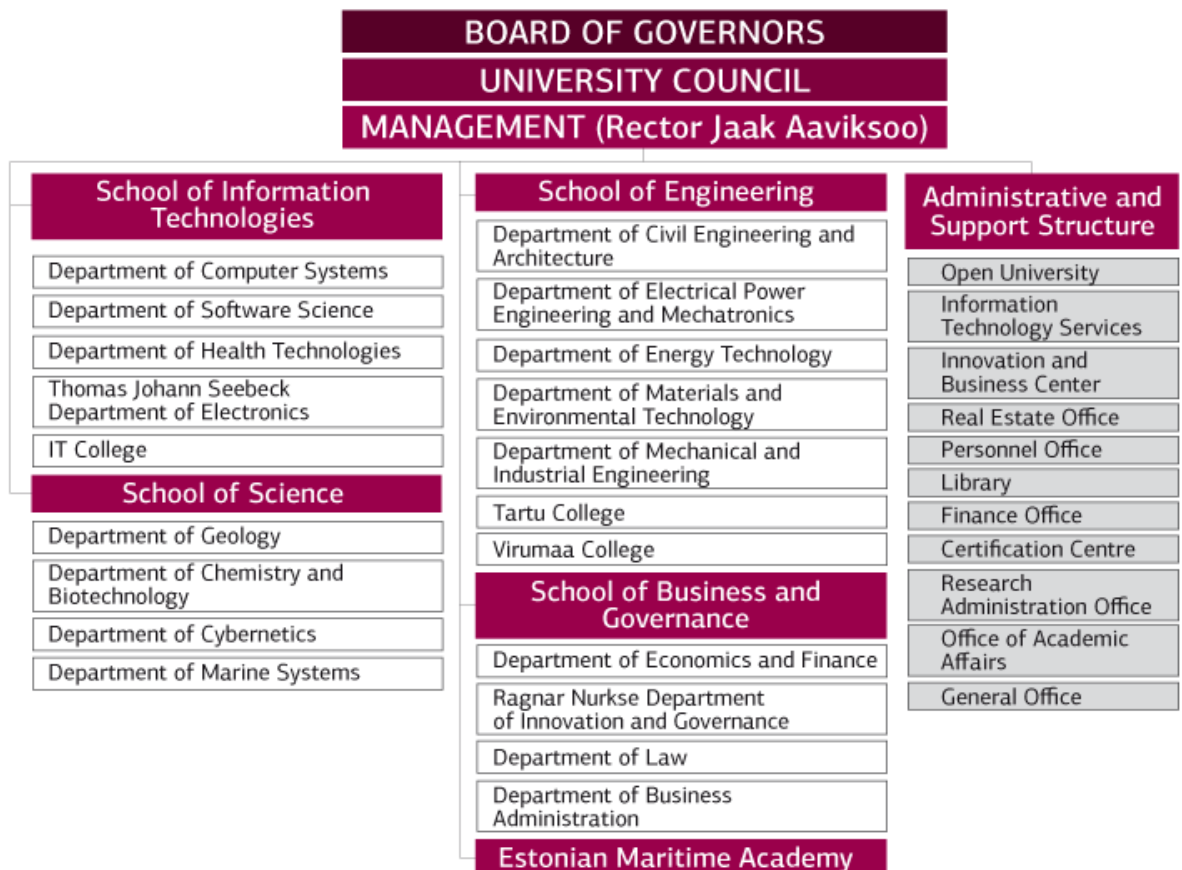


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About the University

Tallinn University of Technology is comprised of four faculties which are sub-divided into specialised departments dedicated to promoting science, technology and innovation. The supportive structure of the institute is also largely credited to cooperation between the university, enterprises and the public sector to significantly contribute to knowledge and academic success of its students.



R&D objectives in Strategic Plan of Tallinn University of Technology 2020



TUT has been an active player in developing their strengths in research and development from different perspectives. They have created the following measures to ensure their continued contribution and participation to R&D development in their institute:

- To introduce an integrated tenure-team academic career model. Student and stakeholder feedback, academic performance, international outreach and industrial partnerships play a key role in the implementation of the career model.
- To increase the share of internationally recognised top researchers in the academic family and strengthen capacity for research, thereby laying a strong foundation for all the activities of the university.
- To regard doctoral students as researchers, who, together with post-doctoral fellows, have a vital role in consistent strengthening of the university's capacity for research.
- To form academically talented research teams, that lay the foundation for the development of science and technology, knowledge-based studies and interaction with society. Research teams shall be able to successfully apply for research funding and engage in research- and innovation-intensive cooperation with enterprises and the public sector in Estonia, as well as abroad.
- On the basis of related research teams to form departments, which are the central academic and administrative structural units of the university. The departments shall provide the academic competence and infrastructure required for teaching and research and the capacity to successfully participate in international research cooperation, including international networks and in cooperation with enterprises, as well as with the public sector.
- To reorganise the faculties and redesign them in accordance with the areas of responsibility arising from the Tallinn University of Technology Act.
- To abide by the principle that the university's strong international position and carefully focused contribution to excellence and state-of-the-art technologies serve the interests of Estonian economy and people in the best way. To implement university's academic potential in particular through strategic partnership with major technology-intensive companies in the world, while being an active partner to Estonian companies and involving them in the activities and development of the university. To create a situation, where cooperation with strong business partners is carried out in every field of research.
- To play an active role in popularising engineering sciences.

School of Information Technologies: Main Areas of Research

The structure of the School of Information Technologies is created from four main departments:

- Department of Computer Systems
- Department of Software Science
- Department of Health Technologies
- Thomas Johann Seebeck Department of Electronics

Due to specialised areas of interest within the field across departments, research is ongoing in the domain of the following scientific topics, including (but not limited to):

- ❖ Study of aging and rejuvenation in nanometer technologies
- ❖ Dependability, test and fault management for many-core systems
- ❖ Embedded test instruments for digital systems
- ❖ Diagnostic test generation and microprocessor testing
- ❖ Acceleration of algorithms in programmable logic
- ❖ Modeling power in computing systems
- ❖ Control of complex nonlinear systems
- ❖ Self-learning and adaptation methods in control systems
- ❖ Computational Intelligence Algorithms - Artificial Neural Networks, Genetic Algorithms, Fuzzy Logic
- ❖ Semiconductor materials based structures and devices
- ❖ Impedance Spectroscopy and it's applications
- ❖ Cognitive Electronics
- ❖ Analysis of electrical oscillations of brain and cognitive processes related with bioelectric signals
- ❖ Non-invasive optical monitoring of cardiovascular condition
- ❖ Biofluid optics
- ❖ oxidative stress markers for patients with cardiovascular disease or diabetes
- ❖ Research and development of multiparameter monitoring systems
- ❖ Development of e-medicine services and research of the use of applications
- ❖ Development of digital decision support and investigation of the clinical use of decision support
- ❖ Research of structural and dynamical changes at molecular level using nuclear magnetic resonance

Study Programmes: School of Information Technologies (IT)

The School of Information Technologies has a variety of study programmes which are taught in Estonian and in English:

Bachelor's programmes	Computer and Systems Engineering (IACB)* Cyber Security Engineering (IVSB) Informatics (IAIB)* IT Systems Administration (IAAB)* IT Systems Development (IADB)* Business Information Technology (IABB)* Computer and Systems Engineering (IASB), admission until 2016* Electronics and Telecommunications (IALB), admission until 2016* Informatics (IAPB), admission until 2016* * in Estonian
Master's programmes (in English)	Computer and Systems Engineering (IASM) Communicative Electronics (IVEM) e-Governance Technologies and Services (IVGM) Cyber Security (IVCM), joint programme with University of Tartu Software Engineering (IVSM), joint programme with University of Tartu, coordinated by University of Tartu Health Care Technology (YVEM)
Master's programmes (in Estonian)	Analysis and Design of Information Systems (IAAM) Telecommunication (IATM) Business Information Technology (IABM) Informatics (IAPM) Biomedical Engineering and Medical Physics (YADM)
PhD programme (in English)	Information and Communication Technology (IAQD)

School of IT: Department of Computer Systems

Department of Computer Systems was established 01 January 2017 in the course of TTÜ structural reform and is one of the 4 institutes at the School of Information Technologies.

Department of Computer Systems was established based on the [Department of Computer Engineering](#), [Alpha Control Lab of the Department of Computer Control](#), and [Centre for Biorobotics](#).





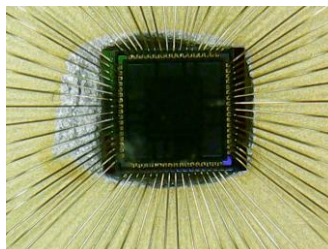
Department of Computer Systems: Research Groups

- ❖ Centre for Dependable Computing Systems
- ❖ Centre for Intelligent Systems
- ❖ Centre for Biorobotics
- ❖ Learning centre of Computer Systems

Centre for Dependable Computing Systems

Centre for Dependable Computing Systems was established in the Department of Computer Systems on January 1, 2017 on the basis of the research group of dependable computing systems design. The centre coordinates several European level research actions (IMMORTAL, TUTORIAL, RESCUE). The research covers a wide range of topics in the areas of digital systems' (including multi-/many-core systems) design, reliability, verification and test:

- Study of aging and rejuvenation in nanomeeter technologies (cooperation with Politecnico di Torino and PUCRS, Brazil);
- Dependability, test and fault management for many-core systems (cooperation: IBM, Recore Systems, Testonica Lab OÜ);
- Embedded test instruments for digital systems (cooperation: firmaga Testonica Lab OÜ)
- Diagnostic test generation and microprocessor testing;
- Acceleration of algorithms in programmable logic (cooperation: Aveiro University, Portugal)
- Modeling power in computing systems (cooperation: Politecnico di Torino, STMicroelectronics).



Head of centre: Jaan Raik

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Centre for Intelligent Systems

Centre for Intelligent Systems was established on January 1, 2017 in the Department of Computer Systems on the basis of Control Systems Research Laboratory, Chair of Automatic Control and System Analysis and Chair of Circuit Theory and Design from the former Department of Computer Control. The Centre consists of the Control Systems Laboratory (<http://a-lab.ee>) and Virtual and Augmented Reality Laboratory (<http://recreation.ee>).

Our core competences:

- Control of complex nonlinear systems;
- Self-learning and adaptation methods in control systems;
- Computational Intelligence Algorithms - Artificial Neural Networks, Genetic Algorithms, Fuzzy Logic;
- Fractional-order modeling and control;
- Distributed Control Systems;
- Data analysis;
- Microcontrollers and design of electronic systems;
- Virtual Reality



Head of centre: Eduard Petlenkov

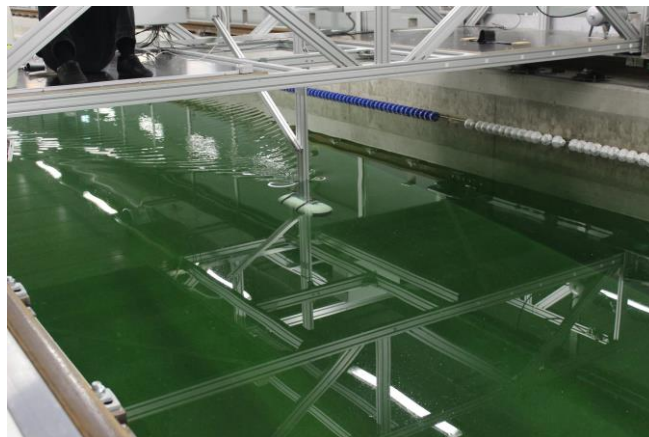
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is-centre.eu/

Centre for Biorobotics

Centre for Biorobotics develops new kinds of robots inspired by biology. We mainly focus on underwater robotics. We work in international research groups with underwater biologists, underwater archaeologist, animal scientist and oceanographers to solve problems in these application areas. Competences: robotics, underwater robotics, sensor technologies, fluid dynamics, mechatronics, robot control, robot software architectures and operation systems.



Head of Centre: Maarja Kruusmaa

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<https://www.ttu.ee/institutes/centre-for-biorobotics/>

Learning centre of Computer Systems

Learning centre of Computer Systems coordinates teaching activities of the department for several study programmes at bachelor and master levels. An active cooperation with the other centres of the department and with the other departments of the university ensures interdisciplinarity and contemporaneity of the taught courses.

Head of Centre: Peeter Ellervee

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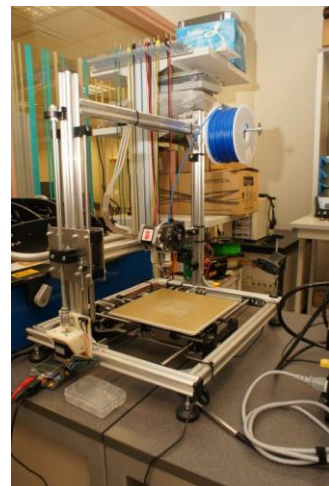
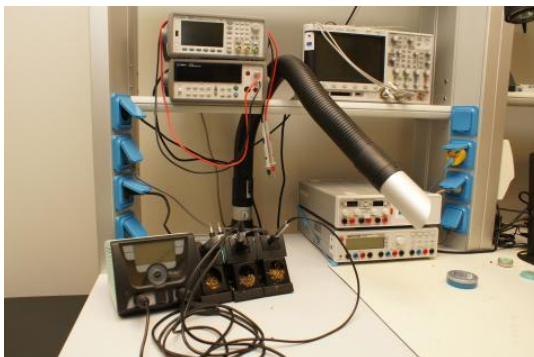
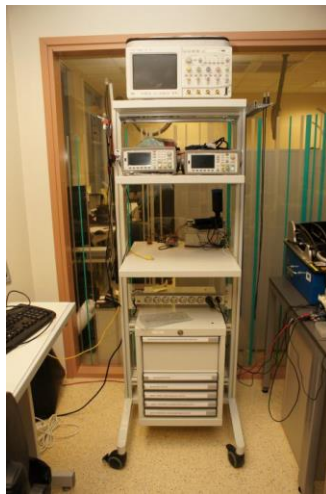
peeter.ellervee@ttu.ee

Infrastructure

Hardware Laboratory

Research lab of Department of Computer Systems is located in room ICT-510. It is a hardware laboratory, where each working place is equipped with soldering machines, power supplies, multi-meters, oscilloscopes. In lab there is a spectrum analyzer as well. In total there are 4 working places. Department of Computer Systems is cooperating with [Tallinn University of Technology Robotics Club](#), which gives the possibility for 3D printing in that lab. Research lab can be used by institute workers and students (for projects and thesis).

Contact person: [Mairo Leier](#)



Infrastructure

Virtual and Augmented Reality Laboratory

Virtual and Augmented Reality Laboratory of Department of Computer Systems is located in [TTÜ Innovation and Business Center Mektory](#) in room 035. The laboratory has 6 working places and is equipped with powerful computer, necessary software and virtual reality headsets: Oculus Rift, HTC Vive, OSVR, Samsung Gear VR (with smartphones). The laboratory is a member of the international network of virtual reality laboratories *VR First*(<https://www.vrfirst.com>).

For more information about Virtual and Augmented Reality Laboratory, please visit: <http://recreation.ee/>

Research lab can be used by institute workers and students (for projects and thesis).

Contact person: [Aleksei Tepljakov](#)



Infrastructure

Control Systems Research Laboratory



Control Systems Research Laboratory of Department of Computer Systems is located in room U02-301A. The laboratory has 7 working places and is equipped with laboratory prototypes of real life processes and industrial systems used for design and verification of advanced control systems. The following laboratory models are available in the laboratory: 3D Crane, Antilock Braking System (ABS), Magnetic Levitation System, Multitank System, Pendulum & Cart System, Tower Crane, Two Rotor System, Pressure and Heater kits. In addition, the laboratory has micro and industrial controllers and 3D Printer.

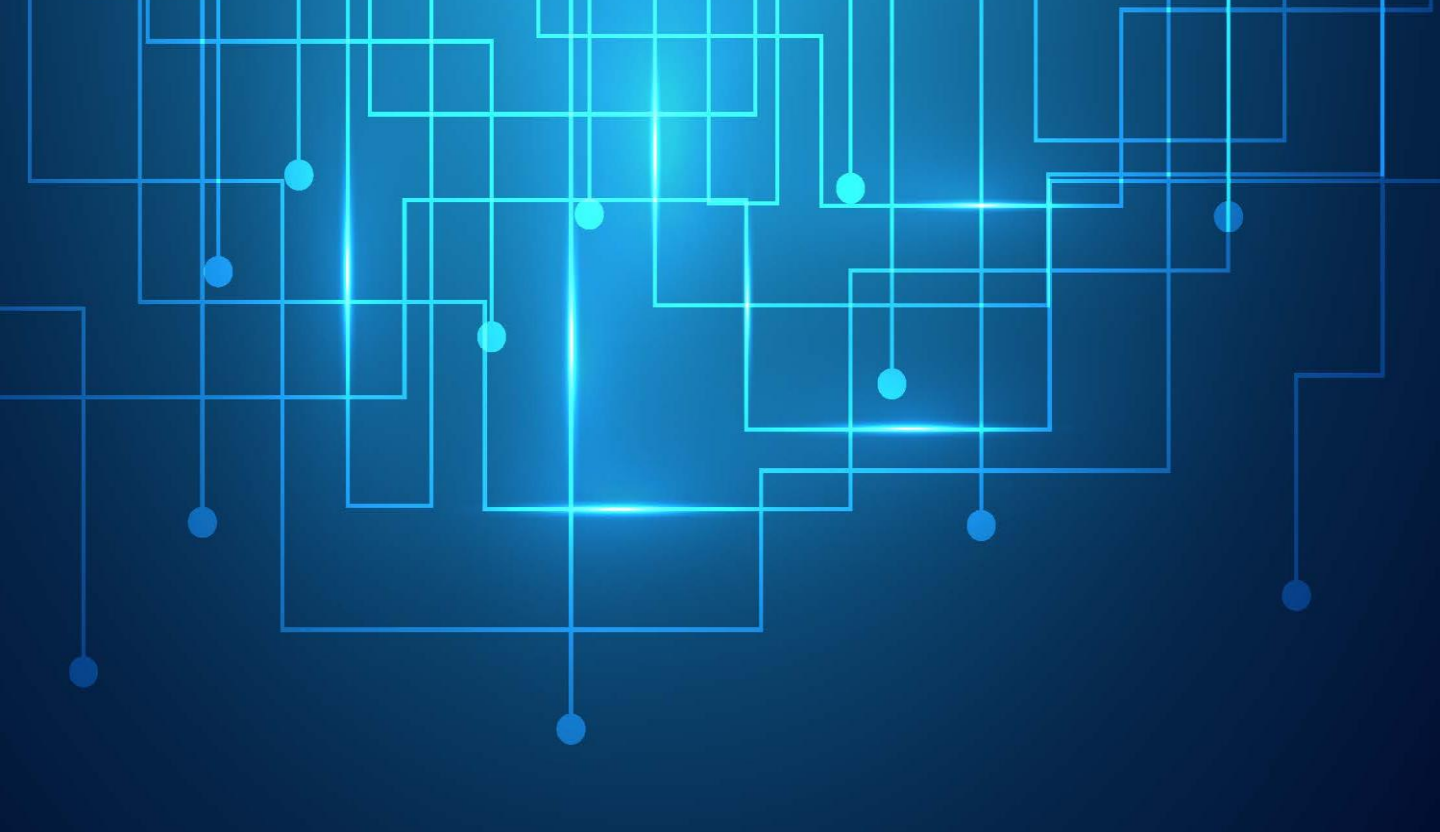
For more details of the devices available in the laboratory, please visit:

<http://a-lab.ee/equipment>

Research lab can be used by institute workers and students (for projects and thesis).

Contact persons: [Juri Belikov](#), [Kristina Vassiljeva](#)





Department of Computer Systems: International Projects, Conferences and Organised events



COMPASS – Horizon 2020 Twinning Project

2016-2018

Contact: [Jaan Raik](#)

<http://www.h2020-tutorial.net/>

[ETIS](#)

The overall aim of the TUTORIAL project is to boost the scientific excellence and technology-transfer capacity in nanoelectronics based dependable cyber-physical systems (NBDCPS) of Tallinn University of Technology (TUT) by creating a network with the high-quality Twinning partners: Delft University of Technology (TU Delft), Politecnico di Torino (POLITO) and Deutsches Zentrum für Luft- und Raumfahrt (DLR). To achieve this aim, the 3 year project will build upon the existing strong research and innovation base of TUT and its Twinning partners.



IMMORTAL – Integrated Modelling, Fault Management, Verification and Reliable Design Environment for Cyber-Physical Systems

2015-2018

Contact: [Jaan Raik](#)

<http://www.h2020-immortal.eu>

[ETIS](#)

In European Union's Horizon 2020 Research & Innovation Action IMMORTAL (Integrated Modelling, Fault Management, Verification and Reliable Design Environment for Cyber-Physical Systems) a consortium of leading European academic and industrial players aim at combining their expertise in developing an integrated, cross-layer modeling based tool framework for fault management, verification and reliable design of dependable Cyber-Physical Systems (CPS).



RESCUE- Interdependent Challenges of Reliability, Security and Quality in Nanoelectronic Systems Design

2017-2021

Contact: [Maksim Jenihhin](#)

<http://rescue-etn.eu/>

[ETIS](#)

RESCUE action advances scientific competences and establishes an innovative training for *Interdependent Challenges of Reliability, Security and Quality in Nanoelectronic Systems Design*. The novel training-through-research platform will **rescue** and enhance design of complex systems at the next generation nanoelectronics technologies by addressing the demanding and mutually dependent aspects of *reliability, security* and *quality*, as well as corresponding *electronic design automation tools*. It will provide recruited Early-Stage Researchers (ESRs) with innovative training in the involved disciplines and beyond, such that they will not only be able to face today and future challenges in nanoelectronics design but also be innovative, creative, and more importantly - have an entrepreneurial mentality.

BASTION

Project BASTION - Board and SoC Test Instrumentation for Ageing and No Failure Found

2014-2017

Contact: [Jaan Raik](#)

<http://fp7-bastion.eu/>

[ETIS](#)

The BASTION consortium partners will unite their forces to contend the aging and No-Failure-Found (NFF) issues. The project will investigate currently unknown defects, uncertain fault coverage and unclassified field returns. A new defect universe will be assembled and faults will be classified into comprehensive classes. BASTION will study the mechanisms of aging and improve the longevity of electronic products. Embedded instrumentation and the IEEE P1687 standard will be applied to develop a scalable and fast error detection and localization infrastructure.

COST

2016-2020

Contact: [Aleksei Tepljakov](#), [Eduard Petlenkov](#)

http://www.cost.eu/COST_Actions/ca/CA15225
<http://fractional-systems.eu/>

ETIS

Fractional-order systems have lately been attracting significant attention and gaining more acceptance as generalization to classical integer-order systems. Mathematical basics of fractional-order calculus were laid nearly 300 years ago and since that it has gained deeply rooted mathematical concepts. Today, it is known that many real dynamic systems cannot be described by a system of simple differential equation or of integer-order system. In practice we can encounter such systems in electronics, signal processing, thermodynamics, biology, medicine, control theory, etc. The Action will favour scientific advancement in above mentioned areas by coordinating activities of academic research groups towards an efficient deployment of fractal theory to industry applications. The cooperation of researchers from different institutions will guarantee wide visibility of Action results.



Estonian Centre of Excellence in ICT Research

2016-2023

Contact: [Maarja Kruusmaa](#)

[ETIS](#)

"EXCITE brings together the top-ranked ICT research groups Estonia to work jointly on a focussed, yet broad and extendable, research programme. It will capitalize on the existing expertise to create synergies on the rich but fragmented landscape of the Estonian ICT research. The consortium will advance foundational theories of model verification and data analysis. On this groundwork, it will develop methods and tools for sound practices of designing and analyzing reliable and secure ICT systems processing large data volumes, as demanded by applications to domains of high socioeconomic relevance (cyberphysical and robotic systems, ehealth and biomedical systems). We will start with 10 cooperation themes with clearly defined objectives, methodology and expected results.

Assessing fish passability using a robotic fish sensor and hydrodynamic imaging

2014-2017

Contact: [Maarja Kruusmaa](#)

[ETIS](#)

The main goal of this work is to provide a robust methodology which combines both the recent developments in biomimetic sensor technology and hydrodynamic imaging data in order to improve fish passability in tributaries to the Baltic Sea. In order to compare functioning and non-functioning passes, the use of a biomimetic fish robot which experiences the flow via a lateral line sensor can greatly improve both the quantity and quality of information gained. Correlating the results of the local flow field measurements and global sensing information with functional and non-functional passes is expected to provide a state-of-the-art analysis of these complex structures in concert with changing environmental conditions.

Sensors for LARge scale HydrodynaMIC Imaging of ocean floor (LAKHsMI)

2015-2019

Contact: [Maarja Kruusmaa](#)

[ETIS](#)

"LAKHsMI will develop a new bio-inspired technology to make continuous and cost-effective measurements of the near-field, large-scale hydrodynamic situation, for environmental monitoring in cabled ocean observatories, marine renewable energy and port/harbor security. We will design, manufacture, and field test prototype smart sensor cables that measure differential pressure and temperature on the ocean floor and enable high resolution imaging of the surrounding volume in space and time, is simple, inexpensive and has very low power consumption. LAKHsMI will also develop innovative methods for hydrodynamic imaging.

Fishfriendly Innovative Technologies for Hydropower

2016-2020

Contact: [Maarja Kruusmaa](#)

http://cordis.europa.eu/project/rcn/205921_en.html

[ETIS](#)

FIThydro addresses the decision support in commissioning and operating hydropower plants (HPP) by use of existing and innovative technologies. It concentrates on mitigation measures and strategies to develop cost-efficient environmental solutions and on strategies to avoid individual fish damage and enhancing population developments. Therefore HPPs all over Europe are involved as test sites. The facilities for upstream and downstream migration are evaluated, different bypass systems including their use as habitats and the influence of sediment on habitat.

Organised conferences

2016	03.-05.10.2016	15th IEEE Biennial Baltic Electronic Conference – BEC (koostöös Thomas Johann Seebecki elektroonikainstituudiga)
	28.-29.09.2016	1st International Workshop on Resilience in Nanoelectronic Systems – RENS'16
	26.-28.09.2016	IFIP/IEEE International Conference on Very Large Scale Integration (VLSI-Soc 2016)
	27.-29.06.2016	11th International Symposium on Reconfigurable Communication-Centric Systems-on-Chip Conference – ReCoSoc16
2015	10.-11.11.2015	MEDIAN Finale - Workshop on Manufacturable and Dependable Multicore Architectures at Nanoscale
2014	08.-10.10.2014	14th IEEE Biennial Baltic Electronic Conference – BEC 2014
	08.-11.06.2014	11th International Baltic Conference on Databases and Information Systems DBIS 2014
	14.-16.05.2014	10th Workshop on Microelectronics Education – EWME 2014
2013	26.-27.11.2013	Nordic Test Forum – NTF 2013
	07.-09.10.2013	HiPEAC Autumn Computing Systems Week
	19.-21.06.2013	1st Biannual European - Latin American Summer School on Design, Test and Reliability – BELAS -1
2012	18.-20.04.2012	DDECS'12 IEEE Symposium on Design and Diagnostics of Electronic Circuits and Systems
2011	20.-23.06.2011	The 15th International Conference on Advanced Robotics - ICAR 2011
2008	25.-26.11.2008	Nordic Test Forum – NTF 2008
	17.-18.11.2008	26th IEEE NORCHIP Conference
	29.06.-02.07.2008	19th EAAEIE Annual Conference
	02.-05.06.2008	8th International Baltic Conference on Databases and Information Systems – DBIS 2008 (koostöös endise Küberneetika instituudiga)
2005	25.-26.05.2005	IEEE European Board Test Workshop - EBTW'05
	22.-25.05.2005	10th European Test Symposium - ETS'05



Department of Computer Systems: International Collaborations

European Partners



International Partners



Duke
UNIVERSITY



PUCRS

Pontifícia Universidade Católica
do Rio Grande do Sul

מכון טכנולוגי חולון
Holon Institute of Technology



大阪大学
OSAKA UNIVERSITY



University of Tehran

Industry Partners



innovations
for high
performance

microelectronics



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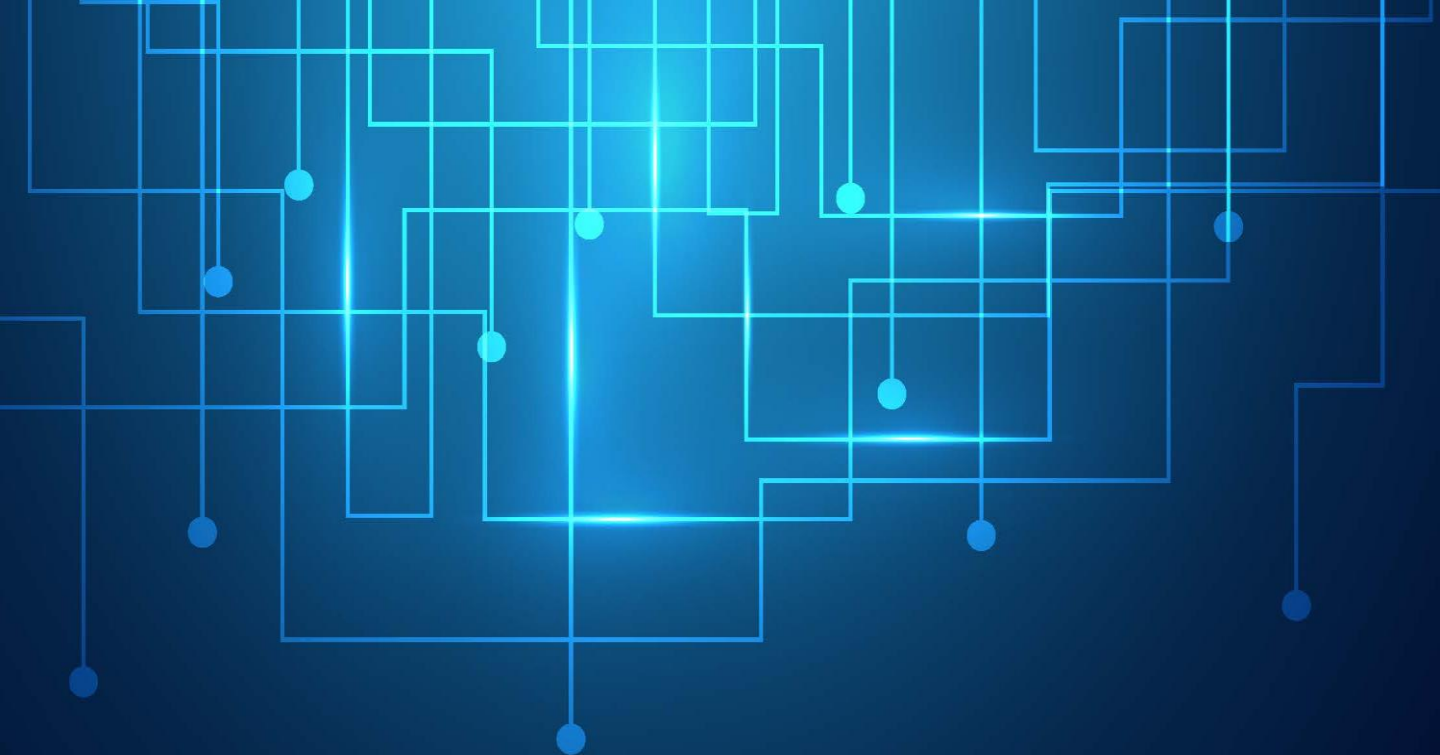
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