

# Affordable and Reliable Automated Recognition and Tracking

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## Summary

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*The candidate will be part of a team developing a camera system which can detect, classify and track objects in real-time using embedded vision. The thesis will use commercial surveillance grade RGB and / or IR cameras such as the Mobotix S16 for observations both in air and underwater. The total cost of the system should not exceed 10,000 EUR. The focus of this project will be to address two major research questions: (1) How can we preprocess images in near real-time (e.g. homomorphic filtering, Gaussian blurring) in order to improve machine learning (e.g. YOLO) recognition and tracking performance for embedded vision? (2) Can multispectral (e.g. RGB+IR) increase the reliability of embedded vision recognition and tracking systems? The results of this 4-year PhD thesis are fundamental, and will be important to a broad range of disciplines including industrial automation, indoor and outdoor security, underwater robotics and environmental monitoring.*

|                       |   |
|-----------------------|---|
| Research field:       | Information and Communication Technology  |
| Supervisors:          | Jeffrey Andrew Tuhtan<br>Mairo Leier  |
| Availability:         | This position has been occupied.  |
| Offered by:           | School of Information Technologies<br>Department of Computer Systems                                  |
| Application deadline: | Applications are accepted between September 01, 2020 00:00 and October 02, 2020 23:59 (Europe/Zurich) |

## Description

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### Description

The research carried out by the PhD candidate will create new embedded software to perform object recognition and tracking in near real-time, here defined as a delay of 60 seconds or less. The methods will incorporate data collected by commercial-grade RGB, IR and / or thermal imaging sensors such as those implemented by the Centre of Biorobotics in their commercialized "HYDROCAM" system, which uses Mobotix S16 surveillance cameras. A key component of this research work is to explore, develop and test new algorithms across different temporal and spatial scales, and make use of the interactions between these scales to improve the speed and robustness of embedded recognition and tracking in laboratory and outdoor conditions. Two real-world tests will be used: the first test site is on a ferry in Estonia and Denmark, where vehicles will be classified, tracked and the data will be used to automate a commercial cargo loading solution. TalTech has a 2 year project using embedded vision to automate the cargo loading procedure on Ro-Ro vessels. In December 2020, TalTech will also start a 3 year research project with DFDS Group (Det Forenede Dampskibs-Selskab) and Denmark Technical University as an external partner to develop automatic trailer handling solution on Ro-Ro vessels. The second test sites will be based on imagery collected by the 30+ HYDROCAMS already installed throughout Europe which monitor fish passage at large hydropower plants. Therefore, the research objectives in this PhD are tied to two different commercial applications, making the research outcomes directly beneficial to the Estonian company, Eksotec OÜ which is the main commercial partner in this project.

### Responsibilities and tasks

- Develop, test and validate the proposed embedded vision system.
- The results of the candidates work require that they must be able to write high-level journal publications, attend and present their work at leading national and international conferences.
- Supervision of BSc, MSc students as well as assisting in lectures and tutorials is also an important part of the candidate's role in order to prepare themselves for academic and professional advancement after completion of their PhD degree (15% of the candidates workload is teaching and supervision).

### Qualifications / requirements:

- This position requires a candidate with a strong educational (MSc or equivalent) and professional background in Software Engineering / Data Science / Machine Learning / Computer Vision (available by the date of application).
- Ability to read, write and teach in English at the level of an internationally active junior researcher.

- Coursework: 60 ECTS; PhD thesis: 180 ECTS; Teaching and student supervision load of 10 – 20%.



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# Research and implementation of the electrical impedance spectroscopy solutions

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## Summary

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*TalTech is worldwide recognized research organization in the field of impedance- based instrumentation and measurements solutions, applications, innovations etc. A PhD-student position is opened to develop next-gen healthcare, industrial and other electrical impedance spectroscopy based solutions. See more at [www.taltech.ee/impedance](http://www.taltech.ee/impedance) or contact [olev.martens@taltech.ee](mailto:olev.martens@taltech.ee)*

|                       |   |
|-----------------------|---|
| Research field:       | Information and Communication Technology  |
| Supervisor:           | Olev Märtens  |
| Availability:         | This position is available.   |
| Offered by:           | School of Information Technologies<br>Thomas Johann Seebeck Department of Electronics                 |
| Application deadline: | Applications are accepted between September 01, 2020 00:00 and October 02, 2020 23:59 (Europe/Zurich) |

## Description

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### Description

Possible directions of the R&D:

1. R&D of novel EIS instrumentation (with improved metrological characteristics, smaller and faster solutions, with various connectivity options); based on novel signals, signal processing and data acquisition approaches; sparse representation of information-rich signals, considering analog and digital approaches, novel mixed hardware, firmware and software aspects;
2. Developing of applications, for healthcare, medical or industrial applications; modeling, simulations and machine learning aspects for specific applications; separation of signal components, correction of various errors, solving of test- and classifications tasks etc.

As an example, a possible result, one application could be the eddy current (EC) based impedance spectroscopy, by specially developed and investigated

- instrumentation: array of sensor-coils and measurement electronics (precise vector measurements in the up to 20 MHz frequency band with ppm-resolution);
- forward electromagnetic models of the measured objects (tissues, metal structures);
- real-time efficient inverse solving of these models

### Responsibilities and tasks

Fruitful, efficient and innovative R&D in the field, including reporting, publishing, developing hardware/and software demonstrators.

### Qualifications:

MSc degree in electronics, ICT or similar;

### The applicants should fulfill the following requirements

Required skills and knowledge include (at least some of them):

- Efficient (real-time, multiplatform- embedded and/or PC-based) algorithm development (using C/C++, Python with packages, OpenCV, ITK/VTK libraries, LabView etc)
- Physical (electromagnetics) and mathematical methods and tools for modelling (EIDORS/MATLAB, MAXFEMM, COMSOL etc)
- Development of hardware and/or software for precise real-time efficient mixed-electronics instrumentation

- Signal and/or image processing skills and knowledge



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# Strategic Advantage through Relationships in Service Marketing: A Critical Examination

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## Summary

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*Taltech School of Business and Governance, Department of Business Administration offers a 4-year PhD position in marketing.*

|                       |   |
|-----------------------|---|
| Research field:       | Economics and Business Administration   |
| Supervisor:           | Edward Rashkov Kasabov  |
| Availability:         | This position is available.   |
| Offered by:           | School of Business and Governance<br>Department of Business Administration                            |
| Application deadline: | Applications are accepted between September 01, 2020 00:00 and October 02, 2020 23:59 (Europe/Zurich) |

## Description

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The project belongs to the general area of Services Marketing, but is – more specifically – positioned at the meeting point of Service, Relationship, and Strategic Marketing. It seeks to establish the strategic value of new types of relations trialled by practitioners in service marketing through the application of various types of online control.

In spite of the dominance of the concept of customer centricity, current research in service marketing demonstrates how highly successful companies focus on persuading customers to comply with their systems, in return for lower prices and, frequently, a better service. By critically examining customer-provider relationships and service provision, the place, role, parameters and implications of control are to be ascertained, with a focus on the strategic advantage of companies introducing such practices.

The project will focus on online service provision, and the establishment on online relations, in view of the fact that innovative relations of the type described above have been introduced across types of online – and less so, off-line – environments. The introduction and growing use of computers in the last 30 years, the ability to link computers, as well as more recent developments in technology and communications have assisted marketing practitioners in designing, applying and refining highly innovative strategies and techniques to manage their customers and business partners, with little to no reference to traditional marketing approaches. While new technologies have supported the application of such novel marketing approaches, it is the ingenuity of marketing practitioners that have broken path dependent norms to such an extent that new relationship and service practices have grown to replace traditional approaches across sectors.

Current marketing theory does not adequately describe and accurately explain some of the innovations introduced by marketing practitioners referred to here. Therefore, this project should shed light on, and makes sense of, technology-enabled innovations introduced by marketing practitioners which should stimulate thinking about what it is that some businesses do so well in terms of competing through new relations in online service provision, and why they have proved successful against their more traditional rivals. What seems to define competitive success are: first, an ability to recognise, and eagerness to embrace, the advantages offered by rapidly developing technologies; and second, recognise the potential of control-based relations. The project will explore both of the above two ingredients, while also exploring the future role of such practices, especially in a post-Covid-19 context which, it appears, will be marked by the negation or re-thinking of long-held assumptions in marketing practice and theory, most notably the concept of customer centricity.

### Qualifications

MSc or MA in Marketing, Business Administration, Political Science, or Sociology

The applicants should fulfill the following requirements:

- The candidate should hold a MSc or MA in Marketing, although applicants holding BA/MA/MSc degrees in Business Administration, Political Science, or Sociology are also welcome

- The candidate should have completed successfully their studies at the time of application, including having successfully defended their thesis



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# The Productivity-Technology Nexus and Socio-environmental Externalities

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## Summary

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*The proposed PhD project aims to investigate the productivity outcomes from introduction and implementation of new or upgraded technologies, while conditioning and accounting for externalities and socio-environmental constraints. The research applies modern approach in productivity estimation via rapidly evolving empirical productivity frontier and efficiency estimation methods, which account for the constraints and externalities emerging in the production process. Supervisor Prof. Kadri Männasoo; Co-supervisor Prof Aaro Hazak*

|                       |   |
|-----------------------|---|
| Research field:       | Economics and Business Administration   |
| Supervisors:          | Aaro Hazak<br>Kadri Männasoo  |
| Availability:         | This position is available.   |
| Offered by:           | School of Business and Governance<br>Department of Economics and Finance                              |
| Application deadline: | Applications are accepted between September 01, 2020 00:00 and October 02, 2020 23:59 (Europe/Zurich) |

## Description

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The present day world puts growing demands on industries in terms of efficiency and productivity, but increasingly so in consideration of socio-environmental aspects and related institutions (incl. regulations). The anticipated doctoral research pays particular attention to inputs and outputs of the production function, while estimating the frontier and benchmarking the production processes/entities against the estimated frontier.

The contemporary empirical methods for benchmarking, performance and/or efficiency evaluation for the study can be:

1. parametric stochastic frontier methods (stochastic frontier analysis, SFA)
2. nonparametric frontier methods (Data Envelopment Analysis, DEA; Free Disposal Hull, FDH).

The quantitative performance analysis enables to specify the most efficient/productive technology or production process and hence separate the efficient and technologically advanced entities from inefficient and technologically backward entities or from entities, whose activity is generating substantial negative socio-environmental externalities. It also provides the statistical significance of the drivers of productivity/efficiency, and their quantitative impact upon improved performance. The research is valuable in reaching a better understanding on how to improve the productivity of existing processes by implementation of contemporary technologies and production processes while taking into account socio-environmental consequences. Ultimately, the projects helps to generate ground for evidence-based decision making in sustainable production, but it also provides input for policy makers in designing regulations for improved incentives by producers and consumers in following economic aims, such as efficiency and competitiveness, without compromising the long-term socio-environmental outcomes.

Some particular applied outcomes of the research may relate to the analysis of economic aspects of implementation of digital technologies, the problems related to carbon capture and storage solutions, and positive and negative production externalities surrounding other sustainable energy solutions, especially in the context of emerging market economies yet to reach sustainable development paths.

The research undertaken as part of the thesis has a primarily empirical as well as a policy oriented focus, with strong focus on developing advanced data use and analysis capabilities.

This doctoral thesis is related to the:

- European Commission Horizon 2020 research project “Individual Behaviour and Economic Performance: Methodological Challenges and Institutional Context” (IBEP), led by Tallinn University of Technology, in collaboration with Aalto, Helsinki and Tel Aviv universities;
- Erasmus+ Programme of the European Union Project No 611059-EPP-1-2019-1-EE-EPPJMO-MODULE “The Economic and Legal Evaluation of Digital Ecosystems in the EU” and

- RiTa programme project „Climate Change Mitigation with CCS and CCU Technologies“ (ClimMit).

**Qualifications:**

- Master's degree in economics or finance or other area closely related to the topic
- Experience in econometric modelling



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# Models of computation, compositionally

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## Summary

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*TalTech School of Information Technologies, Department of Software Science offers a 4-year PhD position in the field of ICT.*

|                       |   |
|-----------------------|---|
| Research field:       | Information and Communication Technology  |
| Supervisor:           | Pawel Maria Sobocinski  |
| Availability:         | This position is available.   |
| Offered by:           | School of Information Technologies<br>Department of Software Science                                  |
| Application deadline: | Applications are accepted between September 01, 2020 00:00 and October 02, 2020 23:59 (Europe/Zurich) |

## Description

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### Description

This project will focus on applying compositional techniques, originating in category theory, to an emerging model of computation.

The insights obtained through compositional descriptions will eventually result in more descriptive programming languages, and better algorithms, e.g. for verification.

The concrete model of computation focussed on will depend on the background and motivation of the successful candidate, and may include e.g. quantum computing, probabilistic computing, or differentiable programming.



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# Compositional approaches to automata and/or learning

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## Summary

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*TalTech School of Information Technologies, Department of Software Science offers a 4-year PhD position in the field of ICT.*

|                       |   |
|-----------------------|---|
| Research field:       | Information and Communication Technology  |
| Supervisor:           | Pawel Maria Sobocinski  |
| Availability:         | This position is available.   |
| Offered by:           | School of Information Technologies<br>Department of Software Science                                  |
| Application deadline: | Applications are accepted between September 01, 2020 00:00 and October 02, 2020 23:59 (Europe/Zurich) |

## Description

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### Description

In recent years the importance of structural accounts of learning has grown, given the increasing importance of reliability and explainability of learning systems.

This project will explore ways of applying techniques and concepts from category theory to break up such systems in a compositional fashion, i.e. where the system description is compatible with the underlying semantics. Concrete topics may include applications to supervised learning, reinforcement learning, transfer learning and automata learning and will depend on the background and motivation of the successful candidate.



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# Power system substation asset monitoring and condition analysis in future power systems

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## Summary

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*Traditionally, the power system asset management is based on interval-based approach and not on actual asset condition. In this PhD project the objective is to thoroughly assess the applicability of existing and alternative measurement options, sensors, IoT and cyber security aspects to enable reliable and usable asset management approaches considering the actual asset condition. This PhD is part of a research and development project between TalTech and Estonian Transmission System Operator.*

|                       |   |
|-----------------------|---|
| Research field:       | Electrical Power Engineering and Mechatronics   |
| Supervisor:           | Jako Kilter   |
| Availability:         | This position is available.   |
| Offered by:           | School of Engineering<br>Department of Electrical Power Engineering and Mechatronics                  |
| Application deadline: | Applications are accepted between September 01, 2020 00:00 and October 02, 2020 23:59 (Europe/Zurich) |

## Description

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### Description

Power system asset management in current power systems is mostly related to interval-based approach and the actual condition of the asset is not observed nor relevant. This approach in future power system is seen as obsolete as the finances available should be used as much as possible in an appropriate manner.

In view of this, there are two main objectives of this research:

- First one is to understand current and alternative approaches for substation asset condition monitoring and what are the main influencing factors to increase the observability of asset condition. These include collecting, assessing and making decisions on available assets conditions using the available measurement data but also considering applicability of new sensors technology, IoT and cyber security. Here, the various sensitivities and alternatives shall be determined and as much as possible highlighted considering the limitations in actual power systems.
- Secondly, to implement probabilistic and risk management theory or some other approach to enable condition based asset management approach in power system. There are various type of information available from the substations and the decisions made shall be based on these. Usually, these include measurements from SCADA, WAMS, environment measurements, etc. In addition, the objective is to develop methodology (including substation based asset condition and component/asset ranking) which combines the available information, assesses the level and content of this data and determine the level and extent of data what is necessary to enable the approach of condition based asset management.

All these aspects shall enable secure, reliable and cost-effective asset life monitoring and management in future power systems including recommendations for appropriate system design enabling the most optimal techno-economical solution for substations. One of the objectives is also to develop comprehensive decision making principles and condition indexes that can be applicable in actual substation maintenance planning.

### Responsibilities and tasks

This is a full time PhD position and student is expected to do research 90% of the time. Other 10% is related to teaching, i.e. supporting lectures and course works in courses related to power system substations and power system optimization. Research results shall be presented through publications and presentations. In minimum, two journal papers and one conference paper shall be published during PhD studies.

### Qualifications

The applicants should fulfill the following requirements:

- Holds a master's degree in Electrical Engineering or Data Analysis/Management (with emphasis on technical assets) or a similar degree with an academic level equivalent to a master's degree

- Have obtained excellent study results and has good knowledge on different mathematical analysis methods (probabilistic and risk assessment theory and methods)
- Have knowledge on power system assets and their operational characteristics
- Have knowledge on power system assets condition monitoring
- Have experience with programming languages, e.g. MATLAB
- Is able to understand, speak and write texts in English language with high proficiency

**Requirements for motivation letter**

The motivation letter included to the application shall include information about applicant background, reasoning why she/he is interested in this topic and discussion about the development of this topic.



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# Proof theory of ultrasubstructural logics and its applications to programming semantics

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## Summary

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*Intuitionistic linear logic is an important “substructural” formalism in the semantics of programming languages. This PhD project is about the proof theory, semantics and applications of yet weaker logics.*

|                       |   |
|-----------------------|---|
| Research field:       | Information and Communication Technology  |
| Supervisors:          | Tarmo Uustalu<br>Niccoló Veltri   |
| Availability:         | This position is available.   |
| Offered by:           | School of Information Technologies<br>Department of Software Science                                  |
| Application deadline: | Applications are accepted between September 01, 2020 00:00 and October 02, 2020 23:59 (Europe/Zurich) |

## Description

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The goal of this project is to work out the proof theory and type theory of certain ultrasubstructural logics, with the view to applications in programming languages. By “ultrasubstructural”, we mean logics weaker than intuitionistic linear logic, such as the logic of skew monoidal categories in the sense of Szlachányi and related logical systems. These are “resourceaware” logics with very fine control over how resources can be consumed. The corresponding type theories can therefore be expected to yield designs for programming languages with fine control of resources.

### Responsibilities and tasks:

- The student’s primary responsibility is research on this PhD project
- The student may have contribute to the teaching activities of the lab as a course assistant

### Qualifications

Candidates must have a MSc degree in computer science, mathematics or philosophy (logic).

The successful candidate is knowledgeable in at least one and interested in all of the following:

- logic (proof theory)
- functional programming
- semantics of programming languages
- program analysis
- certified programming
- formalized programming theory



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# Integration of the freight process of Estonian internal and transit road transport in relation to the compatibility options of other modes of transport

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## Summary

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*Road transport is an integral part of the Estonian transport sector. Throughout Europe, carriage of goods by road forms the largest percentage of cargo transport. In Estonia, the main challenge in planning transport and mobility is organizing more efficient carriage of people and goods in a way that would also be more convenient for users. Incidentally, Estonia's transport is one of the most polluting ones within the European Union, which is why potential solutions must be found for reducing greenhouse gas emissions. One of the possible solutions is decreasing the proportion of road transport, which has not yet been achieved. Reduction of greenhouse gases is part of the Estonian transport policy, achievable through the intensification and optimization of carriage of goods while integrating multiple modes of transport, in order to find opportunities to reduce fuel consumption and apply the principles of green logistics. As follows from the aforementioned issues, the objective of the doctoral thesis is to find opportunities to integrate the freight processes of road transport along with integrating rail, sea, and air transport into the transport system.*

|                       |   |
|-----------------------|---|
| Research field:       | Mechanical Engineering  |
| Supervisors:          | Dago Antov<br>Jelizaveta Janno  |
| Availability:         | This position is available.   |
| Offered by:           | School of Engineering<br>Department of Mechanical and Industrial Engineering                          |
| Application deadline: | Applications are accepted between September 01, 2020 00:00 and October 02, 2020 23:59 (Europe/Zurich) |

## Description

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### Description:

1. How does the integration of smart solutions into the freight process enable the reduction of waste and optimization of the best modes of mobility? Thus, how is it possible to optimize the participation of heavy-duty vehicles in the transport system traffic by implementing intelligent solutions?
2. What is the impact of transit on the Estonian transport sector, and how is it possible to achieve as few external expenses as possible by applying the national transport policy?
3. What is the impact of heavy-duty vehicle traffic on the Estonian seaports and how would it be possible to organize traffic in the port towns in a way that would have the least possible impact on city traffic?
4. What are the prerequisites for the compatibility of different modes of transport and achieving savings in the transport process as a whole? How and to what extent does the integration of modes of transport cause the need for digitalization, and how is it possible to reduce information pollution and time expense created during the freight process, as well as to optimize the use of cargo space? What is the need for digitizing the transport process across different modes of transport?
5. What kind of last-mile transport between compatible transport systems and different types of transport is the most efficient from the perspective of freight operators, end consumers, and the environment?
6. What would be the potential changes in output figures (incl. economic indicators), if integration between types of transport would take place as efficiently as possible; what could be the state's options for increasing tax income from the transport sector compared to the national contribution to the development of the transport sector.

As an output of the doctoral thesis, sample scenarios will be produced for monitoring the implementation of the Estonian transport policy and transport development plan. These scenarios are evaluated primarily from the perspec-

tives of mobility; optimization of the capacity and use of cargo spaces; seaports; smart solutions; and the last mile. In addition to sea transport, rail and air transport developments have been included in the evaluation of scenarios, where possible, especially from the perspective of developments concerning Rail Baltic. The main focus of the created system is on motor transport and its compatibility with other modes of transport.

### **Responsibilities and tasks**

Doctoral research aims to study possibilities of integration of the motor freight transport concerning the compatibility options of other modes of transportation in Estonia mostly. Sample scenarios, as a result, will be produced for monitoring the implementation of the Estonian transport policy and transport development plan shortly. Following aspects as mobility; optimization of the capacity and use of cargo spaces; seaports; smart solutions; and the last mile are considered. Sea transport, rail and air transport developments have been included in the evaluation of scenarios, where possible, as well as developments concerning Rail Baltic.

### **Qualifications**

The call is open for candidates with a wide range of backgrounds in logistics and transportation, both with practical and project related (research) competences. High level of motivation towards developing transportation systems on a regional level with the tight focus on carrying out the results in practice as well as a deep understanding of optimization methods used in transportation is required.



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# Financing public sector innovation

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## Summary

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*In the face of increasing societal complexities and uncertainties, the need for public sector innovations is larger than ever. In order to promote innovation, public sector organizations must have high-level financing and investment capabilities, the development of which can pose considerable challenges for the existing traditional, control-oriented budget processes. The goal of this PhD project is to examine the possibilities for developing high-level budgetary and financing capabilities for promoting public sector innovation.*

|                       |   |
|-----------------------|---|
| Research field:       | Public Administration   |
| Supervisors:          | Ringa Raudla<br>Veiko Lember  |
| Availability:         | This position is available.   |
| Offered by:           | School of Business and Governance<br>Ragnar Nurkse Department of Innovation and Governance            |
| Application deadline: | Applications are accepted between September 01, 2020 00:00 and October 02, 2020 23:59 (Europe/Zurich) |

## Description

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In the face of increasing societal complexities and uncertainties, the need for public sector innovations is larger than ever. Not surprisingly, governments around the globe have recently come up with ever more sophisticated innovation plans and strategies. However, what sets the innovation intentions apart from the actual capabilities to innovate is funding. Yet, the need to promote innovation in the public sector can pose considerable challenges for the existing traditional, control-oriented budget processes. The goal of this PhD project is to examine the possibilities for using budgetary instruments and developing high-level financing capabilities for promoting public sector innovation. The specific research questions addressed in the project include, for example, the following: 1) What kinds of features should budget processes and instruments have to best provide organizations with ability, motivation and opportunity for public sector innovation?; 2) How can we address the trade-offs between flexibility and accountability in the budget process to public sector innovation?; 3) How can the central budget agencies act as innovation-promoters? 4) To what extent do existing instruments and practices like innovation funds, public procurement of innovation, social innovation bonds, strategic outcome goals, spending reviews, block budgets, and performance management actually encourage innovation in public agencies? 5) How resilient have the existing practices proven in the context of a crisis? 6) To what extent can the successful budgeting and funding approaches of the private sector in promoting innovation be emulated in the public sector context?

### Responsibilities and tasks

During the PhD research, the student should:

1. Compile an analytical framework for examining the financing of public sector innovations;
2. Map possible budgeting and funding practices and instruments that can be used to promote innovation in the public sector;
3. Conduct an empirical study of different public sector organizations' or countries' experiences with the practices and instruments;
4. Develop reform proposals for practice.

During the project, the PhD candidate will have the opportunity to expand on these tasks.

### Qualifications

A successful PhD candidate should preferably have:

- a master's degree in social sciences (preferably in public administration, political science or economics);
- a clear interest in the topic of the position;
- excellent command of English;
- strong and demonstrable writing and analytical skills;
- capacity to work both as an independent researcher and as part of an international team;



- capacity and willingness to provide assistance in organizational tasks relevant to the project.

The candidate should also submit a research plan for the topic, including the overall research and data collection strategy. The candidate can expand on the listed research questions and tasks.

**We offer:**

- 4-year PhD position in one of the largest, most internationalized and leading social science research centers in Estonia with a large portfolio of ongoing pan- European and national public administration, digital governance and innovation studies projects;
- The chance to do high-level research in one of the most dynamic digital government contexts globally;
- Opportunities for conference visits, research stays and networking with globally leading universities and research centers in the fields of public administration, innovation studies and digital government.

**About the organization**

The Ragnar Nurkse Department of Innovation and Governance (RND) is an interdisciplinary research center of Tallinn University of Technology that focuses on socially relevant and future-oriented research and teaching issues:

- models and practices of governance and public administration globally;
- fiscal governance and fiscal bureaucracies;
- e-governance and digital transformation of societies: datafication, public services and state-citizen relations in the digital era, smart cities and digital public services and cross-border collaboration;
- P2P technologies, its' governance and potential new production models;
- science and innovation policies and its' management;
- philosophy and ethics of science and technology.

RND is a highly internationalised department and engages some of the top international thinkers and researchers in its research fields. Next to a fully English taught PhD degree it offers a MA degree in Technology Governance and Digital Transformations, and a unique Erasmus Mundus joint MSc programme in Public Sector Innovation and e-Governance in cooperation with KU Leuven (Belgium) and University of Münster (Germany). RND and its staff have coordinated or been involved in a multitude of international research projects with the EU (INTERREG, COST, FP7, H2020), UN (UNDP), OECD (SIGMA), INET, and have participated in various European Commission working groups (the EU's Lisbon Agenda Group, Expert Group on Managing Risks in Public Technology Procurement, Expert Group on Public Sector Innovation). Recently RND initiated a major, 32 MEUR international R&D project on Smart Cities (FinestTwins). RND is also engaged in several international associations, such as the European Master in Public Administration program (EMPA), European Inter-University Association on Society, Science and Technology (ESST), and the European Group for Public Administration (EGPA) where RND coordinates the Permanent Study Group on Public Administration, Technology and Innovation.

**Additional information**

For further information, please contact Prof Ringa Raudla ringa.raudla@taltech.ee and Dr Veiko Lember veiko.lember@taltech.ee or visit <http://ttu.ee/nurkse>



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# Postglacial vegetation change in Northern Europe: Combining Ecosystem Modelling and palaeoecological reconstructions

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## Summary

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*TalTech School of Science, Department of Geology offers a 4-year PhD position in Earth Sciences*

|                       |   |
|-----------------------|---|
| Research field:       | Physical Sciences   |
| Supervisors:          | Siim Veski<br>Anneli Poska  |
| Availability:         | This position is available.   |
| Offered by:           | School of Science<br>Department of Geology  |
| Application deadline: | Applications are accepted between September 01, 2020 00:00 and October 02, 2020 23:59 (Europe/Zurich) |

## Description

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The subject of the PhD project is closely connected to the personal research funding team grant (PRG323) led by Siim Veski „Tracking the time-lags of species response to environmental change using palaeo-proxy data and modelling (TrackLag)”. The PhD project is planned to start in 2020.

Current Earth System Model or Dynamic Ecosystem Model (DEM) based assessments of climate-induced shifts in species distributions rarely account for species interactions and usually ignore potential differences in response times of interacting taxa to climate change. As a consequence, most simulations of vegetation change project an immediate response of vegetation to climate change, with turnover rates at decadal rather than centennial scales. However, the palaeoecological data suggests that non-climatic factors (migration and competitive capacity, nutrient availability etc.) can create substantial time-lags between the creation of favorable climatic conditions and range shifts.

The PhD project will focus on developing, evaluating, and employing a state-of-the-art version of an individual-based DEM LPJ-GUESS (Lund-Potsdam-Jena –General Ecosystem Simulator) in order to improve the predictions of the climate driven forest composition change in boreal and temperate zones using a combination of palaeoecological, ecological and remote sensing datasets.

This PhD project will:

1. Compile an overview of model based assessments of vegetation responses to current climate change in a temperate zone and compare that with known palaeoecological evidence
2. Prepare necessary inputs (e.g. climate, land use) for past, present, and future scenario runs of the DEM LPJ-Guess using the palaeoecological evidence and model based predictions
3. Conduct a series of scenario runs and model sensitivity tests, and use the gained information to improve the ability of LPJ-Guess to predict climate driven vegetation changes.

### Job description

The position is available for a 4-year period and your key tasks as a PhD student at TalTech are to:

- Manage and carry through your research project
- Attend PhD courses
- Write 3 scientific articles and your PhD thesis
- Teach and disseminate your research
- Stay at an external research institution for a few months, preferably abroad
- Work for the department

The student will be expected to conduct a series of DEM simulations, write and modify code written in C++, and to systematize and apply a number of different environmental and ecological datasets (climate, land use, etc.).

### Qualifications

The applicant should fulfil the following requirements:

- General admissions criteria
  - A BSc and MSc degree from an internationally recognised university in a relevant Earth or Environmental science discipline (e.g. Physical Geography, Ecology (Paleoecology), Forestry etc. ). Applicants with a strong Physics, Chemistry, or Mathematics background with an interest in modelling and ecosystem sciences are also welcome.
  - English language proficiency at a minimum of IELTS band 6.5 with no component score below 6.0, or equivalent level.
- Specific candidate requirements
  - Highly motivated graduate, keen to work on a multidisciplinary project, good communicative skills, proactive and independent work
  - Certified knowledge of at least one programming language and a willingness to learn C++
  - An ability to work with GIS software
  - An emphasis will also be laid on previous publications (if any) and relevant work experience
  - Previous experience or proven interest in the research field of Earth Sciences



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# Towards smart and sustainable urban mobility computing in Tallinn

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## Summary

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*TalTech School of Information Technologies, Department of Software Science in cooperation with School of Engineering, Department of Mechanical and Industrial Engineering offers a 4-year PhD position funded by IT-Academy. Supervisor Prof. Sadok Ben Yahia; co-supervisor Prof. Dago Antov.*

|                       |  |
|-----------------------|--|
| Research field:       | Information and Communication Technology   |
| Supervisors:          | Dago Antov<br>Sadok Ben Yahia  |
| Availability:         | This position is available.  |
| Offered by:           | School of Information Technologies<br>School of Engineering<br>Department of Software Science<br>Department of Mechanical and Industrial Engineering |
| Application deadline: | Applications are accepted between September 01, 2020 00:00 and October 02, 2020 23:59 (Europe/Zurich)  |

## Description

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### Motivation

Urban mobility computing is a process of acquisition, integration, and analysis of big and heterogeneous data generated by a diversity of sources in urban spaces, such as sensors, devices, vehicles, buildings, and human, to tackle the major issues that cities face [1,2]. In this respect, one of the major application areas of urban computing is to improve private and public transportation in a city and traffic congestion management stands on top of the most compelling challenges.

One of the most sustainable solutions is to start a feedback loop that induces more and more people to make a modal shift away from driving. Nevertheless, in the city of Tallinn making the public transport free did not increase its attractiveness. In this respect, making the public transport more convenient will increase patronage, which means that the service can be run more frequently and for longer hours, making it attractive to more people.

Key interventions to reduce traffic congestion include:

1. Optimise traffic-light management: Traffic signals have been installed throughout road networks to control competing traffic flows at road intersections. These traffic lights divide time between conflicting flows and enhance vehicle safety while crossing road intersections by scheduling conflicting traffic flows. However, traffic signals may decrease vehicles' efficiency in traffic networks.
2. Car sharing and multi-modal solutions: Car sharing has huge potential to improve quality of life and traffic conditions in cities. It offers a car at your disposal without the need of ownership and has the potential to reduce the number of cars in cities without reducing individual mobility. The wide spread of information and communication devices (smartphones in particular) and of social media and web platforms, together with the sharing economy that is growing into a cultural consumption approach, are at the basis of this development. Moreover, smart technology has helped to improve the experience of using car sharing, making booking, accessing and using shared transport easier.

### Research Questions

- Sustainable global schema of traffic light management
- Impact of this global schema on the reduction of unbalanced ratio of Public Transport and private transport through the determination of key bus stops.
- Quality of Driving assessment and its consequences on car rental/sharing.
- Car sharing and public transport in Tallinn towards a better multi-modal integration [3]

### Methodology

- *Inception phase*: Literature review, discover and comparison of related technologies, running tests for performance analysis.
- *Contribution phase*: Creating algorithms and implementation tools based on them.

### Research Outcome

Target scientific channels:

- Journals
  - IEEE transactions on intelligent transportation systems (Impact Factor: 4.106)
  - Journal of Engineering applications, Elsevier (Impact Factor: 3.117)
  - Information Science journal, Elsevier (Impact Factor: 5.024)
  - Transportation (Impact factor 2.073)
- Conferences
  - VLDB (International Conference on Very Large Data Bases)
  - ICDM (International Conference on Data Mining)
  - IEEE Big Data (International Conference on Big Data)

### References

[1] Zheng, Yu; Capra, Licia; Wolfson, Ouri; Yang, Hai (2014-09-18). "Urban Computing". ACM Transactions on Intelligent Systems and Technology. Association for Computing Machinery (ACM). 5 (3): 1–55. doi:10.1145/2629592. ISSN 2157-6904.

[2] Foth, Marcus (2009). Handbook of Research on Urban Informatics: The Practice and Promise of the Real-Time City. Hershey, PA: Information Science Reference. ISBN 978-1-60566-152-0. OCLC 227572898.

[3] Ferris, Brian; Watkins, Kari; Borning, Alan (2010). OneBusAway: results from providing real-time arrival information for public transit. CHI '10: Proceedings of the SIGCHI Conference on Human Factors in Computing Systems. New York, New York, USA: ACM Press. p. 18071816. doi:10.1145/1753326.1753597. ISBN 978-1-60558-929-9.



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# Participation of plug-in electric vehicles in electricity and ancillary markets

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## Summary

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*TalTech School of Engineering, Department of Electrical Power Engineering and Mechatronics offers a 4-year PhD position in the field of power engineering.*

|                       |   |
|-----------------------|---|
| Research field:       | Electrical Power Engineering and Mechatronics   |
| Supervisors:          | Ivo Palu<br>Fushuan Wen   |
| Availability:         | This position is available.   |
| Offered by:           | School of Engineering<br>Department of Electrical Power Engineering and Mechatronics                  |
| Application deadline: | Applications are accepted between September 01, 2020 00:00 and October 02, 2020 23:59 (Europe/Zurich) |

## Description

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### Description

With the continuous development of renewable energy generation technologies and increasing pressure to combat the global effects of greenhouse warming, plug-in electric vehicles (PEVs) have received worldwide attentions. When numerous PEVs are integrated into a power system, there may be extensive impacts on power system planning and operation, as well as on electricity market development. It is therefore necessary to properly control PEVs' charging and discharging behaviors.

Meanwhile, the vehicle-to-grid (V2G) technology could serve as the energy storage to mitigate the intermittency and uncertainty of the renewable energy generation as well as to effectively provide regulation, spinning reserve and blackstart ancillary services.

This PhD project will investigate the following problems:

- the design of an intelligent network application system for PEVs and its associate communication mechanism;
- unit commitment in a power system considering PEV applications;
- the economic evaluation and bidding strategies on PEV participations in electricity and ancillary service markets;
- optimal coordination of charging and discharging among PEVs to enhance the capability of accommodating renewable energy generation.

### Qualifications

- Work experience would be strongly useful in one or several application domains, such as electricity and/or emission trading, predictive analytics, optimization methods, systems modeling, smart grids, embedded systems, and end-user energy management applications.
- The applicant must itself propose in application an approach to the topic incl. mix of themes and activities that align to the proposed PhD topic that she/he wish to pursue incl. analysis methods and evaluation criteria's that best reflect the objectives and challenges of the proposed topic.

**The applicants should fulfill the following requirements:**

The topic is suitable for a student with excellent English language skills and a master's degree in areas like electrical power engineering, energy economics, computer science or applied mathematics.



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# The enhancement of the human-machine and process-machine interactions in machine learning-based malicious activity detection systems

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## Summary

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*TalTech School of Information Technologies, Department of Software Sciences offers a 4- year PhD position in the field of ICT.*

|                       |   |
|-----------------------|---|
| Research field:       | Information and Communication Technology  |
| Supervisors:          | Sven Nõmm<br>Hayretdin Bahsi  |
| Availability:         | This position is available.   |
| Offered by:           | School of Information Technologies<br>Department of Software Science                                  |
| Application deadline: | Applications are accepted between September 01, 2020 00:00 and October 02, 2020 23:59 (Europe/Zurich) |

## Description

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### Background and motivation

Cyber-attack tools and techniques have evolved rapidly as the cyber domain is a very lucrative target for different threat actors with varying sophistication levels (e.g., cybercriminals, state-sponsored hacker groups, opportunistic attackers). It is widely accepted that human, technology and process aspects should be covered for comprehensive cyber protection. The interaction between these aspects has not been properly investigated in the literature, and machine learning (ML) solutions utilized in the cybersecurity domain are not different in this respect. ML is perceived as a significant solution instrument for the complex problem domain of cyber threats. Despite the fact that the literature includes many promising research results, the incorporation of ML methods into the current technological solutions is limited. We conjecture that the main reason for this discrepancy between the academic achievement and scarce real-world implementation is due to the myopic view that does not reflect the human and process considerations in the learning models. The operations in current security operating centres take place in complex processes with the involvement of various human analyst roles [1]. Human analysts are interested in the high interpretability of the results besides the optimized accuracy [2]. However, interpretability within the cybersecurity field has drawn very little attention in the research communities. Finding labelled data is very difficult due to the lack of enough human resources. The response of the current technology to this problem has been just the utilization of unsupervised learning methods. Unfortunately, it suffers from low accuracy values and inadaptability of learning models to different organizations. Active learning methods, which enable the acquisition of human know-how into the models, could be adapted to the cybersecurity processes. Transfer learning could lead to broader usage of learning models created for one organization to other organizations.

### Main objective and research methods

In this research study, we aim to develop learning methods that adapt transfer and active learning into the cybersecurity problems and investigate the interpretability in this problem domain. However, we consider that the other application areas such as health, manufacturing, smart systems (e.g., vehicles, cities) can benefit from our research outcomes. Quantitative and qualitative interpretability metrics will be developed and evaluated for the cybersecurity field within this research. Interpretability will be investigated within model-specific and model-agnostic contexts. Transfer and active-learning methods will be explored and adapted to the problem domains. The publicly available datasets about IoT botnet, mobile malware, cyber-attacks to autonomous vehicles, SCADA systems (i.e., including the datasets generated by our research group) will be utilized.

### Expected impact

The ability to explain results achieved by the application of machine learning and AI techniques would allow more synergetic human-machine cooperation. On the one hand, it will provide valuable information to increase the goodness of machine learning techniques. On the other hand, it will help to improve the performance of the human agents participating in the cooperation.



### **Candidate's Background and Knowledge**

The candidate is expected to have a solid knowledge of mathematics and statistics and concepts of the cybersecurity and completed master level courses in machine learning and data mining. Experience in the application of deep learning is preferable. Possess skills in software development. Good knowledge of Python is preferable.

#### References

[1] Guerra-Manzanares, Alejandro; Nömm, Sven; Bahsi, Hayretdin (2019). Towards the integration of a post-hoc interpretation step into the machine learning workflow for IoT botnet detection. Proceedings 18th IEEE International Conference on Machine Learning and Applications, ICMLA 2019: 16-19 December, Boca Raton, Florida, USA

[2] Carvalho, Diogo V., Eduardo M. Pereira, and Jaime S. Cardoso. "Machine Learning Interpretability: A Survey on Methods and Metrics." *Electronics* 8.8 (2019): 832.

[3] Guerra-Manzanares, Alejandro; Medina-Galindo, Jorge; Bahsi, Hayretdin; Nömm, Sven (2020). MedBloT: Generation of an IoT Botnet Dataset in a Medium-sized IoT Network. Proceedings of the 6th International Conference on Information Systems Security and Privacy, ICISSP 2020, February 25-27, 2020



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# AI based analysis of human motor skills

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## Summary

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*TalTech School of Information Technologies, Department of Software Sciences offers a 4- year PhD position in the field of ICT.*

|                       |   |
|-----------------------|---|
| Research field:       | Information and Communication Technology  |
| Supervisors:          | Sven Nõmm<br>Aaro Toomela   |
| Availability:         | This position is available.   |
| Offered by:           | School of Information Technologies<br>Department of Software Science                                  |
| Application deadline: | Applications are accepted between September 01, 2020 00:00 and October 02, 2020 23:59 (Europe/Zurich) |

## Description

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### Background and motivation

Motor skills are important determiners of quality of life and also correlates of cognitive performance and cognitive development. Until recently motor skills were estimated outside laboratory conditions either subjectively by relevant professionals (medical doctors, teachers, psychologists) or measured by tests where the criterions of the level of motor skills were time needed to perform the test and/or the number of correctly performed motor acts (such as putting small pegs in holes). Recent developments in recording movement by different devices allow to measure objectively not only time and success rate but also characteristics of movements themselves [1].

### Main objective and research methods

The objective of the thesis is to develop AI based motion skill assessment framework. Advanced methods of the AI and machine learning will be used on two levels. On the lower level AI and machine learning techniques will be applied to the movements recorded by different devices (Motion capture systems, video cameras, tablet PC) to extract accurate models of human body [2]. In order to unlock the full potential of the advanced techniques of the machine learning and artificial intelligence, development of the novel objective measures of gross and fine motor skills is required. Novel characteristics of the movement are going to be tested in different groups of individuals (adults with different levels of educations; elderly and young adults; school-children at different ages; individuals with different forms of brain damage). Relationships between objective measures of fine and gross motor skills and different aspects of cognitive performance and cognitive development are going to be studied in order to understand better the role of motor skills in cognitive performance and cognitive development. On this higher level, this will lead to explosive growth of complexity which will be tackled by most recent AI techniques for data analysis.

### Research methods

The methods of AI will be applied on two different levels. On the level of motion capture and initial processing deep neural-networks to provide higher quality models of human body. On the higher level, where relationships between cognitive development and motor skills will be studied in different groups AI techniques for big data analysis will be employed.

### Expected impact

Improvements in objective description of gross and fine motor skills facilitates diagnosis of cognitive dysfunction, neurological conditions and developmental disorders. It also supports objective follow-up of the effectiveness of rehabilitation as well as better planning of rehabilitation and special education activities.

### Candidate's Background and Knowledge

- The candidate is expected to have solid knowledge of mathematics and statistics
- Completed master level courses in machine learning and data mining
- Basic understanding of deep learning techniques
- Possess skills in software development
- Good knowledge of Python is preferable

## References

[1] Prakash, C., Kumar, R. & Mittal, N. Artif Intell Rev (2018), Recent developments in human gait research: parameters, approaches, applications, machine learning techniques, datasets and challenges 49: 1. <https://doi.org/10.1007/s10462-016-9514-6>.

[2] Zhao, C.; Chen, M.; Zhao, J.; Wang, Q.; Shen, Y. 3D Behavior Recognition Based on Multi-Modal Deep Space-Time Learning. Appl. Sci. 2019, 9, 716.

[3] Toomela A, Nõmm S, Kõnnussaar T and Tammik V (2019) Why Behavioral Indicators May Fail to Reveal Mental States: Individual Differences in Arousal-Movement Pattern Relationships. Front. Psychol. 10:270. doi: 10.3389/fpsyg.2019.00270



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# Synthesis of thermoplastic cellulose derivatives in environment of ionic liquids

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## Summary

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*Sustainable thermoplastic polymers are developed and investigated to partly or fully replace non-renewable-resources-based materials for melt processing technologies. Cellulose appears to be a nearly unlimited renewable resource for polymeric materials. Discovery of dissolution processes of cellulose in ionic liquids opens several new routes for functionalization. Thermoplastic cellulose derivatives can be prepared without use of plasticizers, by attaching long-chain ester branches to the macromolecule of cellulose. The research challenge is to find chemically stable, efficient and recyclable solvent(co-solvent) systems and functionalization routes, which have also potential for industrial upscaling. Also, the functionalization route should provide control over degree of substitution and mixed branching if necessary.*

Research field: Chemical and Materials Technology  
Supervisors: Andres Krumme  
Elvira Tarasova  
Availability: This position is available.  
Offered by: School of Engineering  
Department of Materials and Environmental Technology  
Application deadline: Applications are accepted between September 01, 2020 00:00 and October 02, 2020 23:59 (Europe/Zurich)

## Description

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### Description

The most important renewable resource for producing polymeric materials and composites is cellulose. Its annual production in biosphere is estimated 90 gigatons. Still, it has some drawbacks for processing: it is hard to dissolve cellulose and the material is not thermoplastic in its natural state. Melt processing, however, has several advantages over solution processing, such as high productivity, simplicity and flexibility. Melt processing needs cellulose to be made thermoplastic by functionalizing and this needs the material to be dissolved at first.

Novel and developing solvents for dissolving and functionalizing cellulose in homogeneous conditions are Ionic Liquids (ILs). They are considered to be more sustainable compared to well-known Viscose, CarbaCell and LycoCell processes which are still considered as harsh solvent systems. ILs are highly polar and therefore can break the hydrogen bonds between macromolecules of cellulose. Besides, ILs can be easily regenerated by several methods depending on their composition. IL can act both as a solvent and a functionalization medium.

The first generation of ILs for cellulose dissolution was mostly imidazolium based. However, these ILs have been found to be of low stability and destructive for cellulose macromolecule. Nearly missing vapour pressure of these ILs is preferable for simple systems, as they are not volatile and anti-solvent (water or alcohol) can be easily removed by distillation after precipitation of cellulose. Still, this can be also an issue if more complex dissolving systems, as biomass or cellulosic waste, are in use as several organic or inorganic constituents of low or missing volatility tend to stay in the IL-s.

Therefore, a new generation of ILs is developed in recent years for improving stability and recyclability. Distillable acid–base conjugate ILs were developed, which dissociate back to their original components, organic acid and base at higher temperatures. The components have significantly higher vapour pressure than the ionic compound and are therefore distillable. The most common acids are propionic or acetic acid and several bases are described as 1,5-diazabicyclo[4.3.0]non-5-ene (DBN), 1,8-diazabicyclo[5.4.0] undec-7-ene (DBU), 7-methyl-1,5,7-triazabicyclo[4.4.0]dec-5-ene (MTBD) and 1,1,3,3-tetramethylguanidine (TMG). These distillable ILs vary regarding dissolving capacity, viscosity, susceptibility to hydrolysis and price but all are relevant candidates for dissolution of cellulose and development continues. Probable one of the most studied distillable IL is [DBNH][OAc] which is the main solvent for IonCell process (ioncell.fi), which should start in industrial scale on year 2025 for producing cellulosic fibres.

Distillable IL is a suitable medium for homogeneous esterification of cellulose. One can use classical routes for esterification with carboxylic acid chlorides or anhydrides. Acid side products can still damage the cellulose polymer by hydrolysis. One can use iso- or vinyl esters instead which lead to ketones or aldehydes as side products. Those

are also volatile and can be easily removed by conducting the esterification at low pressures. Moreover, the modern distillable IL based systems allows to overcome several issues related to synthesis of long chain branched cellulose esters. For example DBU/DMSO/CO<sub>2</sub> system allows efficient transesterification with fatty vinyl esters, producing long chain branched cellulose esters of high degree of substitution. Most of the above described shorter-chain branched amidinium ILs are considered as nontoxic.

One can conclude that ILs are the future of sustainable processing of cellulose. Still, describing relations between structure and physical properties of the materials produced by several ways listed above, just begins. The above-mentioned materials differ significantly from commercialized products due to different dissolution mechanisms and functionalization patterns and should be therefore carefully studied. The research challenge is to find chemically stable, efficient and recyclable solvent(co-solvent) systems and functionalization routes, which have also potential for industrial upscaling. Also, the functionalization route should provide control over degree of substitution and mixed branching if necessary.

### **Responsibilities and tasks**

The Ph.D. student has the following tasks as an active member of the thematic research group:

- Composing comprehensive literature survey of the state of the art in the field of functionalization routes of cellulose in environment of ionic liquids.
- Active participation in elaboration of the most feasible solvent systems and functionalization medium, also consulting research collaborates abroad (University of Helsinki, etc.)
- Synthesis and characterization of the derivatives, esters and mixed esters in laboratory scale, chemical characterization of the derivatives, finding relations between functionalization conditions and properties of the novel materials.
- Participation in upscaling of the most relevant functionalization routes for producing the derivatives for technological trials.
- Participation in elaboration of recycling methods of the solvent systems.
- Publishing of the results as journal articles and conference presentations.

### **Qualifications:**

MSc in organic chemistry / biochemistry /polymer chemistry

### **The applicants should fulfill the following requirements:**

- The candidate should be familiar with methods, procedures and safety of laboratory of organic chemistry, which allows to work independently.
- Previous experience in cellulose chemistry would be highly appreciated.
- Previous experience in the most relevant characterization methods (FTIR, NMR, titration, GPC, DSC, rheology) is also expected.



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# Design of the cellulose derivatives based thermoplastic composites for circular economy and sustainable environment

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## Summary

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*Tallinn University of Technology, School of Engineering, Department of Materials and Environmental Technology, Laboratory of Wood Technology offers a 4-year PhD position in materials technology.*

|                       |   |
|-----------------------|---|
| Research field:       | Chemical and Materials Technology   |
| Supervisors:          | Jaan Kers<br>Heikko Kallakas  |
| Availability:         | This position is available.   |
| Offered by:           | School of Engineering<br>Department of Materials and Environmental Technology                         |
| Application deadline: | Applications are accepted between September 01, 2020 00:00 and October 02, 2020 23:59 (Europe/Zurich) |

## Description

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Sustainable thermoplastic polymers are developed and investigated to partly or fully replace non-renewable-resources-based materials for melt processing technologies. Cellulose appears to be a nearly unlimited renewable resource for polymeric materials. Discovery of dissolution processes of cellulose in ionic liquids opens several new routes for functionalization. Thermoplastic cellulose derivatives can be prepared without use of plasticizers, by attaching long-chain ester branches to the macromolecule of cellulose. Based on circular economy and sustainable environment principles the functionalized cellulose based thermoplastic composite materials are considered as viable solution for commodity products.

The research challenge is to design the cellulose thermoplastic composites to enhance the mechanical properties of the novel thermoplastic materials. A laboratory line for pilot production of the novel thermoplastic materials will be started. Producing and processing parameters of the novel materials will be clarified for further commodity applications.

### Responsibilities and tasks

The Ph.D. student has the following tasks as an active member of the thematic research group:

- Composing comprehensive literature survey of the state of the art in the field of cellulose derivatives and enhancement of physical, mechanical and technological properties of cellulose composites. Selection of the suitable additives for improvement of aforementioned properties.
- Active participation in design of cellulose derivative thermoplastic composite material also consulting research collaborates abroad (Aalto University, University of Helsinki, etc.)
- Participation in developing the machinery and pilot line for producing the cellulose derivatives for technological trials.
- Characterization of the cellulose derivatives based thermoplastic composites (DSC, rheology, Vicat softening temp and HDT, MFI) finding optimal relations between chemical, physical and technological properties of the novel materials.
- Design of experiment for material recipes for technological trials and testing of the physical and mechanical properties of the composites.
- Participation in elaboration of methodology for environmental impact evaluation and LCA.
- Publishing of the results as journal articles and conference presentations.

### Qualifications:

MSc in organic chemistry /polymer chemistry/ wood chemistry/ cellulose chemistry and technology/ pulp and paper technology

**The applicants should fulfill the following requirements:**

- The candidate should be familiar with methods, procedures and safety of laboratory of polymer chemistry and wood, which allows to work independently.
- Previous experience in cellulose chemistry and polymer technology would be highly appreciated.
- Previous experience in the most relevant characterization methods (DSC, rheology, Vicat softening temp and HDT, MFI, compounding, injection molding, compression moulding, mechanical testing, creep tests, artificial weathering, evaluation of environmental impacts, LCA) is also expected.



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# Sediment budget on the eastern and southern coasts of the Baltic Sea

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## Summary

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*The proposed PhD studies focus on the understanding of the impact of timing and synchronisation of wave storms and high water level events on the properties of wave-driven sediment transport along sedimentary shores of the eastern and southern Baltic Sea and on the total sediment budget on the shores of this region. The central goal is to build an adequate estimate of sediment budget on these shores by combining i) observed data about changes to the location of the coastal scarp and the waterline and ii) numerical estimates of wave-driven sediment transport on the underwater part of the beach.*

|                       |   |
|-----------------------|---|
| Research field:       | Physical Sciences   |
| Supervisors:          | Kevin Ellis Parnell<br>Tarmo Soomere  |
| Availability:         | This position is available.   |
| Offered by:           | School of Science<br>Department of Cybernetics  |
| Application deadline: | Applications are accepted between September 01, 2020 00:00 and October 02, 2020 23:59 (Europe/Zurich) |

## Description

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The gradual increase in the relative water level along most of the eastern and southern shores of the Baltic Sea (Hünicke et al. 2015) and the projected increase in the frequency of wave storms and extreme water levels (Pindsoo and Soomere 2016) creates a rapidly increasing pressure on sedimentary coasts of the Baltic Sea. This pressure is further amplified by possible changes in the wave approach directions (Soomere et al. 2015; Kudryavtseva and Soomere 2017). This change may radically alter the structural properties (such as the location of divergence and convergence areas; Viška and Soomere 2013) of wave-driven alongshore transport. This in turn not only affects erosion and accretion areas but has also major implications on the maintenance and planning of various coastal engineering structures (harbours, breakwaters, groins etc.).

The existing atmospheric, ocean circulation and wave models make it possible to reliably reconstruct the main features of nearshore wave fields and water levels and thus also the wave-driven transport and to some extent the loss of sediment. Most of the research into wave-driven sediment transport until now has been performed in terms of statistical properties of wave fields. In other word, the actual sequences of events are ignored. This approximation is very crude in the Baltic Sea conditions where the classic „cut and fill“ process usually does not occur and where the local effects may substantially contribute the actual water level near the waterline (Pindsoo and Soomere 2015). In particular, this approximation leads to systematic biases in estimates of the basic properties of sedimentary beaches (Soomere et al. 2017).

### Responsibilities and tasks

The PhD candidate shall:

- evaluate the recession rates of the coastal scarp and the changes in the location of the waterline from available monitoring data;
- establish the structural properties (the areas of divergence and convergence) of wave-driven sediment transport and their stability in space and time;
- estimate the „impact“ of synchronisation of wave storms and changes in the water level on the basic properties of beaches such as the closure depth or the width of the equilibrium profile;
- numerically estimate the changes in amount of sediment in the underwater part of the beach;
- quantify the sediment budget (loss or gain of sediment) along the study area by combining the estimates for the dry beach and for the underwater part of the beach.

**Qualifications:** MSc degree or equivalent qualification in one of the following fields: Earth sciences, physical oceanography, coastal engineering, ocean engineering, mathematics, physics, remote sensing.



The applicants should fulfill the following requirements:

- experience with common scientific software (e.g. Matlab, Python);
- very good command of English.

References:

Hünicke, B., Zorita, E., Soomere, T., Madsen, K.S., Johansson, M., Suursaar, Ü. 2015. Recent change – sea level and wind waves. In: The BACC II Author Team, Second Assessment of Climate Change for the Baltic Sea Basin, Regional Climate Studies, Springer, 155–185, doi: 10.1007/978-3-319-16006-1\_9

Kudryavtseva, N.A., Soomere, T. 2017. Satellite altimetry reveals the impact of rotating winds on spatial patterns of variations in the Baltic Sea wave climate. *Earth Systems Dynamics*, 8, 697–706, doi: 10.5194/esd-8-697-2017

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Soomere, T., Pindsoo, K. 2016. Spatial variability in the trends in extreme storm surges and weekly-scale high water levels in the eastern Baltic Sea. *Continental Shelf Research*, 115, 53–64, doi: 10.1016/j.csr.2015.12.016

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# AI for Court Case Distribution

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## Summary

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*Tallinn University of Technology, Department of Software Science offers a IT-Academy funded 4-year PhD position in the field of ICT*

|                       |   |
|-----------------------|---|
| Research field:       | Information and Communication Technology  |
| Supervisors:          | Sadok Ben Yahia<br>Dirk Draheim   |
| Availability:         | This position is available.   |
| Offered by:           | School of Information Technologies<br>Department of Software Science                                  |
| Application deadline: | Applications are accepted between September 01, 2020 00:00 and October 02, 2020 23:59 (Europe/Zurich) |

## Description

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### Motivation

Court case distribution is an area with a huge potential to increase the state's effectiveness and efficiency in the important field of judiciary. The problem with current course case distribution is the following:

- cases are scheduled on an ad-hoc basis
- knowledge about which judges have the most expertise to handle a given case is only poorly exploited or not exploited at all
- due to (ii) cases are not handled as fast as possible (inefficiency)
- due to (ii) cases are not handled in the best possible way (lack of quality, lack effectiveness)
- there is only a poor estimate or no estimate at all about the efforts needed for a given case. Even if available, such information is often not exploited in scheduling court cases. This leads to poor scheduling (effort-wise) of cases and misbalance in workloads (which leads again to inefficiency)
- current case distribution system allows layers to influence assignment of judges. It gives possibility to corruption

Basic court case management systems help in improving this situation, but not significantly/fundamentally [LT19, MS17, San17]. What is needed is an automatic court case distribution that addresses the problems (i-vi) from scratch. However, the challenge is too complex to be solved by classical recommender systems AI-approaches (rule-based; decision-logics-based; based on CBR, i.e., case-based reasoning). What is needed is a screening of the whole range of currently available AI resp. machine learning techniques and tools to fundamentally improve the situation.

In the Estonian ICT sector, there exists considerable know-how in design and implementation of e-court systems. The PhD research will benefit from this, as it will be built on strong partnership between Estonian ICT industry and academia.

### Objective

The objective is to achieve an AI-based automatization of court case distribution that is tightly integrated into existing e-court systems (concrete: the industrial partner's running project of e-court implementation in several countries and regions).

### Research Questions

- Baseline (main) research questions:
  - Which advanced/recent/emerging AI resp. machine learning techniques/tools (including unsupervised as well as supervised learning!) have been applied successfully in the recommender systems domain?
  - Which AI resp. machine learning techniques/tools can be applied successfully for court case distribution? (a screening of the whole range of machine learning techniques [Jam13, GBC16] and tools is necessary for the purpose of this research question) Otherwise: how to extend/improve existing AI resp. machine learning techniques/tools so that they can be applied successfully for court case distribution?
  - How to formalize rules for court case distribution against which AI-based implementation can be evaluated?
  - How to implement AI-based techniques for court case distribution?

- Advanced research questions:
  - How to integrate an AI-based solution for court case distribution into existing e-court systems, i.e., integration at ERP (enterprise resource planning system) level? (wrt this research question the PhD candidate will be supported by an already exist-ing Taltech PhD student, who is financed by Aktors as an industrial PhD student with the PhD topic “Implementation of e-Court Systems: Driving Forces, Success Factors, and Technology Acceptance”)
  - How to integrate an AI-based solution for court case distribution into e-Court system landscapes, i.e., integration at federation level? (wrt this research question the PhD candidate will be supported by an already existing Taltech PhD student, who is financed by IT Academy funding in the Taltech Information Systems Group (head: Dirk Draheim) with the PhD topic “Generalized Association Rule Mining – Big Data Integration”)
- Auxiliary research questions:
  - Are there legal obstacles wrt course case distributions and how should they be addressed? (Prof. Katrin-Nyman Metcalf, Taltech and eGA (e-Governance Academy), an international renowned expert in IT and law, will help with this research question)

## Methodology

- Inception phase: Systematic literature review (Kitchenham) with respect to the first of the above research questions: “Which advanced/recent/emerging AI resp. machine learning techniques/tools (including unsupervised as well as supervised learning!) have been applied successfully in the recommender systems domain?” (The first screening for related work shows, that the problem field is a highly innovative research field, i.e., we have a clearly visible research gap; so that SLR methodology wrt the remaining of the above research questions is not indicated)
- Contribution phase: Action design research (with Aktors OÜ as industrial partner)

## Research Outcome

Target scientific channels for the research outcomes are:

- Journals
  - Government Information Quarterly, Elsevier (Impact Factor: 4.311)
  - Artificial Intelligence, Elsevier (Impact Factor: 4.483)
  - Big Data Research, Elsevier (Impact Factor: 2.952)
  - International Journal of Law and Information Technology, Oxford Academic
- Conferences
  - EGOV (Joint IFIP Conference EGOV-CeDem-ePart, e-Government, e-Democracy, e-Participation – the leading e-Government conference)
  - CAiSE (Conference on Advanced Information Systems Engineering), Springer

## References

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- [Jam13] Gareth James, Daniela Witten, Trevor Hastie and Robert Tibshirani – An Introduction to Statistical Learning with Applications in R. Springer, 2013.
- [LT19] Lessa, L., Tsegaye, A. Evaluation of the public value of e-government services in Ethiopia: Case of court cas.
- [MS17] Mishra, S.K.a, Singh, V.K.b . Developing a multi agent system model in GAIA for court case management system as a case study and providing an extension to GAIA. In: Pro-ceedings of ICACCA'2017 - the 3rd International Conference on Advances in Computing, Communication and Automation, 2017, pp. 1-4.
- [San17] Sarantis, D. The challenge of accelerating Greek judicial procedure. In: Proceedings of EGOVIS'2017 - 6th International Conference on Electronic Government and the Infor-mation Systems Perspective, LNCS 10441, Springer, 2017, pp. 251-260.

[Sar19] Sarvarian, A. Procedural economy at the international court of justice, Law and Practice of International Courts and Tribunals, vol. 18, no. 1, 2019, pp. 74-100.



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# Development of Satellite Altimetry Algorithm for determining accurate sea surface heights using a synergy of in-situ and marine model data

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## Summary

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*School of Engineering, Department of Civil Engineering and Architecture, Research Group of Geodesy and Road Engineering offers a 4-year PhD position in Satellite Altimetry.*

|                       |   |
|-----------------------|---|
| Research field:       | Building and Civil Engineering and Architecture   |
| Supervisors:          | Artu Ellmann<br>Nicole Camille Delpeche-Ellmann   |
| Availability:         | This position is available.   |
| Offered by:           | School of Engineering<br>Department of Civil Engineering and Architecture                             |
| Application deadline: | Applications are accepted between September 01, 2020 00:00 and October 02, 2020 23:59 (Europe/Zurich) |

## Description

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### Background

Modern satellite altimetry (SA) missions (Sentinel, Cryosat, Jason) have the potential for determining accurate sea surface heights (SSH). It is known however that SA data products over coastal areas contain certain limitations, e.g. due to under-examined wet tropospheric correction, land and calm water interference, heterogeneous atmospheric forcings, etc. This project focuses on improving the range estimation by applying specialized developed retracking schemes. Retracking is necessary for the methodology employed in processing the range, can be study area dependant. For instance, reflected radar pulses are usually recorded against time in waveforms. Over the open ocean, waveforms normally conform well to the Brown model by the least squares estimation. Fitting to this waveform usually yields the required measurements of range (from which SSH is measured). It has been found that about 5-10 km off the coastline a significant portion of the radar waveforms depart from the Brown model (increasing toward the coast). The factors that influence this anomaly includes land contamination, 'bright targets' in the footprint (patches of very calm water in sheltered areas) etc. At coast it is influenced by archipelagos, areas of calm waters and many other processes (e.g upwelling jets, filaments etc.) that may influence the range that is calculated. Thus the necessity for a retracking methodology designed for the coastal area is required in order to obtain accurate SA-SSH estimates.

### Tasks

The PhD candidate shall develop an improved Satellite Altimetry (SA) retracker using a synergy of in-situ and marine model data. This development requires examining the sea surface heights (SSH) from various satellite altimetry (SA) missions (Sentinel, Cryosat, Jason-2 etc.) using the raw measurements along with different retracking methods. Detailed examination of the altimeter radar echoes and corrections applied shall be performed. Validation of SA derived SSH with in-situ data (tide gauges, airborne laser scanner, GNSS) is expected with utilisation of the marine geoid. Signal processing and statistical techniques (in terms of RMS error, stand. dev, uncertainty estimates, error budgets etc.) of the various data sets shall be performed. From these results a specific algorithm shall be developed to fit radar signals from different satellite missions and under different sea state (e.g. waves, sea ice, upwellings, fonts etc.). The candidate is expected to assist in project related field campaigns.

### Requirements

The applicants should fulfill the following requirements:

- University degree (M.Sc.) in geodesy or geomatics. Consideration will be given to applicants whose previous degrees are in appropriate related disciplines, such as Earth Sciences, Mathematics, Physics or software engineering.
- Skills in signal processing (to be trained), data analysis, mathematical and statistics (to be trained).
- Ability for independent research as part of a team, interest in the presentation and publication of scientific results.
- Advanced computer literacy and programming skills.

- Good command of the English language (speaking and writing).

The PhD candidate is expected to be at full time position for a duration of 4 years. The candidate is obligated to participate and fulfil the requirements of Tallinn University of Technology PhD programme. Additional funds will be provided (and whence applicable the associated funding can be applied for) for research trainings, conferences and international mobility/stays abroad with durations of up to 6 months. The research group wishes to increase the number of women interested in Geomatics. Qualified women are therefore also encouraged to apply. Do not hesitate to contact us for questions regarding the position. We look forward to receiving your application.



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# Hardware reliability assessment and enhancement for deep neural networks

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## Summary

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*Tallinn University of Technology, School of Information Technologies, Department of Computer Systems, Centre for Dependable Computing Systems offers a 4-year PhD position in ICT.*

|                       |   |
|-----------------------|---|
| Research field:       | Information and Communication Technology  |
| Supervisors:          | Jaan Raik<br>Masoud Daneshtalab   |
| Availability:         | This position is available.   |
| Offered by:           | School of Information Technologies<br>Department of Computer Systems                                  |
| Application deadline: | Applications are accepted between September 01, 2020 00:00 and October 02, 2020 23:59 (Europe/Zurich) |

## Description

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Emergence of Deep Neural Networks (DNN) has led to a proliferation of artificial intelligence applications. Among other tasks, DNNs have been trained to recognize speech, caption photographs, and translate text between languages at high levels of performance. Although applications of DNNs to real-world problems have become ubiquitous, there is a lack of understanding of how these circuits are affected by faults. Due to this fact, adoption of DNNs in safety-critical domain has been lagging behind. As there exist no commonly accepted reliability assessment metrics for DNNs, their certification for safety-critical applications is not possible. Existing state-of-the-art fault-tolerant solutions rely on redundant DNNs with implementation diversity. However, this solution is both costly and does not contribute to facilitating reliability assessment for the overall system.

To cope with the above-mentioned challenges, this **PhD thesis has the following targets:**

- Perform failure analysis of DNNs at the structural level to develop the low-level fault model for DNNs
- Develop high-level (functional) fault models for DNNs. Identifying mappings between low and high level fault models
- Based on these fault models, develop reliability assessment techniques for DNNs
- Propose architectural level fault-tolerant techniques for DNNs

### Funding:

The work will be fully financed from the ITA ICT programme project.



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# Water quality based management of smart urban drainage systems

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## Summary

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*Urban drainage systems (UDS) are being placed under greater stress due to rapid urban development and changing climate bringing along more frequent extreme rainfall events. This will increase the load to the existing UDS causing the risk of floods and outflow of pollutants to the environment. The objective of the thesis is to develop and test a decentralized water quality based model predictive control approach that enables to make the existing UDS controllable, utilize the free capacity of the system more efficiently and decrease the release of pollutants to the environment.*

|                       |   |
|-----------------------|---|
| Research field:       | Building and Civil Engineering and Architecture   |
| Supervisor:           | Ivar Annus  |
| Availability:         | This position is available.   |
| Offered by:           | School of Engineering<br>Department of Civil Engineering and Architecture                             |
| Application deadline: | Applications are accepted between September 01, 2020 00:00 and October 02, 2020 23:59 (Europe/Zurich) |

## Description

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### Description

Climate change will have a considerable impact on urban areas. One of the consequences is the increase in peak storm water intensities and local extreme weather events that place the existing urban drainage systems (UDS) under great stress. The peak intensities are already now exceeding the UDS design threshold values resulting in increasing number of flood events in urban areas.

It is not financially realistic nor hydraulically reasonable to rebuild all the drainage systems to cope with the new climate conditions. Therefore a change in paradigm is needed to shift from reactive to proactive control of UDS.

This can be achieved by applying real time control (RTC) on UDS. State-of-the art RTC systems are mostly operated on quantity based control approach by implementing rule based, model predictive, decentralized model predictive or a combination of the abovementioned control approaches. The concepts of pollution-based RTC have mainly remained in theoretical level but showing high potential and applicability in preventing untreated wastewater spillages.

**The objective of the thesis is to develop a pollution based RTC algorithm for a decentralized plot based RTC platform (DEPART).**

This platform enables to control the inflow at the upstream catchments in order to minimize the risk of flood and pollution at the downstream of UDS. The platform will be built on top of the existing SWMM5.1 simulation engine.

### Responsibilities and tasks:

- Assessment of the water quality based model predictive control approaches for the urban drainage system management
- Development of decentralized water quality based model predictive control approach for climate proof smart city
- Validation of the developed approach in real life case studies
- Active participation in work group projects (DEPART, CleanStormWater) and preparing new project proposals

### Qualifications:

Master degree in either water engineering, environmental engineering or informatics.

### The applicants should fulfill the following requirements:

- Knowledge in basic hydraulics and hydromechanics
- Knowledge in water quality requirements in urban water systems, main sources and pollutants
- Knowledge of Estonian and EU legislation on urban water system planning (national and regional level) and storm water management



- Good skills in programming languages (e.g. Microsoft C++ and/or Visual Basic)



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# Calibration, monitoring and normalization aspects in energy performance improvement of commercial buildings

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## Summary

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*Tallinn University of Technology, School of Engineering, Department of Civil Engineering and Architecture, Nearly Zero Energy Buildings research group offer a 4-year PhD position in civil engineering.*

|                       |   |
|-----------------------|---|
| Research field:       | Building and Civil Engineering and Architecture   |
| Supervisors:          | Jarek Kurnitski<br>Martin Thalfeldt   |
| Availability:         | This position is available.   |
| Offered by:           | School of Engineering<br>Department of Civil Engineering and Architecture                             |
| Application deadline: | Applications are accepted between September 01, 2020 00:00 and October 02, 2020 23:59 (Europe/Zurich) |

## Description

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### Description

Today, there is large existing building stock in Europe which is waiting major renovation to nearly zero energy buildings according to aims set in the EPBD directive that are to be implemented according to national Long Term Renovation Strategies and a European Green Deal Renovation Wave by 2050. While in Estonia and some other countries renovation grant systems and standard renovation practices exist and are widely used for residential buildings, non-residential buildings have become a subject of substantial energy performance improvement first time in the history. Therefore, it is important to build understanding about the starting point, i.e. current market driven renovation works and corresponding energy performance which is likely far behind from new targets.

Energy use of commercial buildings depends by large extent on HVAC systems, processes, occupancy and operation time of the buildings. Energy use patterns are highly dynamic and proper energy calculation input data is needed for meaningful energy simulations. Calibration against metered data and normalisation for a test reference year and standard use are important issues which need methodological development in order to be able for reliable predictions of high performance solutions.

The main research objective is to develop energy simulation based methodology and monitoring to improve the accuracy of design and performance assessment of cost-optimal buildings.

Research effort should focus to following topics:

1. State of art analyses of energy use in existing commercial buildings and for identification of common market driven renovation solutions
2. Implementation of the office building energy simulations with input data from national regulatory methodology and based on actual performance and user profiles
3. Analysing the building automation system information output in several office buildings in Estonia and conducting measurements of energy and indoor climate components, to evaluate the accuracy of BACS data
4. Development of cost-optimal solutions and energy simulation methods for commercial buildings
5. Development of climate and standard use normalisation methods including benchmarking with existing degree day method

Research tasks will include data collection and measurements from existing buildings, energy modelling and simulations, input data and methodology development, and simulated and measured performance comparisons.

### Qualifications

The applicants should fulfill the following requirements:

- Master degree in the field of HVAC or energy performance of buildings;

- Some experience in energy simulations and indoor climate analyses in buildings



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# Analysis of Production Process and Design of Medical Implants and Tools for Additive Manufacturing

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## Summary

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*Tallinn University of Technology, School of Engineering, Department of Mechanical and Industrial Engineering offers a 4-year PhD position in manufacturing.*

|                       |   |
|-----------------------|---|
| Research field:       | Mechanical Engineering  |
| Supervisors:          | Tauno Otto<br>Lauri Kollo   |
| Availability:         | This position is available.   |
| Offered by:           | School of Engineering<br>Department of Mechanical and Industrial Engineering                          |
| Application deadline: | Applications are accepted between September 01, 2020 00:00 and October 02, 2020 23:59 (Europe/Zurich) |

## Description

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### Topics for Scientific Research

- Better understanding of CAD/CAM reconstruction
- Analysis and optimization of medical implant manufacturing process using 3D-scanning and additive manufacturing
- Design and design process for medical implants (implants, prostheses and orthoses)
- The use of software for the evaluation of medical implants' fixation
- Finite Element Analysis (FEM) for the evaluation of structural behavior of medical implants and medical planning
- Retrieval analysis for implant / prosthesis / orthosis - associated cause of failure
- Others as required by the supervisor (s) for the delivery of the role

### Main Duties and Responsibilities

- Study design, data collection and analysis
- Attend TalTech courses and training
- Participation in relevant East-Tallinn Central Hospital case studies
- Participation in EU projects "3D Printing" and „DIH WORLD“
- Literature research
- Manuscript writing (for submission to peer-reviewed journals)
- Attend weekly research meetings
- Other duties as required by the supervisor(s) for the delivery of the role

**Qualifications:** Master's degree in production or corresponding qualifications

**The applicants should fulfill the following requirements:**

Experience in the field of:

- Industrial processes
- 3D printing of metals
- Mechanical engineering

- 3D simulations (CAD, CAM)



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# Ceramic texturing for the next generation of luminescent monolithic materials and functional layers

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## Summary

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*Motivated by the recent progress in the nanophotonics, photovoltaic and biophotonics applications and the increasing demand for cost-effective and easy-to-use point-of-care platforms, tailoring the emission in luminescence materials has a great scientific interest. These luminescent materials have been synthesized mostly in powder-form, formed by a matrix (host) doped with activators which can be a transition metal or rare earth (RE) ions that act as emitting centers. For practical applications, luminescent particles are incorporated to form thick or thin films. Therefore, the development of monolithic luminescent glass-ceramics and -ceramics by a single and cost-efficient process supported by robust moisture and thermal stability is highly desirable. Recently, we demonstrate that luminescent properties layers depends on random orientation or/and by epitaxial growth. In this context, one of the breakthroughs in this project is the understanding of luminescence in monolithic layers on several surfaces by modulation their crystalline orientation.*

Research field: Mechanical Engineering  
Supervisors: Irina Hussainova  
Rocio Estefania Rojas Hernandez  
Availability: This position is available.  
Offered by: School of Engineering  
Department of Mechanical and Industrial Engineering  
Application deadline: Applications are accepted between September 01, 2020 00:00 and October 02, 2020 23:59 (Europe/Zurich)

## Description

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The doctoral student will be based on the laboratory's of Department of Mechanical and Industrial Engineering site and will integrate in our team.

### **Project Background**

The approaches that will carry out in this project are particularly applicable to the development of luminescent glass-ceramics and ceramics, which belong to an emerging class of photonic materials that compete with "single crystal technology" in a wide range of optical applications. These new glass-ceramics and ceramics offer many advantages, including large-scale shaping and production, and tolerate higher levels of active ion doping than single crystals, which improves optical performance. Mainly, luminescent materials have been synthesized mostly in powder-form, formed by a matrix (host) doped with activators which can be a transition metal or rare earth (RE) ions that act as emitting centers. However, the efficient emission of light is limited due to the strong absorption and the scattering by the particles. This, alongside the drawbacks regarding the thermal stability and aging degradation of the luminescent particles embedded in a polymer matrix, led the attention to the development of luminescent bulk and glass-ceramics and ceramic layers.

Different strategies are proposed to design the luminescent bulk and glass-ceramics layers, including the embedding of luminescent particles in glass matrix or the direct synthesis of the layer by employing a solution or ink directly by sol-gel or/ and screen printing routes or the monolithic bulk by SPS. For all synthesis routes, we are seeking new compositions and structures (at both the unit-cell and microscopic level) to develop materials with superior properties, opting for aluminates and aluminosilicate matrices.

### **Objective**

The objective of the project is to expand the range of known luminescent glass-ceramic and ceramics by two main strategies: a. dispersion of phosphors particles within the bulk glassy matrix and b. direct synthesis of the luminescent layers. The new materials will be characterized structurally (from the unit cell to the micro scale) and physically, to understand the link between structure and properties, allowing their performance to be optimized.

The thesis work will consist of a first experimental and methodological part that will make it possible to identify new glass and glass-ceramic compositions to tailor the emission in the visible and/or infrared regions. The second part of the work will focus on the structural characterization of the ceramic materials obtained: crystallographic characterization of the structure at the unit-cell level by X-ray diffraction and the use of electron microscopy to study the nature

and morphology of the crystals, grain boundaries, or the presence of residual phases. The study of microstructure/luminescence correlation during the synthesis processes should make it possible to optimize the synthesis parameters (e.g. composition, annealing conditions) to obtain high-quality materials and improved properties. The laboratory has a wide range of multi-scale characterization techniques that can be used in-situ (HTXRD, SEM, ...) and numerous spectroscopic methods (UV-VIS, Luminescence characterization, Raman ) to determine the structural characteristics of the synthesized glass- ceramics, as well as mechanical characterization. We have collaborations with HR-TEM, Coupling confocal Raman and AFM facilities, allowing us to carry out highly detailed structural characterizations. Finally, the functional ceramics obtained will be optically characterized within the framework of collaborations. This thesis will allow the candidate to acquire expertise in the field of luminescent materials, for the synthesis of new crystalline materials with emerging optical properties. Depending on the candidate's profile, he or she may prefer an emphasis on innovative synthesis methods, structure- and luminescent characterization. The project benefits from established national and international collaborations for specific physical property measurements, advanced structure, and time-resolved luminescence spectroscopy methods.

#### **Responsibilities and tasks:**

PhD student has a responsibility to communicate their research, to collaborate with others members of the team. Doctoral student has a responsibility to behave honestly and ethically in the course of their research. The research student is expected to adopt a professional approach, including good timekeeping, observing deadlines, reading and responding to communications from the supervisory team and other members of the University and taking responsibility for their own skills and career development.

The main duties of doctoral students are to devote themselves to their research studies. The work task include the development of inorganic luminescent materials (synthesis, characterisation and modification). Interpreting research specifications and developing a work plan that satisfies requirements. Conducting desktop research, and using books, journal articles, newspaper sources, questionnaires, surveys, polls, and interviews to gather data. Analyzing and interpreting experimental results.

#### **Qualifications**

The applicants should fulfill the following requirements:

- Applicants should have a degree in a relevant subject (e.g. Chemistry, Physics, Materials Science), completed Masters research project in solid-state science, and demonstrate a desire to learn more about the field.
- Cross-disciplinary applications are welcome.
- Strong experience in nanofabrication via chemical routes is desirable.
- Preference will be given to candidates that evidence:
  - Background in manufacturing processes from laboratory to pilot scale,
  - Background in properties correlation with materials nano and microstructure;
  - Strong capacity to work in a team and individually.
- Experience in either non-linear effects or programming is a plus, but not required.



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# Analysis and design of composite structures

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## Summary

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*The position is planned for structural analysis and design optimization with advanced materials and structures with main attention on composite structures. The study includes development of methodology for analysis and design of particular practical engineering structures. One application foreseen is an analysis and design optimization of solar panels, also wider class of glass structures and composite laminates since the photovoltaics is rapidly growing renewable energy sector as an alternative to regular fossil fuel powered electricity generation.*

|                       |   |
|-----------------------|---|
| Research field:       | Mechanical Engineering  |
| Supervisors:          | Jüri Majak<br>Kristo Karjust  |
| Availability:         | This position is available.   |
| Offered by:           | School of Engineering<br>Department of Mechanical and Industrial Engineering                          |
| Application deadline: | Applications are accepted between September 01, 2020 00:00 and October 02, 2020 23:59 (Europe/Zurich) |

## Description

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Focus of the study is on numerical analysis, however, depending on particular application the experimental study is included (nondestructive and destructive tests for determining the stiffness and strength properties, vibration analysis, buckling analysis, etc.). Based on work group long time experience in area of Artificial Intelligence, utilization of AI tools like artificial neural network, global optimization algorithms have been foreseen. Development and utilization of powerful AI tools allow to analysis and design complex engineering structures involving geometrical and physical nonlinearity, mixed integer variables, discrete variables, local extremes, etc. As real world engineering problems include multiple objectives (maximum strength and stiffness, minimum cost) the extra attention is paid to development and adaption of multicriteria optimization strategies, methods and techniques.

### Responsibilities and tasks:

- Experimental study  
Nondestructive and destructive tests for determining the stiffness and strength properties of the materials, structures and its components, vibration analysis, buckling analysis. Planned as team work.
- Numerical analysis  
Development and application of simulation models for structural analysis of engineering structures (particular methods used depend on problems considered). Planned as team work.
- Design optimization  
Development, adaption and application of optimization methods and techniques for design of engineering structures

### Qualifications:

- General/basic knowledge in area of numerical analysis of structures, mechanics of composite materials
- MSc in area of engineering / mathematics / physics



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# Psychrotrophic bacteria in food spoilage and safety

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## Summary

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*The doctoral thesis aims to elucidate adaptation mechanisms and their regulation in psychrotrophic bacteria associated with food mostly focusing on the intraspecies variations. Data on correlation between physiological properties, genomes, transcriptomes and proteomes will be implemented into improved microbial hazard identification and prediction of microbial behavior in foods at low temperatures.*

|                       |   |
|-----------------------|---|
| Research field:       | Chemistry and Biotechnology   |
| Supervisors:          | Inga Sarand<br>Pirjo Spuul  |
| Availability:         | This position is available.   |
| Offered by:           | School of Science<br>Department of Chemistry and Biotechnology  |
| Application deadline: | Applications are accepted between September 01, 2020 00:00 and October 02, 2020 23:59 (Europe/Zurich) |

## Description

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### Description

Globalization of food trade and changes in peoples eating habits have increased a consumption of minimally processed ready to eat foods, which shelf life mainly depends on chilling conditions during storage and transport. This has increased an impact of psychrotrophic bacteria that can grow both at processing and storage conditions in food spoilage and safety (e.g. *Listeria monocytogenes*). Different specific adaptation mechanisms to retain metabolic and enzymatic activities at low temperatures have been employed by psychrotrophic bacteria (e.g. regulation of cell membrane fluidity through lipid composition activities). Intraspecific variability in their expression and regulation largely determines potential of different bacteria strains to grow in refrigerated environment. More data is needed to identify genetic markers predicting psychrotrophic bacteria behavior in different foods. Different omics-based approaches in combination with phenotypical characterization and shelf-live studies will be used.

### Responsibilities and tasks

The PhD student will be responsible for planning and conducting experiments and data analysis related to the topic of the current thesis. At least three papers will be published in the peer-reviewed journals by the end of nominal studies time. He/she will participate in preparation of publications (in at least one of which being the first author).

### Qualifications:

- microbiology or biochemistry or molecular biology
- skills in bioinformatics are recommended

**The applicants should fulfill the following requirements:** microbiology, biochemistry.



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# Research, Design, and Implementation of Partial Power DC-DC Converters

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## Summary

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*PhD Research Project in the Field of Applied Power Electronics*

|                       |   |
|-----------------------|---|
| Research field:       | Electrical Power Engineering and Mechatronics   |
| Supervisors:          | Andrii Chub<br>Andrii Blinov  |
| Availability:         | This position is available.   |
| Offered by:           | School of Engineering<br>Department of Electrical Power Engineering and Mechatronics                  |
| Application deadline: | Applications are accepted between September 01, 2020 00:00 and October 02, 2020 23:59 (Europe/Zurich) |

## Description

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### Description

The future of the energy sector is associated with wide electrification of energy production, transportation together with wide use of renewable energy sources. Consequently, it will require extensive use of power electronic converters along with DC distribution for energy transmission and distribution. Conventional power converters that are processing the entire power flow provide high performance in terms of regulation range, controllability and protection are commonly used in such applications. However, their reliability and capital costs can limit their wider adoption in the energy sector. On the other hand, partial power DC-DC converters (PPC) have shown excellent cost-performance ratio in their early applications, like wind turbines with doubly-fed induction generators.

This project is focused on the development of cost-efficient power electronic systems for DC distribution in renewable energy generation and storage applications. The primary outcome of this PhD work will be in the development of bidirectional PPCs based on current-source topologies that are capable of operating in buck and boost modes, while providing soft-switching for semiconductors in a desired load and voltage range. In addition, special attention will be paid to protection methods that enable optimal design of PPCs.

Ph.D. student will develop new topologies of soft-switching buck-boost PPCs as well as optimal design methods for DC distribution systems and associated protection techniques.

### Project tasks:

- Analysis and synthesis of PPCs based on current-source isolated dc-dc converter topologies
- Buck-boost implementation of the PPC for reduced partiality ratio
- Development of multimode control with smooth transition between modes for analysed topologies
- Optimising the voltage and current stresses in components at different PPC operating modes
- Development of effective and low-cost protection methods for the DC power distribution systems
- Experimental verification of developed converters and control methods for selected applications

### Duration:

The duration of the project is planned for four years starting in the Spring semester 2021.

### Preferred qualifications (in order of importance):

- Practical experience in the design of power electronic converters
- Experience in the modeling of electronic circuits in PSIM or PLECS software
- Experience in design of control systems and their implementation in microcontrollers and DSPs
- Good understanding of power semiconductor components and their driving
- Experience with mixed-signal PCB design (preferably using Altium Designer)
- Experience with closed-loop control systems comprising sensors with analog and digital interfaces

### The applicants should fulfill the following requirements:

- The successful candidate should hold an M.Sc. degree in Electrical Engineering.
- A strong background and interest in Power Electronics are expected.
- Prior practical experience with galvanically isolated dc-dc converters is preferred.
- The candidate will work in the international team and collaboration with partner universities and companies. Hence, we expect fluency in spoken and written English.

Questions about the position can be directed to Dr. Andrei Blinov ([andrei.blinov@taltech.ee](mailto:andrei.blinov@taltech.ee)) or to Dr. Andrii Chub ([andrii.chub@taltech.ee](mailto:andrii.chub@taltech.ee)).



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# Research and development of Demand-side flexibility

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## Summary

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*The increase of new kind of loads (electric vehicles, battery storage) and the increase of overall electrical energy consumption with higher peak load has to be covered by new flexible operation functions. Any new and more flexible operation including a higher degree in automation will lead to opportunities in operating power systems more efficient. The evolution of the distribution networks through increased electrification and new load and generation technologies and patterns, calls for an increased overall need for flexibility in the operation and planning of distribution networks. In addition to technological solutions, there is also a clear need for new ways of thinking regarding organizing and regulating the DSO business, together with needs for involving the grid consumers/prosumers.*

Research field: Electrical Power Engineering and Mechatronics  
Supervisors: Roya Ahmadihangar  
Argo Rosin  
Availability: This position is available.  
Offered by: School of Engineering  
Department of Electrical Power Engineering and Mechatronics  
Application deadline: Applications are accepted between September 01, 2020 00:00 and October 02, 2020 23:59 (Europe/Zurich)

## Description

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**The main objectives are the identification of the available flexibility in the demand side, optimization and aggregation solutions at the system level with machine learning-based methods.**

- **Integration of real-data into power system operation to improve the efficiency**
- **Utilizing the available flexibility of local and distributed storage, and residential loads to increase the grid stability and customer cost-effectiveness**

### Expected/hypothetical content of the thesis

1. **Introduction**
2. **State of the Art**
  1. **Challenges and opportunities in the demand side flexibility**
  2. **Overview of machine learning algorithms and their application in smart grids**
3. **Prediction and identification**
  1. **State of art analysis**
  2. **Development and simulation of Learning systems**
  3. **Results**
4. **Optimization**
  1. **State of art analysis**
  2. **Development of optimization methods**
  3. **Development of coordinated Demand Response programs**
  4. **Results**
5. **Validation and evaluation of designed solution**

## 6. Conclusion and discussions



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# Designing wood-bio-based adhesive interphases for enhancing the materials performance in sustainable veneer-based products

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## Summary

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*TalTech Laboratory of Wood Technology is offering PhD position to well-qualified individual to work on a PhD research project to design the wood-bio-based adhesive systems based on well-known and highly reproducible wood surfaces from different wood species with commercially available bio-based adhesive systems. TalTech has excellent facilities and staff for accomplishing this research. TalTech has a laboratory veneer peeling and plywood production line which allows controlling processing parameters to develop reproducible surfaces with a range of characteristics and for testing the surface properties and mechanical properties of the products. The individual assigned to this position will be enrolled to the doctoral study program "Chemical and Materials Technology" and part time employed as early-stage researcher by the Department of Materials and Environmental Technology.*

|                       |   |
|-----------------------|---|
| Research field:       | Chemical and Materials Technology   |
| Supervisors:          | Jaan Kers<br>Heikko Kallakas  |
| Availability:         | This position is available.   |
| Offered by:           | School of Engineering<br>Department of Materials and Environmental Technology                         |
| Application deadline: | Applications are accepted between September 01, 2020 00:00 and October 02, 2020 23:59 (Europe/Zurich) |

## Description

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Although work has been done on developing adhesives for wood bonding with higher bio-based content, almost no research has been made on understanding their impact on the adhesive-wood boundary. These deficiencies in knowledge and methods are the motivation to conduct this study for better understanding the influence of veneer production process parameters to the surface quality and its effect on bonding. Creation of a well-defined and reproducible surface will enable the study of the veneer surface interaction with adhesives and improvement in surface characterization methods for predicting the performance of wood-adhesive systems quality and enhance the development of sustainable veneer-based products from underutilized wood species. Although much work has been done on developing bio-based adhesives, almost no research has been on understanding their weaknesses, especially at the adhesive-wood boundary.

### **Objectives and responsibilities:**

1. To study the influence of the wood processing parameters (log soaking temperatures, drying temperatures to the veneer surface properties of different hardwood and softwood species.
2. To study how bio-based wood adhesives interact with the same surface of veneer substrate differently and thus the correlation of adhesive substrate interface properties with plywood product physical and mechanical properties.
3. Develop new and to improve existing testing and evaluation methods for veneer surfaces and of bonded products performance.
4. Use well defined and highly reproducible wood surfaces to improve the understanding of adhesive performance and accelerate the implementation of new environmentally friendly bio-based resins.

### **Tasks:**

1. Review the existing knowledge in the field of bio-based adhesive systems
2. Preparation and execution of a research plan
3. Design the process parameters to obtain highly reproducible wood surfaces with known properties
4. Design the of wood-bio-based adhesive interphases and develop testing methods

### Qualifications

The applicants should fulfil the following requirements:

- Master´s degree in the field of wood technology, wood science, wood chemistry, materials technology or polymer technology
- Excellent communication skills (written and spoken) in English
- Deep knowledge in the field of wood technology and adhesives bonding of wood materials



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