

kaunas  
university of  
technology

Technology for

**HUMANS**

# **Technology for Humans**

Kaunas University of Technology  
Research overview 2018-2020

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From world record-breaking tandem solar cells to climate change risk perception evaluation in Europe, from innovative cancer diagnostics methods to novel future-oriented approach to science education, from digital technologies to assist *in vitro* fertilisation (IVF) procedures to city traffic flow management – the solutions described in this brochure portray the achievements of research groups of Kaunas University of Technology (KTU) in the recent years.

## **VERSATILE**

KTU is the best illustration of all that Lithuania can offer in higher education and research. One of the largest technological universities in the Baltic States, it delivers studies, research and carries out contracted R&D in the majority fields of science. We believe in human side of technology. We educate well-rounded professionals, knowledgeable not only in technological, but also in humanistic and social aspects of innovation. The so-called “soft” dimension of humanities, social sciences and arts is included into most study programmes, making the University graduates ready for the global challenges of tomorrow.

## **INNOVATIVE**

For almost 100 years, KTU has sustained the tradition of nurturing talented independent thinkers. In Kaunas, KTU is the co-founder of two integrated science, studies and business centres-valleys – Santaka and Nemunas, where state of the art infrastructure is available for research, studies and commercial purposes. KTU is the founder of the first academic start-up incubator in Lithuania – KTU Startup Space.

## **EQUAL**

Speaking the universal language of science, KTU invites people from all cultures and backgrounds to join our open-minded academic community. Curious and motivated minds offer new insights, that expand and challenge our understanding of the world around us. 45% of our faculty staff and 53% of STEM (science, technology, engineering, maths) students are women. After all, Lithuania is one of the few countries in the EU having the majority of women among scientists and engineers.

## **AVANT-GARDE**

Kaunas University of Technology is a leader among Lithuanian institutions by the number of projects funded by European Union’s research and innovation programme Horizon 2020 since the beginning of the Programme (2014–2020). In 2018, KTU became the first university in Lithuania to win ERA Chair competition for attracting top academics. The winning project “Industry 4.0 Impact on Management Practices and Economics (In4ACT)” conceived by the researchers of the KTU School of Economics and Business focuses on the broad impact of the Fourth Industrial Revolution on society.

## CONNECTED

ECIU University is an initiative of the European Consortium of Innovative Universities (ECIU) that creates a ground-breaking and innovative educational model on a European scale. Through this initiative, which started in November 2019, ECIU builds the ECIU University – an entire new concept of the European University for the future. ECIU University will be the first European university where learners and researchers cooperate with cities and businesses to solve real-life challenges. Unbounded by national, geographical, social or language borders, the ECIU University offers knowledge through relevant academic courses and through cutting-edge research. KTU joined the ECIU network in 2016 and is the only Lithuanian university in the Consortium. The ECIU University is an EU-funded Pilot Project between 12 universities in the ECIU network to build the University of the future.

Also, KTU is a member of these international organisations: CESAER, NORDTEK, BALTECH, EUA, EUCEN, SEFI, COPERNICUS Alliance.

## 1922

Founded in 1922, Kaunas University of Technology will celebrate its centenary in 2022.

## 82 %

According to the data from recent years, 82% of KTU graduates are in employment within 12 months.

## 9000

Around nine thousand students are studying at KTU; 46% of study programmes are taught in English.

## 9 FACULTIES

Offering study programmes in a wide range of study fields – from mechanical engineering to economics and business, from chemical technology to electrical engineering, from biomedical engineering to mathematics.

Our nine faculties are: Faculty of Electrical and Electronics Engineering, School of Economics and Business, Panevėžys Faculty of Technologies and Business, Faculty of Chemical Technology, Faculty of Civil Engineering and Architecture, Faculty of Informatics, Faculty of Social Sciences, Arts and Humanities, Faculty of Mathematics and Natural Sciences, Faculty of Mechanical Engineering and Design.

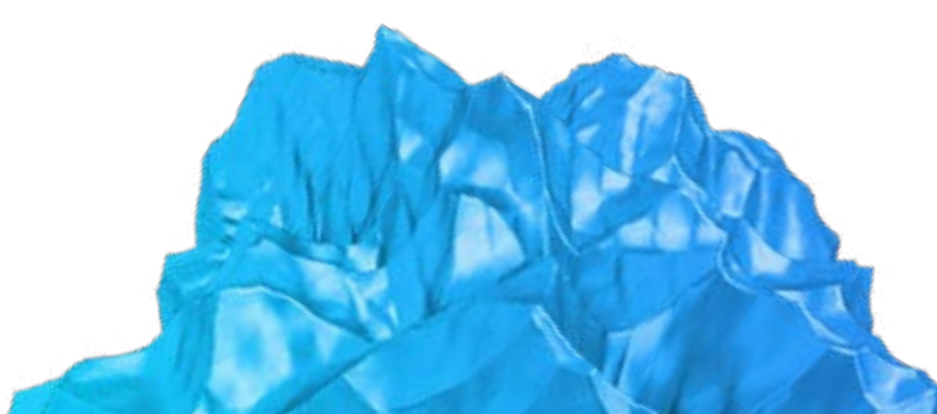
## 8 RESEARCH INSTITUTES

KTU engages in research and experimental development in technology, natural and social sciences, while research of medical sciences and humanities is also promoted.

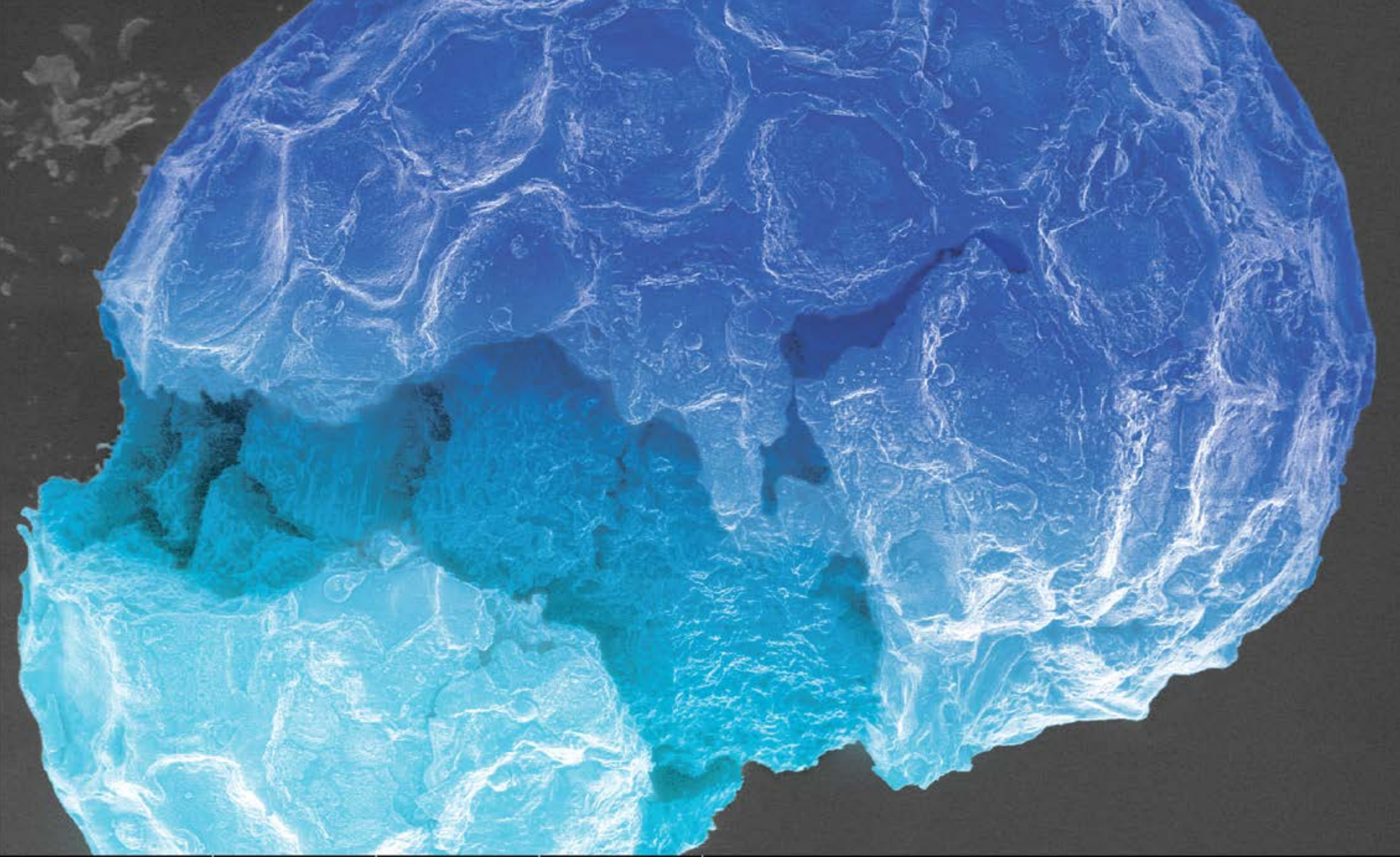
All of that fits into 8 research institutes of KTU: Institute of Materials Science, Institute of Mechatronics, Health Telematics Science Institute, Prof. K. Baršauskas Ultrasound Research Institute, Institute of Environmental Engineering, Institute of Architecture and Construction, Biomedical Engineering Institute, Food Institute.

## ~ 100 START-UPS

KTU is the founder of Startup Space, the first academic start-up community in Lithuania. Around 100 start-up companies have been established since 2012.







HEALTH

HV 5.00 kV

mag 99 x

mode SE

500  $\mu$ m

WD 11.3 mm

det LFD

HFW 1.51 mm

Dr. Tomas Tamulevičius

Grain of poppy seed



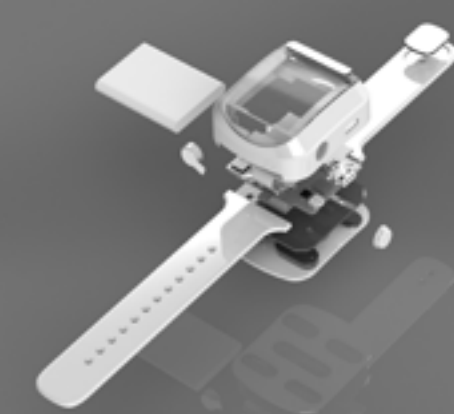
	<b>Self-Learning Image Recognition System for Automatic Early Stage Human Embryo Assessment</b>	
2019		

NOVELTY	RELEVANCE	DESCRIPTION
An automated approach is proposed to detect human embryo development stages during <i>in vitro</i> fertilization (IVF) incubation and to highlight embryos with abnormal behaviour by focusing on five different stages. This method encompasses two major steps. First, the location of an embryo in the image, and second, a multi-class prediction model used to identify a total cell number in the embryo using the technique of deep learning.	Background infertility and subfertility affect a significant proportion of the human population. The approach presented in this study could be used in the creation of novel algorithms integrated into the assisted reproductive technology used by embryologists. It can increase the chances of conceiving and raising a healthy child for many couples.	The main aim of the research is the development of a computational model that can be used to evaluate health of an early stage human embryo. The presented computational model, based on state-of-the-art artificial intelligence methods, allows automating selection of the embryo and assisting an embryologist in routine job. The proposed algorithm is adopted to work with modern Time Lapse (TL) incubators, which are widely used in <i>in vitro</i> fertilization (IVF) clinics around the globe. TL incubators are able to record the development of early stage embryos up to 5 days with an interval of 5 minutes, and up to 40k images are captured during the incubation process. An artificial intelligence algorithm automatically processes all these images, generates the required annotations, and gives the prediction.
<b>PARTNERS</b>		
JSC "Esco Medical Technologies" (Lithuania)		

<b>CONTACT PERSON</b>	<b>Tools, Technologies and Digital Solutions for Health and Care</b>
Dr. Vidas Raudonis vidas.raudonis@ktu.lt	<p>Article in <i>Computer Methods and Programs in Biomedicine</i>, 2019, DOI: <a href="https://doi.org/10.1016/j.cmpb.2019.05.027">10.1016/j.cmpb.2019.05.027</a></p> <p>Article in <i>Sensors</i>, 2019, DOI: <a href="https://doi.org/10.3390/s19163578">10.3390/s19163578</a></p> <p>Article in <i>BioMedical Engineering OnLine</i>, 2019, DOI: <a href="https://doi.org/10.1186/s12938-019-0738-y">10.1186/s12938-019-0738-y</a></p>

	<b>Unobtrusive Technology for Long-Term Monitoring of Self-Terminating Atrial Fibrillation</b>	
		2018–2020

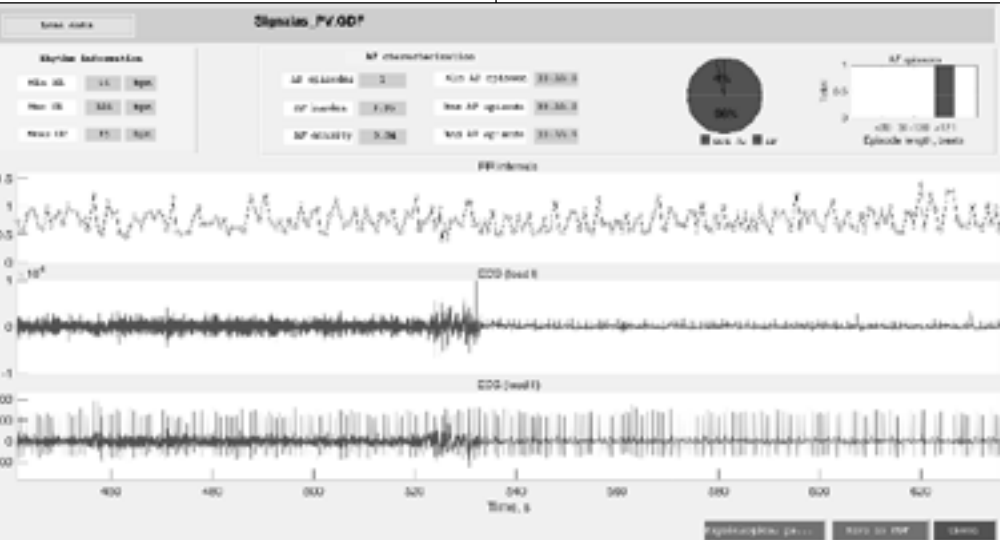
NOVELTY	RELEVANCE	DESCRIPTION
Differently from other manufacturers' products capable of detecting atrial fibrillation-related irregular rhythm during rest periods, the KTU-developed device is programmed for the continuous detection of arrhythmia. To ensure the convenience of long-term monitoring, the information on self-terminating atrial fibrillation is collected by analysing biooptical photoplethysmography signal. A key feature of the device is its ability to acquire a multi-lead intermittent electrocardiogram by touching integrated biopotential electrodes. By transferring and analysing data, the summary on atrial fibrillation occurrence will be provided to a cardiologist and patient via the appropriate app. Consequently, it is expected that the developed technology will stimulate the emergence of new telemedicine services where patients will be equipped with wearables and specific apps informing healthcare providers about the course of arrhythmia management, and enabling new ways in medical treatment personalisation, such as chronotherapy.	In order to prevent patients from arrhythmia-related brain stroke with anticoagulant therapy, atrial fibrillation should be diagnosed first. Developed at KTU, unobtrusive technology for long-term monitoring of cardiovascular health will enable the identification of initial, often asymptomatic, arrhythmia episodes. The capturing of self-terminating arrhythmia episodes will open the possibility to accumulate knowledge of atrial fibrillation circadian characteristics, and may have implications on personalised therapy and prediction of complications.	<p>A research group at Kaunas University of Technology Institute of Biomedical Engineering has developed a wrist-worn device with the embedded atrial fibrillation detection algorithm. Heart arrhythmia is detected in biooptical photoplethysmography signal and is confirmed by acquiring an intermittent electrocardiogram via integrated electrodes.</p> <p><b>PARTNERS</b></p> <p>The technology was tested on patients with atrial fibrillation in collaboration with cardiologists from Vilnius University Santara Clinics. The license to manufacture the device was acquired by Lithuanian high-tech company JSC "Teltonika Telemedic" (Lithuania).</p>



<b>Tools, Technologies and Digital Solutions for Health and Care</b>	<b>CONTACT PERSONS</b>
<p>Patent, 2020, <a href="https://doi.org/10.1088/1361-6579/ab029c">WO2020104986</a></p> <p>Article in <i>Physiological Measurement</i>, 2018, DOI: <a href="https://doi.org/10.1088/1361-6579/ab029c">10.1088/1361-6579/ab029c</a></p> <p>Article in <i>Computers in Biology and Medicine</i>, 2018, DOI: <a href="https://doi.org/10.1016/j.compbiomed.2018.08.027">10.1016/j.compbiomed.2018.08.027</a></p> <p>Article in <i>IEEE Transactions on Biomedical Engineering</i>, 2018, DOI: <a href="https://doi.org/10.1109/TBME.2018.2810508">10.1109/TBME.2018.2810508</a></p> <p>Alcaraz, Raúl; Corino, Valentina D. A.; Laguna, Pablo; Mainardi, Luca T.; Marozas, Vaidotas; Petrėnas, Andrius; Platonov, Pyotr G.; Rieta, José Joaquín; Sandberg, Frida; Sörnmo, Leif. <i>Atrial fibrillation from an engineering perspective</i>. Leif Sörnmo. Cham: Springer, 2018. DOI: <a href="https://doi.org/10.1007/978-3-319-68515-1">10.1007/978-3-319-68515-1</a></p>	<p>Dr. Vaidotas Marozas <a href="mailto:vaidotas.marozas@ktu.lt">vaidotas.marozas@ktu.lt</a></p> <p>Dr. Andrius Petrėnas <a href="mailto:andrius.petrenas@ktu.lt">andrius.petrenas@ktu.lt</a></p>



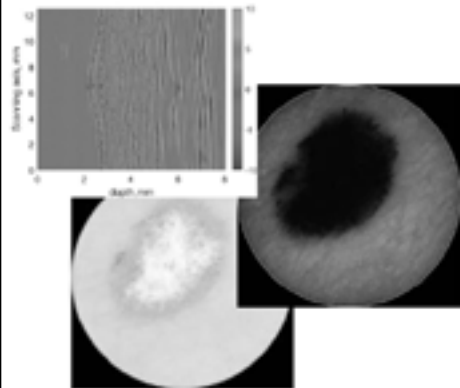
	<b>Method and Biomedical Electronic Equipment for Monitoring Patient's Condition after Brain Stroke</b>	
2020		

RELEVANCE	DESCRIPTION	NOVELTY
<p>A brain stroke is a cardiovascular disease with rapidly evolving clinical signs and disturbances of cerebral function. A post-stroke period is crucial for the recovery of patients. The systematic approach to monitoring both brain and cardiovascular states of the post-stroke patient can help a physician to assess the trends of patients' post-stroke states of health, to predict and to prevent possible complications and comorbidities such as atrial fibrillation, impending cardiovascular crisis and risk of a secondary stroke.</p>	<p>The equipment combines temporal and spatial (tomographic) signals of the cerebral bioimpedance and cardiovascular (electrocardiogram, photoplethysmogram) signals for joint processing and analysis. Multimodal signal processing algorithms are used to follow human post-stroke states, assess the course of the disease, and predict the consequences.</p>	<p>The post-stroke state of health of a patient is evaluated non-invasively by measuring two sets of parameters. The first set of parameters is derived from the measurement of electrical bioimpedance of the brain. The second set includes multi-channel cardiovascular system parameters obtained from electrocardiography, plethysmography, and human motion sensors. All measurements are taken continuously and are synchronised by using an electrocardiogram. The bioimpedance parameters are much faster and cheaper to acquire than computer tomography images. The developed system can be used for the detection of one of the causes of stroke – atrial fibrillation arrhythmia. The analysis of the acquired data could potentially serve for the timely detection of a risk of secondary brain stroke.</p>
		<p><b>PARTNERS</b></p> <p>The research was carried out jointly with JSC "Gruppo Fos Lithuania" (main partner) and Lithuanian University of Health Sciences.</p>

<b>CONTACT PERSONS</b>
<p>Dr. Vaidotas Marozas  <a href="mailto:vaidotas.marozas@ktu.lt">vaidotas.marozas@ktu.lt</a>          Dr. Darius Jegelevičius  <a href="mailto:darius.jegelevicius@ktu.lt">darius.jegelevicius@ktu.lt</a></p>

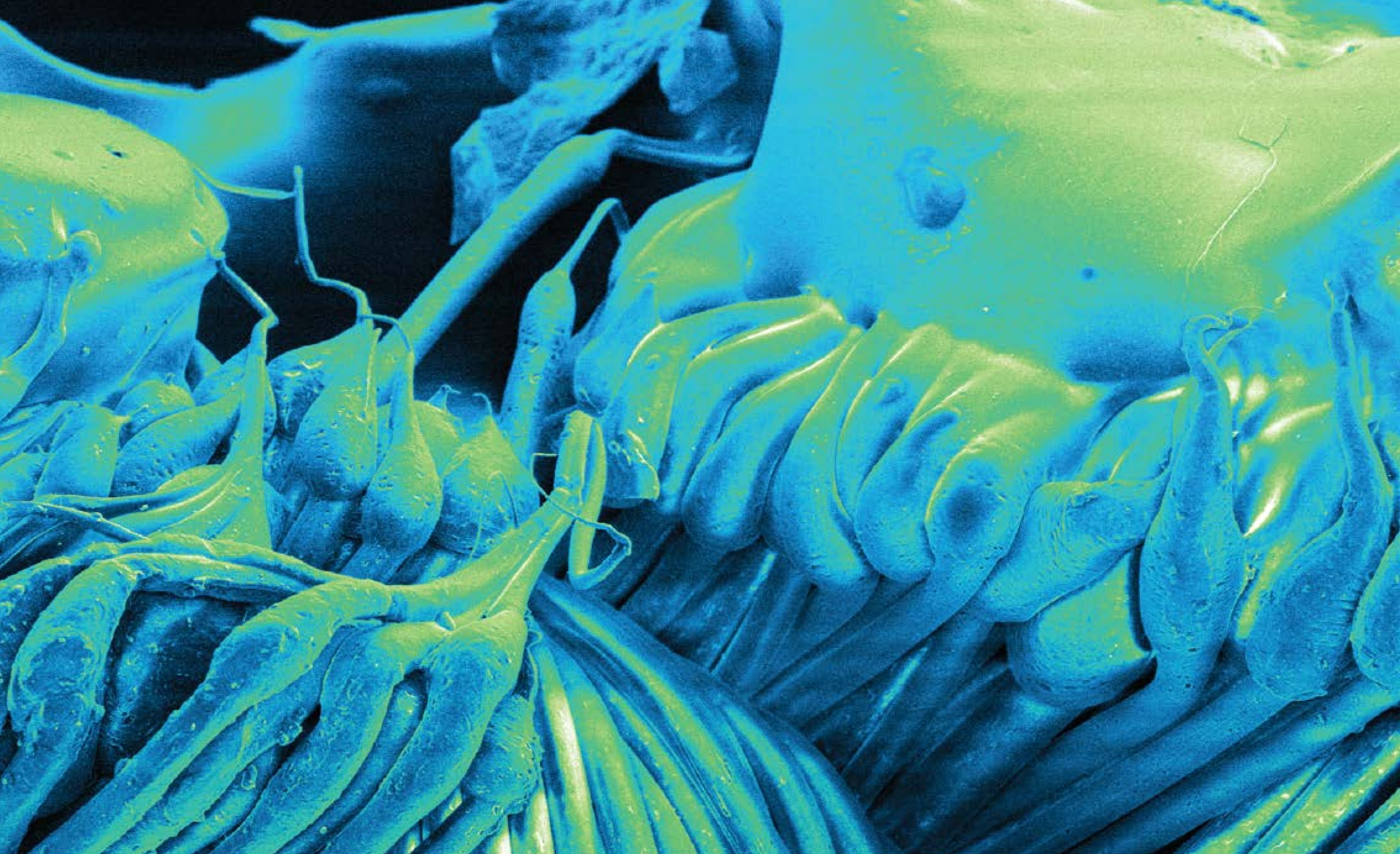
<b>Tools, Technologies and Digital Solutions for Health and Care</b>
<p>Patent application, 2020, <a href="https://patents.google.com/patent/WO2020031104">WO2020031104</a></p>

	<b>Complex Analysis Method of Spectrophotometric and Ultrasound Data for the Automatic Differential Diagnosis of Early Stage Malignant Skin Tumours</b>	
		2016–2020

DESCRIPTION	RELEVANCE	NOVELTY
<p>In 2019, a group of researchers of the Ultrasound Research Institute and Lithuanian University of Health Sciences patented a method for the automatic differential diagnosis of early stage malignant skin tumours based on complex analysis of spectrophotometric and high frequency ultrasound data. This involved analysis and selection of the significant qualitative and quantitative parameters of the non-invasive visualisation methods (spectrophotometric analysis and ultrasonic examination) for the early stage malignant skin tumour diagnosis.</p>	<p>Skin melanoma (or malignant melanoma, MM) is the most aggressive malignant skin tumour, which occurs due to DNA damage of the melanocytic cells. The incidence rate of the MM is growing worldwide (Garbe et al., 2016). The incidence rate of MM in Lithuania increased three times during the period of 1978–2002, and is currently 11.6 cases per 100 000 people (National Cancer Prevention and Control Programme 2014–2025). The incidence rate of MM in Europe is about 10-20 cases, in the USA – 20-30 cases and in Australia 50-60 cases per 100 000 population each year (Garbe et al., 2016).</p> <p>Early stage diagnosis of MM is crucial for for excision and patient survival. Therefore, the demand arises for the development of a non-invasive method which is suitable to perform at early stage diagnosis of MM, because conventional diagnostic methods are invasive or non-invasive methods are insufficiently accurate (close to 65 %) and are not suitable to perform the early stage diagnosis.</p>	<p>Using complex automatic analysis of the parameters obtained from two non-invasive imaging modalities (spectrophotometer and ultrasound) of the skin tumours increases the diagnostic accuracy of the patented new method, which could be a valuable addition to currently used clinical methods for diagnosing melanoma. The method can increase the accuracy higher than 90% of differential diagnostic of melanoma, thus reducing the number of unnecessary surgeries and pathological examinations, alleviating the risk to the patients, the economic costs and the time required for periodical examination.</p>
		<p><b>PARTNERS</b></p> <p>Department of Skin and Venereal Diseases of Lithuanian University of Health Sciences</p>

<b>Tools, Technologies and Digital Solutions for Health and Care</b>	
<p>Project "Complex Analysis Method of Spectrophotometric and Ultrasound Data for the Automatic Differential Diagnosis of Early Stage Malignant Skin Tumours (SkinImageFusion)", No. MIP1791, 2017-2020, funded by Research Council of Lithuania          Patent "Complex Analysis System of Spectrophotometry and Ultrasound Images and Data for Automatic Early Stage Diagnostic of Malignant skin Tumours", 2019, <a href="https://patents.google.com/patent/US2019016670">US 6670</a>          Article in <i>Ultrasound in Medicine &amp; Biology</i>, 2016, DOI: <a href="https://doi.org/10.1016/j.ultrasmedbio.2016.07.026">10.1016/j.ultrasmedbio.2016.07.026</a>          Article in <i>Skin Research and Technology</i>, 2018, DOI: <a href="https://doi.org/10.1111/srt.12587">10.1111/srt.12587</a>          Article in <i>Diagnostics</i>, 2020, DOI: <a href="https://doi.org/10.3390/diagnostics10090632">10.3390/diagnostics10090632</a></p>	<p><b>CONTACT PERSON</b></p> <p>Dr. Renaldas Raišutis  <a href="mailto:renaldas.raisutis@ktu.lt">renaldas.raisutis@ktu.lt</a></p>





CULTURE, CREATIVITY AND  
INCLUSIVE SOCIETY

HV 5.00 kV

mag 1000 x

100  $\mu$ m

WD 7.8 mm


det LFD

spot 2.0


Dr. Virgilijus Urbelis

Textile fabric



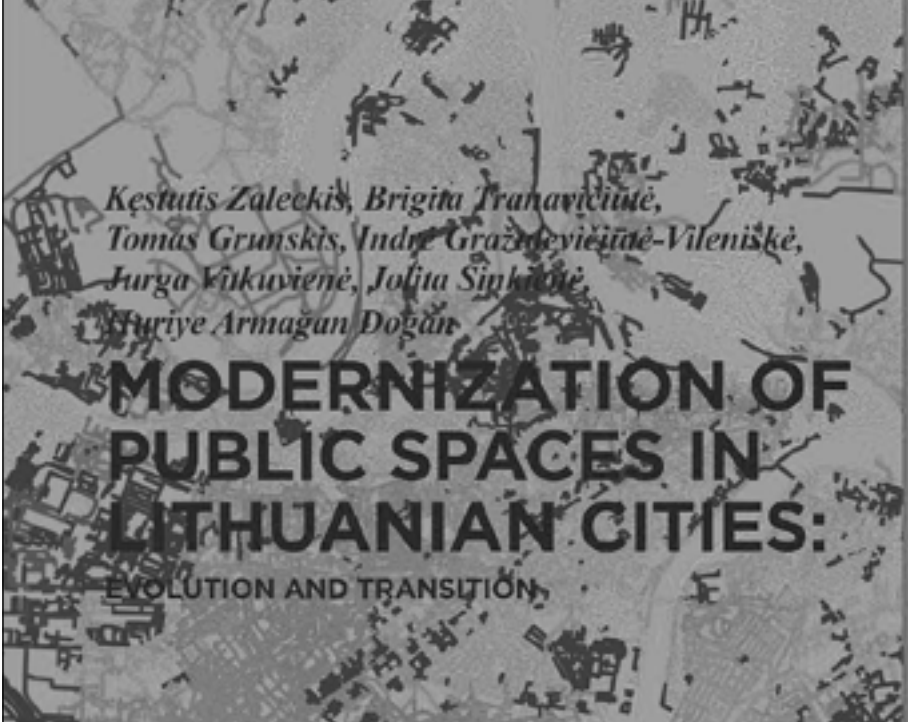
2018–2021	<b>Democratic Efficacy and the Varieties of Populism in Europe (DEMOS)</b>		<b>Politics with a Human Face: Identity and Experience in Post-Soviet Europe</b>		
DESCRIPTION	RELEVANCE	NOVELTY	RELEVANCE	DESCRIPTION	NOVELTY
<p>The Horizon 2020 programme project, DEMOS, is built on the assumption that populism is symptomatic of disconnection between how democratic polities operate and how citizens perceive their own aspirations, needs and identities within the political system. As such, DEMOS explores the practical value of “democratic efficacy” as the condition of political engagement needed to address the challenge of populism.</p>	<p>DEMOS combines in-depth research on populism and democratic efficacy with action research and pilot projects in order to develop lasting tools and timely policy recommendations; project methods include experiments, deliberative polling, text mining, surveys, and legal analysis. DEMOS focuses not only on the polity, but equally on citizens’ perspectives: how they are affected by, and how they react to populism. Politically underrepresented groups and those targeted by populist politics are of particular focus, e.g. youth, women, and migrants.</p>	<p>Based on developed indicators and predictors of populism, DEMOS elaborates scenarios on the interactions of populism with social actors and institutions both at national and EU levels.</p>	<p>The book creates a better understanding of the paradoxical side of politics. In times of post-truth and populism, it provides a theoretical premise to understand these new political realities and their role in shaping public life.</p>	<p>The monograph presents a holistic study of post-Soviet political identity formation processes. Its aim is to analyse the ways that human factors, such as imaginaries, human experiences, political myths and historical narratives, affect post-Soviet politics. A study at the juncture of Social Sciences and Humanities, <i>Politics with a Human Face</i> explores a number of cases, including Estonia, Lithuania, Poland and Russia, as well as the ongoing conflict in Ukraine, examining issues of liminal transition, far-right movements, victimhood, ethnic conflict and political paradoxes. As a result, the monograph presents a discussion on how post-Soviet identities were defined and structured by human experience, appeals to political mythologies and historical narratives, instead of more obvious rationalist economic or policy factors.</p>	<p>The book presents a unique interdisciplinary combination of inquiry that accounts for the cultural and human side of politics. Its novelty lies in its approach in political sciences: the book integrates literal and visual methods in exploring the impact of human experience and imagination on political structures and institutions. The monograph offers a theoretical approach for assessing the influence of non-rationalistic factors, such as associative symbolism, human experience, political images and historical narratives, in both domestic and foreign affairs.</p>
					
CONTACT PERSON		Democracy and Governance	Democracy and Governance		CONTACT PERSON
Dr. Eglė Butkevičienė <a href="mailto:egle.butkeviciene@ktu.lt">egle.butkeviciene@ktu.lt</a>		H2020 project 822590 <a href="#">DEMOS</a> , 2018-2021	Scientific Monograph: Grišinas Arvydas, <i>Politics with a Human Face: Identity and Experience in Post-Soviet Europe</i> . Routledge, 2018, ISBN 9781138242197. DOI: <a href="https://doi.org/10.4324/9781315278971">10.4324/9781315278971</a>		Dr. Arvydas Grišinas <a href="mailto:arvydas.grisinas@ktu.lt">arvydas.grisinas@ktu.lt</a>

	<b>Conservation Management Plan for the Historical Military Research Laboratory in Kaunas</b>	
2019–2021		

DESCRIPTION	RELEVANCE	NOVELTY
<p>Project funded by the Getty Foundation programme “Keeping It Modern”. Kaunas University of Technology Institute of Architecture and Construction, together with a team of researchers and partners from other institutions, will undertake the historical and physical investigation of the former Military Research Laboratory (now Faculty of Chemical Technology of Kaunas University of Technology). Based on open discussion with the heritage community on the physical assessment of the condition of the building and theoretical research of cultural values, the project will propose a practical conservation management plan, which will serve as a model for other cultural heritage sites in Lithuania and the region.</p>	<p>The main goal of the management plan is to create a strategy for the preservation of the Research laboratory that meets the challenges of the 21st century. It will ensure a sustainable balance between today’s functions, preservation of valuable authentic elements and presentation and opening of object values to the public. The value of a historic building is presented not only as a material work of art or technology, but also as a unique history of the university and the city community.</p>	<p>The conservation management plan as an integral document based on thorough research of physical condition, historical values and detailed analysis of the constraints and opportunities arising out of the object’s significance is an innovative approach in the cultural heritage preservation sector.</p>
		
<b>PARTNERS</b>		
<p>Kaunas City Municipality (Lithuania); Bartlett School of Architecture, University College London (UCL) (United Kingdom)</p>		

<b>CONTACT PERSON</b>	<b>Culture, Cultural Heritage and Creativity</b>
Dr. Vaidas Petruolis <a href="mailto:vaidas.petruolis@ktu.lt">vaidas.petruolis@ktu.lt</a>	<a href="#">Getty Foundation project</a> “Laboratory for Faculty of Chemical Technology at Kaunas University of Technology, Vytautas Landsbergis-Zemkalnis, 1935, Kaunas, Lithuania”

	<b>Modernisation of Public Spaces in Lithuanian Cities: Evolution and Transition</b>	
		2020

DESCRIPTION	RELEVANCE	NOVELTY
<p>The monograph presents the complex analysis and evaluation of the changes in the social-spatial genotype of the largest Lithuanian cities (Kaunas, Klaipėda and Vilnius) caused by the modernist urbanisation of the Soviet era. The interdisciplinary theory of networks and mathematical network models are the main methodological tools in the research. The idea behind the monograph is that the modernistic urbanism not only introduced the new spatial configurations in a specific location of a city with a specific social scenario of public space usage, but essentially affected the overall functioning of the city. Soviet transformations of the three largest Lithuanian cities in 1939–2016 are used as examples of the aforementioned processes.</p>	<p>Despite the fact that the monograph represents historical urban analysis, its results could be used while creating scenarios for contemporary urban regenerations – especially for those of modernistic urban blocks.</p>	<p>The methods used in the research presented in the monograph combine content analysis of pictures of public spaces, sociotope mapping and multimodal space syntax graphs in order to create a complex understanding of dependencies between special transformations and street culture.</p>
		

<b>Culture, Cultural Heritage and Creativity</b>	<b>CONTACT PERSON</b>
<p>Scientific Monograph: K. Zaleckis, B. Tranavičiūtė, T. Grunskis, I. Gražulevičiūtė Vileniškė, J. Vitkuvienė, J. Sinkienė, H. A. Doğan. (Editor K. Zaleckis) <i>Modernisation of Public Spaces in Lithuanian Cities: Evolution and Transition</i>, De Gruyter Sciendo, 2020, <a href="#">ISBN 9788395793868</a></p>	Dr. Kęstutis Zaleckis <a href="mailto:kestutis.zaleckis@ktu.lt">kestutis.zaleckis@ktu.lt</a>



	<b>Future-Oriented Science Education to Enhance Responsibility and Engagement in the Society of Acceleration and Uncertainty (FEDORA)</b>			<b>The Changing Face of Innovation in China</b>	
2020–2023					2018

DESCRIPTION	RELEVANCE	NOVELTY	DESCRIPTION	RELEVANCE	NOVELTY
<p>The overarching goals of Horizon 2020 programme project FEDORA are to produce a new future-oriented approach to science education and to foster proactive and anticipatory policy-making aimed at aligning science education (a key component of responsible research and innovation, RRI) with the fast-changing society and with the fast-changing modus operandi of Research &amp; Innovation (R&amp;I). The aim of the approach is to provide young people with thinking and future-scaffolding skills (Branchetti et al., 2018). Among possible thinking skills, FEDORA will focus on inter-multi-trans-disciplinary, linguistic/argumentative and imaginative skills needed to grapple with the new methods of R&amp;I and to enhance the capacity to talk of and about the societal challenges. As for the abilities to navigate the world with an Anticipation-Action-Reflection mindset (OECD, 2018), FEDORA will focus on future-scaffolding skills: they refer to the ability to construct visions of the future (anticipation) that empower action in the present, in a responsible and sustainable way (reflection). Future-scaffolding skills include scenario thinking, systems thinking, thinking beyond the realm of possibilities, action competence, and managing uncertainty and complexity.</p>	<p>FEDORA's research outcomes will contribute to: a) breaking down the current institutional, conceptual and cultural barriers that hinder an effective cooperation between institutions to improve the relations between science and society; b) developing new languages, narratives and forms of knowledge transmission able to equip citizens with the thinking skills required to get oriented and actively participate in the contemporary challenges of a society of acceleration and uncertainty, in a responsible and sustainable way; c) futurising science; d) developing a future-oriented, inter-multi-trans-disciplinary and diversity-responsive approach to science education; e) suggesting strategies for proactive and anticipatory policy-making to align educational institutions; f) forming a new generation able to manage the complexities of a fast-changing and fragile world and value science learning as locus of identity formation as persons, responsible citizens more engaged in science and future science, technology, engineering, maths (STEM) professionals.</p>	<p>FEDORA focuses on the variable "tempo" as the key to point out the three blind spots that concern people's needs, and that emerge from difficulties that the educational institutions encounter to keep the pace of change of R&amp;I and society. The three blind spots regard the inertia of formal education systems (i) to revise the current organisation in disciplines, (ii) to open up the classes to new languages and expertise coming from society and science communication and (iii) to foster the Anticipation-Action-Reflection mindset that represents a compass to navigate contemporary society (OECD, 2018).</p>	<p>The article identifies emergent management challenges in an assertive China and issues general strategy recommendations.</p> <p>Until recently in China, foreign research and development (R&amp;D) competed against other foreign R&amp;D in higher-end markets, while Chinese companies operated in lower-end markets. But with enhanced Chinese capabilities, the context for succeeding in China has changed:</p> <ol style="list-style-type: none"> <li>1. Western multinational corporations are no longer the first choice for top talent.</li> <li>2. China's intellectual property regime has been strengthened.</li> <li>3. Sharing Western technology becomes higher-risk.</li> <li>4. Maturing markets and heavier state influence makes China innovation costlier and slower.</li> <li>5. Time-to-market becomes even more important.</li> </ol> <p>The authors recommend a better balance between Chinese localisation and internationalisation, engaging selectively in cutting-edge innovation in China, and focusing on talent, culture, and operations toward faster time-to-market.</p>	<p>Massachusetts Institute of Technology (MIT) Sloan Management Review used the issue with this cover article at the world's main academic management conference, the Academy of Management (AOM) Meeting in Chicago, August 2018, attended by some ten thousand management researchers and practitioners. The article was also an early contribution to the emerging policy debates of increasing global technology influence by Chinese firms, affecting the U.S.-China trade war and recent revisions in the European Union's position towards China. The MIT Sloan Management Review is among 50 prestigious journals used for ranking Business Schools by The Financial Times (FT-50).</p>	<p>The topic is only emerging, and its implications are intensively debated at top-government levels in Europe, the U.S. and China. After having published several articles in academic journals, the authors approached the MIT Sloan Management Review for publishing a managerial summary of the research results.</p>



<b>CONTACT PERSONS</b>		<b>Social and Economic Transformations</b>	<b>Social and Economic Transformations</b>		<b>CONTACT PERSON</b>
<p>Dr. Raminta Pučėtaite  <a href="mailto:raminta.pucetaite@ktu.lt">raminta.pucetaite@ktu.lt</a>                  Dr. Brigita Janiūnaitė  <a href="mailto:brigita.janiunaite@ktu.lt">brigita.janiunaite@ktu.lt</a>                  Dr. Rimantas Rauleckas  <a href="mailto:rimantas.rauleckas@ktu.lt">rimantas.rauleckas@ktu.lt</a></p>		<p>H2020 project 872841 <a href="#">FEDORA</a>, 2020-2023</p>	<p><a href="#">Article</a> in <i>MIT Sloan Management Review</i>, 2018. D. Prud'homme; M. von Zedtwitz. "The Changing Face of Innovation in China: Foreign companies must retool their R&amp;D strategies to keep pace with newly innovative Chinese enterprises"</p>		<p>Dr. Maximilian Joachim von Zedtwitz  <a href="mailto:max.zedtwitz@ktu.lt">max.zedtwitz@ktu.lt</a></p>





CIVIL SECURITY  
FOR SOCIETY

HV 15.00 kV

mag 1000 x

100  $\mu$ m

WD 9.7 mm

det ETD

spot 2.5

Dr. Ramunė Rutkaitė


Granules of starch derivatives



2019	<b>Governing the Termination Problem in Solar Radiation Management</b>	

	<b>Climate Change Risk Perception in Europe: Natural Hazards, Political Contexts and Mediating Individual Effects</b>	2019
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RELEVANCE	DESCRIPTION	NOVELTY
<p>In the intensifying political, scientific, and societal debates on Solar Radiation Management (SRM) in the face of an intensifying climate crisis, the termination problem is widely understood as an external constraint on governability. This article demonstrates that this need not be the case and that there are endogenous governance solutions in existence. It therefore provides an impetus towards a theoretically more robust discussion on SRM and related climate engineering technologies.</p>	<p>Technologies for SRM have been proposed for counteracting global warming by manipulating the Earth's radiation balance. The termination problem, referring to catastrophic global impacts from sudden discontinuation, is widely considered a major objection to SRM. This is the first article which assesses the institutional design questions for resolving the termination problem. Based on an analysis of potential scenarios and drivers, the publication proposes institutional solutions in the form of excludable benefits, scientific oversight and phase-out mechanisms.</p>	<p>Whereas hundreds of scientific articles on SRM have been published in geosciences, atmospheric physics and related disciplines, very few publications from the social sciences assess questions related to the governance of such high-risk technologies. This article breaks new ground by endogenising the termination problem into the discussion of governance by demonstrating the invalidity of a range of intuitive, common-sense assumptions.</p>



DESCRIPTION	RELEVANCE	NOVELTY
<p>The article looks into the complex structure of underlying factors determining public risk perceptions of climate change, combining individual level indicators (related to social structures) and macro level indicators (at national level) related to the countries' exposure to natural hazards and national political contexts in European countries. The article analyses data from the Eurobarometer (2017) survey, including 20 713 respondents from 28 countries. Multilevel mixed-effect linear regressions were applied. The results of the research reveal that a few macro level variables related to natural hazards can explain climate change risk perceptions (such as temperature rise or water deficit), and political contexts at macro level do not sufficiently explain the variance in the levels of concern about climate change. However, individual level variables (education and political orientation) significantly mediate how natural hazards and political contexts influence climate change risk perception.</p>	<p>This study contributes to the understanding of objective and contextual factors and mediating effects that shape climate change risk perception in Europe. Furthermore, the analytical technique used in this study – namely multi-level analysis – advances the understanding of multidimensionality of climate change risk perceptions.</p>	<p>The article uses multilevel analysis, which is not often employed in climate change perception research. Our study is innovative in several ways: we incorporate both natural and political dimensions in the macro level, and we also consider the mediating effects across levels. Moreover, this article adds new insights into the methodological approaches of climate change risk perception research. Therefore, the publication significantly contributes to the understanding of the multidimensionality of climate change risk perceptions.</p>
<b>PARTNERS</b>		
<p>The article is co-authored with José Manuel Echarren, Universidad Pablo de Olavide (Spain).</p>		

<b>CONTACT PERSON</b>	<b>Disaster Resilient Societies</b>
Dr. Florian Rabitz florian.rabitz@ktu.lt	Article in <i>Environmental Politics</i> , 2019, DOI: <a href="https://doi.org/10.1080/09644016.2018.1519879">10.1080/09644016.2018.1519879</a>

<b>Disaster Resilient Societies</b>	<b>CONTACT PERSONS</b>
Article in <i>Safety Science</i> , 2019, DOI: <a href="https://doi.org/10.1016/j.ssci.2019.08.024">10.1016/j.ssci.2019.08.024</a>	Dr. Aistė Balžekienė aiste.balzekiene@ktu.lt Dr. Audronė Telešienė audrone.telesiene@ktu.lt





DIGITAL, INDUSTRY  
AND SPACE

HV 5.00 kV

mag 4000 x

WD 9.9 mm

det ETD

40  $\mu$ m

spot 2.0

Dr. Dalia Nizevičienė

Gypsum crystals



2018	<b>Conformity Assessment Measurement Methods for Traceability Assurance</b>	

RELEVANCE	DESCRIPTION	NOVELTY
<p>Collaboration with industrial partners, contracts and market-oriented research projects led to the development of innovative and competitive products that are intended for metrological supervision, diagnostics, and process control. The experiences were widely used in expanded expert activity and non-formal learning. Some research results were applied directly in practice, leading to a resolution of conflicts arising in commercial transactions and litigations.</p>	<p>Research carried out, together with industrial partners, encompasses modelling for the companies that own or develop measurement systems for time accounting, dynamical multi-function, electromagnetic disturbance detection and other purposes. The aims of the research were proposals for the stability and systematic error analysis, and the reduction of systematic errors. In order to reach the aim, complex solutions related to the certification of measuring systems, integration of new (unique) measuring transducers, measuring instruments into technological control and traceability assurance processes, sensor networks metrological supervision infrastructure were implemented. One of the research results is the suggested method for the energy meter's remote error monitoring. The main idea of the method is based on a temporary injection of the additional load at the location of a remote device and acquisition of synchronised power readings by both reference and remote devices.</p>	<p>New methods of conformity assessment were proposed, disclosing potential metrological problems associated with possible improper installation of measuring instruments, their aging, contamination and other factors. The suggested method for the energy meter's remote error monitoring cancels the influence of the measurement unit propagating medium between the reference and remote devices.</p>
<b>PARTNERS</b>		
JSC "Telia Lietuva" (Lithuania); JSC "Orlen Lietuva" (Lithuania); JSC "Fima" (Lithuania)		

<b>CONTACT PERSON</b>	<b>Manufacturing Technologies</b>
Dr. Žilvinas Nakutis zilvinas.nakutis@ktu.lt	Article in <i>IEEE Transactions on Instrumentation and Measurement</i> , 2019, DOI: <a href="https://doi.org/10.1109/TIM.2018.2857118">10.1109/TIM.2018.2857118</a>

	<b>Sustainable Technology of Potassium Dihydrogen Phosphate Production and Liquid Waste Recovery</b>	2018

DESCRIPTION	RELEVANCE	NOVELTY
<p>During the research, highly concentrated fertiliser potassium dihydrogen phosphate from potassium chloride and ammonium dihydrogen phosphate via conversion was created. It was discovered that the interaction between KCl and <math>\text{NH}_4\text{H}_2\text{PO}_4</math> in aqueous solution when molar ratio of the starting materials 0.8:0.2 is the most suited for pure <math>\text{KH}_2\text{PO}_4</math> composition. Optimal reaction time was 5 hrs, and temperature – 600 °C. The best parameters of granular potassium dihydrogen phosphate (65 % marketable fractions, static strength of the granule – 8.73 N/gran.; moisture of the granule – 1.7 %) was obtained with the drum granulator when the raw material mixture contained 5 % cellulose and 21 % humidity. After the reaction between potassium chloride and ammonium dihydrophosphate and the removal of solid potassium dihydrophosphate, the liquid fraction is left. This by-product liquid fraction could be use as a liquid fertilizer. It is possible to produce the liquid fertilizer 4–5–15 grade by adding 6 % of <math>\text{CO}(\text{NH}_2)_2</math> or 8 % of <math>\text{NH}_4\text{NO}_3</math> wherein the crystallisation temperature is 15 °C or 6 °C. Such solutions can be used to produce summer liquid fertilisers for cereal.</p>	<p>A griculture is one of the crucial industries in the world in terms of food production and employment provision for millions of people. In the context of the systematic growth of the worldwide population without the increase of the total area of arable land, the sufficient amount and quality of food products may only be ensured by employing all the available strategies contributing to the efficiency of agriculture. In order to achieve the maximum potential of the fertility of various crops, fertilizers are used and their manufacturing technologies are systematically improved, novel fertilisers are devised, and new methods of obtaining fertilisers in more efficient ways are created. One of the ways of boosting the impact of fertilisers is the production of concentrated fertilisers while using the cheapest available raw materials and the simplest methods of manufacturing.</p>	<p>The production of potassium dihydrogen phosphate commonly involves expensive raw materials; for example, phosphoric acid, potassium hydroxide or potassium carbonate. In this work, equilibrium parameters of potassium chloride and ammonium dihydrogen phosphate in aqueous solutions were researched, and optimal conditions for obtaining potassium dihydrogen phosphate via conversion were obtained. The main product of a conversion reaction can be separated by filtering and can be granulated using drum granulator. Residual filtrate can be used for the production of a liquid complex fertilizer, therefore the phase equilibrium diagrams from the liquid phase are established, and the influence of the urea and ammonium nitrate additives on the properties of fertilizers is assessed. This method of conversion enables the production of granular chlorine-free phosphorus potassium (PK) fertilizer and liquid compound fertilizer suitable for fertilizing fields. Using this conversion method the replacement of costly substances with cheaper ones make the final product cheaper, no waste is generated, therefore the viability and economy of its use is increased.</p>

<b>Manufacturing Technologies</b>	<b>CONTACT PERSON</b>
Patent "Method for Producing of Potassium Dihydrogen Phosphate", 2018, <a href="#">LT 6403</a> Article in <i>Chemical Industry and Chemical Engineering Quarterly</i> , 2018, DOI: <a href="https://doi.org/10.2298/CICEQ160705019J">10.2298/CICEQ160705019J</a> Article in <i>Chemical Industry and Chemical Engineering Quarterly</i> , 2020, DOI: <a href="https://doi.org/10.2298/CICEQ191029013J">10.2298/CICEQ191029013J</a>	Dr. Rasa Šlinkšienė rasa.slinksiene@ktu.lt

2018	<b>Waterproof and Heat-Insulated Safe: Filler and Constructor</b>	

RELEVANCE	DESCRIPTION	NOVELTY
<p>During the research, a unique safe was created: although there are class III and IV security safes, there are fewer that are certified as fire-resistant, and there is none that can be filled with water and preserve the contents of the documents inside in the event of a fire.</p>	<p>A new generation of safe has been developed with the following performance characteristics: (safe size 670x510x510 mm, weight not exceeding 270 kg and wall thickness not exceeding 45 mm): burglary resistance – class III according to EN 1143-1; fire resistance – 30 min. LFS 30P according to EN 15659; water resistance is the ability to maintain a tightness at a depth of 4m (i.e., a water pressure of 1.4 atmospheres (0.4 MPa)).</p>	<p>To achieve the results, ultra-high strength concrete with a compressive strength above 150 MPa, developed at Kaunas University of Technology, was used. Safe spatial geometric and computational models were created using Solidworks software, thermal regime calculations were performed using Solidworks Simulation. Nonlinear problems of modelling the transient processes of time-varying external effects and temperature-dependent material properties were solved. The initial data for the computational analysis were the relevant thermal impact assessment standards EN 15659 and EN 1363-1, the nominal size of the safe, wall construction variants (position of the thermal insulation layer inside the wall and special coating outside), the materials used to make the safe (steel, concrete filler, thermal insulation materials) and special thermal insulation paints basic physical-mechanical properties.</p>



	<b>An Ultrasonic Non-Destructive Testing System for Detection and Quantification of Early Stage Subsurface Creep Damage in the Thermal Power Generation Industry (CreepUT)</b>	
		2017–2019

DESCRIPTION	RELEVANCE	NOVELTY
<p>The aim of the project is the development of an ultrasonic measurement system for inspection of existing pipelines of power generation industry, in order to detect the subsurface damages due to creep and the validation for detection of this damage mechanism in its early stages.</p>	<p>Creep is the time-dependent, thermally assisted deformation of a component operating under stress. It is often a key factor to keep in mind not only when designing the components used in the power generation industry, particularly in fossil fuel and nuclear plants, but also when assessing their longevity. Pressurised components such as boiler tubing, headers, and steam piping in fossil-fuel power plants operate at temperatures of 538°C up to about 570°C and this causes appearance of creep damage over the operating life of the pipeline components.</p>	<p>During the project, a special high frequency and low noise ultrasonic measurement system for generation, reception, amplification and digitisation of ultrasonic wave signals was developed. The lab testing and validation of the developed system using the real X20CrMoV121 and P91 samples with welds were performed. Furthermore, the on-site experiments were performed in a power plant in Lithuania. The sophisticated post-processing algorithm and the software for detection of the internal regions of the pipe wall affected by creep damage were developed.</p>
<b>PARTNERS</b>		
INETEC (Croatia); TWI Limited (United Kingdom); Public Power Corporation S.A. (Greece)		



<b>CONTACT PERSON</b>	<b>Manufacturing Technologies</b>
Dr. Vitoldas Vaitkevičius <a href="mailto:vitoldas.vaitkevicius@ktu.lt">vitoldas.vaitkevicius@ktu.lt</a>	Research work "Safe with water and thermal insulation, filler and constructive development" with cooperation of company JSC "Seifuva" (Lithuania)

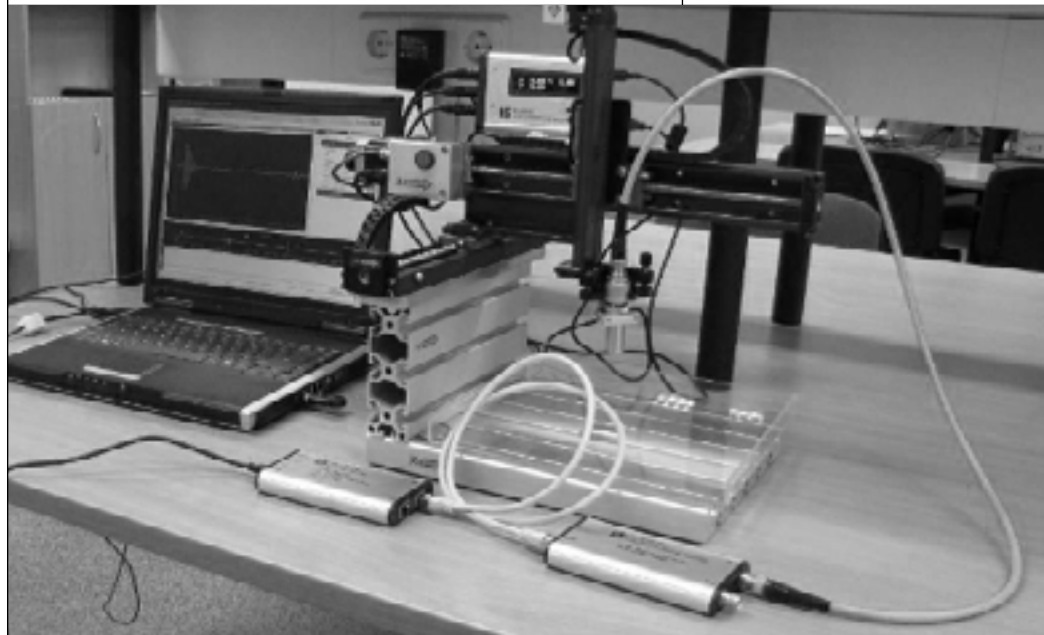
<b>Manufacturing Technologies</b>	<b>CONTACT PERSONS</b>
H2020 project 760232 <a href="#">CreepUT</a> , 2017-2019	Dr. Liudas Mažeika <a href="mailto:liudas.mazeika@ktu.lt">liudas.mazeika@ktu.lt</a> Dr. Renaldas Raišutis <a href="mailto:renaldas.raisutis@ktu.lt">renaldas.raisutis@ktu.lt</a>

	<b>Methods and Systems for</b>	
2018	<b>Detection of Objects in a High Temperature Environment</b>	

RELEVANCE	DESCRIPTION	NOVELTY
<p>MYRRHA is the project of the Belgian Nuclear Research Centre SCK CEN. It is an accelerator-driven system with a non-critical fission core providing protons and neutrons for nuclear waste transmutation, production of radioisotopes, irradiation purposes, etc. The core of the reactor is cooled by a liquid Pb-Bi eutectic. The new IV generation of nuclear reactors such as MYRRHA requires a novel approach in non-destructive technologies. The patented technology will allow a safe operation of the generation IV nuclear reactors. For safety and licensing reasons, an imaging method of the interior of accelerator driven system, based on application of ultrasonic waves, was developed.</p>	<p>The Generation IV fast critical reactors such as the Multi-Purpose Hybrid Research Reactor for High-Tech Applications (MYRRHA) developed in the Belgian Nuclear Research Centre SCK CEN in Belgium are cooled by liquid lead-bismuth eutectic. In order to solve the inspection issue SCK CEN and the Ultrasound Research Institute of Kaunas University of Technology collaborated on the development of ultrasonic ranging and imaging techniques for this particular application. The joint patent is devoted to manufacturing technology of ultrasonic transducers resistant to high temperature, and neutron radiation that operate continuously in a liquid Pb-Bi alloy up to a temperature of 450°C. The main problems were acoustic coupling of a piezoelectric element to a protector and wetting of the sensor by a heavy liquid metal. The piezoelectric element was attached to the sensor body by a gold to gold diffusion bonding process, assisted by low frequency ultrasonic vibrations. Long-lasting wetting of the active surface of the sensors was achieved by coating the front face with a protective diamond-like carbon layer.</p>	<p>The developed manufacturing technology, based on gold to gold diffusion bonding of ultrasonic transducer elements, allows the achievement of a long term operation in high temperature and radioactive environments. This is a major technological breakthrough in the field of ultrasonic transducers used for non-destructive testing and measurements.</p>
<b>PARTNERS</b>		
SCK CEN (Belgium)		

<b>CONTACT PERSON</b>	<b>Manufacturing Technologies</b>
Dr. habil. Rymantas Jonas Kazys <a href="mailto:rymantas.kazys@ktu.lt">rymantas.kazys@ktu.lt</a>	Patent, 2018, <a href="#">FR 2980268</a>

	<b>Ultrasonic Measurement System for Nanocomposite Research</b>	2017-2019
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DESCRIPTION	RELEVANCE	NOVELTY
<p>This system enables the evaluation and control of the dispersion of dopant nanoparticles in the composites. Hardware and software were developed for the non-destructive automatic characterisation of mechanical property spatial distribution within the sample. Evaluation is performed using spread spectrum ultrasonic signals. Information obtained represents elastic constants of composites (Young's, Bulk, Shear Modulus and Poisson's ratio), in addition to other parameters such as density, sound velocity and thickness, providing information of nanoparticle dispersion in the samples.</p>	<p>Dispersion evaluation of nanoparticle doping is important in nanocomposite development. The technique developed allows to obtain 2D images of mechanical property distribution.</p>	<p>Conventional signals do not allow for simultaneous bandwidth and signal-to-noise ratio. In the research, novel class of spread spectrum signals was used including arbitrary position and width pulses' (APWPP) sequences. This type of signal provides ability to program spectral shape and correlation properties of the signal used for probing.</p>
		
<b>PARTNERS</b>		<b>PARTNERS</b>
		Miguel Hernández University (Spain)

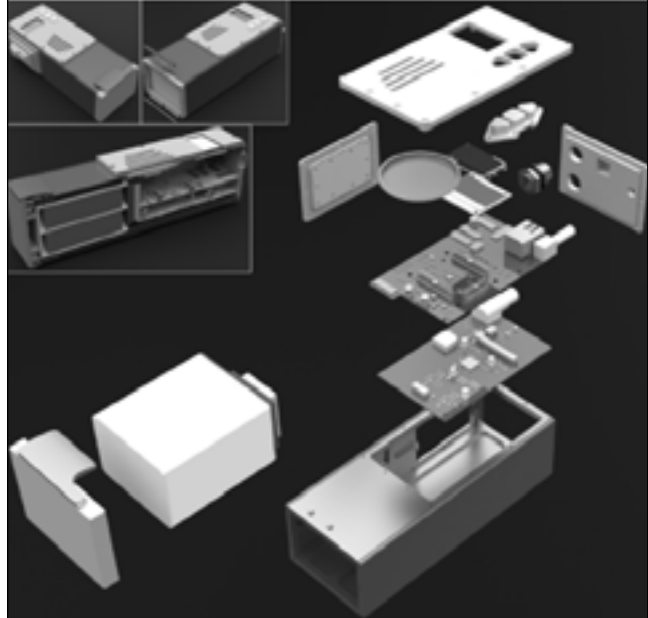
<b>Key Digital Technologies</b>	<b>CONTACT PERSON</b>
<p>Article in <i>Ultrasonics</i>, 2017, DOI: <a href="#">10.1016/j.ultras.2017.01.003</a>            Article in <i>Ultrasonics</i>, 2018, DOI: <a href="#">10.1016/j.ultras.2017.06.017</a>            Article in <i>IEEE Transactions on Instrumentation and Measurement</i>, 2018, DOI: <a href="#">10.1109/TIM.2018.2809838</a></p>	Dr. Linas Svilainis <a href="mailto:linas.svilainis@ktu.lt">linas.svilainis@ktu.lt</a>

	<b>Multifunctional Automatized Mecha- tronic Solutions for Electronic Devices’ Programming, Testing and Classifica- tion after Manufacturing</b>	
2017–2018		

RELEVANCE	DESCRIPTION	NOVELTY
<p>Thorough tests increase the reliability of the product, reduce production time and the costs of labour at the integration stages of the final product; they can also shorten the product delivery time to the end user. Testing possibilities of different products on the same system reduce the cost of tool production.</p>	<p>The multifunctional, automatized system ensures firmware updates, generation of multi-stimuli signals, multi-parameter measurements, preparation of flexible test strategies, a comprehensive analysis of functional testing results pointing to possible defects in assembling, and components. The developed system is compatible with 6 different products.</p> <p>The system combines: Different FPGA, CPLD, MCU, Flash memory programmers; different interfaces testing tools; programmable stimulus sources; programmable power sources; programmable load sources; different reactions parameters measurement units; automatic visual testing of DUT displays; mechanical stimulation of DUT pushbuttons and touch screens; mechanical positioning parts; SW tool for testing process development; SW tools for bugs localization; traceability measures for different DUT using RFID's; mechanical parts for products classification.</p>	<p>The testing systems that are currently available on the market are usually non-adaptive and can be used only to test one type of product. This solution enables parallel testing of up to 6 different types of products through programming, functional testing, and classification. The system stimulus sources and measuring devices have an automatic self-calibration function. Testing strategies are flexibly and quickly programmed with a specially designed script.</p>
<b>PARTNERS</b>		
JSC "Selteka" (Lithuania)		

<b>CONTACT PERSON</b>	<b>Key Digital Technologies</b>
Dr. Vytautas Deksnys <a href="mailto:vytautas.deksnys@ktu.lt">vytautas.deksnys@ktu.lt</a>	Project "Research and Development of Smart Robotic System for Automatic PCB Testing and Calibration (Robotizacija)", 2017-2018, funded by EU Structural Funds

	<b>Low Detection Probability Mobile Radio Station Prototypes</b>	
		2016–2018

DESCRIPTION	RELEVANCE	NOVELTY
<p>The aim of the project was to develop new technology for digitised and scrambled voice transmission over channels using an ultra-low power spectrum density profile. The developed system must be "invisible" for standard spectrum analysers and difficult to detect for specialised spectrum analysers. During the project, functional prototypes of such a system were developed and tested.</p>	<p>The new technology allows for more rapid development in the field of national defence. Acquired expertise in software defined radio systems, spread spectrum, and real-time complex signal processing could be used in further research and development projects.</p>	<p>The developed technology allows secure radio communications using non-repeating spread spectrum signals with signal to noise ratio (SNR) in receiving station below 0 dB. Such radio frequency (RF) signals are complicated to detect using electromagnetic wave detection, identification, and direction-finding equipment.</p>
		

<b>Key Digital Technologies</b>	<b>CONTACT PERSON</b>
Project "Development of Prototype Radio Station for Secret Communications", 2016–2018, funded by Agency for Science, Innovation and Technology of Lithuania	Dr. Darius Gailius <a href="mailto:darius.gailius@ktu.lt">darius.gailius@ktu.lt</a>

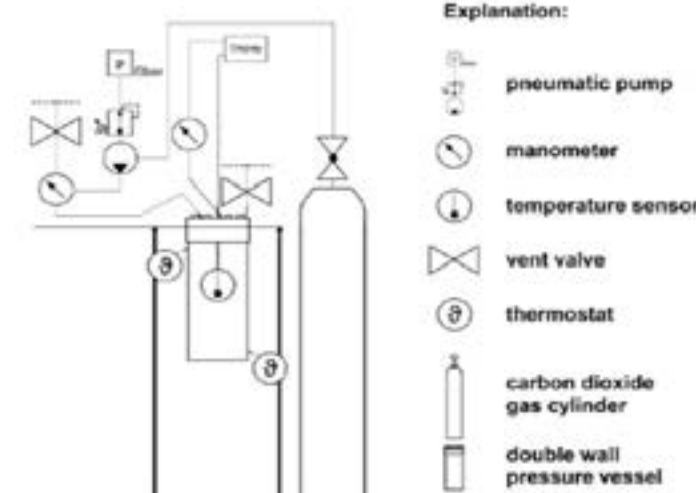


	<b>Method and AMR-Sensors-Equipped Device for Fast Determination of Vehicle Moving Speed</b>		
2018–2020			

RELEVANCE	DESCRIPTION	NOVELTY
The invention described herein can determine average vehicle speed, taking into account the vehicle length. In intelligent traffic flow control technologies, this device can be used to identify traffic flow parameters, and to perform vehicle classification. Such technologies may help reduce the negative impact of vehicle emissions on climate and the environment (air pollution, including CO <sub>2</sub> emissions and Greenhouse effect, noise).	This invention introduces a new method and a device for the computation of land vehicle speed using Anisotropic Magneto-Resistive (AMR) sensors. For traffic flow control, it is needed to measure the vehicle speed, to process and to transmit data quickly without losing data quality. The new computation method is implemented by measuring the average speed on a particular stretch of road using two gauges at a known distance from each other, equipped with technical means for vehicle identification.	This invention provides a new, fast method, and a device for determining the speed of a vehicle. The method not only shortens the computation time, but also allows a more efficient use of the energy consumed by the speed meter.  In addition, when using two speed meters (equipped with vehicle identification means) are arranged at a predetermined distance, the average vehicle speed on the stretch between these two meters can be calculated.

	<b>Key Digital Technologies</b>
<b>CONTACT PERSON</b>	Patent "Method for Fast Determining of Vehicle Movement Speed and Device with AMR Sensors Implementing It", 2019, <a href="#">LT 6678</a> Patent application, 2019, <a href="#">WO 2019153324</a> Article in <i>Sensors</i> , 2018, DOI: <a href="#">10.3390/s18072225</a> Article in <i>IEEE Intelligent Transportation Systems Magazine</i> , 2019, DOI: <a href="#">10.1109/MITS.2018.2889693</a> Article in <i>Sensors</i> , 2019, DOI: <a href="#">10.3390/s19235234</a> Article in <i>Sensors</i> , 2020, DOI: <a href="#">10.3390/s20123541</a>
Dr. Darius Andriukaitis <a href="mailto:darius.andriukaitis@ktu.lt">darius.andriukaitis@ktu.lt</a>	

	<b>The Synthesis and Application of Low-Lime Calcium Silicates and Its Application for the Production of Environmentally Friendly Materials</b>		
			2018–2020

DESCRIPTION	RELEVANCE	NOVELTY
The cement industry is responsible for 5–7% of global greenhouse gas emissions. Current strategies to alleviate the adverse effect, such as clinker substitutions, alternative fuels and improved energy efficiency alone, are not enough to meet the target of CO <sub>2</sub> reductions. One of the most promising approaches is the production of low-lime calcium silicate cement. This binding material requires lower amounts of limestone, and has lower production temperature, thereby resulting in much lower CO <sub>2</sub> emissions. Moreover, such binders are also environmentally friendly for the ability to permanently store CO <sub>2</sub> in the concrete structure. The aim of this work is to develop the technology of environmentally friendly cements, which will combine the hydrothermal synthesis of calcium silicates/hydrates and their solid-state sintering at a low temperature.	Environmentally friendly and economically attractive synthesis technology of low-lime calcium silicate and its application is matured to the 4th technology readiness level (TRL) – products were produced at a laboratory scale. The obtained project results are relevant for modern production of alternative cementitious materials and will also make presumptions for continuing the higher technology development.	A new methodology for the formation of anhydrous calcium silicates under hydrothermal conditions was developed. An innovative preparation technique for the production of environmentally friendly cementitious materials was developed. The obtained binder satisfies the essential requirements with regard to the currently existing state-of-the-art technologies, and can be characterized by the required physico-chemical and mechanical properties. After the hardening process in the water and CO <sub>2</sub> environment, in low-lime calcium silicate cement forms CaCO <sub>3</sub> thus increasing product density and reducing porosity. These factors improve durability and strength.
		

	Article in <i>Scientific Reports</i> , 2019, DOI: <a href="#">10.1038/s41598-019-54219-6</a> Article in <i>Ceramics International</i> , 2019, DOI: <a href="#">10.1016/j.ceramint.2018.07.291</a> Article in <i>The American Ceramic Society</i> , 2018, DOI: <a href="#">10.1111/jace.15530</a> Article in <i>Powder Technology</i> , 2019, DOI: <a href="#">10.1016/j.powtec.2019.07.078</a> Article in <i>Journal of Thermal Analysis and Calorimetry</i> , 2019, DOI: <a href="#">10.1007/s10973-019-08590-1</a> Article in <i>Journal of Thermal Analysis and Calorimetry</i> , 2019, DOI: <a href="#">10.1007/s10973-019-08795-4</a> Article in <i>Ceramics International</i> , 2020, DOI: <a href="#">10.1016/j.ceramint.2020.05.027</a> Doctoral Dissertations: Tadas Dambrauskas "Synthesis and Functional Properties of - C <sub>2</sub> SH, Kilchoanite and Hydroxyldegrewite", 2019 Agnė Šmigelskytė "Synthesis, Properties, and Application of Rankinite in the Production of CO <sub>2</sub> Cured Concrete", 2019	<b>Advanced Materials</b>
		<b>CONTACT PERSON</b>
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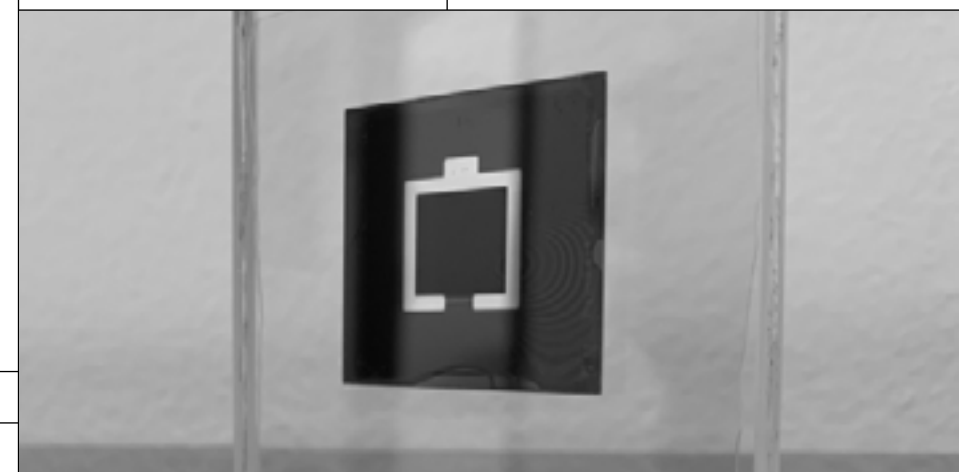
2018–2021	<b>Heavy Metal for New-Generation Light Sources (MEGA)</b>	

RELEVANCE	DESCRIPTION	NOVELTY
Organic heavy metal free fluorescent materials demonstrate an exceptional potential for use in new-generation light sources, such as organic light-emitting diodes (OLEDs) and organic lasers. It is anticipated that these new materials will enable organic electronic devices to be constructed with higher efficiency, simpler device structures, lower fabrication costs, and reduced environmental impact.	In the frame of the Horizon 2020 programme project MEGA, two types of organic electroactive materials are being developed and studied:  (1) Materials exhibiting thermally activated delayed fluorescence (TADF) for use in OLEDs applied in displays and lighting devices.  (2) Fluorescent materials with low thresholds for amplified spontaneous emission for use in organic lasers applied in spectroscopy and telecommunication.	New efficient heavy metal free multifunctional emitters with high photoluminescence quantum yields for organic light emitting diodes with external quantum efficiencies exceeding 20% and organic lasers are developed. Special attention is paid to the development of efficient, stable and inexpensive fully organic blue emitters, which are currently in high demand on the market.
<b>PARTNERS</b>		
University of Glasgow (United Kingdom); TU Dresden (Germany); CY Cergy Paris University (France); Lviv Polytechnic National University (Ukraine); Belarusian State University (Belarus); National Taiwan University (Taiwan); University of Malaya (Malaysia); Creaphys GmbH Dresden (Germany); Cynora GmbH (Germany); JSC Femtika (Lithuania); SRC Carat (Ukraine); Intelligentsia Consultants (Luxembourg)		

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Dr. habil. Juozas Vidas Gražulevičius <a href="mailto:juozas.grazulevicius@ktu.lt">juozas.grazulevicius@ktu.lt</a>	H2020 project 823720 <a href="#">MEGA</a> , 2018-2020, Coordinated by Kaunas University of Technology


	<b>Hole Transporting Self-Assembled Monolayer for Perovskite Solar Cells</b>	2019

DESCRIPTION	RELEVANCE	NOVELTY
Simple organic molecules, synthesised at Kaunas University of Technology, which self-assemble to form a molecular-thick electrode layer, presents a simple way of realising highly efficient perovskite single-junction and tandem solar cells. The molecules are based on carbazole head groups with phosphonic acid anchoring groups and are able to form self-assembled monolayers (SAMs) on various oxides. The SAM materials were applied in the production of a functioning solar cell in collaboration with Helmholtz Zentrum Berlin (HZB) in Germany. The silicon/perovskite tandem cell, in which SAM material was used, reached 29.15% efficiency. This is currently the new world record for a tandem solar element. The license to produce the materials synthesised at KTU laboratories was purchased by a Japanese company Tokyo Chemical Industry Co., Ltd.	The limits of efficiency of currently commercially used silicon-based solar elements are saturating. Perovskite-based single-junction and tandem solar cells are the future of solar energy, as they are cheaper and potentially much more efficient. Materials synthesised at Kaunas University of Technology present a simple way of realizing highly efficient perovskite single-junction and tandem solar cells.	The developed monolayers can be called a perfect hole transporting material, as they are cheap and formed by a scalable technique. When using traditional technologies, 1 gram (g) of silicon is enough to produce only a couple of square centimetres of a solar element. In contrast, 1 g of the SAM material synthesised by the KTU team is enough to cover up to 1000 square meters (m <sup>2</sup> ) of the element's surface. In addition, the self-assembling organic material synthesised at KTU is less expensive than the materials currently used in photovoltaic elements. This is a major technological breakthrough that turns the conventional notion on SAMs and is an important starting point to suggest a new direction of research for developing SAMs.
<b>PARTNERS</b>		
Helmholtz Zentrum Berlin (HZB) (Germany)		




<b>Advanced Materials</b>	<b>CONTACT PERSON</b>
Patent, 2019, <a href="#">DE102018115379</a> Patent application, 2019, <a href="#">WO2019207029</a> Article in <i>Energy and Environmental Science</i> , 2019, DOI: <a href="#">10.1039/c9ee02268f</a>	Dr. Vytautas Getautis <a href="mailto:vytautas.getautis@ktu.lt">vytautas.getautis@ktu.lt</a>

	<b>Synthesis and Anti-Mitotic Activity of 2,4- or 2,6-disubstituted- and 2,4,6-trisubstituted-2H-pyrazolo [4,3-c]pyridines</b>	
2018		

RELEVANCE	DESCRIPTION	NOVELTY
<p>Due to its wide spectrum of biological activities, pyrazole is a common structural unit in many pharmaceuticals and a central axis of numerous ongoing studies devoted to the synthesis and biological evaluation of novel pyrazole moiety-bearing molecules. Among the vast variety of biologically active annelated pyrazole derivatives, synthetically demanding 2H-pyrazolo [4,3-c]pyridines are relatively understudied. Therefore, in this study, we prepared a collection of various 2H-pyrazolo[4,3-c]pyridines, primarily varying by the substituents at the 2-, 4- and 6-positions in order to assess their biological activity and to formulate possible structure-activity relationships.</p>	<p>An efficient approach for the synthesis of variously substituted 2H-pyrazolo[4,3-c]pyridines, employing Sonogashira cross-coupling and a subsequent substituent-tolerant annulation reaction in the presence of ammonia was developed. Synthesised compounds were evaluated for their cytotoxicity against K562 and MCF-7 cancer cell lines. The compounds exhibited anticancer activity <i>in vitro</i> through arresting cell cycle in mitosis and induction of apoptosis.</p>	<p>A collection of various novel 2H-pyrazolo[4,3-c]pyridines, primarily varying by the substituents at the 2-, 4- and 6-positions and possessing cytotoxicity against K562 and MCF-7 cancer cell lines was prepared.</p>
		
<b>PARTNERS</b>		
Palacký University Olomouc (Czechia); University of Vienna (Austria)		

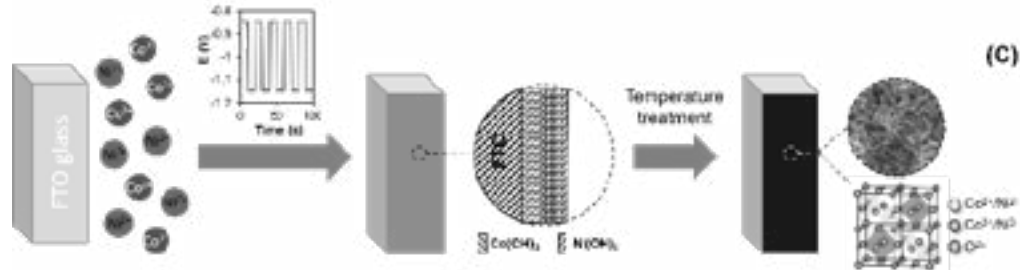
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<p>Dr. Eglė Arbačiauskienė  <a href="mailto:egle.arbaciauskiene@ktu.lt">egle.arbaciauskiene@ktu.lt</a>          Dr. Vaida Milišūnaitė  <a href="mailto:vaida.milisiunaite@ktu.lt">vaida.milisiunaite@ktu.lt</a>          Dr. habil. Algirdas Šačkus  <a href="mailto:algirdas.sackus@ktu.lt">algirdas.sackus@ktu.lt</a></p>	<p>Article in <i>European Journal of Medicinal Chemistry</i>, 2018, DOI: <a href="https://doi.org/10.1016/j.ejmech.2018.03.037">10.1016/j.ejmech.2018.03.037</a></p>

	<b>New Photochromic Compounds, Method of Production Thereof and Intermediate Compounds</b>	
		2015–2018

DESCRIPTION	RELEVANCE	NOVELTY
<p>A new class of photochromic compounds was synthesised at Kaunas University of Technology. These compounds are based on methano-benz[[1,3]oxazepino[3,2-a]indole structure. These photochroms exist in ground colourless form and can be transferred to coloured form. When compounds are irradiated with pulses of UV light, covalent bond C-O breaks and bipolar coloured form appears. The coloured form converts back to the ground state - uncoloured form, when UV radiation ceases.</p>	<p>Photosensitive materials can be used in numerous situations and integrated into various products – from photochromic lens, which darken on exposure to ultraviolet light, to photochromic coatings in construction, which change colour under extreme pressure. Photochromic compounds can be applied in various fields of industry, such as production of protective screens from radiation or in CD- and DVD production. Over the last decades, the field of life sciences and imaging processes in live cells has been developing very rapidly. New photochromic substances are necessary for the development of new imaging technologies, for creating of new chemosensors. The invention can contribute to the appearance of new consumer goods.</p>	<p>The compounds synthesised at KTU are the fastest known photochromes – they react to UV pulses becoming coloured, and last in coloured form less than 5 ns. They are characterised with high resistance to photodestruction and can withstand more than 5000 opening-closing cycles. Differently from traditional photochromes such as indolino spiro-pyrans, the photochrome synthesised at KTU can function in an open air environment. Cis-Methanobenz[[1,3]oxazepino[3,2-a]indoles are characterised with peculiar resistance to changes of medium, and coloured form appears only by action of UV radiation. Alkalies do not open [1,3]benzoxazine rings easily and do not generate coloured 4-nitrophenolate moieties.</p>
		
<b>PARTNERS</b>		
Vilnius University (Lithuania)		

<b>Advanced Materials</b>	<b>CONTACT PERSONS</b>
<p>Patent, 2017, <a href="https://patents.google.com/patent/EP3230400">EP3230400</a>, CN107207523, JP2018506510, US20170355709          Article in <i>Dyes and Pigments</i>, 2014, DOI: <a href="https://doi.org/10.1016/j.dyepig.2014.09.006">10.1016/j.dyepig.2014.09.006</a></p>	<p>Dr. Vytas Martynaitis  <a href="mailto:vytas.martynaitis@ktu.lt">vytas.martynaitis@ktu.lt</a>          Dr. habil. Algirdas Šačkus  <a href="mailto:algirdas.sackus@ktu.lt">algirdas.sackus@ktu.lt</a></p>



2018	<h2>Metal Chalcogenide and Oxide Semiconductors for Energetics</h2>		<h2>Nano and Microfibrous Matrixes for <i>In Vitro</i> Material Testing and Discovery</h2>	2017–2021	
RELEVANCE	DESCRIPTION	NOVELTY	DESCRIPTION	RELEVANCE	NOVELTY
<p>During the research, the environmentally friendly methods for obtaining metal chalcogenide and oxide films at near-room temperatures were created. Environmentally friendly sulphides and selenides, including copper and cadmium compounds, can potentially be used as viable substitutes. Metal chalcogenides, such as CdS and CdSe, are considered as one of the most promising semiconductor material classes for early-stage thin-film transistor development. Photovoltaic cells with chalcogenide films are very attractive for electricity generation because they use free and renewable solar energy.</p>	<p>Metal chalcogenide and oxide semiconductors are current mainstream thermoelectric materials with high conversion efficiency. Due to the unique optical and electrical properties, inorganic semiconductors are widely used in thin film and composite material manufacturing. The idea of this research was to create environmentally friendly and economically feasible synthesis methods of metal chalcogenide and oxide films using new precursors, and to propose their perspective application fields. Synthesis and properties of metal chalcogenide films deposited on polymers were explored for the development of low-cost, hybrid inorganic-organic materials at large scales with excellent photovoltaic properties. The results of the research extended the perspectives of Kaunas University of Technology researchers in search of new precursors and methods for obtaining composites with inorganic semiconductor films.</p>	<p>Hybrid inorganic-organic materials, comprised of organic photovoltaics and tunable absorption inorganics, possess high potential for solar light harvesting.</p>	<p>The aim of this research is the development of fibrous matrixes for organ-on-chip or whole-cell biosensor systems to be applied in <i>in vitro</i> models for the testing of toxicity and discovery of new chemical/pharmaceutical substances. The synthesis of various morphologies and modification of fibrous matrixes has been demonstrated with a variety of bio-compatible polymers.</p>	<p>The research fulfils the strategic aim of decoupling toxicology research from <i>in vivo</i> animal models (laid out in EU directive 2010/63) by providing an effective <i>in vitro</i> platform. Whole cell bio-sensors are among the most promising methods for toxicological testing and research.</p>	<p>Fibrous scaffolds provide broad opportunities for the development of new concepts for the <i>in vitro</i> animal models, especially taking into account combinations of various polymers, surface treatment methods, functionalisation, and combination with direct environmental sampling.</p>
					
CONTACT PERSON	Advanced Materials	Advanced Materials	CONTACT PERSON		
Dr. Ingrida Ancutienė ingrida.ancutiene@ktu.lt	<p>Article in <i>Materials for Renewable and Sustainable Energy</i>, 2018, DOI: <a href="https://doi.org/10.1007/s40243-017-0108-2">10.1007/s40243-017-0108-2</a>            Article in <i>Journal of Nanoscience and Nanotechnology</i>, 2018, DOI: <a href="https://doi.org/10.1166/jnn.2018.13927">10.1166/jnn.2018.13927</a>            Article in <i>Applied Surface Science</i>, 2019, DOI: <a href="https://doi.org/10.1016/j.apsusc.2018.11.121">10.1016/j.apsusc.2018.11.121</a></p>	Project "Innovative Advanced Therapy Construct for Cartilage Regeneration (ICAR)", 2017–2021, funded by EU Structural Funds	Dr. Dainius Martuzevičius dainius.martuzevicius@ktu.lt		

2018–2022	<b>New Multifunctional Polymer Composites with 2D Nanoparticles</b>			<b>Silicone Materials Having Antimicrobial Efficiency</b>	2019

RELEVANCE	DESCRIPTION	NOVELTY	DESCRIPTION	RELEVANCE	NOVELTY
<p>During the project, model-integrated technology methods for synthesis of various MXenes and manufacturing of MXene-polymer composites are developed. Electrically conductive MXene-polymer composites can be used from wearable and flexible electronics to structural health monitoring applications or electromagnetic interference shielding in aviation, wind turbines or transport. Experimental characterisation of morphology, electronic, thermo-physical, and mechanical properties of MXenes and MXene/polymer composites are designed. In addition, multi-scale modelling tools for assessment of operational properties of MXene-polymer composites are being developed. The process of validation of MXene-polymer composites for use in practical applications is being carried out by the development of lab-scale product prototypes demonstrating better performance and efficiency compared to common graphene- and other 2D nanoparticle-based composites or providing new applications.</p>	<p>The aim of the Horizon 2020 programme project NANO2DAY is the development of advanced multifunctional composites with outstanding electronic and mechanical properties by the incorporation of novel MXene nanosheets into polymer matrixes. During the first stage of the project, the researchers carry out a rational design and systematic exploration of MXene-polymer nanocomposites for wearable electronics and advanced structural components for aerospace applications. This is achieved by intersectoral consolidation and sharing of knowledge and expertise of 11 members from Europe and USA working in different areas and collaborative research on the development and assessment of novel materials, including technology, characterisation, modelling, and validation.</p>	<p>The innovative aspects investigated in the project are based on up-scaling novel technologies for “close to industrial” syntheses of MXenes and MXene-doped polymer masterbatches and implementation of MXenes into the design of structural polymer composites, including fibre reinforced plastics. The project essentially contributes to the integration of scientific insights into innovation-based industrial environments and the successful implementation of novel, advanced materials into practical applications.</p>	<p>The patented invention relates to polymeric antimicrobial coatings with mechanical properties highly suitable for orthopaedic and medical application. The antimicrobial coatings can not only inhibit the growth of pathogens, but can also be used for distribution of pressure, prevention of bedsores and wounds, and can increase healing intensity.</p>	<p>In the patent, disclosed are antimicrobial silicone substances, which are obtained by loading of multifunctional cellulose/silver into silicone matrix. Silver nanoparticles were deposited on cellulose surface by environmentally friendly, simple deposition technique. The cellulose/silver modified silicone nanocomposite is characterised by excellent physical and mechanical properties, and strong antimicrobial effect.</p>	<p>Although silicones, dipped in or coated with silver compounds have already been used in the health sector for some time, the antimicrobial silicone developed at KTU is based on completely different technology, and on different materials. The silicone has antimicrobial effects both on gram-positive and on gram-negative microbial strains and fungi.</p>



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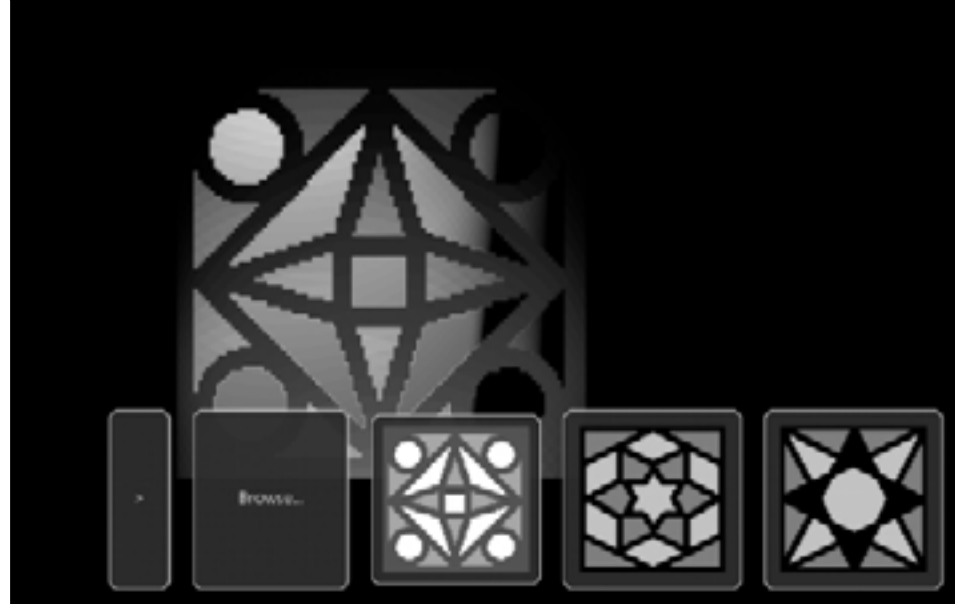
2019	<b>Manipulation of Plasmonic Nanoparticles for Biosensing and Nanolasing</b>	

RELEVANCE	DESCRIPTION	NOVELTY
<p>The SLR-featuring plasmonic metal arrays show tremendous promise in both fundamental nanoparticle research and as nanophotonic applications. Specifically, SLR-based nanolasers can produce very narrow lasing linewidths, low response times and high tunability through mechanical manipulation and refractive index tailoring.</p> <p>The templates for capillary force-assisted nanoparticle assembly (CAPA) can be produced using replica moulding of such master stamp, which, together with large scale colloidal nanoparticle synthesis, can allow for scalable and low-cost biosensing, nanolasing photocatalysis, and other applications.</p>	<p>CAPA – a type of template-assisted method that uses convective currents and confining capillary forces at the air/liquid/template interface to selectively deposit nanoparticles inside patterned obstacles by tailoring the wetting, temperature, and assembly speed conditions in a temperature-controlled single-axis translation setup – was used for the production of silver nanoparticles based 2D nanostructures. We demonstrated that periodically ordered plasmonic nanoparticle arrays can sustain a surface lattice resonance (SLR) – a hybrid mode featuring a delocalised and amplified electromagnetic field as well as ultra-narrow extinction peaks. The templates used to self-assemble the arrays were created via soft lithography, replicating patterns in hard materials such as silicon using polydimethylsiloxane (PDMS). This feature eliminates many steps that would normally require expensive cleanroom nanofabrication facilities. Furthermore, our method is not limited to Ag nanoparticles that we had used: self-assembly may be used to pattern a variety of different materials and nanoparticle shapes.</p>	<p>Until now, similar 2D nanostructures have exclusively been produced using top-down techniques to pattern the nanoparticle arrays. The technique and method developed by us offer a lot of potential for the exploration of a) different/hybrid plasmonic materials; b) different arrangements of nanoparticles; and c) different shapes of nanoparticles. It is difficult to generate these kinds of features with top-down techniques. Using our assembly method, we can make the substrate itself a gain medium by dispersing the dye in PDMS and use anything else (another layer of PDMS, analytes, or nothing at all) as the superstrate, which could also be a new advancement in the field. This work is at the cutting edge of the current state-of-the-art in nanoparticle self-assembly and nanolasing, and these achievements could work in favour of further development in this field.</p>
<b>PARTNERS</b>		
National Institute for Materials Science (Japan)		

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	<b>Complex Holograms for Anti-Counterfeiting Applications with Original Validation Software</b>	2018

DESCRIPTION	RELEVANCE	NOVELTY
<p>A security tag featuring holographic elements is used for anti-counterfeiting applications. A range of hologram-originating technologies could be applied, including direct laser interference patterning, wafer scale holographic lithography, and UV mask aligner exposure in photoresist or high-resolution patterning with electron beam lithography. The content and colours of a diffraction image that would be seen by an observer are often counterintuitive in the design stage. During the research, described in the article, an original algorithm based on the conical diffraction formalism, which can be used to describe the variations of a diffraction image with respect to all aspects of observation was proposed. The anti-counterfeiting tag prototypes with complex holographic effects were showcased. Moreover, direct laser interference patterning (DLIP) technology was implemented to originate the holograms on metal surfaces.</p>	<p>The globally increasing scale of forgery requires efficient tools to fight against it. The proposed, widely accessible software and the related hologram origination technologies broaden the fields of hologram applications and increase awareness of the working principles of light-diffracting structures used in holographic labels. The use of the proposed algorithm is not limited to only rendering the hologram view, but can also be extended for the designing and authenticating of the holographic means.</p>	<p>Original software “HoloApp” compatible with smart devices based on the Android platform was proposed for the intuitive, realistic experience of the holograms used for anti-counterfeiting applications. In addition, competitive hologram origination technology was introduced, capable of imposing holographic effects on the surfaces that were not compatible with any of the existing technologies before.</p>



<b>Advanced Materials</b>	<b>CONTACT PERSON</b>
Article in <i>Scientific Reports</i> , 2018, DOI: <a href="https://doi.org/10.1038/s41598-018-32294-5">10.1038/s41598-018-32294-5</a>	Dr. Tomas Tamulevičius <a href="mailto:tomas.tamulevicius@ktu.lt">tomas.tamulevicius@ktu.lt</a>



2019–2021	<b>Adaptive Control Algorithms and Systems for Biotechnological Processes</b>			<b>KRUONIS Floating Solar Power Plant (FPV)</b>	
				2019–2021	
RELEVANCE	DESCRIPTION	NOVELTY	DESCRIPTION	RELEVANCE	NOVELTY
<p>The research results are important on both a national and international scale. The adaptive control algorithms and systems could be implemented in national and international biotechnology companies. The developed adaptive control algorithms and systems for automatic control of biotechnological processes allow us to improve stability, productivity, and product quality of pilot-scale and industrial biotechnological processes.</p>	<p>The research objectives are pilot-scale and industrial biotechnological processes carried out in bioreactors and used at biotechnology companies. The main aim of the project is to develop adaptive control algorithms and systems for the control of typical biotechnological processes and software for the realisation of the algorithms and systems suitable for installation on the most widely used industrial controllers.</p>	<p>The investigations are performed on the adaptive control systems that are suitable for a biotechnological process control, while taking into account non-linearity and non-stationarity of these processes. Various aspects of the practical application of the adaptive control systems in pilot-scale and industrial bioreactors for the cultivation of various cultures at biotechnology companies are extensively analysed.</p>	<p>The aim of the project is to radically improve the floating solar power plant (FPV) system, to adapt it to the hydroelectric (HE) basin operating conditions (variable water levels, freezing water), and to develop a new controller-driven solar power plant and HE system with a unique artificial intelligence based control algorithm, which will enable HE plants to provide new services.</p>	<p>The target customers of the project are operators of pumped storage hydroelectric plants (PSHP) and other technical basins, electricity producers, distribution, and transmission network operators. The value of the project is the opportunity to exploit the water sector, which has never been used in any other way before in order to create new services. The project is particularly relevant for regions of Europe and Southeast Asia, which are characterised by relatively high land prices.</p>	<p>The operation of such an FPV power plant would create a significant competitive advantage over other energy companies and thus contribute to the ambitious 2030 National Energy Independence Strategy (NENS) and Lithuania's goal of developing green energy, optimise the operation of the hydroelectric power plants, and provide strategic primary reserve services to the market. The uniqueness and innovation of this project would allow Lithuania to become a leader in integrated solar and water energy solutions. Also, the implementation of the planned wind energy development in the area and the expansion of the Kruonis PSHP by installing Hydro Unit 5 would make Kruonis PSHP one of the most unique renewable energy facilities in Europe and possibly the world.</p>
					
			<b>PARTNERS</b>		
			JSC "Ignitis Gamyba" (Lithuania)		
<b>CONTACT PERSON</b>		<b>Artificial Intelligence and Robotics</b>	<b>Artificial Intelligence and Robotics</b>		<b>CONTACT PERSON</b>
Dr. Vytautas Galvanauskas <a href="mailto:vytautas.galvanauskas@ktu.lt">vytautas.galvanauskas@ktu.lt</a>		Project "Development and Investigation of Adaptive Control Algorithms and Systems for Biotechnological Processes", 2019-2021, funded by EU Structural Funds	Project "KRUONIS FPV", 2019-2021, funded by EU Structural Funds		Dr. Saulius Gudžius <a href="mailto:saulius.gudzius@ktu.lt">saulius.gudzius@ktu.lt</a>

	<b>Concept of a System Using a Dynamic SWOT Analysis Network for Fuzzy Control of Risk in Complex Environments</b>	
2020		

RELEVANCE	DESCRIPTION	NOVELTY
A new concept of a closed-loop feedback system is presented, which improves the performance of processes in the specific environment under consideration; the quality of those processes is analysed by the newly developed SWOT and computing with words (CWW) tools, and after the RISK evaluation the system proposes adequate leverage for use in control.	The article advocates a new concept for risk control that makes up one organic universal closed loop feedback system, consisting of: 1) the evaluation of the features of situation under investigation through strengths, weaknesses, opportunities, and threats (SWOT) analysis; 2) the determination of the level of fuzzy risk concealed in this situation (using RISK evaluation); and 3) the proposal of leverage, recommendations, or actions enabling the improvement of target performance. Fundamental approaches, definitions, and particularities of this concept are examined, and for the first time, the network called the fuzzy SWOT map is introduced. This instrument appeared as an extension of the fuzzy cognitive maps paradigm enhanced by computing with words and elements of explainable artificial intelligence (XAI) in the form of fuzzy rules. The concept serves for the development of functional organisation of control systems of complex and dynamically interacting projects or situations, and for the implementation of an adequate set of tools satisfying the concrete system requirements. The results of conceptual modelling and the confirmation of the vitality of the approach are presented based on the example of a risk-control system covering three interacting projects in a case of city development.	The novelty of our case is its proposal that experts use words from the selected vocabulary for the verbal evaluation of all possible entities during SWOT analysis. As far as we know, no other study has included the possibility of a CWW paradigm for SWOT analysis.

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	<b>Numerical Solution of Reliability Models Described by Stochastic Automata Networks</b>	
		2018

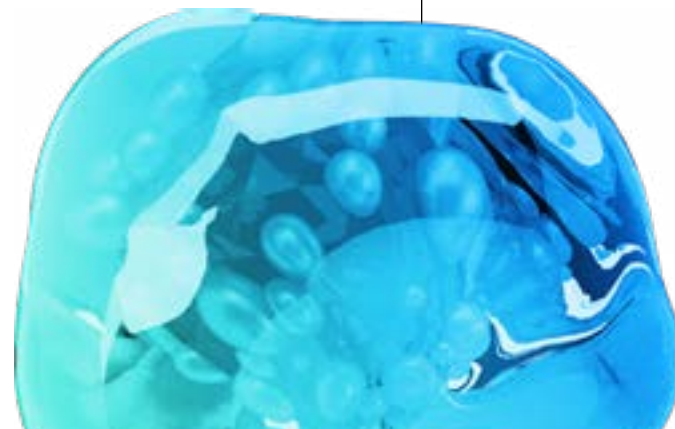
DESCRIPTION	RELEVANCE	NOVELTY
The work presents the solution of Markov chain reliability models with a large state-space. To specify a system reliability model, we use our previously proposed methodology, which is based on the Stochastic Automata Networks (SANs) formalism. The parts of the system are modelled by arrowhead matrices with functional transition rates. As a result, the infinitesimal generator matrix of the reliability model has a distinctive structure. In this article, it is demonstrated that a block Gauss-Seidel method can be applied very efficiently to such a structure. The application of the proposed methodology is illustrated by an example of a standard 3/2 substation configuration. Even though its Markov chain reliability model has almost two million states, its steady-state probabilities can be estimated in just a few seconds of CPU time.	Efficient application of numerical methods is a crucial part of Markov chain modelling of large systems. However, it is still rarely addressed in reliability modelling studies, and only in a few exceptions can one find examples of steady-state solutions of reliability models whose state-space exceeds a million. The problem is solved in the article.	Our research demonstrates that the distinctive structure of the created reliability models allows us to apply a block Gauss-Seidel method very efficiently. That is, due to the high fidelity of system components, the steady-state solution of power systems described by arrowhead matrices converges very rapidly when using the Gauss-Seidel algorithm. In addition, the specific block structure arising from the SAN formalism is very suitable for block-iterative methods. Moreover, the analytical research showed that inner iteration of the block Gauss-Seidel method can be solved very efficiently. Numerical experiments supported the analytical results and the block Gauss-Seidel method outperformed other standard methods in solving steady-state probabilities of a representative Markov model of a 3/2 substation configuration with nearly two million states.

Artificial Intelligence and Robotics	CONTACT PERSON
Article in <i>Reliability Engineering &amp; System Safety</i> , 2018, DOI: <a href="https://doi.org/10.1016/j.ress.2017.09.024">10.1016/j.ress.2017.09.024</a>	Dr. Mindaugas Šnipas mindaugas.snipas@ktu.lt



2019	<b>Active-Passive Vibration Control on Thin-Walled Composite Beam</b>			<b>3DOF Ultrasonic Motor with Two Piezoelectric Rings</b>	
					2020

RELEVANCE	DESCRIPTION	NOVELTY	DESCRIPTION	RELEVANCE	NOVELTY
<p>The data revealed in the article can be used as methodology for vibration control of thin-walled composites applied in aerospace, automotive, construction, medical and energy industry. The idea of combining the use of active Macro Fiber Composite (MFC) actuator and passive (magnetic forces) vibration damping is new and enables the development of lighter, often-cheaper composite structures exhibiting superior performance.</p>	<p>In the study presented in the article, active and passive vibration control techniques for a thin-walled composite beam were developed and experimentally analysed. MFC actuator was used together with the magnetic forces between two permanent cuboidal magnets (passive vibration control) for vibration damping applications.</p>	<p>The results of the active-passive MFC actuator and magnetic forces vibration control obtained at resonant and non-resonant frequencies were found and discussed. Idea of using together active MFC actuator and passive (magnetic forces) vibration damping is new and has not been previously discussed in other literature sources.</p>	<p>A novel design of a multiple degrees of freedom (multi-DOF) piezoelectric ultrasonic motor (USM) is introduced in the article. The main idea of the motor design is to combine the magnetic sphere type rotor and two oppositely placed ring-shaped piezoelectric actuators into one mechanism. Such a structure increases impact force and allows rotation of the sphere with higher torque.</p>	<p>The main purpose of the study was to design a motor for attitude control systems used in small satellites. A permanent magnetic sphere with a magnetic dipole is used for orientation and positioning when the sphere is rotated to the desired position, and the magnetic field synchronizes with the Earth's magnetic dipole. Moreover, the innovation can also be applied in developing smart devices and smart robots as it demonstrates autonomous behaviour in complex, safety- and time-critical systems, such as those used in avionics, health or industrial applications.</p>	<p>The advantages of the proposed piezoelectric motor are high force density, simple mechanical construction, low speed without additional gear or spindle mechanisms, noiseless operation, high holding forces without an energy supply, absence of magnetic fields, high dynamics, and very good positioning accuracy. These qualities make the novel ultrasonic motor attractive for many industrial applications such as robotic systems, laser beam manipulation, and others.</p>



CONTACT PERSON		Artificial Intelligence and Robotics	Artificial Intelligence and Robotics		CONTACT PERSON
Dr. Vytautas Jūrėnas vytautas.jurenas@ktu.lt		Article in <i>Composite Structures</i> , 2019, DOI: <a href="https://doi.org/10.1016/j.comps.2019.110975">10.1016/j.comps.2019.110975</a>	Article in <i>Sensors</i> , 2020, DOI: <a href="https://doi.org/10.3390/s20030834">10.3390/s20030834</a>		Dr. Vytautas Jūrėnas vytautas.jurenas@ktu.lt

	<b>Magnetic Plucking Dynamics in a Frequency Up-Converting Piezoelectric Energy Harvester</b>			<b>Financial Supervision and Technological Compliance Training Programme (FIN-TECH)</b>	
2018					2019–2021

RELEVANCE	DESCRIPTION	NOVELTY	DESCRIPTION	RELEVANCE	NOVELTY
<p>Micro energy harvesters, as a subset of green energy sources, belong to one of enabling technologies and are a prerequisite for advancement of Internet of Things and Smart Environments, which rely on various smart devices used in manufacturing, building, transport, healthcare, security, defence and other sectors. Specifically, high-performance vibration energy harvesters are crucial for reliable operation of various energy-autonomous systems such as wearable health monitoring devices or wireless sensors used for equipment, habitat, inventory, traffic or structural monitoring. This work addresses major operational issues related to micro-power generation inefficiencies in challenging low-frequency excitation conditions that are common in various natural and built environments.</p>	<p>The study addresses a problem of improving performance of contactless excitation of piezoelectric micro-power generators via transient magnetic coupling (plucking). It is an advantageous noiseless approach that allows to reduce detrimental sensitivity of vibration energy harvesting performance to varying mechanical inputs (a serious issue). Plucking dynamics is thoroughly analysed in order to propose design guidelines for power output increase in ubiquitous low-frequency excitation applications. Effective design criteria are defined in terms of useful dimensionless parameters and the conditions for power maximisation are quantified on the basis of transient resonance. The results are widely applicable to different plucking cases and generators with arbitrary dynamic properties.</p>	<p>The reported theoretical and experimental results contribute to better understanding of key operational principles of magnetically-plucked piezoelectric micro-power generators. The established regularities of magnetic plucking process are conducive to the development of novel generator architectures that will provide more efficient and stable operation in low-frequency excitation cases. Overall, the newly proposed versatile dynamic criteria serve as a helpful guideline for the engineers in the rational design of high-performance vibration energy harvesters based on different magnetic and structural configurations.</p>	<p>The Horizon 2020 programme project FIN-TECH intends to create a European training programme, aimed at providing shared risk management solutions that automatize compliance of Fintech companies (RegTech) and, at the same time, increases the efficiency of supervisory activities (SupTech). In other words, we aim at connecting financial supervision with technological compliance.</p> <p>The project programme was built jointly by 25 universities and FIN-TECH partners that are established experts in Fintech risk management, research partners who share knowledge with regulators, supervisors and Fintech associations and hubs from all 28 European Union countries, plus Switzerland.</p> <p>The goals of the project will be achieved through research activity in risk management models for Big data analytics, Artificial Intelligence (AI) and Blockchain applications to finance, discussed in three different research workshops and two levels of knowledge exchange sessions.</p>	<p>There is a strong need to improve the competitiveness of the European Fintech sector, creating a common regulatory field across all countries which, while encouraging innovations in Big Data analytics, Artificial Intelligence, and Blockchain technologies, can correctly measure their risks. Europe is a broad mosaic of regulatory landscapes, that is why European Commission aims to standardize these procedures. Moreover, policy makers and regulators must move quickly to establish a new regulatory framework for emerging FinTechs, without stifling their economic potential.</p>	<p>In general, from all activities three groups of results are planned: repositories, coding environment and web pages. Furthermore, special use cases and research papers in Big Data analytics, Artificial Intelligence, and Blockchain technologies are developed and validated to become standards in future FinTech supervision and regulation.</p>



CONTACT PERSON		Artificial Intelligence and Robotics	Artificial Intelligence and Big Data		CONTACT PERSON
Dr. Rolanas Daukševičius rolanas.dauksevicius@ktu.lt		Article in <i>Smart Materials and Structures</i> , 2018, DOI: <a href="https://doi.org/10.1088/1361-665X/aac8ad">10.1088/1361-665X/aac8ad</a>	H2020 project 825215 <a href="#">FIN-TECH</a> , 2019-2021		Dr. Audrius Kabašinskas audrius.kabasinskas@ktu.lt



2019–2020	<b>Innovative Reprocessing Technologies of Technogenic Raw Materials</b>	

	<b>Environmental Impact Assessment Model for Substitution of Hazardous Substances by Using Life Cycle Approach</b>	
		2019

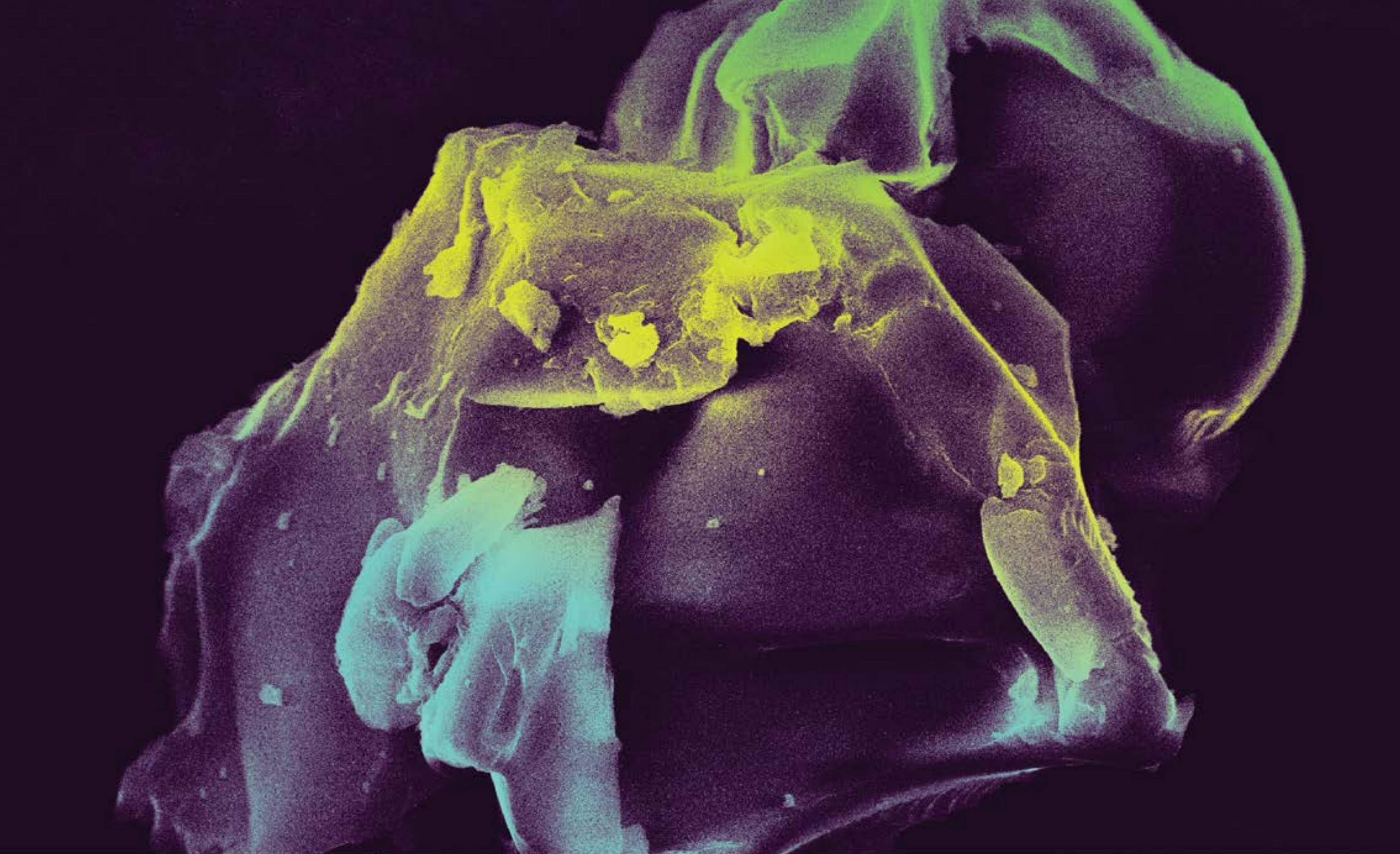
NOVELTY	DESCRIPTION	RELEVANCE
<p>The possibility of processing large volumes of technogenic raw materials is created, which is very important in implementing waste management strategies in both Lithuania and the EU. New competitive technologies and products will be developed and introduced in the market. It was proven that it is possible to reduce the concentration of fluorine ions in silica gel waste to 1.5% by changing the treatment conditions, and by adding alkaline compounds. Based on established optimum treatment conditions, additional equipment was installed, and industrial tests were carried out in the <math>AlF_3</math> production line of Lifosa, JSC. Finally, fluorine ions removal technology was proposed; it not only allowed reducing the concentration of fluoride ions in silica gel to 1.5%, but also increased the yield of aluminium fluoride.</p>	<p>Large amounts of silica gel waste contaminated with fluoride ions are generated in the industrial production of aluminium fluoride. However, due to the strong bonding of fluoride ions to the crystal structure of the latter compound, the purification of silica gel waste poses a great challenge.</p> <p>The idea behind this research was to create silica gel waste processing technology, which will enable to reduce <math>F^-</math> ions in silica gel waste and/or immobilise these ions by creating products of commercial value.</p>	<p>According to the specifics of the application of technology readiness level (TRL) methods, the level of preparedness at the start of the project is TRL1, and at the end of the project – TRL8. The created new material without aggressive additives can be used in the production of cementitious and building materials, and in other industries. Applying the results of the research, the process of industrial production of the fertiliser aluminium fluoride can become more efficient by minimising costs associated with waste management and the introduction of new materials into product portfolio.</p>
<b>PARTNERS</b>		
JSC "Lifosa" (Lithuania)		

NOVELTY	RELEVANCE	DESCRIPTION
<p>The main scientific novelty of this research is the developed environmental impact assessment model that enables companies with limited resources to perform simplified life cycle impact assessments concerning environment and occupational safety, and incorporates life cycle accidental and fugitive emission impacts in these assessments.</p>	<p>The proposed model is promising for its use in chemical alternatives' assessments, and can cover important aspects with a streamlined scope that are recently missing in chemical alternative assessment framework. The model requires case-specific information which is accessible and easily understandable by the companies, especially with the help of software that improves the application of life cycle thinking in practice. The results demonstrate that the proposed model can be applied for solving the environmental problems, informing the assessor about substances of very high concern (SVHC), along the life cycle, and it has the potential to be further improved with the help of supporting software and databases. In addition, it can also be effective in the occupational safety area that concerns risks of work accidents.</p>	<p>The aim of the research was to develop an environmental impact assessment model for the substitution of hazardous substances by using a life cycle approach. The developed environmental impact assessment model enables companies to assess life cycle environmental impact with a streamlined scope, including substances of very high concern, fugitive and accidental emissions, as well as life cycle occupational safety concerns. The developed model can be used by any industrial company to reduce the environmental impacts and occupational safety risks of production chains. A number of case studies have been developed in companies in various industrial sectors.</p>

<b>CONTACT PERSON</b>	<b>Manufacturing Technologies</b>
<p>Dr. Kęstutis Baltakys kestutis.baltakys@ktu.lt</p>	<p>Article in <i>Journal of Thermal Analysis and Calorimetry</i>, 2019, DOI: <a href="https://doi.org/10.1007/s10973-019-08481-5">10.1007/s10973-019-08481-5</a>                  Article in <i>Sustainability</i>, 2019, DOI: <a href="https://doi.org/10.3390/su11030634">10.3390/su11030634</a>                  Article in <i>Ceramics International</i>, 2019, DOI: <a href="https://doi.org/10.1016/j.ceramint.2018.07.286">10.1016/j.ceramint.2018.07.286</a>                  Doctoral Dissertation:                  Valdas Rudelis "Innovative reprocessing technologies of silica gel with incorporated aluminum and fluorine ions", 2020</p>

<b>CONTACT PERSONS</b>	<b>Manufacturing Technologies</b>
<p>Dr. Jolanta Dvarionienė jolanta.dvarioniene@ktu.lt Dr. Semih Oguzdjan</p>	<p>Article in <i>Environmental Pollution</i>, 2019, DOI: <a href="https://doi.org/10.1016/j.envpol.2019.07.113">10.1016/j.envpol.2019.07.113</a>                  Article in <i>Environmental Science and Pollution Research</i>, 2019, DOI: <a href="https://doi.org/10.1007/s11356-019-06307-3">10.1007/s11356-019-06307-3</a>                  Doctoral Dissertation:                  Semih Oguzdjan "Environmental impact assessment model for substitution of hazardous substances by using Life cycle approach", 2019.</p>







	<h2>Socio-Technical Factors Fostering Sustainability in Urban Transportation: A Worldwide Analysis</h2>			<h2>Comparative Environmental Life Cycle Assessment of Electric and Conventional Vehicles in Lithuania</h2>		
2018–2020						2019–2020
RELEVANCE	DESCRIPTION	NOVELTY	DESCRIPTION	RELEVANCE	NOVELTY	
<p>The results of the study suggest that the determination of distance-based connectivity of networks is an important proxy to understand road transportation performance. Consequently, two main results were obtained: (1) an increase in average short-distance connectivity of road networks (average closeness centrality and RCRC) eases road congestion, presumably because the network distributes road traffic more homogeneously while decreasing low-permeability choke points, (2) an increase of the average short-distance connectivity of networks of alternative modes such as rail or bike (average weighted rail clustering coefficient and average cycle closeness centrality) does alleviate road congestion. Presumably, well-connected, alternative networks with short and direct routes can convince car users to shift to the alternative mode, which decreases road traffic volumes.</p>	<p>The aim of the research was to establish the role of socio-technical factors in enhancing sustainability of the urban mobility system. An associations scheme was used to derive which transport strategies can minimize the socio-economic costs and the environmental footprint of the urban transportation system.</p> <p>Worldwide analysis and comparison of urban areas required a large and diverse multi-dimensional database. Open data was sourced from regional statistical offices, government sources, municipalities, and studies. The Python software package OSMnx was used for the extraction and conversion of each transport infrastructure information for the desired urban locations as well as for performing some infrastructure design-related calculations. The database of specific transportation data was created and used to calculate urban indicators ensuring sustainable mobility. The results of the present research and the developed supportive socio-technical scheme for urban mobility can be used by local governments, urban transportation planners, and policy makers to shape future urban strategies.</p>	<p>This is the first systematic transport multivariate analysis using recent directly observable open source data from different urban areas around the world. An integrated and supportive socio-technical scheme was created based on the worldwide analysis and systematic literature review. The results of the present thesis and the developed supportive socio-technical scheme for urban mobility can be used by local governments, urban transportation planners, and policy makers to shape future urban strategies.</p>	<p>Electrification of city transport and the use of renewable energy sources (RES) in transport systems became leading trends for sustainable transportation. There is a substantial body of research evidence pointing out the potential environmental benefits of an electric vehicle (EV) when integrating RES into production of electricity, which is needed to recharge the EV's battery. However, it is still unclear under what electricity mix scenarios environmental advantages will be the most significant, and what technologies/fuel type have a major impact on the environment. Aiming to explore these issues, the article presents a comparative environmental life cycle assessment (LCA) of a battery electric vehicle (BEV) and internal combustion engine vehicles (ICEVs) fuelled with petrol and diesel. Besides, LCA of BEV under different electricity mix scenarios that are prognosticated for the years 2015 – 2050 in Lithuania is assessed. The article demonstrates a complete life cycle, composed of a "Well-to-Wheel" and "Cradle-to-Grave" analysis for conventional and electric vehicles.</p>	<p>The results prove that integration of RES into electricity production has potential environmental benefits of BEV performance in the transport system. Furthermore, the results explain how different proportions of RES integrated into the electricity mix provide different impacts on the environment when analysing and comparing the BEV's operation stage.</p>	<p>The novelty of this research firstly lies in the provided comprehensive comparative analysis that considers the performance of both commercially new vehicles with multiple electricity generation pathways and forecasts of changes in the energy systems for the period 2015 – 2050. Secondly, it applies directly to the country situation, and thirdly, the analysis offers a unique comparison of LCA results for BEVs and ICEVs, which were obtained by other authors.</p>	
	Zero-Carbon Energy		Zero-Carbon Energy		CONTACT PERSONS	
CONTACT PERSON	<p>Article in <i>European Transport Research Review</i>, 2018, DOI: <a href="https://doi.org/10.1186/s12544-018-0334-4">10.1186/s12544-018-0334-4</a>          Article in <i>Social Sciences</i>, 2018, DOI: <a href="https://doi.org/10.3390/socsci8080227">10.3390/socsci8080227</a>          Article in <i>Sustainability</i>, 2019, DOI: <a href="https://doi.org/10.3390/su11154060">10.3390/su11154060</a>          Article in <i>International Journal of Transport Development and Integration</i>, 2019, DOI: <a href="https://doi.org/10.2495/TDI-V3-N4-331-343">10.2495/TDI-V3-N4-331-343</a>          Article in <i>EPIC Series in Engineering</i>, 2018, <a href="https://doi.org/10.29007/i7pk">10.29007/i7pk</a>          Doctoral Dissertation:          Ali Enes Dingi "Socio-technical factors fostering sustainability in urban transportation: a worldwide analysis", 2020</p>		<p>Article in <i>Journal of Cleaner Production</i>, 2020, DOI: <a href="https://doi.org/10.1016/j.jclepro.2019.119042">10.1016/j.jclepro.2019.119042</a></p>		<p>Dr. Jolanta Dvarionienė  <a href="mailto:jolanta.dvarioniene@ktu.lt">jolanta.dvarioniene@ktu.lt</a>          Kamilė Petrauskienė  <a href="mailto:kamile.petrauskiene@ktu.edu">kamile.petrauskiene@ktu.edu</a></p>	
62					63	





FOOD

HV 20.00 kV

mag 1000 x

spot 3.5

40  $\mu$ m

WD 9.1 mm

det LFD

HFW 256  $\mu$ m

KTU Laboratory of Scanning Electron Microscopy

Silicagel waste




	<p><b>New Functional Materials by Biorefining Berry Pomace and Their Application for Improving Food Safety and Healthiness (BERRY4FOOD)</b></p>			<p><b>High-Protein Food Product Enriched with Bioactive Compounds for the Elderly</b></p>		
<p>2017–2021</p>				<p>2020</p>		
<p>RELEVANCE</p>	<p>DESCRIPTION</p>	<p>NOVELTY</p>	<p>DESCRIPTION</p>	<p>RELEVANCE</p>	<p>NOVELTY</p>	
<p>Reduction of food waste is one of the most challenging global problems. One of the most promising ways of a more effective utilisation of agro-food processing by-products and waste is their conversion into high added value functional ingredients by applying the so-called biorefinery concept for the recovery of various constituents. Such ingredients may find various applications, e.g. in the development of functional foods and nutraceuticals, natural food additives and other valuable products. The objectives of the project are completely in compliance with the tasks of Smart Specialisation priorities in Lithuania.</p>	<p>The main task of the project is to develop new and ready-for-industrial implementation functional ingredients from berry pomace by applying innovative biorefining and encapsulation technologies, and to apply them for increasing food nutritive value and safety. The task is achieved by fulfilling the following objectives: (1) developing innovative berry pomace biorefining technologies; to produce the prototypes of the most promising functional ingredients and evaluate their composition and properties; (2) developing encapsulation technologies for functional ingredients for increasing their stability during technological applications and storage until their release in human digestion tract and by that to improve their bioaccessibility; to produce the prototypes of the most promising encapsulated ingredients; (3) testing functional ingredients in different food matrices, to evaluate their effects on food quality and to prepare recommendations on their use for increasing food safety and healthiness; to develop formulas of new food supplements and to produce their prototypes; (4) investigating the release of bioactive substances from functional ingredients and products produced with them during <i>in vitro</i> digestion process and to preliminarily evaluate their possible anticancer effects.</p>	<p>Berry pomace biorefining technologies and the products obtained are new on the global scale, and this achievement will foster creation of new and competitive segment of agro-food industry in Lithuania.</p>	<p>During the research, a nutrient-dense food product for the elderly population was developed. Multiple bioactives-loaded double emulsion containing vitamins A, D, C, B9 and B12 and health-promoting berry polyphenols was used in the formulation of food product as delivering systems of priority bioactives for the elderly. Obtaining the therapeutic benefits of the multiple bioactives-loaded double emulsion requires the high entrapment of these compounds and their controlled release during digestion. The suitability of developed food product for elderly diet was proved in the focus group of geriatric patients, which was formed from the patients hospitalised in the Geriatric Department of Lithuanian University of Health Sciences.</p>	<p>With a rapid rise of the elderly population, the development of food products targeting the nutritional and health requirements of older persons has become a growing concern worldwide. Today, the market still lacks such products. The possible reason for this situation is several technological limitations in producing food products enriched with micronutrients, vitamins, and other bioactive compounds. The product, developed at KTU, introduces a simple way of realising highly efficient, nutrient-dense food product with controlled release of bioactives during digestion.</p>	<p>When looking for the suitable delivery vehicles for bioactives' in food, the most important parameter is the protection of the encapsulated bioactive compound until the moment when it reaches the targeted physiological sites. The KTU team succeeded in reaching this goal by formulating a stable, multiple bioactive-loaded double emulsion to simultaneously deliver priority bioactives for the elderly. This system was suitable for nutrient dense food applications, the therapeutic benefits of which was proved in the focus group of geriatric patients.</p>	
	<p>Food Systems</p>		<p>PARTNERS</p>	<p>Geriatric Department of Lithuanian University of Health Sciences</p>		
<p>CONTACT PERSON</p>	<p>Article in <i>Journal of Supercritical Fluids</i>, 2020, DOI: <a href="https://doi.org/10.1016/j.supflu.2020.104884">10.1016/j.supflu.2020.104884</a>                  Article in <i>Journal of Food Science</i>, 2020, DOI: <a href="https://doi.org/10.1111/1750-3841.14995">10.1111/1750-3841.14995</a>                  Article in <i>Journal of CO2 Utilization</i>, 2020, DOI: <a href="https://doi.org/10.1016/j.jcou.2019.09.020">10.1016/j.jcou.2019.09.020</a>                  Article in <i>Food Chemistry</i>, 2019, DOI: <a href="https://doi.org/10.1016/j.foodchem.2019.126072">doi.org/10.1016/j.foodchem.2019.126072</a>                  Article in <i>Food Chemistry</i>, 2020, DOI: <a href="https://doi.org/10.1016/j.foodchem.2020.126767">doi.org/10.1016/j.foodchem.2020.126767</a>                  Article in <i>Antioxidants</i>, 2020, DOI: <a href="https://doi.org/10.3390/antiox9040274">doi.org/10.3390/antiox9040274</a>                  Article in <i>Food &amp; Function</i>, 2020, DOI: <a href="https://doi.org/10.1039/D0FO00021C">doi.org/10.1039/D0FO00021C</a>                  Article in <i>LWT - Food Science and Technology</i>, 2020, DOI: <a href="https://doi.org/10.1016/j.lwt.2020.109820">doi.org/10.1016/j.lwt.2020.109820</a>                  Article in <i>Foods</i>, 2020, DOI: <a href="https://doi.org/10.3390/foods9101413">doi.org/10.3390/foods9101413</a></p>		<p>Food Systems</p>	<p>CONTACT PERSON</p>		
<p>Dr. Petras Rimantas Venskutonis <a href="mailto:rimas.venskutonis@ktu.lt">rimas.venskutonis@ktu.lt</a></p>			<p>Article in <i>Food &amp; Function</i>, 2020, DOI: <a href="https://doi.org/10.1039/D0FO00021C">10.1039/D0FO00021C</a></p>	<p>Dr. Daiva Leskauskaitė <a href="mailto:daiva.leskauskaite@ktu.lt">daiva.leskauskaite@ktu.lt</a></p>		





2019–2020	<b>EIT Food RIS Consumer Engagement Labs</b>	

RELEVANCE	DESCRIPTION	NOVELTY
<p>Consumer co-creation is an important learning process, through which a combination of knowledge, lifetime experience, diverse personal value systems and preferences could be turned into innovative ideas and product designs.</p> <p>Seniors in age group 65-85 years worked together with scientist, food producers and retail company with aim to identify needs of this segment of consumer and to develop the product with specific sensory properties.</p>	<p>EIT Food Consumer Engagement Labs are pre-competitive co-creation sessions carried out by a relatively coherent group of consumers (selected based on specific segmentation criteria) in a joint, physical place and limited in time, focused on ideation/development of new product concepts.</p> <p>EIT Food Consumer Engagement Labs use novel techniques to engage consumers, stimulate creativity and foster the acceptance of new products. Such a format allows non-experts to modify product features without the need to master specialist vocabulary or understand ingredients and manufacturing methods. This collective exercise can yield non-obvious, counter-intuitive combinations of product features and be attractive for consumers involved in the co-creation.</p> <p>EIT Food Consumer Engagement Labs put the consumers in the centre of the creative process, unleashing their creative potential and turning the consumers into genuine change agents, who can propose new products or services to be implemented by companies.</p> <p>As project result – innovative product Gri-kola was introduced to market. It is organic granola from buckwheat with beetroots and carrots, where various fractions of buckwheat were applied to get specific texture properties.</p>	<p>The activity elaborated a co-creation methodology that could be further used in other geographies, consumer segments and product categories, as well as inspire participants of various activities of EIT Food.</p> 
<b>PARTNERS</b>		
University of Warsaw (coordinator) (Poland); JSC "Palink" (Lithuania); JSC "Ekofriša" (Lithuania); AVOO (Lithuania)		

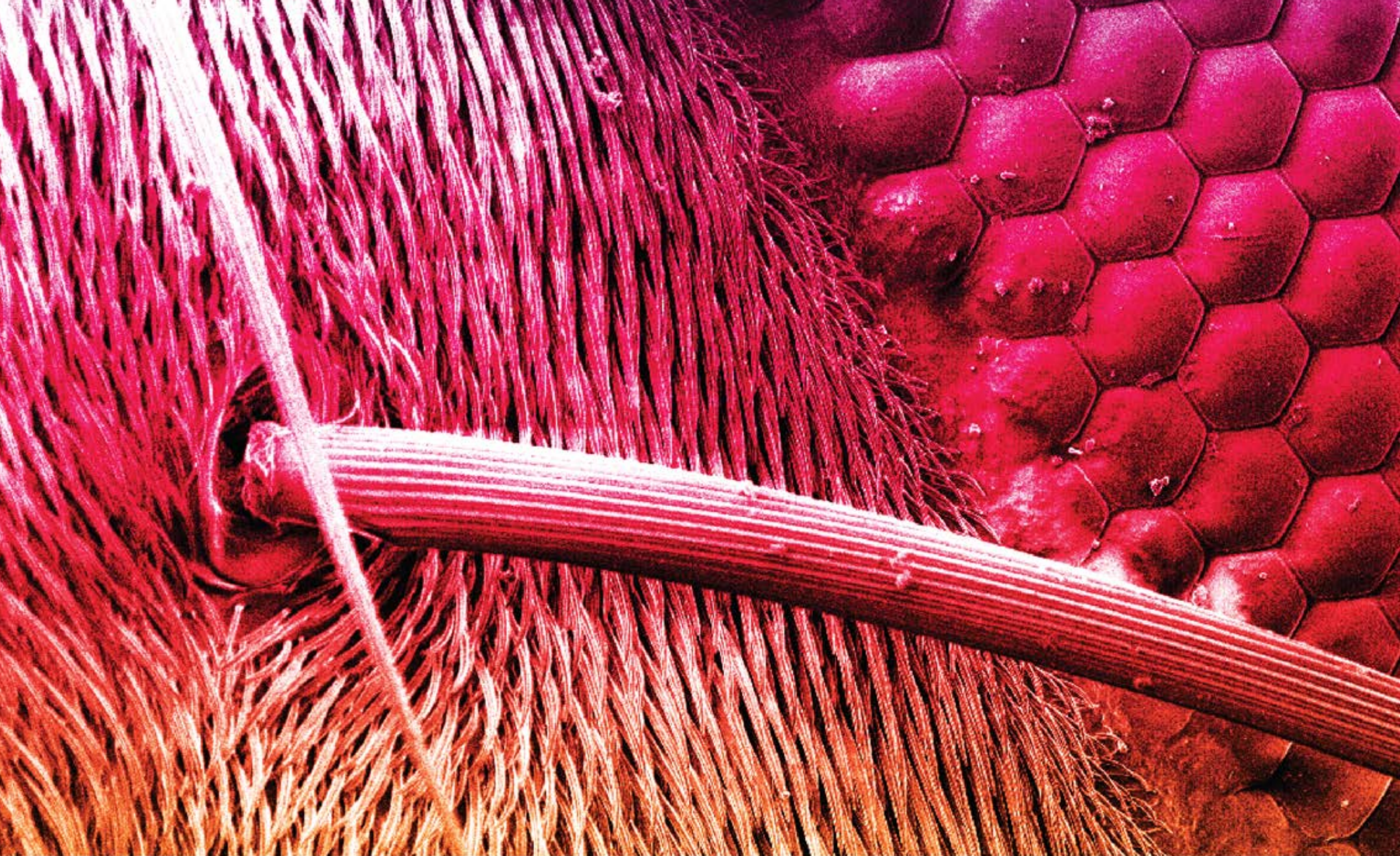
<b>CONTACT PERSON</b>	<b>Food Systems</b>
Dr. Gitana Alenčikienė <a href="mailto:gitana.alencikiene@ktu.lt">gitana.alencikiene@ktu.lt</a>	EIT Food project " <a href="#">RIS Consumer Engagement Labs</a> ", 2019-2020

	<b>Early Diagnostic Method of Depressive Disorder: Computer-Based Screening of Emotional Response to Different Tastes of Food</b>	2017–2020

RELEVANCE	DESCRIPTION	NOVELTY
<p>Although very common (globally more than 264 million people are affected by depression), depressive disorder (DD) in primary care often remains undiagnosed. Therefore, the development of early contactless computer-based diagnostic methods of the DD becomes very relevant. DD shortens a healthy and productive human life, incurs significant public health costs, and is associated with high suicide rates. The DD should be recognised, diagnosed and treated at the earliest stage. However, the epidemiological data of DD consists a variety of limitations due to the differences in diagnostic methodologies and their diagnostic reliability problems. The hypothesis has been proved under real conditions with patients that the emotional expression of the subject's face to different food tastes can be used as a diagnostic moderator in the development of a new contactless computer DD diagnostic method and DD diagnostic algorithm. The confirmation of this hypothesis can shed a new perspective on early contactless, computer-based psychiatric diagnostic strategies and early identification of DD symptoms.</p>	<p>The aim of the project is to develop an early diagnostic method to identify DD based on computer-based screening of the emotional responses of people to different tastes of food. A group of researchers of KTU together with partners evaluated the different variables-moderators, which could be used for early diagnosis of DD. Loss of appetite, changes to the taste of food, and the loss of pleasure in eating are important criteria in the diagnosis of DD. We hypothesised that a patient's facial expressions and emotional responses to different tastes can be used as the diagnostic moderators for the development of a new, contactless, computer-based method for diagnosis of DD. Keeping in mind the growing body of research evidence on the influence of nutrition on mental health, which is especially relevant for affective symptoms, the hypothesis that the emotional response to different tastes of food could be used as an early diagnostic means of affective disorders was confirmed and the innovation was filed for patenting.</p>	<p>The benefits of this method can be perceived from several perspectives: (I) patients can use the self-rating instrument to assess their DD symptoms; this may act as an incentive to seek professional help; (II) family and community can use the instrument for early recognition of DD symptoms and encourage the individual to seek professional help; (III) general practitioners can have a reliable instrument for preliminary diagnosis of DD in primary care; (IV) public health benefits include early diagnosis and treatment of DD and better outcomes, reductions in disability-adjusted life years and the global burden of the disease. Although it is important to recognise the limitations and risks of contactless diagnosis of DD, the method might be used for early diagnosis of DD symptoms.</p>
<b>PARTNERS</b>		
Lithuanian University of Health Sciences		

<b>Food systems</b>	<b>CONTACT PERSON</b>
Project "Development of early diagnostic methods of depressive disorder: computer-based screening of emotional response to different taste of food (EMOPSYCHOSCREEN)", 2017-2020, funded by Research Council of Lithuania Patent "System for the People's Early Stage Depressive Disorder Detection", 2020, <a href="#">LT 6735</a> Article in <i>Food Research International</i> , 2018, DOI: <a href="#">10.1016/j.foodres.2018.06.064</a> Article in <i>Frontiers in Psychiatry</i> , 2018, DOI: <a href="#">10.3389/fpsy.2018.00687</a> Article in <i>BioMed Research International</i> , 2019, DOI: <a href="#">10.1155/2019/2097415</a>	Dr. habil. Gražina Juodeikienė <a href="mailto:grazina.juodeikiene@ktu.lt">grazina.juodeikiene@ktu.lt</a>





"There's real poetry in the real world. Science is the poetry of reality." - Richard Dawkins



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