Review of Kaunas University of Technology R&D&I

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Contents

Kaunas University of Technology

It is a leading wide-ranging university, one of the leaders in research and experimental development and innovation (R&D&I) projects in Lithuania.

The University develops the potential of high international level researchers by developing nature, technology, medicine and health, social and humanitarian international, intradisciplinary and interdisciplinary research. Every year, clever investments are being made in breakthrough directions, and efforts are being made to create new knowledge. Technologies are being transformed at all levels - not only in the segment of academic studies, but also in non-formal education.

KTU has been working closely with the business sector for many years in a wide variety of areas.In order to achieve continuous synergy between the science and business sectors in a dynamic innovation ecosystem, the University effectively implements the processes of technology transfer, intellectual property management, young business creation and cooperation development coordinated by KTU National Innovation and Entrepreneurship Center (NIEC).

Centric IT Solutions Lithuania, UAB

“As I am involved in various environments and as I am participating in discussions, I often say that foreign investments choose Kaunas as a location particularly because of KTU's proactivity. Business needs an effective partnership with universities like fresh air. I am glad that since the establishment of *Centric* in Kaunas in 2018, thanks to common understanding, we have founded many joint initiatives that will benefit not only us as partners but also the entire society.”

PAULIUS SAMOŠKA
National Manager

Medicata Filia, UAB

“We are pleased with the cooperation with Kaunas University of Technology and see it as professional and smooth. Together, we have participated in the project of the European Union-supported funding instrument, therefore, the high competence of the University team in the management of science-business funding programs greatly facilitated the work of everyone involved. We highly appreciate the enthusiasm, initiative, scientific potential, sincerity and maturity of the team we have worked with. We value the experience very well and hope and have no doubt about having more success stories with Kaunas University of Technology in the future.”

SIGITAS VASILIAUSKAS
Co-Owner

Teltonika Telemedic, UAB

“By creating advanced products and developing innovative medical technologies, we strive for the highest quality results. Cooperation with Kaunas University of Technology helps us to implement the set goals and assist those who need it the most. With the help of talented university scientists, we started developing a smart medical watch project. This new device, based on a unique atrial fibrillation recognition technology, will become one of the most advanced medical devices on the market, accessible to all. We appreciate the progressiveness and productivity of KTU, which has so far successfully accompanied our cooperation on all technological issues. Currently, *Teltonika Telemedic* is employing as many as 11 promising KTU graduates. The knowledge and contribution brought by each of them is important for the further growth of the company. We are glad to have a partner we can trust.”

MARTYNAS OSAUSKAS
Chief Executive Officer

Achema, AB

“We are cooperating with KTU in order to attract students to work in our company: we are involved in the Career Days organized by KTU, the KTU Want’ed project and regularly organizing student internships in our company. Cooperation with KTU also takes place in resolving sensitive technical issues for the company. We are very happy to communicate directly with scientists, we know that we can always contact them and find a solution to the problem together. We hope that the latest initiative launched with KTU at the very end of 2020 will be successful, the research results will be important not only for AB Achema, but also for Lithuania as it is committed to reducing GHG emissions.”

ANDRIUS ŠOSTAKAS
Head of Innovation Center
of AB Achema

Biomedical Engineering Institute

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The entirety of infrastructure, prototyping equipment and competencies accumulated at the KTU Institute of Biomedical Engineering enables participation in international and national projects, creating and testing innovative prototypes, and providing research services to business and medical institutions.

KEY WORDS

Research on biosignal processing methods I Research on medical image processing I Research on physiological and biomechanical information sources and sensors

*National Innovation and Entrepreneurship Centre

Research on biosignal processing methods

Adaptive, model-based processing and application of parallel-registered multimodal biomedical signals in monitoring and diagnostics.

APPLICATION

Innovative solutions based on artificial intelligence can be applied in both medical and healthy lifestyle areas.

Stress level measurements, body fatigue, or atrial fibrillation can be monitored by collecting and processing various integrated biosignals, such as the ematization and recognition of photoplethysmographic (for continuous monitoring) and electrocardiographic (control monitoring) data by two types of sensor systems.

RESEARCH ARTICLES

Henriksson, M; Petrėnas, A.; Marozas, V.; Sandberg, F.; Sörnmo, L. (2018). **Model-based assessment of f-wave signal quality in patients with atrial fibrillation.** IEEE Transactions on Biomedical Engineering, 65(11), 2600-2611. doi: 10.1109/TBME.2018.2810508

Petrėnas, A.; Marozas, V.; Sološenko, A.; Kubilius, R.; Skibarkienė,J.; Oster, J.; Sörnmo, L. (2017). **Electrocardiogram modeling during paroxysmal atrial fibrillation: application to the detection of brief episodes.** Physiological Measurement, 38(11), 2058-2080. doi: 10.1088/1361-6579/aa9153

Research on medical image processing methods and algorithms

Processing and parameterisation of medical images with a view to increasing the objectivity and clinical value of their interpretation, 3D segmentation, and image merging.

APPLICATION

Automated solutions can allow determining the segmentation of facial bones by using computed tomography images. The technology allows matching three-dimensional images in space (superimposition). This unique examination methodology allows identifying changes in the lower jaw after surgery.

Researchers of the Medical Imaging and Information Processing Laboratory are developing research on ocular microcirculation, which is a vital part of blood circulation. The technology with additional software can quickly measure and evaluate the fundus and conjunctival microvessels during critical conditions.

RESEARCH ARTICLES

Marozas, M.; Zykus, R.; Sakalauskas, A.; Kupčinskas, L.; Lukoševičius, A. (2017). **Noninvasive evaluation of portal hypertension using a supervised learning technique.** Journal of Healthcare Engineering, 2017, 1-10. doi: 10.1155/2017/6183714

Rutkūnas, V.; Gečiauskaitė, A.; Jegelevičius, D.; Vaitiekūnas, M. (2017). **Accuracy of digital implant impressions with intraoral scanners. A systematic review.** European Journal of Oral Implantology, 10(1), 101-120. doi:10.4047/jap.2019.11.5.271

Research on physiological and biomechanical information sources and sensors

Development of and research on a new medical and biomechanical information source – intelligent sensors and transducers – and their wireless networks.

APPLICATION

Various R&D activities can involve standard or specialized sensors adapted to calculate a specific parameter or an integrated whole. Various sensors are used which are adapted to each project accordingly. For physiology, movement analysis and ultrasonic (including nonlinear interactions) tissue for diagnosis are used.

RESEARCH ARTICLES

Petrėnas, A.; Marozas, V.; Sörnmo, L. (2015). **Low-complexity detection of atrial fibrillation in continuous long-term monitoring.** Computers in biology and medicine, 65, 184-191. doi:10.1016/j.compbiomed.2015.01.019

Sološenko, A.; Petrėnas, A.; Marozas, V. (2015). **Photoplethysmography-based method for automatic detection of premature ventricular contractions.** IEEE transactions on biomedical circuits and systems, 9(5), 662-669. doi:10.1109/TBCAS.2015.2477437

Faculty of Chemical Technology

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The results of research carried out at the Faculty of Chemical Technology are published in high-level scientific journals. National and international projects are constantly implemented, and equipment, laboratories and other facilities for science and studies are systematically improved.

KEY WORDS

Human-friendly technologies I Physical and inorganic chemistry
Food chemistry I Organic chemistry I Polymers I Silicate materials
Molecular synthesis I Chemical technology I Functional materials
Biotechnology I Sustainable development I Biologically active substances

*National Innovation and Entrepreneurship Centre

Functional food materials

Development of new functional nutrients and technologies for their production from non-traditional raw materials and by-products of agricultural and food industry processing and production waste.

APPLICATION

New functional nutrients can be applied to the development of novel cosmetics, foods and food supplements as well as to the improvement of the quality and nutritional value of foods. Their production technologies can benefit the development and commercialization of innovative waste-free biorefining processes, thus contributing to the development of the sustainable circular economy.

RESEARCH ARTICLES

Kitrytė, V., Laurinavičienė, A., Syrpas, M., Pukalskas, A., Venskutonis, P. R. (2020). **Modeling and optimization of supercritical carbon dioxide extraction for isolation of valuable lipophilic constituents from elderberry (Sambucus nigra L.) pomace.** Journal of CO2 Utilization, 35, 225-235. doi: 10.1016/j.jcou.2019.09.020

Kitrytė, V., Bagdonaitė, D., Venskutonis, P. R. (2018). **Biorefining of industrial hemp (Cannabis sativa L.) threshing residues into cannabinoid and antioxidant fractions by supercritical carbon dioxide, pressurized liquid and enzyme-assisted extractions.** Food Chemistry, 267, 420-429. doi:10.1016/j.foodchem.2017.09.080

Bioprocesses in the food system, bioproducts and non–invasive control

Development of new biotechnological processes to increase the efficiency of bioconversion of secondary food products, waste and lignocellulosic biomass into value-added products by selecting their treatment methods, enzymes and microorganisms and control methods.

APPLICATION

Various R&D activities can be carried out with the application of traditional bioprocesses or the development of new biotechnologies for the processing

of secondary food products, waste and lignocellulosic biomass into value-added products. Treatment methods, enzymes and/or microorganisms will be selected to increase the efficiency of bioprocesses. A bioprocess control system has been developed.

RESEARCH ARTICLES

Juodeikiene, G.; Zadeike, D.; Trakselyte-Rupsiene, K.; Gasauskaite, K.; Bartkiene, E.; Lele, V.; Viskelis, P.; Bernatoniene, J.; Ivanauskas, L.; Jakstas, V. (2020). **Functionalisation of flaxseed proteins assisted by ultrasonication to produce coatings enriched with raspberries phytochemicals.** LWT - Food science and technology, 124, 1-10.

Klupšaitė, D.; Juodeikienė, G.; Arbones, E.; Quintáns, A. P.; Žadeikė, D.; Bartkiene, E.; Glasner, C.; Dikiy, A.; Shumilina, E. (2019). **A comparison study on the production and recovery of lactic acid by fermenting dairy by-products with P. acidilactici and Lb. delbrüeckii spp. Bulgaricus.** Waste and biomass valorization, 10, 1519-1528.
doi: 10.1007/s12649-017-0171-z

Research and design of food structures

Design of food structures ensures the desired texture properties of the product, the best possible activity of the product's biologically active compounds during the technological process and storage, and the controlled release of these compounds in the consumer’s digestive tract.

APPLICATION

Design of food structures can be applied to the development of both conventional and special-purpose foods and beverages. The structure of foods and beverages can be assessed by using instrumental methods, and the release of biologically active compounds in the digestive tract can be assessed by simulating the processes and conditions that take place during digestion. Simulation of the gut ecosystem (microbiota) allows determining whether foods affect the viability of good gut bacteria and defining their benefits to the gut microbiotia.

RESEARCH ARTICLES

Keršienė, M., Jasutienė, I., Eisinaitė, V., Venskutonis, P. R., Leskauskaitė, D. (2020). **Designing multiple bioactives loaded emulsions for the formulations for diets of elderly.** Food & Function, 11(3), 2195-2207.
doi:10.1039/d0fo00021c

Kaya, M., Česonienė, L., Daubaras, R., Leskauskaitė, D., Zabulionė, D. (2016). **Chitosan coating of red kiwifruit (Actinidia melanandra) for extending of the shelf life.** International journal of biological macromolecules, 85, 355-360. doi: 10.1016/j.ijbiomac.2016.01.012

Multi-component heterogeneous inorganic systems and technologies of their application

Development, research and application of catalysts, adsorbents and liquid chemosorbents, special compound fertilizers with bioactive and environmentally friendly substances.

APPLICATION

Transition metal oxide sorbents, catalysts, and selective chemosorbents are used to separate, concentrate, or remove target substances from process streams. Balanced fertilizers of adjustable composition with bioactive substances are developed according to need in solving relevant problems of the sustainability of agroecosystems.

RESEARCH ARTICLES

Makarevičienė, V., Sendžikienė, E., Čiutelytė, R., Kitrys, S., Jaskūnas, A. (2015). **Kinetics characteristics and efficiency of carbon dioxide absorption from biogas by dolomite suspensions.** Chemistry and Technology of Fuels and Oils, 51, 147-153. doi: 10.1007/s10553-015-0587-8

Sharma, L., Brigaityte, O., Honer, K., Kalfaoglu, E., Slinksiene, R., Streimikis, V., Sviklas, A., Baltrusaitis, J. (2018) **Carnallite-Derived Solid Waste as Potassium (K) and Magnesium (Mg) Source in Granulated Compound NPK Fertilizers.** ACS Sustainable Chemistry & Engineering, 6(7), 9427-9433. doi:10.1021/acssuschemeng.8b01773

Electrochemistry and chalcogen chemistry

Development and application of innovative functional materials with specific physical and chemical properties.

APPLICATION

- Development of oxide and chalcogenide functional materials, their nano derivatives or multicomponent composites and their application in photovoltaic systems.
- Modification and application of graphite fibre felt electrodes in fuel cells, flowing electrolyte accumulators, and microbial fuel cells.

RESEARCH ARTICLES

Krylova, V., Dukštienė, N., Žalenkienė, S., Baltrusaitis, J. (2017). **Chemical and structural changes in polyamide based organic–inorganic hybrid materials upon incorporation of $SeS2O6^{2-}$ precursor.** Applied surface science, 392, 634-641. doi:10.1016/j.apsusc.2016.09.042

Dukštienė, N., Sinkevičiūtė, D., Tatariškinaitė, L. (2016). **Electrochemical behavior of SeO2 in sodium citrate solution on a polycrystalline SnO2 electrode.** Journal of solid state electrochemistry, 20, 813-825. doi:10.1007/s10008-015-2974-9

Synthesis of organic semiconductors

Synthesis of efficient organic semiconductors, research on their properties and their application in energy saving technologies.

APPLICATION

Organic semiconductors that transport or generate both positive and negative charge carriers can be used in a variety of optoelectronic devices, such as organic or hybrid solar cells, organic light emitting diodes, and efficient field effect transistors.

RESEARCH ARTICLES, PATENTS

Al-Ashouri, A., Magomedov, A., Roß, M., Jošt, M.,Talaikis, M., Chistiakova, G., Bertram, T., Márquez, J. A., Köhnen, E., Kasparavičius, E., Levcenco, S., Gil-Escrig, L., Hages, C. J., Schlatmann, R., Rech, B., Malinauskas, T., Unold, T., Kaufmann, C . A., Korte, L., Niaura, G., Getautis, V., Albrecht, S. (2019). **Conformal monolayer contacts with lossless interfaces for perovskite single junction and monolithic tandem solar cells. Energy Environ Sci,** 12(11), 3356-3369.

Braukyla, T., Xia, R., Daskeviciene, M., Malinauskas, T., Gruodis, A., Jankauskas, V., Fei, Z. F., Momblona, C., Roldan-Carmona, C., Dyson, P. J., Getautis, V., Nazeeruddin, M. K. (2019). **Inexpensive hole-transporting materials derived from Troger's base afford efficient and stable perovskite solar cells. Angew. Chem,** 58, 11266-11272. doi: 10.1002/anie.201903705

Gratia, P., Nazeeruddin, M. K., Graetzel M., Getautis, V., Magomedov, A., Malinauskas, T., Daskeviciene, M. **Small molecule hole transporting material for optoelectronic and photoelectrochemical devices: United States Patent US 10680180**

Polymer research

Research on and application of the modification of natural polymers, composites and nanomaterials.

APPLICATION

The use of natural, synthetic or modified polymers allows creating new materials that can be used in fibre engineering, pharmaceutical industry, production of cosmetics and hygiene products, packaging materials, bioplastics and biocomposites as well as in water treatment.

RESEARCH ARTICLES

Daugėla, P., Pranskūnas, M., Juodžbalys, G., Liesienė, J., Baniukaitienė, O., Afonso, A., de Sousa Gomes, P. (2018). **Novel cellulose/hydroxyapatite scaffolds for bone tissue regeneration: in vitro and in vivo study.** Journal of tissue engineering and regenerative medicine, 12, 1195-1208. doi:10.1002/term.2651

Liudvinaviciute, D., Rutkaite, R., Bendoraitiene, J., Klimaviciute, R. (2019). **Thermogravimetric analysis of caffeic and rosmarinic acid containing chitosan complexes.** Carbohydrate polymers, 222, 497-510. doi:10.1016/j.carbpol.2019.115003

Merijs-Meri, R., Zicans, J., Ivanova, T., Bochkov, I., Varkale, M., Franciszczak, P., Bledzki, A. K., Danilovas, P. P., Gravitis, J., Rubenis, K., Stepanova, V., Locs, J. (2019). **Development and characterization of grain husks derived lignocellulose filler containing polypropylene composites.** Polymer engineering and science, 59, 2467-2473 doi:10.1002/pen.25245

Synthesis and research of functional and biologically active substances

Functional heterocyclic compounds, chiral and achiral amino acids development by using modern methods of organic synthesis.

Synthesis and studies of enantiomerically pure peptides.

Purification and structure determination of compounds.

APPLICATION

Various functional heterocyclic compounds synthesized by modern synthesis methods could be used as photochromic substances, molecular switches, bio-markers, UV stabilizers.

Synthesized novel chiral and achiral heterocyclic amino acids and their derivatives can be used to generate DNA-encoded libraries, to obtain enantiomerically pure peptides or other compounds with biological activity.

Detailed structural analysis provides conclusive evidence for the structure of the tested compounds. For this activity, the institute is equipped with modern research tools.

RESEARCH ARTICLES, PATENTS

Varvuolytė, G., Malina, L., Bieliauskas, A., Hošíková, B., Simerská, H., Kolářová, H., Kleizienė, N., Kryštof, V., Šačkus, A., Žukauskaitė, A. (2020). **Synthesis and photodynamic properties of pyrazole-indole hybrids in the human skin melanoma cell line G361. Dyes and pigments,** 183, 1-12. doi:10.1016/j.dyepig.2020.108666

Šačkus, A., Martynaitis, V., Krikštolaitytė, S., Ragaitė, G., Vengris, M. **Photochromic compounds and intermediate compounds for production thereof: United States Patent US** 10023585 B2.

Šačkus, A., Martynaitis, V., Dagilienė, M., Krikštolaitytė, S., Ragaitė, G. **Spiro[chroman 2,2'-indole]derivatives as cyanide ion chemosensors: European patent EP** 2999704 B1.

Synthesis and isolation of bioactive compounds from renewable raw materials

Development of plant growth regulators and antimicrobial compounds and development of technologies for alternative fuels from renewable organic plastics.

In vitro evaluation of antioxidant, antibacterial activity and quantification of bioactive compounds in callus cultures of medicinal plants.

Research on the production of biopolymers (xanthan, alginate) from renewable sources.

APPLICATION

Research conducted by the researchers of the Faculty:

- Work for the synthesis of five- and six-membered heterocyclic compounds with antimicrobial, antioxidant and carbonic anhydrase inhibitory properties is performed.
- As the importance of renewable energy sources continues to grow, technological research on the isolation of bioactive substances from biomass and biofuels is carried out.
- Plant biotechnological studies related to in vitro callus cultures of medicinal plants and isolation of bioactive metabolites as well as microbiological studies related to the production of biopolymers from renewable sources are conducted.

RESEARCH ARTICLES

Balandis, B., Ivanauskaitė, G., Smirnovienė, J., Kantminienė, K., Matulis, D., Mickevičius, V., Zubrienė, A. (2020). **Synthesis and structure-affinity relationship of chlorinated pyrrolidinone-bearing benzenesulfonamides as human carbonic anhydrase inhibitors. Bioorganic chemistry,** 97, 1-12. doi: 10.1016/j.bioorg.2020.103658

Jasiūnas, L., Peck, G., Bridžiuvienė, D., Miknius, L. (2020). **Mechanical, thermal properties and stability of high renewable content liquefied residual biomass derived bio-polyurethane wood adhesives. International journal of adhesion and adhesives,** 101, 1-14. doi:10.1016/j.ijadhadh.2020.102618

Synthetic organic chemistry

Development of new organic compounds using modern methods of organic chemistry synthesis, compound purification and structure determination.

APPLICATION

- Modern methods of organic synthesis can be used in the synthesis of organic compounds for research or for high-tech companies developing pharmaceutical and functional materials.
- Structural studies of organic compounds can be applied to fully clarify the structure of organic compounds.

RESEARCH ARTICLES

Milišiūnaitė, V., Arbačiauskienė, E., Řezníčková, E., Jorda, R., Malínková, V., Žukauskaitė, A., Holzer, W., Šačkus, A., Kryštof, V. (2018). **Synthesis and anti-mitotic activity of 2,4- or 2,6-disubstituted- and 2,4,6-trisubstituted-2H-pyrazolo[4,3-c]pyridines.** European Journal of Medicinal Chemistry 150, 908-919. doi:10.1016/j.ejmech.2018.03.037.

Lipp, B., Kammer, L. M., Kücükdisli, M., Luque, A., Kühlborn, J., Pusch, S., Matulevičiūtė, G., Schollmeyer, D., Šačkus, A., Opatz, T. (2019). **Visible Light-Induced Sulfonylation/Arylation of Styrenes in a Double Radical Three-Component Photoredox Reaction.** Chem. Eur.J., 25, 8965 –8969. doi:10.1002/chem.201901175

Milišiūnaitė, V., Kadlecová, A., Žukauskaitė, A., Doležal, K., Strnad, M., Voller, J., Arbačiauskienė, E., Holzer, W., Šačkus, A. (2020). **Synthesis and anthelmintic activity of benzopyrano[2,3-c]pyrazol-4(2H)-one derivatives. Molecular diversity,** 24(4), 1025-1042 doi:10.1007/s11030-019-10010-3

Advanced environmental technologies

RESEARCH DIRECTIONS

Purification of polluted air, water and soil and recovery of resources by nano, bio and other advanced technological methods. Recycling of waste and recovery of valuable materials by using environmentally friendly processes. Numerical and experimental modeling of pollutant decomposition / concentration processes. Process eco-efficiency assessment, analysis, design and management.

Air pollution research and technology

Research on air pollution in the city, premises and work in the open air; development and prototyping of polluted air treatment technologies.

APPLICATION

- Competent research and expert assessment services are carried out in the air of cities, premises and the working environment so that to ensure good air quality;
- Analysis of pollutant release from materials and processes is performed so that to provide advice on optimizing production processes in the air with the objective of reducing emissions;
- Development and research of air cleaning and purification technologies based on complex process engineering, bio and nanotechnology solutions.

RESEARCH ARTICLES

Du, L., Leivo, V., Prasauskas, T., Täubel, M., Martuzevicius, D., Haverinen Shaughnessy, U. (2019). **Effects of energy retrofits on indoor air quality in multifamily buildings. Indoor air,** 29, 686-697.

Sidaravičiūtė, R., Krugly, E., Dabašinskaitė, L., Valatka, E., Martuzevičius, D. (2017). **Surface-deposited nanofibrous TiO2 for photocatalytic degradation of organic pollutants. Journal of sol-gel science and technology,** 84, 306-315.

Matulevičius, J., Kliučininkas, L., Prasauskas, T., Buivydienė, D., Martuzevičius, D. (2016). **The comparative study of aerosol filtration by electrospun polyamide, polyvinyl acetate, polyacrylonitrile and cellulose acetate nanofiber media. Journal of aerosol science**, 92, 27-37.

Advanced water and wastewater treatment technological solutions

Difficult challenges are increasingly frequent in the use of traditional water and wastewater treatment processes. Innovative technologies that integrate advanced water treatment processes allow ensuring efficient and cost-effective technological solutions.

APPLICATION

- Combined water treatment systems that integrate advanced oxidation, photocatalysis, sorption, and biodegradation processes can increase water and wastewater treatment efficiency to 99.9%.
- The use of these processes effectively eliminates not only traditional but also priority pollutants. They not only allow meeting stricter environmental requirements but also recovering water resources.
- Optimal combination of processes ensures not only high efficiency but also low operating costs.

RESEARCH ARTICLES

Tichonovas, M.; Krugly, E.; Jankūnaitė, D.; Račys, V.; Martuzevičius, D. (2017). **Ozone-UV catalysis based advanced oxidation process for wastewater treatment.** Environmental science and pollution research, 24, 17584-17597. doi:10.1007/s11356-017-9381-y

Abromaitis, V., Račys, V., van der Marel, P., Ni, G., Dopson, M., Wolthuizen, A. L., Meulepas, R.J.W. (2017). **Effect of shear stress and carbon surface roughness on bioregeneration and performance of suspended versus attached biomass in metoprolol-loaded biological activated carbon systems.** Chemical engineering journal, 317, 503-511. doi:10.1016/j.cej.2017.02.097

Research on waste management

In order to develop more efficient technologies for waste recycling and resource recovery from waste as well as waste management feasibility assessment methodologies, attention is focused towards multi-layer composite waste (packaging, electronics, etc.), landfill mining and forecasting models for the generation of various types of waste.

APPLICATION

Waste management investigations include:

- Investigations of the morphological composition of waste – technologies for its division into separate recyclable components are tested and proposed. Increased efficiency of waste recycling potential is achieved.
- Assessment of the economic and environmental feasibility of recovery from landfills and multi-layer composite waste is performed.
- Determination of the amount of microplastics in the fine fraction of waste and in environmental objects is achieved.

RESEARCH ARTICLES

Mumladze, T., Yousef, S., Tatariants, M., Kriūkienė, R., Makarevičius, V., Lukošiūtė, I., Bendikienė, R., Denafas, G. (2018). **Sustainable approach to recycling of multilayer flexible packaging using switchable hydrophilicity solvents.** Green chemistry, 20(15), 3604-3618. doi:10.1039/c8gc01062e

Tatariants, M., Saed, A. S. Y., Sakalauskaitė, S., Daugelavičius, R., Denafas, G., Bendikienė, R. (2018). **Antimicrobial copper nanoparticles synthesized from waste printed circuit boards using advanced chemical technology.** Waste management, 78, 521-531. doi:10.1016/j.wasman.2018.06.016

Life cycle assessment (LCA)

In order to develop more effective measures to improve environmental performance, solutions are sought through a life-cycle approach – the environmental impact of a product, service or process from its physical occurrence to its disappearance is examined.

APPLICATION

- LCA is used to assess the environmental impact of a process or service. Identification of the causes allows improving the environmental performance of a product, service or process and to reduce the environmental impact. Research focuses on the life cycle assessment of technological processes.
- LCA can be used for the calculation of the carbon footprint (that of a product or company) as well as for eco-labelling.

RESEARCH ARTICLES

Stasiulaitienė, I., Martuzevičius, D., Abromaitis, V., Tichonovas, M., Baltrušaitis, J., Brandenburg, R., Pawelec, A., Schwock, A. (2016). **Comparative life cycle assessment of plasma-based and traditional exhaust gas treatment technologies.** Journal of cleaner production. 112, 1804-1812. doi:doi.org/10.1016/j.jclepro.2015.01.062

Synthetic biology and biotechnology

The aim is to develop and apply technologies based on synthetic biology that will accelerate the detection of low molecular weight compounds such as phenolic, itaconic and other acids in the environment and in microorganism cells, and the development and application of new biotechnological processes for the biosynthesis of high value biomaterials.

APPLICATION

- Gene expression and metabolism of microorganisms.
- Bioinformatics and experimental studies of gene expression regulation processes and metabolism of small molecule compounds.
- Modeling by using bioinformatics, numerical and experimental methods
- Search, development and application of cellular biosensors for the detection and quantification of small molecule compounds.
- Modeling, development and application of synthetic metabolic pathways for the biosynthesis of high value low molecular weight biomaterials.

RESEARCH ARTICLES

Valanciene, E.; Jonuskiene, I.; Syrpas, M.; Augustiniene, E.; Matulis, P.; Simonavicius, A.; Malys, N. (2020). **Advances and Prospects of Phenolic Acids Production, Biorefinery and Analysis. Biomolecules,** 10, 874. doi: 10.3390/biom10060874

Chemistry of materials

Rapid, delayed fluorescence of organic radiation phosphorescence at room temperature, synthesis and studies. Synthesis and investigation of bipolar organic semiconductors with high excited triplet state energy. Development of products for the additive formation of polymers and polymer composites of natural origin by using light technologies.

APPLICATION

The developed organic electroactive materials are intended for organic light emitting diodes, oxygen and other analytical sensors, organic lasers.

The developed polymers and polymer composites are used in optical 3D printers, direct laser writing devices, 3D micro and nanolithography.

RESEARCH ARTICLES

Skliutas, E., Lebedevaite, M., Kasetaite, S., Rekstyte, S., Lileikis, S., Ostrauskaite, J., Malinauskas, M. (2020). **A Bio-Based Resin for a Multi-Scale Optical 3D Printing, Scientific Reports,** 10, 9758. doi: 10.1038/s41598-020-66618-1.

Singh, M., Jou, J.H., Sahoo, S., Sujith, S.S., He, Z.K., Krucaite, G., Grigalevicius, S., Wang (2018). **High light-quality OLEDs with a wet-processed single emissive layer, Scientific Reports,** 8, 7133

Keruckiene, R., Volyniuk, D., Leitonas, K., Grazulevicius, J.V. (2020). **Dual emission fluorescence/room-temperature phosphorescence of phenothiazine and benzotrifluoride derivatives and its application for optical sensing of oxygen, Sensors and Actuators B-Chemical,** 321, 128533. doi: 10.1016/j.snb.2020.128533

Synthesis, properties and application of functional silicate materials

Modern hydrothermal, microwave and solid-phase sintering processes that cover the specifics of the synthesis of silicate and related substances; research on their properties and structure and their use in technologies for the environmentally friendly production of low-energy cements and other products.

APPLICATION

The technology allows:

- Synthesizing binders, ceramics and other target-controlled properties of inorganic materials for research and higher technology companies.
- Determining the chemical, mineral composition, structure, features and properties of substances with the objective to propose rational ways of their use.
- Bringing new, innovative, high value-added products to the market.

RESEARCH ARTICLES

Šiaučiūnas, R., Bankauskaitė, A., Baltakys, K., Stankeviciūtė, M. (2019). **The impact of Na_2O on the synthesis of α-C2SH with different mineral composition and the stability of intermediate and final products. Ceramics international,** 45(2), 2846-2851. doi: 10.1016/j.powtec.2019.07.078

Dambrauskas, T., Baltakys, K., Eisinas, A., Kitrys, S. (2019). **The specific surface area and porosity of synthetic and calcined α-C2SH, kilchoanite and hydroxyledgrewite** 355, 504-513.

Development, research and application of the structure and properties of CO_2-curing, low-CaO cements from local raw materials and technogenic products for the production of high-strength, durable concrete products.

APPLICATION

This technology allows

- Reducing the amount of CaO in the raw material mixture by 1.5-1.8 times compared to the synthesis of Portland cement clinker, and at the same time reducing CO_2 emissions into the environment.
- Abandoning high temperature combustion operations and thus achieving ~ 30% reduction in energy consumption.
- As products solidify in the CO_2 environment, this technology allows combining these greenhouse gases with inert $CaCO_3$

RESEARCH ARTICLES

Šiaučiūnas, R., Hilbig, H., Prichockienė, E., Šmigelskyte, A., Takulinskas, Ž. (2020). **Accelerated carbonation of C2SH based dense concrete. Ceramics International,** 46(18), 29436-29442.
doi: 10.1016/j.ceramint.2020.05.027

Šmigelskytė, A., Šiaučiūnas, R., Hilbig, H., Decker, M., Urbonas, L., Skripkiunas, G. (2020). **Carbonated rankinite binder: effect of curing parameters on microstructure, strength development and durability performance. Scientific Reports,** 10(1), 1-13.

Use of synthetic hydrosilicates and related materials in adsorption and catalysis processes.

APPLICATION

- Use of calcium hydrosilicates for the removal of heavy metals from industrial and domestic wastewater. Advantage: adsorption reactions are irreversible - all heavy metal ions are bonded by chemical interaction.
- Use of synthesized materials with interfering metal ions in oxidation reactions of light organic compounds.
- AlF3 production waste - silica gel modified by using a constant water flow technology to use as a mineralizer since wollastonite begins to form as early as at 800°C.

RESEARCH ARTICLES

Eisinas, A., Ruginytė, K., Baltakys, K., Dambrauskas, T. et al. (2020). **Cu2+ ion adsorption by synthetic mayenite and its thermal stability. Ceramics International,** 46(18), 29429-29435. doi: 10.1016/j.ceramint.2020.05.028

Dambrauskas, T., Knabikaitė, I., Eisinas, A., Baltakys, K., Palou, M.T. (2020). **Influence of Cr3+, Co2+ and Cu2+ on the formation of calcium silicates hydrates under hydrothermal conditions at 200 °C. Journal of Asian Ceramic Societies,** 8(3), 753-763. doi: 10.1080/21870764.2020.1789287

Chemical engineering of binders, natural and technogenic resources

Research on and technological application of various technogenic and natural additives that can replace conventional Portland cement clinker.

APPLICATION

Technology allows

- Increasing the pozzolanic activity of mica clay, which is widespread and abundant in Lithuania, by adding waste of smectite clay used for refining edible oil.
- Replacing up to 5% of Portland cement clinker with pozzolanic additive synthesized from mica clay and biofuel fly ash without compromising the strength of the cement stone.
- By adding buckwheat husks or their ash additive, to improve the strength of ceramic shards made of easily melted clay. In the production of porous ceramic products, they are replaced with sawdust. As the technological parameters do not change, the density of fired ceramic samples is higher, and the values of compressive strength are close to or even better than those of similar materials but without additives.

RESEARCH ARTICLES

Kaminskas, R., Kubiliūtė, R., Prialgauskaitė, B. (2020). **Smectite clay waste as an additive for Portland cement. Cement & Concrete Composites,** 113, 1-10. doi: 10.1016/j.cemconcomp.2020.103710

Šiaučiūnas, R., Valančienė, V. (2020). **Influence of buckwheat hulls on the mineral composition and strength development of easily fusible clay body (2020). Applied Clay Science,** 197, p. 1-10. doi: 10.1016/j.clay.2020.105794

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The Faculty develops research in technology, humanities and arts, and performs outsourced work. Research is carried out by about 100 teachers and researchers. The Faculty has developed integration of science and business, where business is enabled to benefit from the most advanced technological solutions and services.

KEY WORDS

Research on concrete I Research on alkali-activated binders, mortars Indoor air quality research I Sustainable energy system research

*National Innovation and Entrepreneurship Centre

Evaluation of the quality of architectural concrete surface

Modern technologies for the production of concrete and reinforced concrete products allow creating concretes with unique properties for various purposes to be used for construction of hydraulic engineering, transport, public, residential and other types of buildings.

APPLICATION

Solutions based on the application of various assessment methodologies are applied in the assessment of the surface characteristics of prefabricated concrete elements and concrete monolithic structures installed on a construction site. The causes of defects that have formed on the concrete surface are evaluated, and recommendations for the reduction or elimination of defects in the future are developed and provided.

Research on ultra-high performance concrete (UHPC)

Ultra-high performance concrete is a new class of concrete which has compressive strength over 100 MPa. With a good selection of raw ingredients and proper particle size distribution, the compressive strength can be increased up to 230 MPa. Nevertheless, concrete has advantageous microstructure and durability properties.

APPLICATION

Experiments showed that, after 270 cycles of salt-scaling in 3% NaCl solution, in the UHPC samples, no surface scaling or mass loss was detected. On the contrary, the compressive strength increased even further (up to 250 MPa). UHPC has exceptionally good durability properties and can be up to 1000 times more resilient to various aggressive environments comparing to the ordinary concrete. Thus, UHPC is more similar to granite or basalt rock. Since UHPC has very good compressive strength and durability properties, in some areas it can even replace steel constructions; also, it can be used in the manufacturing of machine frames, table countertops and street furniture. Consequently, it opens new ways for architects in the future construction technology.

RESEARCH ARTICLES

Vaitkevičius, V., Šerelis, E., Vaičiukynienė, D., Raudonis, V., Rudžionis, Ž. (2016). **Advanced mechanical properties and frost damage resistance of ultra-high performance fibre reinforced concrete.** Construction and building materials, 126, 26-31. doi:10.1016/j.conbuildmat.2016.09.012

Research on the durability of concrete using shredded rubber waste from used tires

Every year, the world accumulates a huge amount of used tires, which are essentially non-degradable in the natural environment. About 275 million tires a year are discarded in the US alone, and around 180 million in the European Union. We can also mention here the recent environmental disaster in Alytus. These statistics can be alleviated by applying used tires in concrete production. Therefore, the application of shredded rubber waste in concrete is now of increasing interest.

APPLICATION

Shredded rubber waste can be used for the manufacture of special-purpose concrete structures. Replacing some of the sand in the concrete mix with a fine rubber filler produces more deformable concrete than the ordinary one, and, most importantly, concrete that is more resistant to frost and ice-melting salts than that used to make reinforced concrete elements for roads and bridges. The frost resistance of concrete can be enhanced by using lightweight porous aggregates.

When disposing of used tires, it is expedient to mechanically shred and fractionate them so that to produce a rubber additive suitable for concrete and to replace part of the fine concrete aggregate with this additive.

RESEARCH ARTICLES

Grinys, A., Augonis, A., Daukšys, M., Pupeikis, D. (2020). **Mechanical properties and durability of rubberized and SBR latex modified rubberized concrete.** Construction and building materials, 248. doi:10.1016/j.conbuildmat.2020.118584

Research on alkali–activated binders, mortars or concretes

Alkali-activated materials provide a certain binder system obtained by a reaction of an alkaline solution (activator) with powdered aluminosilicate (precursor).

APPLICATION

The production of this type of material enables the recycling of a large amount of industrial waste such as fly ash and furnace ash, slag, technogenic silica gel, ground glass waste, perlite waste, phosphogypsum, gypsum board waste, etc.

Alkali-activated paste, mortar or concrete has similar properties to Portland cement systems but, in some cases, can have even better properties.

RESEARCH ARTICLES

Vaičiukynienė, D.; Nizevičienė, D.; Kielė, A.; Janavičius, E.; Pupeikis, D. (2018). **Effect of phosphogypsum on the stability upon firing treatment of alkali-activated slag.** Construction and Building Materials, 184, 485-491. doi:10.1016/j.conbuildmat.2018.06.213

Vaičiukynienė, D., Borg, R. P., Kielė, A., Kantautas, A. (2018). **Alkali-activated blends of calcined AlF3 production waste and clay.** Ceramics International, 44(11), 12573-12579. doi:10.1016/j.ceramint.2018.04.054

Research on indoor air quality

Experimental and digital assessment of indoor air quality, including thermal comfort and quality of the environment.

APPLICATION

Research on indoor air quality serves as the basis for:

- Determination and assessment of indoor air quality, levels of thermal comfort of buildings and air distribution in buildings,
- Studies of indoor air quality and thermal comfort in low energy buildings,
- Analysis of energy consumption due to infiltration for households,
- Characteristics of the indoor environment and the feedback of inhabitants.

RESEARCH ARTICLES

Jurelionis, A., Stasiuliene, L., Prasauskas, T., Martuzevicius, D. (2016). **Dispersion of indoor air pollutants emitted at near-floor levels in rooms with floor heating and mixing ventilation.** Indoor and Built Environment, 27, 205-2018. doi:10.1177/1420326X16669975

Seduikyte, L., Stasiulienė, L., Prasauskas, T., Martuzevičius, D., Černeckienė, J., Ždankus, T., ... & Fokaides, P. (2019). **Field Measurements and Numerical Simulation for the Definition of the Thermal Stratification and Ventilation Performance in a Mechanically Ventilated Sports Hall.** Energies, 12(12), 2243. doi:10.3390/en12122243

Research on sustainable energy systems

Technical, environmental and financial assessment of sustainable energy systems used in the created environment for the conversion of renewable energy into heat or energy.

APPLICATION

Research on the energy efficiency of sustainable energy systems, including solar thermal systems, ground source heat pumps, biomass boilers, mechanical hydraulic systems for the conversion of wind energy to heat, thermal energy storage and accumulation, and sustainable HVAC systems.

RESEARCH ARTICLES

Tamašauskas, R., Šadauskienė, J., Bruzgevičius, P., & Krawczyk, D. A. (2019). **Investigation and Evaluation of Primary Energy from Wind Turbines for a Nearly Zero Energy Building (nZEB).** Energies,12(11), 2145. doi:10.3390/en12112145

Valancius, R., Singh, R. M., Jurelionis, A., & Vaiciunas, J. (2019). **A Review of Heat Pump Systems and Applications in Cold Climates: Evidence from Lithuania.** Energies, 12(22), 4331. doi:10.3390/en12224331

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Researchers of the Faculty of Electrical and Electronics Engineering successfully cooperate with business in creating innovative and adaptable solutions, conducting relevant research and proposing ideas for improvement. The Faculty consists of 4 departments: Department of Electrical Engineering, Department of Automation, Department of Electrical Systems, Institute of Metrology. The conducted research is highly relevant for electrical and electronics engineering, thermal engineering and experimental development. Academic activity in these fields of research is directed towards the strengthening of the relationship with business and state institutions and cooperation with local and foreign partners. It is of fundamental importance for the economic and technological development of the country.

KEYWORDS

Wireless sensors I Internet of Things I Monitoring of parameters Signals treatment I Measurement of delay time I Radio communication (SubGHz, NB, Lora, SigFox) I Real-time measurement and control systems Signal compression / decompression I Electric motor control controllers Artificial intelligence I Computer vision I Robotics | Process and equipment automation I Renewable energy sources I Energy storage I Ergonomics Legal and industrial metrology I Calibration methods and techniques Certification of measuring systems

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Interactive electronic systems

The problems to be solved are related to the monitoring and control of industrial environment parameters using electronic systems, automated energy-efficient data transmission both in the smart city area and in industry or medicine. Innovative devices are being developed that extract energy from vibrations, thus allowing the creation of battery-free sensors.

APPLICATION

The developed ultrasonic parking sensor is used in intelligent parking systems. These systems have been installed in 28 supermarkets in Europe and the Middle East.

Analog and digital fuel level gauges have been developed for installation in trucks, heavy machinery, agricultural machinery and tanks. These products have been successfully commercialized and sold in many parts of the world.

A sensor integrated into the road surface has been developed for monitoring traffic parameters (number of cars, speed, length). This sensor, when it detects a vehicle, can control the video camera and searchlight, thus ensuring the best picture quality of the passing vehicles.

Research has been carried out, and a prototype of a silent ventilation diffuser with UltraKPS technology, a prototype of a “Universal Sensor Block” for national defense needs, a ground probing and electric potential measurement system have been developed. Battery-free sensors transmitting information to the Internet of Things have been developed.

RESEARCH ARTICLES

Markevicius, V., Navikas, D., Miklusis, D., Andriukaitis, D., Valinevicius, A., Zilys, M., Cepenas, M. (2020). **Analysis of methods for long vehicles speed estimation using anisotropic magneto-resistive (AMR) sensors and reference piezoelectric sensor.** Sensors, 20(12), 3541. doi: 10.3390 s20123541.

Markevicius, V., Navikas, D., Andriukaitis, D., Cepenas, M., Valinevicius, A., Zilys, M., Malekian, R., Janeliauskas, A., Walendziuk, W., Idzkowski, A. (2018). **Two thermocouples low power wireless sensors network. AEU - International Journal of Electronics and Communications,** 84, 242–250. doi: 10.1016/j.aeue.2017.11.032.

Markevicius,V., Navikas, D., Idzkowski, A., Andriukaitis, D., Valinevicius, A., Zilys, M. (2018). **Practical methods for vehicle speed estimation using a microprocessor-embedded system with AMR sensors**. Sensors, 18(7), 2225. doi: 10.3390/s18072225.

Signal technology

Research is carried out in the following areas:

- spread spectrum signals; principles of signal formation and application in ultrasonic measurements and visualization,
- ultrasonic electronics; electronics for signal transmission, reception and digitization,
- ultrasonic super-resolution methods; delay measurement, decomposition, visualization,
- electromagnetic compatibility; testing methods, equipment, ensuring compatibility, interference mitigation methodologies, application in industry.

APPLICATION

The research has yielded a methodology of signal quality prediction. A prototype of a climbing robot combined controller has been delivered as commissioned by AUT Solutions Group LLC (USA). A prototype of ultrasonic non-destructive testing robot electronics has been produced. A prototype of an ultrasonic measuring system for the study of nanocomposites has been designed.

A prototype of a vibrax spinner with a LED light has been developed. The designed LED technologies have been adapted for the design of amateur fishing equipment. Feasibility study of coordinate detection systems used indoors has been performed, the reduction of electromagnetic interference in electronic testing equipment has been conducted, a model of an ultrasonic generator of high voltage radio pulse packets has been designed, and a model of a rally judge's video information system has been devised. An electronic prototype of a tank leak ultrasonic detection system has been produced.

RESEARCH ARTICLES

Svilainis, L., Chaziachmetovas, A. (2020). **Electroluminescence-based isolated high voltage bus DC current sensor. Measurement,** 151, 107203. doi: 10.1016/j.measurement.2019.107203.

Svilainis, L. (2019). **Review on time delay estimate subsample interpolation in frequency domain. IEEE Trans. Ultrason.,** Ferroelect., Freq. Contr., 66(11), 1691–1698. doi: 10.1109/tuffc.2019.2930661.

Embedded systems

Automatic production systems for electronics industry companies are being developed. The Faculty closely cooperates with German, English, Lithuanian and Italian companies. In total, the laboratory has developed production facilities with an annual output of about 100 million EUR value of production. The developed innovations which have already spread across the EU include district heating pipeline diagnostics and leakage monitoring systems, mixture production systems for building materials manufacturers, communication interfaces for smart precision farming, digital TV solutions, smart lighting control systems, etc.

APPLICATION

Automatic technology for programming, calibration, functional testing and classification of various types of electronic products and a robotic mechatronic line have been developed for its implementation. Methods for analysis of test results have been developed for qualitative and quantitative evaluation of testing technological equipment and methods of automatic self-diagnosis and calibration.

A multi-protocol IoT communication node with PLC functions and software for communication and control using cryptographically secure data exchange technology has been developed.

The physical effects of heat exchange through layered insulated heat supply pipes have been investigated, which allows to evaluate possible heat losses due to insulation defects. A device for defect detection and evaluation of their types has been developed.

A data center, a training program, special software for modern DVB technologies, e-commerce and alarm message dissemination training have been created. Technology and a mechatronic system have been developed for programming, testing and qualitative classification of electronic assemblies with RF communications and determining the types of defects.

The needs of numerous building materials and road construction companies have been addressed by designing systems of adaptive dosing and production of inert materials and aggregates. Quality control systems for rebar forming machines and production of ceramic tiles have been developed. Terrestrial and IPTV digital television set top boxes have been devised.

Biotechnological processes

The main works are related to the application of advanced modeling, optimization and control methods and numerical intelligence algorithms in biotechnological processes.

APPLICATION

The results of the research allowed the development of high-productivity systems for the synthesis of recombinant proteins, as well as for the university partner to gain a competitive advantage in supplying dedicated recombinant proteins to the global market. An effective control system for the management of feeding solutions for biotechnological processes has been researched and developed. The tools developed during the project allow to significantly reduce the glucose concentration in the medium (<0.5 g / L) at all stages of bioprocess development, increase the repeatability of developed biotechnological processes, reduce the release rates of secondary metabolites and unwanted products, and control the maximum allowable oxygen consumption in the reactor. Concentration of carbon dioxide in the culture media has been investigated. A prototype of a real-time feeding system for the control of Feeding box-B technological processes has been developed and researched. A model of an intelligent automation platform for efficient control of recombinant protein synthesis processes is currently being developed and tested, innovative software sensors and control schemes for controlling the relative growth rate of biotechnological processes have been developed.

RESEARCH ARTICLES

Butkus, M., Repšytė, J., Galvanauskas, V. (2020). **Fuzzy logic-based adaptive control of specific growth rate in fed-batch biotechnological processes. A simulation study. Applied Sciences,**10(19), 6818. doi: 10.3390/app10196818.

Urniezius, R., Survyla, A., Paulauskas, D., Bumelis, V. A., Galvanauskas, V. (2019). **Generic estimator of biomass concentration for Escherichia coli and Saccharomyces cerevisiae fed-batch cultures based on cumulative oxygen consumption rate. Microb Cell Fact,** 18(1). doi: 10.1186/s12934-019-1241-7.

Galvanauskas, V., Simutis, R., Levišauskas, D., Urniežius, R. (2019). **Practical solutions for specific growth rate control systems in industrial bioreactors. Processes,** 7(10), 693. doi: 10.3390/pr7100693.

Robotics / Image processing / Computer vision

The research is dedicated to the development of a human-assisted robotic system capable of autonomous sensing of 3D space and recognizing human gestures (commands) by using sterovization and numerical intelligence algorithms. Such systems are designed to assist people in the most natural way - by interpreting gesture or voice commands.

The robot's 3D scanning system is designed to feel the surrounding space and allow it to move without hitting the surrounding objects. Research is also underway to monitor eye movements.

APPLICATION

Technological solutions have been developed, on the basis of which, small-scale production is fully automated from product assembly to packaging. The results increase the competitive advantage of the university partner. A multimodal interface has been developed and adapted for the disabled to control the robot arm.

A model of a vertical axis wind turbine operating efficiently in low wind areas has been developed. The results of the research allowed to offer optimal solutions for ensuring the charging of batteries at low wind speeds, which would allow the use of such energy production systems in low wind force places.

New algorithms for collecting sports statistics have been developed. These tools can now be widely used regardless of whatever information output solutions are used in various sports arenas.

RESEARCH ARTICLES

Augustauskas, R., Lipnickas, A. (2020). **Improved pixel-level pavement-defect segmentation using a deep autoencoder. Sensors,** 20(9), 2557. doi: 10.3390/s20092557.

J. Žemgulys, V. Raudonis, R. Maskeliūnas, and R. Damaševičius. (2019). **Recognition of basketball referee signals from real-time videos, J Ambient Intell Human Comput,** vol. 11, no. 3, pp. 979–991, Jan. 2019, doi: 10.1007/s12652-019-01209-1.

Damaševičius, R., Maskeliūnas, R., Narvydas, G., Narbutaitė, R., Połap, D., Woźniak, M. (2020). **Intelligent automation of dental material analysis using robotic arm with Jerk optimized trajectory. J Ambient Intell Human Comput,** 11(12), 6223–6234. doi: 10.1007/s12652-020-02605-8.

Numerical intelligence

The focus is on the reliability of electricity systems and security of energy supply, the energy market, the development of smart technologies, the development of renewable and distributed generation energy systems and their integration into energy systems.

Research also includes the development of numerical intelligence-based methods for adaptive data analysis and decision-making, and the study of the characteristics of electrical converters and electrical machines.

APPLICATION

Methods and algorithms for identifying Parkinson's disease by using speech signal analysis (both sustained phonation recording and regular Lithuanian language recording) were developed. Methods and algorithms for the extraction, evaluation and selection of the most important features of various cell shape features in digital images have been developed, which allow to obtain an accurate description of the cell shape. Methods and algorithms for the recognition of the natural population of *P. minimum* cells in digital images have been developed, which allow to achieve a high accuracy of P. minimum cell recognition, which is sufficient in practical applications in this field.

LEES adequacy assessment for years 2013-2018 service was awarded, the adequacy assessment of the Lithuanian electricity system was performed in 2019-2030. Consultations were provided and updates were introduced regarding the use of the probability method and the scenario for limiting the access of Belarusian NPP electricity to the Lithuanian market, 110 kV North Cinema Studio and Verkiai-Vilnius with cable inserts, performance efficiency modeling, asynchronous six-phase motor and motor/generator study, DC/DC converter model and characteristics study. Consulting services for identification of possible restrictions of the electricity from Astravets nuclear power plant under construction in the Republic of Belarus, as well as consulting services for the second LitPol connection, study “Selection of measures to reduce negative overvoltage influence/impact on AB LESTO electric distribution network" were provided. A prototype of a moving vehicle detection system was created, the concept "Test norms and volumes of electrical equipment" was designed. Currently, the aim is to install an experimental solar power plant floating on water at Kruonis Hydro Accumulation Power Plant, to adapt it to the operating conditions in the hydroelectric power plant basin and to create a system operation model that would allow the power plant to provide a new and reliable primary electricity reserve service.

RESEARCH ARTICLES

Marčiulionis, P. (2020). **Analysis of electrohydrodynamic air flow induced by DC corona field in wire-to-plane electrode system. Journal of Electrostatics,** 105,103446. doi: 10.1016/j.elstat.2020.103446

Dambrauskas, K.,Vanagas, J., Bugenis, S., Zimnickas, T., Kalvaitis, A. (2020). **Methodology for asynchronous motor impedance measurement by using higher order harmonics. Energies,** 13(10), 2541. doi: 10.3390 en13102541.

Deltuva, R., Lukočius, R. (2020). **Distribution of Magnetic Field in 400 kV Double-Circuit Transmission Lines. Applied Sciences,** 10(9), 3266. doi: 10.3390/app10093266

Metrology and measurement technologies

Development of new (unique) measuring transducers, measuring instruments and systems. Research of their technical and metrological characteristics, integration into technological and control processes, networks of sensor devices, metrological guarantee infrastructure, focusing on security and reliability.

Development, modeling, processing and analysis of multidimensional measurement results of complex measurement algorithms. Development of new effective conformity assessment methods. Integrated solutions related to the certification of reference measures.

APPLICATION

Comparison and analysis of various measurement methods of raw materials and production was performed, recommendations were provided; a verification analysis of the measuring instruments used to measure the production volume was performed. A new optimal model for quantity measurement error management has been developed, and recommendations for its implementation have been provided. The service of analysis, research and study of hot water losses generated in hot water systems of buildings, compliance with the objectives of the hot water pricing methodology, conformity assessment of measuring vessel volume control procedures, conformity assessment of prepacked product quantity control procedures, mass difference in cylindrical tank uncertainty calculation and modeling of the height dependence situation have been performed.

A technology has been developed that allows information to be received by radio which is applicable in the cases when the detection of the exact location of the signal source by various means of scanning, directing and locating electromagnetic waves is difficult.

A test program for the weighing system of moving vehicles has been prepared (identification of metrological parameters of the system; analysis of test data of individual parts of the modular system; options for complex measurement methods; computer modeling of errors and test optimization; preparation of the required scope program).

A prototype of the method and means (device) for checking the homogeneity of the concentrate of prepacked suspensions has been developed. A control system has been developed which - within economically and technically reasonable means - provides knowledge for the process of measuring the homogeneity of fertilizer suspensions and for complex metrological evaluation of the measurement results.

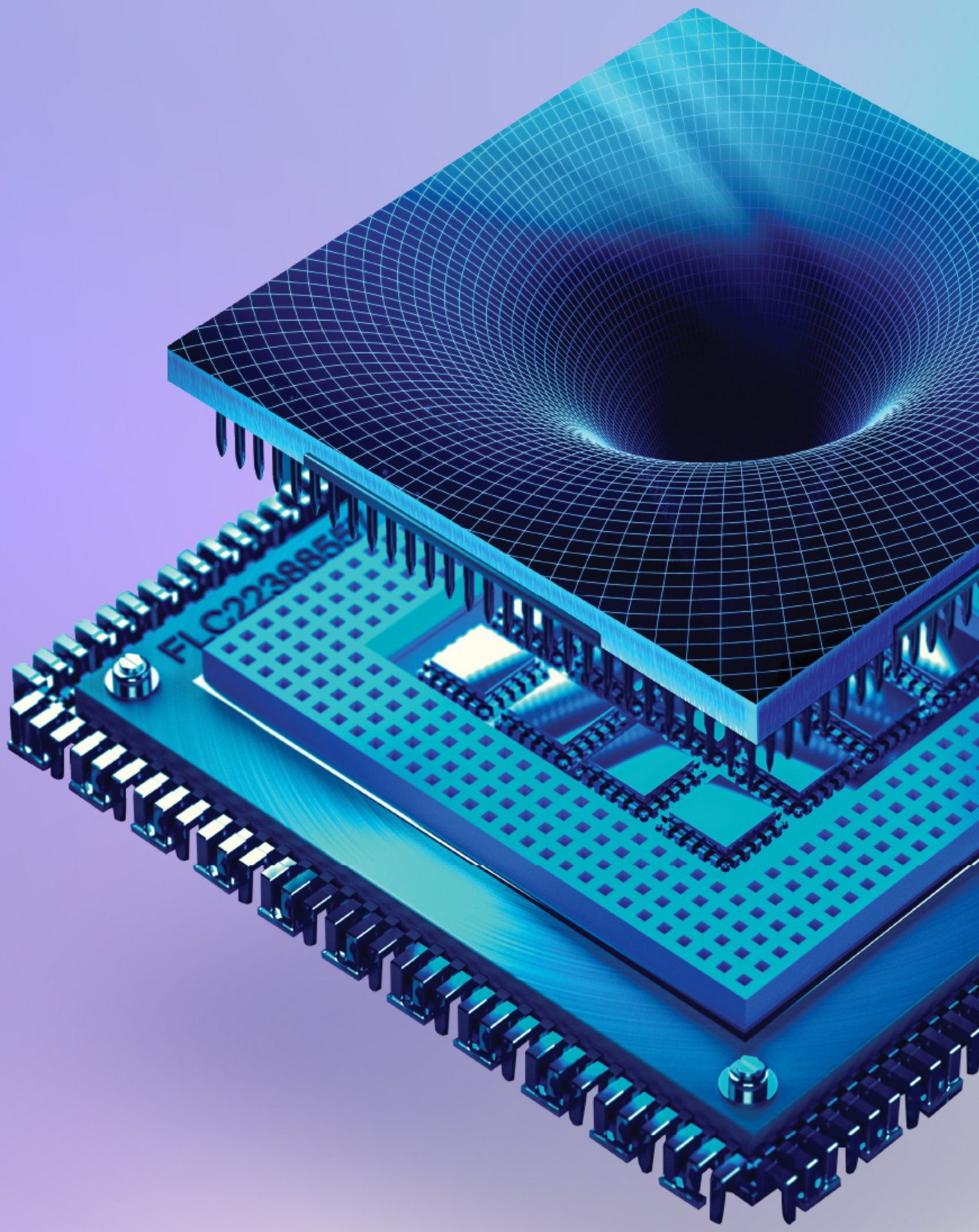
Prototypes of NPP converters have been developed, their production technology has been improved, a unique methodology and equipment for calibration of NPP converters has been developed, and a reference automatic timer has been developed to ensure metrological sieve.

RESEARCH ARTICLES

Raudienė, E., Gailius, D., Dobilienė, J., Balčiūnas, G., Meškuotienė, A. (2020). **Assessment of qualitative characteristics of carbon dioxide respiration rates evaluation in wheat measurements. MAPAN.** doi: 10.1007/s12647-020-00380-7.

Draudviliene, L., Meskuotiene, A., Tumsys, A., Mazeika, L., Samaitis, V. (2020). **Metrological performance of hybrid measurement technique applied for the lamb waves phase velocity dispersion dvaluation. IEEE Access,** 8, 45985–45995. doi: 10.1109/access.2020.2974586.

Nakutis, Ž., Saunoris, M., Ramanauskas, R., Daunoras, V., Lukočius, R., Marčiulionis, P. (2019). **A method for remote estimation of wattmeter's adjustment gain. In IEEE Transactions on Instrumentation and Measurement,** 68(3), 13-721. doi:10.1109/TIM.2018.2857118.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The Faculty is the only Lithuanian member of Informatics Europe, the community bringing together the strongest informatics scientists and academic staff of European countries, which unites as many as 115 members from all over Europe. The Faculty is satisfied with scientific and interdisciplinary projects it successfully carries out with external institutions and organisations.

KEY WORDS

Internet systems I Multimodal human-computer interfaces
Semantic network I Systems design and testing

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Internet of Things and Services

Internet of Things and Services is a global infrastructure for the information society. Applications of Internet of Things include environmental protection, transport, logistics, agriculture, trade, healthcare, public safety, smart and digital cities, and smart houses.

APPLICATION

More than 10 projects have been ordered by economic operators: TEO LT, Telia, Elsis TS, Freor, LL Optic, Katra, CNC Technologies, Axies Industries, and US-based Thermo Fisher Scientific.

Many products have been commercialized, the most significant of which include Gala TV, Home Computer System, Smart Food Machine, e-Fridge, and Refrigeration Equipment Smart Computer System. Lora, an Internet-of-Things technology network, has been developed and implemented in Kaunas; there is one base station in Vilnius currently.

RESEARCH ARTICLES

Gircys, R., Liutkevicius, A., Kazanavicius, E., Lesauskaite, V., Damulevicienė, G., Janaviciute, A. (2019). **Photoplethysmography-based continuous systolic blood pressure estimation method for low processing power wearable devices.** Applied sciences, 9, 1-16. doi:10.3390/app9112236

Mikuckas, A., Ciuzas, D., Prasauskas, T., Mikuckiene, I., Lukas, R., Kazanavicius, E., Jurelionis, A., Martuzevicius, D. (2017). **A grey model approach to indoor air quality management in rooms based on real-time sensing of particles and volatile organic compounds.** Applied mathematical modelling, 42, 290-299. doi:10.1016/J.APM.2016.10.030

Analysis of signals surrounding intelligent human-computer interfaces

The research focuses on modern engineering applications of artificial intelligence methods in order to understand the meaning of the signals surrounding us (images, sounds, movements, neurocognitive data, etc.). The research can be characterized by intelligent solutions which are often based on the principles of deep learning, surrounding individuals and their environment.

APPLICATION

Research aims to:

- reproduce the invisible sides of images captured by depth sensors, to detect posture;
- understand ambient sounds;
- analyze video recordings and classify images according to what is depicted;
- during the research, it is sought to predict the symptoms of a disease;
- detect distinctive signs of signals emitted by the human body (movement, muscles, and brain signals);
- develop intelligent solutions such as autonomous navigation and route finding, encryption, and personal identification.

RESEARCH ARTICLES

Kulikajevas, A., Maskeliūnas, R., Damaševičius, R., S.L. Ho, Edmond. (2020). **3D object reconstruction from imperfect depth data using extended YOLOv3 network.** Sensors, 20(2025), 1-28. doi:10.3390/s20072025

Polap, D., Wozniak, M., Damaševičius, R., Maskeliūnas, R. (2019). **Bio-inspired voice evaluation mechanism.** Applied soft computing, 80, 342-357. doi:10.1016/j.asoc.2019.04.006

Lauraitis, A., Maskeliūnas, R., Damaševičius, R., Połap, D., Wozniak, M. (2019). **A smartphone application for automated decision support in cognitive task based evaluation of central nervous system motor disorders.** IEEE Journal of biomedical and health informatics, 23(5), 1865-1876. doi:10.1109/JBHI.2019.2891729

Systems design and testing

Design of programme systems deals with issues of solving the problems of the real world in the development of programme systems. Systems testing is relevant in the development of correct, long-lasting and consistently operating programme systems.

APPLICATION

The real application field: test-making methods for testing delay faults for consistent schemes without a scan register.

The methods: black box method based on a functional model at a high level of abstraction.

RESEARCH ARTICLES

Jusas, V., Japertas, S., Baksys, T., Bhandari, S. (2019). **Logical filter approach for early stage cyber-attack detection.** Computer science and information systems, 16, 491-514. doi:10.2298/CSIS190122008J

Jusas, V., Samuvel, Sam G. (2019). **Classification of motor imagery using a combination of user-specific band and subject-specific band for brain-computer interface.** Applied sciences, 9(23), [1-17]. doi:10.3390/app9234990

Bareiša, E., Jusas, V., Motiejūnas, K., Motiejūnas, L., Šeinauskas, R. (2018). **Black box delay fault models for non-scan sequential circuits.** Computer Science and Information Systems, 15(1), 237-256. doi:10.2298/CSIS161118040B

Multidisciplinary models

Development and analysis of multidisciplinary models deals with aspects of the modelling and simulation of objects and processes existing in the real world in computer systems. The models are based on mathematics, computer science and physics.

Computational fluid dynamics (CFD), computational electromagnetics, and computational solid mechanics are just a few of the many possible specializations. Physically based animations is a related specialization which is used in computer graphics for the synthesis of real or physical reality-like visual effects.

APPLICATION

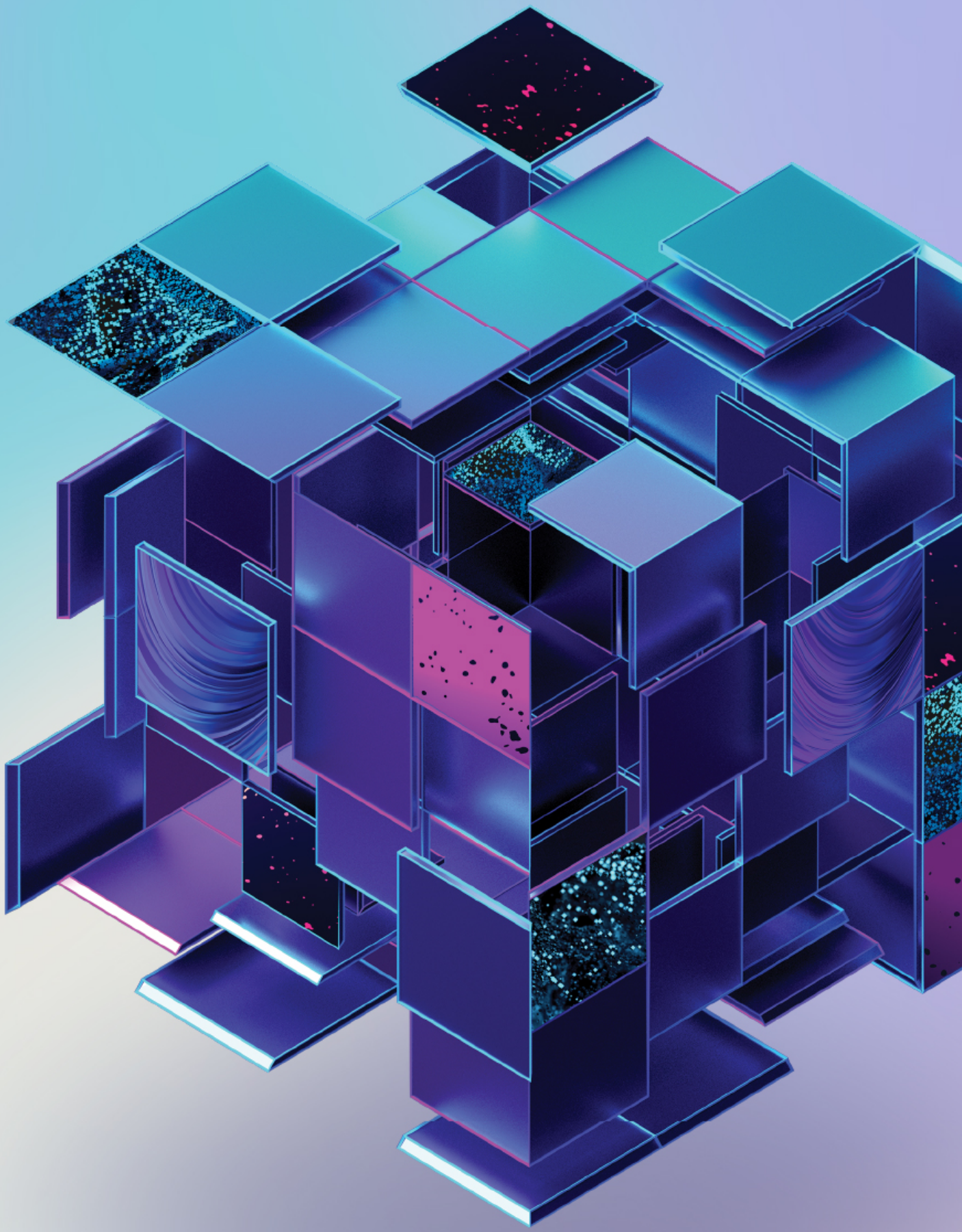
- The use of multidisciplinary models in dentistry enables calculating the contact areas of teeth and joints formed during human occlusion and predicting what they would be like after prosthetic dentistry. This enables improving the quality of dental surgery planning and facilitating this process;
- Numerical models are applied in predicting the destruction of cancerous tumours by radiofrequency ablation. The generated high temperature field is the result of interactions between the electric current, heat transfer and blood perfusion. The models made it possible to find the best configuration of the ablation electrodes and the duration of the ablation process, and also explained the influence of active and disconnected blood flow on the spatial shape of the burned area;
- Models applied to the analysis of textile engineering systems make it possible to determine the impact of new smart materials integrated in the fabric (bioceramics, phase change materials, microcapsules, nanotubes, active ventilation layer, 3D textiles, etc.) on thermoregulation and wearing comfort. Another area of the application of the models in textile engineering is the models of the interaction of protective textile vests with a bullet-proof layer. They enable to physically correct the depiction of the whole interaction process from the initial contact to the deformation and stopping of the bullet.
- Ultrasonic measurement processes are simulated in the modelling of the propagation of elastic waves in solids and liquids. The results obtained by the models make it possible to obtain real signals, which, after numerous reflections and interferences, reach the receiving converter. They are used to identify internal defects in materials or physical properties of materials by the nature of the received signal.

RESEARCH ARTICLES

Čalnerytė, D., Rimavičius, V., Barauskas, R. (2019). **Finite element analysis of resonant properties of silicon nanowires.** Acta mechanica, 230(5), 1907-1917. doi:10.1007/s00707-019-2375-8

Liaukonis, D., Mazeika, L., Barauskas, R., Neciunas, A. (2018). **Model based ultrasonic measurement technique for evaluation of the adhesive properties.** Elektronika ir elektrotechnika, 24(5), 36-41. doi:10.5755/j01.eie.24.5.21840

Barauskas, R., Sankauskaitė, A., Abraitienė, A. (2018). **Investigation of the thermal properties of spacer fabrics with bio-ceramic additives using the finite element model and experiment.** Textile Research Journal, 88(3), 293-311. doi:10.1177/0040517516677228



Faculty of Mathematics and Natural Sciences

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The faculty is an active participant in applied research and interdisciplinary national and international projects. It develops models and technologies and provides a variety of services which meet the needs of business and the state. The researchers of the Faculty develop solutions for businesses operating in various industries, thus making it a reliable partner at the national and international level. The Faculty actively participates in COST and NATO activities and conducts research projects together with partners from all over the world.

KEY WORDS

Artificial Intelligence I Nonlinear systems and Microsystems Mathematical Workshops | Systems Modeling Data analysis and modeling Development and analysis of identification and cryptographic methods Applied optics and photonics | Formation of multifunctional thin structures and nanocomposites | Radiation and medical physics

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Artificial intelligence, data analysis and modeling

The Data Analysis and Modeling Research Team conducts innovative applied research related to mathematics, informatics and technology, interdisciplinary national and international research projects and outsourced work in data science and engineering, develops new methods, models and technologies, conducts studies as well as analysis and other R&D services.

APPLICATION

- Research on biomedical signals and various images as well as on sports and health data and technologies, analysis of financial and business small and big data, and risk and uncertainty analysis is conducted.
- Models of the application of artificial intelligence and machine and deep learning, forecasting and optimization services are developed.
- Investigations of climate and technological emergencies, failures, accidents, human errors and fraud cases are carried out.
- Automated health and disease diagnostic modelling services are provided, remote monitoring data analysis, data mining and visualization, longevity and reliability modeling, probabilistic risk or safety assessment are performed.

RESEARCH ARTICLES

Žigienė, G., Rybakovas, E., Alzbutas, R. (2019). **Artificial intelligence based commercial risk management framework for SMEs.** Sustainability, 11(16), 70-85. doi:10.3390/su11164501

Alzbutas, R., Voronov, R. (2019). **Probabilistic safety assessment and human reliability analysis for the Wendelstein 7-X fusion device.** Fusion engineering and design, 149, 1-11.

Iešmantas, T., Alzbutas, R. (2020). **Convolutional neural network for detection and classification of seizures in clinical data.** Medical & biological engineering & computing, 58(9), 1919-1932. doi: 10.1007/s11517-020-02208-7.

Radiation and medical physics

Knowledge of radiation and medical physics is applied in the treatment and prognosis of oncological disorders. Fundamental knowledge of physics medicine and materials engineering is integrated with international experience. Modern research methods and radiation technologies are developed along with innovative science-based solutions and products which are not only created but also implemented in clinical practice.

APPLICATION

- Experimental and theoretical research on the impact of various types of radiation on an individual, materials and the environment. Measurements of radiation.
- Development of new exposure assessment methods in radiation therapy, radiology and nuclear medicine; development of patient dosimetry methods, dosimeters and dosimetry systems for radiation therapy and their implementation in the clinical environment.
- Radiobiological research and biodosimetry, patient radiation safety and its optimization.
- Development of lead-free nanocomposite radiation protection devices, development of new materials for radiation detectors and phantoms, modification of the properties of materials by particle flows, and modelling of energy transfer processes in radiation-exposed materials.

RESEARCH ARTICLES

Adliene, D., Urbonavicius, B. G., Laurikaitiene, J., Puiso, J. (2020). **New application of polymer gels in medical radiation dosimetry: Plasmonic sensors.** Radiation Physics and Chemistry, 168, 1-7. doi: 10.1016/j.radphyschem.2019.108609

Adlienė, D., Gilys, L., Griškonis, E. (2020). **Development and characterization of new tungsten and tantalum containing composites for radiation shielding in medicine.** Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms, 467, 21-26. doi:10.1016/j.nimb.2020.01.027

Sevcik, A., Adlienė, D., Laurikaitienė, J., Nedzinskienė, R., Masiulytė, I. (2020). **Low energy deposition patterns in irradiated phantom with metal artefacts inside: a comparison between FLUKA Monte Carlo simulation and GafChromic EBT2 film measurements.** Nuclear Instruments and Methods in Physics Research Section B: Beam Interactions with Materials and Atoms, 478, 142-149. doi:10.1016/j.nimb.2020.06.003

Applied optics and photonics

A growing team of researchers is carrying out globally ambitious research in the fields of applied optics and photonics, actively participating in project activities, and is offering high-tech solutions that respond to challenges faced by businesses as well as the latest scientific trends. Laser technologies is one of the areas where Lithuania has made an industrial breakthrough, and our research group serves as its ambassadors at Kaunas University of Technology.

APPLICATION

Formation and development of micro- and nano-optical elements and structures using a variety of clean room and interference lithographs technologies, vacuum deposition of thin coatings and plasma etching processes, and femtosecond laser ablation. The optical properties of these structures are modeled and researched by using modern analytical methods.

The following are used for research:

- Photolithography, electron beam lithography, UV interference lithography, holography, deep reactive plasma feeding;
- Formation of microstructure on the surface and volume of materials using a femtosecond laser;
- Self-assembly of nano- and microparticles controlled by embossed masks;
- High resolution microscopy methods (electron, atomic force optical microscopy);
- Spectroscopic measurements (continuous UV-VIS-NIR spectroscopy, FTIR, μRaman, spectroscopic ellipsometry, differential absorption spectroscopy);
- Other modern methods of analysis.

The research covers elements of nanophotonics, i.e., metal nanoparticles, their aggregates, hetero-derivatives and nanocomposites by combining optical spectroscopy and microscopy methods.

RESEARCH ARTICLES

Tamulevičius, S., Meškinis, Š., Tamulevičius, T., Rubahn, Horst-Günter. (2018). **Diamond like carbon nanocomposites with embedded metallic nanoparticles.** Reports on Progress in Physics, 81, 1-31. doi:10.1088/1361-6633/aa966f

Juodėnas, M., Tamulevičius, T., Henzie, J., Erts, D., Tamulevičius, S. (2019). **Surface lattice resonances in self-assembled arrays of monodisperse Ag cuboctahedra.** ACS Nano, 13, 9038-9047. doi:10.1021/acsnano.9b03191

L.,Tamulevičius, T., Žutautas, A., Juodėnas, M., Juškevičius, K., Drazdys, R. ,Tamulevičius, S. **Diffraction efficiency optimization of multilayer dielectric mirror-based gratings for 1030 nm femtosecond lasers.** Optics and Laser Technology, 126, 1-8. doi: 10.1016/j.optlastec.2020.106071

Formation of multifunctional thin structures and nanocomposites

By integrating fundamental knowledge of physics and materials engineering with international experience, modern research methods and the latest technologies are applied and developed, research on multifunctional thin structures and nanocomposites is carried out.

APPLICATION

- Investigations of the formation and properties of nanocomposite layers;
- Formation of transparent and electrically conductive thin layers;
- Investigations of thin layer formation technologies and properties (protective: hard coatings, transparent electrodes, ionic conductivity layers, ferromagnetic coatings, deposition of layers by vacuum evaporation, magnetron deposition, electron beam evaporation, and reactive deposition);
- Modification of the properties of thin layers by laser irradiation and thermal heating methods;
- Obtaining of materials with desired physical properties for use in hydrogen energy by synthesizing material coatings.

RESEARCH ARTICLES

Sriubas, M., Bockute, K., Kaibayev, N., Laukaitis, G. (2018). **Influence of the Initial Powder's Specific Surface Area on the Properties of Sm-Doped Ceria Thin Films,** 8(12), 443. doi:10.3390/cryst8120443

Mathematical research on nonlinear systems

Scientists study nonlinear mathematical systems, model business and economic systems, analyze technical, medical, information systems.

Research on large business data, cryptographic and image coding is being carried out.

APPLICATION

- Innovative methods for research on nonlinear systems are developed;
- Visual cryptographic algorithms are created by using fractal moiré gratings and chaotic oscillations;
- Investigations of the influence of magnetic fields on human and animal health and well-being are carried out.

RESEARCH ARTICLES

Palevičius, P., Aleksa, A., Maskeliūnas, R., Ragulskis M. K. (2017). **Circular geometric moiré for degradation prediction of mechanical components performing angular oscillations.** Mechanical systems and signal processing, 86, 278-285. doi:10.1016/j.ymssp.2016.10.011

Landauskas, M., Masoen Cao, Ragulskis, M. (2020). **Permutation entropy based 2D feature extraction for bearing fault diagnosis.** Nonlinear Dynamics. Springer-Nature, 102, 1717-1731. doi: 10.1007/s11071-020-06014-6

Zhou, X., Cheng, J., Cao, J., Ragulskis, M. (2020). **Asynchronous dissipative filtering for nonhomogeneous Markov switching neural networks with variable packet dropouts.** Neural Networks. Elsevier, 130, 229-237. doi: 10.1016/j.neunet.2020.07.012

Research on microsystems and nanotechnologies

The most recent instrumentation development work is focused on the hybridization of fragmented “near optical field”, “atomic force”, and “confocal

micro-Raman" spectroscopy (surface and probe-stimulated Raman spectroscopy), development and application of equipment for nanomedicine and nanomaterials research, and solution of problems of space and aeronautics instrumentation.

APPLICATION

The investigations of samples by surface-stimulated Raman spectroscopy (in a solution and dry sample), research on surface morphology (in a solution and dry sample) and determination of surface roughness.

Determination of optical properties of a sample by UV-Vis spectrometry in a solution and on a clear/opaque substrate, and real-time monitoring of the reaction by UV-Vis spectroscopy.

RESEARCH ARTICLES

Žūkienė, R., Snitka, V. (2015). **Zinc oxide nanoparticle and bovine serum albumin interaction and nanoparticles influence on cytotoxicity in vitro.** Colloids and surfaces B: Biointerfaces, 135, 316-323. doi:10.1016/j.colsurfb.2015.07.054

Research on unbalanced heterogeneous processes

Mathematical modelling of technological (physico-chemical) processes taking place on surfaces.

APPLICATION

- Investigations of the kinetics and dynamics of processes for the modification of corrosive and mechanical properties of biomaterials by atomic particle radiation.
- Investigations of mass transfer processes in nanostructured powder catalysts. .
- Investigations of the kinetics and dynamics of the structure and texture change of thin coatings on solid surfaces.
- Investigations of mass transfer processes in hydrogen fuel cells of solid electrolytes. .
- Modeling of the formation of two-dimensional surface structures by plasma and ionic etching methods.

RESEARCH ARTICLES

Galdikas, A., Moskalioviene, T. (2020). **The anisotropic stress-induced diffusion and trapping of nitrogen in austenitic stainless steel during nitriding.** Metals, 10(10), 1-13. doi: 10.3390/met10101319.

Moskaliovienė, T., Galdikas, A. (2019). **Kinetic model of anisotropic stress assisted diffusion of nitrogen in nitrided austenitic stainless steel.** Surface and Coatings Technology, 366, 277-285. doi: 10.1016/j.surfcoat.2019.03.054.

Mathematical Workshop

The Workshop of Mathematical Solutions in Business and Industry (Mathematical Workshop) is the first event in Lithuania and the Baltic States, during which, a team of researchers for the period of an entire week focus exceptionally on solving tasks presented by business companies while employing mathematical knowledge and running discussions in the team.

APPLICATION

The Mathematical Workshop is intended to:

- Optimize business and production processes, assess durability, identify, analyze and predict errors and failures;
- Analyze sales;
- Forecast the riskiness of companies' activities, assess operational efficiency;
- Solve the tasks of electronic data security and encryption systems;
- Address the problems of personal health monitoring, medical diagnostics and trials of medicinal products;
- Optimize logistics processes.

Stochastic, economic and medical systems mathematical modeling

Mathematical modeling of stochastic, economic and financial systems and data analysis.

APPLICATION

- Pension fund operations and bond-related operations are performed along with analysis and interest calculations;
- The quantification of the investment portfolio and the assets in it are presented along with analysis of characteristics and optimization possibilities;
- Mathematical models of sequential systems are developed and analyzed.

RESEARCH ARTICLES

Kabašinskas, A., Maggioni, F., Šutienė, K., Valakevičius, E. (2018). **A multistage risk-averse stochastic programming model for personal savings accrual: the evidence from Lithuania.** Annals of Operations Research, 279, 43-70. doi: 10.1007/s10479-018-3100-z

Dagilienė, L., Šutienė, K. (2019). **Corporate sustainability accounting information systems: a contingency-based approach.** Sustainability accounting, management and policy journal, 10, 260-289. doi: 10.1108/sampj-07-2018-0200

Development and application of identification and cryptographic methods

Applied research on cryptographic systems. Development, realization and implementation of cryptographic algorithms.

APPLICATION

Development and security analysis of new and promising cryptographic methods intended for cryptographic data protection and their integration in cybersecurity systems, block chain technology and the Internet of Things.

RESEARCH ARTICLES

Mihalkovich, A., Levinskas, M. (2019). **Investigation of Matrix Power Asymmetric Cipher Resistant to Linear Algebra Attack.** International Conference on Information and Software Technologies, 1078, 197-208.

Muleravicius, J., Timofejeva, I., Mihalkovich, A., Sakalauskas, E. (2019). **Security, trustworthiness and effectivity analysis of an offline e-cash system with observers.** Informatica, 30, 327-348. doi:10.15388/Informatica.2019.208

Faculty of Mechanical Engineering and Design

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The Faculty's distinguishing feature is interdisciplinarity in solving engineering issues in research and education. The research fields of the Faculty include various topics in mechanical engineering, transport engineering, energy and energy technology, and materials engineering. The faculty also carries out artistic activities in design.

KEY WORDS

Alternative energy in transport I Clothing materials, products and their operation processes I Sustainable mobility transport systems Ethnographic textiles and ornamentation I Functional textiles Defence technologies I Graphic media I Heterogeneous polymeric materials Wood and biocomposites I Behaviour of vehicle structures

*National Innovation and Entrepreneurship Centre

Alternative energy in transport

Feasibility studies and the efficiency of the application of alternative fuels, hybrid and electric power plants in light and heavy transport.

APPLICATION

Research is conducted on:

- Dynamics and energy efficiency of vehicles running on alternative fuels and powered by electric and hybrid power plants; development and modeling of dynamic models.
- Development and modernization of vehicles with alternative power plants.
- Application of third-generation algal biofuels in internal combustion engines.

RESEARCH ARTICLES

Raslavičius, L., Keršys, A., Makaras, R. (2017). **Management of hybryd powerrain dynamics and energy consumption for 2WD, 4WD, and HMMWV vehicles.** Renewable, and Sustainable Energy Reviews, 68(1), 380-396. doi:10.1016/j.rser.2016.09.109

Raslavičius, L., Felneris, M., Pukalskas, S. et al. (2019). **Evaluation of P. moriformis oil and its blends with diesel fuel as promising contributors to transportation.** Energy, 189, 116196. doi:10.1016/j.energy.2019.116196

Clothing materials, products and their operation processes

Analysis of the quality and properties of clothing products, their evaluation methods and e-design.

APPLICATION

The following studies are being carried out:

- Research on the quality forecasting of modeling processes of clothing materials and products;
- Application of 3D virtual technologies in research on the quality of clothing products.

RESEARCH ARTICLES

Lagė, A., Ancutienė, K. (2019). **Virtual try-on technologies in the clothing industry: basic block pattern modification.** International journal of clothing science and technology, 31(6), 729-740. doi:10.1108/IJCST-11-2018-0140

Sustainable mobility transport systems

Research on transport and passenger flows and their interaction with the environment.

APPLICATION

- Development of mobility models in the transport system; modeling of the interaction of the elements of the system vehicle-driver-environment.
- Development of innovative engineering systems and their implementation in transportation/logistics processes.
- Development of intelligent transport systems/new movement (unmanned) and communication technologies.

RESEARCH ARTICLES

Raslavičius, L., Keršys, A., Pukalskas, S., et. al. (2015). **City transport analysis using the General Motors (GM) microscopic model.** Public Transport, 7, 159-183. doi:10.1007/s12469-014-0094-z

Ethnographic textiles and ornamentation

Ethnographic research on textile materials and products.

APPLICATION

Modern technologies are applied in ethnocultural research on textile; virtual and real reconstruction of materials is performed: selection of ornaments characteristic of the Lithuanian nation, creation of their databases and their new implementation by using modern technologies.

RESEARCH ARTICLES

Kumpikaitė, E., Kot, L., Tautkutė-Stankuvienė, I. (2016). **Double-layer fabrics with folk motives. Experimental and theoretical study of their characteristics.** Fibres and textiles in Eastern Europe, 24(6(120)), 100-108. doi:10.5604/12303666.1221743

Muraliene, L., Mikucioniene, D., Laureckiene, G., Brazaitis, M. (2019). **New approach to evaluation of orthopaedic supports compression properties: article.** Journal of industrial textiles, (3), 49, 352-364. doi:10.1177/1528083718783312

Functional textile materials and products

Development of and research on textile materials and application of nanotechnologies in fibrous materials.

APPLICATION

- Investigations for the determination of various mechanical and other physical properties of textile materials and their dependence on structural parameters are performed.
- Manufacturing parameters of textile production are investigated and optimized; new textile materials and their nanostructured coatings are developed according to their functional or aesthetic requirements.
- Methods of the electrospinning of nanofibres, new-generation multifilament yarns from microfibres and nano and micro filter textile materials are developed;
- Development of and research on biomedical frameworks for tissue engineering, antibacterial textile materials, and textiles with embedded pharmaceuticals is performed.

RESEARCH ARTICLES

Muralienė, L., Mikučionienė, D., Laureckienė, G., Brazaitis, M. (2019). **New approach to evaluation of orthopaedic supports compression properties: article.** Journal of industrial textiles, (3), 49, 352-364. doi:10.1177/1528083718783312

Baranauskaitė, J., Adomavičiūtė, E., Jankauskaitė, V., Marksa, M., Barsteigienė, Z., Bernatonienė, J. (2019). **Formation and investigation of electrospun Eudragit E100/oregano mats.** Molecules, 24(3), 1-13. doi:10.3390/molecules24030628

Kumpikaitė, E., Tautkutė-Stankuvienė, I., Redeckienė, D. (2019). **Interrelation between tensile properties of yarns and woven fabrics with these yarns.** Autex Research Journal, 19(4), 387-393. doi:10.1515/aut-2018-0054

Defence technologies

Development, research, installation and commercialization of military training equipment.

APPLICATION

Problems of the development, research and practical application of rocket training equipment are solved on the basis of the ongoing research.

Theoretical and experimental research on and computer modelling of aerodynamic flow, internal and external ballistics of training rockets are performed. On the basis of the performed research, rocket equipment for military training is developed to train soldiers serving short and medium-range air defence systems as well as to conduct tactical exercises in training ground conditions.

The developed rocket training equipment allows reducing the economic costs of soldier training and tactical exercises as well as improving the efficiency and safety of the training process.

RESEARCH ARTICLES

Fedaravičius, A., Klilikevičius, S., Survila, A. (2019). **Short range rocket-target: research, development and implementation.** Aircraft Engineering and Aerospace Technology, 91(7), 1027-1032.

Fedaravičius, A., Klilikevičius, S., Survila, A. (2019). **Numerical Study on Internal Ballistics Characteristics of a Solid Porpellant Rocket Motor.** Mechanics of Fluids and Gases, 25(3), 187-196. doi:10.5755/j01.mech.25.3.23742

Graphic media equipment, materials and processes

Research on graphic media technologies and equipment and development of research on paper materials and products.

APPLICATION

- Research into the application of green printing technologies, smart materials and nanotechnologies in printing and advertising technologies is conducted.
- New organic materials are developed for packaging which decompose quickly into harmless materials under the action of the environment.
- Investigations are carried out to determine the mechanical and physical properties of packaging materials and the possibilities of their application in the packaging industry.

RESEARCH ARTICLES

Pyryev, Y., Zwierzyński, T., Kibirkštis, E., Gegeckienė, L., Vaitasius, K. (2019). **Model to predict the top-to-bottom compressive strength of folding cartons.** Nordic Pulp and Paper Research Journal, 34(1), 117127. doi:10.1515/npprj-2018-0032

Systems of heterogeneous polymeric materials

Surface, rheological and adhesion phenomena of composite materials and development and evaluation of nanocomposites and biopolymers for medicine and innovative industries.

APPLICATION

- Investigations of the physical and mechanical properties of polymer materials for various applications (plastics, rubber, leather, soft laminates, and polymer composites).

- Polymer mixtures, polymer nanocomposites and biocomposites are developed, and investigations of their mechanical behaviour are carried out.
- Microstructures are formed in photopolymer nanocomposites, search for new forming methods, and investigations of the mechanisms of action and optical investigations are performed.
- Possibilities of the recycling and reuse of polymer waste are studied; superhydrophobic and antimicrobial polymer coatings for medical purposes are developed.

RESEARCH ARTICLES

Jankauskaitė, V., Narmontas, P., Lazauskas, A. (2019). **Control of polydimethylsiloxane surface hydrophobicity by plasma polymerized hexamethyldisilazane deposition.** Coatings, 9(1), 1-7. doi:10.3390/coatings9010036

Skrockienė, V., Žukienė, K., Jankauskaitė, V., Baltušnikas, A., Petraitienė, S. (2016). **Properties of mechanically recycled polycaprolactone-based thermoplastic polyurethane/polycaprolactone blends and their nanocomposites.** Journal of elastomers and plastics, 48(3), 266-286. doi:10.1177/0095244314568691

Wood and biocomposites

Development of and research on wood materials and products and fibre composites.

APPLICATION

- Modeling and evaluation of sorption, mechanical and performance properties of wood and wood-based materials as well as modification of wood surface is performed.
- The Faculty conducts research on the interaction between polymeric materials and wood, develops its composites, and investigates their properties.

RESEARCH ARTICLES

Vitosytė, J., Krystofiak, T., Lis, B., Ukvalbergienė, K. (2018). **Nanocomposite wood coating film parameter stability after short term intensive uv+ir irradiation.** Drewno, 61, (201), 107-118. 10.12841/WOOD.1644-3985.258.08

Behaviour of vehicle structures

Development of optimal vehicle structures, active and passive safety systems and measures, and assessment of their impact on traffic safety and operation.

APPLICATION

- Research on load-bearing vehicle structures in the directions of vehicle safety improvement, environmental impact reduction and energy saving.
- Development and analysis of numerical models and computer programmes for the optimization of vehicle load-bearing structures and movement parameters and improvement of environmental pollution assessment, vehicle reliability and comfort.
- Development and implementation of advanced, resource-efficient technologies and products that are in demand in the international market and reduce environmental pollution and mitigate climate change.

RESEARCH ARTICLES

Lukoševičius, V., Keršys, R., Keršys, A. (2020). **Three-and-four mass models for vehicle front crumple zone. Transport problems,** 15(3), 79-92 doi:10.21307/tp-2020-035

Dzerkelis, V., Lukoševičius, V., Girkontas, E., et al. (2018). **Modeling and Research of Bus Equipped with Dynamic Stability Control System.** Mechanika, 21(1), 65-73 doi:10.5755/j01.mech.24.1.18246

Faculty of Social Sciences, Arts and Humanities

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The distinctiveness of the Faculty of Social Sciences, Humanities and Arts is the desire to create an integrated environment for research and services in the social sciences and humanities in cooperation with technological sciences. The faculty's research strategy is based on three main goals: internationality, interdisciplinarity, and the methodological quality of research.

KEY WORDS Healthy lifestyle | Educational technologies

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Educational research

Healthy lifestyle education technologies.

APPLICATION

Technologies for occupational health promotion and their impact on workers' lifestyles, health condition, and performance.

RESEARCH ARTICLES

Klizienė, I., Sipavičienė, S., Klizas, Š., Imbrasienė, D. (2015). **Effects of core stability exercises on multifidus muscles in healthy women and women with chronic low-back pain.** Journal of back and musculoskeletal rehabilitation, 28(4), 841-847. doi:10.3233/BMR-150596

Food Institute

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Food Institute is a research subunit of KTU established in 1958 as a research institution and reorganised into the Food Institute of Kaunas University of Technology (KTU FI) in 2003. The activities of the Institute are focused on solving the main challenges of the Lithuanian food industry and providing research, practical and methodical services.

KEY WORDS Food system safety I Food system quality I Food technology development

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Food systems safety design and research

Identification, validation of risk factors in food systems and design of risk management measures to achieve comprehensive food safety.

APPLICATION

Integrated food safety solutions can be applied to validate the safety of a particular company's food system by identifying new risks of chemical and/or microbiological origin or those related to the authenticity and sustainability as well as in validating the management of the already existing ones with accredited studies.

The accredited activities of the Food Research Centre provide opportunities for companies to check the physical, chemical and microbiological parameters of their currently produced and newly developed food raw materials, products or water, and to confirm the shelf life of the product.

RESEARCH ARTICLES

Riešutė, R., Šalomskienė, J., Moreno, D., Gustienė, S. (2021). **Effect of yeasts on food quality and safety and possibilities of their inhibition.** Trends in Food Science & Technology, 108, 1-10. doi: 10.1016/j.tifs.2020.11.022

Šalomskienė, J., Jonkuvienė, D., Macionienė, I., Abraitienė, A., Zeimė, J., Repeckienė, J., Vaičiulytė-Funk, L. (2019). **Differences in the occurence and efficiency of antimicrobial compounds produced by lactic acid bacteria.** European Food Research and Technology, 245, 569-579. doi: 10.1007/s00217-018-03227-3

Food systems quality design and research

Research on food quality and attractiveness in promoting a balanced and sustainable diet.

APPLICATION

Studies focusing on analysis of the attractiveness of food to consumers, i.e., sensory analysis, can be applied in developing innovative or reformulating

existing food raw materials and products. Technological solutions can be applied to ensure the quality parameters of sustainable technologies.

The accredited activities of the Food Research Centre enable companies to validate physical, chemical and microbiological indicators related to food quality.

RESEARCH ARTICLES

Traksele, L., Speiciene, V., Smicius, R., Alencikiene, G., Salaseviciene, A., Garmiene, G., Zigmantaite, V., Grigaleviciute, R., Kucinskas, A. (2021). **Investigation of *in vitro* and *in vivo* digestibility of black soldier fly *(Hermetia illucens L.)* larvae protein.** Journal of Functional Foods, 79. doi: 10.1016/j.jff.2021.104402

Bobinaite, R., Grootaert, C., Van Camp, J., Sarkinas, A., Liaudanskas, M., Zvikas, V., Viskelis, P., Venskutonis, P.R. (2020). **Chemical composition, antioxidant, antimicrobial and antiproliferative activities of the extracts isolated from the pomace of rowanberry (Sorbus aucuparia L.).** Food Research International, 136. doi: 10.1016/j.foodres.2020.109310

Food products and processes design and research

Development of health-friendly food technologies to promote an environmentally and climate-friendly food system.

APPLICATION

- Innovative solutions can be applied to the prototyping of new-generation personalized nutrition products, such as balanced foods, non-allergenic foods, and functional foods;
- Rational technology solutions for the use of food raw materials can be applied in transforming the existing technologies of a particular company into environmentally friendly models;
- Biotechnology solutions can be applied to the processing of secondary food raw materials and the production of health-friendly products;
- The accredited activities of the Food Research Centre enable companies to validate food safety and quality parameters of new product prototypes and processes.

RESEARCH ARTICLES

Sarkinas, A., Sakalauskiene, K., Raisutis, R., Zeime, J., Salaseviciene, A., Puidaite, E., Mockus, E., Cernauskas, D. (2018). **Inactivation of some pathogenic bacteria and phytoviruses by ultrasonic treatment.** Microbial Pathogenesis, 123, 144-148. doi: 10.1016/j.micpath.2018.07.004

Dominguez-Hernandez, E., Salaseviciene, A., Ertbjerg, P. (2018). **Low-temperature long-time cooking of meat: Eating quality and underlying mechanisms.** Meat Science, 143, 104-113. doi: 10.1016/j.meatsci.2018.04.032

Institute of Architecture and Construction

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The studies conducted at the Institute are significant for the civil engineering science and experimental development. Scientific work in these areas of research is focused on the strengthening of relations with business and state institutions, expansion of cooperation with Lithuanian and foreign partners; it is significant for the country's economic and energy development. Studies in the field of art history are focused on the evaluation of the history of the Lithuanian architecture from the point of view of heritage identification.

KEY WORDS

Accredited tests I Building materials I Certification I Territorial planning
Architectural heritage research

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Building materials, products and their durability studies

Research on the physical and mechanical properties and durability of building materials and products and their results are intended to develop new and improve existing construction finishing products, to improve the life cycle analysis methods of finishing materials.

APPLICATION

Laboratory and experimental research in this area provides an opportunity to identify changes in the properties of building materials and products during operation and to improve methods for predicting their durability. Innovative research based on laboratory tests and digital modeling can be applied to improve the production and performance of building materials and products. Accredited standard and non-standard testing services help businesses to optimize the properties of materials they produce and supply based on their intended use.

RESEARCH ARTICLES

Norvaišienė, R., Buhagiar, V., Burlingis, A., Miškinis, K. (2020). **Investigation of mechanical resistance of external thermal insulation composite system (ETICS).** Journal of building engineering, 32, art. 1-8. doi: 10.1016/j.jobe.2020.101682

Geležiūnas, V., Banionis, K., Bliūdžius, R., Paukštys, V., Kumžienė, J. (2020). **Analysis of air permeability of insulated masonry walls.** Energies, 13(10), 1-16. doi: 10.3390/en13102654

Makaveckas, T., Bliūdžius, R., Burlingis, A. (2020). **The influence of different facings of polyisocyanurate boards on heat transfer through the wall corners of insulated buildings.** Energies, 13(8), 1-14. doi: 10.3390/en13081991

Research on the decisive impacts of heritage on future cities and society

Analysis of the event horizon, forecasting of the future (far and near) and studies of wider urban processes based on the patterns of heritage.

APPLICATION

Modeling of non-standard methods with a view to predicting future scenarios of both the city as a phenomenon and individual urban structures and proposing solutions. Focus on less populated urban areas and towns.

RESEARCH ARTICLES

Rudokas, K., Landauskas, M., Gražulevičiūtė-Vileniškė, I., Viliūnienė, O. (2019). **Valuing the socio-economic benefits of built heritage: local context and mathematical modeling.** Journal of cultural heritage, 39, 229-237. doi:10.1016/j.culher.2019.02.016

Rudokas, K., Landauskas, M., Viliūnienė, O., Gražulevičiūtė-Vileniškė, I. (2019). **Hedonic analysis of housing prices and development in Kaunas: heritage aspect.** Environmental research, engineering and management, 75, 15-27. doi:10.5755/j01.erem.75.2.22823

Rudokas, K., Grazuleviciute-Vileniske, I. (2020). **The concept of pervading authenticity: contribution to Historic Urban Landscape approach.** Journal of heritage management, 5(2), 144-157. doi:10.1177/2455929620974897

Research on landscape architecture, spatial planning and sustainable landscape development

The performed research allows determining the tendencies of urban development, possible consequences of rational use of territories, landscape, quality of the living environment, the peculiarity of spatial structure of residential areas.

APPLICATION

The results of the research can be used to improve the legal framework of the country's territorial planning, to implement innovative land management measures, to improve the process of preparation of complex territorial planning documents, and to simulate urban decision-making.

RESEARCH ARTICLES

Dringelis, L., Ramanauskas, E., Povilaitienė, I., Mačiukūnaitė, J. (2015). **Exploration and respectation of the spatial structure of cities, towns, townships and villages as a significant formant of their identity.** Journal of Architecture and Urbanism, 39(1), 79-100. doi:10.3846/20297955.2015.1028509

Research on energy properties and heat exchange in buildings

Two research groups are distinguished:

- Applied research on the thermal inhomogeneity properties of buildings in linear thermal bridges and parameters for the evaluation of the thermal properties of a building.
- Applied research on the tightness properties of building structures for the evaluation of building infiltration prediction.

APPLICATION

In this area, research is being carried out on reducing the energy consumption of buildings, improving energy efficiency and exchanging heat in buildings. During the research, heat flows through various types of thermal insulation layers with various heat-conducting joints are analyzed as well as building infiltration prediction and in situ measurements of building tightness and analysis of results are performed.

RESEARCH ARTICLES

Banionis, K., Kumžienė, J., Burlingis, A., Ramanauskas, J., Paukštys, V. (2021). **The changes in thermal transmittance of window insulating glass units depending on outdoor temperatures in cold climate countries.** Energies, 14(6), 1-22. doi:10.3390/en14061694

Stonkuvienė, A., Bliūdžius, R., Burlingis, A., Ramanauskas, J. (2021). **The impact of connector's thermal and geometrical characteristics on the energy performance of facade systems**. Journal of building engineering, 35, 1-13. doi:10.1016/j.jobe.2020.102085.

Tukhtamisheva, A., Adilova, D., Banionis, K., Levinskytė, A., Bliūdžius, R. (2020). **Optimization of the thermal insulation level of residential buildings in the Almaty Region of Kazakhstan.** Energies, 13(18), 1-16. doi:10.3390/en13184692.

Research on the history and heritage of Lithuanian architecture and urban planning

Scientific works and their results are intended for the research on and evaluation of Lithuanian architectural and urban heritage.

APPLICATION

- Studies of the history of Lithuanian architecture. Specialization: the history of the Lithuanian architecture of the 20th century.
- Expert review of heritage protection. Specialization: special expert review of the assessment of immovable cultural values (architectural, urban, historical, and memorial heritage).
- Accumulation, storage and analysis of Lithuanian architectural archival documentation of the 19th and 20th centuries.
- Popularization of the history of architecture.

RESEARCH ARTICLES, MONOGRAPHS

Dogan, Huriye Armagan (2020). **Same language different dialects: expression of the modern movement in Ankara and Kaunas.** METU journal of the Faculty of Architecture, 37(2), 153-172. doi:10.4305/METU.JFA.2020.2.7

Tranavičiūtė, B. (2020). **Dreaming of the West: the power of the brand in Soviet Lithuania, 1960s–1980s.** Businesss history, 62(1), p. 179-195. doi:10.1080/00076791.2017.1379505

Petrulis, V. (2021). **Kaunas – a Baltic garden city?** Acta historiae artis Slovenica, 26(1), 133-149. doi:10.3986/ahas.26.1.07

Institute of Environmental Engineering

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In the context of partners and competitors, the Institute of Environmental Engineering stands out for its interdisciplinarity that combines environmental engineering, manufacturing engineering and business, and focuses on the preventive approach to solving environmental problems related to sustainable industrial development. More than 25 years of experience in research and expert activities in the area of sustainable development serve as a reliable ground to tackle global challenges while using local means and innovation.

KEY WORDS

Life cycle assessment I Ecodesign I Chemicals management
Cleaner production I Environmental impact assessment
Sustainable and smart city I Eco-innovation

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Life cycle assessment (LCA)

LCA means the identification and assessment of the environmental aspects and potential effects related to products, technologies or services throughout the life cycle of a product or process, from raw material extraction, transportation, production, use to final disposal.

APPLICATION

LCA is used:

- LCA is used to assess and optimize the qualitative and quantitative environmental impact of various production technological processes, services and products. This method not only allows identifying an existing negative impact (a hotspot), but also justifying the potential benefits for the environment through the development or implementation of various eco-innovations and the implementation of measures of the Circular Economy.
- Eco-labeling means the certification of products that are less harmful to the environment and human health than others in the same group throughout their life cycle.
- Ecodesign of products, Environmental declarations of products, methodology for determining the carbon footprint of products and organizations are all environmental measures that are also based on the LCA.

RESEARCH ARTICLES

Feiferytė, A.; Dvarionienė, J.; Gumbytė, M. (2015). **Assessment of properties and life cycle of biosynthetic oil.** Journal of cleaner production, 95, 281-290. doi: 10.1016/j.jclepro.2015.02.044

Petrauskienė, K., Skvarnavičiūtė, M., Dvarionienė, J. (2020). **Comparative environmental life cycle assessment of electric and conventional vehicles in Lithuania.** Journal of Cleaner Production, 246. doi:10.1016/j.jclepro.2019.119042

Ecological design of products (Ecodesign)

Ecological design of products (Ecodesign) is a way to integrate significant environmental protection aspects in an already existing product design and development system with consideration of economic, social and technical aspects.

APPLICATION

Ecodesign is used in manufacturing companies to develop and improve products and to achieve their maximum environmental efficiency. It is also used to change the characteristics of the product while leaving its normal functions, but meeting one of the principles of ecodesign:

- Consumption is reduced in the production of the product quantity of raw materials;
- The product uses less energy;
- The product uses less or no harmful substances at all;
- The product can be recycled at the end of its shelf life.

Ecodesign is one of the most important instruments for implementing the Circular Economy principles as it allows the systematic integration of environmental aspects at the earliest possible stage of product design, thus minimizing or eliminating the negative effects of the product on the environment throughout its whole life cycle.

RESEARCH ARTICLES

Kliaugaite, D., Varžinskas, V., Baikauskienė, A., Miliūnas, V, Stasiškienė, Ž. (2018). **Greenhouse gas emission reduction in frozen food packaging.** Environmental engineering and management journal, 17, 2977-2990.

Environmental performance improvement through pollution prevention and cleaner production

It is one of the most advanced methods for managing or reorganizing the industrial system, while taking into account long-term needs and relying on

the principles of sustainable development, which include ecological, social and economic harmony.

APPLICATION

The following methods of pollution prevention and cleaner production are applied:

- For technological innovations that reduce the negative impact of economic activities on the environment, i.e., cleaner production innovations.
- Description and assessment of production processes (from inputs to the final product output) for production technology audits to determine whether specific technologies and production processes as a whole correlate with technological developments in the field, i.e., whether the production processes use the latest knowledge, whether the processes are efficient when assessed in comparison with other possible technologies now and in the future, and so on.
- For the implementation of technological innovations - after the introduction of new or significantly improved products or processes related to the change of equipment and technologies, the implementation of which reduces the negative impact of economic activities on the environment, promote industrial symbiosis and ensure a continuous environmental protection effect.
- Technological eco-innovations include methods of the rational use of resources and pollution prevention (such as modernization (optimization) of a process with a view to reducing negative impact on the environment and/or conserving natural resources, ensuring waste-free production, reuse and/or recycling of waste, use of waste heat (recovery, regeneration), flow separation, and others). Improvement in products or technological processes is understood as improvement that allows reducing or eliminating negative environmental impact due to air pollution, sewage pollution and waste generation.
- IPPC (Integrated Pollution Prevention and Control) feasibility assessment, including comparison of currently existing production methods with BAT, development of raw material saving and waste reduction plans, and drawing-up of applications for IPPC or emission allowances.

RESEARCH ARTICLES

Malinauskienė, M., Kliopova, I., Christoph, H., Staniškis, J.K. (2018). **Geostrategic Supply Risk and Economic Importance as Drivers for Implementation of Industrial Ecology Measures in a nitrogen Fertilizer Production Company.** Journal of Industrial Ecology, 22(2), 422-433. doi:10.1111/jiec.12561

Malinauskienė, M., Kliopova, I., Slavickaitė, M., Staniškis, J. K. (2016). **Integrating resource criticality assessment into evaluation of cleaner production possibilities for increasing resource efficiency.** Clean technologies and environmental policy, 18, 1333-1344. doi: 10.1007/s10098-016-1091-5

Sustainable and smart city

Integrated waste management helps to evaluate and use all possible waste management alternatives that reduce management costs and the environmental impact. This concept covers the entire system, including proper waste collection and management.

APPLICATION

The investigations are applied to solve the problems of management and processing of individual waste streams in companies or regions.

Research is carried out on the management (use) of biodegradable waste (BSA) (from the municipal waste stream, manufacturing industry, agriculture, domestic sewage treatment plant sludge); feasibility assessment while using international methodologies.

RESEARCH ARTICLES

Yousef, S., Tatariants, M., Denafas, J., Makarevicius, V., Lukošiūtė, S. I., Kruopienė, J. (2019). **Sustainable industrial technology for recovery of Al nanocrystals, Si micro-particles and Ag from solar cell wafer production waste.** Solar energy materials and solar cells, 191, 493-501. doi: 10.1016/j.solmat.2018.12.008

Kliopova, I., Staniškis, J. K., Stunžėnas, E., Jurovickaja, E. (2019). **Bio-nutrient recycling with a novel integrated biodegradable waste management system for catering companies.** Journal of cleaner production, 209, 116-125. doi: 10.1016/j.jclepro.2018.10.185

Chemicals management

Research to assess the impact of chemicals on industry, business, health and environment.

Research on chemicals management in companies (risk assessment and mitigation, analysis of alternatives/changes, etc.).

APPLICATION

Based on these studies, elements of chemicals management can be proposed:

- A chemicals management audit is performed,
- Chemicals accounting is developed,
- Assessment of risk of chemicals posed at workplaces is carried out,

- Assessment as to which chemicals need to be replaced, whatever the alternatives may be, and assessment of the alternatives is performed,
- Advising on the implementation of REACH, CLP, RoHS and other chemicals-related requirements is provided.

It is important to avoid the entry of hazardous chemicals into products and processes: preventive solutions that complement the control of hazardous factors allow reducing the risks to workers, consumers and the environment.

RESEARCH ARTICLES

Anne, O., Burškytė, V., Stasiškienė, Ž., Balčiūnas, A. (2015) **The influence of the environmental management system on the environmental impact of seaport companies during an economic crisis: Lithuanian case study.** Environmental science and pollution research, 22, 1072-1084. doi: 10.1007/s11356-014-3410-x

Miliūtė-Plepienė, J., Hage, O., Plepys, A., Reipas, A. (2016). **What motivates households recycling behaviour in recycling schemes of different maturity? Lessons from Lithuania and Sweden.** Resources, conservation and recycling, 113, 40-52. doi:10.1016/j.resconrec.2016.05.008

Environmental Impact Assessment (EIA)

Assessment of the environmental impact that may be caused by the proposed economic activity. In such cases, the potential impact of the proposed economic activity, the impact on natural resources, the social and cultural environment, and the impact due to noise or pollution are analyzed.

APPLICATION

Studies and procedures of Environmental Impact Assessment (EIA) and Public Health Impact Assessment (EIA) of the proposed economic activity (PEA) in order to reduce or avoid the negative impact of the PEA on the environment and human health are conducted.

RESEARCH ARTICLES

Židonienė, S., Kruopienė, J. (2015). **Life cycle assessment in environmental impact assessments of industrial projects: towards the improvement.** Journal of cleaner production,106, 533-540. doi: 10.1016/j.jclepro.2014.07.081

Kliopova, I. (2018). **Environmental impact assessment procedures for sustainable urban planning: major requirements in EU countries and implementation by example of urban object construction,** 51-59.

Institute of Materials Science

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This University's research institute of high scientific competence conducts fundamental and applied research with focus on the priorities of the national and the European Union's research, actively participates in the development of high technologies in Lithuania, including thin films and coatings deposition, optical technologies, nanolithography, reactive ion etching for nano- and microstructures, diffractive optics, nanophotonics, microfluidic devices and sensors, is integrated in the University's study process at all levels, provides analytical and technological services to science and business partners.

KEY WORDS

Laser microfabrication I Electron beam lithography I Dot matrix holography Deep reactive ion etching I Soft lithography I Capillary force assisted nanoparticle assembly | Plasma based deposition methods I Gauges and sensors I Surface analysis techniques

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Materials and nanostructures for sensors and actuators

- Ion beam deposition of various allotropes of carbon (diamond-like carbon, graphene); nanostructured diamond-like carbon coatings for advanced optical metrology components, diamond-like carbon-based nanocomposites;
- Diamond-like carbon-based piezoelectric and optical sensors; graphene-based optical and magnetic sensors.
- Evanescent wave mode biosensors and plasmonic sensors for research on processes in liquids and gases.
- Ultrafast laser kinetic spectroscopy.
- Development and production of micro-optical elements (photonic crystals, wavefront splitters, submicron diffraction gratings) in quartz and other optical materials.
- Development and application of new nano/microstructures, and microfluidic devices.

APPLICATION

Nanostructured diamond-like carbon coatings are used to create wear-resistant scales for high precision laser measuring systems.

Surface modification or microfabrication employing a femtosecond laser has been shown to be a versatile technology to produce micro-nano structures for a variety of applications (photonics, plasmonics, optoelectronics, biosensors, microfluidic devices). Ultra-broadband antireflection coatings based on highly absorbing thin layers of nanocomposites with metallic nanoparticles are developed. Periodically ordered plasmonic nanoparticle arrays sustaining a surface lattice resonance--a hybrid mode featuring a delocalized and amplified electromagnetic field as well as ultranarrow extinction peaks are shown as low-cost biosensing and nanolasing systems. Diffraction elements are used in laser physics for beam compression, expansion and selective filtration as well as in various systems requiring specialized lighting, such as endoscopy.

RESEARCH ARTICLES

Meškinis, Š., Vasiliauskas, A., Andrulevičius, M., Jurkevičiūtė, A., Peckus, D., Kopustinskas, V., Viskontas, K., Tamulevičius, S. (2019). **Self-saturable absorption and reverse-saturable absorption effects in diamond-like carbon films with embedded copper nanoparticles.** Coatings, 9(2), 1-14. doi:10.3390/coatings9020100

Juodėnas, M., Tamulevičius, T., Henzie, J., Erts, D., Tamulevičius, S. (2019). **Surface lattice resonances in self-assembled arrays of monodisperse Ag cuboctahedra.** ACS nano, 13(8), 9038-9047. doi:10.1021/acsnano.9b03191

Peckus, D., Chauvin, A., Tamulevičius, T., Juodėnas, M., Ding, J., Choi Chang-Hwan, El Mel, Abdel-Aziz; Tessier, Pierre-Yves; Tamulevičius, S. (2019). **Polarization-dependent ultrafast plasmon relaxation dynamics in nanoporous gold thin films and nanowires.** Journal of physics D: Applied physics, 52(22), 1-13. doi:10.1088/1361-6463/ab0719

Organic materials for energy and electronics

Formation of metal-polymer nanocomposites using electron beam evaporation and heat treatment or colloidal solutions for sensors and biological applications.

Research and development of organic electronics elements, including field-effect transistors, organic LEDs, and solar cells.

APPLICATION

Due to unique optical, electrical, and optomechanical properties, metal nanoparticles exhibiting plasmonic response are broadly used in photocatalysis, nonlinear optics, sensors, and solar elements.

Organic thermally activated delayed fluorescence emitters can theoretically achieve 100% internal quantum efficiency and, therefore, have great prospects for application in the production of light-emitting diodes.

RESEARCH ARTICLES

Keruckas, J., Volyniuk, D., Simokaitiene, J., Narbutaitis, E., Lazauskas, A., Lee, Pei-Hsi; Chiu, Tien-Lung; Lin, Chi-Feng; Arsenyan, P., Lee, Jiun-Haw; Grazulevicius, J. (2019). **V. Methoxy- and tert-butyl-substituted meta-bis(N-carbazolyl phenylenes as hosts for organic light-emitting diodes.** Organic electronics: physics, materials, applications, 73, 317-326. doi:10.1016/j.orgel.2019.06.026

Ivaniuk, K.; Cherpak, V.; Stakhira, P.; Baryshnikov, G.; Minaev, B.; Hotra, Z.; Turyk, P.; Zhydachevskii, Ya.; Volyniuk, Dmytro; Aksimentyeva, O.; Penyukh, H.; Lazauskas, A., Tamulevičius, S., Gražulevičius, J. V., Ågren, H. (2016). **BaZrO3 perovskite nanoparticles as emissive material for organic/inorganic hybrid light-emitting diodes.** Dyes and Pigments, 145, 399-403. doi:10.1016/j.dyepig.2017.06.020

Functional materials, structures, products and technologies for document security

Complex holograms including micro/ nanostructures and original validation software.

Development of materials and technologies for 2D and 3D holograms employing e-beam, UV, and nanoimprint lithography.

APPLICATION

The possibilities for the use of functional materials:

- A security tag featuring holographic elements is used for anti-counterfeiting applications. Holographic security marks are used for the protection of the intellectual property rights of documents and various goods against counterfeiting and falsification as well as for ensuring authenticity and originality.
- The combination of the near-field plasmonic properties of nanostructures with the far-field properties of periodic structures allows creating both scientifically and application-relevant optical devices and/or elements that are used for spectral filtering, sensors, and optical anti-counterfeiting elements.

RESEARCH ARTICLES

Tamulevičius, T., Juodėnas, M., Klinavičius, T., Paulauskas, A., Jankauskas, K., Ostreika, A., Žutautas, A., Tamulevičius, S. (2018). **Dot-matrix hologram rendering algorithm and its validation through direct laser interference patterning.** Scientific reports, 8, 1-11. doi:10.1038/s41598-018-32294-5

Andriulevičius, M., Puodžiukynas, L., Tamulevičius, T., Tamulevičius, S. (2017). **Diffraction efficiency and noise analysis of hidden image holograms.** Optik, 131, 805–812. doi:10.1016/j.ijleo.2016.11.178

Jurkevičiūtė, A., Armakavičius, N., Virganavičius, D., Šimatonis, L., Tamulevičius, T., Tamulevičius, S. (2017). **Fabrication and characterization of one- and two-dimensional regular patterns produced employing multiple exposure holographic lithography.** Journal of optoelectronics and advanced materials, 19, 119-126.

Institute of Mechatronics

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The Institute of Mechatronics provides open access to a wealth of technological and measurement equipment that allows researchers to conduct a wide range of applied research in a variety of fields of macro, micro and bio mechatronics, responding to the needs of the precision instrument, aerospace and manufacturing industries and the healthcare and sports training sectors. Both machining and additive production technologies are used for the realisation of models and prototypes.

KEY WORDS

Intelligent materials I Micro power generators I Laser measurements
Efficient materials processing I Biomechanical research
Piezomechanical systems I Precision positioning techniques I 3D printing

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(Bio)mechatronics technologies for health, prevention, diagnosis and treatment

Development, research and application of equipment and methods intended for healthcare, sports training, prevention and diagnosis of health disorders, treatment, rehabilitation and disability compensation.

APPLICATION

- Products intended for medicine (orthopedics, dentistry), healthy lifestyle, prevention, rehabilitation, and sports are designed.
- In carrying out research and providing experimental development services, the biomechanical properties and ergonomics of materials and already manufactured products are determined.
- Research is conducted for highly skilled athletes and amateurs to improve their sport excellence and reduce the risk of injury.

RESEARCH ARTICLES, PATENTS

Domeika, A.; Grigas, V.; Žiliukas, P.; **Unstable rowing simulator: United States patent / US 9623279 B2**

Lukonaitienė, I.; Kamandulis, S.; Paulauskas, H.; Domeika, A.; Pliauga, V.; Kreivytė, R.; Stanislovaitienė, J.; Conte, D. (2020). **Investigating the workload, readiness and physical performance changes during intensified 3-week preparation periods in female national Under18 and Under20 basketball teams. Journal of Sports Sciences,** 38(9), 1018-1025. doi:10.1080/02640414.2020.1738702

Piezomechanical actuators for precision dynamic systems

Development, research and application of piezomechanical high-resolution actuators for precision positioning, vibratory processing of materials, etc.

APPLICATION

- Piezometric actuators are used for high-resolution displacement control systems required in precision devices for optical beam intensity control or stabilization as well as for optical beam position control and multi-coordinate control of precision positioning tables.
- Ultrasonic excitation is applied to improve material processing technologies or to activate chemical reactions or processes.
- The actuators developed by the Institute can also be applied in health promotion.

RESEARCH ARTICLES

Gaidys, R., Dambon, O., Ostaševičius, V., Dicke, C., Narijauskaitė, B. (2017). **Ultrasonic tooling system design and development for single point diamond turning (SPDT) of ferrous metals.** International journal of advanced manufacturing technology, 93, 2841-2854. doi:10.1007/s00170-017-0657-7

Jūrėnas, V., Kazokaitis, G., Mažeika, D. (2020). **3DOF ultrasonic motor with two piezoelectric rings.** Sensors: Special issue: Development of piezoelectric sensors and actuators, 20(3), 1-14. doi:10.3390/s20030834

Rimašauskienė, R.; Jūrėnas, V.; Radzienski, M.; Rimašauskas, M.; Ostachowicz, W. (2019). **Experimental analysis of active-passive vibration control on thin-walled composite beam.** Composite structures, 223, 76-91. doi:10.1016/j.compstruct.2019.110975

Micro power generators and sensors for smart (micro) systems

Development, research and application of vibration-based micro energy generators and mechanical sensors with integrated piezoelectric transducers in multifunctional industrial and various (bio) mechatronic macro/micro systems.

APPLICATION

Piezoelectric transducers are used as mechanical sensors or autonomous sources of electrical power in various sensing devices to monitor the condition of technological devices (such as machining equipment with integrated vibration sensors and/or micro energy generators).

Piezoelectric transducers developed by using 3D printing are used as flexible vibration, pressure or displacement sensors, micro energy generators or biocompatible electroactive devices. They can be applied in wearable devices, biomedical devices (intelligent orthopaedic techniques, physiological properties meters, etc.).

RESEARCH ARTICLES

Dauksevicius, R., Gaidys, R., Ostasevicius, V., Lockhart, R., Vásquez Quintero, A., Rooij, Nico de; Briand, D. (2019). **Nonlinear piezoelectric vibration energy harvester with frequency-tuned impacting resonators for improving broadband performance at low frequencies.** Smart materials and structures, 28(2), 1-21. doi:10.1088/1361-665X/aaf358

Žižys, D., Gaidys, R., Daukševičius, R., Ostaševičius, V., Daniulaitis, V. (2016). **Segmentation of a vibro-shock cantilever-type piezoelectric energy harvester operating in higher transverse vibration modes.** Sensors, 16(1), 1-14. doi:10.3390/s16010011

Dauksevicius, R., Kleiva, A., Grigaliunas, V. (2018). **Analysis of magnetic plucking dynamics in a frequency up-converting piezoelectric energy harvester.** Smart materials and structures, 27, 1-19. doi:10.1088/1361-665X/aac8ad

Prof. K. Baršauskas Ultrasound and Research Institute

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In many industries, the staff of the Institute of Ultrasound Science has developed unique technologies thus accumulating specific know-how that no other scientific team in the world possesses.

KEY WORDS

Ultrasonic transducers | Ultrasonic measurements for defect detection and structural monitoring | Applied applications of long-range ultrasound Visualization of internal structures using X-ray micro-tomography and acoustic microscopy | Medical applications | Ultrasonic measurements for technological process monitoring

*National Innovation and Entrepreneurship Centre

Ultrasonic transducers

Specialized ultrasonic transducers are designed and manufactured for measurements in extreme conditions: high temperature, pressure, air gap measurements or other complex conditions where standard transducers available on the market cannot be used.

APPLICATION

There are three types of ultrasonic transducers:

- Ultrasonic transducers capable of long-term operation in liquid lead-bismuth alloy are not cooled to 460 °C.
- Ultrasonic transducers for non-contact measurements over air are designed for thin film testing, gas flow measurements, ash and dust concentrations.
- Ultrasonic transducers for contact testing of composite materials.

RESEARCH ARTICLES

Dierckx, M., Kažys, R., Voleišis A. (2018). **Procede et systeme de detection dans des environnements a haute temperature,** FR 2980268 B1. 2018-05-04., 39

Kažys, R., Šliteris, R., Šeštokė, J. (2017). **Air-coupled ultrasonic receivers with high electromechanical coupling PMN-32%PT strip-like piezoelectric elements,** Sensors, 17(10), 2365. doi:10.3390/s17102365

Raišutis, R., Tumšys, O. K., Rymantas J. (2017). **Development of the technique for independent dual focusing of contact type ultrasonic phased array transducer in two orthogonal planes, NDTE Int.,** 88, 71–80. doi: 10.1016/j.ndteint.2017.03.004

Ultrasonic measurements for defect detection and structural monitoring

Research and development of methods for detecting defects in various materials or structures is performed. The methods also allow long-term

monitoring of the structure to identify dangerous or undesirable changes during operation.

Research includes:

- modeling,
- experimental measurements,
- verification of methods,
- selection or development of the necessary equipment.

APPLICATION

- Defect detection in composite materials is used in aviation or land transport, wind turbines and metal structures.
- The method is intended for automatic testing of aluminum thermothermal welding seams.
- Method for inspection of welds in plastic pipes with automatic defect detection.
- Method of inspecting fuel tanks without emptying them.

RESEARCH ARTICLES

Jasiūnienė, E.; Mažeika, L.; Samaitis, V.; Cicėnas, V.; Mattsson, D. (2019). **Ultrasonic non-destructive testing of complex titanium/carbon fibre composite joints.** Ultrasonics, 95, 13-21 doi:10.1016/j.ultras.2019.02.009

Samaitis, V., Mažeika, L., Rekuvienė, R. (2020). **Assessment of the Length and Depth of Delamination-Type Defects Using Ultrasonic Guided Waves, Applied Science – Basel,** 10(15), 5236. doi: 10.3390/app10155236

Tiwari, K. A. , Raišutis, R., Samaitis, V. (2017). **Hybrid signal processing technique to improve the defect estimation in ultrasonic nondestructive testing of composite structures. Sensors,** 17(12), 2858 doi: 10.3390/s17122858

Long-range ultrasound applied research

Ultrasonic directional waves are adapted to measurements from a greater distance and enable the detection of defects or the inhomogeneity of material properties in wider areas or in inaccessible places.

APPLICATION

- Detection of microbiologically induced corrosion in automatic sprinkler systems.
- Rapid detection of corrosion-damaged areas in pipelines and multi-purpose tanks.

RESEARCH ARTICLES

Kažys, R.J., Mažeika, L., Šeštokė, J. (2020). **Development of Ultrasonic Techniques for Measurement of Spatially Non-Uniform Elastic Properties of Thin Plates by Means of a Guided Sub-Sonic A(0) Mode**. Applied Science – Basel, 10(9), 3299. doi: 10.3390/app10093299

Raišutis, R., Kažys, R. J., Mažeika, L.; Samaitis, V., Žukauskas, E. (2016). **Propagation of ultrasonic guided waves in composite multi-wire ropes.** Materials, 9(6), 1-15. doi: 10.3390/ma9060451

Visualization of internal structures using X-ray microtomography and acoustic microscopy

3D visualization of the internal structures of opaque objects and materials is performed. The internal structures of small objects can be reproduced with a precision of several microns.

APPLICATION

Visualization of the internal structure of various components or products by detecting unwanted damage or material unevenness is performed. It can also be used to detect delamination of electronic components, to detect microcracks in solar cells, to investigate dental and prosthetic components, to determine the parameters of defects in composite structures, to visualize the internal structure of concrete products, to determine the quality of precision welding, etc.

RESEARCH ARTICLES

Jasiūnienė, E., Cicėnas, V., Grigaliūnas, P., Rudžionis, Ž., Navickas, Arūnas A. (2018). **Influence of the rheological properties on the steel fibre distribution and orientation in self-compacting concrete.** Materials and structures, 51(4), 1261-1281. doi: 10.1617/s11527-018-1231-y

Jasiūnienė, E., Žukauskas, E., Dragatogiannis, D.A., Koumoulos, E.P., Charitidis, C.A. (2017). **Investigation of dissimilar metal joints with nanoparticle fillers.** NDT & E international, 92, 122-129 doi :10.1016/j.ndteint.2017.08.005

Application in medicine

The methods developed by the institute are based on various ultrasonic measurements, signal and image processing, enabling the diagnosis of changes in biological media caused by various pathologies.

APPLICATION

Methods and systems for non-invasive early diagnosis of diabetes, non-invasive automatic diagnosis of intraocular tumors, skin cancer diagnosis based on ultrasound signal processing, analysis of ultrasound and optical images using artificial intelligence methods. The method and system for monitoring the blood coagulation process are based on precise ultrasonic velocity measurements.

RESEARCH ARTICLES

Paškevičiūtė, M., Januškevičienė, I., Sakalauskienė, K., Raišutis, R., Petrikaitė, V. (2020). **Evaluation of low-intensity pulsed ultrasound on doxorubicin delivery in 2D and 3D cancer cell cultures.** Scientific Reports, 10, 1-8. doi: 10.1038/s41598-020-73204-y

Tiwari, K. A., Raišutis, R., Liutkus, J., Valiukevičienė, S. (2020). **Diagnostics of melanocytic skin tumours by a combination of ultrasonic, dermatoscopic and spectrophotometric image parameters.** Diagnostics, 10(9), 1-14. doi: 10.3390/diagnostics10090632

Ultrasonic measurements for the monitoring of technological processes in industry

Ultrasonic methods for monitoring the dynamics of various technological parameters, such as gas or liquid flow rates, product thickness changes,

location of electrical discharges, are being developed and researched. The methods are based on accurate measurement of ultrasonic wave parameters.

APPLICATION

- Precision gas flow measurement on calibration stands.
- Non-contact measurement of the thickness of chocolate or other products in the food industry.
- Determination of zirconium tube wall and diameter variations in nuclear power plant fuel channels.

RESEARCH ARTICLES

Kažys, R., Šliteris, R., Mažeika, L., Van den Abeele, L., Nielsen, P., Snellings, R. (2021). **Ultrasonic monitoring of variations in dust concentration in a powder classifier.** Powder technology, 381, 392-400. doi: 10.1016/j powtec.2020.11.072

Kažys, R. J., Šliteris, R., Rekuvienė, R., Žukauskas, E., Mažeika, L. (2015). **Ultrasonic technique for density measurement of liquids in extreme conditions.** Sensors, 15(8), 19393-19415. doi: 10.3390/s150819393

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At the School of Economics and Business, research is conducted in 3 research areas, various international projects and interdisciplinary science clusters are carried out, and scientific conferences are organized.

KEY WORDS

Innovation and entrepreneurship I Digitization
Sustainable management | Sustainable economy

*National Innovation and Entrepreneurship Centre

Innovation and entrepreneurship

Collaboration-based multidisciplinary research on innovation, entrepreneurship, organizational strategy and competitiveness.

APPLICATION

- Evaluation of various types of initiatives and entrepreneurship promotion programs;
- Development of business process optimization, growth and management models and applicable methodologies.

Digitization

Research on the challenges and opportunities of digitization for the sustainable development of business and society.

APPLICATION

- Assessment of the impact of digitization;
- Digital and technological upgrading of processes.

Sustainable management

Development of new ideas that enable the expression of the sustainability dimension in rganizational development, value creation, customer relations, and human resource management.

APPLICATION

- Solutions for creating consumer value;
- Human resource strategy development;
- Assessment of the impact of future-creating technologies on the development of organizations.

Sustainable economy

Research on sustainable economy related to the sustainable development of the society, including micro and mezzo levels.

APPLICATION

Determination of the social and economic impact of business, public sector and state policy development in the region.

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The Faculty carries out various scientific activities responding to the needs of the world in the 21st century: multidisciplinary research, national and international projects, scientific conferences, research for business, and non-formal education. The implemented global grant instruments allow the Faculty's researchers to achieve significant results.

KEY WORDS Digital and analogue electronics I Materials research

*National Innovation and Entrepreneurship Centre

Design of digital and analogue electronic assemblies

Design of electronic devices, tracing, ordering of prototypes of printed circuit boards, soldering of prototypes or ordering of soldering, programming, and adjustment. Design of 3D housing prototypes for electronic devices and electrical equipment.

APPLICATION

Design of ultrasonic manipulator electronics.

Development and adjustment of parametric speaker electronics and housings.

RESEARCH ARTICLES

Pelenis, D., Dzedzickis, A., Morkvėnaitė-Vilkončienė, I., Bučinskas, V., Barauskas, D., Vanagas, G., Mikolajūnas, M., Katkus, J., Viržonis, D. (2018). **Non-contact sensing of elastic modulus of the UV cured furniture coatings by the transverse acoustical waves.** IEEE sensors journal, 18, 6527-6532. doi:10.1109/JSEN.2018.2850362

Studies on the composition, properties and environment of materials

Mathematical modeling of physical processes and product properties by the finite element method.

APPLICATION

A project of ultrasonic PE film washing was carried out according to individual orders of a company, and a model of a fan with a thermoelectric module was created.

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