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# Health Sciences

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**TRL 6** – technology demonstrated in relevant environment (industrially relevant)

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## Short description of the work

Ligence develops Deep Learning algorithms for cardiac ultrasound image analysis - automated 2D Echocardiography. Software is capable of recognizing different heart image views and it is trained to assess anatomical and functional heart's features. We are targeting US, Europe markets.

## Novelty of the work

There has been few attempts to automate heart ultrasound imaging examination and it still remains poorly automated and heavily dependent on human operator. Our unique approach allows seamless integration into hospital's workflow without interruptions.

## **Technical or other problems that are solved with the work**

- reduces manual work for a physician;
- makes up for the skill lack;
- reduces the overall exam time by 50%;
- increases patient admission rates.

## **The benefits and value to the potential users**

Increased patient admission rates, increased revenue by up to 40%.

# Emplastrum -

MB "Emplastrum"

## Treat psoriasis comfortably

### Authors:

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Evaldas Kalvaitis,  
Edvardas Satkauskas,  
Alina Vilkaitė

**TRL 5** – technology validated in relevant environment (industrially relevant)

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### Short description of the work

Psoriasis is a long-lasting autoimmune disease characterized by patches of abnormal skin. Around one-third of people with psoriasis report a family history of the disease, and researchers have identified genetic loci associated with the condition. Psoriasis has a strong hereditary component. The patient has the problem, but also there is a big chance that their family members also can be affected.

More than 125 million people worldwide suffer from psoriasis including some of our friends and family members. Each year these people spend over EUR 8B on psoriasis treatment worldwide. Scientists and market researchers forecast that the global psoriasis treatment market will be worth \$12B (€10B) by 2024.

Emplastrum team has developed new and better way for psoriasis treatment. We created device that is a flexible, silicon patch with a small screen on top with integrated UVB LED lights. The innovation gives the opportunity to shift psoriasis treatment from hospital to home and makes the treatment itself more comfortable compared to current, time-consuming methods patients are not satisfied with, based on survey responses and research.

### **Novelty of the work**

Product is patenting in Lithuania and North Europe countries.

### **Technical or other problems that are solved with the work**

With our patches, people will be able to have treatment anywhere (at home, at work, in a car and etc.), avoid unnecessary UV rays and treat several damaged skin places at one time. Emplastrum solution gives the opportunity to shift psoriasis treatment from hospital to home.

### **The benefits and value to the potential users**

On average, patients spend more than 6 hours a week for psoriasis treatment. With our devices, patients would be able to spend approximately 35minutes/week. Especially this product will be suitable for older citizens bringing the treatment to home. The patients will save 10x more time (they do not need to go to the hospitals for treatment). More than 80% of unnecessary UV rays will not get on the patients' skin. 60-90% chance that the symptoms improve noticeably or go away completely for a while.



# Black chocolate could be a source of vitamin D

Kaunas University of  
Technology and  
Lithuanian University  
of Health Sciences

## Authors:

Otilija Lieščinskaitė,  
Mantas Būdvytas

**TRL 2** – technology  
concept formulated

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## Short description of the work

Vitamin D, which is stored in human body, melts in fat. Its main form circulating in blood is 25 (OH). This vitamin is necessary for people of different ages because it is involved in all functions of organs as it regulates the metabolism of the minerals. But the tendency is noticed that vitamin D insufficiency is becoming a worldwide phenomenon and its prevalence is observed in different geographical regions.

The work formed the hypothesis that the consumption of black chocolate with inserted vitamin D will give the daily recommended dose of it. The aim is to work on the black chocolate, enriched with the leftovers from squeezed out raspberries, and insert the recommended daily rate of vitamin D.

## **Novelty of the work**

It would be the first of such kind products, which would look like a sweet to the customers, but in reality it does a great job replacing for most of us unwanted fish oil supplements, and therefore keeping the immune system in good condition.

## **Technical or other problems that are solved with the work**

Solution developed solves problem of lack of Vitamin D.

Each year the research reveals that vitamin D value for health is far greater than many people think. Summer, which is the hottest period of the country, is not long, so it is one of the main reasons why the body cannot muster the required quantity of vitamin D. In addition, people, fearing ultraviolet light, sometimes intensely use unnecessary measures, which reduces the risk of irritation of the Sun, but also inhibit the production of vitamin D in the skin. Besides, children health problems are also often connected with the lack of this vitamin.

## **The benefits and value to the potential users**

In countries where statistics show that the population lacks vitamin D, it would be a possibility to obtain my special black chocolate. It is expected that the overall rate of people who lack this specific vitamin would decrease. Also one piece of chocolate would contain enough vitamin D amount for the whole day, making it easier to track the consumption and not overdosing, which makes it attractive to customers.

# NeuroEna –

giving the power of movement  
for people with neurological  
disabilities

## Authors:

Lukas Arlauskas,  
Antanas Ramanauskas,  
Ugnė Glinskytė,  
Deimantė Krutulytė,  
Simas Bašinskas

**TRL 2** – technology  
concept formulated

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## Short description of the work

We are creating an exoskeleton, designed to help people with hyperkinetic movements disorders such as dyskinetic cerebral palsy, and other patients suffering from tics and chorea. We are designing the solution in the way that electromyography (EMG), gyroscope and accelerometer sensors would be planted all over the exoskeleton and the inputs will be passed to the artificial neural network to process and determine if the movement is valid or not. If our exoskeleton decides that the movement is not valid, it will try to suppress the movement from happening by inducing opposite force through stimulating the antagonist muscle via neuromuscular electrical stimulation. The garment should be adaptable to various sizes and we understand that not every patient might suffer from the hyperkinetic movements

equally, so we decided to design the exoskeleton in a way that would be modular so the excess parts manufacturing would be reduced as much as possible.

Customer segment: ideally patients between ages of 4 up to 70 years old, who have the hyperkinetic disorders with no contraindications. Market geography: planning on starting in Lithuania, however the bigger plans for the future are EU and global expansion.

### **Novelty of the work**

The novelty is that hyperkinetic disorder would be tracked by artificial intelligence and therefore there would be no need for calibration with physicians. The combination of AI driven detection mechanisms and AI controlled functional electrical stimulation is what allows the solution to be powerful and unique. Also it is important to mention that NeuroEna is the ultimate solution which includes the non-restriction of patients mobility and lets the patient set it and forget it.

### **Technical or other problems that are solved with the work**

It solves the hyperkinetic movements disorders for the patients so that they could live their normal lives.

### **The benefits and value to the potential users**

Reduced social awkwardness, better overall physical state, better physical balance, no weird jerky movements.

# Cognitive Contact-free Care

## Authors:

Murad Abushaikha,  
Sabyasachi Chakraborty

**TRL 5** – technology  
validated in relevant  
environment  
(industrially relevant)

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## Short description of the work

Cognitive Contact-free Care solution, harnesses Smart care technology to create safer environments for babies, kids and seniors who live at home alone or with a partner. Through advanced monitoring and communication, these services are detecting falls, vital signs, sleeping pattern, movement or other safety concerns – they are attempting to prevent them altogether using a unique A.I. model.

The product is aimed at B2C (kids and elderly), home care agencies, Rehabilitation Centers, Senior Living communities, offices, nurseries, schools.

## Novelty of the work

The first completely contact-free intelligent monitoring platform, monitoring real-time activity, with a high degree of privacy, detecting objects accurately and within a wide range. Customizable system to accommodate different needs and requirements.

## **Technical or other problems that are solved with the work**

- Cognitive Contact-free Care solution is mindful of privacy; because it doesn't use cameras.
- Setup is also simple for out-the-box use;
- Automatic arming of system and intruder alerts;
- Breathing and sleep analysis.
- Gait analysis and daily patterns;
- All upgradeable via software updates.

## **The benefits and value to the potential users**

Contact-free solution, privacy ensured, real-time visibility, acts automatically, multi-functional, plays a good role to save people health conditions, and to improve their lifestyle.

# PainLess –

Lithuanian University  
of Health Sciences  
Hospital Kauno Klinikos

## Acute pain objectivization: non-invasive pain diagnostic patch

### Authors:

Lina Jankauskaitė,  
Goda Camille Mickevičiūtė,  
Aistė Pociūtė

**TRL 2** – technology  
concept formulated

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### Short description of the work

Our group “PainLess” is working on a development of a non-invasive acute pain diagnostic patch. This diagnostic patch detects specific pain-induced hormones and their fluctuations in sweat. All the data is further transferred to a mobile application/platform and the patient/ his or her relatives or physician has possibility to follow-up, to analyse this data. This will lead to a selection of more individualized pain management and better outcomes.

### Novelty of the work

Currently, there are plenty of pain detection methods, such as pain assessment scales or physiological parameters which are very subjective. Anxiety and fair of health-care facility could lead to increased

physiological parameters, such as respiration, heart rate or blood pressure. Moreover, still a lot of prejudice via pain diagnostics is observed, especially in pediatric emergency medicine, such as infants do not feel pain, girls feel less pain, boys have to stay “strong” and not cry during painful procedure which leads to less medication. This contributes to pain underdiagnosis and undertreatment. Additionally, new methods as specific biosensors are only experimental or only for a specific group of people (e.g. sportsmen, astronauts). Our pain detection patch will combine detection of excreted pain-induced hormones with physiological parameters and will transfer data to a mobile/cloud platform. This patch will be available for hospital and home use. It will give possibility for a patient to monitor his/her pain associated inflammatory changes. Adding, it will facilitate pain-related processes for a physician leading to better pain management. It is especially crucial for patients who can not verbalize their pain-related complains (neonates, intubated patients, unconscious, severe disabled patients, patients after stroke).

### **Technical or other problems that are solved with the work**

Most important problem is pain related diagnostics, treatment and costs. We analysed 1000 pediatric trauma induced pain and visceral pain patients and discovered high (up to 20%) of undertreatment of pain in all pediatric age groups (<https://onlinelibrary.wiley.com/doi/full/10.1002/ejp.1527>). Moreover, we performed an online questioning involving 800 of people (only 50% were health-care workers) where 94% noted pain as important problem in the population. After careful data analysis, we discovered that even 90% of people use painkillers without prescription, they modify doses, use few drugs together even without doctors' consultation ([https://pubmed.ncbi.nlm.nih.gov/27627570/?from\\_term=pain+reliever+adherence&from\\_filter=ds1.y\\_5&from\\_pos=4](https://pubmed.ncbi.nlm.nih.gov/27627570/?from_term=pain+reliever+adherence&from_filter=ds1.y_5&from_pos=4)). The pain related costs are around 300 billions of euros/year in EU, 635 billions of dollars in US which could be decreased with early objective pain diagnostics.



## **The benefits and value to the potential users**

We are targeting individual patients and health-care facility (hospitals etc.) (worldwide).

Non-invasive (not painful, no blood markers needed) early immediate pain diagnostics, analysis and follow-up in time, consultation of a physician, immediate prescription (if needed).

## Precautionary belt which tracks dangerous fetus conditions during pregnancy

### Authors:

Vytautė Razutytė,  
Paulina Bištrickaitė,  
Samanta Čėpononytė

**TRL 1** – basic  
principles observed

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### Short description of the work

BeltaMOM is a comfortable daily wearable belt for pregnant women that tracks dangerous conditions for fetus, including low heart rate and decreased / increased amount of amniotic fluid. Additionally, it will monitor fetus weight and movements which is very important to track from the fifth month of pregnancy. All the measurements are done by 4 wireless ultrasound and 1 stethoscope sensor. Ultrasound sensors are located in the corners of the belt and the stethoscope sensor is in the lower front. If there is any negative change in one of the indicators, sensors would immediately alert in form of detailed information in the mobile application via Bluetooth, which analyses the data real-time and provides insights. All the information about fetus condition may also be seen by gynecologist – obstetrician. Preventive actions may be taken to avoid higher risks and assure

calm state of mind.

Every year there are 10 million pregnant women worldwide which represents market opportunity worth over 2 billion dollars.

Our target market is any pregnant women who is worried about their fetal health and who want to obtain an objective information about fetus as opposed to their intuition and feelings. However, we are mostly focusing on women who have high risk pregnancies, since BeltaMOM features are the most important for monitoring fetus in the high risk.

In 2019 BeltaMOM was awarded as the Best Health care innovation in Sillicon Valey Innovation challenge.

### **Novelty of the work**

There are just a few brands that have one or two features of our product (monitoring fetus heart rate, counting movements), but none of their devices can monitor fetus weight and count the amount of amniotic fluid. These are new measurements in this market.

### **Technical or other problems that are solved with the work**

1. Every year about 2.6 million fetuses die during pregnancy and even more babies are born with defects and disabilities. According to The Centre for Disease Control and Prevention, 6-8% of USA women have high-risk pregnancies. Emotional stress of mothers is regarded as among most important risk factors. Stress can lead to raised blood sugar levels, and a reduction of oxygen supply to the tissues - both of which may lead to birth defects. BeltaMOM will assure calm state of mind by showing daily fetus health condition.

2. A lot of expecting women feel stressful, mostly concerned with their baby's health leading to multiple visits to doctors, which in turn results in an increased workload. Based on Survey of America's Physicians 2017, 80% of physicians are overextended or are at capacity, with no time to see additional patients. BeltaMOM will reduce the number of unnecessary visits to gynecologists - obstetricians by letting pregnant women know that their fetus is in the good state of health.

### **The benefits and value to the potential users**

- Calm state of mind (as pregnant women can monitor fetus daily health condition);
- Ergonomic wireless belt for daily wearing (supports lower back, supports belly);
- Comprehensive fetus screening in one device at a comfort of your home (effortless, simple usage, daily notifications, updates);
- Data shared with both users and their physicians;
- Non-invasive;
- Harmless for the fetus (sensors and the amount of measurements are adapted for safe daily usage);
- Eco friendly buyback distribution (there are additional opportunities to get the device: buy back distribution and renting).

# Posture Improving T-shirt

Kaunas University  
of Technology

## Authors:

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and assoc. prof. Kristina  
Ancutienė

**TRL 7** – system pro-  
totype demonstration  
in operational environ-  
ment

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## Short description of the work

Conventional orthopedic products designed to improve posture can cause discomfort when worn, as such products are difficult to hide under outer clothing. Also, these products can only be worn for a certain period of time. To solve the problems of irregular posture, a posture-enhancing t-shirt was designed and created. These t-shirts are attractive in their appearance and can be worn indefinitely. In order to improve technology, bonding technology was used to strengthen the target areas of the product.

## Novelty of the work

Usually such type of products does not use bonding technology, so this product is one of the first in the market that helps to maintain straight posture and has been designed while using this technology to strengthen target areas.

## **Technical or other problems that are solved with the work**

Final product improves posture and helps to maintain it in correct position while being attractive and easy to use.

Also, this product has simple construction and it is quite easy to produce it.

## **The benefits and value to the potential users**

- Improving posture;
- Product is attractive in appearance/design and easy to use/wear;
- Cheaper than other products on the market;
- Adjustable back buckle size;
- Comfortable to wear without hiding under clothes.

# MimicTherapy – face & speech recognition to ease rehabilitation

Kaunas University of  
Technology, Lithuanian  
University of Health  
Sciences and UAB  
“Netipiniai sprendimai”.

## Authors:

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Birutė Vabalaitė,  
Brigita Motiejauskaitė,  
Paulius Patalavičius,  
Algirdas Palubinskas

**TRL 3** – experimental  
proof of concept

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## Short description of the work

We are creating medical software (mobile application and web platform for specialists) for people who have speech and face muscle motor dysfunction and need rehabilitation. Software reduces logotherapists workload and allow remote logotherapy for patients.

## Novelty of the work

Application utilizes face & speech recognition to ease rehabilitation - patients would see video exercises and get real-time feedback by video and audio algorithm about their performance.  
Web platform for specialists lets optimize their workload and work remote.

## **Technical or other problems that are solved with the work**

Visually presents exercises, recognizes face & speech to evaluate exercise execution, accumulates stats, shows long-term progress, aids logotherapists, enables rehab control.

## **The benefits and value to the potential users**

Benefits for patients - remote and virtual speech and language therapy (SLT), lower price, rehab wherever you go, motivation by instant feedback, weekly progress overview, faster return to social & work life.

Benefits for specialists (hospitals, clinics, sanatoriums and private logotherapists) - remote and unlimited SLT, equipment for patients, reduces SLT workload, additional motivation from progress stats, involvement of other rehab specialists, unlimited number of patients.



## Authors:

Ričardas Kundelis,  
Kajus Merkevičius,  
Kristupas Skarulis

**TRL 2** – technology  
concept formulated

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### Short description of the work

Intracardiac electrophysiological procedures are the gold standard for accurate diagnostics and treatment of complex heart rhythm and conduction abnormalities. Such interventions are carried out by inserting catheters into the blood vessels and placing them in core locations within the heart using fluoroscopy (real-time radiological imaging) control. Depending on the inserted equipment it can either record the electrical processes within the heart (represented by the intracardiac electrograms on a computer screen) or can be used to manipulate specific pathological regions if the need arises. Recent advances in prior 3D cardiac chamber reconstruction techniques using computer tomography imaging have made catheter navigation and ablation easier. We propose a concept of an artificial neural network - based assistance tool to make these procedures even more effective. This human - artificial intelligence co-operation tool assists by analyzing intracardiac electrograms according to pathology-specific criteria and provides a possibility to detect the arrhythmia-causing region earlier than with electrophysiologists' eyes alone. Moreover, periprocedural intracardiac electrogram analysis could provide the possibility to calculate exact distances to electropathological loci

allowing more accurate procedures as well. As a result of the technology, physicians will receive less radiation exposure from obtaining fluoroscopic images each intervention due to shorter operating time and lower rates of repeated procedures.

### **Novelty of the work**

Real-time abnormal electroanatomic substrate detection and quantitative distance calculation achieved by applying artificial neural networks. According to our research, there is no such product in the market.

### **Technical or other problems that are solved with the work**

- High radiation exposure during electrophysiological studies / procedures;
- Higher pathological region detection and treatment accuracy in difficult arrhythmia cases.

### **The benefits and value to the potential users**

1. Physicians receive less radioactive exposure per procedure;
2. Increased performance accuracy;
3. Less post-procedural complications and repeated interventions.



# Information Technologies

# Household Recyclable Waste Sorting System

Kaunas University  
of Technology

**Authors:**  
Ovidijus Grigas

**TRL 3** – experimental  
proof of concept

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## Short description of the work

Rapid growth of human population develops numerous problems such as enormous amounts of waste, overfilled landfills, contaminated rivers, oceans. Humans leave trash footprints around the globe. We, society, should be responsible and together contribute to the waste management, which has one of the most efficient method – recycling. Recycling industry every year loses many valuable resources, because people are careless, lazy, busy or have lack of knowledge of sorting and often throw all of the trash to one trash bin, that is why part of the waste which could be recycled, end up in landfills. Household Recyclable Waste Sorting System suggests a solution – automatic recyclables sorting system, which would make sorting in households exciting, accessible and simple. Device of the system makes use of artificial intelligence to sort and distribute trash into different waste categories: paper and cardboard, metal, glass, plastic. Information system, which is adapted to devices, provides an opportunity for the user to monitor associated trash bins containers fill

amount in real time, review inferences and collected statistics. Prototype of the system device provides sorting accuracy of 90 percent and the information system fulfils the purpose of the idea.

### **Novelty of the work**

Artificial intelligence is used to sort trash.

### **Technical or other problems that are solved with the work**

Reducing waste, preventing inefficient sorting of trash, saving resources for recycling industry.

### **The benefits and value to the potential users**

Potential users, households, who want to participate in recycling do not need to worry about if he/she does not know exact category of trash which is being thrown away. That also solves the problem, if users are too lazy or does not have enough time to recycle.

## Full identity verification service

### Authors:

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Viktorija Bielskaitė

**TRL 9** – actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies; or in space)

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### Short description of the work

Automated identity verification. Regulation-compliant & enforced with manual oversight.

### Novelty of the work

iDenfy is your reliable partner in swift, secure customer onboarding and fraud detection. We help businesses fight fraud, process customer's data quickly and securely, and improve user experience using the latest AI & biometric technologies.

## Technical or other problems that are solved with the work

Using “iDenfy” within seconds customers can be remotely verified anytime, anywhere.

ID Document Verification.

Automatic ID document detection recognises documents by type and country. 1300+ documents from 200+ countries supported. Our solution extracts identity information in 0.02 seconds, runs a series of technical checks to detect fraud or inconsistencies, and verifies if all information is correct.

Facial recognition.

We use machine learning and biometric data to scan faces, run in-depth analysis, and verify ID photos automatically. After 5 million different face tests, our AI has a 98.4% success rate. Detects spoofing, montage, and other fraud in less than 0.5 seconds.

3D Liveness detection.

Our patented 3D liveness detection and anti-spoofing technology allows your verification volumes to scale without being compromised by fraud. Detects the use of digital images, 2D pictures, high and low-resolution videos, deep fakes, paper, Hollywood and silicone masks, sleeping or closed eyes, wax figures and real-life dolls, animations, and even 3D-manufactured projections or heads.

Anti-money laundering compliance.

We provide the regulatory requirements to meet AML compliance and prevent the use of illegally obtained income on your platform. Our platform automatically checks Interpol, government, lost document, and politically exposed persons databases to ensure that a user is trusted. Allows further compliance officer inspection.

## The benefits and value to the potential users

- Meet Regulatory Compliance with ID verification. Comply with regulations and directives affecting your business. Meet Know Your Customer (KYC) and Anti Money Laundering (AML) requirements. Prevent Fraud. Secure your systems.
- Verify customer IDs with our AI-powered biometric recognition service. Ensure quality verification with our team who manually reviews every audit.
- Save up to 40% of user onboarding costs. Increase the volume of quality customers by preventing fraudulent accounts. users are too lazy or does not have enough time to recycle.



# “Lithuanian Wars of Independence 1919-1920”

Vytautas The Great War  
Museum and Kaunas  
University of Technology

## Interactive educational game

### Authors:

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Tomas Valatkevičius,  
Vadimas Kožuchovskis

**TRL 7** – system prototype demonstration in operational environment

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### Short description of the work

Lithuanian Wars of Independence 1919-1920” is an interactive educational game which presents three wars in which Lithuania defended its independence at the end of World War I. Lithuania fought against the Bolshevik forces (December 1918 – August 1919), Bermontians (June 1919 – December 1919), and Poland (August 1920 – November 1920). The main goal of this game is to educate people and present Lithuania’s history and heritage interestingly and interactively. Players can flip through the encyclopedia and read about the most important battles, personalities, and military equipment used during the Lithuanian Wars of Independence. Also, there is a timeline in the game that allows the player to see the most relevant

events on the map. The player can visit the military equipment park and view 3D models of military vehicles from desired angles. The most important part of this interactive application is a turn-based war game with different scenarios based on real historical events and facts. Each game scenario is preceded by a video that provides additional information for the player and context.

The current version of the game is available at the Vytautas The Great War Museum. When the game is fully developed, we plan to publish it on Google Play and Apple Store.

### **Novelty of the work**

The novelty of this work is the gamification of the learning process. By creating interactive historical games, we apply this educational approach to learn history.

### **Technical or other problems that are solved with the work**

Interactive educational game "Lithuanian Wars of Independence 1919-1920" lets people learn Lithuanian history in an attractive and modern way. Game-based learning maximizes enjoyment and engagement through capturing the interest of learners and motivates them to continue learning. With the help of such games and technologies, we can do it interestingly, involving not only the audience visiting the museum but also Lithuanians or foreign guests interested in our past.

### **The benefits and value to the potential users**

This educational game provides knowledge about the Lithuanian Wars of Independence in 1919-1920. It makes the learning process more exciting and stimulates interest in Lithuanian history.

# Falling Through Clouds

## Authors:

Karolis Butkus,  
Aidas Mazaliauskas

**TRL 7** – system prototype demonstration in operational environment

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## Short description of the work

Falling Through Clouds is a puzzle video game that is in constant development. Game creation started in Global Game Jam 2020 in early February and is specifically created for mobile and personal computer platforms. The game is designed to be enjoyable for youngsters as well as elders. The aim of the game is to complete all levels in the fastest time possible. The time in which the level is completed decides the number of crowns (level completion metric) the player gets. The player controls chess-inspired characters with unique abilities and moves different types of blocks to pave his way to the crown (level's end). At the moment game consists of over 30 different levels, with two characters (pawn and rook) and is published in Google Play for beta testing. In the future game is planned to have a significantly larger variety of chess characters, block types, interesting mechanics, and a story mode. It is planned to realize game through mobile apps e-store Google Play and computer games e-store Steam.

## **Novelty of the work**

Game gives old traditional chess board game new puzzle style body and moves away from the traditional 2 player long and static game-play to more dynamic and singleplayer-based mechanics.

## **Technical or other problems that are solved with the work**

Provides a more beneficial and more intellectual alternative compared to traditional action-based video games.

## **The benefits and value to the potential users**

Develops player's strategic planning, teaches to evaluate different alternatives. Is enjoyable even in the shortest time spans. Provides sense of achievement which results in a better mood.

## play any song you want on the guitar

### Authors:

Simonas Bansevičius,  
Laurynas Varnas,  
Julius Armalis

**TRL 3** – experimental  
proof of concept

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### Short description of the work

PhotoTabs is a mobile app that converts traditional notes to guitar musical notes, or so-called „tabs“, that are easier to read and understand than simple notes.

The usage is simple - you take a photo of traditional notes and it is converted to guitar tabs simultaneously. You could even say that it works like „Google translator“ just for music.

Since all songs, except some guitar songs, are written in traditional notation, our app helps beginners and amateur guitarists to be able to learn any song that they want way easier by converting it to tabs. And it doesn't matter if it's original is written for violin, piano, flute, or any other instrument.

## **Novelty of the work**

This idea is better than already existing solutions because other programs do not have an automatic translation from musical sheets or are very expensive and are mainly made for the experts. Why don't they do what we do then? Because machine learning and AI have gotten considerably more advanced in the past few years, whereas our competitors have established themselves when AI was not so reachable. That is why we have an advantage and great timing.

## **Technical or other problems that are solved with the work**

Most guitarists can only play from guitar tabs but not all songs have guitar 'tabs' versions and converting traditional notes to 'tabs' by yourself is not possible without musical education and even with it, it is quite a tedious work. Our program's machine-learning based algorithm does it for you so you can not only save time but also play any song you want on the guitar.

## **The benefits and value to the potential users**

We are making an app that converts classical sheet music to guitar tablature which makes learning new songs faster and easier for guitarists.

# Sandbox model for interactive learning

Kaunas University  
of Technology

## Authors:

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Eligijus Kiudys,  
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Miglė Zdanavičiūtė

**TRL 3** – experimental  
proof of concept

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## Short description of the work

The main problem regarding modern distance learning tools is that they are designed to provide the material in text, image, audio, or video formats. Sometimes this is not enough in order to learn subjects that require practice or physical work. To solve this issue, we have created and implemented a sandbox model for interactive learning - this means that students have complete freedom to interact with almost every object in the scene and solve problems however they want. To make the experience even more immersive and entertaining, we have invented the futuristic machine that allows us to convert objects into atoms. By using the correct combinations of atoms the students are able to create real molecules, which are then turned into specific items that are required to pass the game.

To make the atom converting progress simpler, we have implemented a scanner that recognizes the chemical elements and provides descriptions. Additionally, we have implemented a system that changes the surrounding world depending on the tasks the player has completed.

Solution targets Educational institutions, Training centers, Gaming market.

### **Novelty of the work**

Interactive learning of various subjects in Virtual Reality.

### **Technical or other problems that are solved with the work**

Allows students to acquire practice and physical work experience without leaving their own houses. Also, most of the current distance learning tools provide only text, video, or audio footage, which lacks the main practice element - interactivity.

### **The benefits and value to the potential users**

Interactive distance learning. Students can see and touch larger scale atoms and molecules, which makes the learning progress more interactive and immersive. This helps to achieve better learning results quicker and easier.



# A Novel Procedural Noise Generation Algorithm

Kaunas University  
of Technology

## Authors:

Arnoldas Rauba

**TRL 3** – experimental  
proof of concept

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## Short description of the work

Procedural noise is essential in Computer Graphics (CG) and other fields. The appearance of the first procedural noise developed by Ken Perlin in 1985 introduced new fields of science, such as Procedural Content Generation and Procedural Texture Synthesis, which offered Computer graphics experts a sophisticated and lightweight solution in terms of computation and memory consumption, in contrast to creating textures and content manually.

Due to the evolution in Computer Graphics, there has been an increasing demand for the simple and efficient alternatives. We therefore propose a novel approach to generating fast, infinite, multidimensional and pleasantly parallelizable procedural noise, and showcase the uses for it. We analyze how to improve the algorithmic complexity for specific use cases. We also utilize the hardware (Graphics Processing Unit) to achieve real-time evaluation using NVIDIA CUDA development kit.

Procedural generation can be applied in Computer Graphics, game development, and for other purposes.

### **Novelty of the work**

A new algorithm for generating procedural noise.

### **Technical or other problems that are solved with the work**

When choosing a procedural noise, multiple parameters are taken in consideration:

- Evaluation speed
- Ability to parallelize
- Memory usage
- Ability of infinite generation
- Ability of multidimensional generation
- Uniform spectral distribution in all directions
- Parametric control over the noise
- Being simple to program on all languages

Our noise algorithm is designed to overcome these restrictions. In addition, our noise also allows to “save” the noise parameters into ~8 KB file for portability.

### **The benefits and value to the potential users**

Developers in the field of Computer Graphics developers would have an opportunity to use a fast and efficient texture generation tool that empowers both CPU and GPU.

# “COVID-19 Pandemic” Logic Game

Kaunas University  
of Technology,  
NoStupidGames

**Authors:**  
Augustas Čepas

**TRL 6** – technology demonstrated in relevant environment (industrially relevant)

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## Short description of the work

“COVID-19 Pandemic” Logic Game is a local multiplayer educational game designed for a high school students’ learning material gamification, teaching about the viruses, hygiene, and its importance, developing critical thinking and other soft-skills to achieve players’ common goal. The gameplay currently includes higher class mathematics, physics, and informatics assignments, however, can be easily adapted to different training or classes.

The project developed as a bachelor’s degree final project at KTU Faculty of Informatics with a purpose for teachers to facilitate the learning process using the game as additional learning material or for meaningful extracurricular activity. Also, the project does not require special training, therefore, can be used by the students at home. The game is made with Unity, therefore, can be easily adapted to work with most of the devices and operating systems. It is current-

ly publicly launched as a demonstration version and accessible to everyone to download and play, however, two or more players are necessary to play at the time.

### **Novelty of the work**

Gamification of the high school students' learning material to achieve better results in attracting students' interest and education efficiency.

### **Technical or other problems that are solved with the work**

In reality, it is sometimes difficult for students to take an interest in the learning material. This creates a problem for students, teachers, and schools.

### **The benefits and value to the potential users**

It is easier for teachers to engage students in learning materials. Students understand, learn, and remember the material taught better. Gamification process let's forget that you are learning but achieve the set result.

## Short time precipitation prediction in Lithuania

### Authors:

Aivaras Čiurlionis,  
Mantas Lukoševičius

**TRL 6** – technology demon-  
strated in relevant environment  
(industrially relevant)

### Short description of the work

Although the power of supercomputers is constantly increasing, the traditional analytical approaches to weather forecasting are still not considered to be accurate by the general public. In addition to this, the duration of a single forecast computation sometimes can take up to 2 hours. This means that weather prediction models sometimes fail to react to rapid and dangerous changes in weather conditions, which may result in the destruction of material possessions or potentially cost human lives.

Kadalīs.lt uses machine learning approaches to predict the movement of precipitation from the sequence of observed Doppler precipitation radar images. More than 70 000 different weather radar images were obtained for the training, validation, and testing of the created algorithms. During the validation and experiments, all of the created algorithms have surpassed the accuracy of a simple persistence model. Results of the 3 best algorithms can be viewed interactively, new forecasts are generated every 15 minutes. Website also allows users to view a large database of historical predictions with an ability to evaluate their accuracy when comparing them to actual conditions that were observed at that time.

### Novelty of the work

This is the first precipitation Nowcasting (precise very short-term

forecast) solution in Lithuania; Lithuanian Hydro-Meteorology service does not provide such data (based on publicly available information).

Novel machine learning approaches have been used on a problem that was usually solved using conventional numerical weather prediction methods.

Machine learning algorithms used in the precipitation prediction are very fast compared to the traditional approaches. Predictions can be ran in a matter of seconds, which makes it is possible to react to rapidly changing weather events like sudden storms or potential flooding.

Unlike most other weather prediction services, kadalis.lt allows users to see the accuracy of historical precipitation predictions.

### **Technical or other problems that are solved with the work**

Traditional weather prediction is computationally complex problem that requires a lot of resources and time.

### **The benefits and value to the potential users**

Meteorology scientists can potentially gain insights about precipitation dynamics while exploring historical prediction data, and viewing how different prediction algorithms extrapolated the movement of precipitation.

A solution can be helpful to everyone that wants to know if it will rain in the next couple of hours: whether you are an event planner, or just want to know when is the best time to leave your home so you will not get wet.



# Chemical Technologies

# Nanocellulose & Bionanoplastics Manufacturer for Food and Beverage

Kaunas University  
of Technology,  
Severo Ochoa  
Molecular Biology  
Center

## Authors:

Liucija Urbelytė,  
Lina Jatautė,  
Eglė Narmontaitė,  
Gabrielė Šiupšinskaitė,  
Sergio Assenov,  
Ilona Jonuškienė

**TRL 3** – experimental  
proof of concept

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## Short description of the work

The idea of this project is to create eco-friendly, sustainable, and compatible additive for plastics and bioplastics using pine cones waste as a raw material. Product developed is nanocrystalline cellulose extracted from pine cones through an economic manufacturing process.

The main part is production which consists of two stages: the first stage - extraction of cellulose of the pine cones and the second stage - isolation of nanocrystals. Organic waste or biomass cell wall struc-



ture mainly consists of three kinds of polymers: lignin, cellulose, and hemicellulose, therefore, cellulose fibers have to be isolated from the raw material using industrial chemical processes. Isolated cellulose fibers consist of cellulose chains and these ones – of amorphous and crystalline regions. The main focus is on the crystalline region and this is our nanocrystalline cellulose which has to be extracted with the solid acid under controlled conditions, keeping the crystalline region intact.

The final product, nanocrystalline cellulose, may be applicable in Plastic Packaging Industry for Food and Beverage Manufacturers and has specific physical and biological properties: biodegradability, biocompatibility, sustainability, gas barrier properties, lightweight, high elasticity, strengthen, no toxicity. Plastic Packaging Industry for Food and Beverage Manufacturers has a value of 37 billion euros and uses 26 million tons of plastic in Europe.

The key competitive advantages are Intellectual Property Rights and Economies of Scales. Our goal is to turn to 1st in Europe and the largest manufacturer worldwide. Exclusive Long-term Agreement with Spanish association of Pine nut producers, and location – Catilla y Leon area for manufacturing plant for more economical and faster production close to our potential partners.

The aim is to work on the black chocolate, enriched with the leftovers from squeezed out raspberries, and insert the recommended daily rate of vitamin D.

### **Novelty of the work**

Product is a bio-nanomaterial extracted from pine cones waste.

## **Technical or other problems that are solved with the work**

Project solves plastic pollution and food waste problems by increasing biodegradability of plastic and increasing the shelf-life of food and beverage because of the packaging properties improvement by our product.

## **The benefits and value to the potential users**

Solves plastic pollution and food waste problems by increasing biodegradability of plastic and increasing the shelf-life of food and beverage because of the packaging properties improvement.

# “BITES”

## Energetic freeze-dried snacks

Kaunas University  
of Technology and  
UAB “Geld Baltic”

### Authors:

Aušrinė Žiūkaitė,  
Jonas Damašius,  
Laura Kaziukonienė

**TRL 7** – system prototype demonstration in operational environment

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### Short description of the work

Due to increased population the need of developing functional and energetic foods have emerged. Busy working people are searching for fast and natural ways to energize during working day, so the market of energetic drinks and snacks have rapidly increased. However, there are not so many options for natural energetic products. For this reason, new energetic freeze-dried snack “BITES” with dates and coffee was developed. This snack contains natural freeze-dried sweetener dates with natural caffeine from freeze-dried coffee (100 % arabica), cacao butter and pea protein isolate. The snack is energetic because it is high in hydrocarbohydrates from freeze-dried dates and caffeine from freeze-dried coffee. Freeze-drying technology preserves biological properties of dates and coffee which makes this snack rich in biologically active compounds. All ingredients are plant-based, so this snack is suitable for vegetarians and vegans. Moreover, energetic snack “BITES” is produced in small and light cube shapes

(1 cm<sup>3</sup>) which makes it even more attractive to consumers. The prototype of snacks is completed, qualified and ready for market.

### **Novelty of the work**

Freeze-dried date powder makes the product exceptional from other similar date-based products. Because of the dry date mass the shelf-life of snack is prolonged and this snack could be exported to various countries in the world. Also, the snack contains hydrocarbohydrates from freeze-dried dates and caffeine from freeze-dried coffee which makes it energetic.

### **Technical or other problems that are solved with the work**

Prolonging the shelf-life of natural functional snack.

### **The benefits and value to the potential users**

Dates are known as natural sweetener and contains various natural minerals such as potassium, manganese, magnesium and etc. It is high in natural carbohydrates which have high energy value. All ingredients of energetic freeze-dried snacks "BITES" are suitable for vegetarians and vegans.

# Nanofibrous airborne particle sampling membrane

Kaunas University  
of Technology

## Authors:

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Tadas Prasauskas,  
Edvinas Krugly,  
Darius Čiužas,  
Dainius Martuzevičius

**TRL 3** – experimental  
proof of concept

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## Short description of the work

Fine fraction of ambient aerosol particles has detrimental effects on human health as demonstrated by multiple studies. However, a clear understanding about what actually causes these effects to human health is still missing. Particle number, mass, size, shape, surface area, chemical composition (organic and inorganic) have been indicated among factors having the effects on human health. Thus highly efficient and customized sampling substrates allowing subsequent analyses provide important prerequisites for such studies.

We aim to research the potential of electrospun nanofibrous membranes to be used as particle sampling membranes. Although multiple sampling substrates have been researched in the past and many have been established as an industry standard for various applications (such as quartz, Teflon, Nylon etc.), the current progress in nanofiber applications allow researching a wide variety of polymers to be ap-

plied as particle collection substrates, balancing pressure drop and collection efficiency. Furthermore, additive manufacturing allows designing custom shape filters that may be applied in variety of samplers. We present design, fabrication and testing of membranes electrospun from cellulose acetate, polyamide 6/6, and polydimethylsiloxane. Collection efficiencies comparable to commercial collection membranes have been achieved, at the same time indicating lower pressure drops, which minimizes the load and extends the service of sampling equipment.

### **Novelty of the work**

The presented technology allows:

- Providing novel substrates for particulate matter research at cellular and molecular levels.
- Balancing pressure drop and collection efficiency to minimize energy use and equipment wear during sampling.
- Shape and material customisation for filters.

### **Technical or other problems that are solved with the work**

Researching wide variety of polymers to be applied as substrate for particle collection thus balancing efficiency of collection and pressure drop. Furthermore, custom shaped filters that may be used in variety of samplers using additive manufacturing.

### **The benefits and value to the potential users**

Customized shaped filters using additive manufacturing results can be used in variety of samplers. Wide variety of polymers were researched to be used as substrates for particle collection, pressure drop balancing including collection efficiency that serves potential users.

# Bio-based resins for optical 3D printing

Kaunas University  
of Technology and  
SC Ameralabs

## Authors:

Miglė Lebedevaitė,  
Vaidas Talačka,  
Jolita Ostrauskaitė

**TRL 7** – system prototype demonstration in operational environment

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## Short description of the work

The idea of this work was to replace petroleum-based substances by materials derived from renewable sources in photocurable resins for optical 3D printing.

In recent years, optical 3D printing emerged as a flexible additive manufacturing technique where photosensitive resin is polymerized layer by layer using UV/VIS irradiation. Up to now commercial photosensitive resins for optical 3D printing are composed from petroleum-based materials. Natural oils are one of the best bio-based alternatives for petroleum-derived materials due to their biodegradability, renewability and richness in double carbon bonds which can be polymerized or converted to other functional groups.

Acrylated epoxidized soybean oil (AESO) is used commercially in various plastics formulations, although its usage in optical 3D printing has not been commercialized yet. In this work, a bio-based resin composed of AESO and bio-based reactive diluents was designed

and successfully applied in optical 3D printing using digital light processing machine. The designed AESO-based resin was tested by SC Ameralabs and validated to be suitable for industrial applications. Also, 3D printed products of bio-based resin were proved to be biodegradable showing their huge advantage in easier waste management.

Developed bio-based resin can be used in dentistry facilitating the management of treating plan where 3D dental models are needed, also, in companies producing complex plastics parts and single disposable products, and in prototyping companies.

### **Novelty of the work**

The plant-derived resin was used in table-top optical 3D printing for the first time.

### **Technical or other problems that are solved with the work**

This work solves environmental and economic issues, due to the plant-derived resin low toxicity and high biodegradability, improved recovery and recycling options, less dependency on limited and increasingly expensive fossil resources. Additionally, soybean is one of the most abundant cultural plant in the world and acrylated epoxidized soybean oil along with other bio-based reactive diluents are commercially available.

### **The benefits and value to the potential users**

3D printing technologies could be used for production of novel sustainable polymeric materials from commercially available bio-based materials by combination of green chemistry and green engineering concepts. Also, 3D printed parts would be biodegradable and the waste management after the usage will be easier.



# 2PACz – materials for efficient solar cells

Kaunas University  
of Technology

## Authors:

Artiom Magomedov,  
Ernestas Kasparavičius

**TRL 9** – actual system proven in operational environment (competitive manufacturing in the case of key enabling technologies; or in space)

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## Short description of the work

The use of solar energy for electricity generation is an integral part of human development. It is expected that in the coming decades more energy will be produced from the sun, than from fossil fuels. The most popular silicon-based solar cells have almost reached the practical efficiency limit, therefore novel concepts need to be applied in the industry. One of the ways to overcome the limitations – construction of the tandems. When two solar cells are placed on top of each other, each of them efficiently works in the respected part of the solar spectra (top cell – blue part; bottom cell – red part). This could theoretically almost double amount of the produced electricity. The aim is, by adding several technological steps, to deposit a

perovskite solar cell on top of the Si solar cells. This would enable to use existing production capacities for fast technology transfer. In this case, one of the most important issues is the formation of the layer, interconnecting these two different technologies.

To solve this problem we have created new organic materials, under the general name 2PACz. These are the materials, that can form layers with the thickness of the single-molecule (monolayers) on the surfaces of different oxides, and provide selectivity for holes (charge carriers).

Several exceptional features: possibility to deposit films on rough surfaces (makes it compatible with the textured Si solar cells); very low material consumption (due to layer thickness  $< 1$  nm); simple process optimization for mass production.

With these materials, researchers at Helmholtz Zentrum Berlin have constructed a record-breaking 29.2% efficient Si/perovskite tandem solar cell, and this result is expected to be further improved in the near future.

### **Novelty of the work**

A conceptually new method of the hole-selective layer formation has been developed and the advantages of the concept over existing analogs have been demonstrated. Instead of traditional organic semiconductors, from which layers with a thickness of  $\sim 10$ -300 nm are formed, we have developed materials capable of forming a monolayer ( $< 1$  nm). Despite such a small thickness, these materials ensure good hole selectivity, which has been demonstrated by the construction of the record-breaking solar cells.

### **Technical or other problems that are solved with the work**

Currently used organic hole-transporting materials are very expen-

sive, which hampers the commercialization of perovskite solar cells and related technologies (e.g., tandems). An example is the PTAA polymer. The film with a thickness of 10 nm will increase the cost of a solar cell by 20 EUR/m<sup>2</sup>. Given that about 90% of the material is wasted during spin-coating, the cost of one layer may exceed the cost of all other components. Our materials are formed in a much simpler way, their commercial price is 5 times lower, and the layer thickness is less than 1 nm. Overall, this reduces the cost of this layer down to <0.5 EUR/m<sup>2</sup> without reducing the efficiency of the device.

### **The benefits and value to the potential users**

The use of 2PACz materials will reduce the cost of research and development and accelerate the market penetration of perovskite solar cells, increasing the competitiveness of the product.



# **Economy, Social and Humanities**

# Social media artificial intelligence tool

Kaunas University  
of Technology

## Authors:

Eglė Vaičiukynaitė,  
Ineta Žičkutė,  
Justas Šalkevičius,  
Viktorija Varaniūtė

**TRL 3** – experimental  
proof of concept

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## Short description of the work

Given the changes in customer behaviour resulting from information and communication technologies, it is appropriate to seek a deeper and broader understanding of the characteristics of company posts, its links to customer engagement behaviour on Facebook, and business performance (e.g., sales growth, loyalty). In addition, optimizing social media for effective company campaigns is an integral part of a company's daily routine. Despite the fact that companies collect various data on customer behaviour on social media platforms, traditional analytical methods used by companies do not allow for complex processing and forecasting of customer behaviour and improvement of company's performance. This can be achieved through Social media Artificial Intelligence (AI) solutions that enable companies to manage the effectiveness of social media campaign results,

which can ensure their competitiveness in the marketplace. Therefore, social media AI tool empowers companies to predict customer engagement behaviour (CEB) on social media platforms and design posts for engagement success. Finally, this tool can satisfy different goals of diverse companies in terms of size and industries.

*\*Acknowledgement. This research was supported by the Research and Innovation Fund of Kaunas University of Technology (grant No. PP59/2012).*

### **Novelty of the work**

The current digital social media tools used by companies rely on descriptive statistics measures provided by social media vendors (i.e., Facebook) or third-party companies (e.g., Social Bakers). Most of these platforms enable companies to understand their audience and track a limited number of metrics of CEBs (i.e., likes, comments). While the most important metrics including characteristics of the company's posts and predictive analysis of both measures CEBs and the results of the company's social media campaign are not provided yet. There are only these solutions for today for companies.

### **Technical or other problems that are solved with the work**

Visual content is fundamental for companies to understand what kind of features of company posts drive customer engagement behaviour on social media platforms, like Facebook. Usually, social media managers make decisions on social media post strategy based on intuition or descriptive tools provided by various companies such as Google Analytics, FanPage Karma, social media vendors (e.g., Facebook, Instagram). The full picture how to craft companies' posts on Facebook for engagement success remains unsolved. However, there is a need to have a social media AI tool that enables to predict customer engagement behaviours based on diverse features of compa-

nies' posts (e.g., content of post, media type, emoticons and emoji).

### **The benefits and value to the potential users**

The potential users include social media managers of diverse companies in terms of size and industries. Social media AI tool enables companies: to develop their own social media strategy very quickly, save time and costs; to enhance social media marketing performance; to revolutionize the way how companies create posts for social media platforms and reduce customer acquisition costs. Moreover, the potential users encompass educational institutions, where social media AI tool enables students to learn how to craft social media posts for customer engagement success and gain practical skills.



# **Material Science and Mechanics**



# Biodegradable plant based plastic packaging in the modern industry

Kaunas University  
of Technology

## Authors:

Lina Stabingytė,  
Laura Gegeckienė

**TRL 3** – experimental  
proof of concept

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## Short description of the work

The plastics are one of the most universal materials: it is lightweight, inexpensive, has an unlimited choice of colors and thickness. However, while the cost, mechanical properties, and a wide range of uses of the currently widely used plastic are advantages, the recycling of it is a major concern. Growing concern about plastic waste all around the planet raises the need for alternative research. Plant-based biodegradable plastic could be an appropriate option for packaging production considering its mechanical properties.

In this work, new composites were developed theoretically and practically for the production of flexible packaging from starch (potatoes, corn, and others). Such packaging is able to decompose quickly and is environmentally friendly. The aim is to produce a packaging film

that is equal to traditional types of packaging in terms of mechanical properties. Various plasticizers are used for this purpose. The aim of this work is to create a composite that could have real use in a sustainable industry. This type of film could be used for food and non-food packaging, as wrapping film or bag.

### **Novelty of the work**

Currently plant-based plastic has become an increasingly popular research direction. It is usually produced from materials such as biopolymer – lignin, a polysaccharide – cellulose, a polysaccharide – starch, and bioethanol. Degradable plastic is a plastic that retains its specific mechanical properties as long as it is present in the product and then biodegrades in nature under natural conditions. The decomposition of plant-based plastics takes place by naturally occurring microbes (bacteria, fungi, algae) decomposing the plastic into CO<sub>2</sub>, H<sub>2</sub>O, CH<sub>4</sub>, and biomass. These substances integrate into the natural ecosystem without harmful effects on the environment and without hazardous soil pollution and remain part of the carbon cycle. The increased usage of biodegradable plastics in the future depends on technological development at the moment. Due to the instability of biodegradable plastics, blends with plasticizers or stabilizers are used to provide strength.

### **Technical or other problems that are solved with the work**

The negative effects of plastics usage are becoming clearly dangerous in nowadays society and environment. It makes a huge harm to the landscape, animals, and humans. Especially those plastics whose mechanical-physical properties are designed to be as strong, durable, resistant to many environmental factors are the most bigger problem these days. The production of plastic packaging is the most problematic branch of environmental pollution, as packaging is usually destined for a single short-use, after which it is thrown away.

The solution developed would contribute to the reduction of world-wide plastic pollution.

### **The benefits and value to the potential users**

Plastic manufacturing, packaging manufacturing (for food and non-food products) industries would benefit from cleaner production using product of natural origin, society would benefit from sustainable usage of packaging, lower land pollution, responsibility for consumerism would be increased.

# Virtual Reality Racing Simulators

MB "Virtuali Trasa"

## Authors:

Paulius Paražinskas,  
Jonas Paulauskas

## TRL 8 – system

complete and qualified

### Short description of the work

We are here to provide users – those motorsport fans and car-lovers with the thrill of racing, which is something that very few actually get to experience in real life. By presenting the state of art simulation technology installed to real racing cars we make virtual racing as realistic as real world racing.

Market size is estimated to be around 270M in Europe and 1.6B globally. We plan that our SOM in Europe will be around 1.5 - 2.3 percent and then we plan to expand to US swiftly. US has the biggest market which is estimated to be at 0.9B.

### Novelty of the work

The simulation equipment is installed in a full scale racing car. The racing car body will be attached to a motion platform. Lamborghini Huracan Super Trofeo or any other popular GT, Rally or Formula car will be used as body. In some near future we are planning to devel-

op “Nascar“ body to be able to enter US market. And some day to develop bodies of “Gran Turismo” prototype cars that will allow us to reach millions of “Gran Turismo” users.

### **Technical or other problems that are solved with the work**

There are millions of speed lovers, the die-hard motorsport fans around the world who dream to drive fastest cars on Earth. Deep inside, all those petrol-heads secretly wish they could be race car drivers. Unfortunately, there are serious reasons they are not doing racing for real:

1. there is no secret it is not a safe sport. That is why most people prefer just to watch it;
2. it is insanely expensive. Just 1 single racing weekend costs around 50 000 Eur in a decent racing series. Top racing series cost 200 – 500 000 Eur per weekend with exclusion of Formula 1, Nascar, Indy-car and WRC – they cost even much more than this.

### **The benefits and value to the potential users**

The customers can finely experience the true thrill and joy of racing without spending a fortune and doing it in a safe environment for them and people around. We engineer realism so that we trick your brain in to believing that you are actually on a race track.

# Manufacturing of Continuous Carbon Fibers Reinforced Polymer Composites for Structural Applications

## Authors:

Tomas Kuncius,  
Nabeel Maqsood

**TRL 5** – technology  
validated in relevant  
environment  
(industrially relevant)

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## Short description of the work

The emerging field of 3D printing of continuous carbon fiber reinforced polymers (CCFRPs) offers unparalleled advantages in design flexibility, possibility to produce high complexity parts, reduction of product waste and shorten the design manufacturing cycle. On the other hand, the demand of CCFRPs material is constantly increasing

because of their good mechanical properties and suitability for aerospace, automotive and marine, industries, unattainable by traditional manufacturing methods. CCFRPC are now becoming substitute materials to replace the conventional metals due to their excellent mechanical properties, recycling capability and potential to use as lightweight structures. The aim of our research work is to develop the 3D printing technology for production of lightweight composite structures that becomes an alternative material to replace the conventional thermosetting polymers composites and metals. To achieve this goal, continuous carbon fiber impregnation technology and equipment was created. Carbon fiber must be impregnated before printing to increase adhesion and printability. Custom printing head which is fully capable to print CCF reinforced thermoplastic composites was designed and manufactured. Second generation printing head has unique two channels feeding system for fiber and filament and one standard output channel. Developed printing head and production process provide stable, fast and easy composite part manufacturing using FDM printing technology. Mechanical test results showed, that by adding continuous carbon fiber reinforcement to the thermoplastic matrix can increase tensile strength more than five times.

Developed technology can be used in various industries where prototyping and production of innovative products are necessary, for example parts for drones, quadcopters, robots from composites can be made. Moreover, this technology can change traditional manufacturing methods in key industry sectors like aerospace, automotive, wind generation.

### **Novelty of the work**

New developed, original 3D printing head and process for CCF reinforced polymer composites manufacturing.

## **Technical or other problems that are solved with the work**

CCF printing technology drastically improves product mechanical properties to produce strong, light and durable composite structures. Combination with additive technologies allow to print very complex geometrical forms and produce structures with optimal mass-stiffness ratio which are impossible to manufacture using traditional existing technologies.

## **The benefits and value to the potential users**

User will have full freedom to part design, complexity and properties, moreover strong, light and durable continuous carbon fiber reinforced composite structures can be produced easier with low cost and time consumptions. Production process allows to print composite structures without wastes, while printed parts can be easy recycled and reused.



# Medical equipment storage boxes with antimicrobial coating

Kaunas University  
of Technology

## Authors:

Nijolė Buškuvienė (dokt.),  
Virginija Jankauskaitė  
(prof.),  
Erika Adomavičiūtė (doc.)

**TRL 3** – experimental  
proof of concept

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## Short description of the work

Complex epidemiological situation, microbial contamination, and infection risks in hospital and dental equipment have led to an ever-growing need for prevention of microbial infection. A World Health Organization (WHO) report states that this serious threat is no longer a prediction, but is happening right now in every region of the world and can affect anyone, of any age, in any country. Prevention technologies are vital weapons in the battle against infection and antimicrobial packaging solution can enhance the infection prevention and control. For this purpose electrospun nonwoven antibacterial material was formed on the inner layer of medical equipment packaging. The combination of the thermoplastic polyvinylbutyral

and triclosan is characterized by good electrospun mesh structure, optical clarity, adhesion interaction to various surfaces, toughness and flexibility, with high antimicrobial activity against various pathogens. A suggested technology can be applied to various applications where antimicrobial properties is needed, for example, secondary food packaging, household goods and etc.

### **Novelty of the work**

A unique nonwoven nano-microfibers material with antimicrobial properties is coated on packing paper by electrospinning.

### **Technical or other problems that are solved with the work**

It can inhibit the growth of various pathogens during storage and transportation of medical equipment and medicines.

### **The benefits and value to the potential users**

Prevention of infection risks in hospital and dental equipment.

# LAR Technologies – Linear and rotational welding machines for laser welding

LAR Technologies

## Authors:

Naglis Ausmanas,  
Simonas Stonkus

**TRL 8** – system  
complete and qualified

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### Short description of the work

Our work consists of two separate parts: Linear welding machine for sheet metal laser welding and a Rotational welding machine for cylindrical laser welds. These machines are designed to be used in manufacturing applications. Specifically, where thin sheet metal welding is used.

Using automated machines such as ours for welding is highly desirable, because repeatable welds can be produced. When compared to manual welding, strength of welds is more consistent, visual appearance is improved, sheet metal warp is greatly reduced and burn-through eliminated. Since welding process is automated when using our welding machines risk of operator error is greatly reduced, improving yield and potential profits of the user.

Simple design of our machines means that they can be easily modified for specific applications of potential customers. In addition, they

are cheap to manufacture and very simple to operate compared to industrial grade welding machines, making our linear and rotational welding machines for laser welding very cost-efficient.

### **Novelty of the work**

Simple construction of our welding machines means that they are cheap to manufacture and very simple to operate compared to industrial grade welding machines. Construction is easily adaptable to specific applications of individual users/customers.

### **Technical or other problems that are solved with the work**

- Weak sheet metal welds
- Burn-through when welding
- Warped metal sheets when welded
- Inconsistent welds
- Visually unappealing weld lines
- Lots of wasted material, caused by high error rate

### **The benefits and value to the potential users**

- Increased quality of sheet metal welds by improving repeatability, consistency of welds.
- More reliable strength of welds, improved visual appearance and reduced sheet metal warp compared to manual welding.
- Reduced rate of operator errors.
- Even bigger improvement when welding thin sheets of metal.



# Natural Sciences and Mathematics

# Algy - air purifier that fights climate change

**Authors:**  
Simas Banyas

**TRL 2** – technology  
concept formulated

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## Short description of the work

Fully automated, consumer friendly micro-algae growing - air filtering aquarium is being created as air purifier that fights climate change. Excess CO<sub>2</sub> indoors, which is a result from bad air ven-tilation, is used to grow micro-algae biomass, therefore indoor micro-climate is improved, which leads to improved cognitive performance. HEAP filters removes dust and allergens, while UV light kills viruses and bacteria - a must solution in COVID-19 times.

Automated growing and harvesting technology allows to use such bio-reactor in traditional in-door spaces, taking advantage of naturally occurring CO<sub>2</sub> consumption from growing micro-algae.

The world needs more micro-algae biomass - as world is shifting to clean and sustainable solu-tions in many industries, there is increasing demand for bio-based products, but current solutions can't provide scalable and cheap solutions to meet those needs.

## **Novelty of the work**

Simple construction of our welding machines means that they are cheap to manufacture and very simple to operate compared to industrial grade welding machines. Construction is easily adaptable to specific applications of individual users/customers.

## **Technical or other problems that are solved with the work**

Fully automated, consumer friendly micro-algae growing - air filtering aquarium is being created as air purifier that fights climate change. Excess CO<sub>2</sub> indoors, which is a result from bad air ventilation, is used to grow micro-algae biomass, therefore indoor micro-climate is improved, which leads to improved cognitive performance. HEPA filters removes dust and allergens, while UV light kills viruses and bacteria - a must solution in COVID-19 times.

Automated growing and harvesting technology allows to use such bio-reactor in traditional in-door spaces, taking advantage of naturally occurring CO<sub>2</sub> consumption from growing micro-algae.

And world needs more micro-algae biomass - as world is shifting to clean and sustainable solutions in many industries, there is increasing demand for bio-based products, but current solutions can't provide scalable and cheap solutions to meet those needs.

## **The benefits and value to the potential users**

Sustainably produced biomass has very important role to play in the transition to a more circular and sustainable economy and will help deliver the ambitions of the European Green Deal. Micro-algae biomass has huge potential - micro-algae based product market is expected to reach 2.7 billion euros by 2030 from current 500 million. At the moment Europe consumes around half of worldwide micro-al-

gae supply, while produces only 1%. If we want to achieve goals of European Green Deal, this situation needs to change.

Currently, majority of micro-algae biomass is produced in open water ponds, where productivity is low and it is very hard to maintain high product quality. And it will become even harder - extreme climate condition, which are caused by Climate change, are impacting the ability to produce micro-algae in open water ponds.

Industry is slowly turning to bio-reactors - closed, fully controlled systems, that produce micro-algae. But such solution requires a lot more electricity and are not price competitive. Electricity cost can contribute to 50%-70% of micro-algae production costs in bio-reactors. Industry is actively looking for solutions how to lower micro-algae production costs, but at the moment there is no wide spread solution, that could enable effective transition to bio-based economy.



# Ultrasonic system for detection and localization of partial discharges

Kaunas University  
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**TRL 6** – technology demonstrated in relevant environment (industrially relevant)

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## Short description of the work

According to the EU study on electricity supply disruptions, in the period 2010–2014 up to 850 GWh of electricity annually have not been supplied to the consumers. The lost value from these disruptions is estimated to be up to 25 billion EUR per year to the commercial users. Lithuania's annual average of the power loss due to disruptions is 410 minutes for single user which significantly exceeds the average of all EU member states. The vast majority of these disruptions occur due to the problems in distribution grid which are mainly caused by failure related to partial discharge phenomenon (PD). PD is defined as localized breakdown of insulation under the stress of high voltage, which tend to develop over time and after a while leads to the false operation of the equipment. Here we present

non-invasive partial discharge detection and localization device that is designed to operate in open space and to assess dielectric conditions of connectors of air power lines and bushing insulators. The device has an optical camera which tracks the spatial position of the discharge induced acoustical noise by using sophisticated ultrasonic signal processing and deep learning methods. The device requires no physical connection to HV assets nor the mechanical steering to find the source of discharge, thus it can be used for permanent or temporal monitoring of discharge activity on-site. The proposed device can serve as a tool for detection of early stage anomalies in HV substations and can reduce the number of shut-downs and maintenance costs of HV assets, going from scheduled to condition based inspection.

### **Novelty of the work**

Proposed prototype has the following aspects of novelty:

- Uses multiple ultrasonic channels for discharge detection and localization.
- Does not require manual steering of the apparatus to find the source.
- Requires no physical connection to the HV assets, making an easy, non-invasive and cost-effective inspection without disturbance to the power network.
- Can be used for permanent or temporal monitoring of discharge activity with on-site deployment. Clustering of multiple systems in a client server architecture is possible.
- Incorporates sophisticated ultrasonic signal processing algorithms, machine learning and deep learning methods for autonomous discharge detection with increased reliability and accuracy.
- Does not require additional software or transformer models to obtain discharge source position.

## **Technical or other problems that are solved with the work**

Discharge induced acoustical noise is usually weak and difficult to detect in open air, where acoustic signals are strongly attenuated. Many other factors, like random surrounding noise can influence the accuracy of such inspection system. Our device uses sophisticated machine learning methods to distinguish between random noise and discharge induced signals by using a collection of predescribed signal features. Each feature has to be carefully selected and tested in order to achieve required classification accuracy. If the signal appears to be originated from a random source, it's no longer processed with the device. For the discharge induced signals, the type of discharge (discrete or continuous) is then determined using yet another machine learning models. The angular direction of the discharge source in open space is estimated using ultrasonic measurements from three different channels. Advanced signal processing algorithms are implemented that allow to precisely estimate the arrival time of each signal and to achieve lateral discharge source positioning error of 5cm if the source is located at 10m distance from the detection device. Once the angular positions are obtained, a pan-tilt servo manipulator steer the optical camera to the direction of the source. The image captured by the camera is further processed with deep learning methods to detect and mark suspicious HV assets. Both signal processing and artificial intelligence methods are integrated into a single device that can work autonomously and be a part of permanent discharge monitoring system.

## **The benefits and value to the potential users**

In contrast to existing discharge detection systems, the proposed solution has following benefits:

- Does not require manual steering of the device in order to detect discharge source position.
- Automatically detects discharge signals, classifies them, esti-

mates origin and type of the signal.

- Recognizes potential discharge source in optical image.
- Require no physical connection to the HV assets, making it non-invasive inspection without disturbance of power network.
- Can be used for permanent monitoring of discharge activity with on-site installation in high voltage substations.
- Can be connected to clusters in a client-server like architecture, with data transferring capabilities and event logging.

# Open Source Ionizing Radiation Measurement Systems

Kaunas University  
of Technology

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**TRL 3** – experimental  
proof of concept

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## Short description of the work

Radiometric and dosimetric ionizing radiation measurements are complicated in nature and requires relatively exotic equipment to perform. Open source solutions for these problems are scarce and most of time still require specialist tools and equipment to implement. Our team proposes two measurement methods designed for radiometric detection and 2D imaging of ionizing radiation fields. Being open source in nature these designed measurement systems (approaches) are to be an easy entry for professional and citizen scientists a like.

Radiometric measurement system employs surplus high voltage Geiger tubes for the interrogation of the physical world and IoT software stack to collect/process/transfer data. Geiger tubes requires high voltage (up to 1000V) thus a simple charge pump was designed, that uses low voltage (to be powered by USB) as main power supply. IoT system has an open API, which allows a multiplatform data receival.

2D ionizing radiation imaging system leverages the availability of the CCD sensors, commonly found in digital imaging cameras. Digital camera conversion was performed by the use of in-house made custom firmware for Canon ARM processor. Custom software allowed to use the full capabilities of the imaging digital signal processor. Since the captured data is saved as a raw image data it can be processed using any image processing software. This allows the user to adapt this radiation imaging technique to a specific case.

Use of simple components and devices allows these ideas to be a low cost solution for a traditionally high cost problem.

These prototypes are aimed at lowering the entry difficulties for radiation measurements in different fields of science and industry. These measurement systems were designed having medical physics and environmental measurements in mind but can be adopted for other tasks easily due to open source nature.

### **Novelty of the work**

Designed measurement systems boats simplicity in design and availability of components, which is of high importance in relatively exotic measurement area of ionizing radiation.

### **Technical or other problems that are solved with the work**

Designed measurement systems can be operated remotely through the use of IoT or pre-programmed for a specific measurement task,

which is an important and relatively rare feature in the field of radiation measurements. This allows to perform radiometric measurements in harsh radiation environment without the danger for the operator.

### **The benefits and value to the potential users**

These prototypes are aimed at lowering the entry difficulties for radiation measurements in different fields of science and industry. Measurement systems were designed having medical physics and environmental measurements in mind but can be adopted for other tasks easily due to open source nature.

# Sinergetic advanced oxidation technology

Kaunas University  
of Technology and  
BIOKSA LTD

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**TRL 6** – technology  
demonstrated in rele-  
vant environment  
(industrially relevant)

## Short description of the work

Numerous problems arise at the global level with regard to the environmentally toxic and persistent substances (pesticides, pharmaceuticals, antibiotics, textile dyes, surfactants, polycyclic aromatic hydrocarbons, etc.) occurrence in surface and ground drinking water. If entered in the food chain, these compounds accumulate in living organisms and adversely effect functional vital processes.

The principle of operation of SAOT is based on the innovative interaction of the ozonation process, catalytic UV photolysis, together with specially modified catalysts, and specially prepared adsorbents in one hybrid system. In this system, ozonation of water generates active radicals, which removal, difficult-to-decompose compounds into carbon dioxide and water by traditional technologies. The efficiency of the process is increased in conjunction with ozonation in one system by the use of photolysis of UV radiation, with a catalyst deposited on a special structure (TiO<sub>2</sub>, MnO<sub>2</sub>, etc.). The formation of active radicals accelerates the mineralization of degradable compounds. The final purification step is filtration through a charge of the modified adsorbent. In this case, additional contact time is en-



sured and any oxidation products formed are removed. Using the hybrid SAOT prototype, the water is not only purified but also additionally disinfected, so the innovation and versatility of this technology allows the system to be used in an extremely wide range in many industries.

The solution is intended to urban domestic wastewater treatment plants, companies in various industries.

Water treatment prototype was developed during the joint project between BLOKSA LTD and Kaunas University of Technology.

### **Novelty of the work**

- Combined synergetic interaction of two processes - ozonation and photocatalysis. Such technology has higher performance due to reduced energy consumption and improved efficiency than using these processes separately.
- The treated water is not only purified but additionally disinfected as well.
- The system can be easily adapted to treat the tertiary water in wastewater treatment system or to recover water from industrial processes, thus implementing the principles of the circular economy.

### **Technical or other problems that are solved with the work**

This technology can be used to solve water contamination problems, for which other water treatment technologies cannot be used.

### **The benefits and value to the potential users**

The technology is extremely easy to maintain and install in industrial facilities. Hybrid SAOT reactors are easy to dismantle, transport and maintain, easily replace wearable structures and working parts.



# Electricity, Electronic and Energy

# 3D environment scanning device

Kaunas University  
of Technology

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**TRL 5** – technology  
validated in relevant  
environment  
(industrially relevant)

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## Short description of the work

3D environment scanning device is oriented in gathering data of obstacles 360 degrees around, within 6 meters distance. Scanned data is written to the memory card or send by Wi-Fi in format of point cloud (.xyz), compatible with the point cloud import tools. Device is suitable for recreating shapes and areas, which are difficult to measure, with traditional techniques.

Additional specifications:

- Horizontal angle resolution  $1^\circ$ , which could be maximized to  $\approx 0,35^\circ$
- Distance measurement accuracy  $< 2$  mm

## Novelty of the work

Majority of analogous 3D scanning devices on the market are expensive and smaller architects/designers offices can't afford. Device would give an opportunity for those offices to acquire cheaper scan-

ner for recreating and modeling shapes.

### **Technical or other problems that are solved with the work**

Ancient architecture, usually have high ceiling and columns and there comes the difficulties of recreating them for restoration. Also, in new built house, architect or a designer can scan the area and by importing point cloud it to appropriate software, make a design for a client.

### **The benefits and value to the potential users**

Recreation areas and shapes becomes easier, as a result work efficiency grows. Places that are difficult to reach due to human limitations can be measured.

# Aircraft detection using radio broadcast and other signals

Vilnius University

## Authors:

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**TRL 3** – experimental  
proof of concept

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## Short description of the work

Passive radar systems are receiving increasing attention in the radar market due to their many advantages. Radar systems that do not emit any powerful radiation are attractive for the militaristic sector due to their easy operation in different terrain areas and the low visibility of the system's equipment. Adapting this technology to the needs of the private sector, such as the detection of unwanted aircraft at airports or other strategic sites, could potentially initiate a new radar technology niche. Accordingly, a model of a passive radar system was developed using two types of easily accessible and very cheap software defined pair-synchronized receivers: "RTL-SDR RT-L2832U" and "Hack RF One". Solution may be applied for detection of unwanted aircrafts/drones in airport security areas.

## **Novelty of the work**

With this system, passive aircraft detection has the potential to become relatively easily accessible and affordable for civilian/private sector use. Despite the potential of the technology, passive radar systems are not yet widely used, but there is an increasing focus on drone detection in the area of civil aviation airports. This technological approach could replace expensive detection systems that are currently covering the market, such as: radio frequency (RF) analysers, acoustic sensors (microphones), optical sensors and active radars.

## **Technical or other problems that are solved with the work**

Passive radar systems that do not emit any electromagnetic signals could complement the conventional applicability of radar in many important civil and military sectors. For example, in 2018 December hundreds of flights were cancelled at Gatwick Airport near London, England, following reports of a drone sighting near the runway. The reports caused major disruptions, affecting approximately 140,000 passengers and 1,000 flights. The Drone attack, which disrupted Gatwick Airport for three days, brought in 1.4 million. pound loss. Following the incident, many of the world's airports rushed to increase the security of access to the area and purchase drone detection systems. Gatwick Airport itself in 2019 spent about 5 million pounds for a new unmanned aerial vehicle detection system. Given the fact that there are over 400 airports in Europe, this identifies a high demand for similar systems, for which only a few manufacturers compete.

Using the developed prototype and gained experience, an attempt will be made to implement a system for the detection of unwanted drones. In line with good practice, Hack RF One receivers, software used in the system, and ultra-high frequency background radiation sources, such as transmitters from civil airport radar systems, will

be used for this purpose. Such a technological solution has the potential to decrease the expenses and complexity of drone detection systems in relation to relatively small price of the hardware and easy electromagnetic compatibility with other radiolocation systems used within the airports.

### **The benefits and value to the potential users**

Passive radar system does not emit any strong electromagnetic radiation which mitigates the need of electromagnetic compatibility with the surrounding radiolocation hardware. Also, the proposed model of aircraft detection reduces the cost of such a system dramatically.

## Authors:

Linās Minkevičius

**TRL 2** – technology  
concept formulated

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### Short description of the work

TimerBox is for easy, portable, widely configurable time tracking IoT device for various activities with included client application.

The product is intended for developers, researchers, personal work, athletes, and all others that need precise time tracking.

### Novelty of the work

Most of the time tracking is now done using apps in phones/PCs. Which is extremely complex and requires multiple clicks to start. While TimerBox device is a physical device which needs only a couple of minutes of preparation before starting a new work and can be used by only 3 buttons. Which makes it easier than trying to navigate an app to track time. Current rival does not have an ability to reconfigure and ability to track multiple tasks at the same time as my device does.

### Technical or other problems that are solved with the work

Ease of WiFi configuration at any network, user assignment, battery management, portability.



## **The benefits and value to the potential users**

TimerBox makes it easier to track wanted activities for personal reasons. For work environment it allows better handling of project timings, and see if some workers are stuck at certain tasks, but not telling others. For researchers, it makes it easier to handle and run experiments, by configuring experiments and even attach certain triggers for their devices.

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**TRL 7** – system prototype demonstration in operational environment

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## Short description of the work

ADS-B TRAC system is designed to receive ADS-B communication packets, that are mandatory in commercial aircraft. ADS-B packets include aircraft ID (also known as tail number), GPS coordinates, altitude, velocity, planned trajectory etc. USA government has plans to make ADS-B transponders mandatory in every consumer drone over ~250grams. ADS-B devices allow consumer drones to use „Sense and Avoid“ system. The ADS-B TRAC started out as a semester project at Electronics Engineering department of Kaunas University of Technology and was developed by students up to fully functional prototype stage.

Our ADS-B TRAC system is able to track aircraft in two methods:

1. ADS-B packet decoding method. Receive and decode ADS-B packets using only one ADS-B TRAC unit.

2. Multilateration method. Received ADS-B packets are processed in server and aircraft position based on packet arrival timestamp is calculated. This method requires at least four ADS-B TRAC units for 3D coordinate solution.

Our current research goal is to assess aircraft tracking speed, resolution and precision using these two methods and explore possibility using this technology for high speed tracking of consumer drones in distance limited areas up to several km. range.

The following hardware and software solutions were developed by our team and implemented in the ADS-B TRAC modules:

1. ADS-B packet detector circuit operating at 1.09 GHz frequency range

2. ARM microcontroller based solution for ADS-B signal decoding, local data collection to microSD card, current data representation on a color display, data transmission to an online database over WiFi connection.

3. Initial ADS-B packet processing and precise timestamping in ADS-B TRAC unit implementing global GPS time base synchronization

4. Algorithm for multilateration position solution was selected and implemented in the server computer for aircraft visualization in PC software.

5. Portable battery powered module modular solution in water resistant IP66 grade case. The modular solution allows to work in different frequency ranges if necessary.

## **Novelty of the work**

Functional multilateration method based portable ADS-B TRAC solution prototype implementing modern ARM based microcontroller with ability of precise time stamping of received data packets us-

ing GPS global time.

### **Technical or other problems that are solved with the work**

Portable ADS-B tracking system ADS-B TRAC can find its use as a local solution for drones equipped with ADS-B transponders tracking and in those cases when any aircraft does not transmit global coordinate in the ADS-B message.

### **The benefits and value to the potential users**

Integrated modular portable solution ADS-B TRAC in a water resistant case with ability to track, process and time stamp the arriving ADS-B packets and to store the data in Internet server for storage and visualization.

# Smart vehicle traffic parameterization and identification device

Kaunas University  
of Technology

## Authors:

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**TRL 6** – technology demonstrated in relevant environment (industrially relevant)

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## Short description of the work

In today's world, due to the ever-increasing number of vehicles, traffic monitoring devices are becoming more obedient and relevant. We are creating smart vehicle traffic parameterization and identification device which helps to determine the composition and the intensity of traffic at a certain period of time. The millimeter-wave radar used in the device allows to record the number of vehicles in a non-invasive way without installing the device under the pavement surface. More, device can determine cars speed, identify and classify them. The analysis of the results of the obtained data allows to increase traffic flow by enabling efficient traffic management and improving traffic flow planning, optimizing the operation of automatic traffic light regulation and traffic control systems in real - time. Also, acquired data helps to reduce financial expenses by reducing traffic congestion and travelling times, reduces air pollution level.

Smart vehicle traffic parameterization and identification device for traffic monitoring is automatic, portable and easy to install, sends data via Bluetooth to the user so it is suitable for short-term traffic monitoring in autonomous way.

### **Novelty of the work**

Millimeter-wave radar used in the device ensures acquisition of higher accuracy traffic flow data over extended distances than other devices in the market. Data is sent via Bluetooth Low Energy to the user, device can be used in any weather conditions: rain, snow, fog or light conditions: sunshine, darkness.

### **Technical or other problems that are solved with the work**

Use of smart vehicle traffic parameterization and identification device for traffic monitoring, helps to determine composition and the intensity of traffic at a certain time of day. Acquired data analysis increases traffic flow by enabling efficient traffic management and improving traffic flow planning, reduces financial expenses, shortens travelling time.

### **The benefits and value to the potential users**

Device is portable, easy to install, fully autonomous, the privacy of people involved in traffic is not compromised because information about number plates or person's identity are not collected.

## Authors:

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Elvinas Darvidas

**TRL 6** – technology demonstrated in relevant environment (industrially relevant)

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### Short description of the work

JUPLLA+ is a pick and place machine made from scratch by KTU students. The main objective of the machine is to pick components from one location and place them where required on printed circuit board.

The main part that does all the lifting is the machine's head which uses vacuum to pick and place components as little as 0201 (0.6 \* 0.3mm). With the help of stepper motors the machine is able to move its head around 3 axes (X, Y, Z) and also rotates its nozzle around Z axis. The workspace size is defined using inductive limit sensors that stop the machine as soon as it goes off boundaries.

System has two cameras: Bottom camera is used to see if component was picked up successfully and to rotate it as preparation for placement. Top camera is used to aid the operator to navigate the pick up nozzle around the working area as well as used to train the machine to recognize new component pick up and placing locations. The main control software is OpenPnP. It uses G-code to operate the

machine and its peripherals. By utilizing the dual camera setup the software allows to pick up components from feeders, tape strips and even recognize and place loose components.

JUPLLA+ latest upgrade was the integration of dedicated drivers that now allow to operate up to 15 component feeders which make the machine work even faster.

### **Novelty of the work**

The PCB manufacturing market is always on the rise so this machine will stay relevant for years to come.

### **Technical or other problems that are solved with the work**

Removes the need to manually place components in PCB manufacturing process.

### **The benefits and value to the potential users**

- Wide variety of component recognition modes.
- Easy to use software.





# Interdisciplinary Works

# Low cost, Hexapod-based Jaw movement articulator

Kaunas University  
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**TRL 7** – system pro-  
totype demonstration  
in operational environ-  
ment

## Short description of the work

Tracking jaw movements is useful in several research fields, such as bruxism detection, sleep apnea and dysphagia research, dental prosthetics testing, and chewing efficiency evaluation. To create methods for tracking jaw movements, the trajectories need to be simulated in precise, controlled fashion and in natural velocity. There are high-end, extremely expensive solutions, such as linear actuator based Stewart platforms that could be programmed to simulate jaw movements. We present a low cost solution for jaw tracking development. It is a servo-motor driven, 6 degree of freedom hexapod, with a mounted 3D printed polyactide model of human jaw. It has a graphic user interface where control coordinates are added as a .txt file, and the trajectories can be played and reviewed in graphic 3D rendering

before the start. Speed can be adjusted mid-work. For positioning reference and validation, it has an integrated electromagnetic positioning sensor controlled via TrakStar system.

### **Novelty of the work**

Hexapod-based Jaw movement articulator is a low cost robotic jaw articulator, enabling research and sensor development for masticatory disorders.

### **Technical or other problems that are solved with the work**

- It simulates any human jaw movements in precise and controlled fashion, natural speed and with the knowledge of the exact position it is in. Live subjects are unable to do that.
- By using this platform, jaw tracking methods are developed.

### **The benefits and value to the potential users**

Commercial Stewart platforms, that could be programmed to simulate jaw movements in 6 degrees of freedom, are extremely expensive. Therefore, our low cost device serves as a platform to research temporomandibular disorders and expand accessibility to science.

# Multifunctional MXene-polymer composites and coatings

Kaunas University  
of Technology

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**TRL 3** – experimental  
proof of concept

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## Short description of the work

MXenes are a new nanoparticle group of metal carbides and nitrides with a unique combination of high electrical conductivity, hydrophilicity and excellent mechanical properties. MXenes have already been used in applications such as Li-ion batteries, organic solar cell, electromagnetic interference shielding coatings and supercapacitors. But now, the research focus is directed to nanosensors. For example, the possibility of molecular intercalation between the nanolayers can result as a gas or humidity sensor. In addition to this, the multilayered and porous structure of MXenes films causes a highly sensitive response to any deformation and morphology change. Till now, MXenes have not been used for sensing purpose in fibre reinforced

epoxy composites. The main focus of this work is to develop an easily processed and scalable MXene nanosensor or multifunctional MXene-polymer composite, which could detect micro deformations and cracks. The behaviour of MXenes under the deformations analysis is based on the electrical resistance change. Simple preparation methods and monitoring systems are a priority. In this work, experimental results of new multifunctional MXene-polymer composites with self-sensing abilities are presented.

Solution developed is oriented into Automotive, Aeronautics, Wind Energy industries.

### **Novelty of the work**

For the first time, MXenes are used for structural health monitoring of the composite materials.

### **Technical or other problems that are solved with the work**

Constantly growing automotive, aeronautics and renewable energy industry require new engineering solutions such as advanced electronics, smart-materials, robust and long-lasting composites. During the exploitation, composite structures incur high cyclic and impact loads, which over time lead to material cracking and overall structure degradation. The best candidate to overcome such challenges is hydrophilic, strong and self-sensing MXene nanoparticles, which creates opportunities for real-time structure health monitoring, that allows to detect and locally track damaged material without any additional sensors.

### **The benefits and value to the potential users**

Zero-mass nano-sized coatings, self-sensing multifunctional composites, scalable and cost-efficient manufacturing process.

# Carbon nanotubes based smart sensors for damage sensing of 3D woven composites

Kaunas University  
of Technology

## Authors:

Prasad Shimpi,  
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**TRL 2** – technology  
concept formulated

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## Short description of the work

The present work focuses on development of smart Carbon nano tubes (CNT) composites. This type of composites can function as sensors for monitoring damage in the structure of composite. Being thermally and electrically conductive, the same composites can dissipate or generate heat and electrical charges to function in extreme environmental conditions. The composite base material is made from 3D woven fabric which has fibers in all three axis as compared to regular fabric which has fibers only in 2 directions. The composites are prepared by Vacuum assisted Resin Transfer Molding (VaRTM) process which infuses the resin uniformly throughout the fabric us-

ing vacuum and reduces air voids in the structure. To integrate the the nano particles in composite structure, they are dispersed in the epoxy resin by solvent process and integrated on the composite substrate by casting or spraying. Sensing function of the nano composite can be utilized by measuring the change in its electrical resistance as and when the damage develops in the composite.

### **Novelty of the work**

3D woven composites have several advantages over 2D laminated composites such as higher delamination resistance, higher impact strength, resistance to crack propagation and dimensional stability. The manufacturing of 3D woven preform also allows controlling the shape of fabric as well as quantity and material of fibers used thus providing homogeneous hybridization, achieving near net fabric structure and reducing the stress on fibers for complex geometries.

The conductive coating of CNT can be directly applied on the surface on the composite material as a multi functional material . Changes in the composite structure due to mechanical load directly affects the electrical resistance of the conductive element which is utilized to measure the stress- strain values and hence monitor the structural health of the composite. Sensor can also act as thermal and electrical conductive material on the surface of the composite to dissipate heat and charge buildup.

Solution developed is oriented into aerospace, automobile and wind energy industries.

### **Technical or other problems that are solved with the work**

Apart from being expensive, conventional non-destructive testing techniques cannot be applied for continuous monitoring of the composite material during its actual usage. The CNT coating can serve as sensor during actual use of the composite.

Various materials such as Optical fibres, metallic yarns (copper, aluminium, steel etc.), piezoelectric materials, yarns coated with conductive dyes etc. can be chosen as sensor material and integrated in fabric by weaving process. However, these are less efficient methods as damage to the sensing elements itself during manufacturing process is very high and many times results into improper functioning. CNT coating is an additive manufacturing method and does not impart any damage during manufacturing.

CNT casting can be easily applied at joints of complex shapes where it is difficult to integrate sensor wires.

### **The benefits and value to the potential users**

These kind of smart composite can save time and cost incurred to check damage in the composite materials. The damage detection is quick and easy as compared to other non-destructive testing methods. They offer multiple functions than just structural components.



# GFRS: 3-axis G-force racing simulator

## Authors:

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**TRL 7** – system pro-  
totype demonstration  
in operational environ-  
ment

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## Short description of the work

The authentic GFRS G-force racing simulator designed and manufactured stands out in the high-demand racing simulator market by recreating the driving conditions and mechanics that are very similar to those experienced in the real life, but are less expensive and offer more features. The simulator enables the users discover and learn various racing and everyday driving experiences. 3 degrees of freedom simulate acceleration, braking, turning, traction loss and road imperfections, enabling the users feel as if they were driving an actual vehicle. By making respective changes in the software and user-interactable hardware it is possible to simulate light cars, trucks, military equipment, boats and even airplanes. The simulator does not have an age limit, and even children and teens can start gaining experience.

The solution is aimed at development of practical skills (driving schools, vocational centres, autosport schools, individuals) by simulating various situations, road surfaces and different vehicles (light cars, trucks, military vehicles, farming equipment).

### **Novelty of the work**

An electromechanical mechanism - the simulator with 3 degrees of freedom and feedback simulates pitch, roll, sway, surge, yaw axes - has been developed, manufactured and integrated. An authentic gear shifter has been developed to simulate the real gear shifter feel and feedback. Reproduction of the tire and suspension noise and vibration is possible by integrated low-frequency drivers.

### **Technical or other problems that are solved with the work**

The simulators available in the commercial world share one major flaw: non-linear force transmission. This flaw makes it difficult to simulate the forces acting during movement at extreme angles. This issue has been solved by developing an authentic transmission to deliver constant linear torque to all 3 axes instead of using common linear actuators. To simulate gear shifter feedback, an authentic electromechanical construction has been developed.

### **The benefits and value to the potential users**

Optimal in terms of quality-price ratio and authentic in its idea and implementation, the simulator enables the users develop driving skills and knowledge in various situations. Potential users will gain driving experience in various situations and driving conditions without posing danger to themselves, other people or property. By making respective changes in the user-interactable equipment, it is possible to simulate a wide range of vehicles.

# Noninvasive oxygen uptake rate prototype

MB Cumulatis, Kaunas  
University of  
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Kauno klinikos

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**TRL 7** – system pro-  
totype demonstration  
in operational environ-  
ment

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## Short description of the work

The aim of this project was to develop a prototype of a non-invasive monitoring device for a potential COVID-19 patient, to test it in laboratory conditions. This prototype would provide a preliminary initial assessment of a person's body condition through oxygen uptake, and would allow the planning and management of hypoxemia correction measures that delay or prevent intubation and artificial lung ventilation altogether. It will allow non-invasive monitoring of the maximum oxygen solubility of a potential patient. The develop-

ment is relevant because the complex data collected will substantially deepen the knowledge on how to improve the efficacy of oxygen therapy in patients.

The solution is applicable to all medical equipment that throw away exhaust gas: chambers, incubators, face masks and etc. Because we analyze exhaust gas.

### **Novelty of the work**

Noninvasive oxygen uptake rate estimation in patient body and control of maximal oxygen solubility in a human body.

### **Technical or other problems that are solved with the work**

It lays engineering infrastructure to help better understand the model of overall human body perfusion cycle.

### **The benefits and value to the potential users**

Upon comprehension of the human perfusion cycle oxygen transfer capacity we can create tools to better plan hypoxemia correction measures. Not only for Covid-19 patients.



**Food**

# Line of 4 Seasons -

Kaunas University  
of Technology

## Instant Buckwheat Porridge

### Authors:

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**TRL 5** – technology  
validated in relevant  
environment  
(industrially relevant)

### Short description of the work

Popularity of instant oat porridge is unquestionable with market analysts predicting distinctive growth and expansion. The demand for convenience food that also has high nutritional value boosts the market. The segment of customers who are looking to integrate healthy products into their lifestyle will choose the product that offers nutritional value and good taste. Buckwheat is one of the most important alternative crops and a valuable raw material for food production since it is rich in essential amino acids, fatty acids and vitamins, and it is a good source of minerals and fibres.

The aim of this work is to develop an alternative instant porridge, maintaining the health benefits and enhancing the consumption of buckwheat. To the best of our knowledge there is no sweet flavoured instant buckwheat porridge in the European market. The Line of Four Seasons (LOFS) offers 4 exciting flavour combinations that reflect

the seasons:

- Tropical Summer with coconut, peach, banana and mango.
- Trick-O-Treat Autumn with pumpkin and cinnamon.
- Cozy Winter with chocolate, coconut and cinnamon.
- Blooming Spring with Mulberry and Elderflower.

Main attributes of these products are the buckwheat flake base, new sweet flavours, beneficial nutritional effects, convenience of use. LOFS can be a good example of how to expand the instant porridge market, with a completely new base, an option not just for breakfast. In Lithuania buckwheat as a sweet porridge ingredient has not been considered as a commercial product yet.

The food-related lifestyles instrument that identified consumer segments from research (based on European countries) can be used to define the target group that LOFS would reach. Urban type segments can be reached on many levels: quality, convenience, health, tradition (buckwheat is already present in the national diet) with a new twist (sweet taste). Based on the survey that we created to analyse the situation about our new food product we found out that middle-aged people and students were most interested.

### **Novelty of the work**

Traditionally, buckwheat is eaten as a savoury dish, side dish, the novelty of our work is to showcase it in a new way as a breakfast meal (instant snack) for consumers having a knack for sweet taste but with a goal to lead a healthy lifestyle.

### **Technical or other problems that are solved with the work**


- Preparation time is comparatively lower.
- Healthy alternative retaining the essential nutrients.

- Can be consumed by people having issues with dairy intake and by vegans.
- Made from naturally occurring sugars discarding the addition of any external or artificial sweeteners mainly for those suffering from different types of diabetes

### **The benefits and value to the potential users**

- Preparation time.
- Healthy alternative with sweet flavour.
- Dairy-free & Vegan.
- Only contains naturally occurring sugars, no added sugar.





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