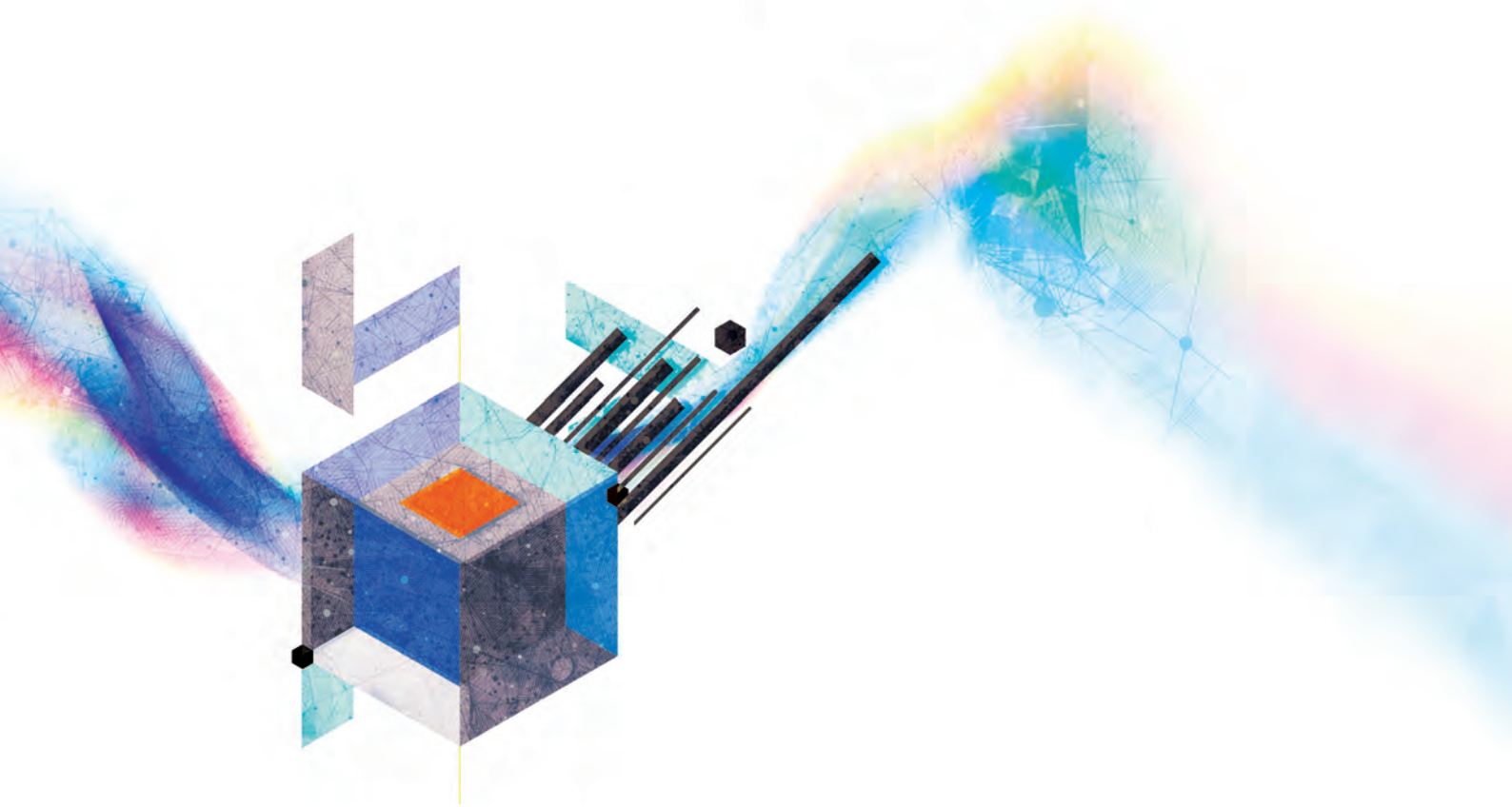
FERIT

FACULTY OF ELECTRICAL ENGINEERING, COMPUTER SCIENCE AND INFORMATION TECHNOLOGY **OSIJEK**

Research Areas, Projects and Technical Solutions



Osijek, 2023.

Research Areas, Projects and Technical Solutions

The research activities at the Faculty of Electrical Engineering, Computer Science and Information Technology Osijek (FERIT) are oriented towards the current global trends in research and development and are focused on the creation of new knowledge through research in the fields of computer science, information and communication technologies, automation, power engineering, electrical machines and automotive industry.

Researchers at FERIT are involved as project leaders or team members in a range of scientific and development projects that generate new knowledge and innovations and facilitate knowledge transfer from the university to the industry.

This document presents the research areas of nine FERIT research groups and technical solutions developed by the research groups.

SVEUČILIŠTE JOSIPA JURJA STROSSMAYERA U OSIJEKU
Fakultet elektrotehnike, računarstva i informacijskih tehnologija Osijek

Research Areas, Projects and Technical Solutions

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Research Areas, Projects and Technical Solutions

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Osijek, 2023.

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I. Research Group for High-Performance Computing and Data Analysis

Link: https://www.ferit.unios.hr/research-groups/IG02

This research group aims to make research results applicable in the field of collecting and data storage, their analysis by using complex procedures of computer intelligence and machine learning (for the web, mobile and service environments and real-time data analysis) as well as parallel and distributed data processing in energy efficient high-performance computer systems.

There are possibilities for professional cooperation with respect to an efficient application of cloud computing, automated testing and setting in motion multiple platform web, mobile and embedded software solutions based on the current methodologies and platforms including agile development procedures, test-driven development and open-source environment. Those solutions include the procedures of detecting, collecting and data processing from scientific and embedded systems as well as the Internet of Things. Cooperation can be realized within the application and adjustment of machine learning procedures for the purposes of pattern recognition (classification, regression, etc.) and cognitive procedures applied to various problems and data. Since optimisation problems range from machine learning modelling to building solar panels in fields, development, adjustment and embedding of different evolutionary algorithms can be used to tackle the problems. For time critical services, the data-flow real-time analysis, business intelligence approaches and appropriate visualisations are used. The main fields of application are biomedicine and medical services, mobility and transportation system, agriculture, food industry, smart and energy efficient environment, scientific computing, cybersecurity, business computer systems and data centres of companies and institutions.

Project title:

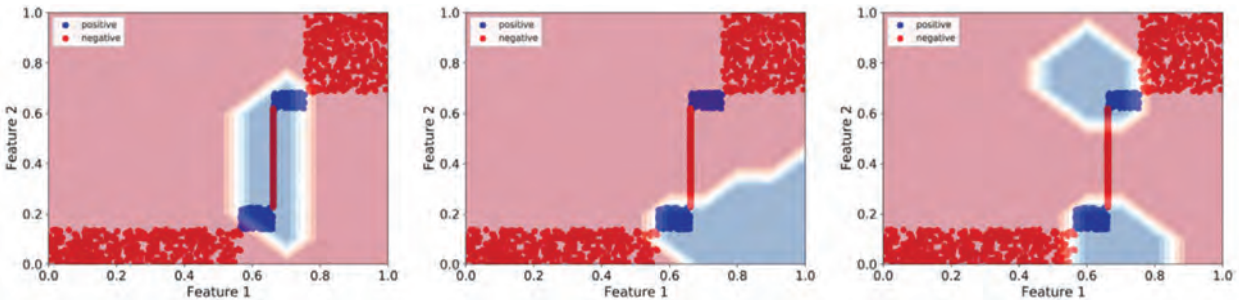
DATACROSS – Advanced methods and technologies in data science and cooperative systems

Supported by the European Regional Development Fund (EFRR) under project KK.01.1.1.01.009
Link: https://across-datascience.zci.hr/en/datacross

I Solution:

Framework for identification and ranking of difficulty factors when learning from imbalanced data

We have developed a framework for identifying and ranking difficulty factors in learning from imbalanced data. Prior to developing the framework, a contemporary empirical study was conducted on the behaviour and performance of five well-known classifiers on a large number of imbalanced datasets that exhibit numerous combinations of data-intrinsic features such as small disjuncts, class overlap, noise, and data rarity. Based on the results of the study, a framework was developed to identify and rank the difficulty factors in learning from imbalanced data depending on the type of classification algorithm used. In addition, the framework suggests the selection of appropriate techniques to mitigate the problem of class imbalance, especially with respect to oversampling and undersampling procedures.



Publications:

Dudjak, M., & Martinović, G. (2021). An empirical study of data intrinsic characteristics that make learning from imbalanced data difficult. *Expert Systems with Applications*, 182, 115297. https://doi.org/10.1016/j.eswa.2021.115297

II Solution:

Data mining model for credit scoring based on feature selection and ensemble classifiers

We have proposed a hybrid data mining model based on a combination of feature selection procedures and an ensemble of classifiers. As part of the proposed model development methodology, five different feature selection algorithms were investigated, which were used with the support of voting procedures after the evaluation. Also, a new voting procedure has been proposed that achieves better performance than the existing ones. Several classification algorithms were combined into ensemble models using the proposed soft voting. Experimental data have shown that the proposed hybrid model based on the features obtained by soft voting and the proposed ensemble achieves very good performance and can be successfully used in the client creditworthiness assessment.

Publications:

Nalić, J., Martinović, G., & Žagar, D. (2020). New hybrid data mining model for credit scoring based on feature selection algorithm and ensemble classifiers. *Advanced Engineering Informatics*, 45, 101130. https://doi.org/10.1016/j.aei.2020.101130

Nalić, J., & Martinović, G. (2020). Building a credit scoring model based on data mining approaches. *International Journal of Software Engineering and Knowledge Engineering*, 30(02), 147-169. https://doi.org/10.1142/s0218194020500072

Project title:

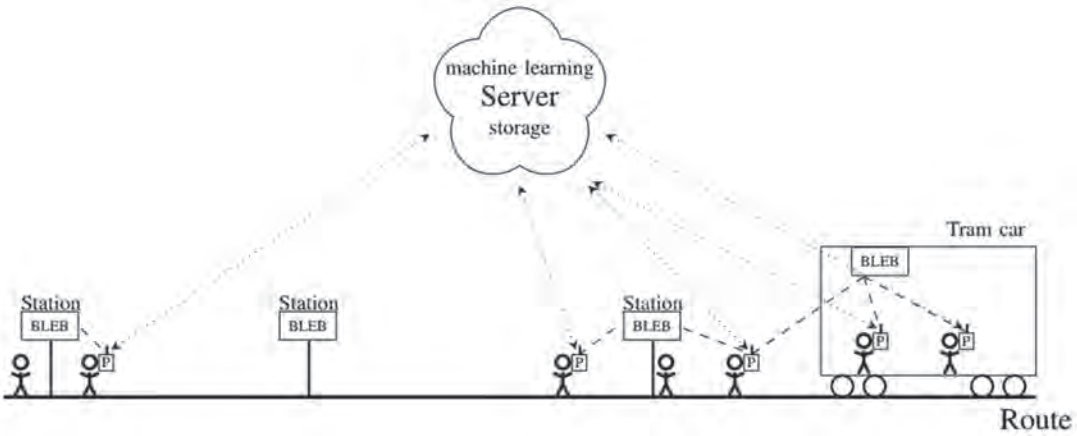
Researching beacons for the purpose of movement network creation – Urban mobility platform development

Supported by the European Regional Development Fund (EFRR) under project KK.01.2.1.01.0127

Solution:

A system for public transport congestion and arrival time prediction

We have developed a system that enables prediction of congestion and tram arrival times in public transport. Passenger data is collected through crowdsourcing, where BLE beacons placed on stations and tram cars are detected by passenger mobile phones. Several regression models were evaluated and deployed as a web service to facilitate the previously described use cases.



Publications:

Bajer, D., Zorić, B., Dudjak, M., & Martinović, G. (2020). Benchmarking bio-inspired computation algorithms as wrappers for feature selection. *Acta Electrotechnica et Informatica*, 20(2), 35-43. https://doi.org/10.15546/aeei-2020-0011

Bajer, D., Zorić, B., Dudjak, M., & Martinović, G. (2019). Evaluation and analysis of bio-inspired optimization algorithms for feature selection. In W. Steingartner, Š. Korečko, A. Szakal (Eds.), *Informatics 2019 Proceedings* (pp. 18-25). Košice. https://doi.org/10.1109/informatics47936.2019.9119256

Zorić, B., Dudjak, M., Bajer, D., & Martinović, G. (2019). Design and development of a smart attendance management system with Bluetooth low energy beacons. *2019 Zooming Innovation in Consumer Technologies Conference (ZINC) (pp.86-91)*. Novi Sad. https://doi.org/10.1109/zinc.2019.8769433

Project title:

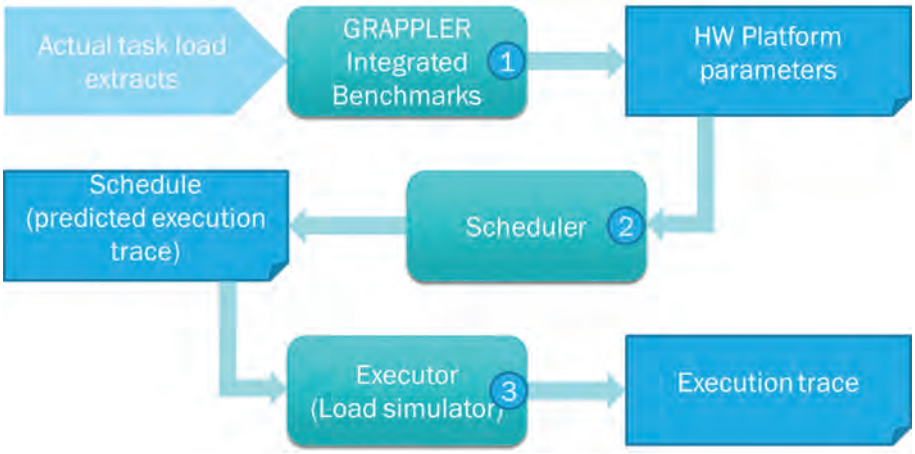
GRAPPLER

Internal FERIT project

Solution:

Adjustable-scale graph-based parallel workload executor framework – GRAPPLER

We have developed software that enables running (but is not restricted to) MPI-based parallel applications given as task graphs onto parallel and distributed HPC systems. This software enables executing large scale parallel and distributed HPC applications in a drastically reduced form, obtaining execution traces in a reasonable time. Runtime observations can be used to improve the future runs of this application on a real system. GRAPPLER generates application execution traces per processing unit and per type of load (computation and communication between tasks) in a human-readable format which helps identify bottlenecks of the application, the platform, and the configuration.



Publications:

Krpić, Zdravko; Lukić, Ivica; Köhler, Mirko
Towards a synthetic load generator framework for validating schedules in HPC environment //
2020 19th International Symposium INFOTEH-JAHORINA (INFOTEH), Istočno Sarajevo, Bosna i Hercegovina: IEEE, 2020. pp. 1-6 doi:10.1109/infoteh48170.2020.9066314

II. Research Group for Computer Science and Human-Computer Interaction

Link: https://www.ferit.unios.hr/research-groups/IG03

This research group deals with 3D reconstruction of organs from digital medical images obtained by a CT device. The resulting 3D model is used to better predict the health status of patients. In addition to the organs obtained by CT devices, bone retopology is obtained from large point clouds, providing smooth surfaces to identify deformations.

In addition to healthcare, this group deals with laser analysis of 3D models of cultural goods obtained by laser scanning, which are then processed by smoothing and interpolation algorithms for the purpose of their digital display. We develop a system for assisting blind and partially sighted people based on computer image processing in real time.

In terms of this, specific objects (stairs and pedestrian crossings) that are of great importance for the movement in space are detected. In-room directional sounding is performed. The group is developing virtual applications that would help people overcome obstacles in the environment with minimal dangers, e.g. educating children to cross the road in varying traffic density. Research is also being conducted in the direction of neural networks and their evolution through extended topology for the purpose of machine learning in games to reach the solution.

Project title:

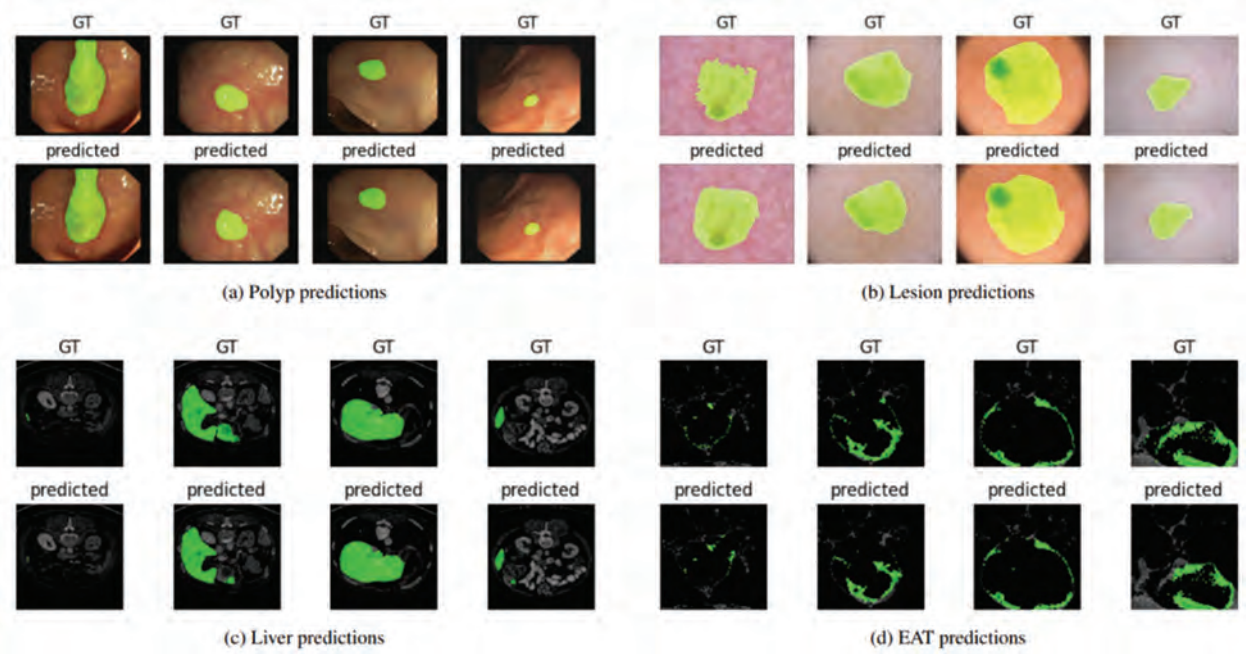
Medical image interpretation methods for a detailed heart health analysis

Supported by the Croatian Science Foundation under project UIP-2017-05-4968 Link: imagineheart.online

Solution:

Deep learning-based tissue segmentation in 2D and 3D medical images with small datasets

We have developed several methods of training neural networks for slice-based segmentation of tissues in 3D CT scans and other medical image modalities which work especially well for small datasets, for instance, datasets containing only 20 CT scans. We achieve this by using domain-specific pre-processing and augmentation such as using polar coordinates for elliptically distributed tissues, or by embedding depth information to the 2D input images to the network. We found that these approaches generally improve segmentation accuracy and network convergence times for various types of medical images.



Publications:

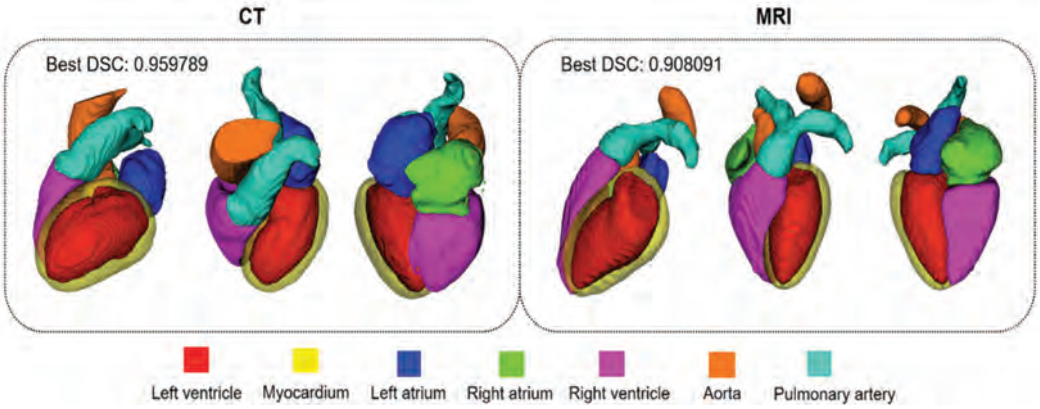
Benčević, Marin; Galić, Irena; Habijan, Marija; Babin, Danilo
Training on Polar Image Transformations Improves Biomedical Image Segmentation // IEEE Access, 9 (2021), 133365-133375 doi:10.1109/access.2021.3116265

Benčević, Marin; Habijan, Marija; Galić, Irena
Epicardial Adipose Tissue Segmentation from CT Images with A Semi-3D Neural Network //
2021 International Symposium ELMAR
Zadar, Hrvatska: IEEE, 2021. str. 87-90 doi:10.1109/elmar52657.2021.9550936

II **Solution:**

Whole heart and heart substructures segmentation

We have developed software for whole heart and heart substructures segmentation from CT and MRI images. The software includes three new methods for extracting the whole heart and individual heart structures (left ventricle, right ventricle, left atrium, right atrium, pulmonary arteries, aorta) in both image modalities with high accuracy and its computation takes only a few seconds.



Publications:

Habijan, Marija; Galić, Irena; Leventić, Hrvoje; Romić, Krešimir
Whole Heart Segmentation Using 3D FM-Pre-ResNet Encoder–Decoder Based Architecture with Variational Autoencoder Regularization // Applied Sciences, 11 (2021), 9; 3912, 21 doi:10.3390/app11093912

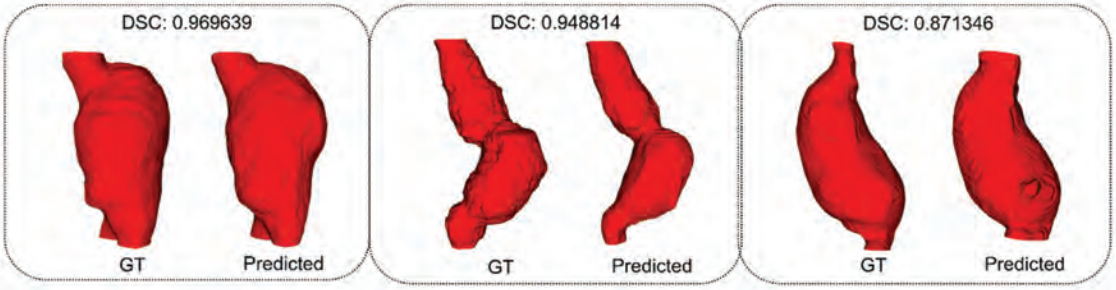
Habijan, Marija; Leventic, Hrvoje; Galic, Irena; Babin, Danilo
Whole Heart Segmentation from CT images Using 3D U-Net architecture // 2019 International Conference on Systems, Signals and Image Processing (IWSSIP)
Osijek: IEEE, 2019. str. 121-126 doi:10.1109/iwssip.2019.8787253

Habijan, Marija; Leventić, Hrvoje; Galić, Irena; Babin, Danilo
Neural Network based Whole Heart Segmentation from 3D CT images // International journal of electrical and computer engineering systems, 11 (2020), 1; 25-31 doi:10.32985/ijeces

III **Solution:**

Abdominal aortic aneurysm segmentation

We have developed software for abdominal aortic aneurysm segmentation from CT images. The software includes new deep learning-based methods for automatic extraction of different types of abdominal aortic aneurysms, has a high segmentation accuracy and its computation takes only a few seconds.



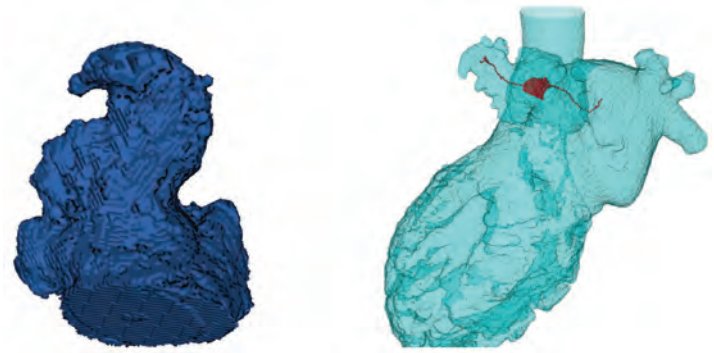
Publications:

Habijan, Marija; Galic, Irena; Leventic, Hrvoje; Romic, Kresimir; Babin, Danilo
Abdominal Aortic Aneurysm Segmentation from CT Images using Modified 3D U-Net with Deep Supervision // 2020 International Symposium ELMAR
Zadar: IEEE, 2020. str. 123-128 doi:10.1109/elmar49956.2020.9219015

Solution:

One-click interactive left atrial appendage segmentation from cardiovascular CT images

We have developed a software package for a one-click segmentation of the LAA from cardiovascular CT images. The user has to select a single seed point inside the LAA, and the segmentation algorithm creates a 3D model of the appendage. Our software determines the threshold, detects the centreline connecting the seed point and the centre of the left atrium, performs the centreline based LAA segmentation, detects the location of the LAA orifice and creates a 3D model of the LAA.



Publications:

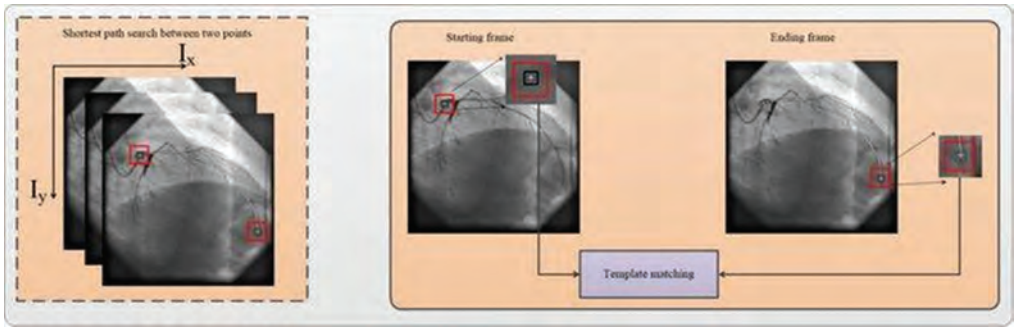
Leventić, Hrvoje; Babin, Danilo; Velicki, Lazar; Devos, Daniel; Galić, Irena; Zlokolica, Vladimir; Romić, Krešimir; Pižurica, Aleksandra
Left atrial appendage segmentation from 3D CCTA images for occluder placement procedure //
Computers in biology and medicine, 104 (2019), 163-174 doi:10.1016/j.compbiomed.2018.11.006

Vdovjak, Krešimir; Leventić, Hrvoje; Habijan, Marija; Galić, Irena
Adaptive Thresholding for Single Click Left Atrial Appendage Segmentation //
Proceedings ELMAR-2019 / Muštra, Mario ; Vuković, Josip ; Zovko-Cihlar, Branka (ur.). Zadar, 2019. str. 35-38
doi:10.1109/ELMAR.2019.8918651

Solution:

Centreline tracking of the single coronary artery from X-ray angiograms

We have developed software for semi-automatic centreline extraction and tracking of the single coronary artery. Our approach is based on ridge edge detection and thresholding, after which the centreline of a vessel tree is extracted using skeletonization. After that, we manually select two points: at the start and the end of the single coronary artery. Finding the shortest path between selected points is used for single coronary centreline extraction. Finally, the template matching of selected points allows centreline tracking through the whole angiogram sequence.



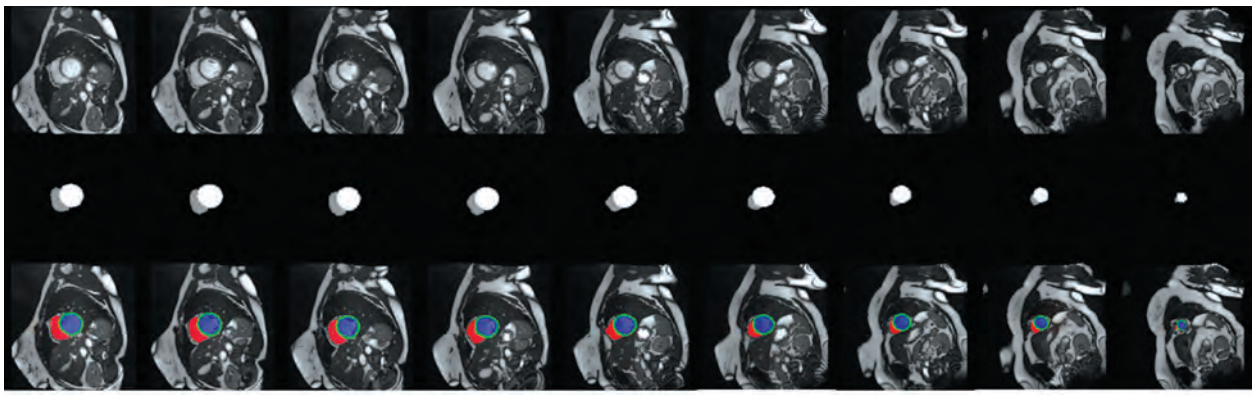
Publications:

Habijan, Marija; Babin, Danilo; Galic, Irena; Leventic, Hrvoje; Velicki, Lazar; Cankovic, Milenko
Centerline Tracking of the Single Coronary Artery from X-ray Angiograms // 2020 International Symposium ELMAR
Zadar: IEEE, 2020. str. 117-122 doi:10.1109/elmar49956.2020.9219025

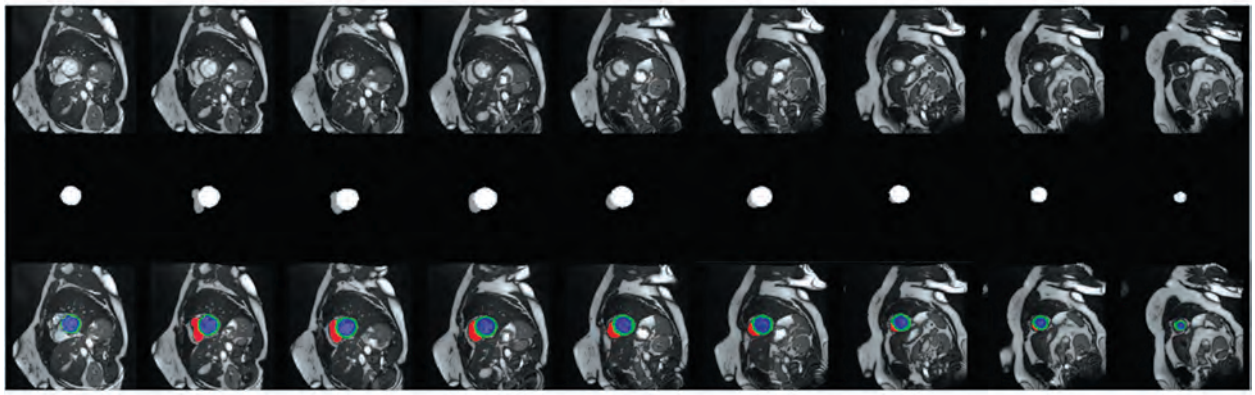
Solution:

Bi-ventricles and myocardium segmentation and quantification

Automatic cardiac MRI segmentation, including left and right ventricular endocardium and epicardium, plays an essential role in clinical diagnosis by providing crucial information about cardiac function. Determining heart chamber properties, such as volume or ejection fraction, directly relies on their accurate segmentation. Therefore, we have developed software that includes a new deep learning method for the segmentation of ventricles and myocardium as well as the calculation of their volume.



(a)



(b)

Publications:

Habijan, Marija; Galić, Irena; Leventić, Hrvoje; Romić, Krešimir; Babin, Danilo
Segmentation and Quantification of Bi-Ventricles and Myocardium Using 3D SERes-U-Net // Systems, Signals and Image Processing / Gregor Rozinaj, Radoslav Vargic (ur.).
Bratislava: Springer International Publishing, 2022. str. 3-14 doi:10.1007/978-3-030-96878-6_1

Project title:

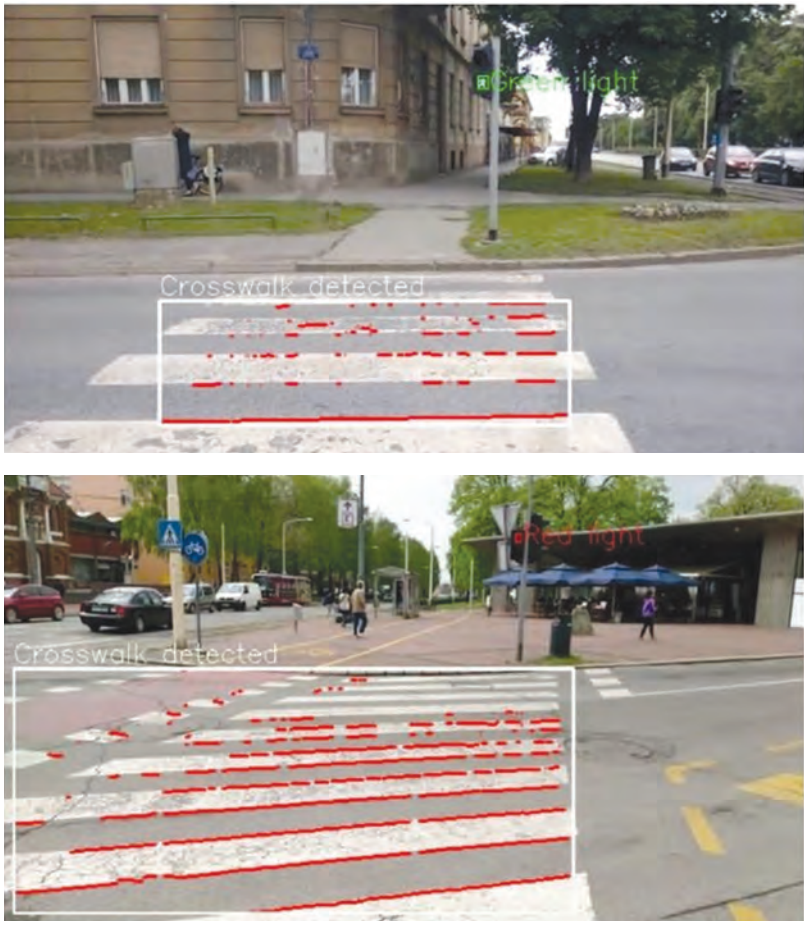
Computer vision-based assistance systems for the visually impaired

Internal FERIT project

Solution:

Crosswalk detection with walk light recognition for the blind

We have developed software for crosswalk detection and walk light recognition with the main aim to help blind people when crossing the road. The proposed algorithm is optimised to work in real-time on portable devices using standard cameras. The images captured by a camera are processed while a person is moving and a decision about the detected crosswalk is provided as output along with the information about a walk light if one is present.



Publications:

Romić, Krešimir; Galić, Irena; Leventić, Hrvoje; Nenadić, Krešimir
Real-time Multiresolution Crosswalk Detection with Walk Light Recognition for the Blind //
Advances in Electrical and Computer Engineering, 18 (2018), 1; 11-20 doi:10.4316/AECE.2018.01002

Romić, Krešimir; Galić, Irena; Leventić, Hrvoje; Habijan, Marija
Pedestrian Crosswalk Detection Using a Column and Row Structure Analysis in Assistance Systems for the Visually Impaired // Acta Polytechnica Hungarica, 18 (2021), 7; 25-45 doi:10.12700/aph.18.7.2021.7.2

Romic, Kresimir; Galic, Irena; Leventic, Hrvoje; Habijan, Marija
SVM based column-level approach for crosswalk detection in low-resolution images //
2020 International Symposium ELMAR
Zadar: IEEE, 2020. str. 133-137 doi:10.1109/elmar49956.2020.9219032

III. Research Group for Intelligent Systems and Robotics

Link: https://www.ferit.unios.hr/research-groups/IG04

The research areas of the research group for intelligent systems and robotics are artificial intelligence, robotics and process automation.

One research focus of this group is machine perception or computer vision with application in robotics. We develop object recognition systems for robot manipulation (pick-and-place tasks, processing, and other operations) and systems for indoor navigation of mobile robots. We develop methods that process the output of cameras and 3D sensors, such as RGB-D cameras and LiDAR. We investigate the application of artificial intelligence to autonomous driving, focusing on the development of object detectors based on deep neural networks.

The second research area focuses on improving process monitoring and control systems by introducing artificial intelligence based on learning from measurement data. This research includes building mathematical models of processes based on process data for estimating process values, fault detection and localisation, and implementing soft sensors and fault-tolerant systems. We also develop adaptive models and continuous learning algorithms based on operational data continuously collected in the process database so that these intelligent monitoring and control systems can adapt to changes in the process and provide optimal control.

The research group for intelligent systems and robotics conducts both basic research and the development of solutions that have the potential to be widely applied in industry, agriculture, autonomous vehicles, healthcare, and other areas.

Project title:

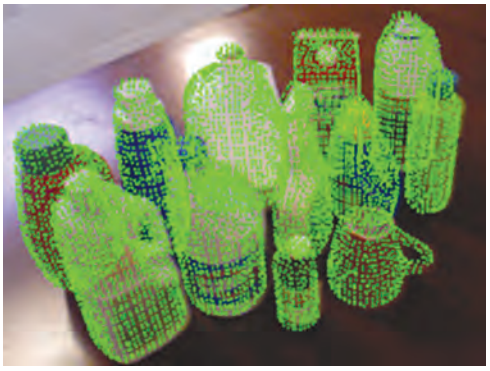
ARP3D – Advanced 3D perception for mobile robot manipulators

Supported by the Croatian Science Foundation under project IP-2014-09-3155

I **Solution:**

Object recognition based on convex hull alignment

We have developed software that recognizes shapes represented by 3D CAD models in complex real-world table-top scenes captured by a 3D camera and accurately estimates their pose with respect to the camera. The software is capable of recognizing multiple shapes as well as multiple instances of the same shape and it takes only a few seconds to do so.



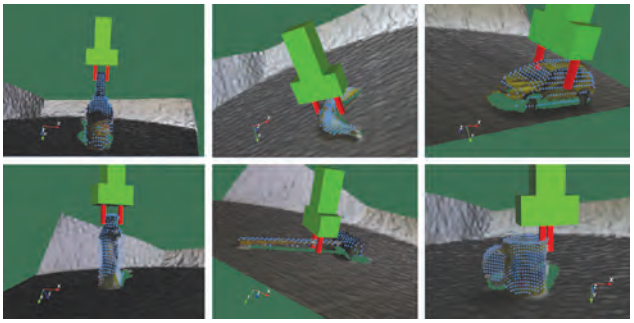
Publications:

Cupec, Robert; Vidović, Ivan; Filko, Damir; Đurović, Petra
Object recognition based on convex hull alignment //
Pattern recognition, 102 (2020), 107199, 19 doi:10.1016/j.patcog.2020.107199

II **Solution:**

Object recognition, 3D shape reconstruction and surface correspondence

We have developed software for the detection of instances of learned object classes and reconstruction of their full 3D shape for robot manipulation. The shape class model, on which the software is based, allows determining correspondences between locations on the object surface, e.g. contact points relevant for a particular robot operation, across members of a shape class.



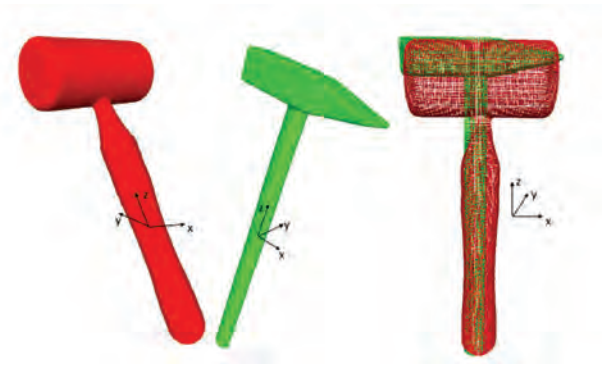
Publications:

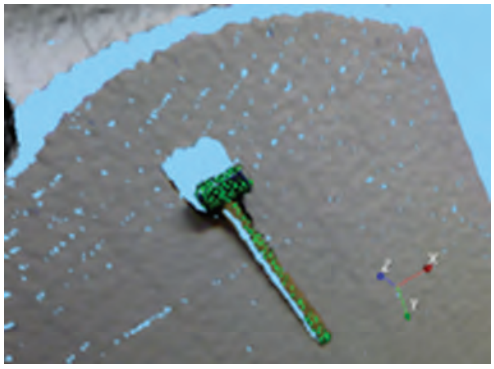
Cupec, Robert; Đurović, Petra
VolumeNet: Flexible Model for Shape Classes // ROBIO 2018
Kuala Lumpur, Malezija, 2018. str. 248-255

III **Solution:**

3D object retrieval

We have developed software for retrieval of the most similar 3D shape in a given 3D model database to a query object in an RGB-D image.





Publications:

Đurović, Petra; Filipović, Marko; Cupec, Robert
Alignment of Similar Shapes Based on their Convex Hulls for 3D Object Classification // ROBIO 2018.
Kuala Lumpur, Malezija, 2018. str. 1586-1593

IIII **Solution:**

Semantic component association within object classes

We have developed an algorithm for a semantic association of the components of an object within the object class. Given a database of 3D models of objects belonging to a semantic class, this algorithm allows the user to annotate an object part relevant to a particular robotic operation on some selected reference models from that database, and automatically annotate that part on the remaining models in the database.

Publications:

Đurović, Petra; Vidović, Ivan; Cupec, Robert
Semantic Component Association within Object Classes Based on Convex Polyhedrons //
Applied Sciences-Basel, 10 (2020), 8; 2641, 20 doi:10.3390/app10082641

Project title:

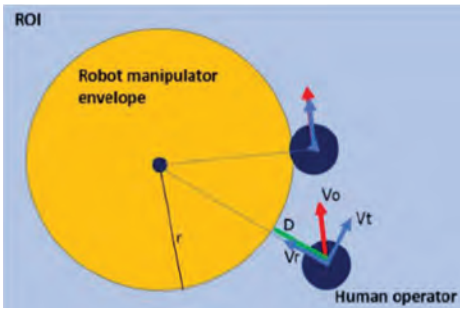
HDR – Humans detected by robots

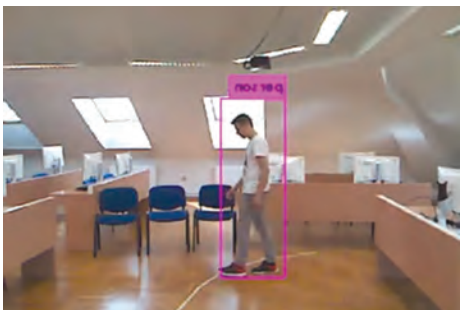
Supported by Danieli Systec d.o.o.

Solution:

Safety system for industrial robots based on human detection

We have developed a system which detects the presence of humans close to the robot's workspace and estimates the direction and velocity of their walk using an RGB-D camera. In the case of a positive detection, the robot adapts its movement based on the proximity and velocity of the detected human.





Publications:

Šimundić, Valentin; Mihelčić, Dario; Svirac, Damian; Đurović, Petra; Cupec, Robert
Safety System for Industrial Robots Based on Human Detection Using an RGB-D Camera //MIPRO Proceedings
Rijeka: Croatian Society for Information, Communication and Electronic Technology – MIPRO, 2021. str. 1348-1354

Project title:

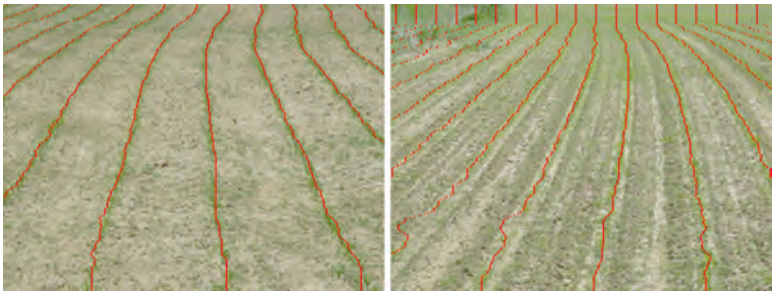
Crop row detection by computer vision

Internal FERIT project

Solution:

Crop row detection algorithm

We have developed an algorithm for the detection of crop rows in RGB images. The algorithm detects straight and curved crop rows. It is highly efficient, highly insensitive to the presence of weeds and shadow, capable of detecting crop rows of different crops, capable of detecting crop rows at different stages of growth and insensitive to the number and spacing of crop rows.



Publications:

Vidović, Ivan; Cupec, Robert; Hocenski, Željko
Crop Row Detection by Global Energy Minimization //
Pattern recognition, 55 (2016), 68-86 doi:10.1016/j.patcog.2016.01.013

Project title:

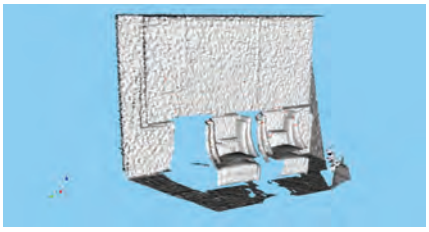
DATACROSS – Advanced methods and technologies in data science and cooperative systems

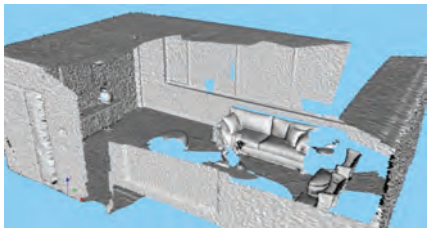
Supported by the European Regional Development Fund (EFRR) under project KK.01.1.1.01.009

Solution:

Active vision for 3D indoor scene reconstruction using a 3D camera on a pan-tilt mechanism

We have developed software for the automatic reconstruction of indoor scenes from RGB-D images captured by a 3D camera with a pan-tilt mechanism from a single viewpoint. During image acquisition, the next view is automatically selected based on the percentage of unexplored scene areas captured within the field of view and the information content in the overlap region between the next view image and one of the previously captured images. After a scan is completed, the 3D scene model is created by registering the captured depth images.





Publications:

Hržica, Mateja; Cupec, Robert; Petrović, Ivan
Active vision for 3D indoor scene reconstruction using a 3D camera on a pan-tilt mechanism //
Advanced Robotics, 35 (2021), 3-4; 153-167 doi:10.1080/01691864.2021.1875042

Project title:

Understanding the visual scene in urban autonomous driving

Internal FERIT project IZIP 2020

Solution:

Deep learning-based object detectors trained on various combinations of real-world and synthetic data

Deep learning models require vast amounts of annotated training data. Gathering and annotating the data from the real world is an expensive and time-consuming process. Thus, synthetically generated data is being researched more and more. Two state-of-the-art deep learning object detectors for car, bus/truck, pedestrian, cyclist, several traffic signs and traffic lights were trained on various combinations of real-world and synthetic data. A total of 12 detectors were tested on real-world test images. Results show that synthetic data can contribute to better detector performance until a certain ratio between real-world and synthetic data is reached.

Publications:

Jelić, Borna; Grbić, Ratko; Vranješ, Mario; Mijić, David
Can we replace real-world with synthetic data in deep learning-based ADAS algorithm development? //
IEEE consumer electronics magazine (2021)
doi:10.1109/MCE.2021.3083206

Project title:

Provision of services based on digital video signals in rural and less populated areas

I Internal FERIT project IZIP 2016

Solution:

Real-time video freezing detection for 4K UHD videos

Video frame freezing is a common artifact which can occur during video content delivery due to errors in the video coding process, video transmission, storage or reproduction. This artifact can significantly decrease the end-user Quality of Experience (QoE). We have developed an efficient no-reference freezing detection algorithm which has a very high detection rate with a very low rate of false positive detections for videos with different content and resolution. The optimized implementation of Intel processor with AVX2 instruction set is proposed along with efficient practical implementation in FPGA.

Publications:

Grbić, Ratko; Stefanović, Dejan; Vranješ, Mario; Herceg, Marijan
Real-time video freezing detection for 4K UHD videos //
Journal of Real-Time Image Processing, 17 (2020), 5; 1211-1225 doi:10.1007/s11554-019-00873-y

IV. Research Group for Computer Engineering

Link: https://www.ferit.unios.hr/research-groups/IG05

The scope of the Research Group for Computer Engineering includes architecture, design and functioning of computer systems, embedded computer systems, reliability, diagnostics and system testing, intelligent system and computer network design, image processing, visual inspection, robotic vision, working in real-time and parallel processing.

Digital circuits, systems and embedded systems are designed by using microcontrollers and FPGA circuits, SoC and NoC technologies, VHDL programing language and Xilinx system development. For known architectures, reliability models and fault diagnostics are developed. Furthermore, computer systems are designed pursuant to requirements for fault tolerance and achieving a certain level of reliability and availability. Embedded systems are designed in the fields of automotive computing, power electronics, medical electronics, agriculture, food industry, etc.

Research carried out by this research group include the development of real-time algorithms, image processing algorithms, product quality visual inspection systems, GPU algorithms, image processing parallel algorithms using CUDA technology, digital processors for signal processing (DSP) algorithms and FPGA integrated circuits. The research group has a significant experience in quality control based on visual detection of raw and baked ceramic tiles in real-time.

The research group fosters the cooperation with ICT subjects and has experience in leading several national and European projects as well as technology and knowledge transfer programmes. The group contributes to technical sciences in the city of Osijek and the region.

Project title:

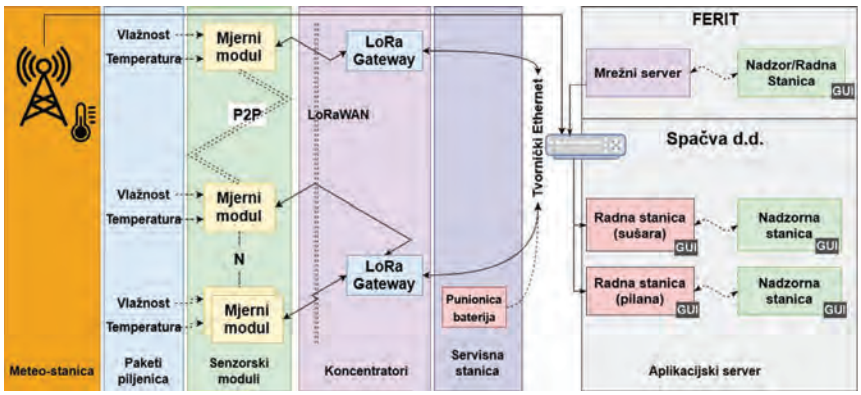
Research in Spačva Inc. for the purpose of developing innovative massive Slavonian oak doors

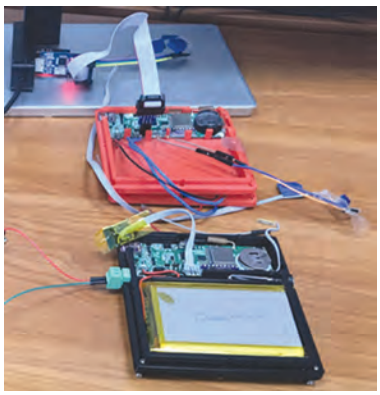
Supported by the European Regional Development Fund (EFRR) under project KK.01.2.1.01.0117

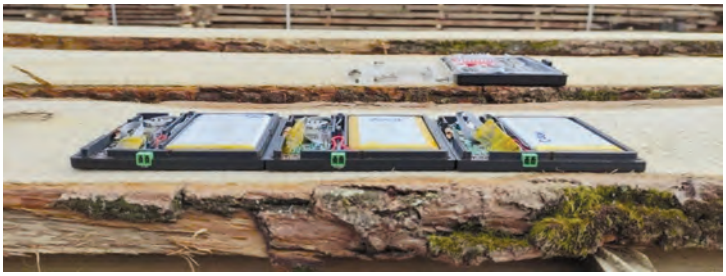
Solution:

A wireless measuring system for plank humidity and temperature measurement

We have developed a system for automated measurement of humidity and temperature of planks during air-drying on the plateau and drying in the dryers of the production plant of the Spačva factory. The system consists of dedicated measuring modules that are placed in plank bundles and are connected to the factory's communication network and the central computer via the LoRa wireless communication network. The main application allows monitoring the physio-structural condition of planks in raw-drying bundles distributed over a wider area of the factory, as well as overviewing historical measurement data.







Publications:

Keser, Tomislav; Božić, Marko; Radman, Hrvoje.; Čereg, Marin
Data management level structure and maintenance in system for actively on-field wood moisture content monitoring // 29th International Scientific Conference 'ORGANIZATION AND MAINTENANCE TECHNOLOGY', OTO 2020, Conference Proceedings / Karakašić, Mirko ; Vidaković, Držislav ; Fekete, Krešimir ; Glavaš, Hrvoje ; Blažević, Damir (ur.). Osijek: Panon Think tank for strategic studies, Osijek, 2020. str. 103-111.

Keser, Tomislav; Bašić, Andi; Božić, Marko; Radman, Hrvoje
Maintenance of LoRa infrastructure in densely obstacle-populated application areas // 29th International Scientific Conference 'ORGANIZATION AND MAINTENANCE TECHNOLOGY', OTO 2020, Conference Proceedings / Karakašić, Mirko ; Vidaković, Držislav ; Fekete, Krešimir ; Glavaš, Hrvoje ; Blažević, Damir (ur.). Osijek: Panon Think tank for strategic studies, Osijek, 2020. str. 111-117.

Božić Marko; Keser Tomislav; Bašić Andi
Assessment of wireless signal propagation in an obstacle rich environment and maintenance communication capability // Proceedings of 30th International Conference on Organization and Technology of Maintenance (OTO 2021) / Glavaš, Hrvoje ; Hadzima-Nyarko, Marijana ; Karakašić, Mirko ; Ademović, Naida ; Avdaković, Samir (ur.). Cham: Springer, 2022. str. 364-377 doi: 10.1007/978-3-030-92851-3_

Project title:

Smart sticker for measuring and monitoring storage and transportation conditions of products

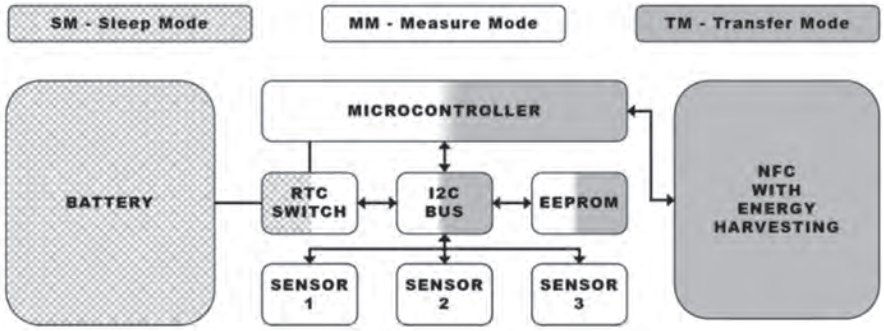
Supported by the European Regional Development Fund (EFRR) under project KK.01.1.1.04.0116

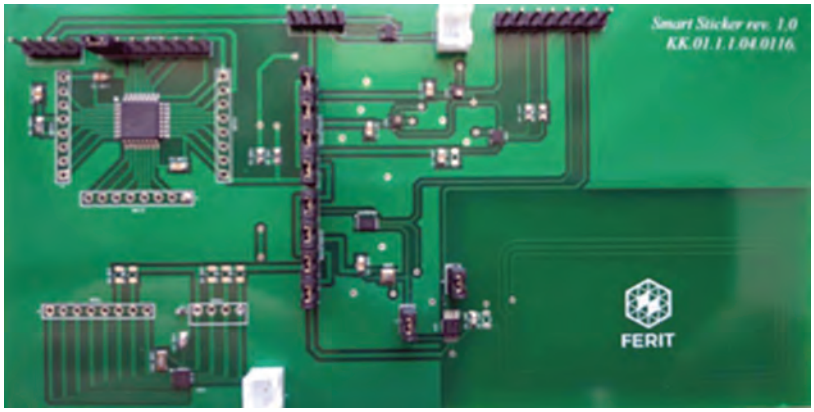
Link: https://smartsticker.ferit.hr/

Solution:

Ultra-low power smart sticker design

A prototype is developed to measure and monitor temperature, humidity and acceleration for use in the supply chain. Different products and goods are available throughout the world due to the complex supply chain system. Products are transported over long distances using different transportation systems where products can be damaged or spoiled. A smart sticker is useful for product environmental condition monitoring that can resolve some problems in the supply chain. A smart sticker records product environmental data in the supply chain and enables monitoring of producer/consumer products.





Publications:

Matić, Tomislav; Zidar, Josip; Aleksi, Ivan; Žagar, Drago
Smart Sticker Ultra-Low-Power Shock Detection in the Supply Chain //
Sensors, 22 (2022), 11; 4003, 21 doi:.org/10.3390/s22114003

Zidar, Josip; Matic, Tomislav; Aleksi, Ivan; Sušac, Filip
Low Power Embedded System Sensor Selection for Environmental Condition Monitoring in Supply Chain //
International journal of electrical and computer engineering systems, 13 (2022), 2; 99-107
doi:10.32985/ijeces.13.2.2

Zidar, Josip; Matic, Tomislav; Susac, Filip; Aleksi, Ivan
Ultra-Low Power Microcontroller Selection for Smart Sticker Design //
Proceedings of the International Convention MIPRO 2021 / Skala, K. (ur.). Rijeka: IEEE, 2021. str. 1042-1045
doi:10.23919/mipro52101.2021.9596662

Project title:

Development of an expert system for food production and processing management

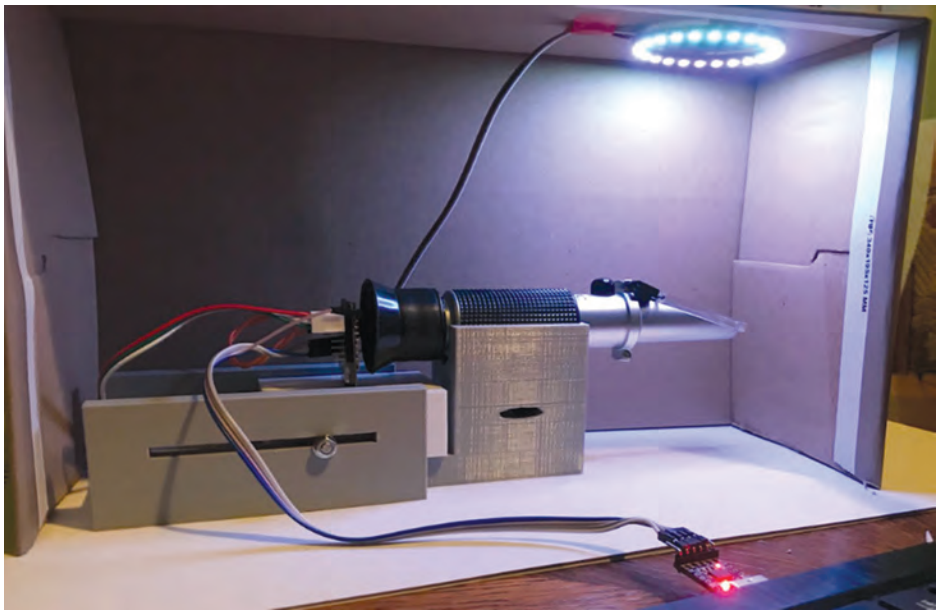
Supported by the European Regional Development Fund (EFRR) under project KK.01.1.1.07.0036

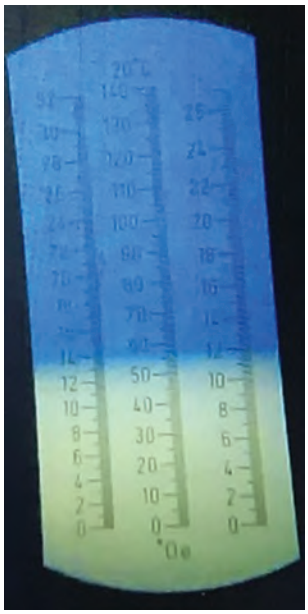
Link: https://www.ferit.unios.hr/dokumenti/projekti/projekti-europskog-fonda-za-regionalni-razvoj/Obrazac%20za%20web_Razvoj%20ekspertnog%20sustava.pdf

Solution:

Expert system for intelligent agriculture – ESIA

The expert system manages the production and processing of wine. The primary purpose is to achieve the desired wine quality. The expert system must provide guidance and actions based on machine learning techniques. The system measures, monitors, and alerts winemakers and winery personnel about critical aspects of the wine-making and storage processes. The proposed solution is based on an Internet of Things (IoT) system that works in conjunction with embedded sensors.





Publications:

Kubat, Toni; Kovacevic, Ivana; Aleksi, Ivan; Matić, Tomislav
Sugar/ethanol level measurement in liquids using analog refractometer and digital image processing // PROCEEDINGS OF ELMAR-2022 / Muštra, Mario ; Zovko-Cihlar, Branka ; Vuković, Josip (ur.). Zagreb: IEEE, 2022. str. 153-157 doi:10.1109/elmar55880.2022.9899784 (predavanje, međunarodna recenzija, cjeloviti rad (in extenso), znanstveni)

Kovačević, Ivana; Keser, Tomislav; Miling, Robert
Winery Monitoring System: A Semi-automated Solutions for Product Quality Maintenance and Production Assistance // Proceedings of 30th International Conference on Organization and Technology of Maintenance (OTO 2021) / Glavaš, Hrvoje ; Hadzima-Nyarko, Marijana ; Karakašić, Mirko ; Ademović, Naida ; Avdaković, Samir (ur.). Cham: Springer, 2022. str. 414-424 doi:10.1007/978-3-030-92851-3_31

Project title:

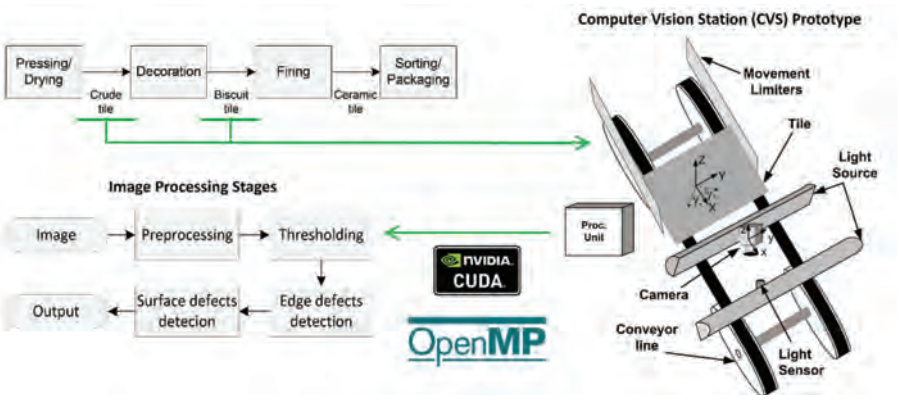
Computer vision station prototype for biscuit tiles quality control

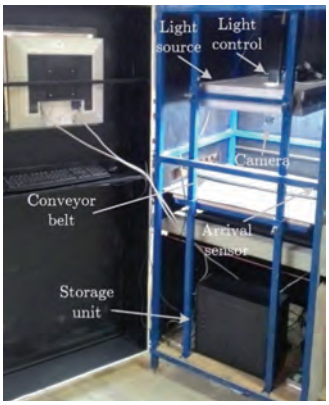
Supported by EU Framework Programme for Research and Technological Development FP7
under project TETRACOM

Solution:

CVS prototype

In the industry, biscuit and crude tiles are not visually inspected for defects. Developed CVS prototype is tested for visual inspection of crude/biscuit tiles. It consists of mechanical construction and a vision system with a camera, lighting, and an industrial computer with a touch screen monitor. The system captures, segments the tile images and detects defects on crude tiles (before glazing) or biscuit tiles (before burning – kiln entry). Tiles with detected defects are rerouted from the conveyor line.





Publications:

Matić, Tomislav; Vidović, Ivan; Hocenski, Željko
Face Template Matching for Ink-Jet Printed Biscuit Tiles //
PROCEEDINGS OF International Conference on Smart Systems and Technologies 2017(SST 2017) / Žagar, Drago ; Martinović, Goran ; Rimac Drlje, Snježana ; Miličević, Kruno (ur.). Osijek: Faculty of Electrical Engineering, Computer Science and Information Technology Osijek, 2017. str. 239-244 (predavanje, međunarodna recenzija, cjeloviti rad (in extenso), znanstveni)

Matić, Tomislav; Aleksi, Ivan; Hocenski, Željko; Kraus, Dieter
Real-time Biscuit Tile Image Segmentation Method Based on Edge Detection //
ISA transactions, 76 (2018), 246-254 doi:10.1016/j.isatra.2018.03.015

Aleksi, Ivan; Sušac, Filip; Matić, Tomislav
Features Extraction and Texture Defect Detection of Sawn Wooden Board Images //
2019 27th Telecommunications Forum. Beograd: Academic Mind, 2019. str. 317-320
doi:10.1109/TELFOR48224.2019.8971381

Sušac, Filip; Matić, Tomislav; Aleksi, Ivan; Keser, Tomislav
Multi-line signal change detection for image segmentation with application in the ceramic tile industry //
Bulletin of the Polish Academy of Sciences-Technical Sciences, 69 (2021), 3; e137121, 11
doi:10.24425/bpasts.2021.137121

Zorić, Bruno; Matić, Tomislav; Hocenski, Željko
Classification of biscuit tiles for defect detection using Fourier transform features //
SA Transactions (2021) doi:10.1016/j.isatra.2021.06.025

Project title:

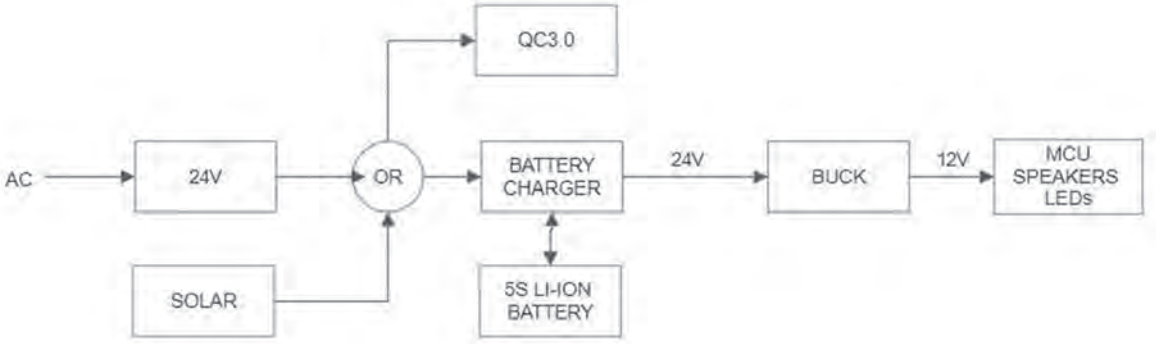
Investing in research activities with the aim of developing a new product line

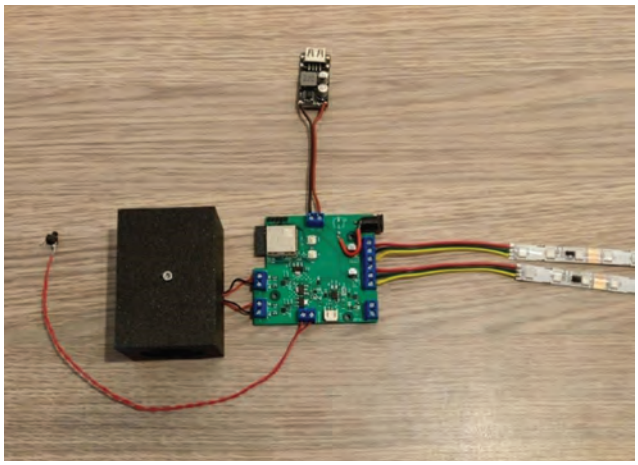
Supported by the European Regional Development Fund (EFRR) under project KK.01.2.1.02.0029

Solution:

Design and development of a computer system as a fundamental component of "smart furniture"

We have developed a computer system for smart furniture that allows streaming audio files from a mobile device with Bluetooth technology and controlling ambient LED lighting. The developed system is powered by the regular power grid or by lithium-ion batteries with a solar panel when no power grid is available.





Publications:

Blažević, Damir; Bukovčan, Mario; Keser, Tomislav; Nenadić, Krešimir
Conceptual Design of Smart Furniture: A Case Study. //
Proceedings of 30th International Conference on Organization and Technology of Maintenance (OTO 2021) / Glavaš, Hrvoje ; Hadzima-Nyarko, Marijana ; Karakašić, Mirko ; Ademović, Naida ; Avdaković, Samir (ur.).
Cham: Springer, 2022. str. 353-363 doi: 10.1007/978-3-030-92851-3_26

Blažević, Damir; Bukovčan, Mario; Rozing, Goran; Stević, Marin
Dizajniranje nove linije proizvoda s osvrtom na mogućnost recikliranja //
Zbornik radova sa 2. konferencije o slavonskom modelu zbrinjavanja komunalnog otpada - Slamko 2021. / Galović, O. (Ed). Osijek: Panon – Institute for strategic studies.

Project title:

Active sensor monitoring network and environmental evaluation for protection and wiSe use of WETLANDS and other surface waters

Supported by the Interreg IPA CBC Interreg Croatia-Serbia, under project HR-RS135

Link: http://senswetlands.ferit.hr

Solution:

System for semi-automated physio-chemical quality analysis of surface water

We have developed a system for semi-automated physio-chemical quality analysis of surface water, utilizing procedures for determining physio-chemical parameters of the observed water surfaces by an in-situ method, as well as through continuous monitoring and measurement of surface water quality in the form of a unified data system with an international aspect.

Publications:

Brkić, Miodrag; Keser, Tomislav; Vasiljević Toskić, Marko; Radić, Jelena; Arbanas, Miloš
Quality assessment of system for automated multi-node environmental water parameter monitoring //
42nd internatinal convention oninformation and iommunication technology, electronics and microelectronics, MIPRO, Opatija, Croatia, 2019. str. 167-171

Project title:

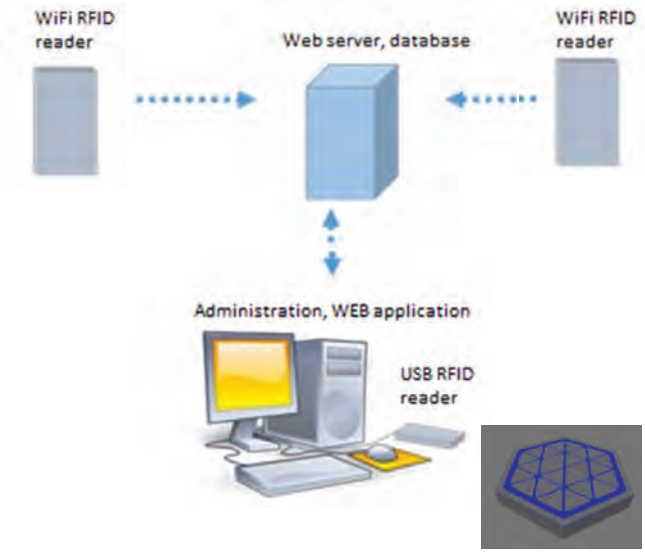
RFID evidence

Internal FERIT project

Solution:

RFID working hours management system

We have developed a wireless system for recording arrivals/departures of employees with RFID consists of software in the form of a web application and hardware in the form of a USB RFID reader and one or more wifi RFID readers. With the USB reader, it is possible to enter RFID cards of employees and save them in the database. With wifi reader(s), through a protected wifi network, employees can record their arrivals and departures. The web interface allows the administrator to view the arrivals and departures of employees in a given period per day and in detail, manually edit arrivals and departures, archive data and export the displayed data in the excel format.



Project title:

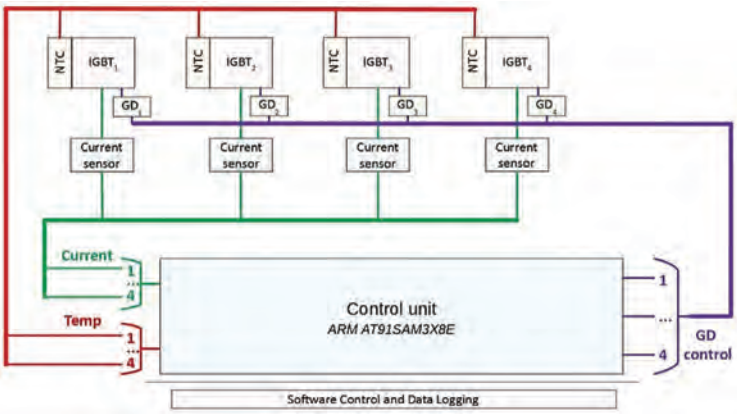
Smart load balancing for parallel HV switches

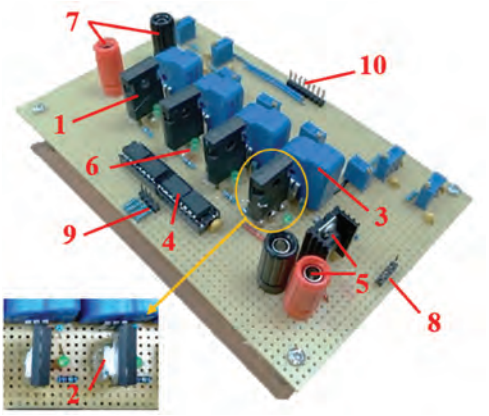
Supported by Rimac Automobili d.o.o.

Solution:

Temperature control concept for parallel IGBTs operation

A prototype is developed for measuring and testing of current and voltage unevenness on characteristic IGBT waveforms. Moreover, IGBT parameters are identified, which might cause a load-balancing problem for a larger number of parallel IGBTs. Control algorithms are developed and tested on four parallel IGBTs.





Publications:

Brandis, Andrej; Pelin, Denis; Matić, Tomislav
Balancing Methods for IGBTs Paralleling in Voltage Source Inverters in Automotiv Electric Drives //
38th Conference on Transportation Systems with International Participation AUTOMATION IN TRANSPORTATION 2018 / Šakić, Željko (ur.). Osijek: KoREMA, 2018. str. 107-113

Brandis, Andrej; Pelin, Denis; Matić, Tomislav; Topić, Danijel
Temperature Control Concept for Parallel IGBT Operation //
Electronics, 10(4) (2021), 429, 17 doi:10.3390/ electronics10040429

V. Research Group for Advanced Industrial Systems

Link: https://www.ferit.unios.hr/research-groups/IG06

Research Group for Advanced Industrial Systems is conducting research in fields of electrical machines, power electronics, electrical and process measurements, materials and industry ecology which are integrated in research of industrial drives as a foundation of industry production. Afore mentioned research is coherent with modern trends in ecology, energy efficiency improvement and complex system optimization in accordance with digital transformation principles.

Research in field of electrical machines is concerned with electrical machines modelling and parameter identification, as well as with advanced electrical drives control methods with purpose of industry drive operation optimization and energy efficiency improvement. The research is complemented with modern developed RCP and HIL systems application for research verification, product testing and teaching in fields of electrical drives.

Research in field of modelling and parameter identification is strongly supported by research in field of numerical methods. Research in field of numerical methods is oriented to mathematical modelling, simulation and analysis of electrical devices (electromagnetic fields, thermal and mechanical stresses). The numerical methods and optimization techniques are also extensively used for solving the optimization and estimation problems in electrical power grid through developed co-simulation approaches.

In field of industrial measurements, the emphasis is on new measurement methods development for electrical and non-electrical values in industrial facilities, as well as on development of new methods for estimation and expression of measurement uncertainty. Researches in this field also cover connection of business logistics with production process and improvement of industrial systems in accordance with digital transformation principles. The information technology application for digital transformation of metrology in broader context should also be pointed out, including the cyber security issues as well.

In field of power electronics research is specifically oriented to three-phase voltage converter control methods for energy storage, so called battery energy storages, using HIL methods. According to growing trends of renewable energy sources applications, the emulation procedures for electrical energy production process in photo-voltaic systems are developed. Additionally, the bifurcation behavior for one-quadrant chopper without galvanic isolation and rectifier feedback effects on AC power grid are investigated.

The reserach group works through four laboratories:

- *Electrical machines and drives laboratory*
- *Power electronics laboratory*
- *Industrial measurements laboratory*
- *Applied numerical analysis in electrical engineering laboratory*

Project title:

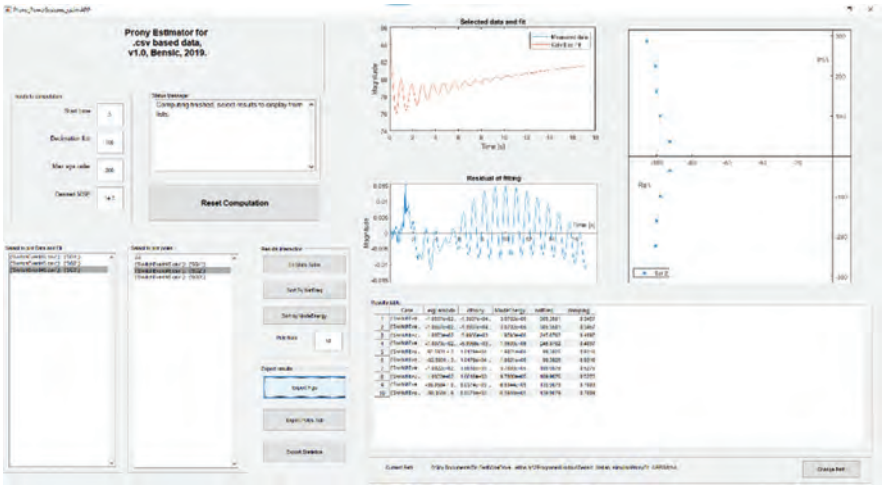
Applied optimisation and estimation in electrical power engineering and electrical machines engineering using evolutionary algorithms

Internal FERIT project IZIP 2016

Solution:

Python-MIDACO-Matlab, Python-MIDACO-OpenDSS co-simulation based optimisation frameworks

The developed co-simulation frameworks are used for computing parameter estimates of an induction motor, Prony estimation and optimal Prony estimation of electrical system modes from transient data, optimal sampling time for data reduction and solving optimisation problems for DG allocation and Var compensation in the electrical grid.



Publications:

Benšić, Tin; Varga, Toni; Barukčić, Marinko; Jerkovič Štil, Vedrana
Optimization Procedure for Computing Sampling Time for Induction Machine Parameter Estimation //
Applied Sciences-Basel, 10 (2020), 3222, 17 doi:10.3390/app10093222

Barukčić, Marinko; Varga, Toni; Jerković Štil, Vedrana; Benšić, Tin
Node voltage estimation in distribution networks by simple ANN //
Proceedings of IEEE 2nd International Conference and Workshop in Obuda on Electrical and Power Engineering, Budimpešta, 2019. str. 155-159, doi:10.1109/CANDO-EPE47959.2019.9110957

Barukčić, Marinko; Hederić, Željko; Benšić, Tin; Ćorluka, Venco
Optimization by the Evolutionary Algorithm and FEM Tools: Example on Switched Reluctance Motor //
7th Symposium on Applied Electromagnetics SAEM 18 Conference Proceedings /
Seme, Sebastijan ; Hadžiselimović, Miralem ; Štumberger, Bojan (ur.).
Podčetrtek, Slovenia, 2018. str. 45-51 doi:10.18690/978-961-286-241-1.6

Project title:

Application of Chaos Theory in Encryption – CryptoChaos

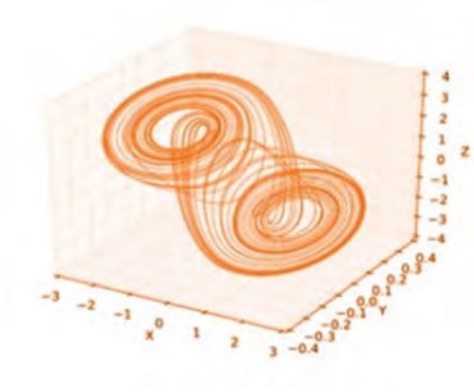
Supported by the Business and Innovation Agency of the Republic of Croatia (BICRO) under project PoC4_12_15-U-1

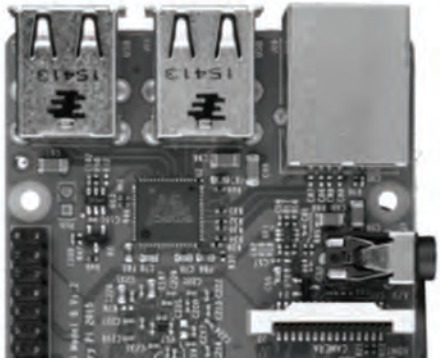
In cooperation with IG02, IG05, IG08 and IG10

Solution:

Ranger: stand-alone random number generator

"Ranger" is a stand-alone true random number generator based on chaos theory, for which the Institute for Information Systems Security of the Republic of Croatia (https://www.zsis.hr/) has issued a certificate of applicability in cryptographic systems for the protection of nationally classified data of all secrecy degrees.





Project title:

Chaos theory-based data encryption

Commercial project

In cooperation with IG02, IG05 and IG10

Solution:

Cryptographic system

The developed cryptographic system is based on chaos theory and related properties (e.g. apparent randomness) and is used to encrypt data, including possible application to block cipher modes. It includes interfaces for using smart cards as HSM. As the core of the algorithm, various chaotic systems can be used - already known as Lorenz or Chua but also new and customised ones.

Project title:

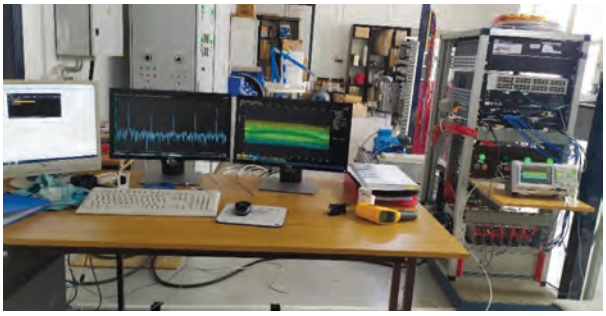
Co-simulation procedures development for soft computing application in power engineering

Supported by the Croatian Science Foundation under project UIP-2017-05-8572

Solution:

HIL co-simulation system for motor control optimisation and testing

The HIL co-simulation system using the advanced OPAL-RT real time simulator together with IMPERIX power electronics is developed. The system can readily be used for advanced HIL testing, electric motor rapid control prototyping and control response optimisation and analysis in both MIL and HIL approaches through a co-simulation framework based on Pyhton, C, Matlab. It can also be used for electric motor and drive testing for motors up to 6 kW.



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Jukić, Domagoj Krešimir; Varga, Toni; Benšić, Tin; Jerković Štil, Vedrana; Barukčić Marinko
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The 10th International Conference on Power Electronics, Machines and Drives
Nottingham, 2020. 307, 6, doi:10.1049/icp.2021.1097

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Proceedings of International Conference on Smart Systems and Technologies 2018. /
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Continuous Control Set Predictive Current Control for Induction Machine //
Applied Sciences-Basel, 11 (2021), 13; 6230, 14, doi:10.3390/app11136230

Project title:

Automated induction motor test bench

Internal FERIT project supported by Danieli Systec d.o.o.

Solution:

Small scale automated induction motor test bench

The IG06 team has developed an automated induction motor test bench. The system includes a precision measurement system for the device under test, an automated loading motor for testing and an automation system to control the entire test procedure. The automation system includes HMI development for operators that monitors both the loading motor and the device under test and allows the operator to use the system in torque or speed based set points, measure temperature and automated winding resistance measurements.

VI. Research Group for Advanced Power Technologies and Systems

Link: https://www.ferit.unios.hr/research-groups/IG07

The research group for advanced power technologies and systems was established in 2018 within the Department for power engineering at the Faculty of Electrical Engineering, Computer Science and Information Technology (FERIT), Josip Juraj Strossmayer University of Osijek.

More info on research group web-site in English: reslab.ferit.hr

The research group is involved in power engineering research and has considerable experience in implementing (international) scientific and professional projects with emphasis on integrating renewable energy sources into the power system from the aspect of smart power grids and microgrids, electricity markets, power protection, stability and quality.

- *The focus is on the optimisation of photovoltaic systems and power plants using renewable energy sources (RES), development of mathematical and computer models for power plant simulations using RES, studies on the impact of RES on the power system and smart grid protection, and energy efficiency and application of efficient technologies in lighting systems and energy management.*
- *The research group deals with advanced protection coordination of active grids with a high RES share, power flow optimisation, calculations of short circuits, stability and reliability of the power system and its components, analysis of oscillatory stability of the power system, parameterisation of automatic voltage regulators (AVR) and generator excitation, as well as PSS and FDS stabilisers.*
- *The group performs electricity market analyses from the prospective of market participants, techno-economic analyses of generation and network plants and management optimisation of a modern power system, dimensioning of grounding systems, measurements of the ground resistance, calculations of the electric arc and issues guidelines on the selection of personal protection equipment.*
- *Measurements of low frequency (50 Hz) electromagnetic fields are performed according to the HRN IEC 61786 standard in an accredited laboratory for low frequency measurements, as well as in all types of power and industrial plants and near renewable power sources. Finally, the group also controls the power quality in accordance with the HRN EN 61000-4-30 standard in line with the restrictions of the HRN EN 50160 standard on voltage properties in public distribution networks.*

Research group for Advanced Power Technologies and Systems and Department sceintific projects:

- *ProPowerNet Prosumer-rich distribution power network, Croatian Science Foundation (HRZZ) project, 2021 - 2025*
- *USBSE Connected Stationary Battery Energy Storage, European Regional Development Fund, Operational Programme: Competitiveness and Cohesion 2014. - 2020.*
- *RESCUE Renewable Energy Sources for smart sustainable health Centers, University Education and other public buildings, Interreg IPA CBC Croatia-Serbia project, 2019 – 2021*
- *SEGIP Smart Electrical Grid Information Platform, European Foundation for Regional Development project, 2019-2021*
- *WECANet A pan-European Network for Marine Renewable Energy with a focus on Wave Energy, Horizon 2020 COST project, 2018-2022*
- *e-ProfEng: Innovative Lifelong e-Learning for Professional Engineers, ERASMUS+ project, 2017-2020*
- *RuRES Renewable energy sources and energy efficiency in the function of rural development, Interreg CBC Croatia Hungary project, 2017-2018*
- *REG-PHOSYS Photovoltaic Systems as Actuators of Regional Development, IPA cross-border Croatia Hungary project, 2013-2014*
- *Joint research and educational framework in RES in pannonian parts of Serbia and Croatia, bilateral Serbian-Croatian project 2011-2012*
- *UNIREG IMPULSE Regional Universities as Generators of Development, IPA cross-border Croatia Hungary, 2010-2011*
- *EMSA Electricity Market Simulation and Analysis, TEMPUS project,2008-2010*

The long list of technical expertise and solutions for industry as a result of decades of cooperation, studies, and projects carried out by the Department for power engineering includes:

- *designing, technical analysis, and assistance, supervising and managing energy power plants both small renewable and conventional,*
- *designing, parametring, bringing into operation and maintaining intelligent electrical installations KNX/EIB in civil engineering, conducting technical-economic analysis and cost-effectiveness studies for energy power plants,*
- *designing Sustainable Energy Action Plan (SEAP) and energy consumption balance for the needs of industry, local self-government and private users, energy examinations and reviews, conducting analysis and energy efficiency studies, and issuing energy certificates in civil engineering, planning*
- *designing systems of public lightning, lightning systems for interior and exterior workspaces,*
- *planning, designing and providing technical assistance regarding energy efficiency*
- *conducting studies regarding the effect on power network including protection coordination, power flow and voltage drop analysis, losses and n-1 safety of transmission for both distribution and industrial networks analysis,*
- *reliability and availability of transmission and distribution networks analysis, studies of circuit breakers, analysis of angle and voltage stability of transmission for both distribution and industrial networks,*
- *measurements and analysis of electrical and low-frequency magnetic fields and power quality*
- *infrared thermographic research in various fields of technical sciences*
- *energy audits of buildings and analysis of energy flows in the industry.*

Project title:

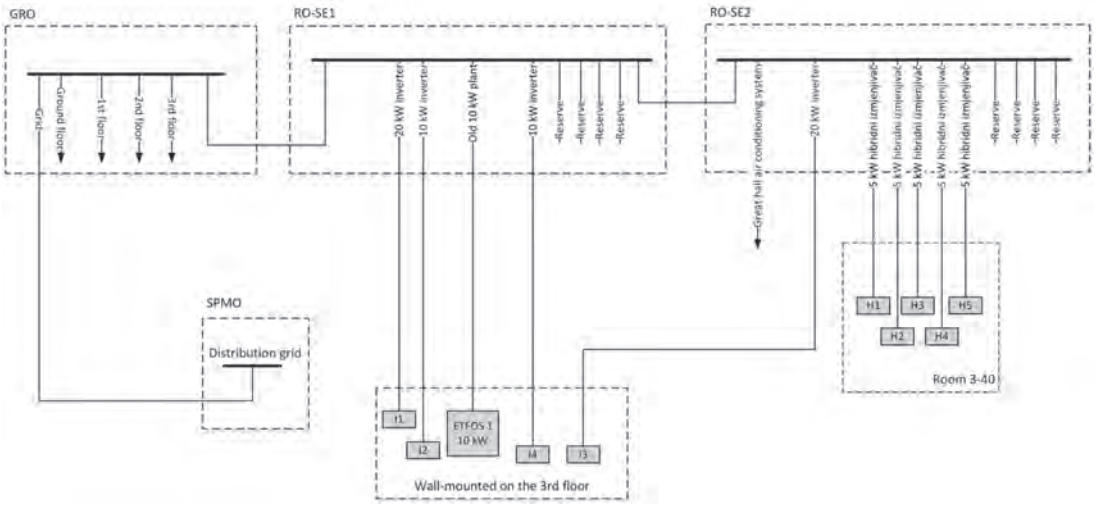
Renewable Energy Sources for smart sustainable health Centers, University Education and other public buildings (RESCUE)

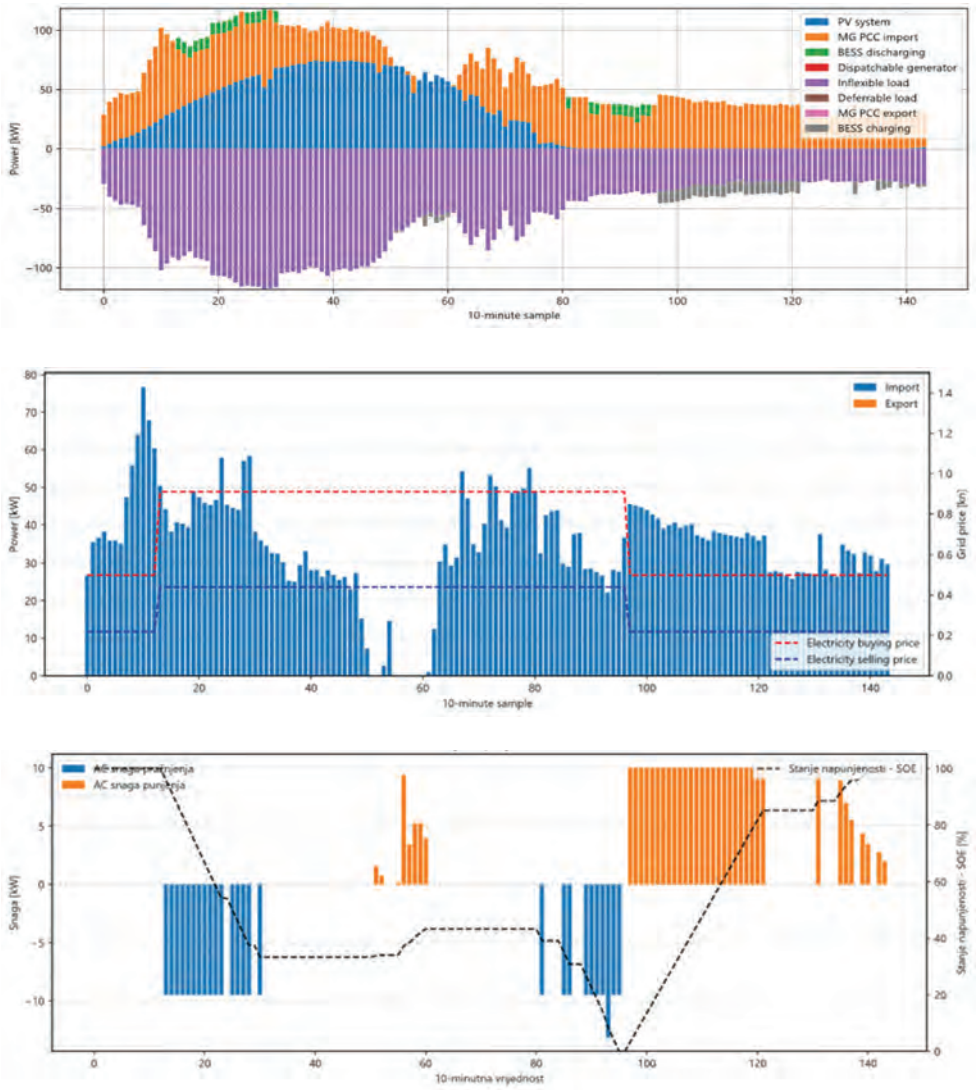
Supported by the Interreg IPAII CBC Croatia-Serbia under project HR-RS303

Solution:

FERIT hybrid PV-based microgrids with building energy management system

Within the RESCUE project, two FERIT buildings are realized as PV-based microgrids equipped with SCADA for optimal energy management. The installed power of the generation systems in Trpimirova street is 95 kW while the installed power of the generation systems in Cara Hadrijana street is 40 kW. The hybrid storage system consists of five 5 kW hybrid inverters equipped with PVs and lithium-ion battery packs with a total installed capacity of 46 kWh. Building a power system enables islanded operation of a part of the building microgrid. The FERIT building energy management systems continuously monitor meteorological parameters at the micro-location of the FERIT buildings. Furthermore, electricity generation by the renewable energy systems, building consumption and power quality are monitored.





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Performance evaluation of simple PV microgrid energy management system //
Proceedings of 2020 International Conference on Smart Systems and Technologies (SST) (pp. 213-218).
Osijek, Croatia: IEEE.

Project title:

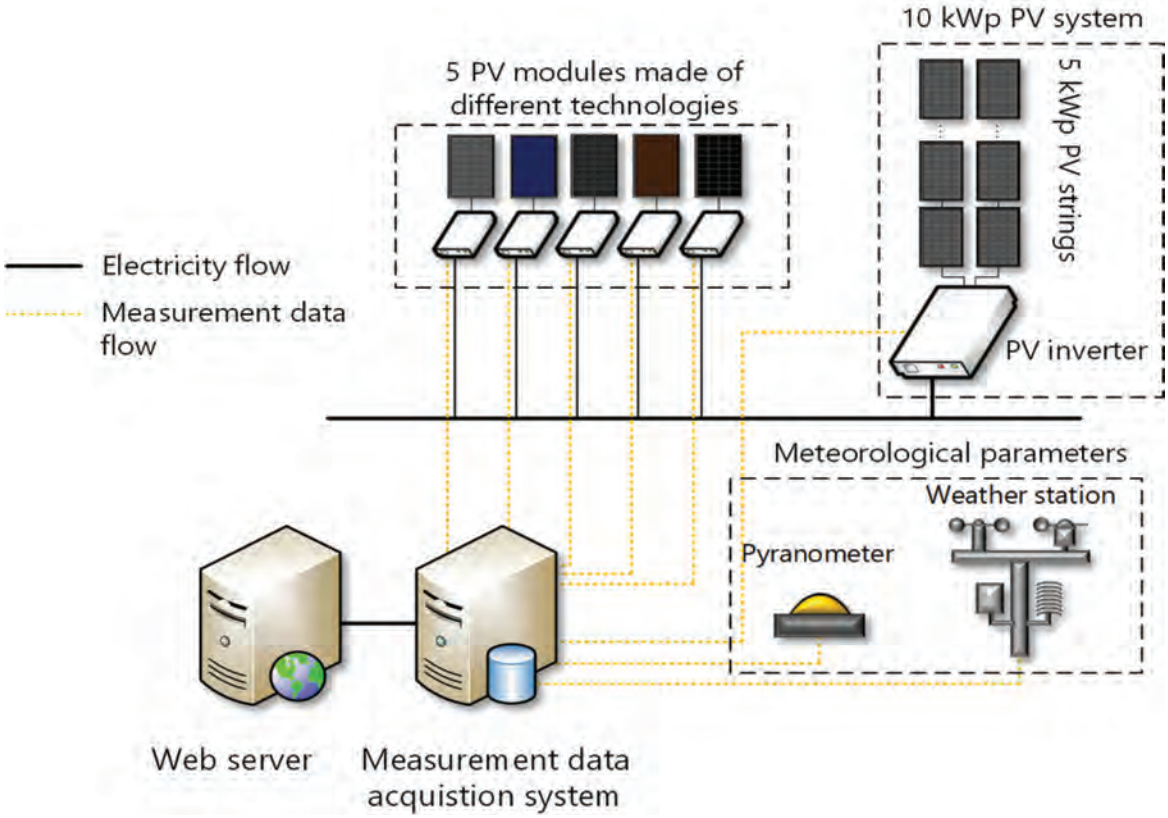
Online measurement database in the Laboratory for renewable energy sources

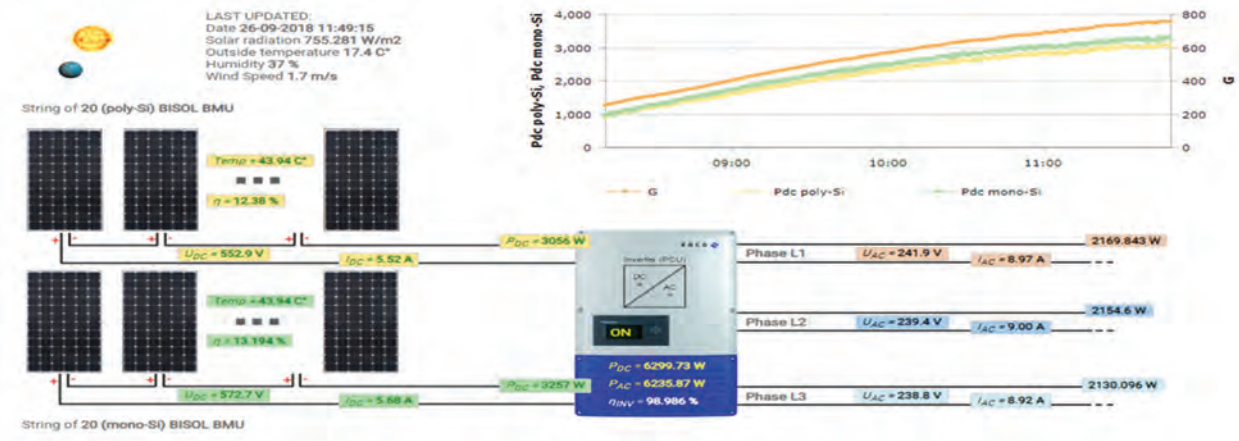
Internal FERIT project IZIP 2017

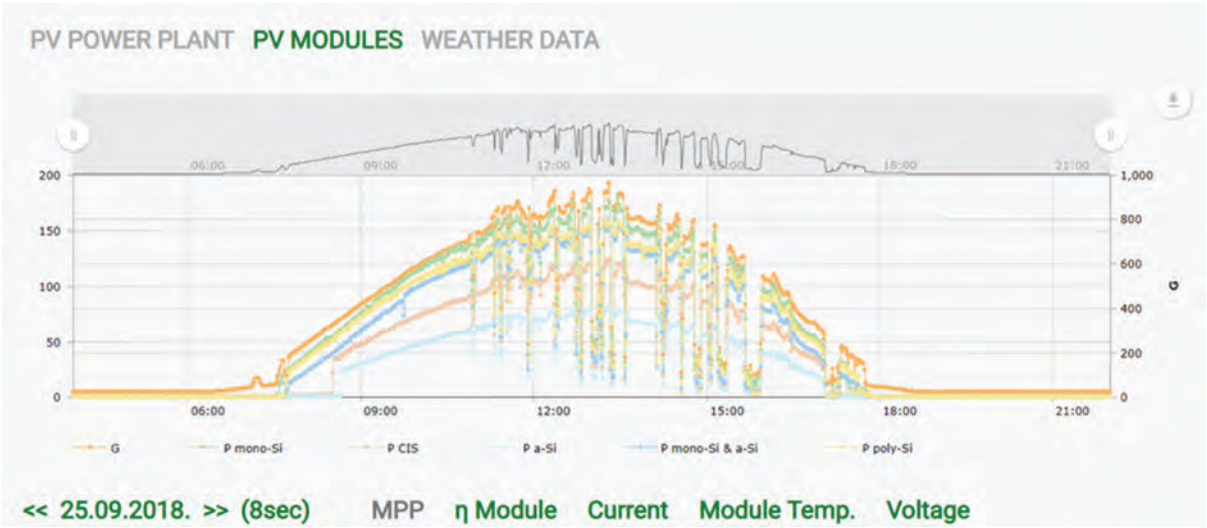
Solution:

Data acquisition system for photovoltaics performance

The online measurement database developed in the Laboratory for renewable energy sources continuously measures electrical parameters of PV technologies and meteorological parameters at the test site. The system measures, processes and stores measurements for long-term performance analysis of photovoltaics. The measurement data acquisition system consists of three main parts: 5 PV module technologies (monocrystalline silicon, polycrystalline silicon, amorphous silicon, copper indium selenide - CIS, heterojunction with intrinsic layer - HIT), 10 kWp PV system (2 PV technologies), data acquisition system of meteorological parameters at the test site.







PV POWER PLANT **PV MODULES** WEATHER DATA

Measured data is sampled and averaged of approx. 60 values per minute. Date: 2018-09-26 Last record: 11:48 Difference: 300 sec			Monocrystalline silicon (mono-Si) BISOL BMO Read specifications $A = 1.40454\ m^2$ (angle 7°) $P_{MPP\ (STC)} = 250\ W$ $\eta_{MODULE\ (STC)} = 15.3\ \%$					*NOT CONNECTED YET!* Copper indium selenide (CIS) SOLAR FRONTIER SF-150 Read specifications $A = 1.16375\ m^2$ (angle 7°) $P_{MPP\ (STC)} = 150\ W$ $\eta_{MODULE\ (STC)} = 12.2\ \%$					Amorphous silicon (a-Si) MASDAR MPV100-S Read specifications $A = 1.4301\ m^2$ (angle 7°) $P_{MPP\ (STC)} = 100\ W$ $\eta_{MODULE\ (STC)} = 7.0\ \%$					Monocrystalline silicon (mono-Si) + Amorphous silicon (a-Si) Panasonic HIT N240 Read specifications $A = 1.107072\ m^2$ (angle 7°) $P_{MPP\ (STC)} = 240\ W$ $\eta_{MODULE\ (STC)} = 19.0\ \%$					Polycrystalline silicon (poly-Si) BISOL BMU Read specifications $A = 1.40454\ m^2$ (angle 7°) $P_{MPP\ (STC)} = 250\ W$ $\eta_{MODULE\ (STC)} = 15.3\ \%$				
Time	Temp	Solar	T_1	I_{MPP}	U_{MPP}	P_{MPP}	η_1	T_2	I_{MPP}	U_{MPP}	P_{MPP}	η_2	T_3	I_{MPP}	U_{MPP}	P_{MPP}	η_3	T_4	I_{MPP}	U_{MPP}	P_{MPP}	η_4	T_5	I_{MPP}	U_{MPP}	P_{MPP}	η_5
11:48	14,38	755,366	43,654	4,922	28,28	139,208	13,121%	43,964	1,136	84,069	95,494	10,863%	39,649	0,872	73,672	64,238	5,947%	38,162	3,437	37,281	128,144	15,324%	43,778	4,665	27,574	128,599	12,121%
11:47	14,31	757,395	43,482	4,797	28,742	137,832	12,957%	43,801	1,136	84,152	95,573	10,843%	39,523	0,856	73,792	63,196	5,835%	38,1	3,448	37,406	128,978	15,382%	43,623	4,533	27,919	126,505	11,892%
11:46	14,13	757,073	43,215	4,742	28,813	136,637	12,85%	43,532	1,135	84,191	95,58	10,849%	39,404	0,861	74,036	63,725	5,886%	38,04	3,433	37,278	127,983	15,27%	43,366	4,453	27,824	123,884	11,651%
11:45	14,25	754,425	43,081	4,683	29,127	136,442	12,877%	43,3	1,148	83,962	96,37	10,976%	39,173	0,869	73,894	64,254	5,956%	37,907	3,403	37,582	127,884	15,312%	43,213	4,391	28,006	123,032	11,611%
11:44	14,13	752,881	43,155	4,75	28,768	136,738	12,931%	43,236	1,123	84,038	94,4	10,774%	38,962	0,854	73,511	62,752	5,828%	37,752	3,424	37,437	128,197	15,381%	43,101	4,512	27,749	125,306	11,85%
11:43	14,25	748,609	43,177	4,753	28,941	137,674	13,093%	43,172	1,12	84,038	94,091	10,8%	38,861	0,852	73,999	63,054	5,89%	37,703	3,39	37,629	127,566	15,392%	42,982	4,504	27,825	125,464	11,932%
11:42	14,19	751,93	43,019	4,703	28,744	135,313	12,812%	43,142	1,13	83,71	94,623	10,813%	38,75	0,841	73,875	62,12	5,777%	37,543	3,402	37,441	127,403	15,305%	42,815	4,488	27,74	124,64	11,802%
11:41	14,19	750,751	42,798	4,766	28,844	137,606	13,05%	43,039	1,128	84,034	94,787	10,849%	38,569	0,852	74,102	63,132	5,88%	37,391	3,417	37,28	127,391	15,328%	42,677	4,514	27,817	125,682	11,919%
11:40	14,25	752,832	42,439	4,785	28,877	138,286	13,079%	42,742	1,142	83,907	95,821	10,937%	38,348	0,86	73,752	63,414	5,89%	37,095	3,398	37,402	127,086	15,248%	42,379	4,526	27,794	125,894	11,906%
11:39	14,31	750,322	42,109	4,898	28,745	140,838	13,364%	42,409	1,128	83,88	94,586	10,832%	38,011	0,852	73,752	62,823	5,855%	36,722	3,412	37,364	127,485	15,347%	42,068	4,577	27,875	127,612	12,109%
11:38	14,19	744,869	41,869	4,848	28,882	140,023	13,384%	42,119	1,13	83,937	94,838	10,941%	37,666	0,844	74,263	62,669	5,883%	36,438	3,397	37,802	128,406	15,571%	41,825	4,533	28,155	127,631	12,199%
11:37	13,94	744,18	41,732	4,72	28,519	134,585	12,876%	41,831	1,13	83,536	94,413	10,902%	37,488	0,843	74,042	62,417	5,865%	36,31	3,378	37,773	127,583	15,486%	41,663	4,342	28,07	121,917	11,664%
11:36	14,13	745,448	41,677	4,814	28,89	139,001	13,276%	41,792	1,125	84,1	94,567	10,901%	37,603	0,837	74,053	61,974	5,813%	36,4	3,393	37,595	127,557	15,457%	41,632	4,465	28,158	125,645	12%
11:35	14,31	745,983	41,589	4,665	29,296	136,629	13,04%	41,732	1,126	84,199	94,824	10,923%	37,688	0,845	74,327	62,79	5,886%	36,384	3,381	37,969	128,359	15,543%	41,631	4,399	28,385	124,819	11,913%
11:34	14,19	744,227	41,473	4,897	28,454	139,293	13,326%	41,544	1,109	83,821	92,951	10,732%	37,668	0,847	73,859	62,553	5,877%	36,288	3,376	37,665	127,159	15,434%	41,483	4,559	27,769	126,509	12,103%

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Project title:

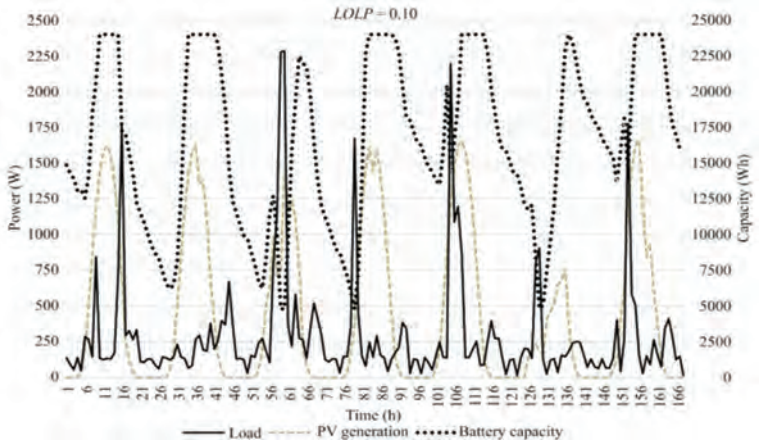
Renewable energy source and energy efficiency in the function of rural development

Supported by the Interreg V-A HU-HR Co-operation Programme 2014-2020 under project RuRES, HUHR/1601/3.1.1/0033

I **Solution:**

Sizing of the off-grid PV systems

This solution provides methods and models for determining the optimal size of off-grid PV systems.



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Energies, 15, 3, 795. https://doi.org/10.3390/en15030795

Project title:

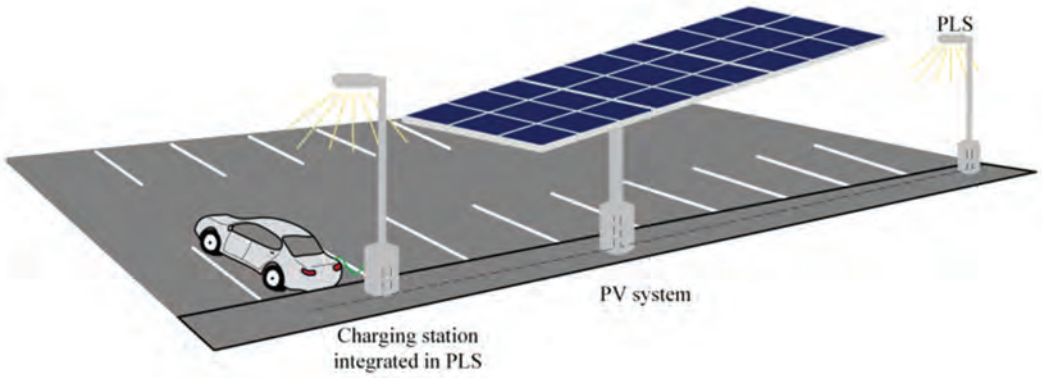
Integration of electric vehicle charging stations into the microgrid through the system of public lighting grid

Internal University project UNIOS ZUP 2018-98

Solution:

Methods for integration of charging stations for EV into the public lighting grid

This solution provides methods for integrating electric vehicle charging stations into the public lighting system, integrating PV systems and controlling the entire microgrid system during electric vehicle charging.



Publications:

Raff, R., Vuković, M., Šimić, Z., Topić, D. (2021).
Modelling of the low voltage distribution network for the integration of distributed generation and charging stations for electric vehicles // 6th International Conference on Smart and Sustainable Technologies (SpliTech) (pp. 1-6).
Bol and Split, Croatia: IEEE. https://ieeexplore.ieee.org/document/9566422

Perko, J., Topić, D., Knezević, G., Žnidarec, M. (2019).
Technical Conditions of EV Charging Stations Integration into Public Lighting Infrastructure //
2019 7th International Youth Conference on Energy (IYCE) (pp. 1-6).
Bled, Slovenia: IEEE. https://ieeexplore.ieee.org/document/8991584

Raff, R., Golub, V., Pelin, D., Topić, D. (2019).
Overview of charging modes and connectors for the electric vehicles //
2019 7th International Youth Conference on Energy (IYCE) (pp. 1-6).
Bled, Slobenia: IEEE. https://ieeexplore.ieee.org/document/8991586

Topić, D., Knežević, G., Šljivac, D., Žnidarec, M., Perko, J. (2019).
Integration of the EV charging stations into the public lighting infrastructure //
Proceedings of 2019 IEEE PES Innovative Smart Grid Technologies Europe (ISGT-Europe) (pp. 1-5).
Bucharest, Romania: IEEE. https://ieeexplore.ieee.org/document/8905590

Topić, D., Chamorro, H., Knežević, G., Rye, R., Gonzalez-Longatt, F., Sood, V. (2019).
Analysis of PV Systems and Charging Stations Integration into the Public Lighting Infrastructure //
Proceedings of 2019 IEEE PES Innovative Smart Grid Technologies Europe (ISGT-Europe) (pp. 1-5).
Bucharest, Romania : IEEE. https://ieeexplore.ieee.org/document/8905562

Project title:

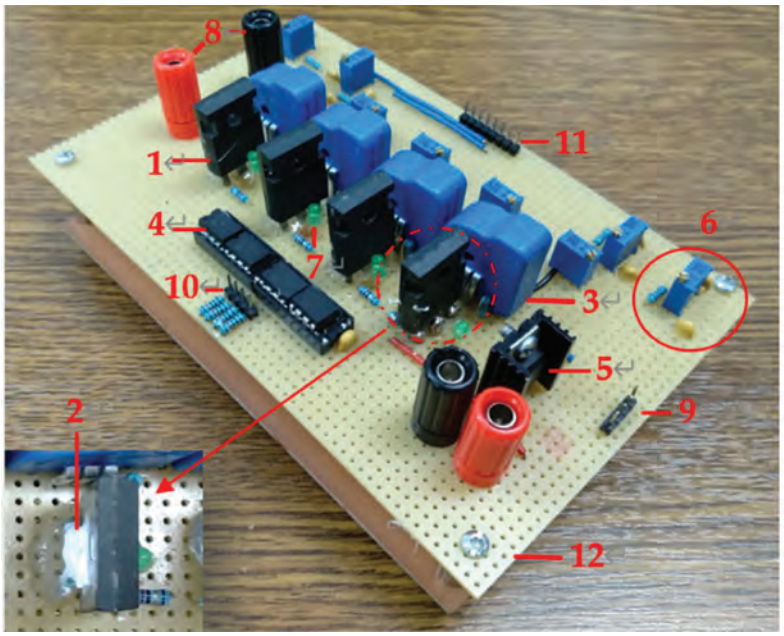
Connected stationary battery energy storage (USBSE)

Supported by the European Regional Development Fund (EFRR) under project KK.01.1.1.04.0034

Solution:

Temperature control concept for parallel IGBT operations

This solution addresses the concept of load balancing in the operation of parallel insulated gate bipolar transistors (IGBTs) where the temperature is used as the main control parameter. In parallel IGBT operation, it is essential to ensure uniform load distribution across all IGBTs. Two basic algorithm concepts for temperature control were developed for the purpose of balancing. A test model based on parallel IGBTs operation was assembled in a laboratory and the developed algorithms were tested for the chosen parameters.



Publications:

Brandis, A., Pelin, D., Matić, T., Topić, D. (2021).
Temperature Control Concept for Parallel IGBT Operation //
Electronics, 10, 429. https://doi.org/10.3390/electronics10040429

Brandis, A., Pelin, D., Topić, D., Tomašević, B. (2020).
Active Li-ion Battery Charge Balancing System Based on Flyback Converter //
2020 IEEE 11th International Symposium on Power Electronics for Distributed Generation Systems (PEDG)
(pp. 164-169). Dubrovnik, Croatia: IEEE. https://ieeexplore.ieee.org/document/9244396

Brandis, A., Pelin, D., Topić, D., Knežević, G. (2021).
Half-Bridge Voltage Source Inverter Control Development Using HIL System //
2021 21st International Symposium on Power Electronics (Ee) (pp. 1-6).
Novi Sad, Serbia: IEEE. https://ieeexplore.ieee.org/document/9628241

Project title:

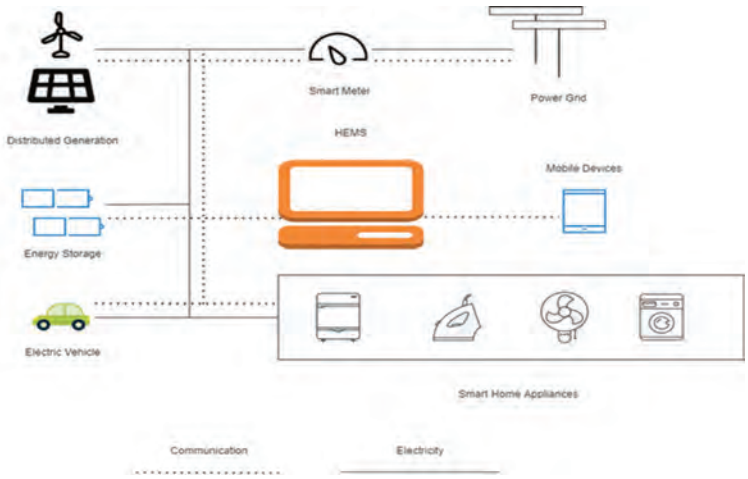
Prosumer-rich distribution power network (ProPowerNet)

Supported by the Croatian Science Foundation under project UIP-2020-02-5796

I Solution:

Optimization algorithm for maximizing the profit of a prosumer

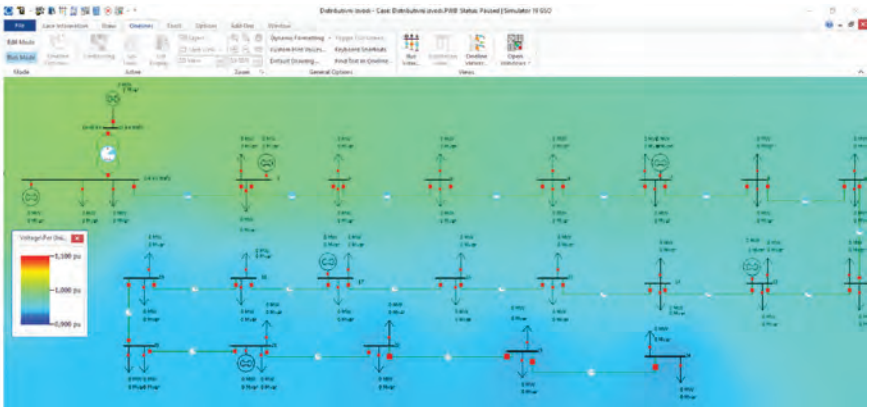
The developed optimization algorithm maximizes the profit of a prosumer taking into account different market conditions. The algorithm implements methods to eliminate uncertainties in predicting the electricity production from RES and electricity consumption of prosumers as well as integrating electric vehicles as control elements. The optimization algorithm aims to achieve the additional flexibility of prosumers, which will allow them to earn more money in the electricity market while maintaining a satisfactory comfort level.



II Solution:

Optimization algorithm for the optimal operation of a distribution network containing a significant number of prosumers

The optimization algorithm aims to include prosumers and their devices (PV inverters and electric vehicle batteries), which, on the one hand, will make the distribution network operation more flexible and, on the other hand, will provide the prosumer with an additional opportunity to earn money (in addition to selling active power and participating in the ancillary services market).



Publications:

Mišljenović, N., Stanić, M., Knežević, G., Jakab, J. (2021).
Optimal Maintenance of the Electric Vehicle Battery Storage Level in Prosumer Power Network //
30th International Conference on Organization and Technology of Maintenance (OTO 2021) (pp. 104-118),
Osijek, Croatia: Springer Nature Switzerland AG. https://doi.org/10.1007/978-3-030-92851-3_8

Šimić, Z., Topić, D., Crnogorac, I., Knežević, G. (2021).
Method for Sizing of a PV System for Family Home Using Economic Indicators //
Energies, 14, 4529. https://doi.org/10.3390/en14154529

Laboratory:

Laboratory for Electromagnetic Compatibility

Accredited Laboratory (https://www.ferit.unios.hr/2021/fakultet/emclab)

Solution:

Measurement of low-frequency magnetic and electric fields

The laboratory performs measurements of low-frequency (50 Hz) electric and magnetic fields in accordance with the standard HRN IEC 61786 Measurement of low-frequency magnetic and electric fields with respect to human exposure - Special requirements for instruments and instructions for measurements, and in accordance with the Ministry of Health (NN 146/14). For the field of testing of low-frequency electric fields, the laboratory is accredited by the Croatian Accreditation Agency according to the standard HRN EN ISO / IEC 17025, and has a permit from the Ministry of Health to perform professional activities for protection against electromagnetic radiation.

SCOPE OF ACCREDITATION

No.	Materials/Products	Type of test/Property Range	Test method
1	Sub-stations, transmission lines and other electric and magnetic field sources of frequency 50 Hz	Testing (measurement) of low-frequency electric and magnetic fields of frequency 50 Hz	HRN IEC 61786:2001 (IEC 61786:1998)

The laboratory employees have 10 years of experience in measuring electric and magnetic fields in the vicinity of electric power facilities (transformer stations, transmission lines and lines) and renewable energy sources - wind farms and biogas power plants.

II **Solution:**

Measurement and monitoring of power quality

The laboratory performs measurements and monitoring of power quality according to the standard HRN EN 61000-4-30, Test and measurement techniques - Methods of measuring the quality of electricity, and in accordance with the limitations of the standard HRN EN 50160, Voltage characteristics of electricity from public distribution networks.

The laboratory employees have 20 years of experience in measuring the power quality in electric power facilities, industrial plants and preparing studies on the impact of renewable energy sources on the electric power network.

Publications:

Klaić, Z., Marić, P., Šljivac, D., Stojkov, M., Žnidarec, M., Primorac, M., Kraus, Z. (2021).
Studija novih tehnoloških rješenja za niskonaponske mreže obzirom na problematiku nelinearnosti i nesimetričnosti opterećenja, te potrebu za kompenzacijom jalove snage, Osijek.

Klaić, Z., Fekete, K., Primorac, P. (2021).
Utjecaj industrijskog potrošača „dmd" zajedničko proizvodno uslužni obrt na kvalitetu električne energije u niskonaponskoj distribucijskoj mreži HEP ODS-a DP Elektra Vinkovci. Osijek

Klaić, Z., Knežević, G. (2020).
Mjerenje kvalitete električne energije u industrijskom postrojenju Tang D.O.O. Nova Gradiška, Osijek

Klaić, Z., Kraus, Z., Primorac, M., Jeršek, Ž. (2021).
Izvješće o ispitivanju niskofrekvencijskih električnih i magnetskih polja – transformatorska stanica ts 10(20)/0,4 kv bioplinsko postrojenje Niza, Osijek

Klaić, Z., Kraus, Z., Primorac, M., Jeršek, Ž. (2021).
Izvješće o ispitivanju niskofrekvencijskih električnih i magnetskih polja – transformatorska stanica ts 10(20)/0,4 kv plinifikacijsko-kogeneracijsko postrojenje na biomasu (Sječka), Cep Belišće 2 D.O.O., Belišće, Osijek

Klaić, Z., Kraus, Z. (2020).
Izvješće o ispitivanju niskofrekvencijskih električnih i magnetskih polja – vjetroelektrana Korlat, Osijek

Klaić, Z., Kraus, Z., Primorac, M. (2019).
Izvješće o ispitivanju niskofrekvencijskih električnih i magnetskih polja u okolini dalekovoda Dv 2 × 110 Kv Ts 110/35 Kv Slavonski Brod – Ts 110/35/10 Kv Slavonski Brod 2, Osijek

VII. Research Group for Information and Communication Technologies

Link: https://www.ferit.unios.hr/research-groups/IG08

The Research Group for Information and Communication Technologies conducts research in four areas, i.e. wireless communications, microelectronics, network technologies and video communications.

In the field of wireless communications, the emphasis is put on modelling, analysis of operation, improvement of the existing and the development of new communication systems or their subsystems, as well as the development of models and testing of radio waves propagation in mobile networks. The following is currently being tested and developed: EM wireless energy transmission processes and systems, high-frequency energy harvesting technologies, modelling, measurement and testing of the effects of EM radiation on living organisms and electromagnetic pollution.

In line with the progress made in the field of microelectronic technology, we conduct research and development of analogue and digital processing, PLD and FPGA device programming, and design and implementation of supervisory control systems. Research group members research and develop radio frequency identification (RFID) devices with their own power supply, enhance alternative power supply methods from the surrounding area, and develop 2D and 3D sensors.

The following research is carried out in the field of network technologies: IP network infrastructure, IP service quality, and application in the area of broadband Internet access and Internet services in urban and rural areas. Special attention is paid to research into security and privacy issues in modern information and communication (wired and wireless) systems. In terms of security, the following issues are researched: modern cryptosystems and their application, methods of detection and prevention of security threats and attacks on wired and wireless networks (WLAN, ad hoc, sensor networks, IoT), security mechanisms and protocols, risk estimation and reduction, secure routing and data aggregation, and user and data privacy protection.

An important segment of research is to develop solutions to improve and evaluate video quality in various applications including Quality of Experience (QoE) when transmitting video signals to fixed and mobile networks.

Project title:

IoT field - an ecosystem of networked devices and services for IoT solutions applied in agriculture

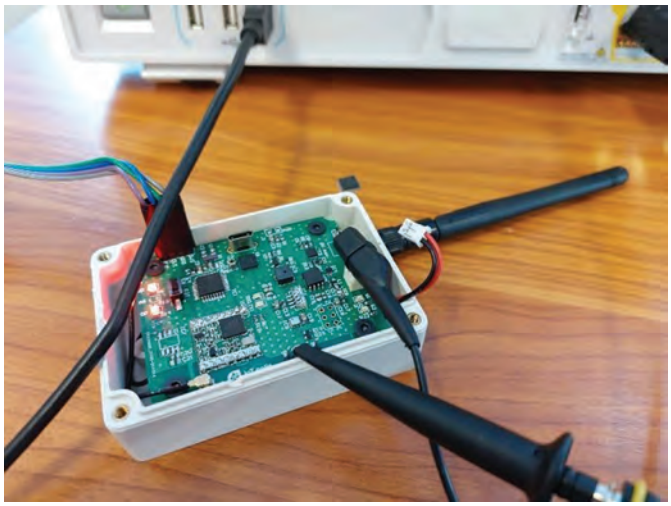
Supported by the European Regional Development Fund (EFRR) under project KK.01.1.1.04.0108

Link: https://iot-polje.fer.hr/iot-polje/en

Solution:

Low-cost wireless sensor node for smart agriculture applications

We have developed a compact IoT device that does not require much space, and by minimizing the number of wires and cables, is practical and easy to implement especially for use in agriculture. The practicality and simplicity of the device reduces the need for maintenance in remote areas. The simplicity of performance as well as the control algorithm makes it reliable for long-term use in bad weather as well as in some unforeseen events, and solar charging extends battery life. The device is relatively inexpensive, and with a long battery life, the RFM95w LoRa module also provides an extended range of communication with low power consumption.



Publications:

Zrnić, M., Spišić, J., Pejković, A., Grgić, K., Balen, J., Žagar, D. (2021).
Low-Cost Wireless Sensor Node for Smart Agriculture Applications //
16th International Conference on Telecommunications (ConTEL), 158-164.
doi: 10.23919/ConTEL52528.2021.9495976. https://ieeexplore.ieee.org/document/9495976

Project title:

"Ranger" - a stand-alone random number generator based on chaos theory

Commercial project

https://www.ferit.unios.hr/projekti/BICRO/primjena-teorije-kaosa-u-kriptiranju---cryptochaos#anc

Solution:

Stand-alone random number generator based on chaos theory

Researchers from the IG08 research group also participated in development of "Ranger" – a stand-alone random number generator based on chaos theory. More details about the solution are available under the IG06 research group.

Project title:

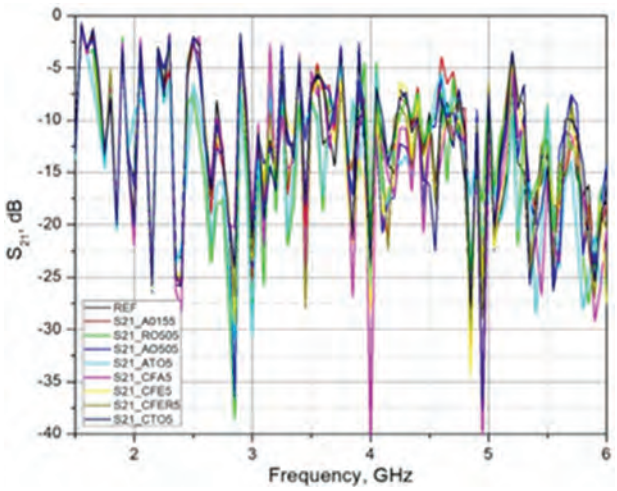
Development and application of advanced building materials for the construction of healthy buildings: protection against non-ionizing radiation

Supported by the European Regional Development Fund (EFRR) under project KK.01.1.1.04.0105

I **Solution:**

Clay composite with increased attenuation of EM radiation

We have developed clay composites with partial substitution of clay with different admixtures: Fly ash, four different particle sizes and phases of titanium dioxide (TiO2), zinc ferrite (ZnFe2O4), maghemite (γ-Fe2O3) and antimony tin oxide (ATO) with the aim of increasing the attenuation of the EM field when passing through such a material. Brick composites can significantly increase the attenuation of the EM field when passing through such a material in a wide range of frequencies and can be used for the construction of buildings with a low level of EM non-ionizing radiation.



Publications:

Vrdoljak, I., Brdarić, J., Rupčić, S., Marković, B., Miličević, I., Mandrić, V., Varevac, D.,
Tatar, D., Filipović, N., Szenti, I. & Kukovecz, Á (2022).
The effect oof different nanomaterials addition in clay-based composites on the electromagnetic transmission //
Materials2022, 15(15),5115.; https://doi.org/10.3390/ma15155115
https://www.mdpi.com/1996-1944/15/15/5115

Project title:

Development of the process of pre-treatment of lignocellulose materials by heat and electric field for the purpose of application in biogas production by anaerobic co-digestion with bovine manure

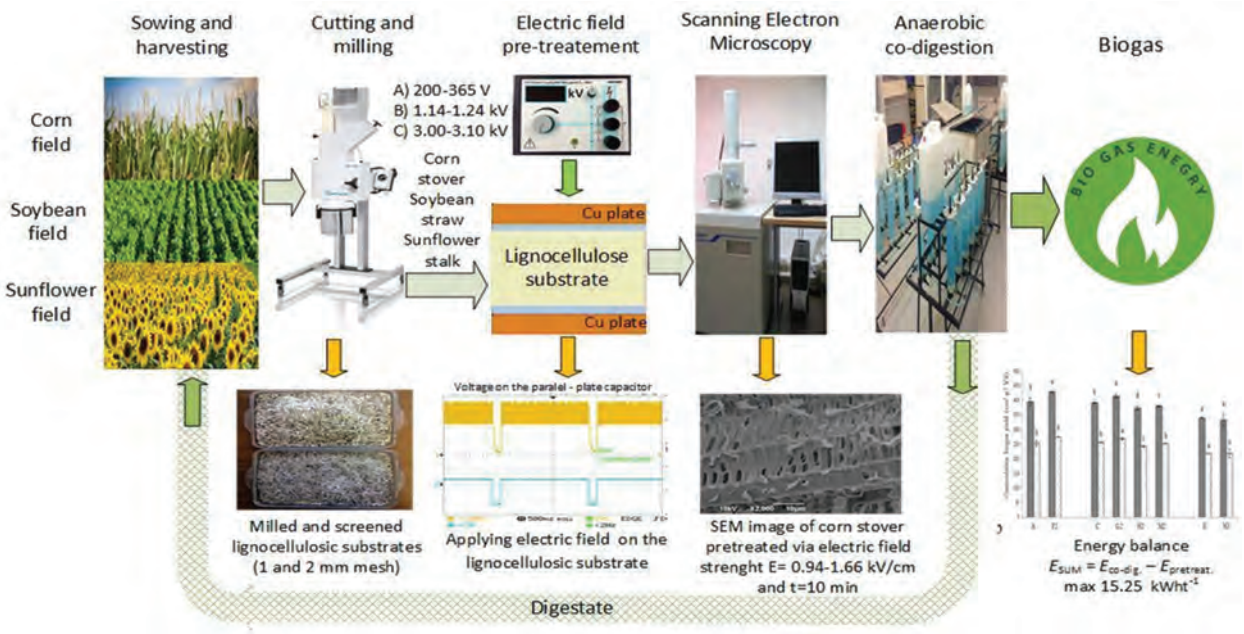
PhD thesis

Link: https://www.researchgate.net/profile/Durdica-Kovacic

Solution:

The process of pre-treatment of harvested residues with an electric field

We have developed a method for pre-treatment of lignocellulose (LC) substrates (harvest residues (HR)) via electroporation (EP) for the purpose of improving the biogas production process. After the conducted pre-treatment and anaerobic co-digestion with dairy cow manure (DCM), the statistical data analysis showed statistically significant differences in biogas and/or methane yields for all three LC substrates and their fractions. It was concluded that, after the pre-treatment of LC substrates via EP, it is possible to achieve a positive energy balance of the whole process.



Publications:

Kovačić, Đ, Kralik, D., Rupčić, S., Jovičić, D., Spajić, R., Tišma, M. (2019).
Electroporation of harvest residues for enhanced biogas production in anaerobic co-digestion with dairy cow manure // Bioresource Technology, 274, 215-224. https://doi.org/10.1016/j.biortech.2018.11.086

VIII. Research Group for Intelligent Vehicles

Link: https://www.ferit.unios.hr/research-groups/IG09

This research group carries out research in the field of software development for autonomous vehicles and its testing according to pre-set standards and methods (AUTOSAR, ISO26262). A part of research relates to networks and protocols in vehicles (CAN, LIN, FlexRay). Furthermore, there is a part of research which deals with developing advanced image processing algorithms for automotive cameras used in autonomous driving. Numerous machine learning methods are applied in this process. The research group employs state-of-the-art equipment purchased within the EU project DRIVE.

Another part of the research group deals with intelligent transport systems (vehicular ad-hoc networks, VANETs), aimed at developing, implementing, testing and evaluating algorithms for efficient information propagation between vehicles and infrastructure. There are applications serving various purposes like traffic security improvement (collision avoidance, accident notification), enhanced driving efficiency (traffic congestion monitoring, booking free parking spaces) and commercial services (entertainment, work). It is crucial for every application to provide the right information in the right place at the right time to be able to make informed decisions.

Finally, the research group is also dedicated to analysing the operation and topology of vehicle drives, auxiliary systems and synthesising aimed to optimise the energy flow and energy efficiency of vehicles. Special emphasis is placed on hybrid energy storage systems, advanced power supply systems and power electronics systems for energy control in vehicles. Through modelling and solving inverse engineering problems, the research group tends to develop control methods aimed at improving the efficiency of the vehicle itself and integrating the electric vehicle into the existing transport system according to EU guidelines of integrated, sustainable and efficient transport system.

Project title:

Increasing the level of reliability of autonomous vehicles using in-vehicle camera system

Internal University project UNIOS ZUP 2018-6

I Solution:

Autonomous driving solution based on traffic sign detection

One of the main goals of the automotive industry is to develop a fully autonomous vehicle with a control system based on traffic sign detection. The most advanced algorithms based on machine learning will be used to detect TS. We have developed an autonomous driving solution based on traffic sign detection. The part of the solution for controlling the vehicle is developed using ROS (Robot Operating System), where the complete solution is tested in the CARLA open-source simulator. TS detectors are evaluated on a real and synthetic dataset, after which the proposed solution is tested on different scenarios created in the CARLA simulator under different weather conditions. The proposed solution achieved high performance in terms of correct actions rate.

Publications:

Mijić, David; Vranješ, Mario; Grbić, Ratko; Jelić, Borna
Autonomous Driving Solution Based on Traffic Sign Detection // IEEE consumer electronics magazine (2021) doi:10.1109/MCE.2021.3090950. https://ieeexplore.ieee.org/document/9464630

II Solution:

Lane detection and lane departure warning system for ADAS

Vehicles equipped with different Advanced Driver Assistance Systems (ADAS) are becoming more common on the roads and have a higher level of autonomy. For autonomous vehicles to function properly, reliable ADAS are required to process different input signals from distinct sensors. One of the most important ADAS algorithms is the one for lane detection and lane departure warning. We developed some different solutions for the purpose of lane detection and lane departure warning. The proposed solutions are suitable for real-time implementation when using the limited hardware resources that are often installed in modern vehicles.

Publications:

Vajak, Denis; Vranješ, Mario; Grbić, Ratko; Teslić, Nikola
A Rethinking of Real-Time Computer Vision-Based Lane Detection // 2021 IEEE 11th International Conference on Consumer Electronics (ICCE-Berlin), Berlin, Njemačka, 2021. str. 1-6 doi:10.1109/ICCE-Berlin53567.2021.9720012 https://ieeexplore.ieee.org/document/9720012

Špoljar, Domagoj; Vranješ, Mario; Nemet Sandra; Pjevalica, Nebojša
Lane Detection and Lane Departure Warning Using Front View Camera in Vehicle // Proceesings ELMAR-2021 / Muštra, Mario ; Vuković, Josip ; Cihlar-Zovko, Branka (ed.).
Zagreb, 2021. pp. 59-64, doi: 10.1109/ELMAR52657.2021.955092. https://ieeexplore.ieee.org/document/9550922

Project title:

Provision of services based on digital video signals in rural and less populated areas

Internal FERIT project IZIP 2016

Solution:

Real-time no-reference blocking visibility estimation in video frames

During lossy video compression, blocking artefact is introduced into a video that can reduce the quality of a compressed video, and end-user Quality of Experience. Thus, it is very important to measure and monitor the quality of compressed videos delivered to the end-user, which can be performed only by using the no-reference (NR) approach, without the original video signal available.

We developed a new algorithm for Real-Time NR Blocking Visibility Estimation (RT-BVE) in video frames that can precisely estimate blocking visibility in video frames for videos compressed according to different compression standards. Additionally, RT-BVE is suitable for usage in real-time applications.

Publications:

Grbić, Ratko; Stefanović, Dejan; Vranješ, Mario; Herceg, Marijan
Real-time video freezing detection for 4K UHD videos //
Journal of Real-Time Image Processing, 17 (2020), 5; 1211-1225 doi:10.1007/s11554-019-00873-y.

Project title:

Research & development of the zero-emission passenger sailing ship

Supported by the European Regional Development Fund (EFRR) under project KK.01.2.1.02.0127

Link: https://www.divgroup.eu/en/research-and-development-projects/research-development-of-the-zero-emission-passenger-sailing-ship/

Solution:

Parameter controlled model for energy consumption optimisation for electric propulsion of the zero emission sailing ship

Modern sailing ships are designed to obtain only 20% of their energy needs from additional sources but, due to the unpredictability of wind, it is necessary to optimise the consumption and production of energy from available resources. The developed model allows the application of various methods, a model that can be parametrically adapted to different navigation scenarios with software management to optimise consumption, simulation state space can be created - data tables to define operational activities of ship management and propulsion under certain circumstances. The model allows testing of existing ships as well as assistance in developing new ones.

Publications:

Hederić, Ž., Vučinić, D., Brlić, M., Bezovnik, M., Cuković, M. Čačić, M., Hmura, A., Jukić, D., Švarcmajer, M., Vučinić, B. *Development of a zero-emission passenger sailing ship with in depth focus on Electrical Design Challenges* // 3rd International Conference on Computing in Mechanical Engineering (ICCME), 22-24 September 2021, plenary talk

Hederić, Ž., Vučinić, D., Benšić, T. *Ship propulsion and hydrokinetic energy modelling and simulation* // 15th International Conference on Advanced Computational Engineering and Experimenting (ACEX2022), July 2022, Firenze Italy, plenary talk

IX. Research Group for Biomedical Engineering

Link: https://www.ferit.unios.hr/research-groups/IG10

The research groups carries out activities in the field of biomedical engineering, microelectronics, biomedical electronics, wireless communication systems, wireless charging systems, energy harvesting and using computer vision in robotics, medicine and agriculture.

In the last several years, several integrated circuits were designed in the field of microelectronics. The most significant one is a patent for the energy efficient system for wireless transfer of analogue and digital signals and a DC/DC converter based on charge pumps. Furthermore, the research group has experience in developing different systems for biological signals measuring. Systems for wireless measuring of oxygen saturation and body temperature have been developed. The research group works on the development of new efficient robust modulation procedures based on wireless data transfer.

Research in the field of wireless charging and energy harvesting have resulted in the development of a capacitive wireless power system for sensor low power circuits and wireless charging system for electronic devices up to 5 W. The research group for the application of computer vision in bioengineering has considerable experience in the development and application of advanced technologies for the analysis of 2D and 3D data obtained by regular or 3D cameras. The developed technologies and algorithms are used in selecting and detecting various types of objects in space. In the field of agriculture, the technologies are used to differentiate fruits and vegetables on plants and detect rows of crops in fields. In the field of medicine, the technologies are used for carrying out a 2D and 3D analysis of chronic wounds, determining a percentage of a specific tissue sample in a wound and measuring physical parameters, latitude, surface and volume. The research group has submitted and been approved of three patent applications so far thus gaining experience in the protection of intellectual property.

Project title:

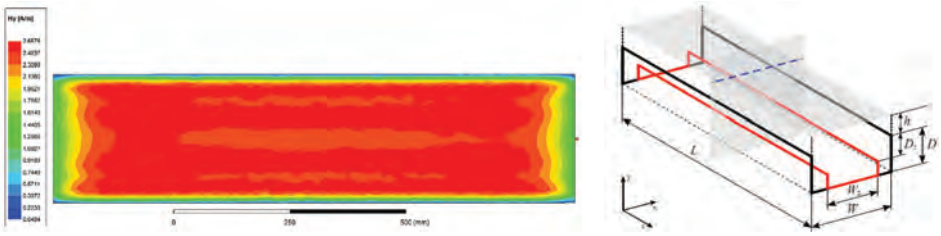
Efficient wireless power supply

Supported by the Croatian Science Foundation under project UIP-2017-05-5373

Solution:

Wireless power transmitter coil with homogeneous magnetic field distribution

We have developed a structure and optimisation methodology for 3D coil with homogeneous magnetic field strength distribution.



Publications:

Bilandžija, Domagoj; Vinko, Davor; Barukčić, Marinko
Genetic-Algorithm-Based Optimization of a 3D Transmitting Coil Design with a Homogeneous Magnetic Field Distribution in a WPT System // Energies, 15 (2022), 4; 1381, 16 doi:10.3390/en15041381

Vinko, Davor; Bilandžija, Domagoj; Mandrić- Radivojević, Vanja
Optimization of a Two-Layer 3D Coil Structure with Uniform Magnetic Field //
Wireless Power Transfer, 2021 (2021), 6303628, 11 doi:10.1155/2021/6303628

Project title:

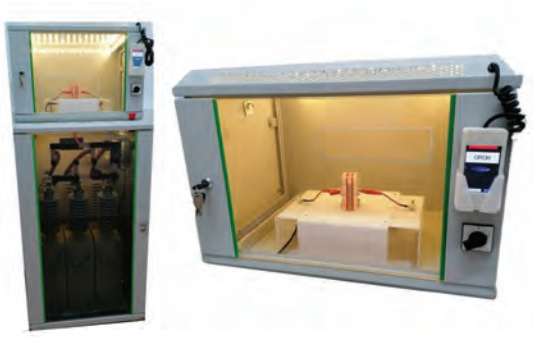
Pulsed electric field

Supported by the Faculty of Food Technology Osijek

Solution:

Device for pulsed electric field treatment

We have developed a device for pulsed electric field treatment of food. Pulsed electric field (PEF) is used to improve food quality and safety by inactivating a large number of microorganisms and enzymes that affect changes in food quality and safety. Also, PEF can be used as a step in processes such as extraction, dehydration by osmosis, air drying, etc. There is no significant increase in temperature during PEF processing.



Device characteristics:

- voltage adjustment in the range from 5 kV to 25 kV
- capacity adjustment in the range from 0.167 uF to 1.5 uF
- energy of a single pulse in the range from 2 J to 450 J

Publications:

Lončarić, Ante; Jokić, Stela; Jozinović, Antun; Babić, Jurislav; Ačkar, Đurđica; Vinko, Davor; Šubarić, Drago
Fruit juice processing with pulsed electric field // VI International Congress "Engineering, Environment and Materials in Processing Industry" - Proceedings / Gligorić, M. ; Došić, A. ; Vujadinović, D. (ur.).
Zvornik: Tehnološki fakultet Zvornik, 2019. str. 41-41

Project title:

Digital video signal based services in rural and rarely populated areas

Internal FERIT project IZIP 2016

Solution:

No-reference packet loss artefacts detection for video signals

We have developed an algorithm for no-reference real-time packet loss artefacts detection. The algorithm has low computational complexity, which enables a real-time processing. Moreover, the developed algorithm is an improvement over similar state-of-the art algorithms.

(a) (b)

Publications:

Glavota, Ivan; Kaprocki, Zvonimir; Vranješ, Mario; Herceg, Marijan
No-Reference Real-Time Video Transmission Artifacts Detection for Video Signals //
Journal of Real-Time Image Processing, 14 (2020), 4; 799-820 doi:10.1007/s11554-018-0824-6

Vranješ, Mario; Herceg, Marijan; Vranješ, Denis; Vajak, Denis
Video transmission artifacts detection using no- reference approach //
2018 Zooming Innovation in Consumer Electronics Conference (ZINC)
Novi Sad, Srbija, 2018. str. 72-77 doi:10.1109/ZINC.2018.8448669

Glavota, Ivan; Vranješ, Mario; Herceg, Marijan; Grbić, Ratko
Pixel-based Statistical Analysis of Packet Loss Artifact Features //
2016 Zooming Innovation in Consumer Electronics International Conference
Novi Sad, Srbija, 2016. str. 16-19

Vranješ, V., Herceg, M., Grbić, R., Pap, I., Kovačević, J.
Method for detecting packet loss artefacts in an image in a transmitted video signal //
RS20180385A1, patent application.
Available at https://patents.google.com/patent/RS20180385A1/en?oq=RS20180385A1

Project title:

An algorithm for vehicle distance and speed estimation

Internal University project UNIOS ZUP 2018-6 and Internal FERIT project IZIP 2020

Solution:

An algorithm for vehicle distance and speed estimation

We have developed an algorithm for vehicle distance and speed estimation. The algorithm has low computational complexity, which enables a real-time processing. The detection of the vehicle is performed using the Viola-Jones algorithm, while the tracking of the detected vehicle is performed using the Median flow algorithm.

Publications:

Šimara, Eugen; Herceg, Marijan; Vranješ, Denis; Zejak, Aleksa
An algorithm for Vehicle Distance and Speed Estimation //
2021 International Symposium ELMAR / Zovko-Cihlar, Branka (ur.).
Zagreb: IEEE, 2021. doi:10.1109/ELMAR52657.2021.9550949

Project title:

Fruit recognition in RGB-D images

Internal FERIT project

Solution:

Detection of fruits for RGB-depth image pairs

We have developed an algorithm for automatic fruit detection by analysing 3D point cloud data generated from RGB-D images, which could facilitate automatic fruit picking.

Publications:

Nyarko, Emmanuel Karlo; Vidović, Ivan; Radočaj, Kristijan; Cupec, Robert
A nearest neighbor approach for fruit recognition in RGB-D images based on detection of convex surfaces //
Expert systems with applications, 114 (2018), 454-466 doi:10.1016/j.eswa.2018.07.048

Project title:

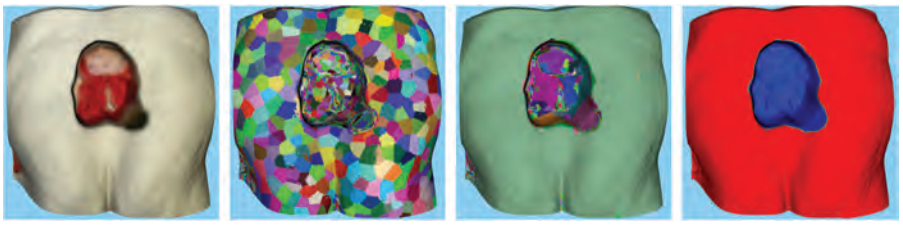
Three-dimensional reconstruction and segmentation of wound surface using RGB-D sensors

Internal University project UNIOS ZUP 2015-9

Solution:

3D reconstruction of wound surface using a handheld 3D camera

We have developed a system for 3D reconstruction and measurement of chronicle wounds using a handheld 3D camera such as Microsoft Kinect. The system first detects a wound on the scene and then creates a 3D reconstruction from RGB-D video feed by utilizing CUDA programming for real-time integration of measurements. The generated 3D model is then automatically segmented in order to extract the wound surface and calculate the circumference, area and volume of the recorded wound.



Publications:

Filko, Damir; Cupec, Robert; Nyarko, Emmanuel Karlo
Wound measurement by RGB-D camera //
Machine vision and applications, 29 (2018), 4; 633-654 doi:10.1007/s00138-018-0920-4

Project title:

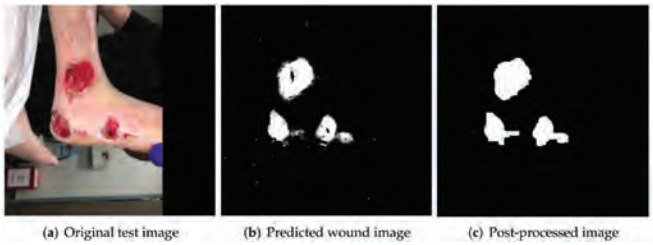
Vision4wounds - methods for 3D reconstruction and analysis of chronic wounds

Supported by the Croatian Science Foundation under project UIP-2019-04-4889 Link: vision4wounds.ferit.hr

Solution:

Neural network detection of chronic wounds

We have developed an algorithm that detects wounds using a neural network consisting of 5 fully connected layers. This recognition algorithm is part of a larger solution for chronic wound analysis that consists of a robotic manipulator, RGB-D camera and 3D scanner.



(a) Original test image (b) Predicted wound image (c) Post-processed image

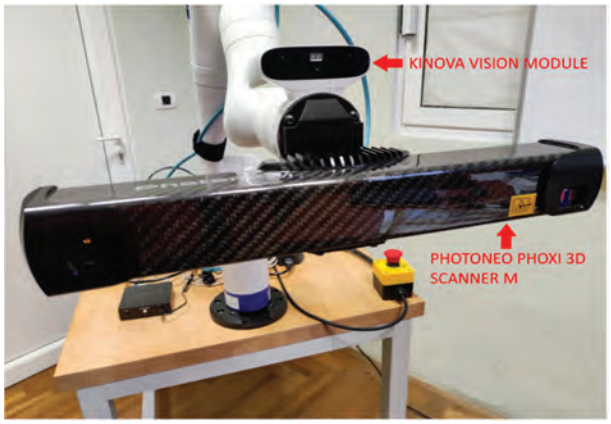
Publications:

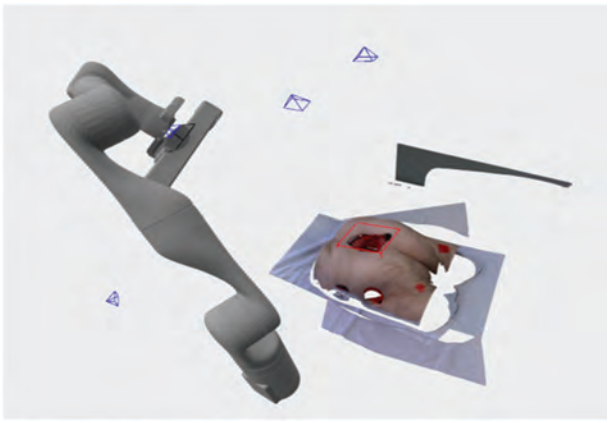
Marijanović, Domagoj; Nyarko, Emmanuel Karlo; Filko, Damir
Wound Detection by Simple Feedforward Neural Network //
Electronics, 11 (2022), 3; 329, 18 doi:10.3390/electronics11030329

II **Solution:**

3D reconstruction of chronic wounds using a robotic manipulator and 3D scanner

We have developed a complex system that uses a 7DoF robot and an industrial precision 3D scanner for automatic 3D reconstruction of chronic wounds. The system uses a complex algorithm to determine the optimal recording poses for generating a full 3D reconstruction and then uses a 7DoF robotic manipulator to achieve that pose for the 3D scanner.





Publications:

Filko, Damir; Marijanović, Domagoj; Nyarko Emmanuel Karlo
Automatic Robot-Driven 3D Reconstruction System for Chronic Wounds //
Sensors, 21 (2021), 24; 8308, 28 doi:10.3390/s21248308

Project title:

Wireless sensor network for analogue signal acquisition

Supported by the Croatian Agency for SMEs, Innovations and Investments (HAMAG-BICRO)

I **Solution:**

Innovative technology for energy-efficient wireless sensor network implementation and analogue signal acquisition

We have developed a prototype of a device for measuring body temperature and wireless transfer of information to the central node via a human body. The patent is granted for the method of energy-efficient multi-user communication.

Publications:

Matić, T., Herceg, M., Job, J.
Energy-efficient system for distant measurement of analogue signals //
(2016) US Patent 9, 531, 432.

Project title:

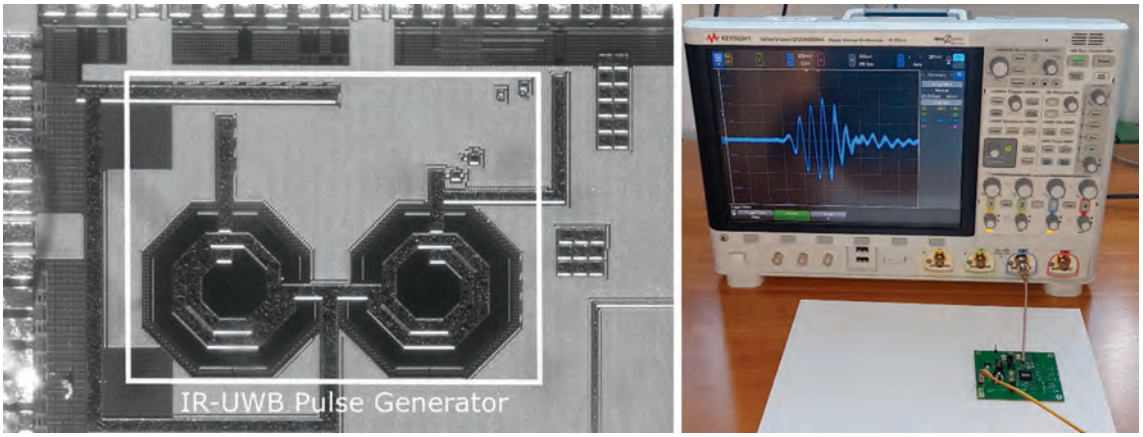
Energy efficient asynchronous wireless transmission

Supported by the Croatian Science Foundation under project UIP-2014-09-6219

Solution:

IC prototypes fabricated in TSMC 180 nm CMOS technology

The first prototype incorporates a novel transmitter architecture for asynchronous short-range wireless communication suitable for simultaneous multi-user wireless acquisition of biological signals. The second prototype includes a novel ultra-wideband (UWB) pulse generator based on a switched oscillator architecture.



Publications:

Matic, Tomislav; Sneler, Leon; Herceg, Marijan
An Energy Efficient Multi-User Asynchronous Wireless Transmitter for Biomedical Signal Acquisition //
IEEE Transactions on Biomedical Circuits and Systems, 13 (2019), 4; 619-630 doi:10.1109/tbcas.2019.2917690

Šneler, Leon; Matić, Tomislav; Herceg, Marijan
A Tunable CMOS IR-UWB Pulse Generator Based on Feedback Controlled Oscillator Switching //
IEEE transactions on circuits and systems. II, Express briefs, 68 (2021), 6; 1902-1906 doi:10.1109/TCSII.2020.3045212