Sensors, Testing and Measurement

22. Juni 2022

Radek Martinek & Petr Bilík, VSB - Technical University of Ostrava

5th WORKSHOP Forming and Punching

VSB TECHNICAL UNIVERSITY OF OSTRAVA | FACULTY OF ELECTRICAL ENGINEERING AND COMPUTER SCIENCE

Tecpa FEELING FOR DETAIL AND PRECISION

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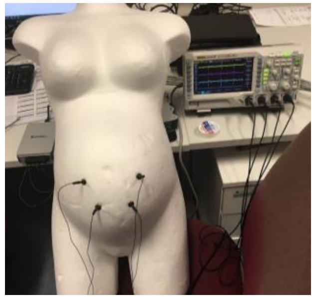
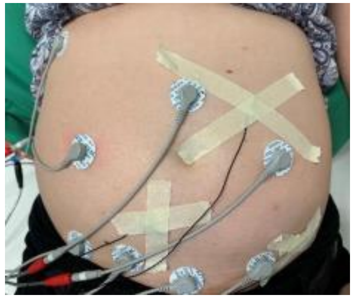
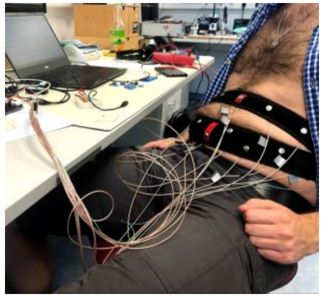
Projects

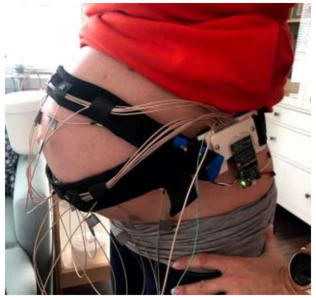
A Comprehensive System for the Development of the Field of Non-Invasive Fetal ECG Monitoring

- TREND - Technology Agency of the Czech Republic
- 1 million EUR
- 2021–2024
- Non-Invasive Fetal ECG Home Monitor





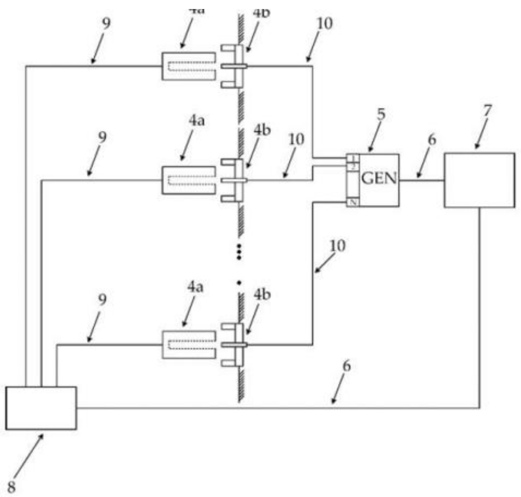


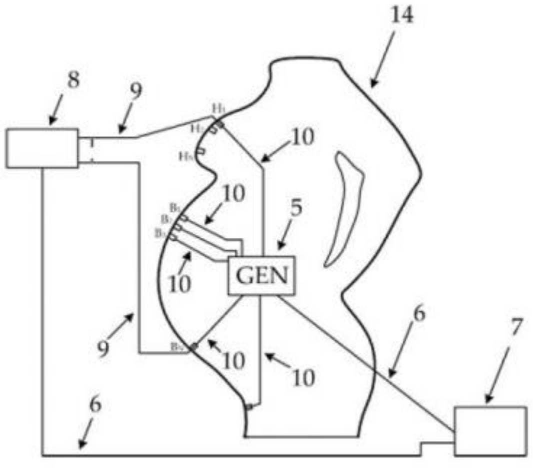


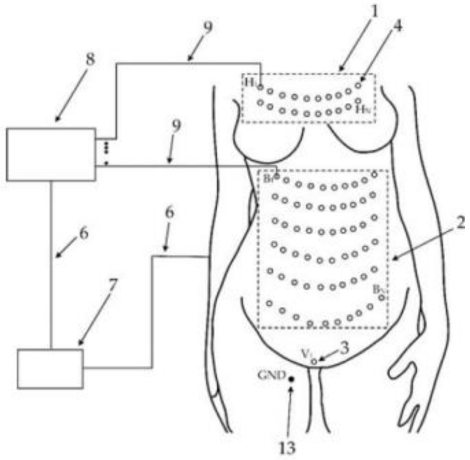
Application Outputs

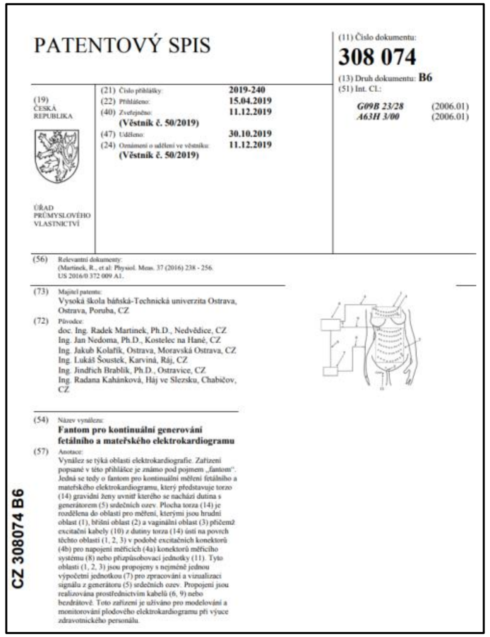
A Comprehensive System for the Development of the Field of Non-Invasive Fetal ECG Monitoring

- Ⓟ Patent PV 2016-518 307183, A device for monitoring vital functions of a pregnant woman's fetus
- Ⓟ Patent PV 2019-240 308074, Phantom for continuous generation of foetal and maternal electrocardiogram









PATENTOVÝ SPIS

(11) Číslo dokumentu: **308 074**

(13) Druh dokumentu: **B6**

(51) Int. Cl.:
G09B 23/28 (2006.01)
A63H 3/00 (2006.01)

(19) ČESKÁ REPUBLIKA

ÚŘAD PRŮMYSLOVÉHO VLASTNICTVÍ

(21) Číslo přihlášky: **2019-240**
(22) Přihlášeno: **15.04.2019**
(40) Zveřejněno: **11.12.2019**
(Věstník č. 50/2019)
(47) Uděleno: **30.10.2019**
(24) Oznámení o udělení ve věstníku: **11.12.2019**
(Věstník č. 50/2019)

(56) Relevantní dokumenty:
(Martinek, R., et al: Physiol. Meas. 37 (2016) 238 - 256.
US 2016/0 372 009 A1.

(73) Majitel patentu:
Vysoká škola báňská-Technická univerzita Ostrava, Ostrava, Poruba, CZ

(72) Původce:
doc. Ing. Radek Martinek, Ph.D., Nedvědice, CZ
Ing. Jan Nedoma, Ph.D., Kostelec na Hané, CZ
Ing. Jakub Kolařík, Ostrava, Moravská Ostrava, CZ
Ing. Lukáš Šoustek, Karviná, Ráj, CZ
Ing. Jindřich Brablík, Ph.D., Ostravice, CZ
Ing. Radana Kahánková, Háj ve Slezsku, Chabičov, CZ

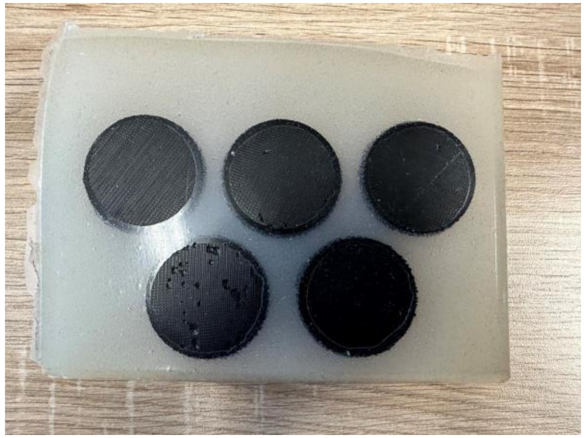
(54) Název vynálezu:
Fantom pro kontinuální generování fetálního a mateřského elektrokardiogramu

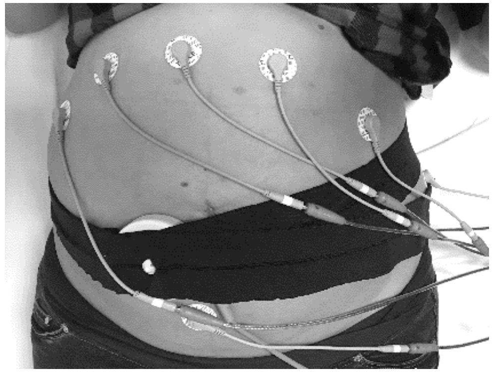
(57) Anotace:
Vynález se týká oblasti elektrokardiografie. Zařízení popsané v této přihlášce je známo pod pojmem „fantom". Jedná se tedy o fantom pro kontinuální měření fetálního a mateřského elektrokardiogramu, který představuje torzo (14) gravidní ženy uvnitř kterého se nachází dutina s generátorem (5) srdečních ozev. Plocha torza (14) je rozdělena do oblastí pro měření, kterými jsou hrudní oblast (1), břišní oblast (2) a vaginální oblast (3) přičemž excitační kabely (10) z dutiny torza (14) ústí na povrch těchto oblastí (1, 2, 3) v podobě excitačních konektorů (4b) pro napojení měřicích (4a) konektorů měřicího systému (8) nebo přizpůsobovací jednotky (11). Tyto oblasti (1, 2, 3) jsou propojeny s nejméně jednou výpočetní jednotkou (7) pro zpracování a vizualizaci signálu z generátoru (5) srdečních ozev. Propojení jsou realizována prostřednictvím kabelů (6, 9) nebo bezdrátově. Toto zařízení je užíváno pro modelování a monitorování plodového elektrokardiogramu při výuce zdravotnického personálu.

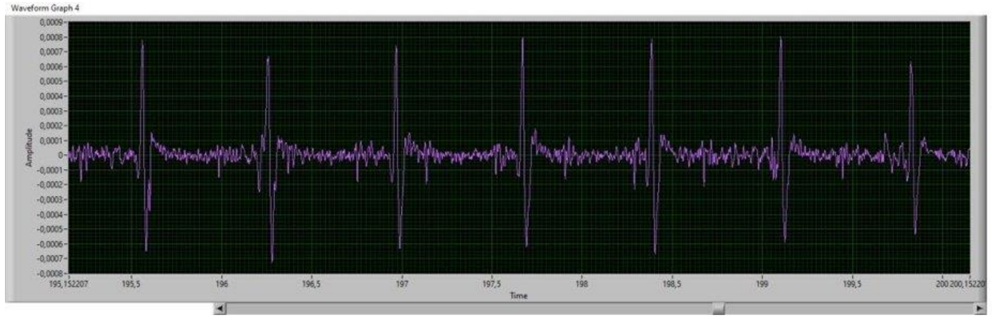
CZ 308074 B6

Project Development

A Comprehensive System for the Development of the Field of Non-Invasive Fetal ECG Monitoring







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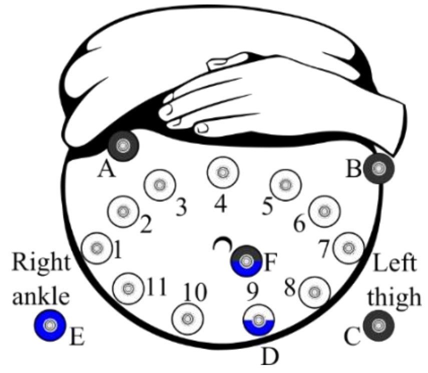
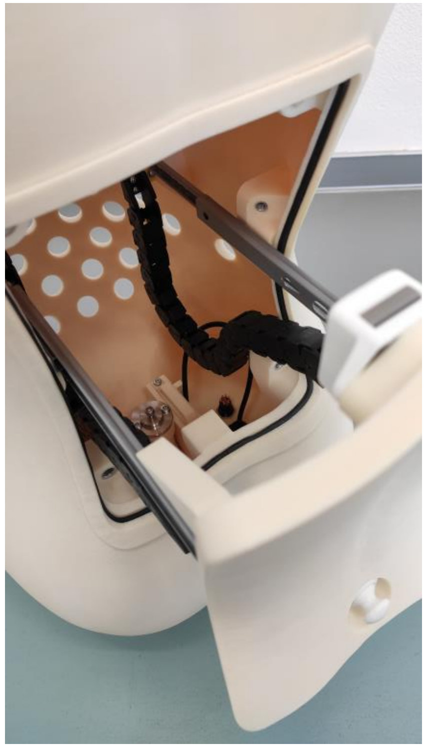
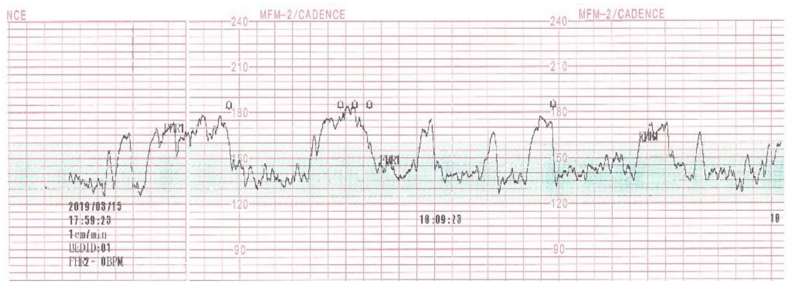
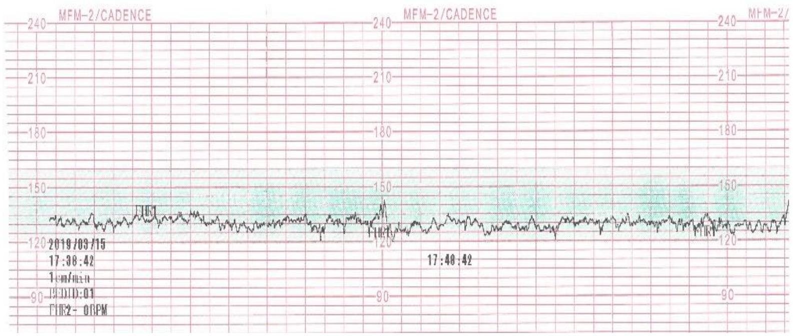
Project Development

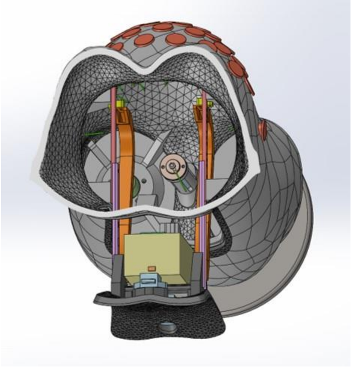
A Comprehensive System for the Development of the Field of Non-Invasive Fetal ECG Monitoring

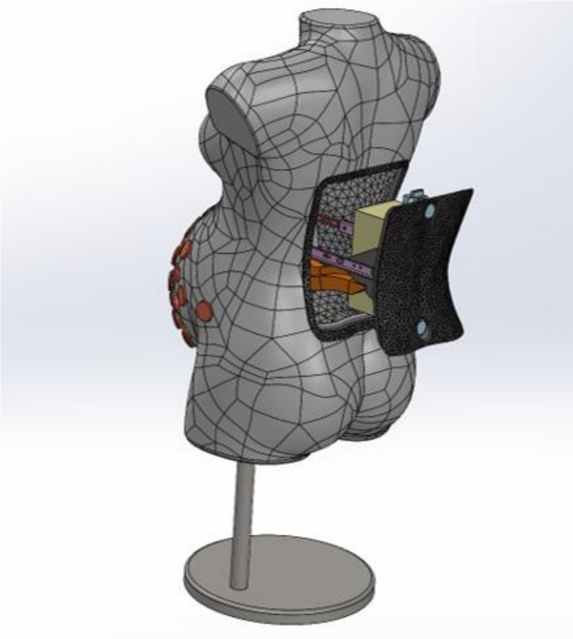






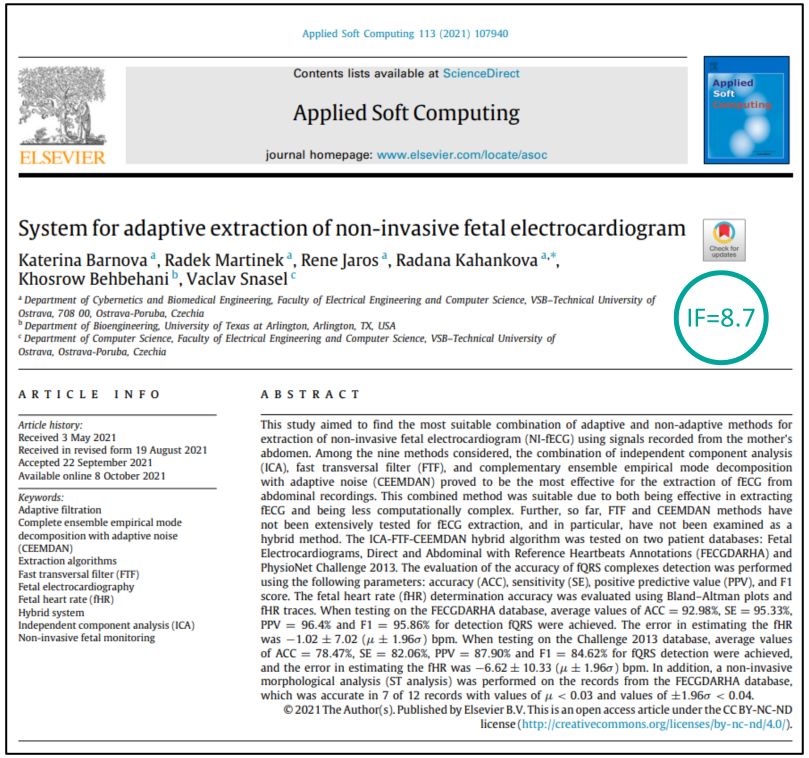


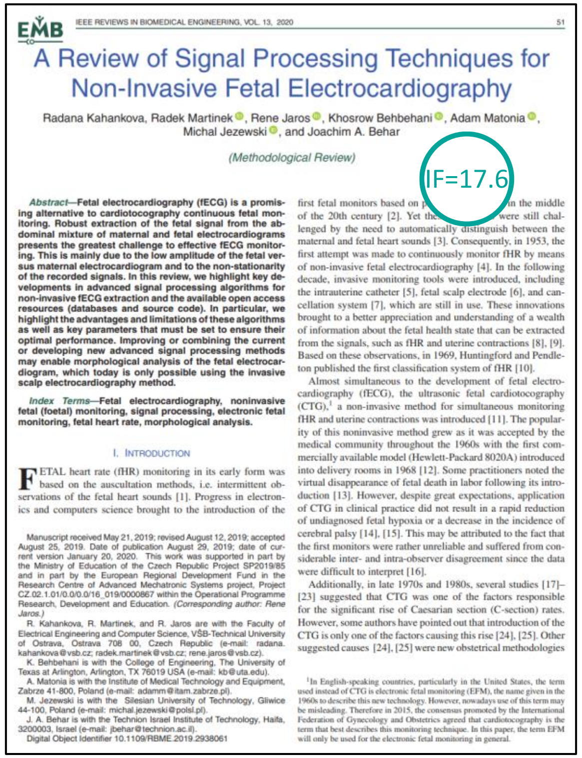


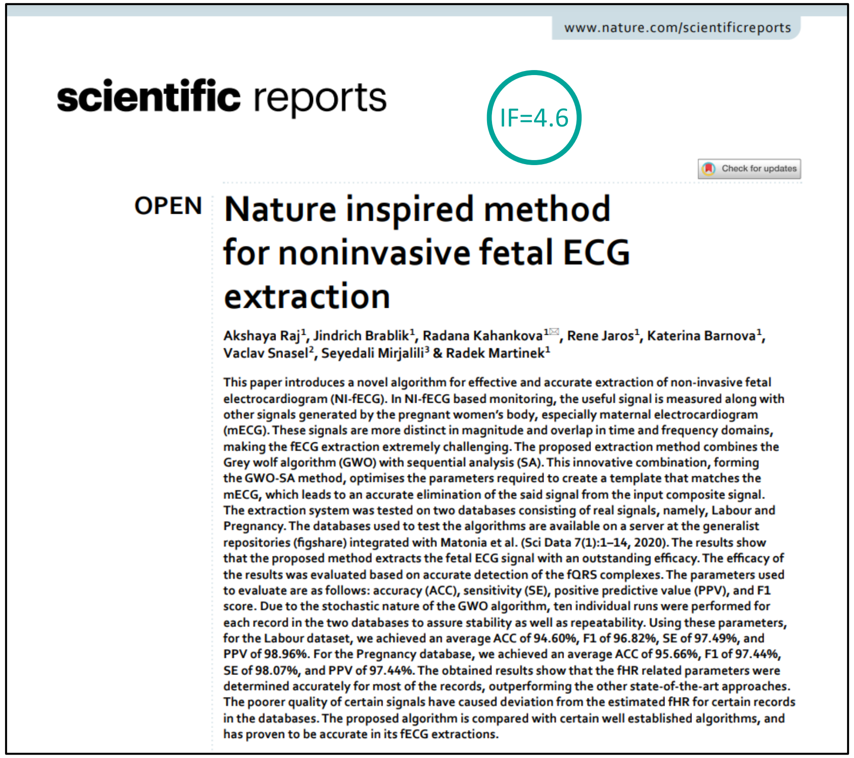


Publication Outputs

A Comprehensive System for the Development of the Field of Non-Invasive Fetal ECG Monitoring


Applied Soft Computing 113 (2021) 107940
Contents lists available at ScienceDirect
Applied Soft Computing
journal homepage: www.elsevier.com/locate/asoc
System for adaptive extraction of non-invasive fetal electrocardiogram
Katerina Barnova, Radek Martinek, Rene Jaros, Radana Kahankova, Khosrow Behbehani, Vaclav Snasel
IF=8.7


IEEE REVIEWS IN BIOMEDICAL ENGINEERING, VOL. 13, 2020
A Review of Signal Processing Techniques for Non-Invasive Fetal Electrocardiography
Radana Kahankova, Radek Martinek, Rene Jaros, Khosrow Behbehani, Adam Matonia, Michal Jezewski, and Joachim A. Behar
(Methodological Review)
IF=17.6

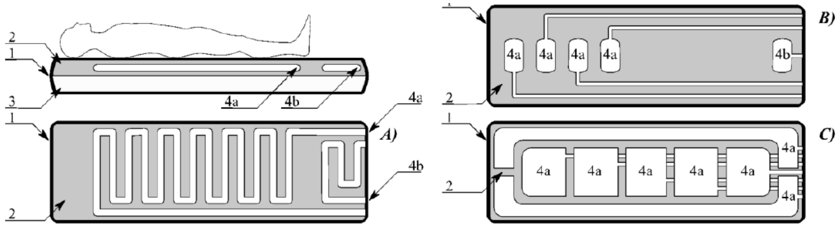

www.nature.com/scientificreports
scientific reports
IF=4.6
OPEN
Nature inspired method for noninvasive fetal ECG extraction
Akshaya Raj, Jindrich Brablik, Radana Kahankova, Rene Jaros, Katerina Barnova, Vaclav Snasel, Seyedali Mirjalili & Radek Martinek

Projects

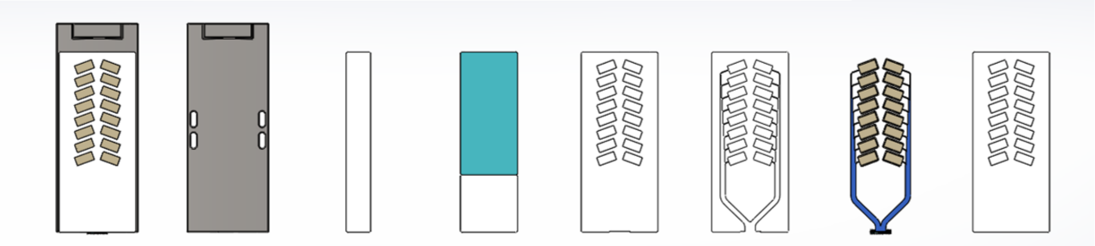
Development of a Complex Sensory System for Effective MRI Control

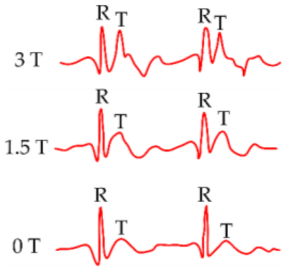
- APLIKACE – VÝZVA VII - Ministry of Industry and Trade
- 1.2 million EUR
- 2020–2022
- Measurement pad for Cardiac and Respiratory Monitoring

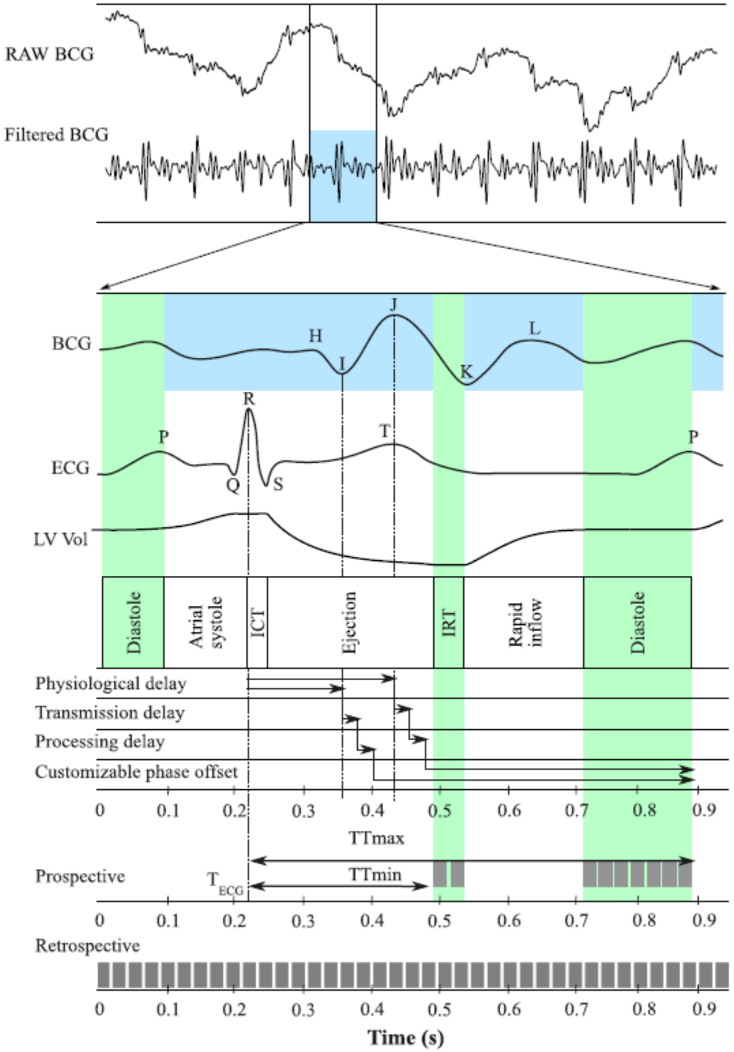
First concept



Final design

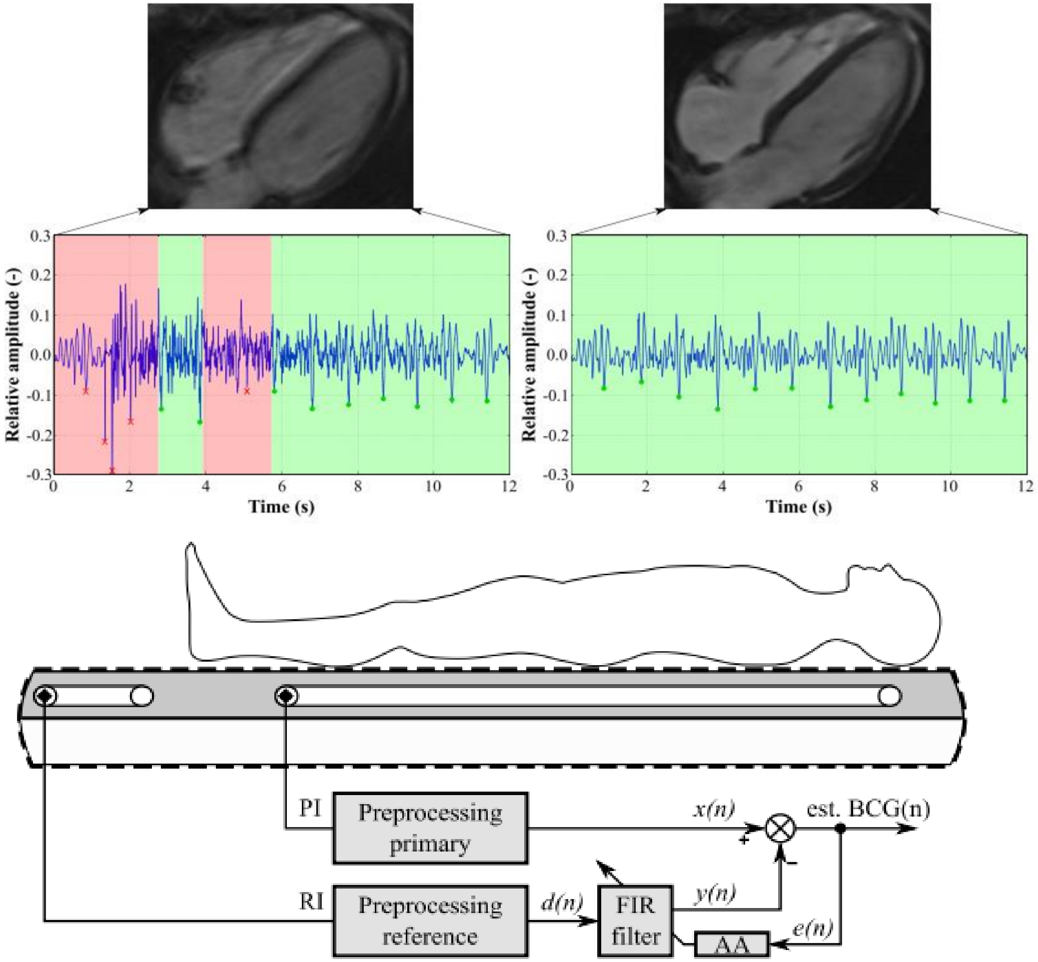






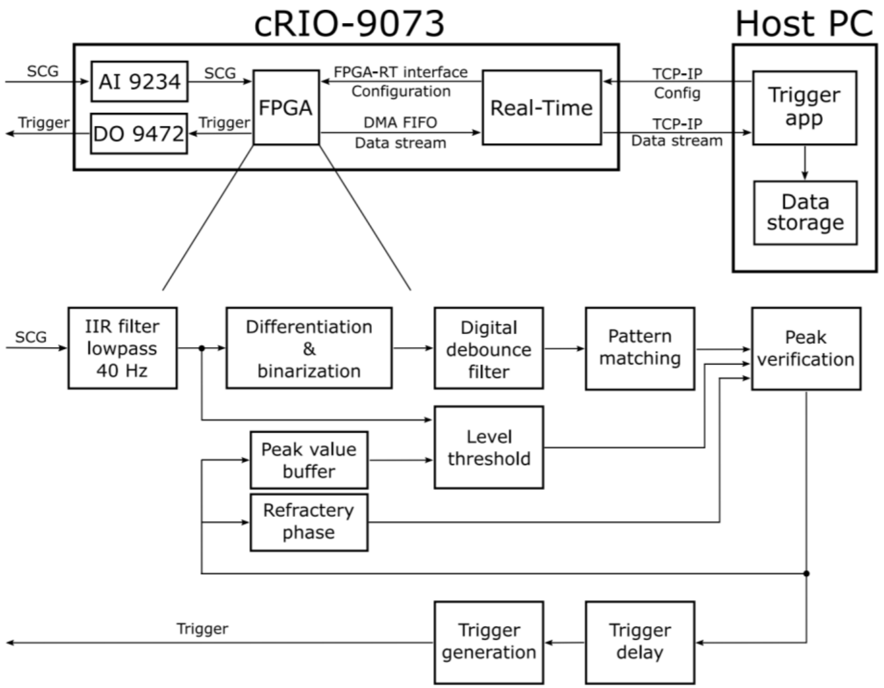
Project Development

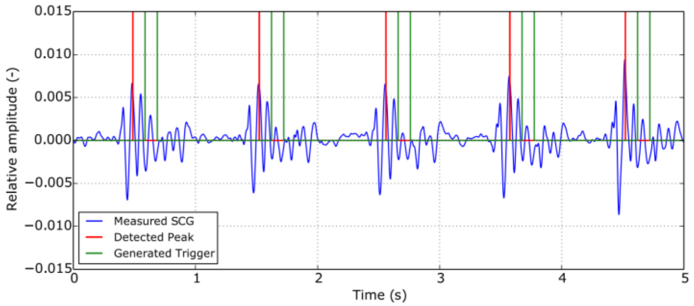
Development of a Complex Sensory System for Effective MRI Control

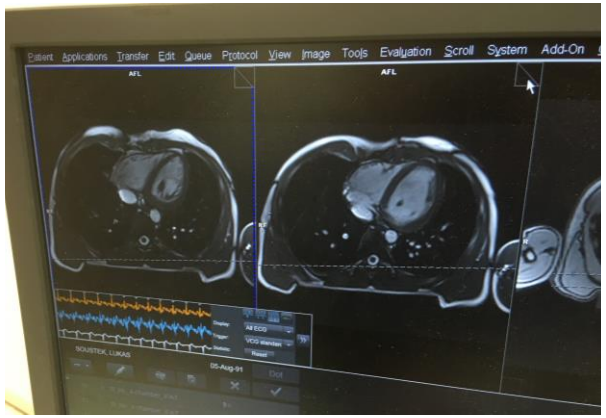


Project Development

Development of a Complex Sensory System for Effective MRI Control



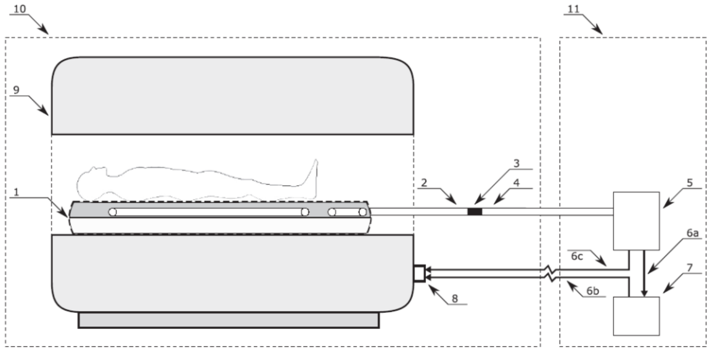


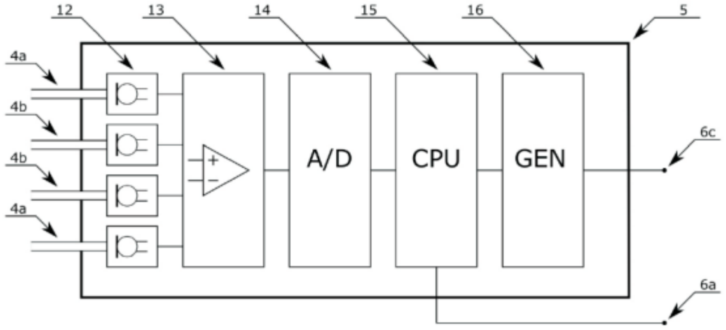


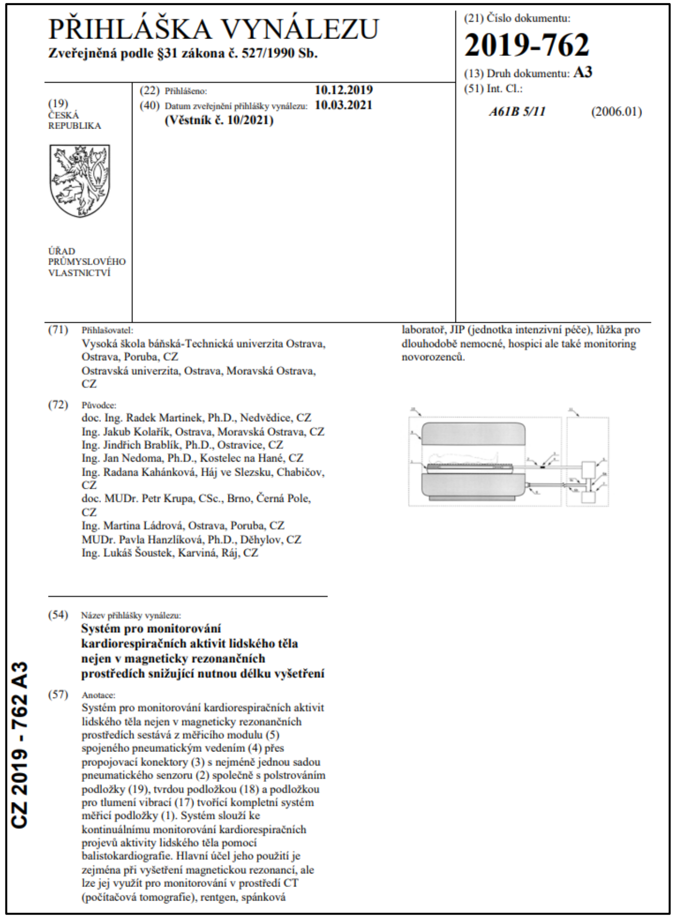
Application Outputs

Development of a Complex Sensory System for Effective MRI Control

- Ⓟ Patent PV 2019-762 08705, System for monitoring cardiorespiratory activities of the human body not only in magnetic resonance environments reducing the required length of examination
- Ⓟ Patent PV 2019-93 308261, System for monitoring cardiorespiratory activities of the human body in magnetic resonance environments
- Ⓟ Patent PV 2018-265 307778, Sensor for monitoring the vital functions of the human body in electromagnetically disturbed environments and how to produce it







PŘIHLÁŠKA VYNÁLEZU
Zveřejněná podle §31 zákona č. 527/1990 Sb.

(21) Číslo dokumentu:
2019-762
(13) Druh dokumentu: **A3**
(51) Int. Cl.:
A61B 5/11 (2006.01)

(19) ČESKÁ REPUBLIKA

ÚŘAD PRŮMYSLOVÉHO VLASTNICTVÍ

(22) Přihlášeno: **10.12.2019**
(40) Datum zveřejnění přihlášky vynálezu: **10.03.2021**
(Věstník č. 10/2021)

(71) Přihlašovatel:
Vysoká škola báňská-Technická univerzita Ostrava, Ostrava, Poruba, CZ
Ostravská univerzita, Ostrava, Moravská Ostrava, CZ

(72) Původce:
doc. Ing. Radek Martinek, Ph.D., Nedvědice, CZ
Ing. Jakub Kolařík, Ostrava, Moravská Ostrava, CZ
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Ing. Jan Nedoma, Ph.D., Kostelec na Hané, CZ
Ing. Radana Kahánková, Háj ve Slezsku, Chabičov, CZ
doc. MUDr. Petr Krupa, CSc., Brno, Černá Pole, CZ
Ing. Martina Ládrová, Ostrava, Poruba, CZ
MUDr. Pavla Hanzlíková, Ph.D., Děhylov, CZ
Ing. Lukáš Šoustek, Karviná, Ráj, CZ

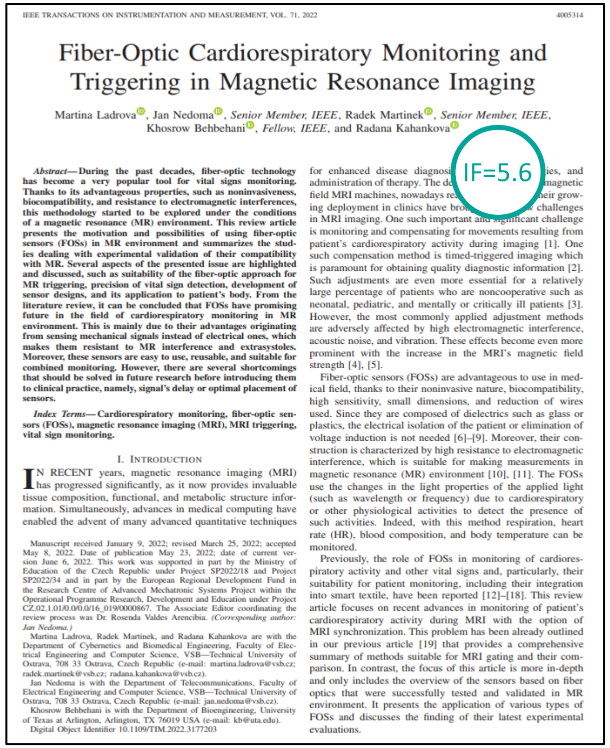
(54) Název přihlášky vynálezu:
Systém pro monitorování kardiorespiračních aktivit lidského těla nejen v magneticky rezonančních prostředích snižující nutnou délku vyšetření

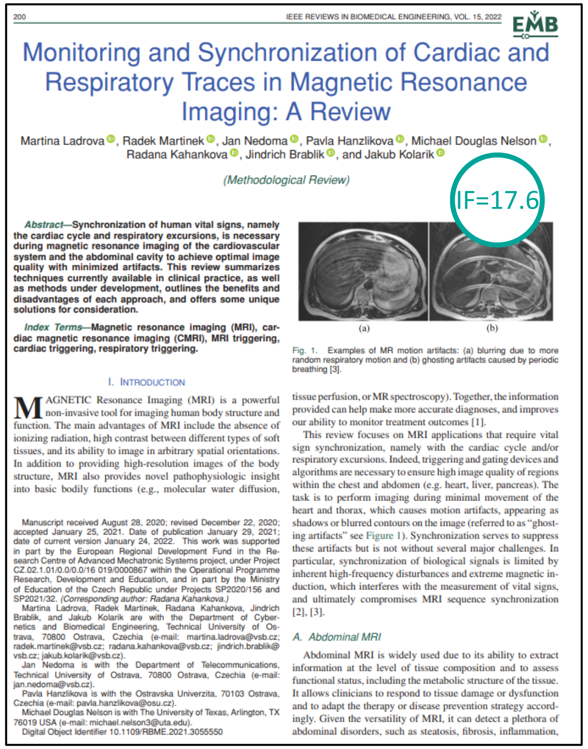
(57) Anotace:
Systém pro monitorování kardiorespiračních aktivit lidského těla nejen v magneticky rezonančních prostředích sestává z měřicího modulu (5) spojeného pneumatickým vedením (4) přes propojovací konektory (3) s nejméně jednou sadou pneumatického senzoru (2) společně s polstrováním podložky (19), tvrdou podložkou (18) a podložkou pro tlumení vibrací (17) tvořící kompletní systém měřicí podložky (1). Systém slouží ke kontinuálnímu monitorování kardiorespiračních projevů aktivity lidského těla pomocí balistokardiografie. Hlavní účel jeho použití je zejména při vyšetření magnetickou rezonancí, ale lze jej využít pro monitorování v prostředí CT (počítačová tomografie), rentgen, spánková laboratoř, JIP (jednotka intenzivní péče), lůžka pro dlouhodobě nemocné, hospici ale také monitoring novorozenců.

CZ 2019 - 762 A3

Publication Outputs

Development of a Complex Sensory System for Effective MRI Control

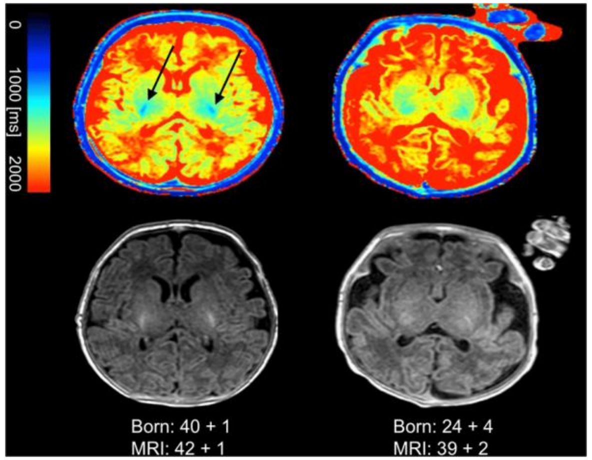


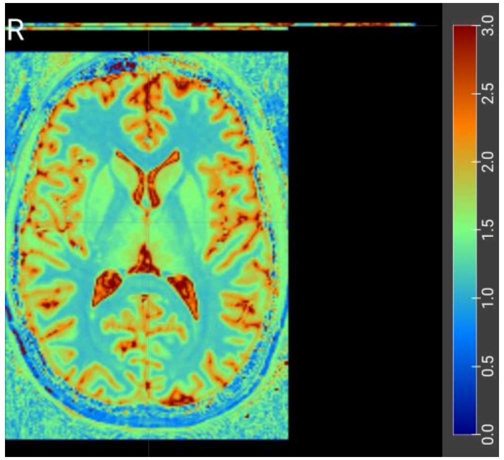


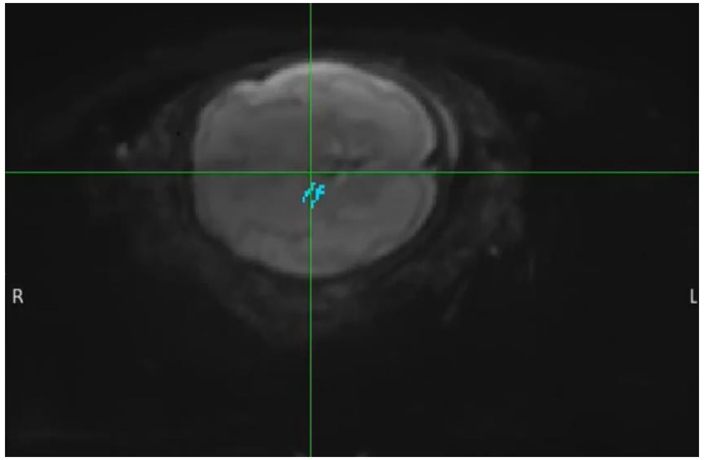
Projects

MR Relaxometric Assessment of Basal Ganglia in Neonates with Hypoxic-Ischemic Encephalopathy (HIE)

- TREND - Technology Agency of the Czech Republic
- 1.1 million EUR
- 2023–2027
- Computer-Aided Diagnosis for Quantitative Evaluation of Brain Development Incorporating AI



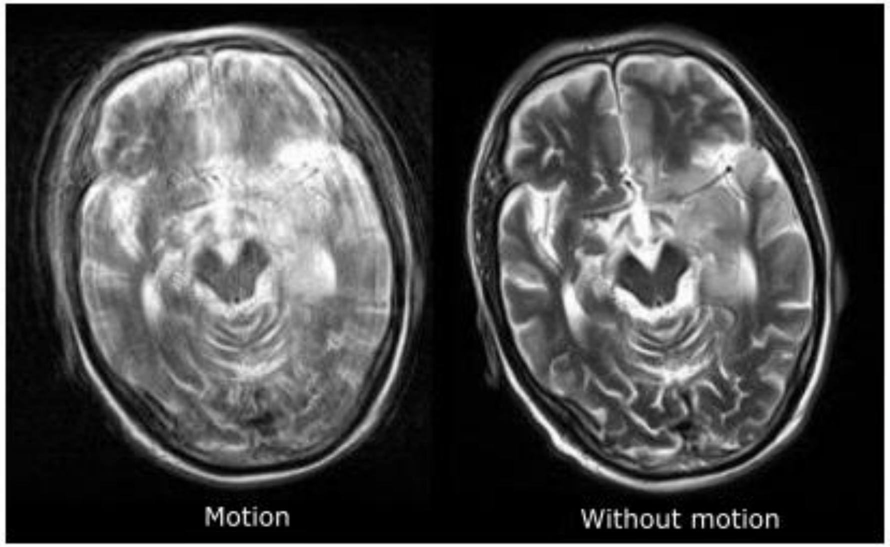




Projects

MR Relaxometric Assessment of Basal Ganglia in Neonates with Hypoxic-Ischemic Encephalopathy

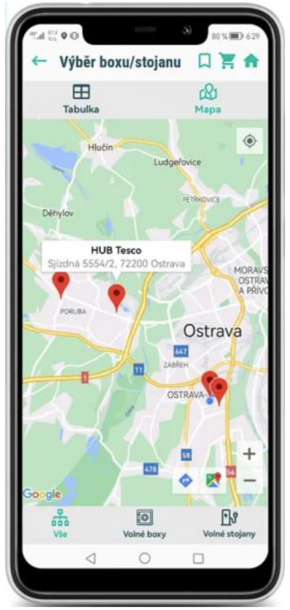
- Motion Detection During MR Examination



Projects

Development of Small Electric Vehicles for Intergenerational Urban E-Mobility Concepts Powered by Smart Infrastructure

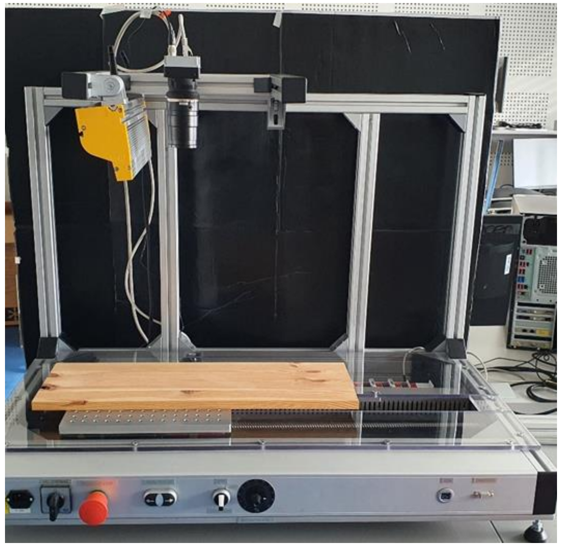
- INTER-EXCELLENCE - Ministry of Education, Youth and Sports
- 620 000 EUR
- 2021–2022
- Smart infrastructure for securing and charging e-scooters and e-bikes
- Parameter tester for the same

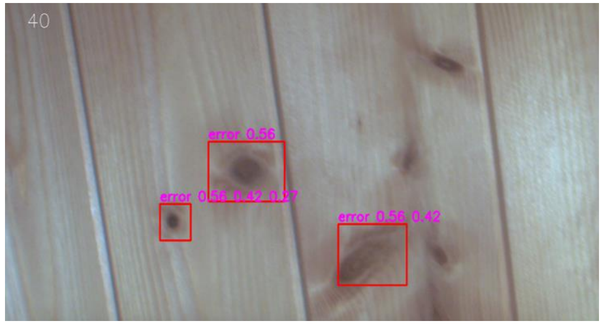


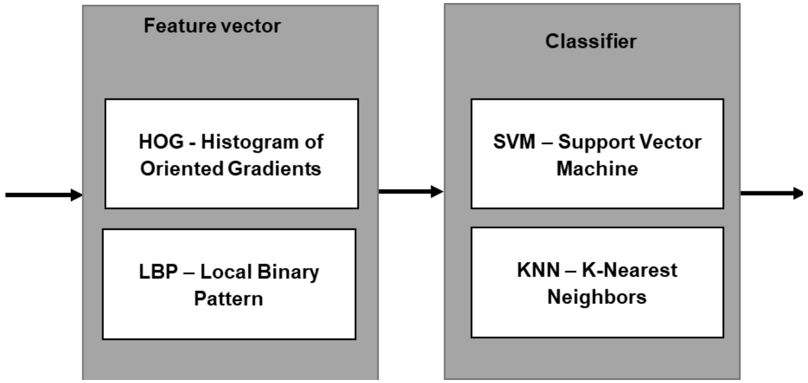
Projects

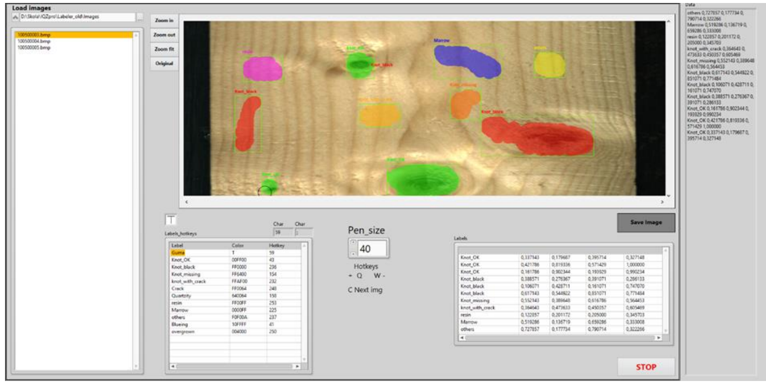
IQZeProd - Inline quality control for zero-error-products

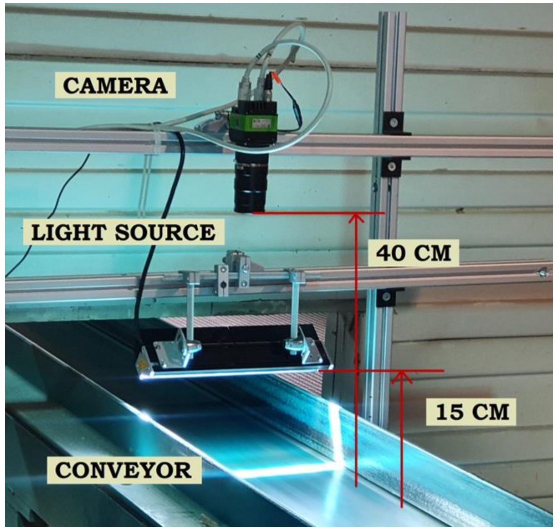
- Ministry of Industry and Trade
- 300 000 EUR
- 2019–2020
- A large-scale image dataset of wood surface defects
- Classification algorithm based on NN







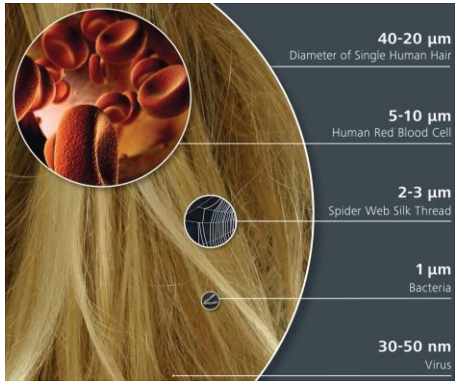


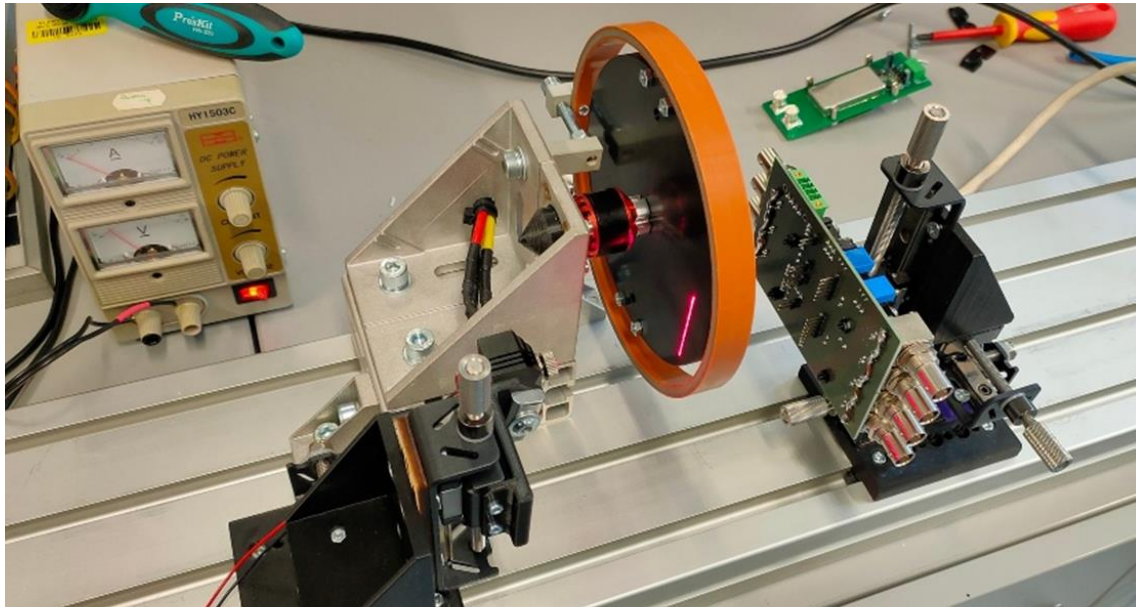


Projects

Research and development of innovative technology for the pin hole detection in the metal strip

- Ministry of Industry and Trade
- 480 000 EUR
- 2021–2023
- Detectable hole diameter >5 µm
- Speed of sheet metal up to 25 ms-1

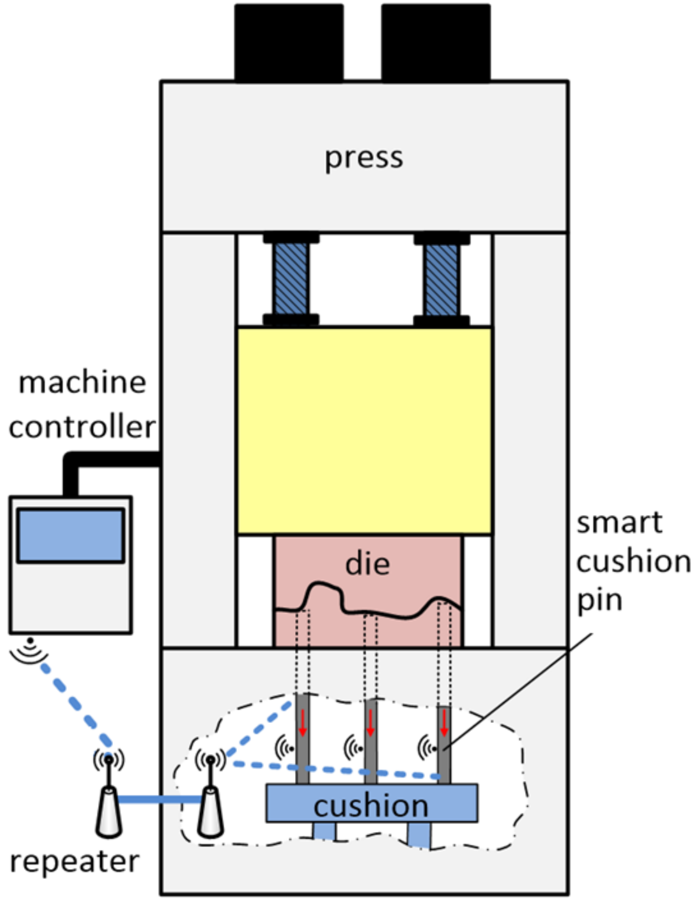




Projects

Research and development of the Smart Cushion Pin for machine presses

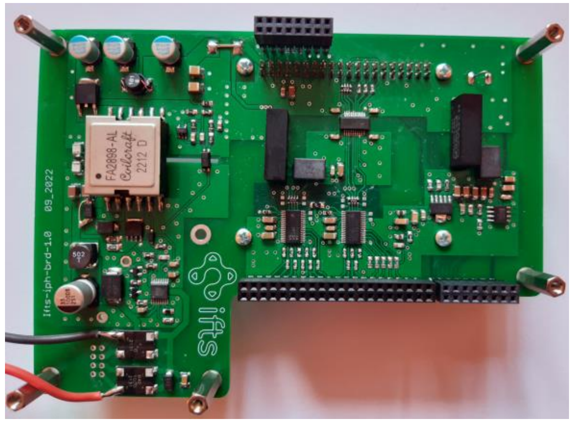
- Ministry of Industry and Trade
- 440 000 EUR
- 2018–2019
- Special sensor development for press machines

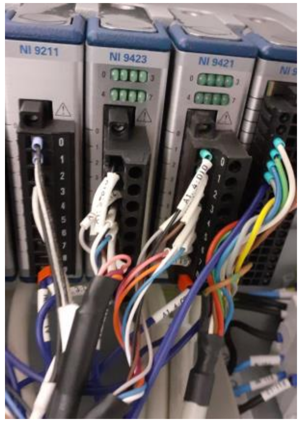


Projects

Smart Steam Valve – an automatic system for predictive maintenance

- DELTA 4 - Technology Agency of the Czech Republic
- 440 000 EUR
- 2021–2023
- Innovation of the blower used to clean the heat exchange surfaces of power plant boilers
- Prototype of a HW and SW for a monitoring system





VSB TECHNICAL UNIVERSITY OF OSTRAVA | FACULTY OF ELECTRICAL ENGINEERING AND COMPUTER SCIENCE

Geothermal Energy
In Special Underground Structures (GeoUS)

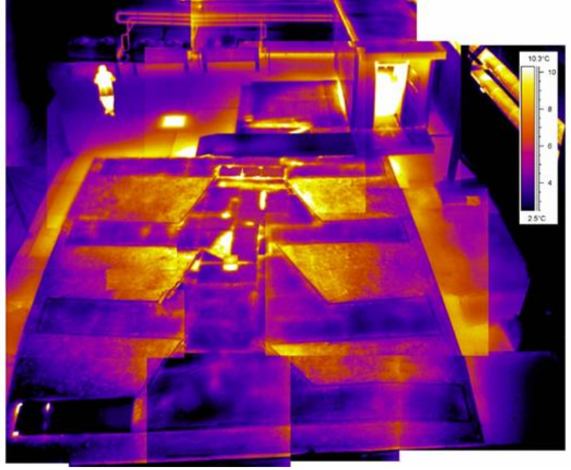
- H2020, Twinning, WIDESPREAD-03-2018
- VSB – TUO (coordinator), Fraunhofer Institute IWU, Germany, University of Vaasa, Finland

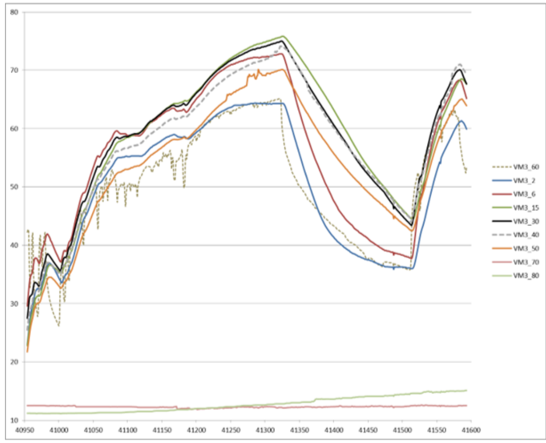
Experience in geothermal energy area:

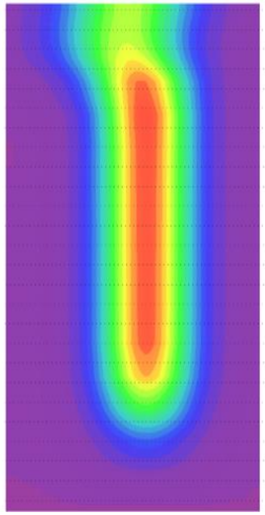
- Assessment of the rock environment.
- Comprehensive design of systems for the use of low-enthalpy geothermal energy.
- Simulation of heat transfer.
- Measurement and control of geothermal systems.
- Special measurements for geothermal systems design – TRT, Temperature profiles, long term measurements.

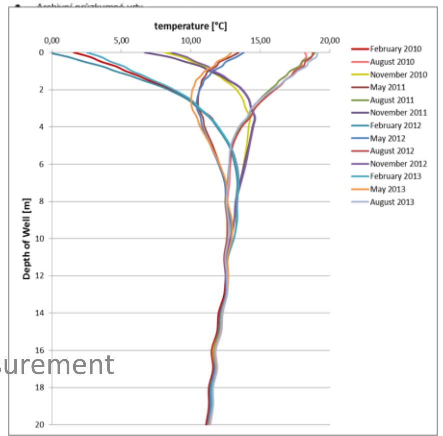
Research team of 3 faculties.

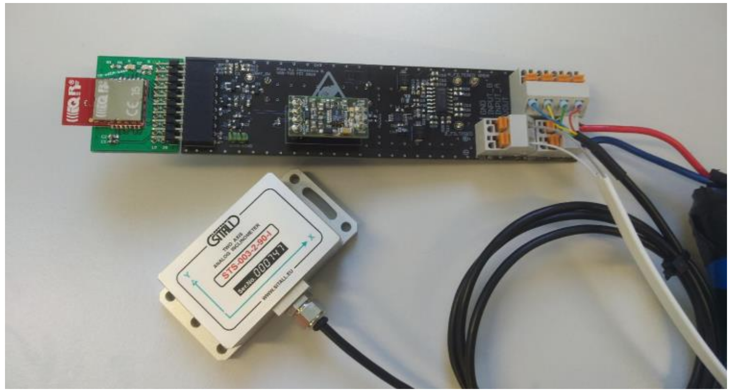
http://geous.vsb.cz/





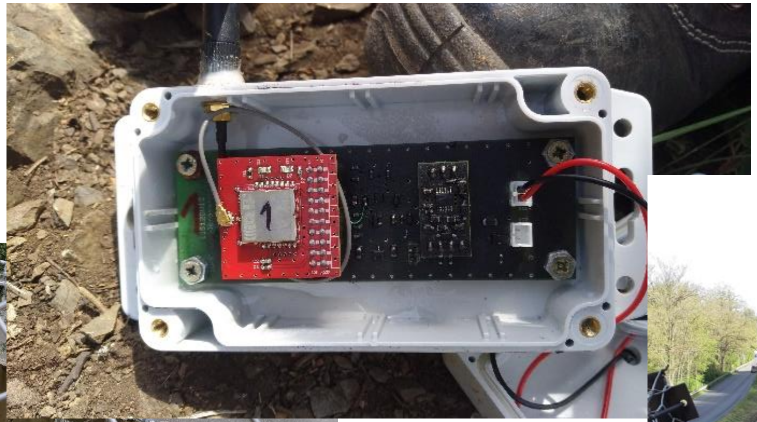






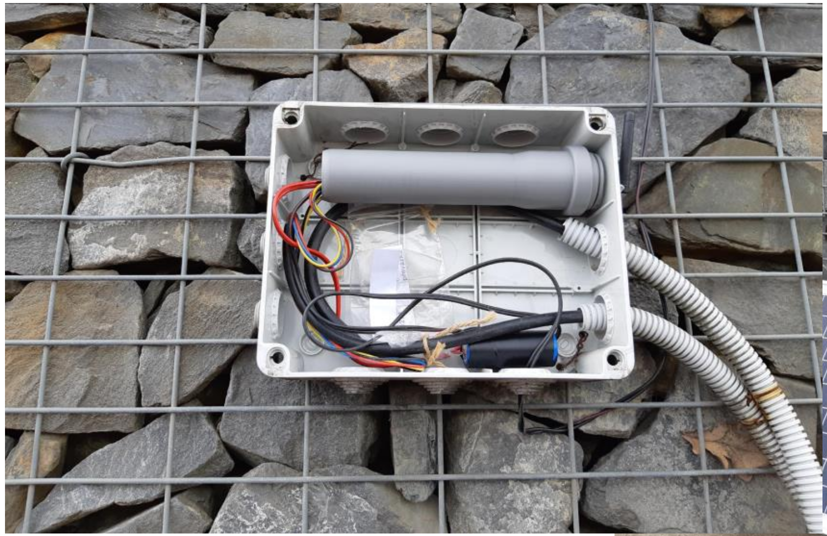
Projects

- Development of wireless monitoring systems for monitoring the state of protective fences near rocky walls.
- Cooperation with STRIX Chomutov, a.s.



Projects

- Development of wireless monitoring systems for slope stability monitoring.
- Cooperation with SG Geotechnika, a.s.



Projects

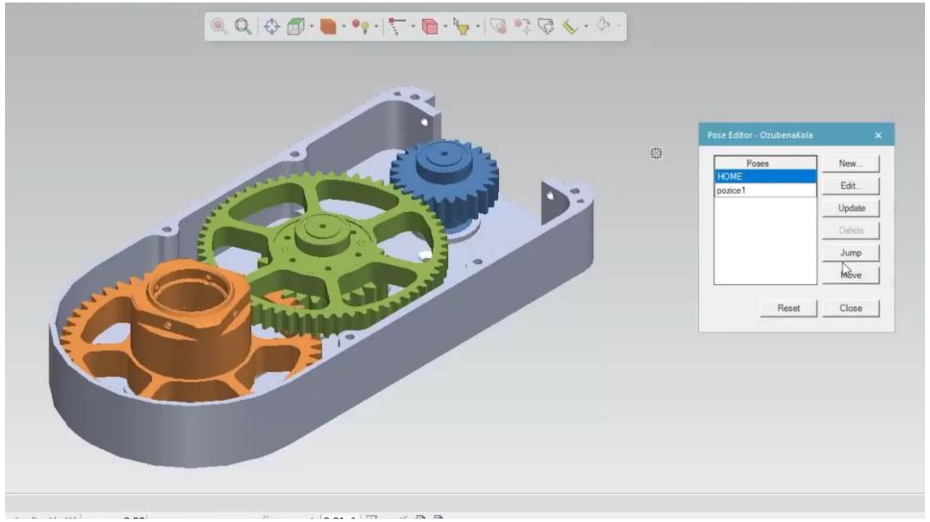
- Development of wireless monitoring systems for monitoring of cracks in rocks massive.
- Cooperation with ČEZ (owner of pumped hydroelectric power plant)

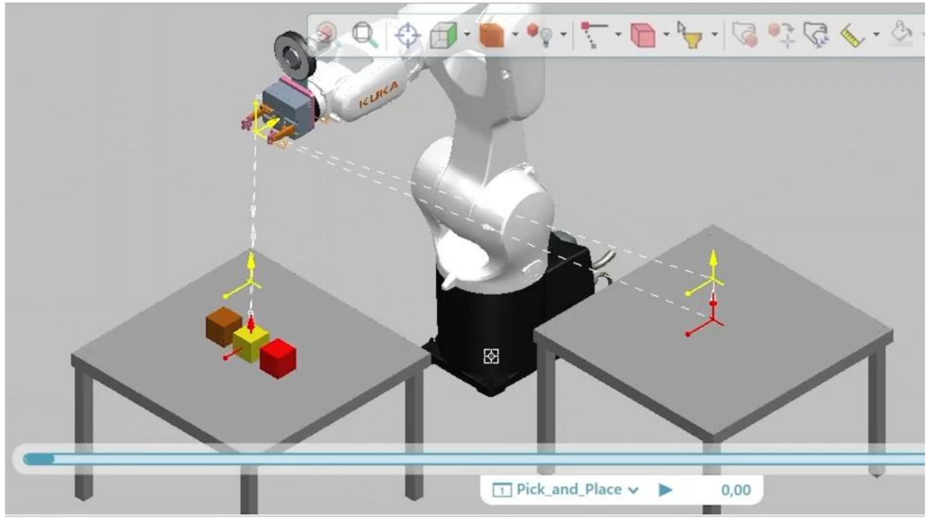
Projects

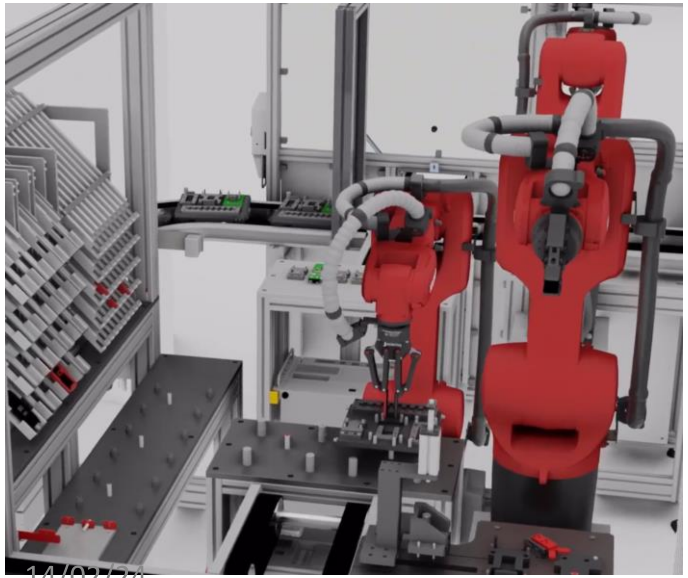
- Development of wireless monitoring systems for thermal processes monitoring at mining dumps.
- Cooperation with DIAMO, s.p., SG Geotechnika, a.s., CANIS Safety, a.s.

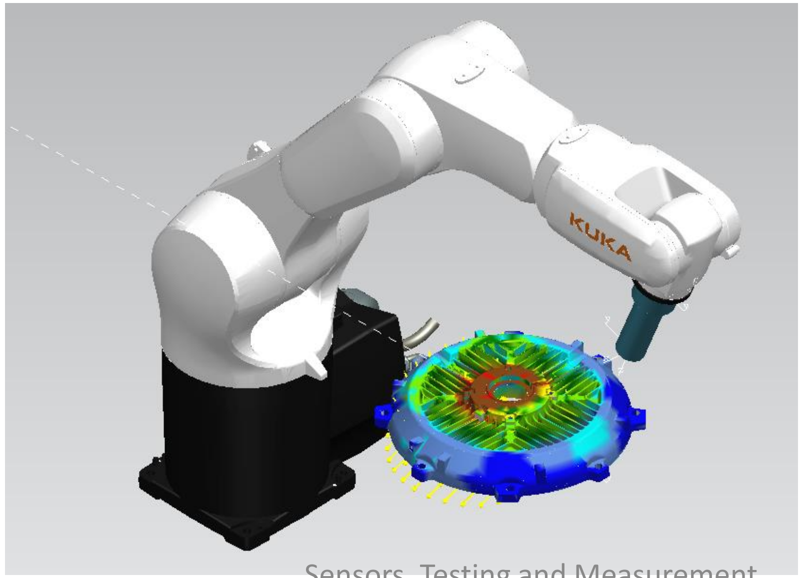
Projects

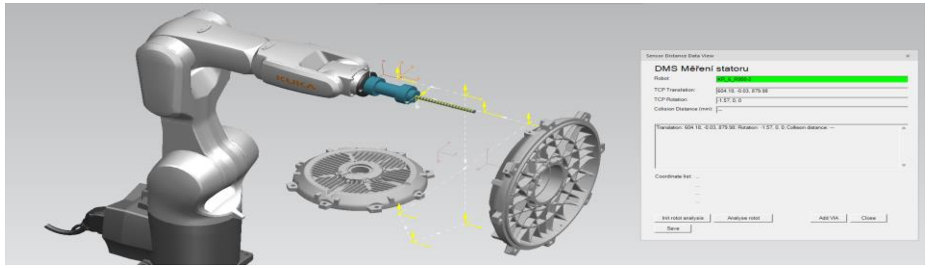
- Digital Twin.



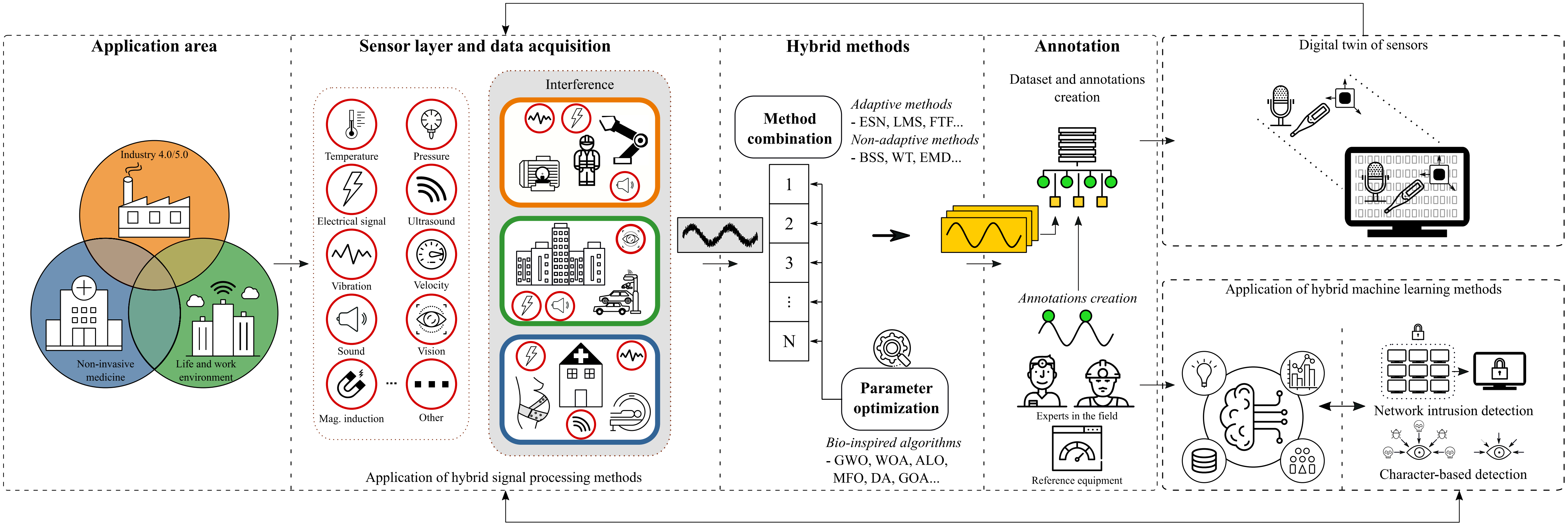




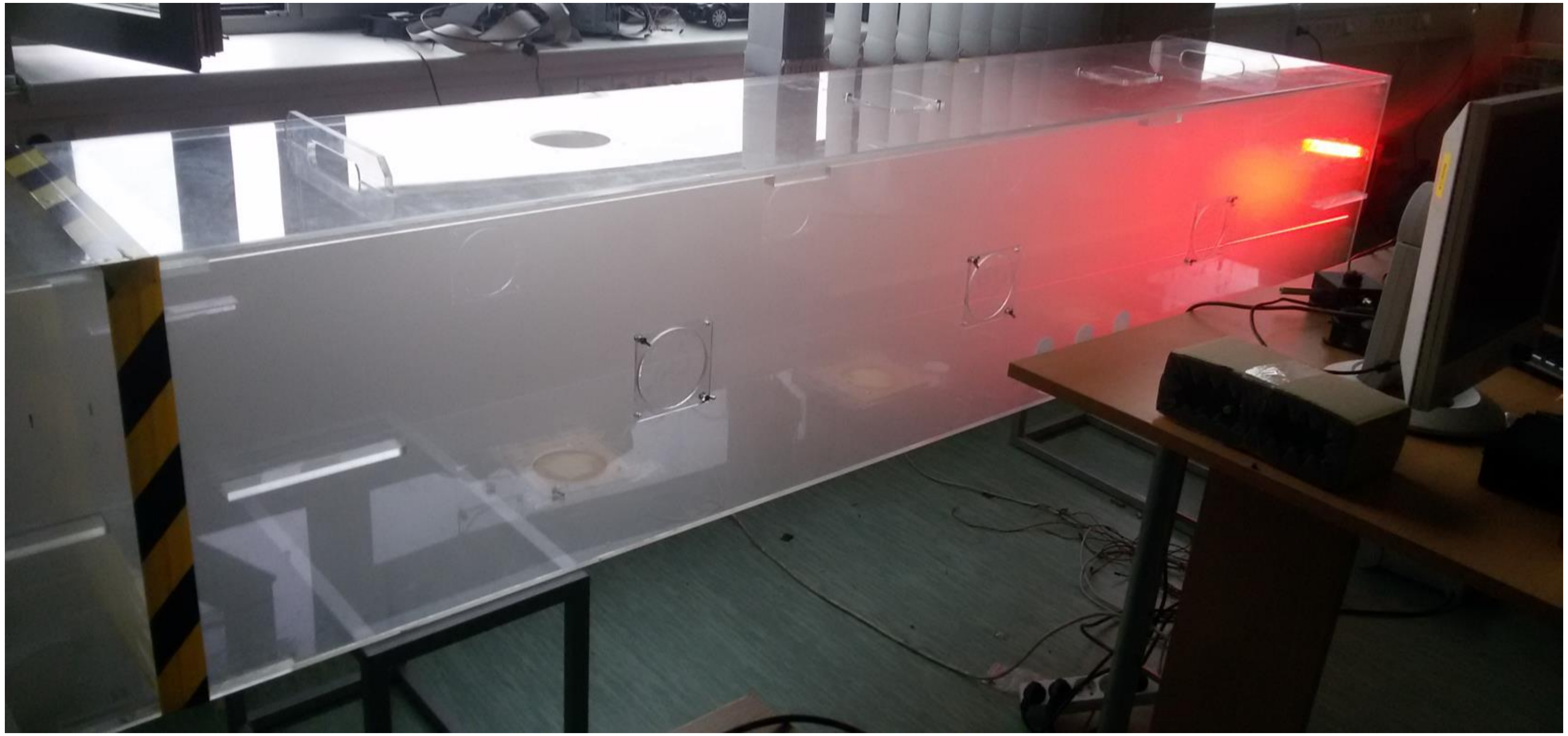




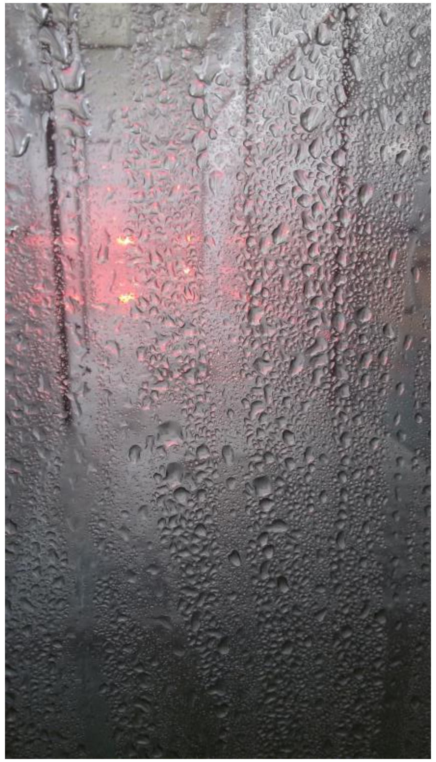
Application Areas in General



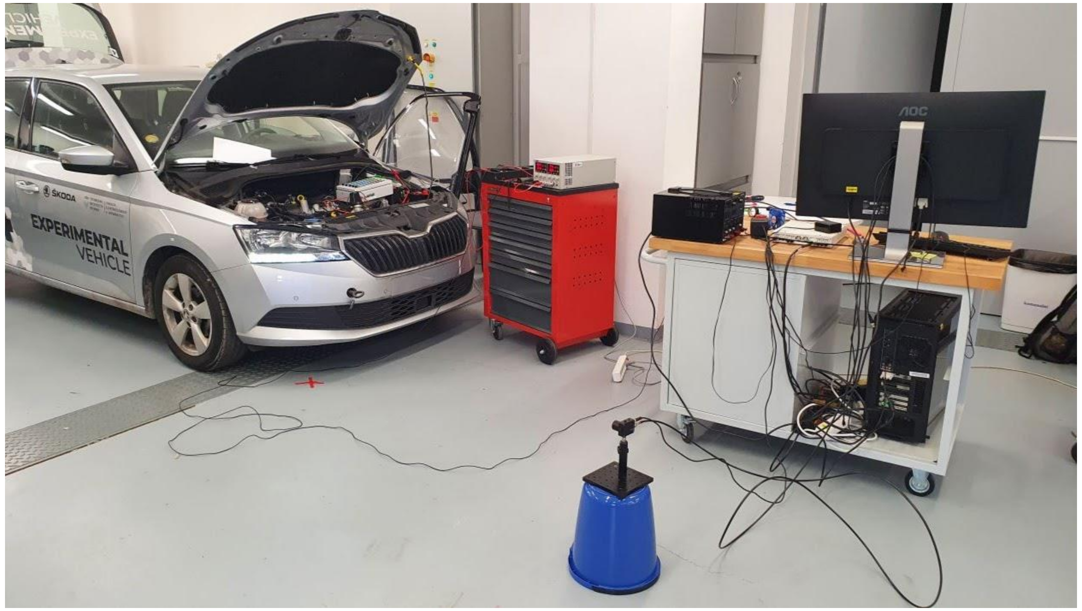
Visible Light Communication



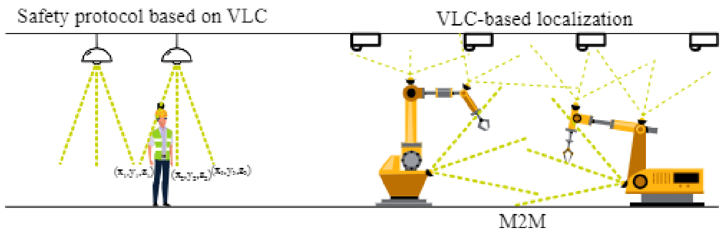
Visible Light Communication



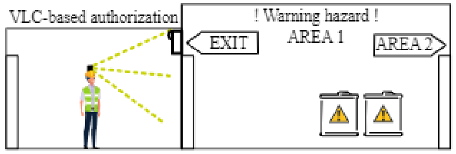
Visible Light Communication



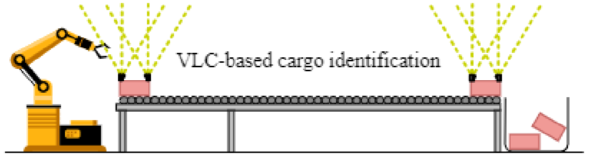
Visible Light Communication



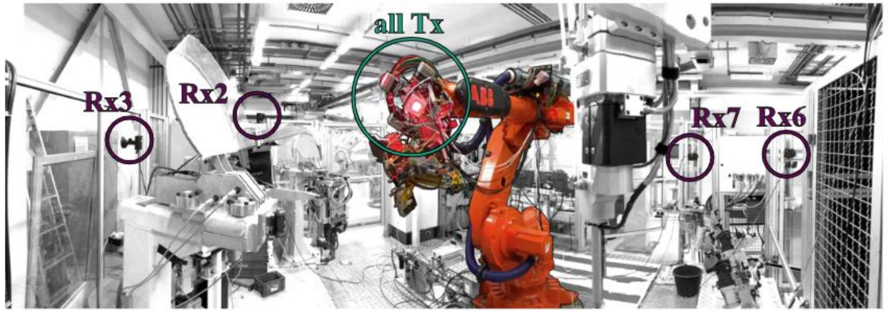
(a) Localization, Safety and M2M Protocols based on VLC.

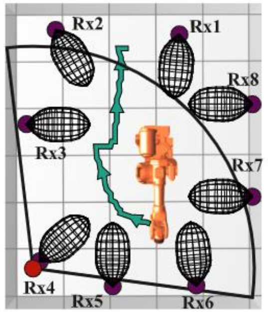


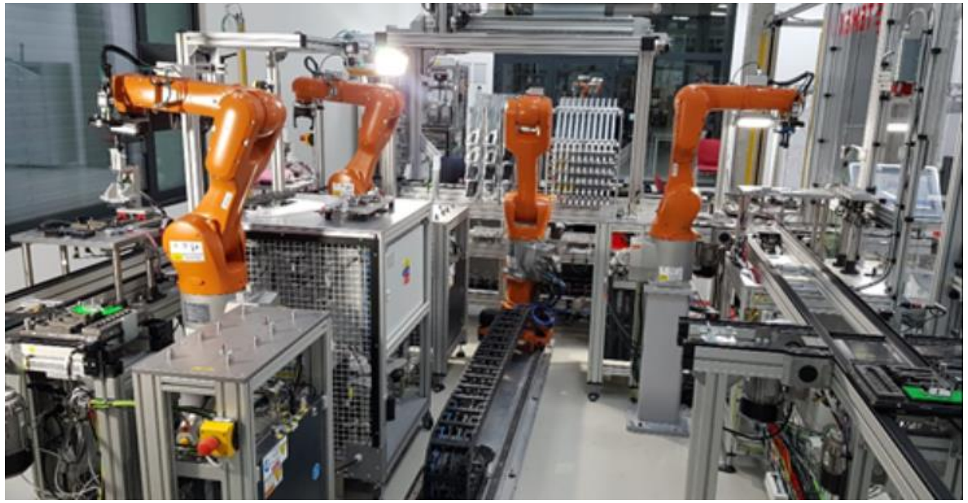
(b) VLC based Authorization in Dangerous Environments.



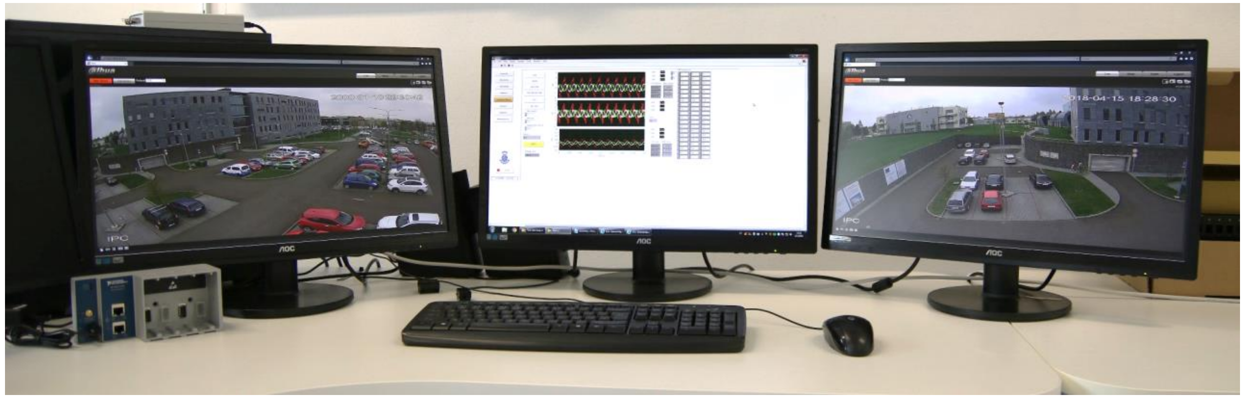
(c) VLC based Cargo Identification and Localization.



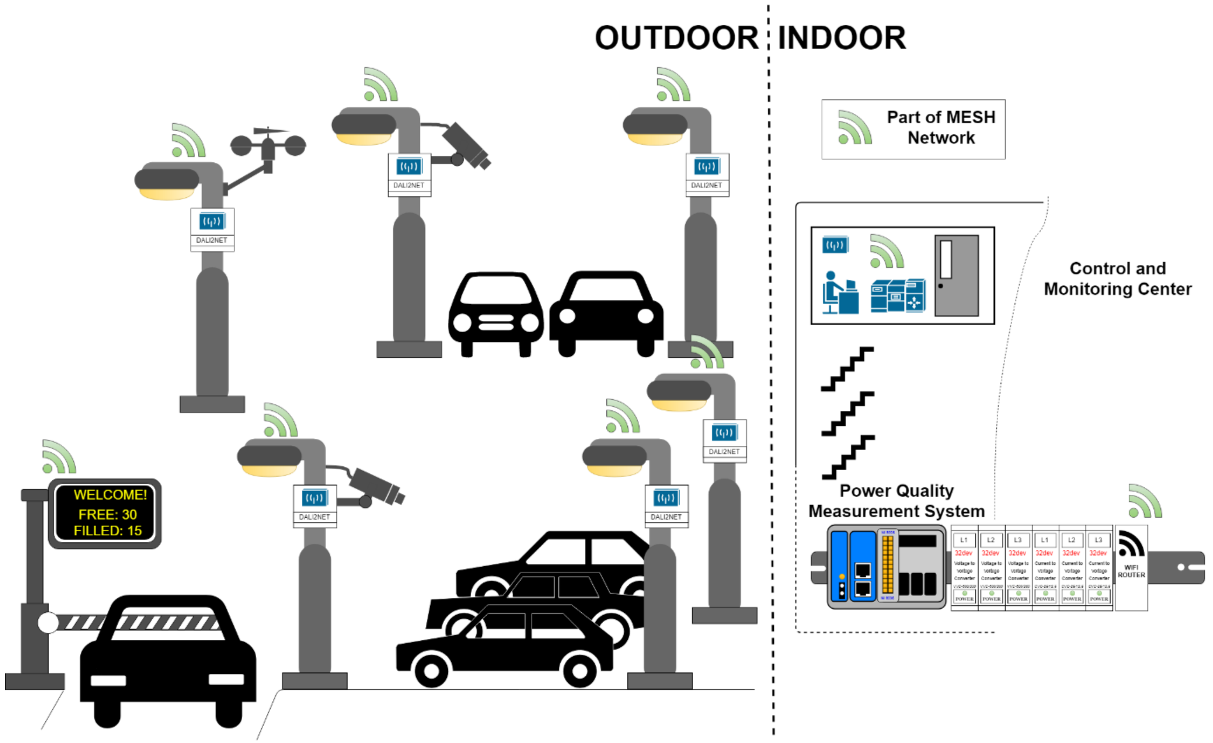




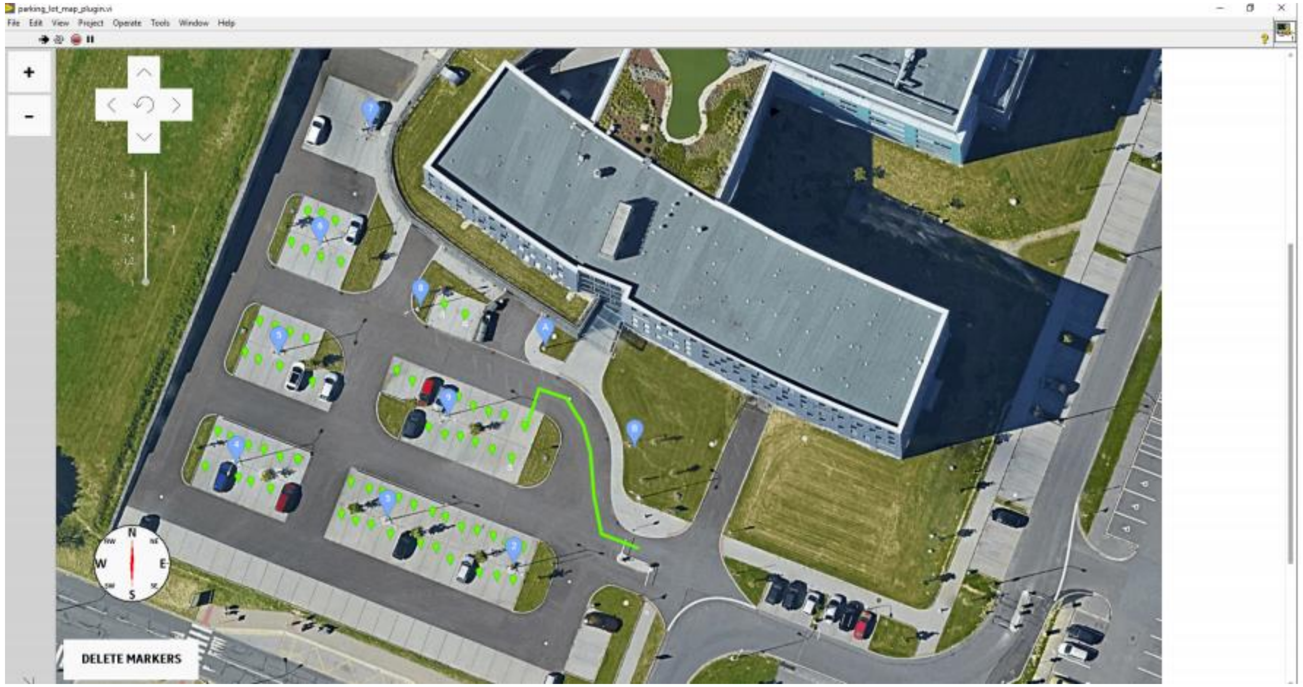
Parking Lot Polygon

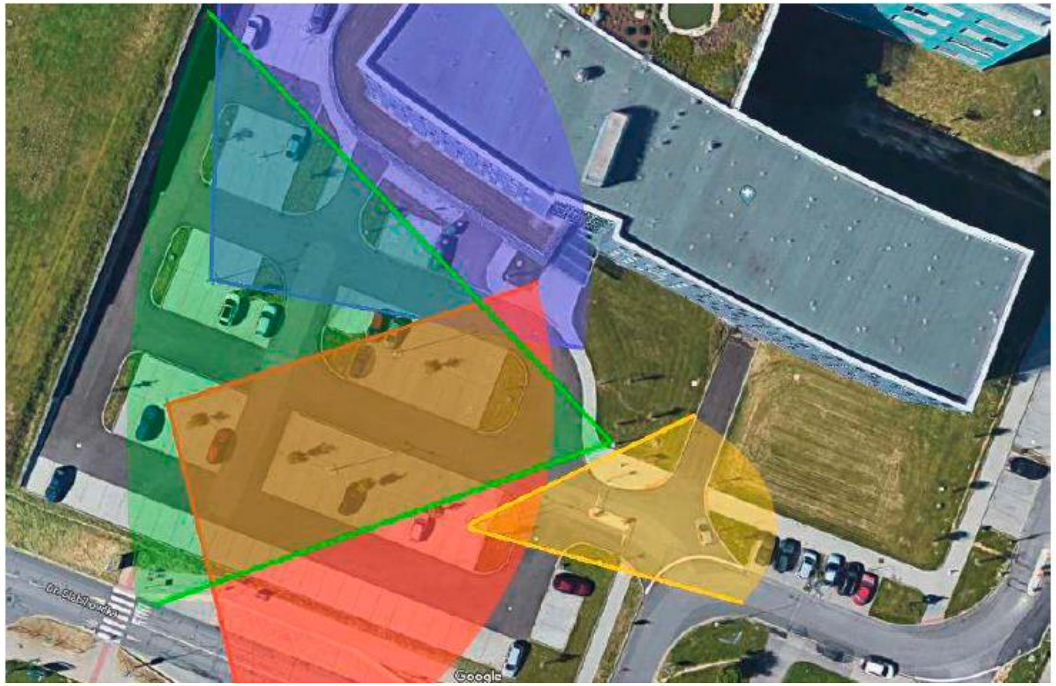


Parking Lot Polygon

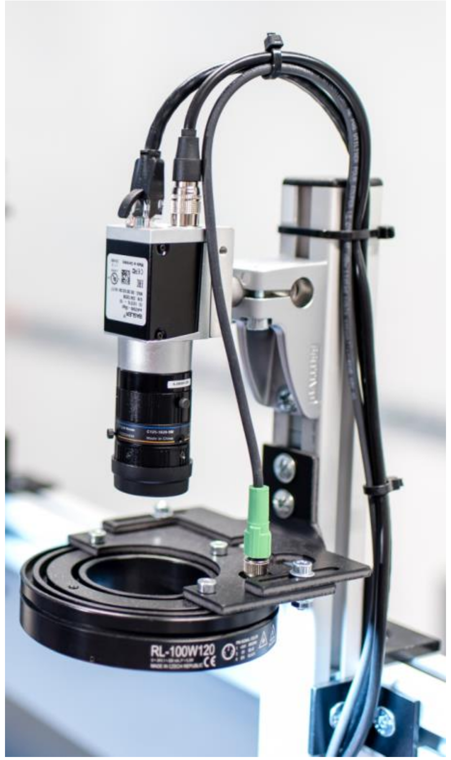


Parking Lot Polygon

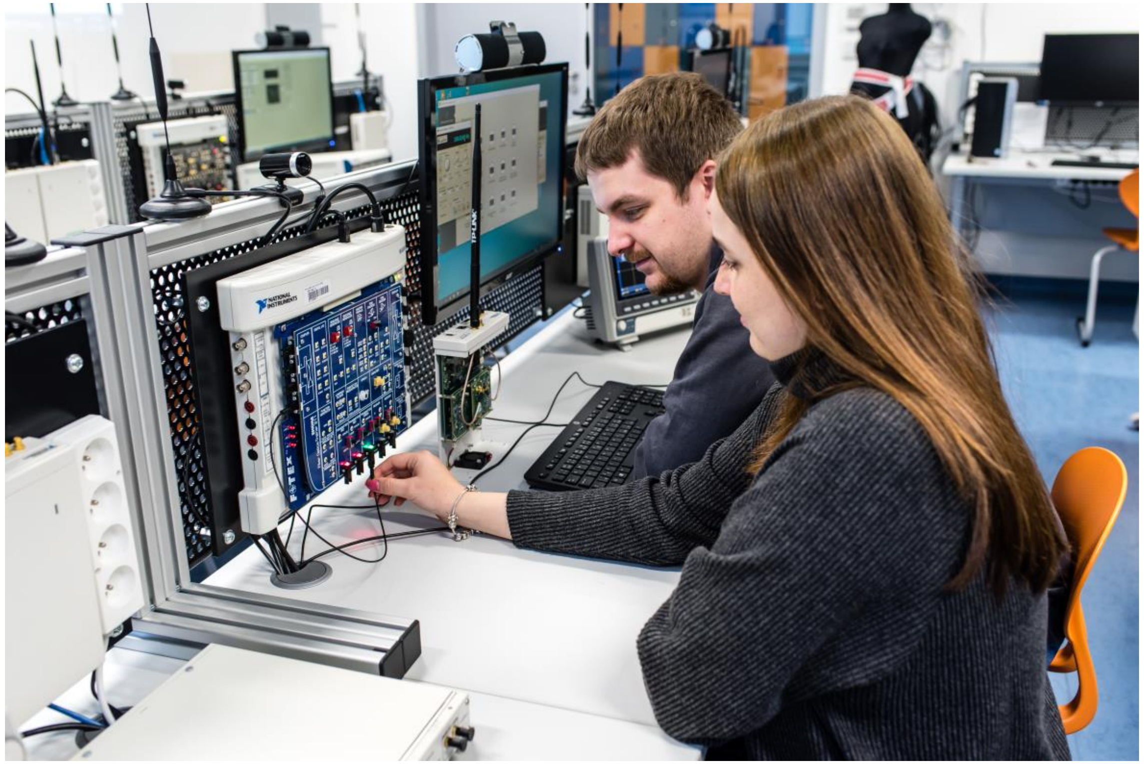




Laboratory of Virtual Instrumentation

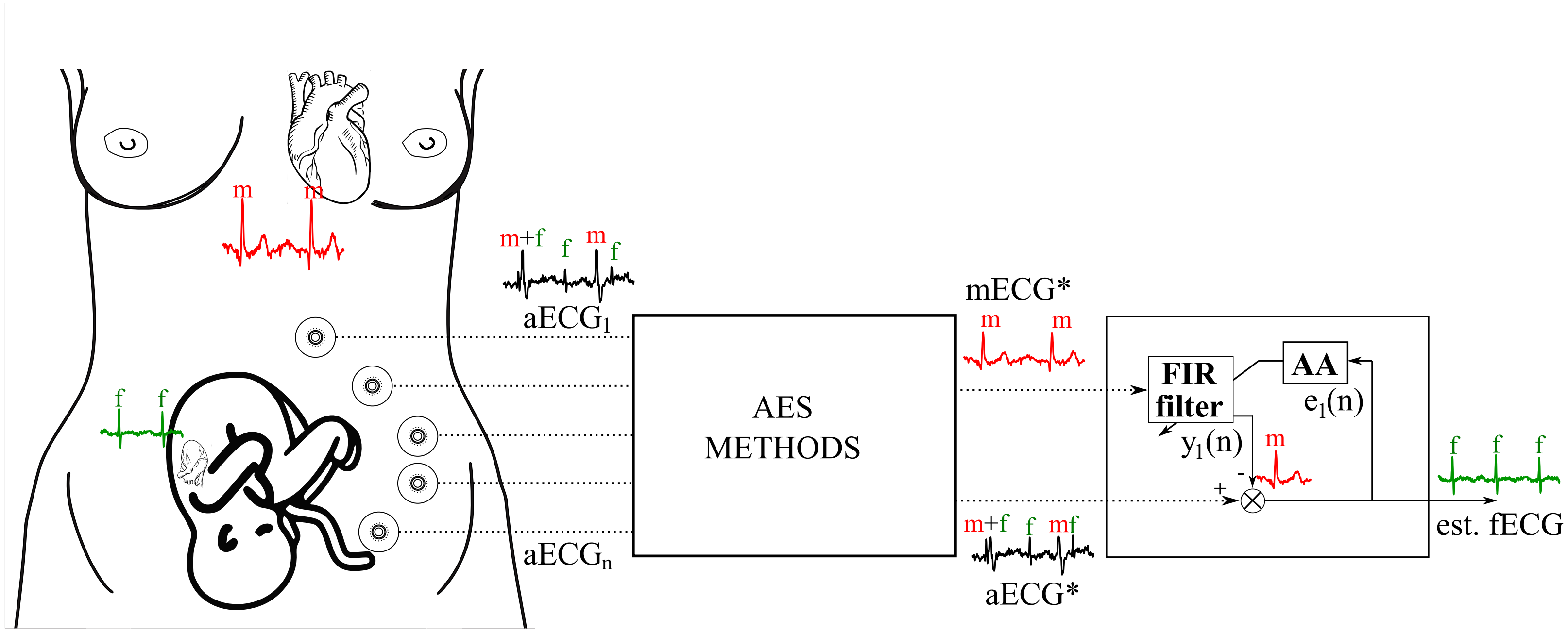


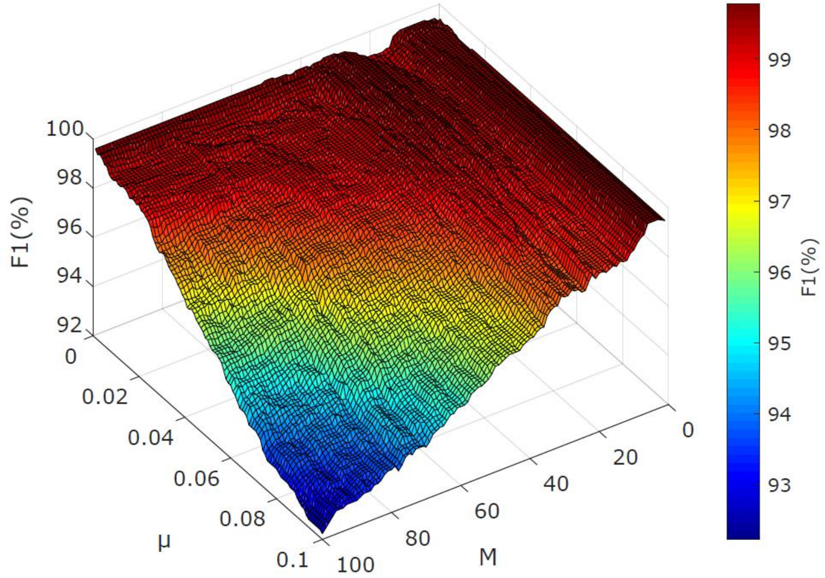
Laboratory of Signals and Systems

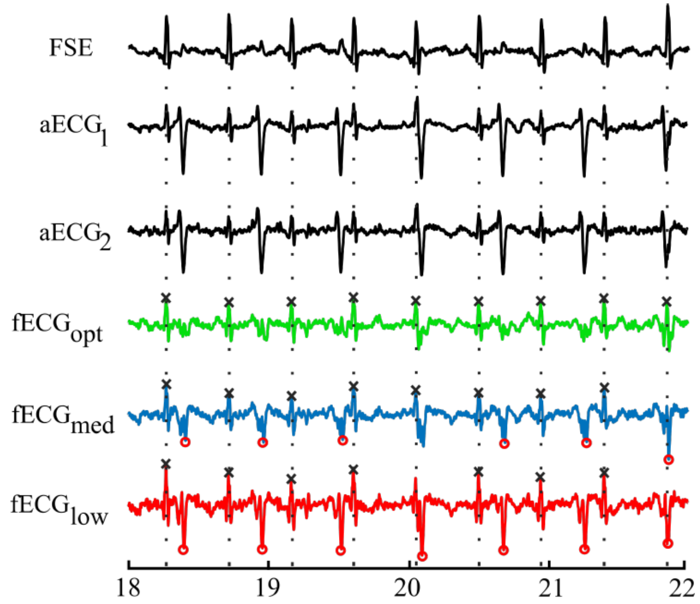


Extraction Algorithms

- **Non-Adaptive, Adaptive and Hybrid Methods.**
- Different parameters that need to be optimized.







Bio-Inspired Optimization

Grey Wolf Optimizer

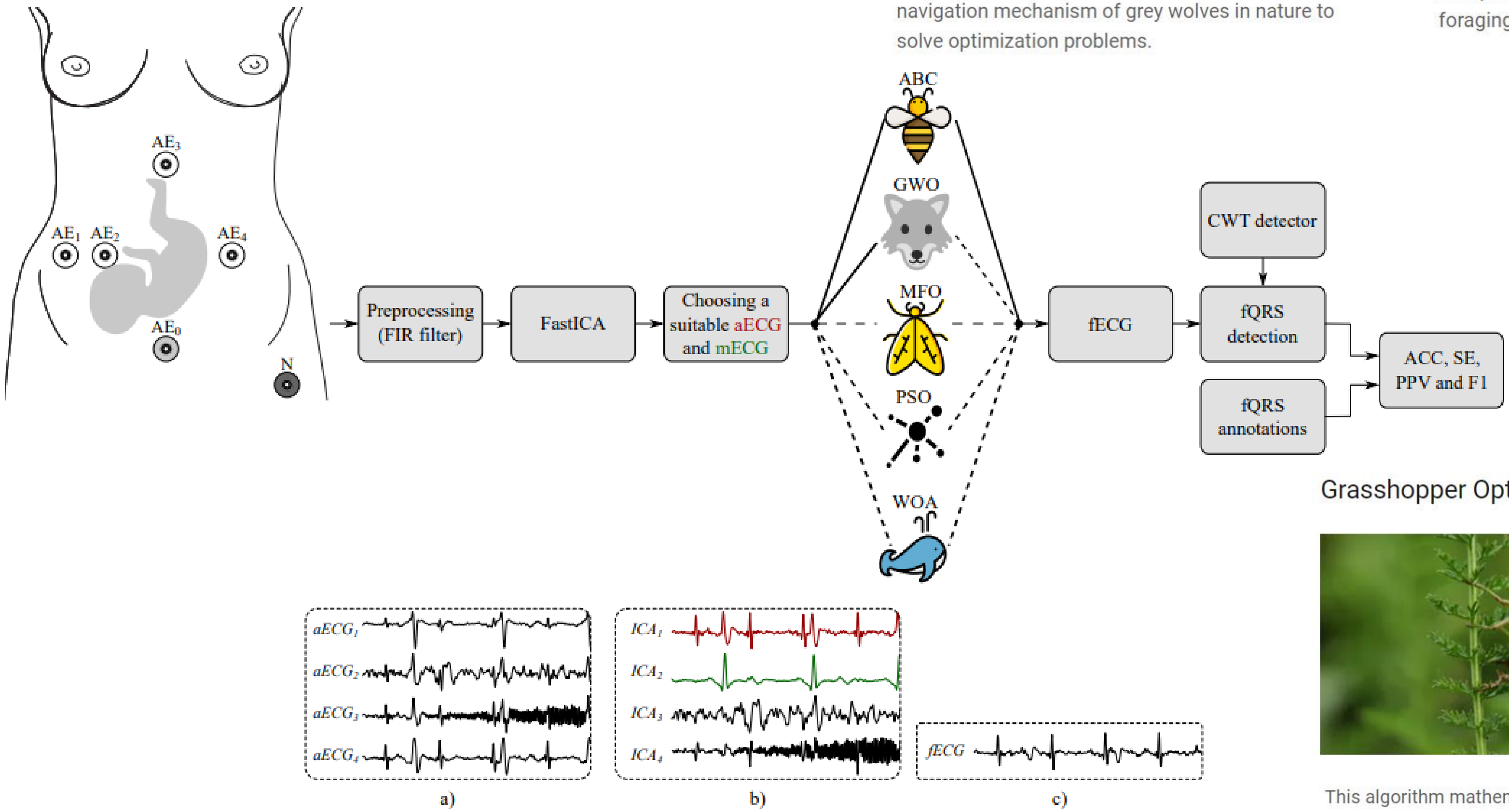
An algorithm that mimics the social hierarchy and navigation mechanism of grey wolves in nature to solve optimization problems.

Whale Optimization Algorithm

An optimization algorithm inspired from bubble-net foraging of humpback whales.

Moth Flame Optimizer

The main inspiration of this optimizer is the navigation method of moths in nature called transverse orientation. Moths fly in night by maintaining a fixed angle with respect to the moon, a very effective mechanism for travelling in a straight line for long distances. However, these fancy insects are trapped in a useless/deadly spiral path around artificial lights. This paper mathematically models this behaviour to perform optimization.

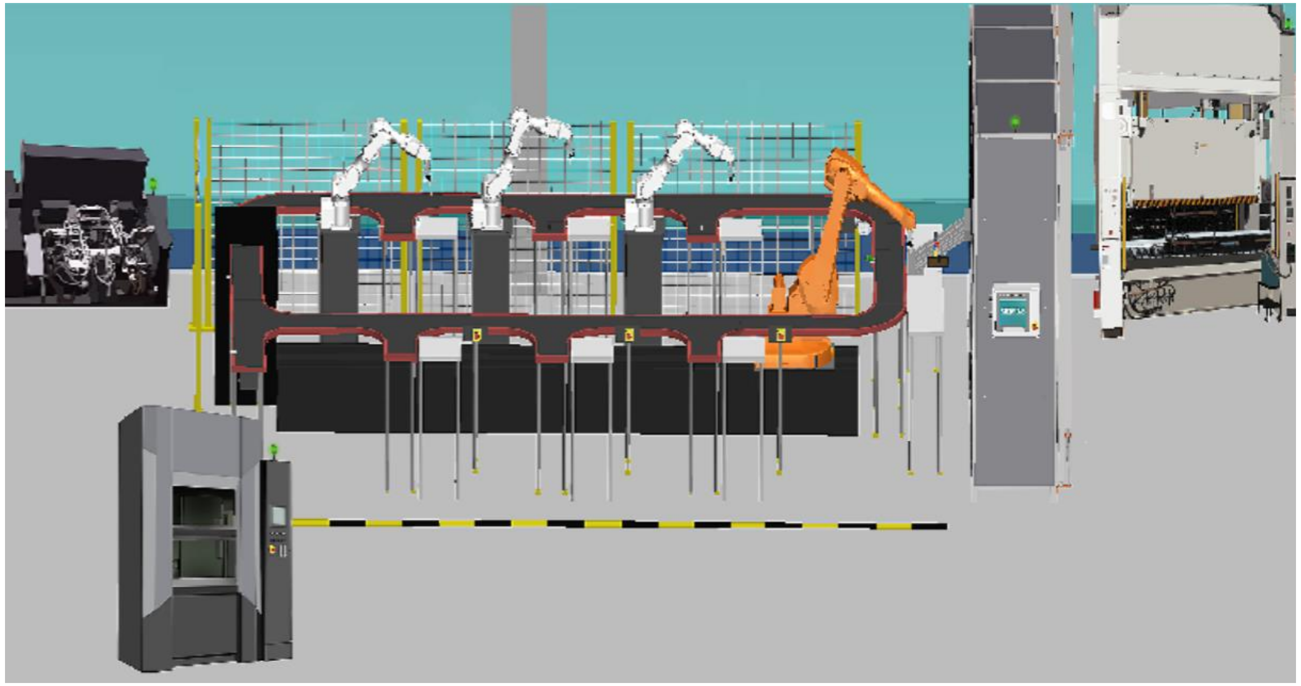


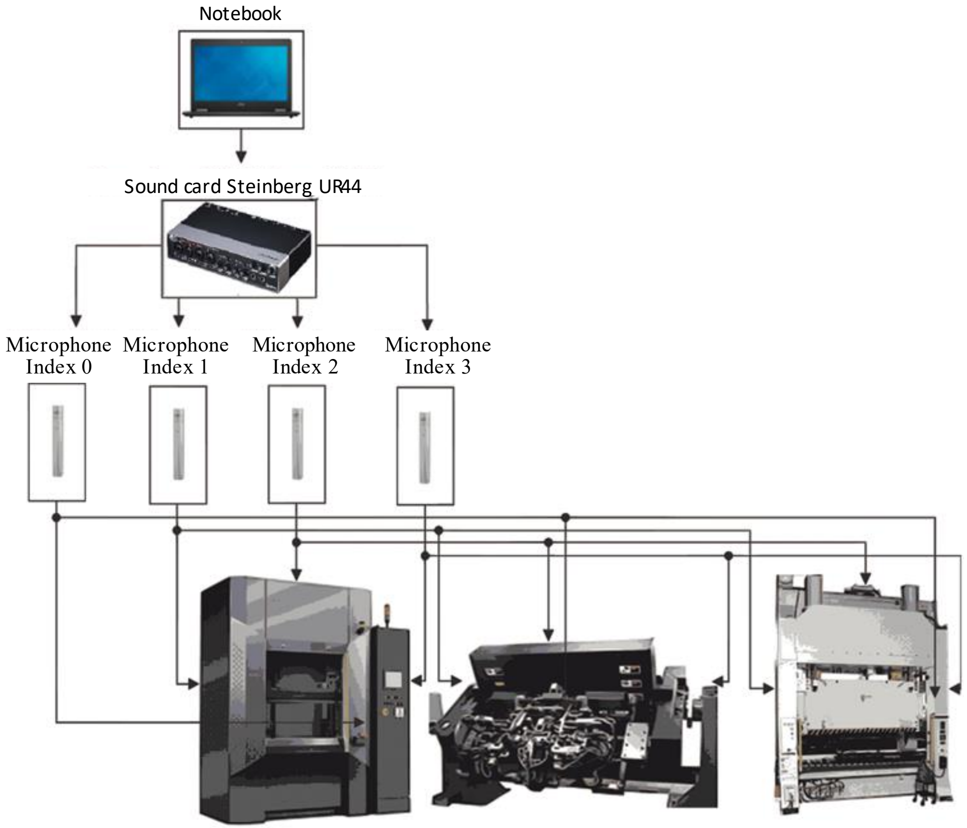
Grasshopper Optimization Algorithm

This algorithm mathematically models and mimics the behaviour of grasshopper swarms in nature for solving optimisation problems.

Speech Processing

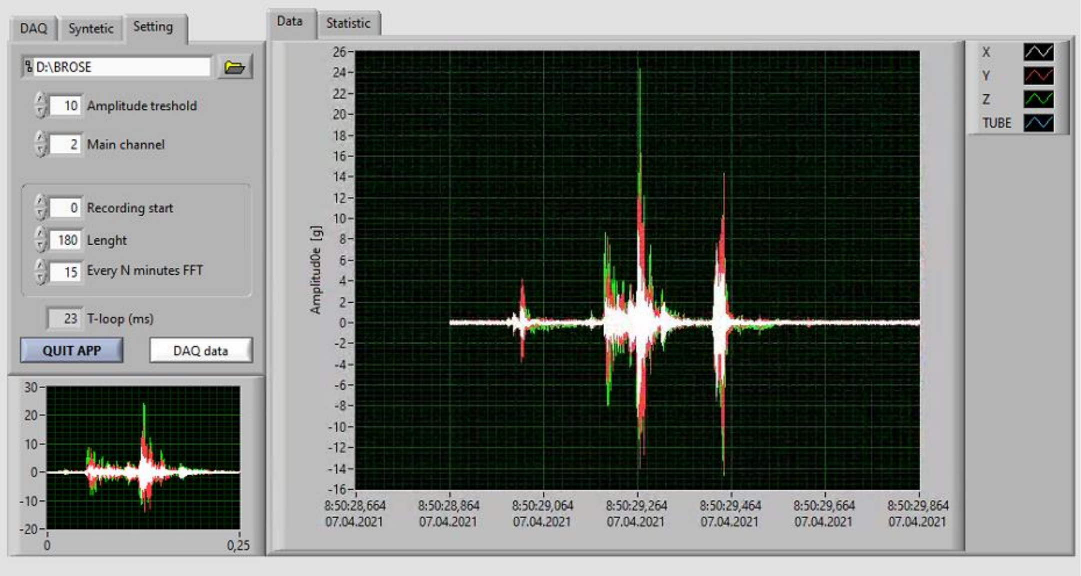
Speech Processing

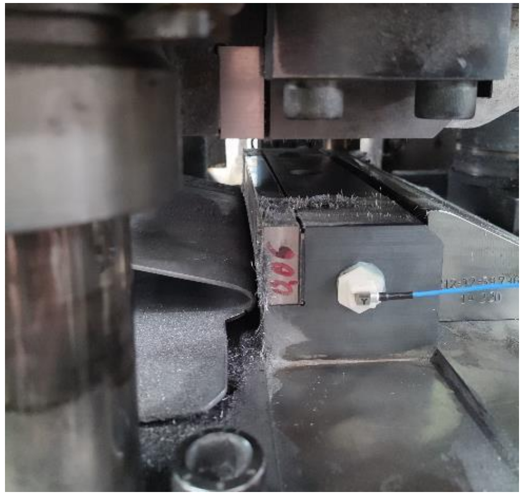




Continuous Monitoring, Predictive Maintenance

- Long-term measurements in two industrial complexes.
- Metal cutting machine monitoring with tri-axial accelerometers.

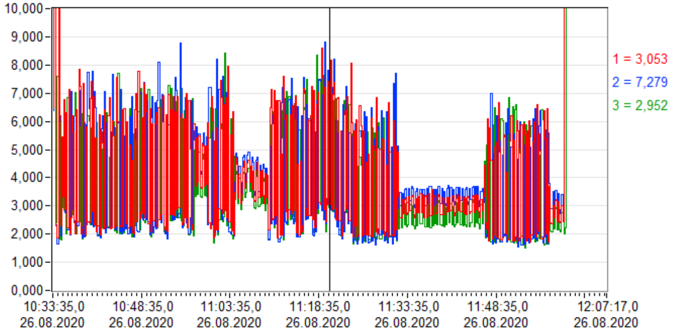


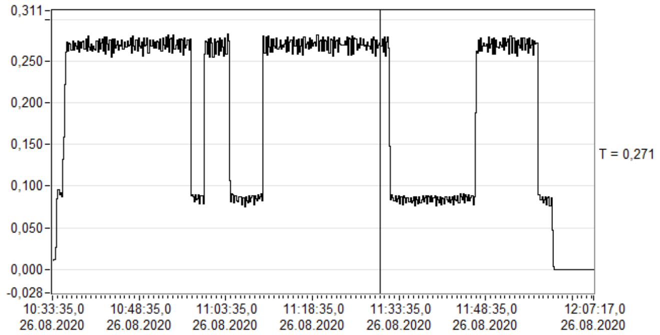


Power Quality Measurement and Evaluation

- ENA330 with Rogowski coils for current up to 3000 A.

THDi (%), Total Harmonics Current Distortion

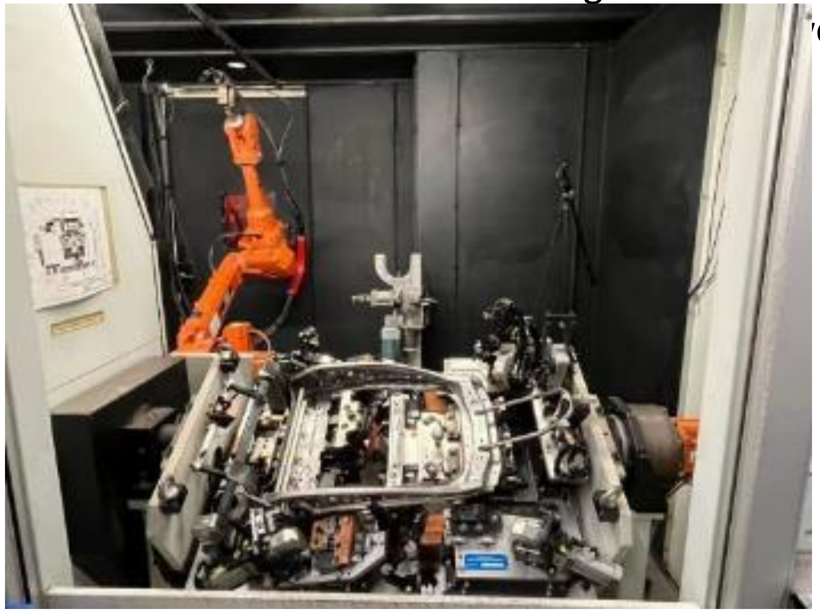


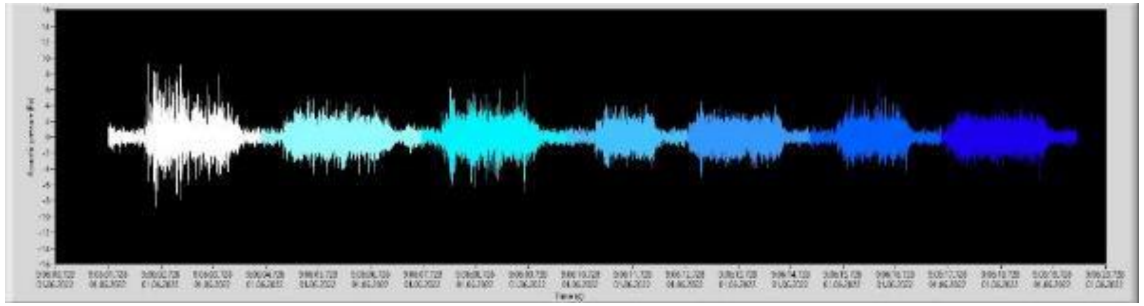


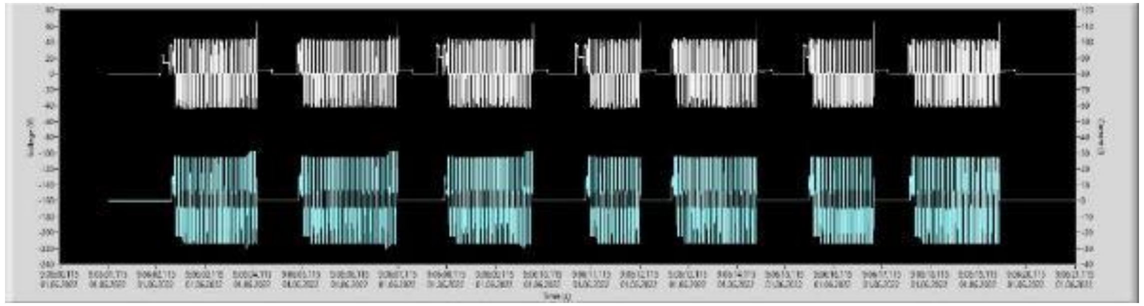
3-Phase Power (kW)

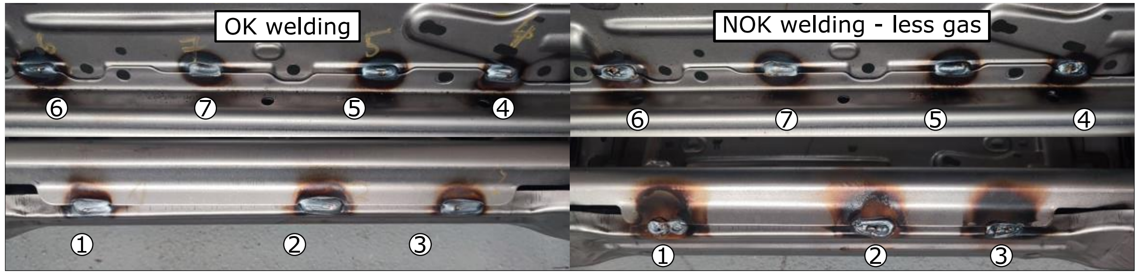
Continuous Monitoring, Predictive Maintenance

- Feasibility study of welding monitoring using acoustic emission sensing.
- Measurement of electric signals and acoustic signals … elds.



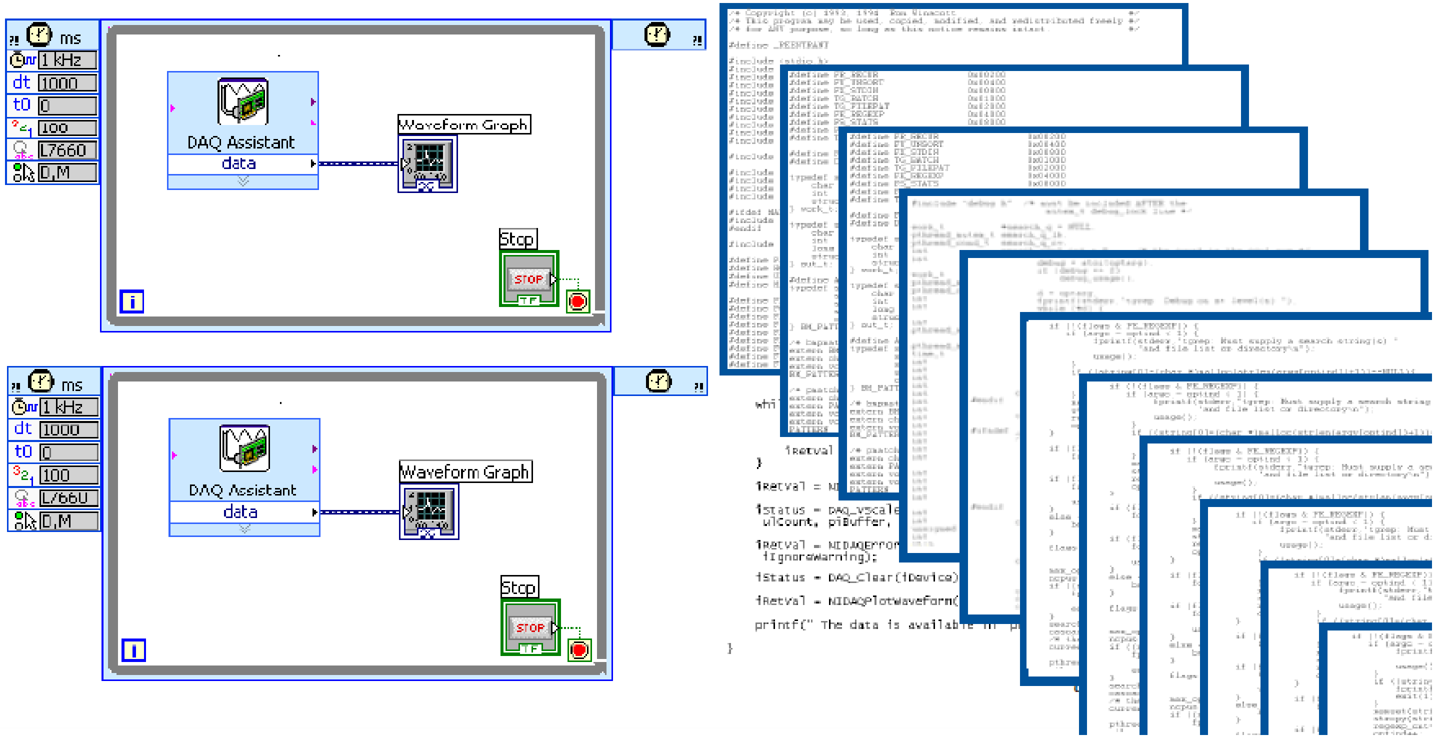






Virtual Instrumentation

LabVIEW	C*



NI PXIe Hardware

- PXIe chassis expandable with I/O, communication and FPGA modules.
- Can have a separate controller.
- Can be remotely controlled via PC/laptop.

Cooperation with the Mendel University in Brno

- Using Solar and Geothermal Energy to Reduce the Energy Intensity of Automated Crop Production.

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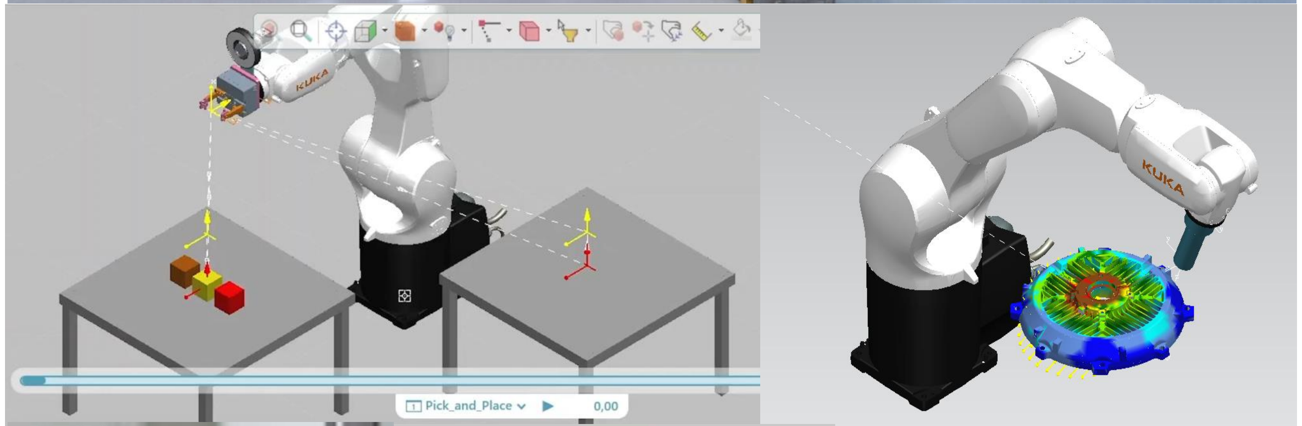
Smart Factory

- Research and training testbed for Industry 4.0
- Test-Before-Invest cooperation

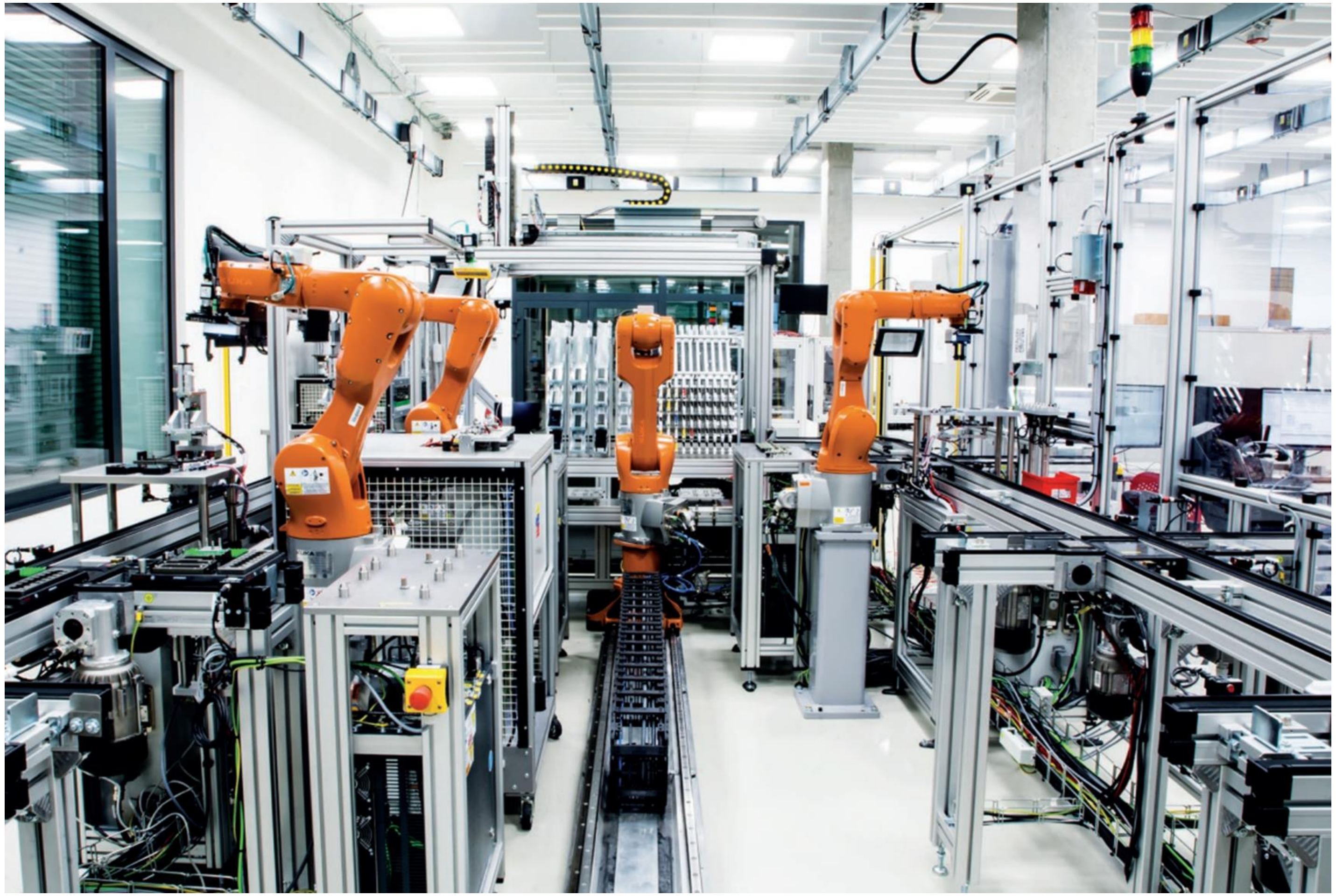
Expertise and research provided by Smart Factory:

- Industrial control systems design (PLC, HMI, SCADA).
- Measurement systems design (virtual instrumentation, condition monitoring)
- Digital twin design (Visual Components, Tecnomatix Process Simulate).
- Modelling and simulations (Comsol, Matlab, Simit)
- Edge computing, IoT
- Machine vision systems
- Implementation of advanced signal processing methods, artificial intelligence, control theory, advanced calculations etc.



http://smartfactory.vsb.cz/

Faculty of Electrical Engineering and Computer Science



Thank you for your attention

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