THE MAGAZINE

FOR PARTNERS AND CLIENTS

AUSTRIAN INSTITUTE OF TECHNOLOGY

01/22

Autonomous working machines:
New test site at Seibersdorf

Virtual Reality:
Innovative training for the police

SARS-CoV-2:
How the virus gets into the brain

Study:
Cross-border quantum communication is possible

Wanted: Battery of the future

AIT intensifies battery research

Many different materials can be used to produce high-performance batteries.

The Battery Lab at AIT researches battery materials of the future and develops sustainable production methods for the batteries of tomorrow.

AIT INTENSIFIES BATTERY RESEARCH

The founding of a separate "Battery Technologies" Competence Unit along with the establishment of a solid-state battery lab consolidates AIT's leading role in the development of the battery of the future. Sustainability is a strong focus here.

With the transport sector emitting about 30% of all CO_2, there is a great need for action in this area. Electric vehicles use energy much more efficiently than conventional vehicles with internal combustion engines and will play a decisive role in achieving climate targets in the future – according to the climate strategy of the Federal Ministry for Climate Protection, Environment, Energy, Mobility, Innovation and Technology (BMK), Austria should become climate-neutral by 2040 at the latest.
The development of electric vehicles has seen great progress in recent years. AIT researchers are significantly involved in this: in cooperation with many partners from science and industry, the AIT Center for Low-Emission Transport takes a holistic approach to developing components and technologies that render electromobility more efficient, more powerful, safer, more sustainable, and more affordable. An important strategic thrust here is the development of high-performance and environmentally friendly batteries. "Our systemic understanding of low-emission transport allows us to make an important contribution to achieving the climate goals while supporting our corporate partners," explains Christian Chimani, Head of Center for Low-Emission Transport at the AIT Austrian Institute of Technology.

Cutting-edge research at AIT
The activities at AIT regarding electric vehicles have expanded considerably in recent years. "Fueled by our successful internationalisation, large EU projects and cooperation with international partners, our activities have doubled in recent years – both in terms of the number of projects and researchers and budget," reports Helmut Oberguggenberger, Head of the Competence Unit "Electric Vehicle Technologies".
As a result of this strong growth, and in order to sharpen the strategic focus, a separate "Battery Technologies" Competence Unit has now been created from this Competence Unit. On the one hand,

Photo: AIT/Clemens Fabry

existing research activities will be bundled here, while on the other hand, further investments will be made in strategic thematic fields. The new Competence Unit with around 30 highly specialised experts is headed by Marcus Jahn and is going to work on the following promising research fields:

- Battery Materials Development and Characterisation
- Sustainable and Smart Battery Manufacturing
- Solid State Batteries

Although these research areas differ in terms of orientation, content, and time line, they are united by a common goal: the search for the "ideal battery". "The ideal battery has a high energy or power density, it is environmentally friendly, safe and cost-effective," Jahn summarises: "With the current lithium-ion batteries, we are still a long way from reaching this goal. They pose a number of challenges, for example in terms of durability, safety, use of resources, or recyclability." Which specific battery types will prevail in the future is not yet foreseeable, says Jahn. "The ideal battery is unlikely to be a single cellular chemistry or shape since many application areas have a wide range of different requirements." In the stationary sector, the cost factor is most important, whereas energy density is not so crucial. The requirements for a mobile phone or a vehicle are completely different. "So the answer is not likely to be one and the same technology for everything." However, there are certain parameters – especially in terms of performance, safety, and sustainability – that play a key role in all battery types and applications.

Three strategic directions

That is why AIT is researching solutions for industrially relevant technologies along many lines.

Photo: AIT

The best combination of material properties, raw material supply, safety, and sustainability is what is being sought.

A research group headed by Katja Fröhlich deals with manufacturing methods for modern batteries. i.e. with taking the step from the lab to industrial production.

New materials that could replace lithium in the future ("Beyond Lithium") are being developed and characterised under the direction of Damian Cupid.

In the area of "Battery Materials Development and Characterisation", new materials that could replace lithium in the future ("Beyond Lithium") are being developed under the direction of Damian Cupid. Lithium poses a number of technical problems, such as its aging and its safety, and is also considered a critical raw material that is extracted on a large scale in only a few countries. Magnesium-ion batteries or sodium-ion batteries, among others, are regarded as future alternatives. It is already known that these principles work and can be attractively priced. But there is still a lot of room for improvement. The same applies to new cobalt-free batteries, in which alternative materials are used as the main electrode components.
The research field "Sustainable and Smart Battery Manufacturing" headed by Katja Fröhlich primarily deals with manufacturing methods for modern batteries, i.e. with taking the step from the lab to industrial production. The past few years have seen the establishment of a high-quality research infrastructure complete with industry-relevant prototype production, in which all processes can be intensively investigated and further developed. A central focus here is on sustainable production – one of the aims, being how to replace environmentally harmful solvents with benign substances.
The third research area, "Solid State Batteries", which is headed by Marcus Jahn, deals with an extremely promising technology. Solid state batteries do not contain liquid electrolytes (which are flammable) and are thus safer and more durable. A number of suitable materials are already known – such as polymers, ceramics and glasses, or sulfide-based substances – each of which has specific advantages and disadvantages. Corresponding manufacturing methods for solid-state batteries are now being developed in a new solid-state battery lab at AIT.

Photos: AIT (2)

Unique selling point for AIT

With this investment, AIT is consolidating its leading position in battery research. In recent years, AIT researchers have already taken on the management of major EU projects in which technologies are being further developed together with partners from science and industry. AIT is also a founding member of the Europe-wide association "LiPLANET", in which operators of battery pilot plants exchange information.

"AIT is one of very few research institutes to enter the field of process research for solid-state batteries at a very early stage," explains Marcus Jahn. The focus here is on the entire process chain. "This is a unique selling point for AIT: in Europe, there are no more than a handful of other groups trying to do anything similar," the researcher says. Building on the knowledge of the materials, completely new manufacturing processes must be developed to make solid-state batteries ready for practical use within a few years. "To better understand these systems, fundamental questions still need to be answered," Jahn explains.

Strong focus on sustainability

The portfolio of research topics and objectives pursued at AIT has varying time lines: While battery manufacturing is addressing today's industrial challenges, solid-state batteries and especially new battery materials still require years of research – both basic and applied.

A key issue in all areas of research is sustainability – a factor that is also currently being strongly promoted by the EU. This applies not only to the efficiency of electric vehicles and the minimization of CO_2 emissions, but also to manufacturing components and their assembly into a complete system. Marcus Jahn specifically cites the following areas: "The ideal battery contains no toxic components. It is easy to recycle, and ideally one already uses a high proportion of recycled materials in its manufacturing process. Furthermore, no critical raw materials are used. And the manufacturing process itself doesn't involve any toxic substances either." Life cycle analyses are carried out for all areas, covering the entire process chain from raw materials via manufacturing and usage all the way to end-of-life and recycling.

"Our systems understanding of low-emission transport systems allows us to make an important contribution to achieving the climate goals and supporting our corporate partners."
Christian Chimani, Head of AIT Center for Low-Emission Transport

"AIT is now one of very few research institutes to enter the field of process research for solid-state batteries at a very early stage. This is a unique selling point for AIT: In Europe, there are no more than a handful of other groups trying to do anything similar."
Marcus Jahn, Head of the "Battery Technologies" Competence Unit

Smart batteries for new fields of application

An increasingly important chapter is the construction of so-called "smart cells". These are battery cells and modules equipped with sensors that monitor their "health". In this way, important information on battery management can be obtained to increase performance, service life, and safety.

Moreover, AIT researchers are breaking new ground in a completely new field of application for batteries: They are working on electric drives for aircraft so as to make them more climate-friendly. "In this area, we still have quite a way to go until we reach the goal in terms of energy and power density," Jahn says. Since weight plays a key role in flying, research is being conducted into load-bearing batteries that can be integrated e.g. into the wings.

Holistic view of the mobility of the future

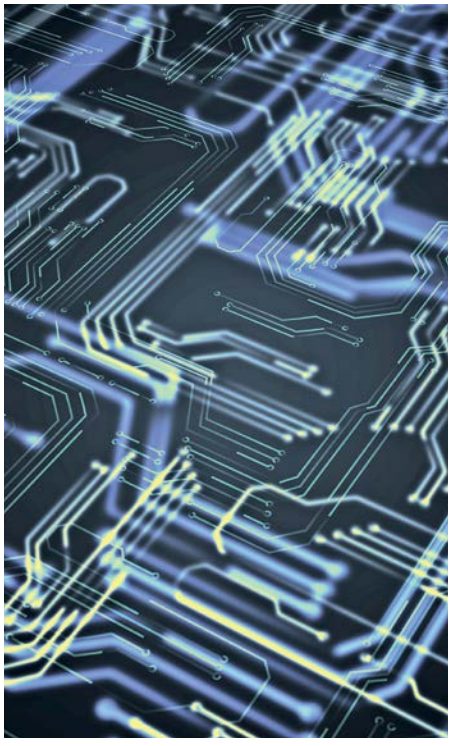
The further development of batteries is part of a whole range of research activities at the Center for Low-Emission Transport: Besides technologies for electric vehicles in the strict sense, these include in particular weight reduction through lightweight construction (aluminium and magnesium alloys, design, etc.), the development of resource-efficient production processes for materials and vehicle components, and as research for a resilient and safe transportation infrastructure, in order to contribute to reducing negative environmental impacts in this area as well.

Photos: AIT (2)

CROSS-BORDER QUANTUM COMMUNICATION

A Bavarian-Austrian study showed that quantum-encrypted networks from different operators can be interconnected via interfaces. As part of an EU initiative, national test networks are now being established and interconnected.

All 27 EU member states have committed to working together to build a secure quantum communications infrastructure (QCI) in Europe. In preparation for this EuroQCI initiative, scientists at the Max Planck Institute for the Physics of Light in Erlangen (Germany) and the AIT Austrian Institute for Technology conducted a feasibility study for a cross-border quantum-encrypted communication network between different operators. So far, only networks whose devices come from the same supplier and are managed by the same operator could communicate with each other. The study was commissioned by the Bavarian Ministry of Digital Affairs and the Austrian Ministry of Climate Protection.



The aim of the EuroQCI initiative is the establishment of a quantum cryptography network in Europe within the next ten years.

"We wanted to find out if it is possible to interconnect networks for the exchange of cryptographic quantum keys in Austria and Bavaria in some way," Hannes Hübel of AIT's Center for Digital Safety & Security told APA. The idea here is to generate and exchange symmetric – in other words, identical – keys at two points based on the laws of quantum mechanics (Quantum Key Distribution, QKD). The security of the current public key infrastructure is based on mathematical calculations that are very complex and very difficult to perform. But such keys will be able to be cracked in a few years. "The advantage of quantum keys is that they are absolutely tap-proof – even against attacks with a quantum computer," says Hübel.

Reliable nodes

The technology required for QKD has been well researched over the past 30 years, and people have been working on it outside the lab in test networks for more than a decade. One weakness of these systems at this time is the short distance of 100 to 200 kilometres that can be bridged between transmitter and receiver with such devices. In order to exchange keys between Munich and Vienna, for instance, several pairs of such devices would have to be linked together in a chain. The problem: at every node along the route, the key is available in classic form and could therefore be tapped there without it being noticed. These nodes must therefore be secured.

The study developed a key management system and explored how to connect such routes and ensure that the sender and receiver have in fact the same key. This is still relatively simple for a single route between Vienna and Munich, but it becomes more complicated in branched networks, where there are branches to e.g. Linz, Graz, or Nuremberg.

Finally, the study also developed concepts for border hubs, where national networks are interconnected in a secure manner. For many years, AIT has been developing devices which allow the theoretical considerations to be transferred into practice. With this wealth of know-how, AIT is a leader in numerous international projects for the establishment of a tap-proof quantum communication.

https://digital-strategy.ec.europa.eu/en/policies/european-quantum-communication-infrastructure-euroqci

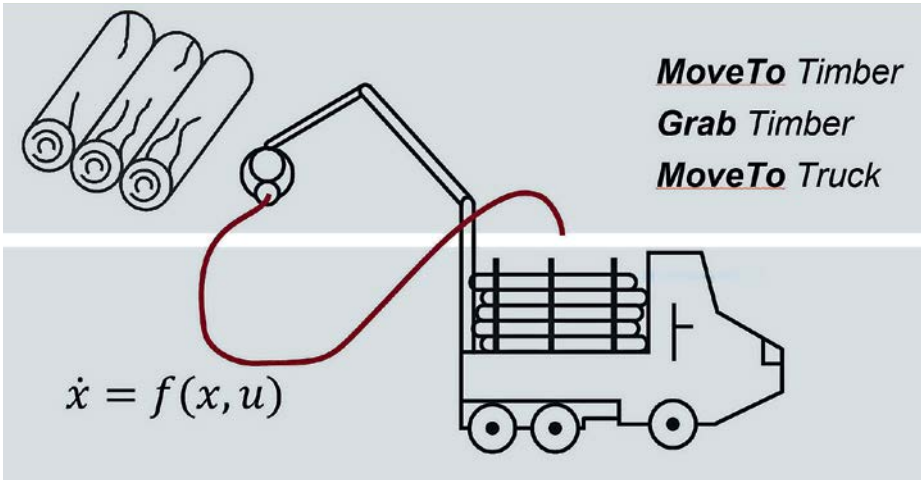
Photo: Getty Images/iStockphoto

SEIBERSDORF: TEST SITE FOR AUTONOMOUS WORKING MACHINES

Patrik Zips, new "Senior Scientist" at the AIT Center for Vision, Automation & Control, is building a test site for autonomous working machines in Seibersdorf.

The automation of excavators, cranes, forklifts etc. is a strategic research goal of the AIT Center for Vision, Automation & Control (VAC). The (partially) autonomous machines are to support humans in their activities and take over heavy, dangerous, or monotonous tasks.
The task "Drive to the tree log, grab the tree log and bring it to the truck!" is a clearly defined and (with the appropriate equipment) easily solvable task for humans. For machines, this has been hardly possible until now. It should nevertheless soon be possible to automate this task for working machines – thanks to the research work at the Center VAC. Behind the seemingly simple command lie many complex research questions. They encompass, for example, the control of hydraulic components and the mechanical system, the reliable planning of tasks and movements including the localization of one's own position, even in changing environments, the correct picking up of objects, the reliable perception of the environment – i.e. even in poor visibility – as well as AI-based object classification for the correct interpretation of the environment, to name just a few.

OpenAir Lab for automated working machines in Seibersdorf
Under the leadership of Patrik Zips, who was recently appointed "Senior Scientist," the Center VAC is currently establishing a test site for autonomous working machines in Seibersdorf – similar to the test infrastructure of Digitrans (www.digitrans.expert), where, however, autonomous road vehicles are tested in an extremely thorough manner. In addition to setting up research infrastructure, a a timber crane and a forklift were equipped with special sensor technology and computing units. The machines will be used in the future to validate research and test different work tasks. In this way, the Center aims to advance its technologies and consolidate its international leadership position. The test site is scheduled to go into operation in the summer of 2022.



"Drive to the tree log, grab the tree log and bring it to the truck!" This task poses no problem for humans (with appropriately capable equipment). For machines, on the other hand, it does.

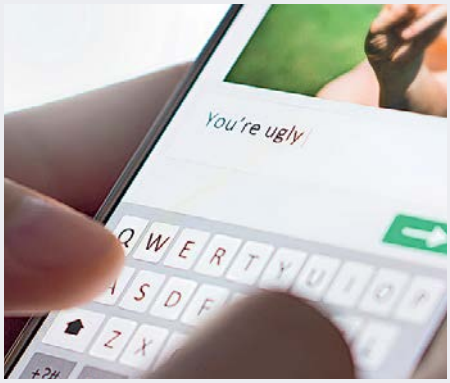
Patrik Zips

Already during his Bachelor's degree course in electrical engineering, Patrik Zips specialized in ultra-wideband communication and automation and subsequently focused on collision-free motion and path planning of automated systems in his Master's and Doctoral theses. He has also acquired well-founded knowledge in the field of imaging sensors and robust environment mapping in semi-autonomous systems. Since 2016, he has been working at the Center VAC in the Complex Dynamical Systems research group.

Photos: AIT/Johannes Zinner, AIT

FOCUS ON PERFORMANCE

Digital Safety & Security
Recognising "Hate Speech" online



"Hate speech has been dramatically increasing in the last few years. In social networks in particular, the exchange of different opinions and points of view increasingly leads to people being slandered, insulted, or even threatened. Hate speech is further amplified by filter bubbles and echo chambers. At the AIT Center for Digital Safety & Security, which comprehensively deals with the design of secure digitisation, tools are being developed based on cutting edge technologies, such as machine learning (AI) and computational linguistics, that will automatically detect hate speech in the future. As part of national and European research projects and in close cooperation with stakeholders from science, industry, and the public sector, data science experts are working on media forensics tools for the evaluation of very large volumes of data from the Internet. A team led by Mina Schütz, who received the AIT Poster Award for her work in 2021, is developing a system for detecting multimedia disinformation, e.g. as part of the research project "Defalsif-AI." The project is funded by the BMK as part of the security research funding programme KIRAS.

Energy
Direct current in the lab

Direct current (DC) is playing an increasingly important role in many areas. Whether photovoltaic systems, storage systems or batteries for electric vehicles: new types of switchgear or direct current grids at medium and low voltage levels will play an important role for the energy system of the future. By expanding the Center for Energy's lab infrastructure for DC currents on the order of 80 kA, AIT creates an efficient and high-performing validation platform for manufacturers of DC components and DC systems. The DC Lab is the largest lab of its kind in Austria. This lab infrastructure is particularly important for European developers and manufacturers of power electronic components. The construction of the plant involved the use of 30 tonnes of steel and over 50 tonnes of copper. The switchgear contains four special transformers that can be connected for various test scenarios. The lab was completed in the fall of last year, but the official opening could not take place due to Corona – it will now take place on 1 June 2022.

EU/Energy
Coordinated research into storage technologies

The EU member states aim to achieve climate neutrality by 2050. An important building block for the transformation of the energy supply is the replacement of fossil fuels with sustainable energy from solar energy, wind power, or hydropower – and energy storage and storage technologies will play an essential role in this. The European research consortium "Storage Research Infrastructure Eco-System" (StoRIES) with 47 partner organizations – technology institutes, universities, and industry – from 17 countries is to accelerate this. AIT contributes its expertise in the field of various storage systems as well as its modern laboratory infrastructure for the development of hybrid energy storage technologies. Through intensive exchange, mutual access to lab infrastructure and the development of new processes, the development of innovative storage technologies from the material through to the complete system is to be visibly accelerated. A transdisciplinary training for the specialists of tomorrow is an important aspect as well. The four-year research project with a budget of seven million euros is coordinated by the Karlsruhe Institute of Technology.
www.eera-energystorage.eu/stories.html

Health & Bioresources

Effective and environmentally friendly fertilisation

Agriculture heavily depends on the use of non-renewable, resource-intensive fertilizers to meet the ever-increasing demand for food and feed. Besides nitrogen, phosphorus is an important fertiliser ingredient: It is quarried in mines and is considered a critical resource, of which 90 percent is imported into the EU. At the same time, many nutrients are lost from fertilizers in agriculture because they are often not available in the right amount and/or at the right time to optimise plant growth. In the EU project SUSFERT, co-coordinated by AIT and RTDS, researchers of the Center for Health & Bioresources are developing more sustainable, multifunctional fertilizers for phosphorus and iron supply that fit into existing production processes and the agricultural practices in the EU. Bio-based and biodegradable coatings for controlled release, probiotics to increase nutrient availability, and the renewable phosphorus source struvite are combined in the process. SUSFERT demonstrates the efficacy of fertilizers for the most important crops, evaluates the economic potential and sustainability of the tested products, ensures regulatory compliance, and finally prepares the market launch.

www.susfert.eu

Energy

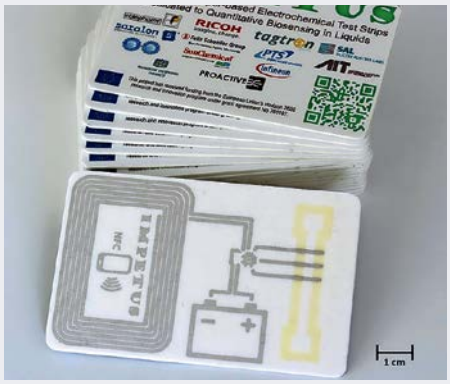
Digital platform for EU taxonomy founded

VIRIDAD is the first Austrian digital platform for answering all questions in the EU taxonomy. The EU taxonomy is a classification system of the European Commission that defines which economic activities are to be classified as sustainable under which conditions. The digital platform VIRIDAD is a service provider that bundles standardized processes and expert knowledge on one platform. Together with the consulting firm OMNIA and three investors, AIT provided significant support for the founding of VIRIDAD in order to drive the systemic change in the financial world and industry towards greater sustainability and the use of innovative technologies. The platform offers services to banks, insurance companies, investors and companies that cover the entire spectrum of the EU taxonomy. These services range from the sustainability assessment of economic activities to the calculation of relevant sustainability metrics for reporting purposes. "We are looking forward to the future collaboration, where our experts will contribute their broad know-how in the field of energy technologies to the platform," says Wolfgang Hribernik, Head of AIT Center for Energy.

www.viridad.eu

Health & Bioresources

Biosensor technology with novel test strips



The EU project IMPETUS is now heading into the homestretch: For four years, twelve leading partners with a strong focus on industrialisation – including, from Austria, the AIT Austrian Institute of Technology, Silicon Austria Labs, and the semiconductor manufacturer Infineon – have been developing fully integrated paper-based electrochemical biosensors that transmit the measured data directly to the users' smartphone. These biosensors are power-saving disposable test strips that combine the simplicity of so-called "lateral flow tests" with a quantitative reading, which is enabled by the implemented electrochemical detection method. Paper, printing, and microchip technologies are combined in order to establish a corresponding pilot line in an industrial environment. Electrodes, connecting lines, the antenna, and the biofunctionalization are printed in a roll-to-roll process, and a highly integrated silicon microchip is mounted onto the paper, enabling electrochemical signal acquisition, data storage, and contactless NFC data transmission. One application example in the IMPETUS project is a rapid and cost-effective differentiation between bacterial and viral infections.

www.project-impetus.com

Photos: GettyImages, www.viridad.eu, www.project-impetus.com

LKR Ranshofen

High-strength aluminium alloy for 3D printing

Stephan Ucsnik, Thomas Klein (on the right)

Great success for the WAM (wire-based additive manufacturing) team at the LKR Leichtmetallkompetenzzentrum Ranshofen (Competence Unit "Light Metals Technologies Ranshofen"): they have successfully processed an aluminium alloy (7075), which was actually considered impossible to fusion weld, using wire-based 3D printing, while also achieving excellent mechanical properties. Al-Zn-Mg-Cu alloys are among the highest performing aluminium alloys, but are extremely difficult to process because of their tendency to hot cracking during solidification. However, the LKR team was able to avoid this by using a high-quality starting material developed in-house as well as extensive process know-how. "In the future, this will make it possible, e.g., to manufacture highly stressed structural components for a wide range of applications in a resource-conserving and energy-efficient way," explains Thomas Klein, Senior Scientist at LKR. Stephan Ucsnik, Thematic Coordinator for Wire-based Additive Manufacturing, adds: "The results obtained prove that the aluminium alloys developed at LKR have the mechanical potential for deployment in industry – not only in aerospace, but also in ground-based sustainable mobility systems, the energy sector or prototyping."

https://www.sciencedirect.com/science/article/pii/S0167577X2200194X

Innovation Systems & Policy

Initiative for scientific integrity

Matthias Weber, Head of Center for Innovation Systems & Policy

The AIT Center for Innovation Systems & Policy joins the initiative of institutions such as WIFO or IHS, through which principles of scientific integrity are established for studies in public contract research. The Memorandum of Understanding that has now been signed by five major social science institutes contains 16 principles for the awarding and publication of commissioned studies – with the aim of consolidating good scientific practice in the Austrian research landscape.

"We will continue to only accept contracts in which our institutes bear the sole responsibility for the results of the scientific work. As soon as completed research and analysis results are actively communicated to the public, the underlying publications must also be presented to the public in full to ensure the traceability of the results," says Matthias Weber, Head of Center for Innovation Systems & Policy, quoting a key passage of the agreement. Moreover, all ideas and work originating from others will be clearly marked and possible conflicts of interest as well as all financiers of the study will be disclosed.

Low-Emission Transport

Research for the railway of the future

As part of the EU project Assets4Rail, the AIT team headed by Project Lead Marian Ralbovsky developed a probabilistic method for fatigue assessment of steel bridges considering actual tensile loads. Various data sources such as traffic management data, operating data, timetables, but also historical data (e.g. macroeconomic key figures) are combined in the process in order to draw conclusions about the remaining service life of railroad steel bridges. Moreover, significant improvements can be achieved using measured axle loads compared to current conservative standard models, which facilitates the planning of necessary maintenance.

This new tool developed by AIT has drawn extremely positive feedback from representatives of rail infrastructure operators and members of the Shift2Rail committee. In the future, necessary measures should be initiated and prioritised in good time in order to extend the useful life of the structures and thus save both costs and CO_2 emissions.

www.assets4rail.eu

Photos: AIT, AIT/Bösendorfer, GettyImages

Technology Experience
Manual for the evaluation of AAL solutions

AIT Project Manager **Julia Himmelsbach**

Technologies from the field of "Active and Assisted Living" (AAL) offer older people the opportunity to live independently in their own homes. These smart "little helpers" in the home include emergency call systems, digital locking systems, fall prevention, stand-up aids or even care robots. However, real implementation often fails due to concerns about costs, benefits, profitability, or stigmatisation. A holistic evaluation of AAL solutions thus becomes all the more important. As part of the "3vAALuation" project, the AIT Center for Technology Experience has now produced a comprehensive evaluation manual containing concrete measurement tools and questionnaires for evaluating the impact of AAL solutions together with the Carinthian University of Applied Sciences. The primary focus is on potential positive effects for elderly users (maintaining and/or increasing the quality of life, participation in social life) and basic requirements for the technologies (usability, simple, intuitive use, etc.). Business and economic aspects were taken into account as well. "With the handbook, we now really have an amazing set of tools – it's a completely new and holistic way of looking at AAL products and services," notes AIT project manager Julia Himmelsbach.

https://www.ffg.at/sites/default/files/allgemeine_downloads/thematische%20programme/IKT/3vAALuation_manual.pdf

Vision, Automation & Control
Blood pumps from the 3D printer

Heart failure is one of the most common causes of death in western countries. Modern mechanical circulatory support systems (blood pumps) promote survival and improve the quality of life for many patients with cardiac insufficiency. However, the production of blood pumps is complex and expensive. PROFACTOR, the Medical University of Vienna, Bionic Surface Technologies GmbH, UpNano GmbH, Lithoz GmbH, and the AIT Center for Vision, Automation & Control are now jointly tackling the task of developing new blood pumps for pediatrics with additive manufacturing processes (3D printing). This is to reduce production costs and offer the possibility of structuring the surface in a targeted manner to enable ideal biocompatibility. The FFG-funded OPTIFLOW 3D project is investigating, among other things, fine surface structures and their compatibility and influence on fluid dynamics. The microstructure is to create the most ideal flow situation possible, which influences the attachment of endothelial cells. These surface structures are to be checked during production using image-processing methods and quality assurance.

Technology Experience
Digital tools for people with visual impairments

The digitisation of work processes, but also crisis situations such as the COVID-19 pandemic, have massively changed our working conditions. However, people with visual impairments often have trouble using related tools such as video conferencing: Consequently, they face significant barriers and are even excluded from many career opportunities. However, many of these barriers can be overcome by applying digital enhancement tools (brightness and contrast adaptation, edge enhancement, colour adjustments, etc.).
As part of the VED Tools project, the AIT Center for Technology Experience has developed individually configurable, innovative digital optimisation tools to optimally support visually impaired people in performing their tasks such as barrier-free video conferencing applications or digital whiteboards for visually impaired users, which may enable integration into new professional fields. The project is being carried out by the AIT Center for Technology Experience together with the Hilfsgemeinschaft der Blinden und Sehschwachen Österreichs [Assistance Association for the Blind and Visually Impaired in Austria] (as coordinator) and is supported by the Digitisation Fund of AK Vienna.

Photos: AIT/Johannes Zinner, AIT/Bernhard Wolf, OPTIFLOW project

EU PROJECT: VR POLICE TRAINING FOR DIFFICULT SITUATIONS

The use of modern technologies – such as virtual reality – makes it possible to prepare for a wide variety of scenarios, especially complex operational situations that are difficult to train for with conventional methods.

Action forces are often confronted with complex situations in which they have to make decisions in a matter of seconds under stress. In order to be able to practice such operations in a realistic manner, an innovative training system was developed in the three-year EU research project SHOTPROS by research institutions in collaboration with police institutions and police officers from all over Europe. Virtual reality (VR) is used to achieve this: The police officers wear a high-tech VR suit and are also equipped with deceptively real weapons, batons, handcuffs, pepper spray, and flashlights. Moreover, a mobile multi-sensory platform developed by the AIT Center for Technology Experience can be used to convey authentic impressions such as wind, temperature, water spray or small electrical shocks during VR training.
"Since the start of the project in 2019, the international research consortium has made great progress in developing an innovative training system for European police officers," reports project coordinator Markus Murtinger. More than 800 police officers from across Europe have already tried and evaluated the new VR solution to enable further improvements. "Our latest studies have shown that 96 percent of the police officers who have tried out the system would recommend the solution for future training," Murtinger is pleased to report. The feedback from the trainers is also very good.
The training of complex operational situations in particular can be carried out very efficiently with the help of SHOTPROS compared to real training. The new VR-based training system makes it easier to acquire skills and as a result, one is much better equipped to deal with real incidents. The safe environment allows for more repetitions as well as detailed debriefing with trainers.

In field tests with police officers from all over Europe, the new VR training system has already received top marks from everyone involved. Now it is to be optimised even further.

Rapid innovation through agile, user-centred adaptation

The VR training solution was developed with the help of continuous feedback from police agencies on the project. In order to enable realistic training, a specific tactical police equipment belt was developed to be used in the VR training setting. The training area was also enlarged to 70 x 100 meters to be able to train large scenarios such as rampages or incidents in public places.
"Our studies show that around three quarters of police officers can orient themselves very well in the virtual environment," emphasizes Helmut Schrom-Feiertag, Project Manager at the AIT Center for Technology Experience. The newly integrated real-time stress measurement, which provides trainers with additional information about the trainees' stress level, was also well-received.
Since February 2022, the VR training system has been presented to emergency forces throughout Europe in a roadshow, e.g. in Romania, Austria, the Netherlands, Germany, and Belgium, and is being continuously improved.
A team of 13 European project partners has been working together on the SHOTPROS European research project since 2019. It is funded by the European Union's Horizon 2020 program (grant agreement no. 833672).
https://shotpros.eu

Photo: AIT/Wahlmüller

ALPBACH: MEETING PLACE FOR THE TECHNOLOGY COMMUNITY

Forum Alpbach TEC from 25 to 27 August 2022

After two years of a virtual or hybrid European Forum Alpbach due to the Corona pandemic, the high-level talks in the Tyrolean mountains will be held again as a face-to-face event this year: The technology community will meet from Thursday, 25 August, through Saturday, 27 August, to debate current and crucial issues of the future. The plenary and content partner sessions will follow the four thematic tracks of the Alpbach Forum: "Securing our Future", "Climate Opportunity", "Financing Europe's Future" and "Democracy and the Rule of Law". The topics range from "Info Wars" to the energy transition and health technologies through to securing global value chains. The programme will be supplemented by numerous networking and community events.

The Forum Alpbach TEC (aka Technology Symposium) is organised by the AIT Austrian Institute of Technology and ORF Radio Ö1. A yearbook, this time on the all-pervasive topic of "Artificial Intelligence", is also being prepared this year.

www.alpbach.org

AIT Managing Director **Wolfgang Knoll**

INNOVATION CALENDAR

28 April 2022
HECOPERMED FINAL CONFERENCE
The final conference of the EU project "HEco-PerMed" (Healthcare- and pharma-economics in support of the International Consortium for Personalised Medicine) saw the presentation of results on how to enable breakthroughs in personalised medicine.
https://hecopermed.eu/

30 April – 5 May 2022
CHI 22
The CHI Conference on Human Factors in Computing Systems in New Orleans brings together researchers and practitioners from a wide range of cultures and backgrounds on the topic of human-machine interfaces, with strong participation by AIT.
https://chi2022.acm.org/

2–5 May 2022
MICROPE 2022
The miCROPe 2022 symposium (Microbe-assisted crop production – opportunities, challenges and needs) addresses the use of beneficial microorganisms in crop production – from biocontrol to nutrition and stress resistance.
www.microp.org

17 May 2022
IT COLLOQUIUM 2022
This year's OVE IT colloquium is dedicated to the topic "5G as the basis of digitisation. Applications, opportunities, and outlook towards 6G" – with numerous contributions from AIT."
https://www.ove.at/news-details/it-kolloquium-2022-5g-als-basis-der-digitalisierung

20 May 2022
LONG NIGHT OF RESEARCH
At this year's "Long Night of Research", AIT will present numerous top-class research activities – from battery research to digital urban planning – thus aiming to raise public awareness of the importance of technologies for our future.
https://langenachtderforschung.at

24–25 May 2022
DHEALTH 2022
Each year, 300 participants from academia, industry, government, and healthcare organizations gather to discuss innovative health informatics and dHealth solutions under the motto "Health Informatics meets Digital Health."
www.dhealth.at

30 May – 2 June 2022
CIGRE SEERC CONFERENCE
At the SEERC Colloquium Vienna 2022, energy researchers will discuss the transformation of the energy system in Central and Eastern Europe, new technologies, and cross-border cooperation.
http://cigrevienna2020.at

31 May – 2 June 2022
INTERNATIONAL DIGITAL SECURITY FORUM
This year's International Digital Security Forum (IDSF) in Vienna's Museumsquartier will once again be attended by top international experts under the motto "Secure digitalisation for a SAFE, green and sustainable future".
https://idsf.io

8–10 June 2022
EUROGUSS
At the Euroguss, the International Trade Fair for Die Casting in Nuremberg, the LKR Leichtmetallkompetenzzentrum Ranshofen (Competence Unit "Light Metals Technologies Ranshofen") will be presenting the latest achievements in research together with the EFM (Europäische Forschungsgemeinschaft Magnesium e.V.) (European Research Association for Magnesium).
www.euroguss.de

Photo: Hans Leitner

HOW SARS-COV-2 COULD PENETRATE THE BLOOD-BRAIN BARRIER

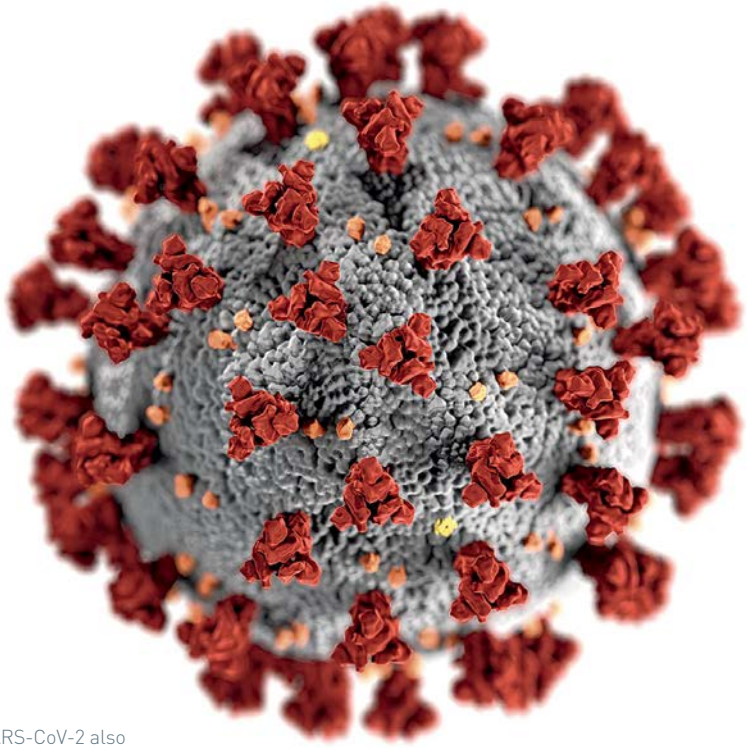
Using a cell model, AIT researchers were able to show why there may be neurological side effects in many cases of Corona. These new findings will help in the search for effective drugs.

There are numerous reports linking SARS-CoV-2 infection and effects on the human nervous system. In the acute phase, these include smell and taste disorders, headaches and muscle pain, and the so-called "fatigue syndrome" (permanent exhaustion and fatigue). There are also reports of long-term effects, such as concentration disorders, memory problems, and sleep disturbances. Whether they occur or how long they last varies from patient to patient.

Exactly how these neurological symptoms are caused is still unclear. These problems could be caused by a direct SARS-CoV-2 infection of the brain; they could also be related to, but not directly caused by, the immune response to the infection; or they could be the result of a systemic disease. Previous publications have already been able to show in animal models that both the spike protein of SARS-CoV-2 and the entire virus can cross the blood-brain barrier. This is likely to be the case with humans as well: Both the genetic information (RNA) and proteins of SARS-CoV-2 could be detected in the brain and cerebrospinal fluid of people who died from COVID-19; however, the viral loads are comparatively low and the results are controversial.

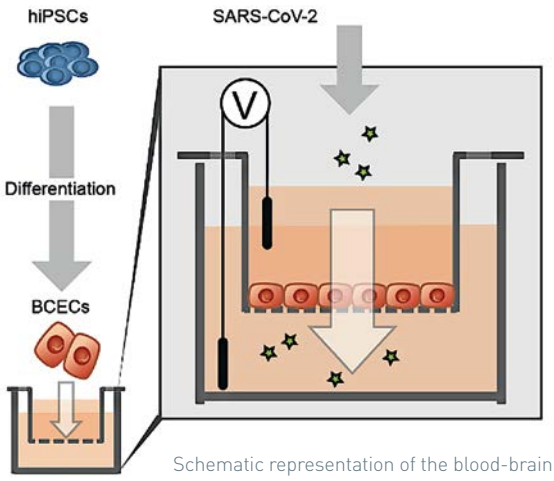
The question of how the virus actually behaves in humans has been investigated by Hamburg researchers led by Susanne Krasemann and Ole Pless in cooperation with 39 other specialists from Germany, Switzerland, the US, and Austria. Anna Gerhartl, Andreas Brachner and Winfried Neuhaus from the AIT Center for Health & Bioresources (Molecular Diagnostics Competence Unit), who played a key role in the establishment and quality control of the unique blood-brain barrier model, significantly contributed to this.

The study, which was recently published in the renowned journal "Stem Cell Reports", now shows that the virus could indeed cross the blood-brain barrier and



The coronavirus SARS-CoV-2 also causes neurological symptoms in many cases. How these come about was unclear until now. Now it could been shown that the viruses can also invade the central nervous system.

Photo: Wikipedia / public domain



Schematic representation of the blood-brain barrier model: Brain capillary endothelial cells (BCEC), which mimic the blood-brain barrier in the lab, are generated from so-called "human induced pluripotent stem cells" (hiPSCs) by the addition of certain stimulation factors. Subsequently, SARS-CoV-2 viruses were added to the cell culture from the blood side. After some time, the viruses were detected on the other side (brain side) as well.

Winfried Neuhaus, Principal Scientist at the Competence Unit "Molecular Diagnostics" of the AIT Center for Health & Bioresources.

enter the brain – and via which pathway this takes place. The blood-brain barrier denotes the physiological barrier between the bloodstream and the central nervous system. It regulates the supply of nutrients such as glucose to our brain, but also protects it from pathogens and toxic substances (toxins). The functions in the brain are highly complex and at the same time very sensitive and require an environment that is as free of disturbances as possible. This strict protective mechanism is therefore of great importance for the functioning and survival of nerve cells.

"The transport function of the blood-brain barrier is altered in many diseases," explains Winfried Neuhaus, Principal Scientist at the AIT Center for Health & Bioresources. Together with his research group "Biological Barriers", Neuhaus has developed cell culture models of the blood-brain barrier, which allow to studies processes in detail. So the transport of medical drugs (e.g. against epilepsy, multiple sclerosis or Alzheimer's disease) into the brain is being investigated in large EU projects.

The models of the blood-brain barrier are based on so-called "human induced pluripotent stem cells". Stem cells are not yet set to any particular tissue type and can potentially develop into any cell type. They are obtained from normal somatic cells, which are reprogrammed into stem cells by the addition of several stimulation factors. These cells could then be differentiated in tissues that mimic the human blood-brain barrier.

For the new study, tissue samples from people who died from COVID-19 were compared to this cell culture model of the blood-brain barrier. The researchers were able to identify mechanisms that were found to be consistent in both cases following infection with SARS-CoV-2. The viruses infected the cell culture model from the blood side, and after incubation they could be detected on the brain side – suggesting invasion of the central nervous system. It was also demonstrated that certain signaling pathways (interferon) were activated in the process. By blocking the known docking sites of the virus with drugs, the infection could be significantly reduced in the cell culture model – this was the case, among other, for spike proteins of the virus, the docking site ACE-2, or certain proteases and antibodies. These findings open a way to search for effective drugs against the neurological consequences of COVID-19. The cell culture model of the blood-brain barrier could be used for medical drug screening in the future.

Related publication:

S. Krasemann, U. Haferkamp, S, Pfefferle et al.: "The blood-brain barrier is dysregulated in COVID-19 and serves as a CNS entry route for SARS-CoV-2"; Stem Cell Reports, Volume 17, Issue 2, 8 February 2022, pages 307–320

Photo: S. Krasemann et al./Stem Cell Reports 17 p. 307, AIT

Scientific Papers

Satisfaction with the Web & apps

Web browsing is one of the most important applications of the Internet. This paper addresses the problem of mobile web and app QoE (Quality of Experience, a measure of customer satisfaction) monitoring from the perspective of the Internet Service Provider (ISP). The well-known speed index (SI) metric serves as a proxy for web QoE. In light of the widespread adoption of end-to-end encryption, machine learning models are used to determine the SI of individual web page and app loading sessions, using only packet-level data as input. Empirical evaluations of a large body of web and app QoE measurements for popular websites and selected apps show that the proposed solution can infer the SI from in-network encrypted traffic measurements. The study also shows relevant network and website content characteristics that affect web QoE in mobile devices and provides a complete overview of the problem of evaluating mobile Web and app QoE.

P. Casas, S. Wassermann et al.: "Mobile Web and App QoE Monitoring for ISPs – from Encrypted Traffic to Speed Index through Machine Learning"; 13th IFIP Wireless and Mobile Networking Conference (IFIP WMNC), 21–22 October, 2021, Montreal, Canada.

Social and ethical dimension of research

Science is increasingly called upon to address societal values, needs and expectations at every stage of its research projects. Researchers of the AIT Center for Innovation Systems & Policy, together with colleagues from other research institutes, have developed a Societal Readiness (SR) Thinking Tool to help realize Responsible Research and Innovation (RRI), such as that required by the EU. "The basic idea was to ask scientists and engineers some curated questions to help them think about possible social and ethical dimensions of their research," explains AIT researcher Michael Bernstein. The tool is designed in such a way as to help researchers find relevant questions about social and ethical concerns they may not have encountered before, regardless of the stage of a project. It also provides practical examples. The focus on Societal Readiness is intended to complement the already established "Technology Readiness" framework for the integration of issues such as RRI, sustainability, and Design Thinking into research and innovation cycles.

https://thinkingtool.eu/

M.J. Bernstein, M.W. Nielsen, E. Alnor et al: "The Societal Readiness Thinking Tool: A Practical Resource for Maturing the Societal Readiness of Research Projects"; Sci Eng Ethics 28, 6 (2022). https://doi.org/10.1007/s11948-021-00360-3 https://link.springer.com/article/10.1007/s11948-021-00360-3

Advantages and disadvantages of optical measuring systems

There are many different measurement systems for non-destructive testing of products in manufacturing that are based on different technologies. It is often difficult for users in quality control to compare the respective advantages and disadvantages. Under the leadership of Lukas Traxler (AIT Center for Vision, Automation & Control, Competence Unit High-Performance Vision Systems), standardised comparisons have now been conducted. The paper shows which parameters are relevant for the treatment of specific measurement problems and that publicly available information about different devices is often not comparable. Furthermore, different optical methods are compared on the basis of typical use cases and the advantages and disadvantages of the individual technologies are shown. This illustrates that different (often conflicting) inspection goals, such as depth of field, speed, or reconstruction of small details, determine which method is best suited for the inspection task at hand.

L. Traxler, L. Ginner, S. Breuss, B. Blaschitz: "Experimental Comparison of Optical Inline 3D Measurement and Inspection Systems"; IEEE Access, 9, 53952-53963.

Owner and publisher: AIT Austrian Institute of Technology, Corporate and Marketing Communications, Giefinggasse 4, 1210 Vienna, Austria / Cover photo: AIT / Editorial management: Michael H. Hlava, Martin Kugler; Marianne Lackner / Production management: Daniel Pepl / Editorial staff: Beatrice Fröhlich-Rath, Florian Hainz, Iman Kulitz, Michael Mürling, Margit Özelt, Fabian Purtscher, Christine Wahlmüller-Schiller / Production: Verlag Holzhausen GmbH/Repromedia GmbH / Design: WHY. Studio / Print: Donau Forum Druck Ges.m.b.H., 1230 Vienna, Austria / Please send your feedback to: presse@ait.ac.at