Fraunhofer IVI

Institute Report 2023

Turning Point

Fraunhofer Institute for Transportation and Infrastructure Systems IVI

»Our positive 2023 annual financial statement makes us optimistic that we will be able to overcome the effects of the current recession and the severe cuts in funding programs without any great damage.«

Prof. Dr. Matthias Klingner

Turning Point

The records do not reflect whether Aristotle lived through times as turbulent as todays'. His aphorism – we cannot change the winds, but we can set the sails differently –, however, has survived for more than two millennia. We are currently experiencing stormy days characterized by serious upheavals and a deep uncertainty – not just in world politics, German economy, and everyday life in our communities, but also within Fraunhofer. The German Federal Chancellor's much-quoted term »turning point« (»Zeitenwende«) reminds me of the period after the fall of the Berlin wall over 30 years ago, when the former political leaders lost control and soon after, society changed for the better with breath-taking speed. Hope remains that things will soon take a positive turn again and that our politicians will not take the old Chinese saying »when the winds of change are blowing, some will build walls and others will build windmills.« too literally.

Ever since the change in its presidency, the fresh, pleasant breeze of a new beginning has been blowing through Fraunhofer. Through trusting and open communication, a clear strategical orientation, and also by critically reassessing time-honored traditions, our research organization has managed to regain its internal cohesion, its creative motivation and its reputation within society in a very short time span. The fact that the Fraunhofer-Gesellschaft is again focusing on their original agenda of promoting the competitiveness and value creation of German industry through innovation suits us very well at Fraunhofer IVI. With an industrial revenue of 35 percent, we fulfill the board's high standards in an exemplary fashion. For the past years we have prepared the institute so that it will be able to survive in economically difficult times. Our commission books are still well-filled, sufficient funds are available for investments in future research areas, and our positive 2023 annual financial statement makes us optimistic that we will be able to overcome the effects of the current recession and the severe cuts in funding programs without any great damage. For this reason, I would like to take the opportunity to thank all my colleagues for their commitment, creativity, and collaborative teamwork. I am certain that this strong, achievement-oriented community will find that the upcoming change in the position of institute director in 2024 offers as a chance for new visions and development opportunities for Fraunhofer IVI.

From a historical point of view, the Renaissance period that started in the late Middle Ages is seen as the original turning point of ages. At the time, Europe was characterized by rapid progress in science, economics, arts, and culture. At the end of the epoch, people did not just want to believe anymore, but they wanted to understand the science of what holds our world together. With hope for better times, I would therefore like to end with what is probably Immanuel Kant's most famous motto – »Have the courage to use your own intelligence« –, and to wish all readers an inspiring time with our annual report.

Director

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Contents

Fraunhofer-Gesellschaft

The Fraunhofer-Gesellschaft based in Germany is the world's leading applied research organization. Prioritizing key future-relevant technologies and commercializing its findings in business and industry, it plays a major role in the innovation process. It is a trailblazer and trendsetter in innovative developments and research excellence. The Fraunhofer-Gesellschaft supports research and industry with inspiring ideas and sustainable scientific and technological solutions and is helping shape our society and our future.

The Fraunhofer-Gesellschaft's interdisciplinary research teams turn original ideas into innovations together with contracting industry and public sector partners, coordinate and complete essential key research policy projects and strengthen the German and European economy with ethical value creation. International collaborative partnerships with outstanding research partners and businesses all over the world provide for direct dialogue with the most prominent scientific communities and most dominant economic regions.

Founded in 1949, the Fraunhofer-Gesellschaft currently operates 76 institutes and research units throughout Germany. Over 30,800 employees, pre-dominantly scientists and engineers, work with an annual research budget of €3.0 billion. Fraunhofer generates €2.6 billion of this from contract research. Industry contracts and publicly funded research projects account for around two thirds of that. The federal and state governments contribute around another third as base funding, enabling institutes to develop solutions now to problems that will become crucial to industry and society in the near future.

The impact of applied research goes far beyond its direct benefits to clients: Fraunhofer institutes enhance businesses' performance, improve social acceptance of advanced technology and educate and train the urgently needed next generation of research scientists and engineers.

Highly motivated employees up on cutting-edge research constitute the most important success factor for us as a research organization. Fraunhofer consequently provides opportunities for independent, creative and goal-driven work and thus for professional and personal development, qualifying individuals for challenging positions at our institutes, at higher education institutions, in industry and in society. Practical training and early contact with clients open outstanding opportunities for students to find jobs and experience growth in business and industry.

The prestigious nonprofit Fraunhofer-Gesellschaft's namesake is Munich scholar Joseph von Fraunhofer (1787–1826). He enjoyed equal success as a researcher, inventor and entrepreneur.

Fraunhofer in Dresden

Institutes, Branches and Research Institutions

- Fraunhofer Institute for Ceramic Technologies and Systems IKTS
- Fraunhofer Institute for Organic Electronics, Electron Beam and Plasma Technology FEP
- Fraunhofer Institute for Photonic Microsystems IPMS
- Fraunhofer Institute for Transportation and Infrastructure Systems IVI
- Fraunhofer Institute for Material and Beam Technology IWS
- Dresden branch of the Fraunhofer Institute for Manufacturing Technology and Advanced Materials IFAM, Bremen
- Dresden branch of the Fraunhofer Institute for Machine Tools and Forming Technology IWU, Chemnitz
- Division Processing Technology of the Fraunhofer Institute for Process Engineering and Packaging IVV, Freising
- Division EAS (Engineering of Adaptive Systems) of the Fraunhofer Institute for Integrated Circuits IIS, Erlangen
- All Silicon System Integration Center Dresden – ASSID of the Fraunhofer Institute for Reliability and Microintegration IZM, Berlin
- Dresden branch of the Fraunhofer Institute for Intelligent Analysis and Information Systems IAIS, Sankt Augustin

Customers and Partners

- Research organizations
- Universities
- Industry and economy
- Public institutions
- Transport associations and providers
- Energy suppliers

The complete list of partners is available on the website:

Academic Cooperation

- Technische Universität Dresden
- Technische Universität Bergakademie Freiberg
- Technische Hochschule Ingolstadt

Fraunhofer IVI

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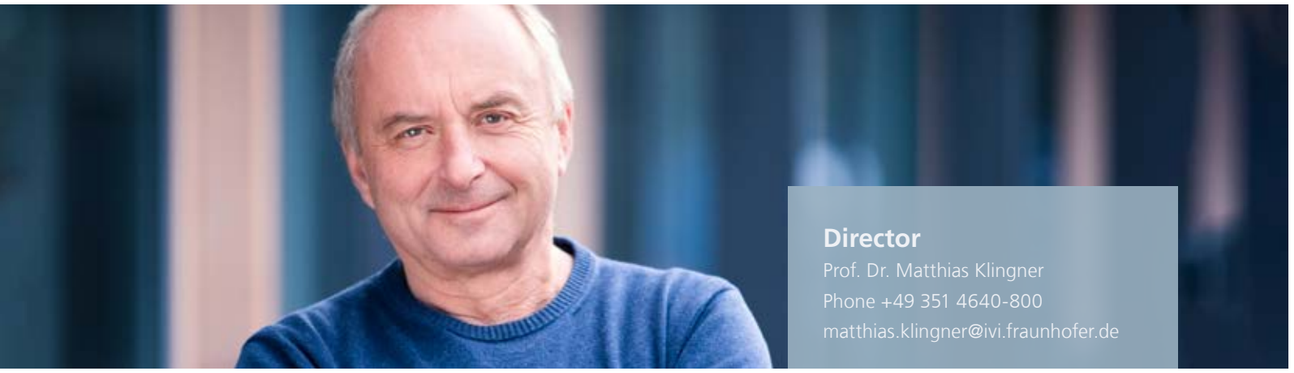
Organization Chart



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Fraunhofer Center for the Security of Socio-Technical Systems (Fraunhofer SIRIOS)

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Highly Automated Flying *Henri Meeß* | Networked Systems *Prof. Dr. Andreas Festag*
Autonomous Systems *Prof. Dr. Klaus Kefferpütz*

Profile

At Fraunhofer IVI's three locations Dresden, Ingolstadt and Berlin, approximately 150 researchers develop technologies and concepts in the fields of mobility, energy and security – from forward-looking research to practical application. The institute cooperates closely with TU Dresden, TU Bergakademie Freiberg and TH Ingolstadt.

For 25 years, Fraunhofer IVI has been developing innovations for the intelligent planning, coordination and management of mobility, shaping the digital transformation of public transport with reliable information and assistance systems, platform solutions for mobility data and services as well as electronic ticketing.

Projects investigating autonomous systems are gaining in importance, especially in heavy goods transport and agriculture. Besides innovative charging technologies, research and development work in the field of electromobility includes, for instance, solutions for remote battery diagnosis. The Fraunhofer Application Center »Connected Mobility and Infrastructure« at TH Ingolstadt focuses on topics of automated and cooperative driving.

In the light of future technological and societal changes, special attention is devoted to security-related topics, covering aspects of civil hazard prevention, the functional safety of vehicle technologies, and developments in the fields of vehicle and road safety as well as accident research. Since 2021, the institute has also been involved in the newly founded Fraunhofer Center for the Security of Socio-Technical Systems (Fraunhofer SIRIOS) in Berlin.

Intelligent Transport and Mobility Systems

- Mobility services and data
- Ticketing and fares
- Transport planning
- Autonomous driving and cooperative driving maneuvers
- Urban Air Mobility

Vehicle and Propulsion Technologies

- Propulsion technologies
- Multi-axle steering systems and lane guidance
- Mobile work machines
- Thermal management

Vehicle and Road Safety

- Functional safety
- Analyses of accident data
- Traffic psychology

Energy Systems

- Autonomous utility systems
- Stationary energy storage systems

Electromobility

- Battery development and recycling
- Charging technologies
- Electric buses and electric commercial vehicles
- Fuel cells / hydrogen technologies

Process Data Analysis

- Transport ecology
- Logistics
- Digital business processes

Civil Protection

- Planning and operational command
- Infrastructure management
- Risk assessment

Facilities and Large Equipment

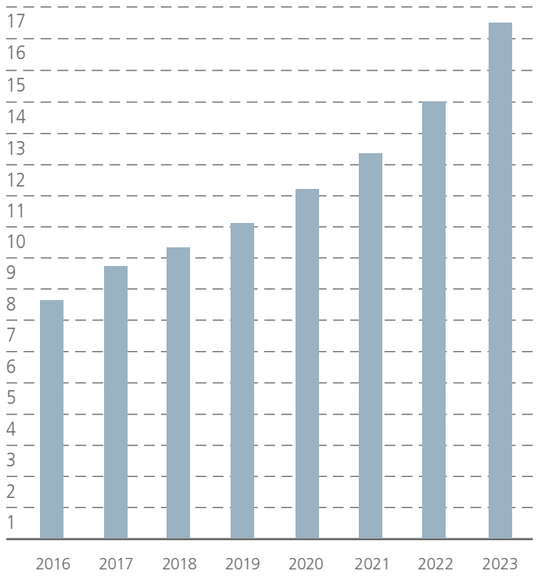
- Technical center with a vehicle hall and an adjacent test track
- Test vehicles and demonstrators
- Measurement technology
- Test rigs
- Software for simulation, Big Data, 3D construction and GIS

The complete list of facilities and large equipment is available on the website:

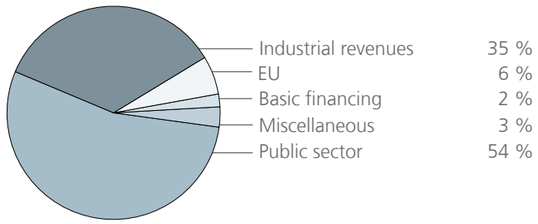
Economic Development

Financial Development

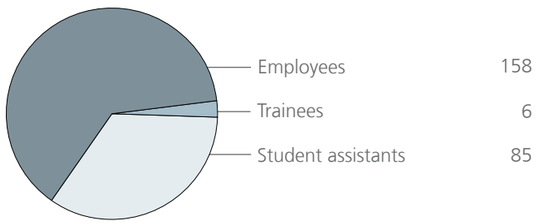
in € million



Operating Budget



Employees



Advisory Board

Members

Prof. Dr. Thomas Brandmeier,
Scientific Director, Institute of Safety in Future Mobility (ISAFE),
Technische Hochschule Ingolstadt (THI)

Dr. Babett Gläser,
Head of Research Department, Saxon State Ministry for Science, Culture and Tourism (SMWK)

Mario Herber,
Senior Chief Superintendent, Head of Department »Central Services«, Dresden Police Department

MinR Hans-Peter Hiepe, retired
Head of Division »Innovation Support; Structural Strengthening«, Federal Ministry of Education and Research (BMBF)

Stefan A. Lang,
Director Innovation Center,
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Katja Müller,
Head of HR Transformation,
Lausitz Energie Bergbau AG (LEAG)

Sonja Penzel,
President, Saxon State Office of Criminal Investigation (LKA)

Prof. Dr. Peter Pickel,
Deputy Director/Manager External Relations,
John Deere GmbH & Co. KG

Nils Schmidt,
Head of Yunex Traffic Germany

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Head of Division »Digital Transformation in Higher Education, Scientific Libraries«, Saxon State Ministry for Science, Culture and Tourism (SMWK)

Dr. Katharina Seifert,
Head of Strategy and Steering Group R&D China,
Volkswagen Group China

Lars Seiffert,
Board of Operations and Human Resources,
Dresdner Verkehrsbetriebe (DVB) AG

Chairman

Nils Schmidt,
Head of Yunex Traffic Germany

Mobility and Digital Services

The level of interconnection and digitalization in complex transport systems is increasing rapidly. With the help of information and communication technologies, it is possible to organize traffic more efficiently, establish new mobility services and integrate traffic participants more actively. For 25 years, Fraunhofer IVI has successfully operated in the field of mobility and digital services. The department's work is based on an in-depth collaboration with a multitude of partners such as transport companies and associations as well as industry and public institutions.

The two working groups »Data Systems and Travel Assistance« and »Ticketing and Fares« successfully realize projects in a large variety of research topics, acting in interdisciplinary teams with a broad range of skills and on the basis of experience and know-how gained in practical project work. The staff includes computer scientists as well as information, transportation and automation engineers.

Range of Services

- Data spaces and platforms for data on transportation and mobility
- Information and navigation applications for conventional and alternative mobility services, as well as for electromobility
- Fare calculator for conventional, electronic and mobile ticketing
- Specific programming language for fares, including development and testing tools
- Fare modeling and simulation
- Software solutions for mobile applications including applications for frontend, backend and the cloud
- Utilization of semantic technologies for data processing and service integration

More information

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FLASH Driverless Automated Shuttle

Autonomous vehicles in public transport are a key technology in the transformation of mobility. As a regularly operating bus line, the automated FLASH bus demonstrates today how this vision of the future can become the reality.

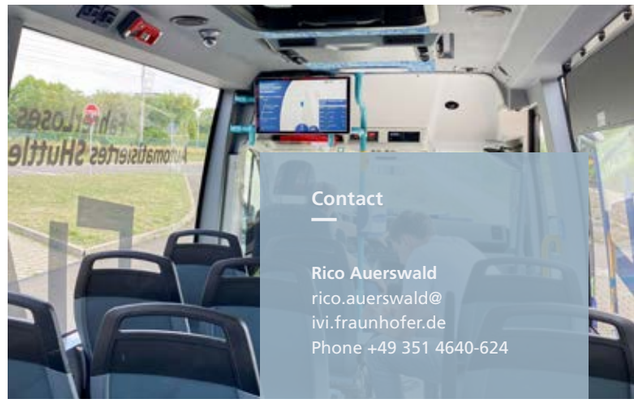
Supported by:
Federal Ministry for Economic Affairs and Climate Action

To expand mobility opportunities in rural areas, the North Saxony District, in collaboration with Fraunhofer IVI, supports the development of automated vehicles for public transport. One milestone in this context was the implementation of the FLASH bus that has been in regular operation in North Saxony since the summer of 2022. The automated bus drives on roads both inside and outside of communities, and it masters different intersections and traffic circles. The vehicle reaches speeds of up to 60 km/h, which means that it can be embedded in the normal flow of traffic.

The operational area sets very high requirements for the automated driving functions. Therefore, the FLASH bus receives assistance from roadside sensors by Fraunhofer IVI at critical route segments such as intersections with difficult visual access. Among others, the infrastructure detects approaching vehicles and reports them to the shuttle. At intersections, networked traffic lights communicate their current signal status and prioritize the bus with the help of V2X communications. At the highly frequented bus stop near Rackwitz station, infrastructure sensors support monitoring the stop's occupancy and the passenger exchange.

Since driverless operation requires technical supervision in Germany, a control center monitors traffic and coordinates appropriate interventions in the case of a breakdown. Fraunhofer IVI provides the tools required for this purpose.

The challenges that operators face in terms of automated mobility options are enormous. The vehicles are important success factors, but they are not the only ones. Rather, road traffic automation needs an interlocking ecosystem consisting of vehicles, supporting infrastructure and control center features for technical supervision. Fraunhofer IVI develops the necessary software and infrastructure components outside the shuttle. In addition, the institute is responsible for connecting them to the automated driving functions and passenger interaction systems. This will allow transforming automated operation with safety personnel into autonomous operation in the future.



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Vehicle Systems

The Department »Vehicle Systems« focuses on novel concepts and technologies for commercial and special-purpose vehicles. This includes overall vehicle design, construction of components and partial solutions, innovative drive systems as well as methods for the energy-efficient operation of both main engine and auxiliaries.

The department contributes their expertise in diverse areas ranging from the development of concepts, the detailed simulation and dimensioning of vehicle systems to the assembly, set-up and testing of prototypes. This also includes different charging technologies for private and public transport.

Range of Services

- Design and dimensioning of electric powertrains in commercial and special-purpose vehicles
- Functional safety of commercial vehicles (ISO 26262)
- Electrification and automation of agricultural machinery
- Fast-charging concepts for electric vehicles
- Development of multi-modal energy supply concepts (trams, buses, stationary)
- Modeling and diagnosis of batteries and fuel cells
- Vehicle systems monitoring
- Development of operating strategies for commercial vehicles

More information

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Megawatt Fast Charging for Electric Commercial Vehicles in Logistics: MEGA-LADEN

Electrifying heavy-duty traffic is especially challenging. Within a research project, an automated underbody charging system for electrically driven commercial vehicles was developed that is able to transmit power in the megawatt range.

Supported by:
Federal Ministry for Economic Affairs and Climate Action

In light of the maturity and market availability that the technology has reached, manufacturers of heavy-duty commercial vehicles will in the near future focus especially on battery-electric vehicles. This change will make a major contribution to decarbonizing freight transport on roads and help reach the German Federal Government's ambitious climate goals by 2030.

Within the scope of the MEGA-LADEN research project, a comprehensive fast-charging concept for electrically driven heavy-duty commercial vehicles was developed. This concept contains solutions for all aspects of the charging process: questions concerning vehicle connection, communication with the vehicle, infrastructure, and a fully automated charging process involving very high charging power. The project results are meant to become the standard for all applications in the fields of commercial vehicles and logistics and will cover the entire spectrum of requirements for recharging e-trucks during their commercial use. The full automation of charging batteries in logistics yards will also make the use of e-vehicles in this sector more efficient in terms of required staff.

The fast-charging concept in the form of an automated underbody contacting system was designed by Fraunhofer IVI and later installed as well as tested on a test stand and the institute's test track. Additional tests carried out simultaneously proved the feasibility of transmitting currents of up to 2000 A. The most important results were, among others:

- an automated fast-charging interface for operating voltage of up to 1250 V optimized for use in the logistics sector with a charging performance scalable into the megawatt range,
- a charging device for different contacting systems that is capable of supplying several charging points and distribute the requested power between them, respectively, as well as
- demonstration of the system's fast-charging capability and its economically optimal applicability.

The project concluded with the system's practical application under real-life conditions at a logistics enterprise located in Berlin.

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Traffic Safety and Vehicle Automation

Ultra-long vehicles can help increase efficiency in the traffic sector, but their operation requires special infrastructure features. Steering systems designed at Fraunhofer IVI improve the maneuverability of these vehicles and simultaneously create broader application options for them.

Automation in the fields of transportation and agriculture is a future-oriented topic. Applications for automation in non-public areas are an important migration path for which the department developed the helyOS® control tower system. helyOS® is capable of coordinating driving tasks, allocating resources to them, and calculating paths.

Highly automated and autonomous vehicles set entirely new standards in terms of establishing and proving their safety. The department carries out accident analyses and traffic observation campaigns that provide a basis for driving and testing scenarios used in the development and approval of functions for automated and highly automated driving.

Range of Services

- Innovative steering systems for extremely long road vehicles with multiple steered axles
- Control center for autonomous driving in non-public areas
- Fully automated maneuver planning for road-bound transport vehicles
- Analyses, surveys and development work in the field of vehicle and road safety
- Traffic psychology – analyses of the experience and behavior of various groups of traffic participants
- Modeling and testing of driving scenarios with the help of motion platforms
- Implementation concepts for electric buses and hydrogen fuel cell buses
- Charging infrastructure for bus depots and logistics yards

More information

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Safe, Automated Depot of the Future: SAFE20

When automating depots with driverless vehicles, safety considerations play a key role. Currently, no holistic, comprehensive concept exists for this matter. The SAFE20 project yielded important answers for regular productive operation and, in turn, for the economic success of autonomous commercial vehicles.

Supported by:
Federal Ministry for Economic Affairs and Climate Action

What characteristics are required of a safety concept for a future highly automated depot so that all processes can run smoothly? In the SAFE20 project funded by the Federal Ministry for Economic Affairs and Climate Action (BMWK), eight partners from economy and science pooled their expertise to generate answers to this question. What is new in this context is their holistic approach: Instead of focusing, as before, primarily on the vehicles' intelligence, SAFE20 considers a comprehensive system whose aim is to complete routine tasks in logistics yards with the help of intelligent vehicles. The key focus lies on optimizing three tasks that occur hundreds of times per day in the depots of logistics hubs. These include

- picking up and moving swap bodies,
- picking up and moving semitrailers and
- automated dispatching of delivery trucks.

The automation and safety features required for having the above work steps planned and monitored by a centralized control system were developed within the project. In the future, driverless vehicles will be capable of efficiently carrying out these tasks at a speed of up to 20 km/h, even in mixed operation with conventional vehicles. The overall system itself consists of the automated vehicles plus an automation zone within the depot that, in turn, comprises the centralized control tower system, infrastructure sensor nodes, and a wireless communications network.

The fact that the vehicles are capable not only of processing data provided by their own systems, but also additional data provided in real-time by the automation zone clears new paths in terms of safety considerations.

Based on the open-source helyOS® framework and enhanced route and path planning services of the TruckTrix® family, a software was created that fully automatically translates logistics tasks into machine-interpretable missions. To realize communications between the vehicles and the control system, the VDA5050 standard for driverless transport systems and mobile robots was implemented, among others.

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Strategy and Optimization

The Department »Strategy and Optimization« consists of three working groups and offers a wide array of services in the areas of security, business process analysis, logistics planning and infrastructure management. The interdisciplinary team includes computer scientists, geoscientists as well as mathematicians with both professional expertise and practical knowledge.

Their application-oriented research and development projects are focused on decision support for optimized planning and control of resources. The core competences of the department comprise developing novel optimization processes and algorithms as well as designing and implementing complex systems. In the age of digitalization, it is not only the controllability of data that counts but also the creation of data value as a business benefit.

Range of Services

- Systems for operational and tactical mission control for firefighters, rescue services, emergency services, police, and specialized units
- Analyses and risk assessment in hazard prevention: planning of fire safety requirements and rescue service zones, optimization of site concepts
- Robust distributed systems using analysis tools from data mining, machine learning and natural language processing on the basis of big/smart data
- Data-driven process optimization using AI methods
- Predictive and prescriptive analyses for decision support systems
- Condition-based maintenance planning

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ICT Solutions for Safety in Society

Natural disasters, extreme weather events, terrorism, organized crime, extremism, and everyday crime are great challenges to our democratic society. These highly complex threat scenarios can only be tackled with the help of the newest information and communication technologies.

For over 20 years, Fraunhofer IVI has been developing technologies with a focus on mission control and communications, including their transfer into practical application. The result is a broad product range comprising flexibly configurable complete systems for end users, components and modules for third-party systems, as well as optimization algorithms and methods for support in decision-making.

The MobiKat® technology is used for networked situational monitoring and gives support for situational assessment and strategical as well as operative decision-making for fire departments, emergency services, civil protection, and police. In addition to networked situational monitoring and visualization across all command levels, the system offers a diverse range of modules including modules for locating staff and resources, mission communication, task administration, situational analysis, and risk assessment. The immediate integration and provision of video sources (e. g., stationary and mobile cameras, but also drones) has proven to be of great value, especially during floods and for the security of large-scale events. A web-based master data portal for the decentralized recording and management of staff, equipment, missions, locations, and key objects serves to significantly reduce the administrative tasks required of the MobiKat® end users. Additionally, the system uses the data to create aggregated analyses for communities and districts.

The SE-Netz/EKUS command and communication system offers command modules for staff and mobile applications for members of special police units. The technology received the Paul Koettig Award from the Association of German Criminal Investigators (BDK) in 2017 and the Joseph von Fraunhofer Prize in 2020. MePol, a solution for regular police units based on SE-Netz/EKUS, has been used in day-to-day operations since 2021 and is continuously being improved.

As a partner in numerous research projects such as PrimAIR, KIWA and TARGET, Fraunhofer IVI can rely on a robust network within national and international security research.

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Cognitive and Cooperating Systems

The Department »Cognitive and Cooperating Systems« investigates anticipatory connected and automated driving under consideration of all road users as well as the transport infrastructure. Special emphasis is put on the cooperation between the involved players, focusing on the reliable exchange of information and messages.

Detecting, learning and anticipating traffic scenarios can be achieved with the help of cognitive systems. For tackling current transportation challenges, these systems offer novel methods and algorithms that serve to effectively support and manage automated and connected driving in urban areas – one example being the so-called smart intersection.

Range of Services

- Concept, test and supply of cooperative and cognitive system solutions for connected and automated driving
- Implementation of hybrid cloud systems, C-ITS backend systems, as well as management systems for connected infrastructures
- Development of algorithms and communication protocols for innovative transport applications and services
- Design and implementation of hybrid simulation environments
- Infrastructure object detection for providing traffic-relevant dynamic objects and scenarios
- Equipment of test vehicles for automated and connected driving including visualization of applications
- Planning, realization and assessment of test drives and communication tests (laboratory, closed test area as well as the public Dresden Digital Testbed)

More information

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Towards the Automated, Cooperative Mobility of the Future

Automated driving in cities is highly complex. Setting up and operating a test field for connected, assisted driving opens up new opportunities for the agile development and safe testing of infrastructure components and vehicles.

The basis of safe and efficient automated mobility lies within a borderless understanding of cooperative driving throughout Europe. In this context, digitalized traffic infrastructure creates the foundation for implementing automated driving in highly complex urban traffic situations.

Fraunhofer IVI was mainly responsible for initiating the Dresden Digital Testbed in 2016. The first showcase for cooperative and automated driving was presented by mounting a connected traffic light system. This was the first building block of a test field open to all partners from science and industry. After applications had been developed and tested, different demo scenarios finally served to make automated and connected driving tangible for specialists of the field.

In the context of automation, the infrastructure is becoming increasingly important. Smart sensor solutions, intelligent traffic management systems and real-time assistance given by the infrastructure are essential for safe and efficient automated mobility in complex situations. The basis for this is provided by C-ITS messages standardized across Europe and harmonized services that facilitate a unified, borderless understanding of V2X.

The environment for infrastructure-assisted driving developed at Fraunhofer IVI does not only comprise the tooling, planning, and real-time monitoring of C-ITS communications, but it also contains intelligent algorithms for environment perception, object classification, tracking and fusion, and even safe, low-latency vehicle control via the cloud or the technical supervision's control center. In the 2023 Urban C-ITS Contest, the institute received the award as »Frontrunner for supporting the automation of vehicles«, for which Dresden was selected among over 50 European cities. Special thanks in this context is extended to all partners, especially to the city of Dresden and the Saxon State Office for Road Construction and Traffic.

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Connected Mobility and Infrastructure

The Fraunhofer Application Center »Connected Mobility and Infrastructure« at Technische Hochschule Ingolstadt (THI) focuses on current and future topics of automated and cooperative driving. By means of roadside protection systems and high-performance car-2-infrastructure communication, the safety risks of partially and fully automated traffic flows will be reduced, and overall traffic will become more efficient.

In the long term, the exploitation of mobility's third dimension – the airspace – will facilitate the shipping of goods as well as passenger transport. To achieve this, diverse competencies in the fields of sensor technology, communications and artificial intelligence are combined, fostering synergies with local industry and promoting close cooperation with the city of Ingolstadt and its partners.

Range of Services

- Testing of connected automated driving within the digital testbed Ingolstadt/Bavaria
- Backend and cloud applications for cooperative systems
- Infrastructure sensors and assistance
- Environment perception and maneuver control for autonomous drones
- High-precision locating for indoor and outdoor areas
- AI-based environment perception and driving functions
- V2X communications (ETSI ITS-G5, C-V2X, 5G), C-ITS facilities and applications
- Traffic monitoring, management and control
- Sensor monitoring, malfunction detection as well as sensor re-calibration and control

More information

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Shaping the Future of Autonomous Flying

Under the mission statement »Leading the world towards safe autonomous flying«, Fraunhofer IVI's application center launched their initiative for highly automated flying two years ago within the scope of the Fraunhofer ALBACOPTER® Lighthouse Project. Its main objective is to develop a modular and universal autopilot suite for different scenarios in lower airspace.

In analogy to autonomous driving, rapid developments in the field of artificial intelligence (AI) open up new perspectives for aviation. The application center focuses on Urban Air Mobility and Advanced Air Mobility. In these fields, intelligent systems are needed to support the most critical flight phases, such as take-off and landing. In addition, automation offers an enormous potential for scaling business models, thus advancing the breakthrough of the entire sector.

The approach pursued is independent of aircraft type and works with generalized interfaces. The ALBACOPTER® eVTOL platform designed within the Lighthouse Project allows the mapping of all relevant flight modalities, enabling development work for drones, air taxis and helicopters. The focus is on creating a fully autonomous system in which AI is initially integrated as a pilot assistance system in the first testing stages. Special attention is paid to the safety and reliability of both the AI and the overall system. To fulfill the high standards of aviation, redundant multi-sensor systems are employed and processed via high-performance embedded systems on-board the aircraft. The mandatory 3D representation of the environment is realized through deep learning approaches and serves as a basis for path planning with the aim of creating safe trajectories. The mission AI is responsible for decision making and scenario evaluation – the final step towards full autonomy, meaning pilot substitution.

The autopilot suite is continually enhanced to incorporate industry's complex tasks and problems. Its first module demonstrated in real life, the protocol for autonomous (emergency) landing in unknown terrain, allows aircrafts to approach safe landing areas independent from additional sources of information.

Within the past year, the application center succeeded in expanding their portfolio in this field by three additional research projects. These projects focus on diversifying the use of AI in aviation and further improving the autopilot suite.

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Fraunhofer SIRIOS

The Fraunhofer Center for the Security of Socio-Technical Systems (Fraunhofer SIRIOS) helps make complex security scenarios tangible and controllable in order to increase security and resilience in society.

With initial funding from the German Federal Government and the State of Berlin, the newly founded institution will use the coming three years to build a research, testing and training environment for safety authorities, rescue service providers and critical infrastructure operators. This environment, which is unique in Europe, serves to simulate scenarios, to experience them virtually and to test them in real life.

Located at the site of Fraunhofer FOKUS in Berlin, an increasing number of researchers from the Fraunhofer Institutes EMI, FOKUS, IOSB and IVI will carry out joint projects. Fraunhofer IVI researchers contribute their long-standing expertise gained from cooperating with end users in the fields of firefighting, rescue services, civil protection and police.

Range of Services

- Simulation of complex socio-technical security scenarios
- Visualization and analysis of deployment scenarios
- Development of courses of action and defense strategies
- Provider-independent environments for development and testing
- Support in the planning of new security solutions
- Simulation-based seminars and training
- Design and execution of simulation games and virtual stress tests
- Interdepartmental large-scale emergency demos
- Development of workshop and networking formats

More information

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Effective Protection of Critical Infrastructures in Urban Areas

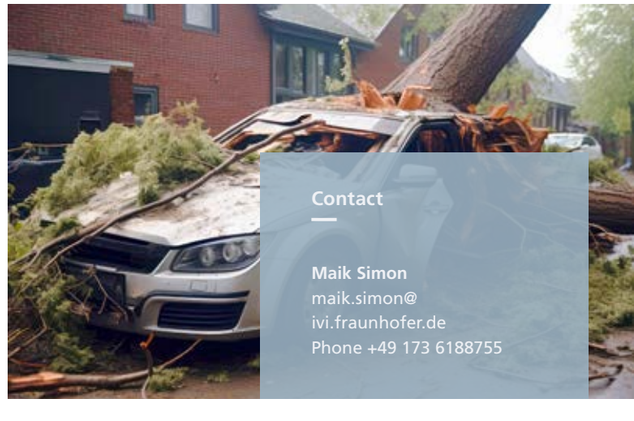
Heavy rainfall, heatwaves, and storms – climate-induced extreme weather events are increasing in frequency and require special attention in terms of hazard prevention. With the aim of protecting critical infrastructures as best as possible, a platform for improving the response capacity of emergency forces, helpers and the general population is being created at Fraunhofer SIRIOS within the PROTECT and SchIRm projects.

In close cooperation with the Fraunhofer institutes IOSB, EMI and FOKUS, Fraunhofer IVI is developing infrastructure simulators for various areas including supply networks for drinking water, electricity, and gas supply as well as telecommunications networks. In addition, building damage analyses are carried out to generate a comprehensive situational overview of the affected critical infrastructure. By providing the agent-based modeling of response forces, the Fraunhofer IVI team made a major contribution to the co-simulation system. This tool generates incidents within a digital city model that are incorporated by a virtual control center model through detection. In a next step, it creates a dispatch strategy in the form of alarm and response regulations. Finally, »digital« response forces signified by tactical symbols displayed on the graphical user interface respond to the generated incidents. At the same time, responsible officials evaluate the efficiency of the alarm and response regulations and, based on scientific findings, derive advice for future crisis situations from them.

The system also allows the direct transfer of temporal developments within infrastructure networks and predicted building damages to the mission events. By simulating one situation multiple times, uncertainties can be identified, and a better-founded situational picture can be presented to mission control.

Accompanying statistical assessments and clear visualizations are provided by the modular MobiKat® system, which has proven itself in practical application for some time now.

In future scenarios, both the response forces simulator and the simulators for infrastructure networks and building damage analysis should be capable of reacting to additional real-time data so that the co-simulation system's performance is further improved. This way, individual impressions by the general population can be transmitted in the form of pictures via a mobile app, or video data from drone cameras can be integrated into the system.



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Strategic Development

Battery Aging Rapid Test

Typically, lithium-ion battery systems in automotive applications have reached the end of their lives when their remaining capacity has fallen to 70 to 80 percent. As so-called second-life batteries, these systems can be used in an economically and ecologically beneficial way for other purposes, for example, in stationary energy storage units. For this, it is necessary to determine the aging status of each cell within the battery system within a very short time.

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Researchers of the »Scientific Coordination« and »Monitoring and Control Strategies« groups have developed a rapid diagnosis method that helps decide within a matter of seconds to a few minutes whether a specific battery cell is suitable for further use in a second life battery.

The method does not require any conventional battery modeling. Rather, it is based on a behavioral analysis of several reference cells that have aged differently. The individual cells are subjected to a predefined current profile and the significant differences in their voltage returns are described in the form of a compact reference diagram. During the test, the battery cell to be diagnosed is subjected to the same current profile and its voltage return projected onto the diagram. From its position in the diagram, relevant parameters can be extracted, most significantly the cell's capacity and internal resistance. The accuracy of the results increases with the duration of the procedure. This means that the method can be flexibly adapted to the required classification quality level.

The rapid test allows the robust assessment of the cells' age and their classification as either suitable for second-life uses or cells to be recycled. By optimizing the diagnosis procedure's duration across all studied cell types, it was shown that classification is possible after only a few seconds and reliable claims about cell parameters can be made within mere minutes.

Self-Sufficient Micro-Settlement for an Energy-Conscious Lifestyle in Rural Areas – AMSEL

Within two related research projects, AMSEL and Telewerk, an experimental platform is being built in Mittweida consisting of modular timber structures. The platform, a networked micro-settlement, is connected to the existing WERKBANK32 building. Due to its shared integrated district storage system, its supply infrastructure is demand-based and largely self-sufficient.

In terms of their architecture, the two newly constructed buildings are designed for maximum energy yield in the winter months. Their solar panel surfaces are oriented strictly towards the south and the winter sun's zenith.

Fraunhofer IVI provided both the basic design and the specific shapes of the building, deliberately carrying forward the autartec® design principle. The AMSEL tiny house is built with the help of three prefabricated and preconfigured modules made from timber.

After the micro-settlement's launch, aspects of energy generation, consumption and provision will be studied within the ensemble. For this purpose, the buildings' roofs and exterior walls bear photovoltaic surfaces, and the interiors contain energy storage units, switchable consumers and thermally activated components.

The smart living approach pursues the aim of user-dependent control. The integrated flexible energy management system will optimize the energy consumption of the individual buildings and will be capable of reacting to signals from the power grid, thus ensuring the demand-based operation of both the building and the overall settlement.

STAATSMINISTERIUM FÜR REGIONALENTWICKLUNG | Freistaat SACHSEN | simul+

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Junior Research

Efficient Headland Planning for Agricultural Machines with Kinematic Constraints

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Agricultural processes can be improved considerably by increasing their level of automation. In doing so, it is important to ensure that work machines can identify obstacles and borders. To solve this challenge, the present thesis developed an algorithm for robust path planning.

The demand for agricultural products is increasing, as is the lack of qualified workers. At the same time, resource-friendly and sustainable farming is becoming more and more important. The automation of agricultural equipment can make a significant contribution to solving these issues. One critical component in this context is the development of a dedicated, robust path planner. Ordinarily, agricultural paths consist of straight, guided lanes and headland paths that are parallel to field and obstacle borders.

The aim of the present thesis was to create an algorithm for path planning along field borders. The paths were to be calculated as close to the borders as possible while complying with a minimum distance value and respecting necessary curve limitations.

First, checkpoints were positioned along the field borders. Based on these, a NURB spline was created for modeling, then a curve profile was calculated and finally, the areas containing curve violations were extracted. In these especially complex regions of the field border, the checkpoints can be analytically repositioned so that the spline is smoothed out.

In the following stages, the path's course was regarded as a non-linear optimization problem that can be approximately solved using the Sequential Least SQuares Programming (SLSQP) method. To reduce computing time, for example, in the case of especially large fields, extended straight segments along the field borders were divided and both halves were considered separately. This resulted in several less complex sub-problems that can be solved simultaneously. Smooth transition between the individual segments is ensured by parameter setting in the NURB splines.

A concluding analysis of the path planner in terms of its suitability for organically shaped field and obstacle borders in real life as well as different machine types supported the thesis' results.

The Diploma thesis was submitted to the Chair of Automation Engineering held by Prof. Dr. techn. Klaus Janschek at TU Dresden.

With special thanks to the reviewers and supervisors of this work, Dipl.-Ing. Nils Dunkelberg of Fraunhofer IVI, as well as Prof. Dr. techn. Klaus Janschek. I would also like to thank Felix Keppler, M. Sc., of Fraunhofer IVI for his support in finding a topic.

Junior Research

Development of a Simulation Model for Decentralized, Regenerative Energy Supply for Full-Electric Agricultural Vehicle Fleets

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Currently, the vehicles used to carry out driving and process-related tasks in farming are mainly diesel-driven. Electrifying them can make a significant contribution to decarbonizing their business sector. The aim of this Diploma thesis was to develop a software tool that forecasts the energy and performance demands of electrified agricultural machines and designs facilities for regenerative energy production based on the forecast made.

Full-electric vehicle fleets are gaining in importance for both established manufacturers and newcomers as well as research institutions. The present thesis used vehicle studies and series-ready models as a basis for generating concepts for electrified agricultural machines. These concepts include different parameters for driving power, energy storage technologies and sizes and represent a spectrum considered realistic today as well as in the future. In the resulting software tool, the selection and adaptation of concepts is done via a graphical user interface. In addition, different kinds of (localized) energy supply can be selected, and technical and economic parameters can be modified. To ensure the tool's broad applicability, the GUI allows creating an individualized sequence of different agricultural work tasks.

The tool was tested using a model farm that grows winter wheat on several fields. The fields differ in size, distance to the main farm buildings and in terms of whether charging devices exist at the field edges. The results show that under the pre-selected conditions, the full electrification of all driving and process-related tasks cannot be realized.

Two key factors determining the number of work steps that can be executed are the energy content of the vehicles' energy storage units and whether there is an option for recharging, or for refueling in the case of fuel cell vehicles. In all scenarios investigated, supplying energy from biogas or external sources proved to be the most economical option. In some instances, this was even more cost-effective than operating diesel-driven vehicles. However, modifying the economy parameters and assessment limits has a significant impact on the result.

By varying relevant parameters, the tool is able to investigate additional scenarios and describe future technological and economic developments. Using a model-based approach, the chances of success of planned electrification measures can be tested and advice for their execution can be given.

The Diploma thesis was submitted to the Chair of Agricultural Systems and Technology held by Prof. Dr.-Ing. habil. Thomas Herlitzius at TU Dresden.

With special thanks to the reviewers and supervisors of this work, Dipl.-Ing. Mirko Lindner and Dipl.-Ing. Jens Fehrmann of TU Dresden, as well as Dipl.-Ing. Catrin Weyers and Dr.-Ing. Sven Klausner of Fraunhofer IVI in Dresden.

Junior Research

Anomaly Detection in Lithium-Ion Battery Field Data Using Probabilistic Data-Driven Models

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Lithium-ion batteries are used today in most e-mobility devices. Modeling and understanding these battery systems plays a vital role for predicting their behavior. Identifying operating anomalies in the battery systems can help prevent catastrophic failures and increase safety and viability. Isolating anomalous sections from the recorded battery time series also helps to further analyze the anomalous components later.

This thesis explores the viability of using model-based approaches to capture battery behavior. A framework based on these models is then used to identify anomalous activity in battery field data. The main approach involves correlating the relationship between battery states (current, state of charge and temperature) to predict the ideal voltage and comparing it to the recorded voltage. The vehicle data is recorded directly from the Battery Monitoring System (BMS) and uploaded to the cloud. There, data sections are extracted and segregated based on whether the vehicle is driving, idling, or charging. Several non-anomalous data sections representing all three types are selected to train the proposed models. A slew of models ranging from linear regression models, equivalent-circuit inspired models to more complex neural network-based approaches such as LSTMs (Long Short-Term Memory) and 1D-CNNs (Convolutional Neural Network) were analyzed.

Another novel addition to the models is that they predict the voltage as a parameterized distribution with mean and a standard deviation (Gaussian Distribution). The advantage of this addition is that the models can exhibit various confidence levels associated with the prediction they make.

Since the predictions were made as a distribution instead of deterministic points, appropriate metrics were chosen to quantify anomalous behavior. The Z-Score metric was used to quantify the likelihood of observing the voltage recorded from the BMS to be sampled from the predicted distribution. Using another metric, the Kullback-Leibler (KL) divergence, it was possible to compare the distribution of actual Z-scores against ideal Z-scores to assess the entire section.

With the help of the proposed framework approach, three different datasets including a sample from Fraunhofer IVI's bus dataset were evaluated for anomalies. From this dataset, ten sections were used to train the models. The best models predicted the anomalous and non-anomalous sections with an accuracy of 93 percent.

The findings presented above were submitted as a Master's thesis to »Friedrich List« Faculty of Transport and Traffic Sciences at TU Dresden, Chair of Vehicle Mechatronics held by Prof. Dr.-Ing. Bernard Bäker.

With special thanks for guiding and supervising me during this thesis, to my external supervisor Dipl.-Phys. Thomas Lehmann, Fraunhofer IVI, and my two reviewers Ivo Horstkötter, M. Sc., TU Dresden, and Dipl.-Ing. Jakob Schmitt, TU Dresden.

Junior Research

Path Planning with Reinforcement Learning: A Policy Optimization Approach

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Path planning is pivotal in numerous applications from logistics to robotics. In contrast to traditional deterministic algorithms, reinforcement learning has lately emerged as a promising method. The research presented here uses the Proximal Policy Optimization (PPO) algorithm for an agent to find optimal paths.

Path planning is one of the problems people have tried to solve since the early days of civilization, and it has a wide range of applications in diverse fields. With recent advancements in robotics, machine learning, and machine vision, the subject is gaining fresh stimulus. Historically, methods such as the shortest path algorithm were prominent. However, recent developments highlight the prowess of reinforcement learning algorithms that are able to learn complex, non-linear policies. Some examples are Q-learning, which estimates action values in states, and policy optimization, which directly determines the best action, making it more sample-efficient and versatile. This study seeks to harness the benefits of policy optimization for optimal path planning.

The approach proposes an agent based in the PPO algorithm to address path planning in environments with static obstructions. Training was facilitated through a custom environment based on the OpenAI Gym toolkit. As the agent traverses, rewards and penalties are imparted based on collision-free actions and obstacles encountered respectively. Initial training in 2D was scaled to 3D without significant adjustments. For authenticity, the agent was also tested on Airsim, a simulator for autonomous vehicles.

With a success fraction of 99.8 percent in Onestep Voxelgym, results are promising. By introducing Manystep and Manystep Stacked Voxelgym variants, computational time was reduced by up to 70 percent. While slightly less optimal, their success rates were commendable, and enhancements are attainable, e. g., through hyperparameter tuning. Comparatively, PPO showed superior policies over other reinforcement learning techniques.

In conclusion, this study proved the PPO algorithm's prowess in path planning through reinforcement learning. Future endeavors could explore introducing dynamic obstacles, improving the agent's predictive abilities by emphasizing aspects such as trajectory prediction and obstacle clearance. As autonomous applications increase in importance, seamless integration of these breakthroughs is essential for success.

The findings presented above were submitted as a Master's thesis to the Faculty of Computer Science at TU Dresden.

I would like to thank my thesis supervisor Henri Meeß, M. Sc., at the Fraunhofer Application Center »Connected Mobility and Infrastructure« in Ingolstadt.

Highlights

January 12, 2023 | Launch of the HV-MELA-BAT project

Under the leadership of Fraunhofer ISE, power electronic converters and a contact system for high currents and voltages are to be developed in the joint »High-Voltage Megawatt Charging System« project by July 2025.

Fraunhofer IVI is contributing its expertise in the field of contact systems to this research project funded by the German Federal Ministry for Economic Affairs and Climate Action (BMWK).

January 16, 2023 | IDEALS project kick-off event

To relieve urban traffic, delivery companies in particular are turning to the third dimension: transport using unmanned drones. The airspace above the required take-off and landing areas – so-called vertiports – must be monitored in a similar way to a major airport.

The IDEALS research project, funded by the German Federal Ministry for Digital and Transport (BMDV), is dedicated to coordinating such flight operations.

January 31, 2023 | Network partners of the Saxon platform simul+ at Fraunhofer IVI

»Future. Bringing it TOGETHER!« – this is the credo of the Saxon platform simul+: networking people to jointly develop visions and achieve added value for Saxony's regions. This was also the motto of the simul+ meeting with regional partners. After initial words of welcome from the Saxon State Minister for Regional Development, Thomas Schmidt, Institute Director Prof. Dr. Matthias Klingner presented Fraunhofer IVI and its research fields.

March 10, 2023 | Inauguration of the DesignLab for Applied Research

In its various disciplines and manifestations, design is increasingly gaining importance in Fraunhofer's research. Supporting this trend, the three Fraunhofer Institutes IVI, IWS and IWU in Dresden, together with Technische Universität Dresden, founded the DesignLab for Applied Research. As a partnership-based institution, the DesignLab offers tailor-made design expertise and research from a single source.

March 29, 2023 | Demonstrator meeting of the Fraunhofer ALBACOPTER® Lighthouse Project

Two years into the project, a demonstrator meeting directed at numerous industry representatives was held in Manching, a town close to Ingolstadt that has favorable conditions for and a long-standing tradition in the field of aviation.

The meeting's focus topics were materials and aerodynamic structures, energy storage and propulsion engineering, autonomous flight, and digital twin mapping.

April 11, 2023 | Connected sensors in Rosenheim thanks to TraffIRNet

In Fraunhofer CCIT's TraffIRNet project, Fraunhofer IVI and other institutes are jointly working on connecting sensors for scalable traffic sensing. The Fraunhofer application center in Ingolstadt developed a sensor box for traffic analysis and optimization by means of infrastructure-based sensor technology. The box was deployed at roadside in Rosenheim. With the help of the 5G Bavaria automotive test bed, the transmission of raw data has been investigated.

June 14, 2023 | Advisory board meeting

The annual advisory board meeting was held at Fraunhofer IVI in the summer. Not only the expert presentations on connected and assisted driving as well as AI-based traffic optimization were met with great interest, but also the live demonstrations and exhibits. All participants emphasized the exceptionally favorable financial situation of the institute.

The meeting was opened on the previous evening with a tour of the Saxon parliament and a joint dinner.

June 30, 2023 | Dresden Science Night

»Schlaugemacht bis Mitternacht!« (Get smart by midnight!) Under this motto, numerous universities, research institutions, and science-related companies opened their doors, laboratories, lecture halls, and archives to the public once again, this year marking the 20th anniversary.

Fraunhofer IVI offered a diverse program for young and old and proudly welcomed 980 curious guests on its spacious premises.

July 3, 2023 | Launch of the RUBIN alliance Feldschwarm® Ökosystem project

The start of the BMBF-funded Feldschwarm® Ökosystem project was officially announced within the scope of the simul+ »Autonomous Mobile Work Machines« forum at Proschwitz Castle near Meißen. The project aims to realize the simultaneous automated operation of multiple field machines and agricultural robots for the first time. The users, who will be able to monitor the work progress on fields and intervene at any time, are the application's focus points.

July 26, 2023 | Delivery of the agricultural robot CAESAR to the Feldschwarm® network

The company InnoTrac2020 GmbH visited Fraunhofer IVI to deliver their remote-controllable equipment carrier system called CAESAR. This novel farming machine will be adapted by institute researchers for fully automated application in fruit farming.

The work carried out on the robot will also serve to expand the concepts for agricultural robotics developed within the Feldschwarm® research project.

July 28, 2023 | Intermediate evaluation of the application center in Ingolstadt

After the initial three-year startup phase of the application center »Connected Mobility and Infrastructure«, external experts from science and industry were invited for an evaluation. The all-day event included presentations of the overall strategy as well as the research priorities of the working groups. In almost all categories, the evaluation turned out to be highly positive. To fulfill all requirements regarding industrial revenues, however, further growth of the center should be carefully controlled.

August 21, 2023 | Commissioning of the H2Bot's energy cell

Smaller vehicles are particularly suitable for the electrification of agriculture. To date, however, there has been little experience of using fuel cell technology in such vehicles. With the recent commissioning of the energy cell of the hydrogen-powered agricultural robot H2Bot, new opportunities to test this technology in practice are opening up. The energy cell is a joint development of TU Dresden, Chair of Agricultural Systems and Technology (AST), and Fraunhofer IVI as part of the H2Bot project.

August 29, 2023 | Field day on »Robotics for Fruit and Wine Farming«

Autonomous field machines were the main focus of the event organized by the Saxon State Office for the Environment, Agriculture and Geology (LfULG) in Dresden-Pillnitz. The participants had the opportunity to get a first-hand experience of different solutions from the field of robotics and of new approaches to, e. g., crop protection on steep slopes, 5G technology, and electric charging. The autonomous elWObot, a robot for fruit and wine farming, demonstrated a number of work tasks such as mowing and mulching.

August 30, 2023 | tryING Engineering Science trial studies

For female high school graduates who are interested in a career in engineering but are still undecided, the tryING trial studies program at TU Dresden is an exciting opportunity. By participating in courses, workshops, and excursions, young women can experience university life and the diverse everyday work of an engineer, while also preparing optimally for the start of their studies. As part of the excursion program, eight prospective students visited the institute to gather information about career options and current research highlights.

September 20, 2023 | National European Road Safety Charter (ERSC) network meeting

This September, Fraunhofer IVI welcomed members of the ERSC within the scope of a network meeting. In its role as National Relay, the institute takes special interest in bringing together different stakeholders from the field of road safety in order to promote professional exchange on the newest relevant research topics. The main goal in this context is achieving Vision Zero in the road traffic sector, which means the complete prevention of deaths in road traffic.

September 26-27, 2023 | Meeting of the Presidential Council at Fraunhofer IVI

The first meeting of the Presidential Council under the new President Prof. Dr. Holger Hanselka was held at Fraunhofer IVI in Dresden. Participants included not only the executive board, but also members of the council from the Fraunhofer Groups, the Fraunhofer Segment for Defense and Security VVS and several employees from the Fraunhofer Headquarters. It was an enormous pleasure for Director Prof. Dr. Matthias Klingner to welcome such high-ranking guests at the institute.

October 16, 2023 | Topping-out ceremony at the Telewerk living lab

Within the two related research projects AMSEL and Telewerk, a modular experimental platform is being developed in the town of Mittweida. The micro settlement will be connected to the existing building WERKBANK32. With representatives from the construction companies and the university as well as the project partners, the topping-out ceremony took place at the Telewerk living lab. According to old traditions, a speech was held, and the final nail was driven in.

October 17, 2023 | VALISENS project consortium meeting

Partners of the VALISENS research project (»Cooperative Sensor System for Assisted Driving«) came together for the first consortium meeting at Fraunhofer IVI to present and discuss their initial results. The project's goal is to systematically create a comprehensive environmental perception for assisted driving, encompassing both peripheral infrastructure and the vehicle's ego perspective.

October 19, 2023 | Annual meeting of Fraunhofer SIRIOS

Fraunhofer SIRIOS draws on combined know-how to support stakeholders from civil security, operators of critical infrastructures and economy in transferring technological solutions from security research into practice. About 140 guests used the annual meeting to inform themselves about the latest results from the technology and innovation platform. Project leaders showcased their solutions in interactive demonstrations. For this purpose, they transformed the room into a demo lab and guided the audience through a crisis scenario.

October 20, 2023 | C-ROADS Urban C-ITS Contest award ceremony in Portugal

The aim of the Urban C-ITS Contest is to showcase and award prizes to activities surrounding connected driving in European cities. This year's award ceremony was held in Porto following the C-ROADS Urban C-ITS City Forum. Fraunhofer IVI presented their developments on cooperative and automated driving. It was a great honor for the researchers to be awarded »Frontrunner for supporting the automation of vehicles« for their work in Dresden.

October 24, 2023 | Hy.CoMM kick-off meeting

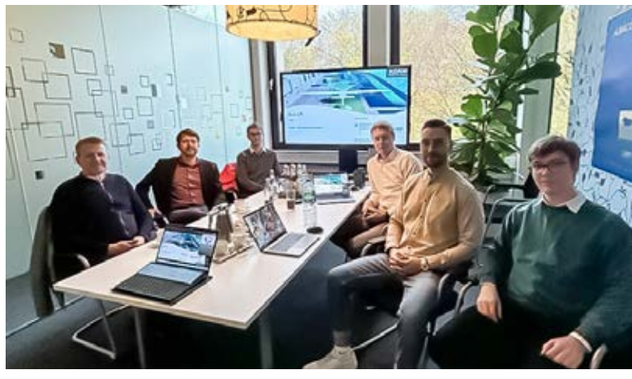
In the European collaborative project »Clean Hydrogen Construction and Mining Machines«, nine partners are developing and testing technologies for construction and mining vehicles with fuel cell propulsion under operating conditions. In addition to addressing challenges related to the vehicle and powertrain, new solutions for decentralized hydrogen production and refueling will be explored. Using only green hydrogen, these construction machines can make a significant contribution to reducing CO_2 emissions. As coordinator, Fraunhofer IVI hosted the kick-off in Dresden.

October 24, 2023 | KIWA consortium meeting

The project team came together for their 5th consortium meeting, where they discussed the current project state. Special attention was paid to methodical improvements of camera-based water monitoring as well as options of using camera-based flood forecasting within Fraunhofer's MobiKat® system. KIWA will investigate how artificial intelligence can be used to improve precipitation-runoff simulations, automatically detect water levels from camera images and derive the flow volumes of river systems from them.

November 7, 2023 | Workshop on safety for VRUs through cooperative systems

The C-ROADS Germany project implements cooperative services in real urban traffic environments. A workshop held at Fraunhofer IVI was dedicated to the safety of vulnerable road users (VRUs). Together with the Hamburg Agency of Roads, Bridges and Water and the Hamburg Verkehrsanlagen GmbH, a digitalization road map for achieving Vision Zero in the context of accidents involving bike riders and pedestrians was discussed.



November 10, 2023 | ADAM kick-off event

Urban Air Mobility is a forward-looking approach in the development of sustainable concepts for individual and freight transportation in highly congested metropolitan areas. Regardless of the application – whether it's logistics drones, air taxis, or rescue and surveillance systems –, the requirements for flight safety are particularly high. The BMDV-funded ADAM research project (»Advanced Air Space Mapping«) aims to improve lower airspace situational awareness using new mapping methods, thereby increasing safety for autonomous flying in cities. The kick-off event was held virtually.

November 23, 2023 | Opening of the eHAUL battery swap station for heavy e-trucks

Europe's first fully automated battery swap station for heavy trucks is located in the town of Lübbenau (Brandenburg). About 100 guests from industry, research and politics followed the live demonstration of the system. Within only 10 minutes, it is now possible to exchange batteries, continue a trip with fully charged batteries, and recharge extracted batteries independently of the vehicles. This marks the technology's next step towards market introduction, which can make a valuable contribution to the electrification of heavy commercial vehicles.

December 4-5, 2023 | SOTERIA General Assembly

SOTERIA, a European research project, aims to accelerate the attainment of the Vision Zero EU goal for vulnerable road users.

During the second General Assembly, project participants gathered for a two-day exchange in Dresden. The agenda included expert presentations, updates on individual work packages, and planning for the next steps, as well as specific workshops on planning the further exploitation of project results.

December 6-7 | ALBACOPTER® advisory board meeting

At the close of a successful year, a meeting was held in Dresden in the presence of the project advisory board and members of the Fraunhofer Headquarters. The consortium showcased the project's current state of research in several expert presentations and with the help of numerous exhibits on topics such as flight control, AI-based emergency landing and flight monitoring, redundant on-board electronics, electrified drivetrain, rotor test rig, and recyclable lightweight materials.

December 7, 2023 | Start of Telewerk experimentation day

At the example of the Telewerk living lab, Fraunhofer IVI, Hochschule Mittweida and Volksbank Mittweida jointly explore and demonstrate options for modern living and working in rural areas that simultaneously help to improve the entire region. At the start of experimentation day, Thomas Schmidt, Saxon State Minister for Regional Development, handed over the keys to the newly constructed project building, which provides a shell for the experimental platform and is a part of it at the same time.

December 13, 2023 | Expression of thanks to Prof. Dr. Matthias Klingner

Prof. Dr. Jana Kertzscher, Director of the Institute of Electrical Engineering at TU Bergakademie Freiberg, officially thanked Prof. Dr. Matthias Klingner for his years of teaching at Faculty 4.

As an honorary professor and Director of the Fraunhofer Institute for Transportation and Infrastructure Systems IVI, he regularly gave lectures in the field of electrical power engineering.

Trade Fairs and Conferences

Fraunhofer IVI at the Automotive Week in Helmond.

April 16-19, 2023 | Automotive Week
Helmond, the Netherlands

How can logistics in ports be made more sustainable with the help of clean energy? Intelligent solutions in the field of digitalization and automation are the key – solutions such as the helyOS® control tower software framework that serves to quickly implement projects in yard automation. At the MAGPIE project's intermediate demonstration event (MAGPIE – sMArt Green Ports as Integrated Efficient multimodal hubs), the system developed by Fraunhofer IVI once again proved its effectiveness.

At the event held within the scope of the 2023 Automotive Week in Helmond, the Netherlands, helyOS® was equipped with map, route and path planning microservices to allow the control of an automated DAF truck. The impressive demonstration took place in collaboration with the MAGPIE partners – an important milestone in reaching the European goal of achieving CO_2-free freight transport in, to and from ports by the year 2050.

April 18, 2023 | International Technical Conference on the Enhanced Safety of Vehicles
Yokohama, Japan

impactEES, a collision calculation program developed at Fraunhofer IVI, was presented at the International Technical Conference on the Enhanced Safety of Vehicles (ESV) in Yokohama. The software is the result of previous long-term research in the field of accident reconstruction and simulation. The work was funded in part by ADAC Stiftung and carried out mainly in collaboration with Toyota Motor Europe, AUDI, Euro NCAP and ADAC Technikzentrum.

Based on deformation energy models (EES models), impactEES estimates the acceleration profiles of vehicles involved in a crash. Through temporally resolved simulation, it is possible to calculate deformations, speed and further technical collision gravity parameters. These parameters are important metrics for the development and evaluation of future vehicle safety systems. The operation of impactEES, therefore, constitutes a significant contribution to increasing road safety.

April 20, 2023 | bonding career fair
Dresden

The bonding career fair was hosted by TU Dresden in April, celebrating its 30th anniversary. More than 120 exhibitors from the fields of engineering, economics and natural sciences presented themselves at the event. The Fraunhofer IVI team informed about internships, final theses and entry opportunities at the institute.

Fraunhofer IVI and Fraunhofer IPMS at the bonding 2023.

May 6-14, 2023 | munich creative business week
Munich

At the munich creative business week (mcbw) 2023, the Fraunhofer Network »Science, Art and Design« presented innovative concepts, prototypes and visions from their current projects. As an addition to the exhibition under the title »FORM FOLLOWS FUTURE«, workshops were held, providing information about the latest research activities and at the same time inspiring the interested audience to participate. The Fraunhofer DesignLab for Applied Research gave a seminar called the »Circular Design Challenge Sprint«, which was dedicated to creating something new from old mobility by developing concepts for cascading use of car body parts.

The Fraunhofer DesignLab for Applied Research at the mcbw.

June 13, 2023 | uniContact
Potsdam

Under the motto »New jobs, new contacts, new perspectives«, Fraunhofer IVI had a successful and exciting day at the uniContact career fair. On the Griebnitzsee Campus of the University of Potsdam, colleagues from Fraunhofer SIRIOS presented promising career opportunities and current research topics.

June 14-17, 2023 | 112RESCUE
Dortmund

This year, 112RESCUE celebrated its premiere at the Messe Dortmund. The trade show for fire safety, rescue, and civil defense will take place annually. With its central location within Germany, 112RESCUE is the first comprehensive nationwide business and information platform for civil security. Fraunhofer IVI presented the latest MobiKat® developments. This modular system for command and administration of resources is available for various hardware applications on all command levels.

The Fraunhofer IVI trade fair team at 112RESCUE.

June 18-20, 2023 | demopark
Hörselberg

At the demopark trade fair, AS-Motor, Fraunhofer IVI and Sensor-Technik Wiedemann GmbH presented three professional RC riding mowers that are capable of working together on lawns in a fully automated way – even on rough terrain (see picture above). The partners showed how one »driver« can control and monitor three riding mowers of the type AS 940 Sherpa 4WD RC, thus covering three times the usual area and executing their task more precisely and in a less tiresome way. Depending on the concrete application case, drivers can operate the mower fleet directly on site or remotely, for example, from their office.

One key technology included is the helyOS® (highly efficient online yard Operating System) control tower software that was created at Fraunhofer IVI with the goal of efficiently developing, testing and operating autonomous mobile machines. In small projects just as in large ones, helyOS® acts as a central node for connecting, controlling and monitoring vehicles fleets via a local network or the cloud. It was already possible to connect and automatically control trucks and agricultural machines with the help of the control tower software. Now, the digital control tower is able to deliver missions for professional mowers, too.

June 19-25, 2023 | International Paris Air Show
Le Bourget, Paris, France

With more than 2500 exhibitors from 46 countries, the Paris Air Show taking place at the Le Bourget airport is one of the most important aviation trade fairs in the world.

At the joint booth of the Fraunhofer-Gesellschaft and the Fraunhofer Aviation & Space Alliance, Fraunhofer IVI and other institutes presented the Fraunhofer ALBACOPTER® Lighthouse Project. In this research project, an airborne experimental platform will be developed and approved for testing and demonstration that combines the VTOL capabilities of multicopters with the aerodynamic advantages of gliders.

June 20-21, 2023 | National Cycling Congress
Frankfurt am Main

Experts from different municipal departments and administrative levels met with representatives from politics, science, economy and practical users for the eighth time . At Germany's most important congress on cycling, relevant topics, current challenges and future visions were discussed.

Fraunhofer IVI presented the »smart intersection«, developed within Fraunhofer CCIT for protecting vulnerable road users (VRUs). VRUs are detected and classified with the help of infrastructure. Subsequently, all traffic participants receive notification of the detected VRUs via V2X communications so that they can adapt their behavior accordingly. Notifications are transmitted via dedicated warnings and via direct infrastructure assistance actions.

The congress center of Messe Frankfurt welcomes the conference participants.

July 4-5, 2023 | Additive Manufacturing Forum
Berlin

This summer, the professional audience had the opportunity to delve into the world of additive manufacturing at the Additive Manufacturing Forum in Berlin. The forum brings together AM decision makers and experts each year, showcasing exciting user stories and use cases for industrial applications.

As one of 75 exhibitors, Fraunhofer IVI presented the CertiFlight project. As there is currently no comprehensive testing and certification process for additively manufactured components, a large portion of the samples must undergo destructive testing. The CertiFlight project aims to simplify and expedite the approval process for such components in aviation, relying on data and results generated and preprocessed in the AMCOCS project. To certify future additive manufacturing processes, CertiFlight is developing a self-learning, big data and AI-based platform for digital testing and certification procedures for additively manufactured components in aviation. This approach aims to make the corresponding processes more cost- and resource-efficient.

Within the project, Fraunhofer IVI focuses primarily on big data analysis based on parallelizable AI methods.

The panel discussion at the 2023 AM Forum.

September 5-8, 2023 | IAA MOBILITY
Munich

Urban Air Mobility (UAM) does more than just open up new potential in terms of transporting goods: If some of urban traffic goes airborne, this will also offer completely new approaches when it comes to sustainable mobility solutions.

In the Fraunhofer ALBACOPTER® Lighthouse Project, six Fraunhofer institutes are addressing the technical and social issues associated with UAM. Led by Fraunhofer IVI, researchers are developing an aircraft that glides in a particularly efficient way – taking inspiration from the albatross. This device and other highlights were exhibited at the joint Fraunhofer booth at the IAA MOBILITY trade show in Munich.

On the opening day, the President of the Fraunhofer-Gesellschaft, Prof. Dr. Holger Hanselka, and the executive vice president for Research Infrastructures and Digital Transformation, Prof. Dr. Axel Müller-Groeling, visited the Fraunhofer booth. Together with the expert team, Director of Fraunhofer IVI and ALBACOPTER® project manager Prof. Dr. Matthias Klingner presented the current development status of the experimental aircraft.

Prof. Dr. Holger Hanselka, President of the Fraunhofer-Gesellschaft, visits the Fraunhofer booth at the IAA MOBILITY.

September 14, 2023 | Data-driven Urban Mobility in Europe
Amsterdam, the Netherlands

Creating a unified data market across Europe has been a key European endeavor for a number of years now. The purpose of such a joint data space is to facilitate access to both existing and future traffic and mobility databases with the aim of exploiting and sharing data. In this context, Global Mass Transit organized the third annual conference »Data-driven Urban Mobility in Europe«. As one of the keynote speakers, Sebastian Pretzsch, manager of the »Data Systems and Travel Assistance« group at Fraunhofer IVI, introduced the Mobility Data Space and the associated activities on a European level.

September 24-28 | IEEE International Conference on Intelligent Transportation Systems
Bilbao, Spain

The ITSC 2023 featured contributions in the fields of analytical and numerical simulation and modeling as well as practical case studies in the field of advanced ITS applications. Fraunhofer IVI presented the RMTRUCK algorithm for the deadlock-free coordination of multiple vehicles in yards and a novel sensor box that allows predictions about traffic flows, ensuring better assessment of traffic situations.

Fraunhofer IVI researchers at the ITSC 2023 in Bilbao.

October 12-14, 2023 | FLORIAN
Dresden

Every year in October, Fraunhofer IVI participates in the FLORIAN (Trade fair for Fire Brigades, Civil Protection and Disaster Control) to present their latest technological developments in the field of security.

At the Messe Dresden, the institute exhibited new solutions for the effective support of complex strategic and operational-tactical decisions in the prevention of hazards and the management of flood situations.

October 25-26, 2023 | Clean Hydrogen Convention
Dresden

Political, scientific, international: This October, Energy Saxony and HZwo e. V. organized the Clean Hydrogen Convention – one of the most significant discussion platforms for hydrogen enthusiasts from theory and practice. High-profile speakers from politics and science came together to address the key question »How can hydrogen drive the energy transition?« Fraunhofer IVI presented their current activities in the fields of hydrogen and fuel cell systems.

Researchers of the »Monitoring and Control Strategies« group at the Clean Hydrogen Convention.

October 26-27, 2023 | ICTCT Conference
Catania, Italy

The International Cooperation on Theories and Concepts in Traffic Safety (ICTCT) is an association that has been dedicated to building and sharing scientific knowledge on road safety since 1988. Their particular focus is on methods that rely not only on accident data, but also on non-accident data.

ICTCT invited its members and the professional audience to Catania, where the 35th conference was held under the theme »Challenges and actual opportunities offered by new technologies to improve traffic safety«.

Fraunhofer IVI presented the Collision Zero project. Building upon PAPS-XR, the project utilizes public accident data from authorities, preparing them for vulnerable road users with the intention of developing a nationwide VR experience online platform. This platform aims to provide an interactive perspective of animated accident scenarios in 3D maps using virtual reality. In doing so, the institute and its partner, Wildstyle Network, make a significant contribution to achieving Vision Zero.

Presentation of the Collision Zero project at the ICTCT Conference.

November 12-18, 2023 | AGRITECHNICA
Hannover

AGRITECHNICA is the world's leading trade fair for agricultural machinery. More than 2600 exhibitors from 53 countries presented their innovations in 24 halls in Hannover. The organizer, DLG e. V. – German Agricultural Society, set the topic of »Green Productivity« as the trade fair's guiding theme, making it an expert forum for the agricultural challenges of the future.

At the joint booth of the Wirtschaftsförderung Sachsen, Saxony Trade & Invest Corp., Fraunhofer IVI informed about the safe realization of efficient fully automated agricultural machinery.

November 14, 2023 | KARRIEREWEGE
Dresden

Whether it's an internship, entry-level job, or details about pursuing a master's degree – the KARRIEREWEGE career fair at HTW Dresden offered something suitable for everyone (see picture above). At the Fraunhofer IVI booth, students had the opportunity to discuss their career options and explore exciting research and project work opportunities.

Life at Work and Beyond

The institute greatly relies on the commitment of its employees, who are actively living the »Fraunhofer spirit« – not just during working hours, but also in their leisure time, engaging in a wide variety of non-scientific activities. These include an impressive range of social and community-building activities, such as fundraisers, volleyball tournaments or joint visits to the Christmas market. The summer party always creates a relaxed atmosphere. Farewell parties are a living proof that the bonds created at the institute extend beyond the professional scope. The life at the institute is not only enriched by the variety of these activities, but it is also shaped by them. Colleagues are not just committed to their projects and the everyday life of their research, but they actively stand up for one another.

Thanks to the commitment of many colleagues at Fraunhofer IVI, we were able to collect donations for »von 0 auf 100 für die Kinderhilfe«, a children's welfare campaign with the goal of creating family rooms within the pediatric intensive care unit of the University Hospital in Dresden.«

Small, well-organized festivities help to build appreciation as well as the team itself, while simultaneously promoting a positive work atmosphere.«

I found real friends in my colleagues and also like to spend my free time with them. This strengthens our team spirit and makes us stick together, even in stressful times.«

The self-organized summer party was a successful blend of fun, sense of community and culinary pleasures. Everyone contributed to the relaxed atmosphere by bringing their own self-made delicacies. The event gave room for lively conversations and provided great opportunities to get to know new colleagues.«

The institute's Christmas party was a festive event that made everyone feel the Christmas spirit. To me, the most special highlight was the performance of the institute's band. Their music created a warm holiday atmosphere.«

We participate in the REWE Team Challenge with full commitment every year. In this city run, we are not only improving our fitness, but we also get the chance to bond as colleagues.«

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Academic Output

- Publications
- Final Theses
- Teaching Engagements
- Public Body Membership
- Patents
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Agrawal, A.; Bhanderi, S.; Amanagi, S.; Doycheva, K.; Elger, G.: **Instance Segmentation and Detection of Children to Safeguard Vulnerable Traffic User by Infrastructure.** 9th International Conference on Vehicle Technology and Intelligent Transport Systems VEHITS, Praha, Czech Republic, April 26-28, 2023
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Velasco Arevalo, A.; Gerike, R.: **Sustainability Evaluation Methods for Public Transport with a Focus to Latin American Cities: A Literature Review.**
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In: Proceedings. Piscataway, NJ, USA, IEEE, 6 pp., ISBN: 9798350398687, DOI: 10.1109/SII55687.2023.10039276

Weiß, F.: **Felddatenbasierte Batteriediagnose und Lebensdauerprognose.** Energy Saxony Summit 2023 Digital, online event, May 24, 2023, presentation accessible via: https://youtu.be/MgxK6xfcrYM

Weiß, F.; Lehmann, T.: **Aging Diagnostics of Lithium-Ion Batteries Using Artificial Intelligence and Real Vehicle Data.** Batterieforum Deutschland, Berlin, January 18-20, 2023, poster presentation

Witte, J.; Striller, B.; Hecker, A.; Holfeld, J.; Pohle, M.; Wolniak, N.; Nothdurft, T.: **Adapting and Enhancing V2X Communication to Agricultural Machinery to Address Road Safety via C-ITS.** 80th International Conference on Agricultural Engineering LAND.TECHNIK AgEng 2023, Hannover, November 10-11, 2023, presentation: J. Witte/ B. Striller
In: Proceedings. Düsseldorf, VDI Verlag, 2023, VDI-Berichte, vol. 2427, S. 371-378, ISBN: 9783180924274

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In: Knowledge-Based Systems, 2023, vol. 277, Amsterdam, The Netherlands, Elsevier, 7 pp., ISSN: 0950-7051, DOI: 10.1016/j.knosys.2023.110815

Final Theses

Doctoral Candidates

Klaproth, Tom
Spectroscopic investigations of two-dimensional magnetic materials: transition metal trichlorides and transition metal phosphorus trichalcogenides. TU Dresden

Diploma Students

Bach, Luckas Maximilian
Flugzeugvorentwurf eines Unmanned Aerial Vehicle (UAV) in Kipprotor-Drachenflugzeug-Konfiguration mit VTOL-Fähigkeiten. TU Dresden

Benken, Frederic
Konzeptentwicklung einer virtuellen Forschungswelt für das Forschungscluster Centre for Tactile Internet (CeTI). TU Dresden

Ermoshin, Andrei
Konzeption und Gestaltung eines AR-Arbeitsplatzes für die Bedienung von Baggern. TU Dresden

Händler, Björn
Krisenresilienz im öffentlichen Gesundheitsdienst. TU Dresden

Heymer, Florian
Auslegung und Optimierung einer Luftkühlungseinheit für ein konduktives Schnellladesystem. TU Dresden

Klotsche, Jonas
Entwicklung eine generalisierten Fahrantriebssteuerung. TU Dresden

Neubert, Lukas
Untersuchungen zu Schadenfällen mit Flugobjekten im Straßenverkehr insbesondere mit Vögeln. University of Applied Sciences Zwickau

Nguyen, Tuyen
Entwurf und Entwicklung eines Plugin-Packages für Grasshopper zur Nutzung im Strak-Prozess. TU Dresden

Poy, Yi Han
Identification of the Aerodynamic Derivatives of a VTOL Aircraft from Flight Data. TU Dresden

Qian, Ina
Adaptives Interaktionsdesign zur Motivation ökologischen Handelns. TU Dresden

Richter, Anton Paul
Flugerprobung eines Unmanned Aerial Vehicle (UAV) in Kipprotor-Drachenflugzeug-Konfiguration mit VTOL-Fähigkeiten. TU Dresden

Richter, Christoph
Erstellung eines Simulationsdatensatzes für Wildunfälle. HTW Dresden

Röhlig, Julius
Entwicklung eines iterativen Entwurfswerkzeugs für die konzeptionelle Konfiguration und Evaluation multimodaler User Interfaces. TU Dresden

Rühlicke, Nico
Entwicklung einer Betriebsstrategie zur Verbesserung der Gesamtkosten von Brennstoffzellenbussen. TU Dresden

Schönnagel, Adrian
Efficient Headland Planning for Agricultural Vehicles with Kinematic Constraints. TU Dresden

Spiridi, Philipp
Entwicklung eines Entwurfswerkzeugs für die prototypenbasierte Konzeption und Evaluation multimodaler Armlehnen mobiler Arbeitsmaschinen. TU Dresden

Teubner, Stefan
Entwicklung eines Minimum Lovable Products für die Anwendung eines digitalen Physiotherapie-Assistenten. TU Dresden

Master Students

Babu, Harisankar
Reinforcement Learning Based Path Planning for Autonomous Flight. TU Dresden

Barvenčik, Jill Lara
Deep multi-agent reinforcement learning for real-life large-scale traffic. TU Berlin

Föppl, Tilman
Modellierung der Stillstandserwärmung von Kurzschlussläufer-Asynchronmaschinen. TU Bergakademie Freiberg

Gajera, Ronakkumar
A Comprehensive Approach to Road User Trajectory Tracking and Prediction with Infrared Camera and Radar Data Fusion. TH Ingolstadt

Kim, Taehyoung
From Supervised to Reinforced: A One-Shot Deep Learning Approach to UAV Path Planning. TU München

Modi, Milinkumar
Determination of Accident-Promoting Safety Factors in Road Traffic. University of Applied Sciences Zwickau

Singaravelan, Thanuj
Detection and Analysis of Anomalies in Timeseries of Li-Ion Battery Field Data. TU Dresden

Ziermann, Max
Untersuchung von Methoden für die datengestützte Betriebsbereichsanalyse automatisierter Fahrzeuge im ÖPNV. HTW Dresden

Bachelor Students

Huang, Zhengyang
Research on AI-based applications in edge communication networks. TU München

Wünsche, Oliver
Unfalltypenklassifikation mithilfe textverarbeitender Algorithmen. HTW Dresden

Zesewitz-Thiel, Selina
Einsatz von Usability-Richtlinien bei der Reimplementierung eines Gantt-Diagramm-Moduls. Berufsakademie Sachsen

Teaching Engagements

Bartholomäus, Ralf
Optimale Steuerung kontinuierlicher Prozesse. TU Dresden, Faculty of Electrical and Computer Engineering, Institute of Control Theory, SS 2023

Vernetzte Energiespeicher. TU Freiberg, Faculty of Mechanical, Process and Energy Engineering, Institute of Electrical Engineering, SS 2023

Elger, Gordon
Computer Aided Engineering. TH Ingolstadt, Faculty of Electrical Engineering and Information Technology, WS 2022/23, SS 2023, WS 2023/24

CAE für die Elektrotechnik. TH Ingolstadt, Faculty of Electrical Engineering and Information Technology, WS 2022/23, SS 2023

Electronics, Measurement and Systems. TH Ingolstadt, Faculty of Electrical Engineering and Information Technology, SS 2023

Halbleiterbauelemente. TH Ingolstadt, Faculty of Electrical Engineering and Information Technology, WS 2023/24

Festag, Andreas
Kommunikationssysteme. TH Ingolstadt, Faculty of Electrical Engineering and Information Technology, SS 2023

Car2X-Kommunikation. TH Ingolstadt, Faculty of Electrical Engineering and Information Technology, WS 2022/23, WS 2023/24

Software-Entwicklung für sicherheitskritische Systeme. TH Ingolstadt, Faculty of Electrical Engineering and Information Technology, WS 2022/23

Group Project (Master Automatisiertes Fahren, International Automotive Engineering). TH Ingolstadt, Faculty of Electrical Engineering and Information Technology, WS 2022/23, SS 2023, WS 2023/24

V2X Services (Master of Applied Research). TH Ingolstadt, Faculty of Electrical Engineering and Information Technology, WS 2022/23

Kefferpütz, Klaus
Sensordata and Information Fusion. TH Ingolstadt, Faculty of Electrical Engineering and Information Technology, WS 2022/23, SS 2023, WS 2023/24

Regelungstechnik 1. Hochschule Augsburg, Faculty of Mechanical and Process Engineering, WS 2022/23, SS 2023

Regelungstechnik 2. Hochschule Augsburg, Faculty of Mechanical and Process Engineering, WS 2022/23

Kertzscher, Jana
Berechnung elektrischer Maschinen. TU Freiberg, Faculty of Mechanical, Process and Energy Engineering, Institute of Electrical Engineering, SS 2023

Einführung in die Elektrotechnik. TU Freiberg, Faculty of Mechanical, Process and Energy Engineering, Institute of Electrical Engineering, WS 2023/24

Komplexpraktikum Elektrotechnik. TU Freiberg, Faculty of Mechanical, Process and Energy Engineering, Institute of Electrical Engineering, SS 2023

Elektrische Maschinen. TU Freiberg, Faculty of Mechanical, Process and Energy Engineering, Institute of Electrical Engineering, WS 2023/24

Einführung in die Elektromobilität. TU Freiberg, Faculty of Mechanical, Process and Energy Engineering, Institute of Electrical Engineering, WS 2023/24

Elektrische Antriebe I. TU Freiberg, Faculty of Mechanical, Process and Energy Engineering, Institute of Electrical Engineering, SS 2023

Theorie elektrischer Maschinen. TU Freiberg, Faculty of Mechanical, Process and Energy Engineering, Institute of Electrical Engineering, WS 2023/24

Klingner, Matthias
Elektroenergiesysteme. TU Freiberg, Faculty of Mechanical, Process and Energy Engineering, Institute of Electrical Engineering, SS 2023

Knote, Thoralf
Fahrzeugsicherheit automatisierter Fahrzeuge. TU Dresden, »Friedrich List« Faculty of Transport and Traffic Sciences, Institute of Transport Planning and Road Traffic, SS 2023

Krzywinski, Jens
Designprozess und -werkzeuge (in der Produktentwicklung). TU Dresden, Faculty of Mechanical Science and Engineering, Institute of Machine Elements and Machine Design, SS 2023

Design von Produkt-Service-Systemen. TU Dresden, Faculty of Mechanical Science and Engineering, Institute of Machine Elements and Machine Design, SS 2023

Nutzerzentrierter Produktentwurf. TU Dresden, Faculty of Mechanical Science and Engineering, Institute of Machine Elements and Machine Design, WS 2022/23, WS 2023/24

Markgraf, Marcel
Vom Hype zur Realität: Ein Einblick in den steinigen Weg vom mobilen Roboter zum autonomen Fahrzeug. In: Lecture »Steuerung mobiler Roboter«, TU Dresden, Faculty of Electrical and Computer Engineering, Institute of Automation, 4. Dezember 2023

Rauschert, André
Ideen-, Innovations- und Change Management. Gründungsmanagement. HS Mittweida (FH), Faculty Industrial Engineering, Media Faculty, WS 2022/23, SS 2023, WS 2023/24

Schmid, Maximilian
Messtechnik. TH Ingolstadt, Faculty of Electrical Engineering and Information Technology, WS 2023/24

Measurement Engineering. TH Ingolstadt, Faculty of Mechanical Engineering, WS 2023/24

Public Body Membership and Patents

Public Body Membership

Auerswald, Rico
– ASAM Association for Standardization of Automation and Measuring Systems e. V.

Danowski, Kamen
– Section »Civil Protection, Euroregion Elbe/Labe«

Elger, Gordon
– International Microelectronics and Packaging Society (IMAPS)

Erbsmehl, Christian T.
– SafeTRANS e. V.

Festag, Andreas
– 5G Automotive Association e. V.
– ETSI European Telecommunications Standards Institute

Fichtl, Holger
– Agronym e. V.

Gründel, Torsten
– Kontiki Working Group in Contactless Smart Card Systems for Electronic Ticketing e. V.
– Fraunhofer Transport Alliance
– UITP International Association of Public Transport
– ASAM Association for Standardization of Automation and Measuring Systems e. V.

Hedel, Ralf
– Spokesperson of ECTRI Thematic Group »Security and Risk Analysis«

Kertzscher, Jana
– VDE Association for Electrical, Electronic & Information Technologies e. V.

Klingner, Matthias
– Dresden-concept e. V.
– Exzellenzstiftung Ingolstädter Wissenschaft – Ignaz Kögler
– HYPOS – Hydrogen Power Storage & Solutions East Germany e. V.
– Fraunhofer Network »Science, Art and Design«
– Fraunhofer ICT Group
– Fraunhofer-Alumni e. V.
– Steering committee of the Fraunhofer Transport Alliance
– »Dresden – Stadt der Wissenschaften« Network

Lorenz, Sebastian
– JUG Saxony e. V.

Meeß, Henri
– SAE, G-34 Artificial Intelligence in Aviation
– BDLI, technical committee UAV
– Urban Air Mobility Initiative Ingolstadt
– Airbus Air Mobility Initiative
– DIN, German Standardization Roadmap AI
– BSI, Working Group for the development of an IT- Grundschutz profile for drones

Otto, Thomas
– Road and Transportation Research Association (FGSV), Working Group 3.3.1 »Recommendation for the technology change to C-ITS at traffic lights« (Head of the Working group)
– Road and Transportation Research Association (FGSV), Working Group 3.2.1 »Sensor fusion and artificial intelligence for situation/event detection and prognosis«
– ECTRI Thematic Group »Mobility«
– ECTRI Thematic Group »Traffic Management & Modelling«

Pohle, Maria
– IRTAD International Road Traffic Accident Database

Pretzsch, Sebastian
– Mobilithek User Group
– Mobility Data Space Technology Committee
– European Mobility Data Space
– International Data Spaces Architecture Working Group
– Gaia-X 4 Future Mobility
– EIT Urban Mobility

Rauschert, André
– Fraunhofer Big Data and Artificial Intelligence Alliance
– Saxon Transfer Network futureSAX
– VDMA Software and Digitalization, Expert group »Machine Learning«

Steinert, Frank
– Fraunhofer Transport Alliance, Head of Working Group »Fraunhofer-Commercial Transport«

Ufert, Martin
– Fraunhofer Battery Alliance
– Fraunhofer Energy Alliance
– HZwo e. V.

Urban, Martin
– EVU European Association for Accident Research and Analysis e. V.

Zarnack, Martin
– bavAIRia e. V. – Bavarian Cluster for Aeronautics, Aerospace and Aerospace Applications

Patents

Breitlauch, P.; Erbsmehl, C. T.: **Verfahren zum Modellieren einer Kollision zweier Objekte.** European patent application: EP 4 009 216 A1, published 2022

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Certificates

DIN EN ISO 9001:2015,
Sector »Development of vehicle and propulsion technology and transporation research and development«, Certificate registration no.: 44 100 190788

Trademarks (Word)

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