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FRAUNHOFER INSTITUTE FOR TRANSPORTATION AND INFRASTRUCTURE SYSTEMS IVI

INSTITUTE REPORT
2020

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RESEARCH STANDS UP TO STANDSTILL

Albrecht Dürer's »Four Horsemen of the Apocalypse« – perhaps one of his most expressive woodcuts – embodies humankind's basic fears like no other work of its discipline. While until a short time ago, war, hunger and mass deaths had only been present for us in the news at best, the pandemic has upturned our lives suddenly and profoundly.

With Dürer, who himself had to flee from the plague to Italy in 1494, the arrow symbolizes the outbreak that hits all people unexpectedly and seemingly out of nowhere. In contrast to the Middle Ages, there seems to be no place in our globalized world that promises safety from the pandemic.

On the other hand, we know today that the causes of diseases are completely earthly. We can classify the genomes of bacteria and viruses, detect mutations, monitor their spread and discover the mechanisms they use to infect human bodies.

There are many places, including Dresden, where reliefs of the Dance of Death remind us of the plague outbreaks of the Middle Ages. The original version of the »Dresden Dance of Death« was divided in two by a depiction of the »tree of knowledge«. Even then, it seems, it was thought that only faith and science can hold the Grim Reaper at bay.

Today, highly efficient vaccines, which have been developed, produced and administered worldwide with unbelievable speed, raise our hopes that the crisis will be over in the foreseeable future.

Of course, the standstill that has paralyzed society and economy this past year has not stopped at the gates of Fraunhofer IVI. Within a matter of days, all work had to be relocated to the home office, childcare had to be organized, business trips replaced by video calls, and new types of collaboration installed via screen. With great mutual understanding, we succeeded in all of this, and we even finished the fateful Corona year with one of our best annual results yet. For this, I would like to thank all our employees from the bottom of my heart.

Loosely based on Max Frisch, standstill leads to death. This gloomy perspective is becoming reality for many companies in a wide variety of sectors. The fact that Fraunhofer IVI can look into the future with great confidence is due to our strong industry partnerships and our well-filled commission books, which guarantee stable finances not only for 2021, but also for many years to come. In the first year of its existence, our application center at TH Ingolstadt has also made a positive development by acquiring interesting projects, increasing their staff numbers and expanding their network. Ingolstadt is a charming former garrison town whose barracks and parade grounds remind me a little bit of the dark days of my own compulsory military service. The military command »Attention« (in German: »Stand still«) – which demands an act of unconditional subordination – hits us during the pandemic in the middle of our day-to-day lives. Therefore, I would like to close with the words of Matthias Claudius »Niemand ist frei, der über sich selbst nicht Herr ist (No one is free who is not their own master)« and hope for the sake of all of us that standing to attention, i. e., »standing still«, will not become a habit and we will soon be able to meet quite freely again.

Director
Prof. Dr. Matthias Klingner

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FRAUNHOFER-GESELLSCHAFT

Five institutes and five additional research institutions with a total of about 2400 employees and an annual turnover of more than 250 million euros (2019) represent the Fraunhofer-Gesellschaft in Dresden.

INSTITUTES

▶ Fraunhofer Institute for Ceramic Technologies and Systems IKTS
▶ Fraunhofer Institute for Material and Beam Technology IWS
▶ 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

BRANCHES AND RESEARCH INSTITUTIONS

▶ Dresden branch of the Fraunhofer Institute for Manufacturing Technology and Advanced Materials IFAM, Bremen
▶ Division EAS (Engineering of Adaptive Systems) of the Fraunhofer Institute for Integrated Circuits IIS, Erlangen
▶ 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
▶ Project Group ASSID (All Silicon System Integration Dresden) of the Fraunhofer Institute for Reliability and Microintegration IZM, Berlin

The Fraunhofer-Gesellschaft is the world's leading applied research organization. Founded in 1949, the research organization undertakes applied research that drives economic development and serves the wider benefit of society. Its services are solicited by customers and contractual partners in industry, the service sector and public administration.

At present, the Fraunhofer-Gesellschaft maintains 75 institutes and research units. The majority of the more than 29,000 staff are qualified scientists and engineers, who generate an annual research budget of more than 2.8 billion euros. Of this sum, over 2.4 billion euros is generated through contract research. Around two thirds of this revenue is derived from contracts with industry and publicly funded research projects. The remaining third comes from the German federal and state governments in the form of basic funding. This enables the Fraunhofer Institutes to work on solutions to problems that are likely to become crucial for industry and society within the not-too-distant future.

International collaborations with excellent research partners and innovative companies around the world ensure direct access to regions of the greatest importance to present and future scientific progress and economic development.

With its clearly defined mission of application-oriented research and its focus on key technologies of relevance to the future, Fraunhofer plays a central role in the German and European innovation process. Applied research has a knock-on effect that extends beyond the direct benefits perceived by the customer: Through their research and development work, the institutes help to reinforce the competitive strength of the economy in their local region, and throughout Germany and Europe. They do so by promoting innovation, strengthening the technological base, improving the acceptance of new technologies, and helping to train the urgently needed future generation of scientists and engineers.

Fraunhofer offers its employees the opportunity to develop the professional and personal skills that will enable them to take up positions of responsibility at the institutes, at universities, in industry and within society. Students who work on projects at Fraunhofer Institutes have excellent career prospects in industry by virtue of the practical training they enjoy and the early experience they acquire.

The Fraunhofer-Gesellschaft is a recognized non-profit organization that takes its name from the Munich scholar Joseph von Fraunhofer (1787–1826), who was equally successful as a researcher, inventor and entrepreneur.

FRAUNHOFER IVI

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The complete list of international partners
can be found on the website:
s.fhg.de/partner-international

CUSTOMERS AND PARTNERS

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

IN ALLIANCES

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ACADEMIC COOPERATION

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- Technische Universität Bergakademie Freiberg
- Technische Hochschule Ingolstadt

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FACILITIES AND LARGE EQUIPMENT

COMPETENCIES

- Vehicle hall with adjacent test track
- Test vehicles and demonstrators
- Measurement technology
- Test rigs

Software for
- Simulation
- Big data
- 3D construction
- GIS

The complete list of facilities and large Equipment can be found on the website: s.fhg.de/equipment

Digital business processes

Autonomous utilities systems

Propulsion technologies

Ticketing and fares

Logistics

Identification of traffic situations

Transportation ecology

Mobility and travel assistance

Sensor and actuator systems   ## Electromobility

Vehicle and road safety

Autonomous systems

Vehicle technologies

Multi-axle steering and guidance systems

Intelligent transport systems

System modeling and process control

Stationary energy storage systems

Civil security

Vehicle connectivity   Transport planning

ADVISORY BOARD

ECONOMIC DEVELOPMENT

MEMBERS *(as of 2020)*

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

Prof. Dr. Viktor Grinewitschus,
Institute for Energy Systems and Energy Business,
Hochschule Ruhr West

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

MinR Hans-Peter Hiepe,
Head of Division »Innovationsförderung; SprinD; Cluster;
Gaia-X«, Federal Ministry of Education and Research (BMBF)

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Deputy Director / Manager External Relations,
John Deere GmbH & Co. KG

Dirk Schillings,
Chief Technical Officer Light Rail Vehicles,
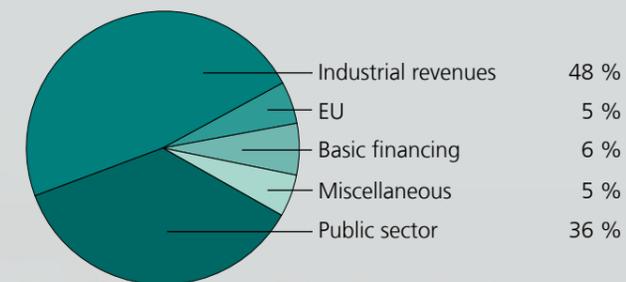Member of the Executive Board, Stadler Rail AG

Nils Schmidt,
Regional Director, Northern Germany Area,
Siemens Mobility GmbH

Prof. Dr. Katharina Seifert,
Director, Institute of Transportation Systems,
German Aerospace Center e. V. (DLR)

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

Carsten Utikal,
Consultant – Federal-State Research Institutions,
Saxon State Ministry of Science, Culture and Tourism (SMWK)

OPERATING BUDGET

Industrial revenues	48 %
EU	5 %
Basic financing	6 %
Miscellaneous	5 %
Public sector	36 %

FINANCIAL DEVELOPMENT

in € million

2013	2014	2015	2016	2017	2018	2019	2020

EMPLOYEES

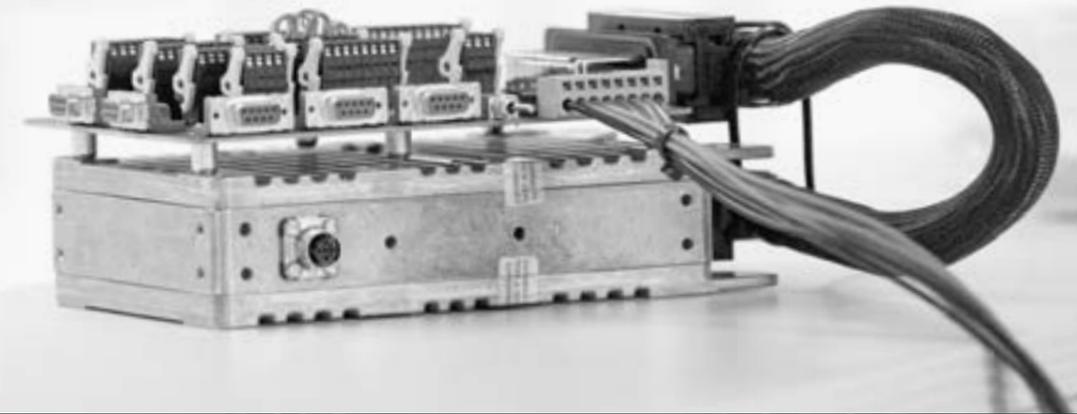| 114	78	5	22
Research fellows	Research assistants	Trainees	Administrative and technical staff

CHAIRMAN

Prof. Dr. Christian Lippold, Chair of Road Planning and Road Design,
Institute of Transport Planning and Road Traffic, »Friedrich List« Faculty of Transport and Traffic Sciences, TU Dresden

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RANGE OF SERVICES

▶ Design and dimensioning of electric powertrains in commercial and special-purpose vehicles
▶ Implementation concepts for electric buses
▶ Fast-charging concepts for electric vehicles
▶ Electrification and automation of agricultural machinery
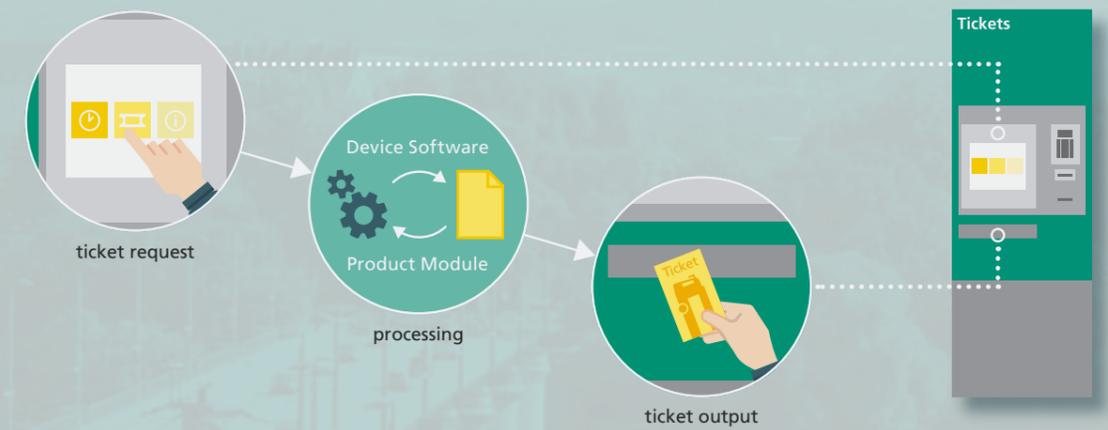▶ Characterization and monitoring of energy storage systems / high-voltage batteries

▶ Control center for autonomous driving in yards
▶ Fully automated maneuver planning for heavy goods vehicles

▶ Analyses, surveys and development work in the field of vehicle and traffic safety
▶ Monitoring and analysis of technical systems
▶ Functional safety of commercial vehicles (ISO 26262)

Since the end of 2018, compliance with the ISO 26262 standard has been mandatory not only in the development of passenger cars, but also in the field of »bus and trucks« . As a result, manufacturers and suppliers in this sector are faced with enormous development expenses.

Since the introduction of the ISO 26262 standard in 2010, there has been an international set of rules for the implementation of functional safety in the electric/electronic systems of passenger cars. In December of 2018, compliance with this standard has also become mandatory for commercial vehicles.

The development departments of large automotive corporations were directly involved in the creation and implementation of the standard, and were able to compensate their expenses due to their large production volumes. The »bus and trucks« niche sector, on the other hand, is faced with a great challenge. Not only the costs, but also the process demands in terms of the design, development and testing of components according to the requirements of ISO 26262 are often very much overburdening.

In order to support this clientele, which has been one of the main customers of the Department for Vehicle and Transport System Engineering for a long time, a highly specialized team was established and trained at the institute.

In close collaboration with the institute's clients in the commercial vehicles sector, this team provides support in the development of new ISO 26262-compliant E/E systems. Their services range from knowledge transfer to the design and development of ISO 26262-compliant systems, as well as their testing and validation. A spin-off company was founded specifically for the purpose of manufacturing and supplying standards-compliant control systems for clients' assembly lines.

The key element in this process is to assess the risk of possible errors in planned components in order to gauge the development process' complexity and the necessity to include the ISO 26262 standard. While a defective fan control, for example, causes almost no further risks, failures and malfunctions of the steering control system can lead to major accidents. Therefore, these technologies must be developed and tested strictly in accordance with the standard. To guarantee compliance, possible failure cases and their consequences are systematically evaluated and categorized (QM = uncritical to ASIL D = very high risk).

It is important to note that certification according to the ISO 26262 standard usually cannot be obtained for an ongoing or concluded development process. Instead, all work carried out for a development project has to be standards-compliant from the start. Therefore, the institute's advice favors mutual communication from an early point on, so that details can be specified and unnecessary expenses can be avoided.

Functional Safety in Commercial Vehicles – a Challenge

MOBILITY
AND DIGITAL SERVICES

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ticket request

Device Software

Product Module

processing

ticket output

Tickets

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The nation-wide industry standard for product and control modules (PKM) developed by Fraunhofer IVI has been used for the first time for purchases made at ticket machines.

The sale of tickets for different local transport tariffs is a great challenge for railway companies. In three railway networks operated by Abellio, ticket machines had to be supplied with a total of ten district tariffs, one state tariff and the German national railway tariff (DB tariff). As the first of over 35 non-state owned railway companies in Germany, Abellio has employed the PKM technology developed by Fraunhofer IVI.

The aforementioned tariffs differ significantly from each other: not only in terms of their systematic approach and product range, but also in their spatio-temporal settings and individual customer characteristics, discounts and transfer/riding along options. The product modules ordered by Abellio contain the entirety of knowledge about the tariffs, with the exception of the DB tariff. This knowledge includes the tariff data itself, but also complex algorithms needed to process the data within the ticket machine.

Essential prerequisites for this are a programming language developed at Fraunhofer IVI that is being used throughout the sector as the »PKM standard«, as well as a standards-compliant interpreter software installed on the ticket machine.

In addition to determining appropriate tariff products including their spatial and temporal validity, the modules execute additional tasks, such as interaction with the user interface. Here, they provide information for displaying and ticket printing and in part also for ticket storage via chip card or barcode.

Initial module configuration was carried out via the »Produkteditor« (product editor, PED). This software allows the creation and editing of standards-compliant modules, as well as the exchange of modules with additional users. All product modules can be updated continuously and tested thoroughly before their operation on devices. PED has already been licensed by a variety of transport companies and associations.

For Abellio, one great advantage of using the PKM technology – in contrast to the tariff data supply method used before – lies in its independence from device software. Both data and algorithms are transparent and can be edited and reused largely independently from the device manufacturer. Another positive effect stems from »memory mapping«, which is run for the first time and which lowers RAM usage to a fraction of the raw data size. This way, ticket machines with limited data storage remain operational without additional hardware even at high data volumes. The operation of PKM ensures an overall level of quality, time savings and efficiency heretofore unknown to the industry.

RANGE OF SERVICES

▶ Testing of connected automated driving within the Digital Test Bed Dresden/Saxony

▶ V2X communication, roadside units, C-ITS facilities

▶ Traffic detection, information and management

▶ Information and navigation applications

▶ Data/semantic technologies for mobility services

▶ Mobile apps; applications for frontend, backend, cloud

▶ Fare-based solutions for conventional, electronic and mobile ticketing

PKM Product Modules:
First Application in Railway Traffic

STRATEGY
AND OPTIMIZATION

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In 2020, the general population as well as public offices and relief organizations were faced with so far unknown and complex challenges caused by the COVID-19 pandemic, for which there are no standard solutions. Since the very beginning of the pandemic, Fraunhofer IVI has given practical support by developing new system components.

Answering a request from the Team Saxony command and situation center – a joint initiative of the Saxon chapters of DRK (German Red Cross), Malteser Hilfsdienst, Johanniter, ASB (Workers' Samaritan Federation) and DLRG (German Lifesaving Association) – Fraunhofer IVI has developed a novel MobiKat® component that is able to coordinate the work of over 3000 individuals. The system allows optimal combination of all incoming data. This way, support was provided for operational decision-making and subsequent messages to affected persons, volunteers and staff concerning order generation, notification, status tracking, etc. were automatically generated and sent.

In addition, the autonomous mobile cameras developed at Fraunhofer IVI, whose primary area of application is flood protection, were quickly modified to suit the new demands and put into operation right at the pandemic's beginning.

Initially, they were used to monitor high-risk material and medication storage facilities (masks, disinfectants, protective gear).

Thanks to the extremely positive experience gained in this area, the cameras later successfully helped monitor the compliance with rules of distance and hygiene in public areas.

The lockdown's unusual framework conditions also called for the ad-hoc development of new methods for the distribution of forces and resources. For the optimized scheduling of patrol cars for the protection of objects closed down or exposed due to COVID-19 and spread over a large area, new processes and algorithms were designed in a short time span and evaluated together with users in the police force.

Within the scope of the Fraunhofer MobiKat®-Pan project, all MobiKat® modules were successfully improved to suit the new demands made by the pandemic. New functions were provided for practical use within short development and testing cycles.

Thanks to the close and trusting cooperation with decision-makers and operative staff, all solutions were continuously adapted to the dynamically progressing demands and quickly applied to tackle the pandemic effectively.

RANGE OF SERVICES

▶ Operational command systems for firefighters, emergency service providers, civil protection services and police

▶ Analyses for the planning of fire safety requirements and rescue service zones, as well as site optimization

▶ Evaluation of manufacturing processes with the help of AI methods

▶ Big/smart data-based data mining and machine learning

▶ Integrated cargo space and production planning

▶ Predictive analysis/condition-based maintenance planning

MobiKat®-Pan:
Emergency Aid for Pandemic Relief

CONNECTED MOBILITY AND INFRASTRUCTURE

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Roadside safety systems and high-performance Car2Infrastructure communications can make a valuable contribution to reducing the accident frequency at inner-city intersections. The so-called »smart intersection« is one of the three key topics within the Fraunhofer IoT-COMMs research cluster.

High-automation transport systems and connected traffic participants, as well as associated questions of increased traffic safety, resource efficiency and utilization of existing transport infrastructures, are synonyms for processes of profound change in the field of mobility.

Due to the fact that only parts of the cognition and active chains are covered by the individual perspective of one vehicle, relying on this one perspective is not considered sufficiently safe for automated and connected driving in complex urban traffic scenarios that involve a high level of interaction with other traffic participants. With the help of a smart intersection, however, inner-city traffic can be observed and evaluated much better and faster.
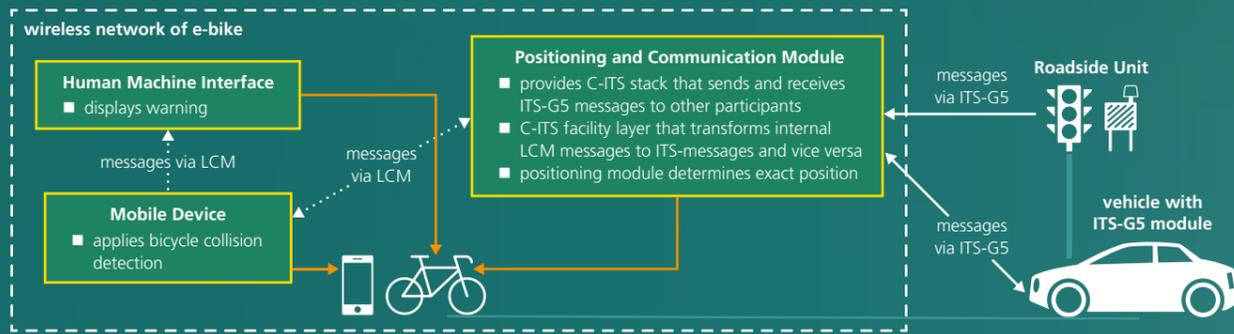
In close collaboration with the »Cognitive and Cooperative Systems« department, the Fraunhofer Application Center »Connected Mobility and Infrastructure« at TH Ingolstadt develops concepts that make traffic safer through infrastructure assistance and security systems.

The implementation of stationary sensors (such as cameras, radar, LiDAR) allows traffic monitoring at inner-city transportation hubs and in complex traffic situations. As a result, support can be provided for the traffic participants.

In addition, communication modules (Car2X roadside units) are installed in order to exchange relevant information – for example, dynamic object maps – between traffic and infrastructure. This assistance and protection improves the safety of the overall traffic system (e. g., for vulnerable road users, such as pedestrians and bicyclists), as well as transport efficiency.

The test beds required for highly automated and connected driving assisted by infrastructure are currently under construction. The Fraunhofer IVI test track in Dresden is available as a non-public traffic area. A public rotary traffic located within the Ingolstadt digital test bed is used for transferring testing scenarios to the complex public traffic area.

RANGE OF SERVICES

▶ Testing of connected automated driving

▶ Backend and cloud applications for cooperative systems

▶ Infrastructure sensors and assistance
▶ 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 & applications

▶ Traffic monitoring, management and control
▶ Sensor monitoring, malfunction detection as well as sensor re-calibration and control

Smart Intersection: Stationary Traffic Monitoring

1 *Structure of the overall system.*

DEVELOPMENT OF A COLLISION PREDICTION MODEL FOR BICYCLES

The results presented above were submitted as a Master Thesis to the Faculty of Mathematics and Computer Science at FSU Jena.

With special thanks to Dr. rer. nat. Frank Löffler, FSU Jena and Dipl-Ing. Wolfram Keil, Fraunhofer IVI.

Vehicle-to-everything (V2X) communications is currently focused exclusively on motorized vehicles. Including bicycles in connected traffic opens up new options for improving their safety. The aim of this master thesis was to develop and implement a V2X-based collision detection concept.

The basis for the investigations was the Fraunhofer IVI »Rad im Fokus« project (»Focus on Bikes«) funded by the European Regional Development Fund (ERDF) and the Free State of Saxony within the scope of the »Synchrone Mobilität 2023« research intiative (»Synchronized Mobility 2023«).

As a first step, six scenarios were defined that cover frequent accident types involving bicycles: collisions with car doors (dooring), intersections with poor visibility, crashes during right turns or lane changes of cars, as well as rear-impact collisions. For each scenario, a specific model was developed and methods for position estimation were applied. In order to determine the risk of a collision, the models process information from V2X messages, such as cooperative awareness messages (CAMs). CAMS can be sent by vehicles and contain, for example, their own current position, speed and direction of travel. In addition, OpenStreetMap data and historical accident data is used. The latter allows the issuing of alerts to bike riders about static danger points where increased numbers of bicycle accidents have occurred.

Implemented as a Java library and run on a mobile device, the software detects potential critical situations involving passenger cars. Incoming messages are viewed as events and collisions are represented by complex event patterns. The Siddhi complex event processing (CEP) engine processes steadily incoming data in real-time and detects complex event patterns. Siddhi is based on Siddhi Streaming SQL, a language similar to SQL that is able to receive, process and publish events. By implementing it into a simple Android application, the library developed in the scope of the thesis was tested in terms of its operability on mobile devices. During the evaluation phase, simulation data was used to validate the model for collision detection and to analyze its CPU load and memory usage on smartphones. It was possible to detect potential collisions especially of the dooring, right turn and poor visibility intersection scenarios reliably and at an early stage.

Within the »Rad im Fokus« project, a prototype of a communications-ready e-bike was built. It is equipped with communication and locating modules, as well as alert components such as vibrating handlebars. The prototype will be used to test both the collision model and the alerts system.

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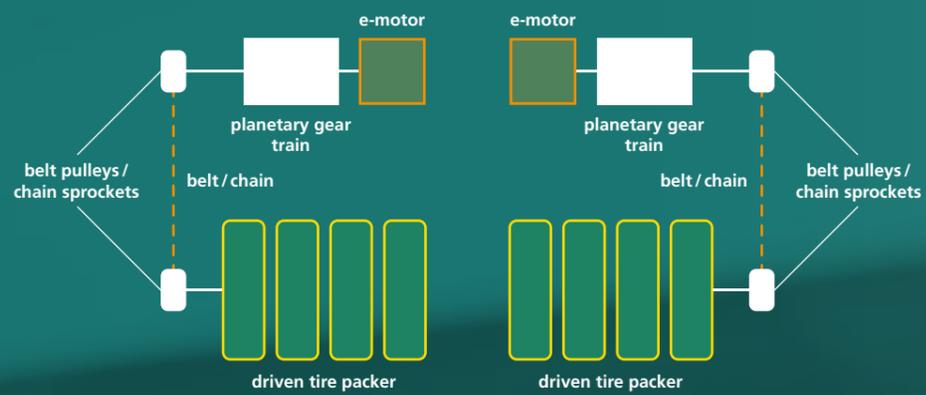
1 *Schematic of the drive concept including e-motors, planetary gear trains and belt transmission / roller chains.*

DESIGN OF A DRIVE SYSTEM FOR A PACKER ROLLER

Due to global population growth and the reduction of agricultural land thoughout the world, fields must be cultivated efficiently without causing any damages in the process. In the presented thesis, a drive system for a packer roller for electrically driven agricultural machines was designed that supports this aim.

Conventional rollers are pulled by agricultural machines. The presented packer roller, however, has its own drive system allowing improved soil cultivation. During the design phase, several variations of packer rollers were developed and investigated. The tire packer design, which consists of eight radial tires in total, proved to be especially well suited for the intended purpose. Proof of the prototype's functionality is obtained in the early stages of development by checking whether the agricultural machine is able to drive on asphalt surfaces without the help of additional wheels.

Figure 1 gives a schematic overview of the drive concept. The tire packer is driven by a combination of two electric motors, two planetary gear trains and two chain drives. Due to this power distribution, the packer roller can be divided into two symmetrical halves, making the design simpler and spreading the components' weight more evenly and symmetrically across the packer roller's length.

After the electric motors and the corresponding planetary gear trains were selected, a decision was made regarding an appropriate transmission system. In a direct comparison between belt transmission and roller chain, the latter emerged as a promising solution for power transmission from the planetary gear train to the tire packer. An important advantage of using roller chains in agricultural machines is their robustness against environmental influence, for example, humidity, high temperatures and dirt. In addition, a roller chain requires less space compared to a belt transmission of similar power specifications, which allows for a compact design and an increased effective length of the packer roller.

Afterwards, the drive system's remaining components were selected with the help of corresponding strength calculations. The concept's construction design was carried out in the CATIA V5 CAD system. A FEM analysis of the construction was then carried out based on the CATIA model in order to find the required dimensions of components. After defining the framework conditions and loads occurring in different load cases, the results were evaluated using von Mises equivalent stresses according to the maximum distortion criterion theory. The thesis' final results were incorporated in the production of a prototype of the agricultural machine.

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HIGHLIGHTS

January 23, 2020
At the TU Dresden **»Branchentreff Energy Management & Environmental Technologies«** event, Fraunhofer IVI presented their latest research topics and attractive job offers.

January 27, 2020
The **SteigtUM project** develops a rental service offering cargo bikes for the cost-efficient transport of luggage and goods. The kick-off took place at TU Bergakademie in Freiberg.

February 6, 2020
During his tour of the Lusatian Lake District, the Brandenburg Minister for Economic Affairs, Labour and Energy, Jörg Steinbach, also visited the **autartec® house** at Lake Bergheide.

June 30, 2020
Fraunhofer IVI's **»SE-Netz« system** is now being used by the Federal Criminal Police Office. The cooperation agreement was signed at the Saxon State Office of Criminal Investigation in Dresden.

August 20, 2020
The **Saxon State Minister for Regional Development**, Thomas Schmidt, acknowledged the autartec® house as an excellent contribution in tackling the current challenges in rural areas.

September 3, 2020
During the 5th **simul+ Future Forum**, institute director Prof. Dr. Matthias Klingner presented the autartec® house in front of a large audience.

September 25, 2020
The 7th **JUG Saxony Day** was held as an online conference. Fraunhofer IVI hosted one of the few Meet&Watch events and welcomed a small group of guests at the institute.

October 9, 2020
Head of Department Dr. Kamen Danowski and Michael Löst of the Saxon State Office of Criminal Investigation received the **Joseph von Fraunhofer Prize** at Fraunhofer's virtual Annual Meeting.

October 27, 2020
At the BMVI in Berlin, the **grant notification** for the KIVI project dealing with artificial intelligence in traffic was handed over. Fraunhofer IVI's application center participates in the project.

December 18, 2020
Federal Minister Andreas Scheuer handed over grant notifications for new research projects. Fraunhofer IVI will receive funding for the **ARCADIA study** and the **SAVeNoW project**.

TRADE FAIRS

DAK

DRESDEN COLLOQUIA ON AUTOMATION TECHNOLOGY

Supported by Fraunhofer IVI and several institutes of the Faculty of Electrical and Computer Engineering at TU Dresden, the Dresden Colloquia on Automation Technology (Dresdner Automatisierungstechnische Kolloquien – DAK) has established itself as a high-profile event series with an over 40-year tradition.

The wide range of topics offered covers the entire field of engineering and includes talks on fundamental control and systems theory, applied automation engineering, mechatronics, sensor development, microelectronics and interesting reports from practice-oriented projects.

Presentations held by renowned experts in the field are the main attraction of the regular events. They are usually accompanied by contributions from the organizing institutes, which underlines the importance of DAK as a specialist communication platform for university institutes, higher education institutions and vocational colleges, non-university research institutes, as well as engineering firms and regional industry.

Datenbasierte Regelung mit Garantien
January 13, 2020
Thomas Beckers, M. Sc.,
Technical University Munich (Germany),
Department of Electrical and Computer Engineering,
Chair of Information-oriented Control

Model-Based Development – The Prosperous Life, Evolution & Impact of a Diesel Engine Model
January 20, 2020
Prof. Lars Eriksson,
Linköping University (Sweden),
Department of Electrical Engineering,
Chair of Vehicular Systems

11th GPEC® – General Police Equipment Exhibition & Conference, Frankfurt/Main
February 18-20, 2020
Presentation of systems for operational command and communication for police and task forces in the following areas:

– Reconnaissance and situation assessment,
– Operative and tactical command,
– Evaluation and documentation of missions, as well as
– Strategic analyses and planning.

System functions include, among others, mission-internal exchange of message including photos, videos and audio recordings, file transfer, file storage, situation visualization on digital maps, as well as AR for orientation purposes.

19th FLORIAN – Trade fair for Fire Brigades, Civil Protection and Disaster Control 2020, Dresden
*October 8-10, 2020*
Demonstration of the modular MobiKat® system for firefighting and presentation of its newest components:

– Expansion of application range to include Apple devices,
– Redesigned master data portal with the option of representing individual organizational structures within the master data portal.

In addition to the command and documentation of operations, MobiKat® supports complex analyses on the compliance with legal help periods, as well as the development of concepts for the planning of fire safety requirements and rescue service zones.

LIFE AT WORK AND BEYOND
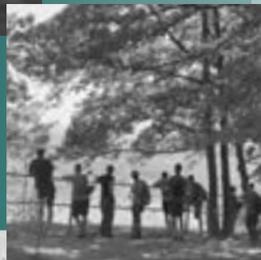
Events taking place away from the desks, conference rooms and laboratories have always been a vital part of the working life at Fraunhofer IVI. At these occasions, all employees can come together on an informal basis and take the opportunity to exchange ideas, celebrate traditions and seasonal highlights together or join one of the offers promoting physical and mental health – all of which enable them to think beyond their everyday work routines. These events make working at Fraunhofer IVI so attractive and help raise the level of everyone's satisfaction.

But how can life at the institute be kept up like this in times of social distancing, canceled events and joint activities being reduced to a minimum? 2020, the year of the coronavirus pandemic, has presented enormous challenges to the entire world and therefore also to Fraunhofer IVI.

The staff was forced to learn how to transfer their working routines into the digital world. Thanks to the excellent availability of technical equipment, the tireless effort of the IT department as well as the individual commitment of each and every colleague, the employees managed to successfully work on their projects from home and prevent their close collaboration from coming to a halt.

A lot of patience and good humor were helpful when having to deal with the additional burdens that have been caused by closed schools and daycare centers.

Before virtual kick-off meetings, homeschooling tasks have been quickly corrected, important calls were made on benches beside playgrounds and toddlers popping up in front of cameras have been cheering up weekly team meetings. All these scenes belong to a novel everyday working routine, which will certainly stick around for most of 2021.

Despite all the restrictions throughout the past year, it was still possible to realize a few events before and during the pandemic – then, of course, with the necessary distance and face masks. Before the first lockdown, the popular holiday week was held at the institute in February, offering experiments, fun and games for schoolchildren in grades 1 to 4. After many other events had been cancelled, the staff was also looking forward to the annual fall excursion. This time, it was carried out twice in order to give everyone the chance to take part in the light of the current restrictions. The Pillnitz castle park and the hiking trail leading to the historical Meixmühle mill offered enough space and fresh air so that this traditional event could take place and the corona rules of conduct were abided by.
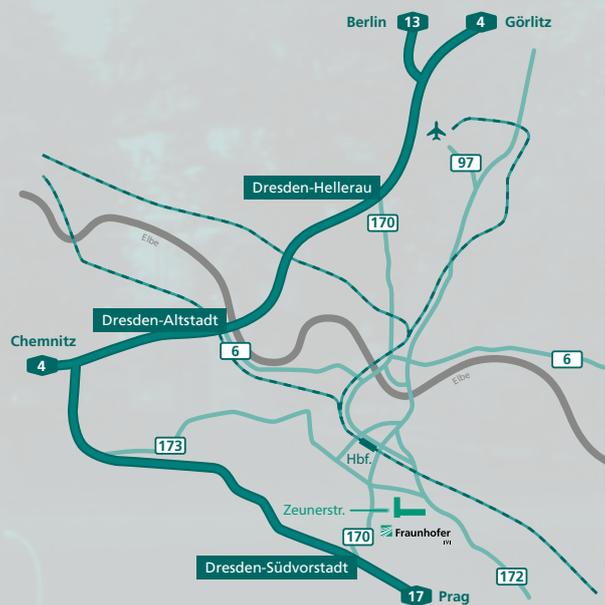
All colleagues are now hoping for a speedy success in fighting the pandemic. Every employee – anywhere at Fraunhofer – is playing their part in this fight with great effort.

HOW TO REACH US

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ACADEMIC OUTPUT

PUBLICATIONS

ARTICLES AND PRESENTATIONS

Bhogaraju, S. K.; Conti, F.; Elger, G.: **Copper Die Bonding Using Copper Formate Based Pastes with α-Terpineol, Amino-2-Propanol and Hexylamine as Binders.** IEEE 8th Electronics System-Integration Technology Conference ESTC, virtual conference, September 15-18, 2020, presentation G. Elger
In: Conference Proceedings. Piscataway, NJ, USA, IEEE, 2020, 7 pp.,
ISBN: 978-1-7281-6293-5, DOI: 10.1109/ESTC48849.2020.9229801

Bhogaraju, S. K.; Conti, F.; Kotadia, H. R.; Keim, S.; Tetzlaff, U.; Elger, G.: **Novel Approach to Copper Sintering Using Surface Enhanced Brass Micro Flakes for Microelectronics Packaging.**
In: Journal of Alloys and Compounds, vol. 844, 2020, Elsevier, 6 pp., ISSN: 0925-8388,
DOI: 10.1016/j.jallcom.2020.156043

Bhogaraju, S. K.; Conti, F.; Schmid, M.; Meier, M. R.; Schweigart, H.; Elger, G.: **Development of Sinter Paste with Surface Modified Copper Alloy Particles for Die-Attach Bonding.**
In: Proceedings of 11th International Conference on Integrated Power Electronics Systems CIPS. Berlin, VDE Verlag, 2020, p. 582-587, ISBN: 978-3-8007-5225-6

Bhogaraju, S. K.; Mokhtari, O.; Conti, F.; Elger, G.: **Die-Attach Bonding for High Temperature Applications Using Thermal Decomposition of Copper(II) Formate with Polyethylene Glycol.**
In: Scripta Materialia, vol.182, 2020, p. 74-80, Elsevier, ISSN: 1359-6462,
DOI: 10.1016/j.scriptamat.2020.02.045

Borgdorf, H.-J.; Burgmann, S.; Steinert, F.; Lenz, F.; Perbandt, M.; Steinert, J.; Strehl, M.: **Berufskraftfahrer Lkw / Omnibus. Lehrbuch und Nachschlagewerk.** Munich, Germany, Heinrich Vogel, 2020, ISBN: 978-3-574-60334-1

Consilvio, A.; Sanetti, P.; Crovetto, C.; Papa, F.; Dambra, C.; Jimenez-Redondo, N.; Kandler, U.: **Validation of Data Analytics and Optimization Algorithms within an Intelligent Asset Management System for Rail Signaling.**
In: Ingegneria Ferroviaria, vol. 75, issue 7-8, 2020, Rome, Italy, Collegio Ingegneri Ferroviari Italiani CIFI, p. 525-548, ISSN: 0020-0956

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Conti, F.; Bhogaraju, S. K.; Wunderle, B.; Liu, E.; Elger, G.: **Finite Element Simulations and Raman Measurements to Investigate Thermomechanical Stress in Semiconductors.** IEEE 8th Electronics System-Integration Technology Conference ESTC 2020, virtual conference, September 15-18, 2020
In: Conference Proceedings. Piscataway, NJ, USA, IEEE, 2020, 7 pp.,
ISBN: 978-1-7281-6293-5, DOI: 10.1109/ESTC48849.2020.9229843

Da Rosa Zanatta, M.; da Costa, J. P. c.l.; Antreich, F.; Haardt, M.; Elger, G.; de Mendonca, F. L. L.; de Sousa, R. T.: **Tensor-Based Framework with Model Order Selection and High Accuracy Factor Decomposition for Time-Delay Estimation in Dynamic Multipath Scenarios.**
In: IEEE Access, vol. 8, 2020, Piscataway, NJ, USA, IEEE, p. 174931-174942,
ISSN: 2169-3536, DOI: 10.1109/ACCESS.2020.3024597

Delooz, Q.; Riebl, R.; Festag, A.; Vinel, A.: **Design and Performance of Congestion-Aware Collective Perception.** IEEE Vehicular Networking Conference VNC 2020, virtual conference, December 16-18, 2020
In: Conference Proceedings. Piscataway, NJ, USA, IEEE, 2020, 8 pp.,
ISBN: 978-1-7281-9221-5, DOI: 10.1109/VNC51378.2020.9318335

Delooz, Q.; Festag, A.; Vinel, A.: **Revisiting Message Generation Strategies for Collective Perception in Connected and Automated Driving.** 9th International Conference on Advances in Vehicular Systems, Technologies and Applications VEHICULAR, virtual conference, Porto, Portugal, October 18-22, 2020
In: Conference Proceedings. Suzuki, A.; He, Y.; Thulasiraman, P. (eds.), Wilmington, DE, USA, IARIA, 2020, p. 46-52, ISBN: 978-1-61208-795-5

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In: Conference Proceedings. VDE/VDI-GMM; DVS (eds.), Berlin, Germany, VDE Verlag, 2020, p. 301-308, ISBN: 978-3-8007-5185-3

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Festag, A.: **V2X Communication for ML-based Autonomous Driving.** ACM MobiHoc Workshop on »Cooperative Data Dissemination in Future Vehicular Networks« D2VNet 2020, virtual conference, Oktober 11, 2020

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Hegde, A.; Festag, A.: **Artery-C: An OMNeT++ Based Discrete Event Simulation Framework for Cellular V2X.** 23rd Annual International Conference on Modeling, Analysis and Simulation of Wireless and Mobile Systems MSWiM 2020, virtual conference, November 16-20, 2020
In: Conference Proceedings. New York, NY, USA, Association for Computing Machinery, 2020, p. 47-51, ISBN: 978-1-4503-8117-8, DOI: 10.1145/3416010.3423240

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Keim, S.; Tetzlaff, U.; Elger, G.: **The Influence of Different-Sized Ni Micro-and Nanopowders on the Processing and Microstructural Properties of Sn-Ag-Cu-Solder with Low Ag Content.** IEEE 70th Electronic Components and Technology Conference ECTC, virtual conference, June 3-30, 2020
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Keppler, F.; Wagner, S.: **Prioritized Multi-Robot Velocity Planning for Trajectory Coordination of Arbitrarily Complex Vehicle Structures.** IEEE/SICE International Symposium on System Integration SII, Honolulu, HI, USA, January 12-15, 2020, presentation: F. Keppler
In: Conference Proceedings. Piscataway, NJ, USA, IEEE, 2020, p. 1075-1080,
ISBN: 978-1-7281-6667-4, DOI: 10.1109/SII46433.2020.9026256

Keppler, F.; Wagner, S.; Janschek, K.: **SAFESTOP: Disturbance Handling in Prioritized Multi-Robot Trajectory Planning.** 4th IEEE International Conference on Robotic Computing IRC 2020, virtual conference, November 9-11, 2020, presentation: F. Keppler
In: Conference Proceedings. Piscataway, NJ, USA, IEEE, 2020, p. 226-231,
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In: Conference Proceedings. Piscataway, NJ, USA, IEEE, p. 2081-2086,
ISBN: 978-1-7281-5414-5, DOI: 10.1109/IECON43393.2020.9254336

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Klingner, M.: **Mobilität trotz(t) Wende.** Metzler meets Fraunhofer Mobilitätskonzepte der Zukunft«, Frankfurt/Main, Germany, February 5, 2020

Klingner, M.; Sähn, E.: **Mit Umweltzonen und Dieselfahrverboten in eine elektromobile Zukunft?** 11. Internationales AVL Forum Abgas- und Partikel-emissionen, Ludwigsburg, Germany, March 3-4, 2020, presentation: M. Klingner

Klöppel-Gersdorf, M.; Grimm, J.: **Evaluating Suitable Glosa-Algorithms by Simulation Considering Realistic Traffic Conditions and V2X-Communication.**
In: Transport and Telecommunication Journal, vol. 21, 2020, issue 4, Sciendo, p. 303-310, ISSN: 1407-6179, DOI: 10.2478/ttj-2020-0025

Klöppel-Gersdorf, M.; Otto, T.: **Linked Real and Virtual Test Environment for Distributed C-ITS-Applications.** 6th International Conference on Vehicle Technology and Intelligent Transport Systems VEHITS 2020, virtual conference, May 2-4, 2020, presentation: M. Klöppel-Gersdorf
In: Conference Proceedings. Berns, K.; Helfert, M.; Gusikhin, O. (eds.), ScitePress, 2020, p. 377-384, ISBN: 978-989-758-419-0, DOI: 10.5220/0009426003770384

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In: Conference Proceedings. Piscataway, NJ, USA, IEEE, 2020, p. 489-494,
ISBN: 978-1-7281-9809-5, DOI: 10.1109/ICSTCC50638.2020.9259658

Kraaijenhagen, B.; van der Zweep, C.; Wittig, H. et al.: **AEROFLEX – AEROdynamic and FLEXible Trucks, Rethinking Long Distance Transport.**
Published online: https://aeroflex-project.eu/

Kratzing, R.: **Battery Diagnosis Based on Field Data.** The Battery Conference 2020, hybrid conference, Seoul, Korea, October 21-23, 2020

Kühlmorgen, S.; Lu, H.; Festag, A.; Kenney, J.; Gemsheim, S.; Fettweis, G.: **Evaluation of Congestion-Enabled Forwarding with Mixed Data Traffic in Vehicular Communications.**
In: IEEE Transactions on Intelligent Transportation Systems, vol. 21, 2020, issue 1, Piscataway, NJ, USA, IEEE, p. 233-247, ISSN: 1558-0016, DOI: 10.1109/TITS.2018.2890619

Kühn, S.; Pandey, A.; Zippelius, A.; Schneider, K.; Erdogan, H.; Elger, G.: **Analysis of Package Design of Optic Modules for Automotive Cameras to Realize Reliable Image Sharpness.** IEEE 8th Electronics System-Integration Technology Conference ESTC 2020, virtual conference, September 15-18, 2020
In: Conference Proceedings. Piscataway, NJ, USA, IEEE, 2020, 6 pp.,
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Liu, E.; Conti, F.; Bhogaraju, S. K.; Signorini, R.; Pedron, D.; Wunderle, B.; Elger, G.: **Analysis of Thermomechanical Stress in GaN LEDs Soldered on Cu Substrate by Finite Element Method and RAMAN Spectroscopy.**
In: Journal of Raman Spectroscopy, vol. 51, 2020, issue 10, John Wiley & Sons, p. 2083-2094, ISSN: 1097-4555, DOI: 10.1002/jrs.5947

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Nitzsche, G.; Wagner, S.; Belov, N.; Viol Barbosa, C. E.: **AutoTruck and helyOS: Enabling Highly Efficient Yard Operation by Automation.**
Published online: http://publica.fraunhofer.de/dokumente/N-581119.html

Osten, J.; Weyers, C.; Petereit, J.: **Modular and Scalable Automation for Field Robots.** 78th International Conference on Agricultural Engineering LAND.TECHNIK 2020, virtual conference, November 3-4, 2020
In: Conference Proceedings. Düsseldorf, Germany, VDI-Verlag, 2020, VDI-Berichte 2374, p. 227-232, ISBN 978-3-18-092374-1

Pandey, A.; Kühn, S.; Erdogan, H.; Schneider, K.; Elger, G.: **Finite Element Analysis: A Tool for Investigation of Sharpness Changes in Automotive Cameras.** 21st International Conference on Thermal, Mechanical and Multi-Physics Simulation and Experiments in Microelectronics and Microsystems EuroSimE, virtual conference, July 5-8, 2020
In: Conference Proceedings. Piscataway, NJ, USA, IEEE, 2020, 7 pp., ISBN: 978-1-7281-6049-8, DOI: 10.1109/EuroSimE48426.2020.9152716

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Published online: https://www.mobility-data-space.de/

Pretzsch, S.: **Connecting Data Platforms: The Mobility Data Space Approach for Smart Mobility Applications.** Open Data for Smart Mobility in Europe 2020, virtual conference, November 17, 2020

Pretzsch, S.: **The Mobility Data Space Approach for Smart Mobility Applications.** Tag der Datenökosysteme, virtual conference, November 26, 2020

Randhahn, A.; Knote, T.: **Deployment of Charging Infrastructure for Battery Electric Buses.**
In: Towards User-Centric Transport in Europe 2. Enablers of Inclusive, Seamless and Sustainable Mobility. Müller, B.; Meyer, G. (eds.), Cham, Springer, 2020, p. 169-183, ISBN 978-3-030-38028-1, DOI: 10.1007/978-3-030-38028-1_12

Schmid, M.; Bhogaraju, S. K.; Liu, E.; Elger,G.: **Comparison of Nondestructive Testing Methods for Solder, Sinter, and Adhesive Interconnects in Power and Opto-Electronics.**
In: Applied Sciences, vol. 10, 2020, issue 23, Basel, Switzerland, MDPI, 19 pp., ISSN: 2076-3417, DOI: 10.3390/app10238516

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In: IEEE Transactions on Instrumentation and Measurement, vol. 70, 2020, Piscataway, NJ, IEEE, 9 pp., ISSN: 1557-9662, DOI: 10.1109/TIM.2020.3011818

Schmid, M.; Bhogaraju, S. K.; Riedel, A.; Elger, G.: **Development of an In-Line Capable Transient Thermal Analysis Equipment for a Power Module with Five Half Bridges.** 26th IEEE International Workshop on Thermal Investigations of ICs and Systems THERMINIC, virtual conference, September 14 - October 9, 2020

Senel, N.; Festag, A.; Elger, G.: **Sensor Time Synchronization in Smart Road Infrastructure.**
In: *Conference Proceedings. FISITA Web Congress. FISITA, 2020, 7 pp.*

Shi, E.; Gasser, T.; Seeck, A.; Auerswald, R.: **The Principles of Operation Framework: A Comprehensive Classification Concept for Automated Driving Functions.**
In: SAE International Journal of Connected and Automated Vehicles, vol. 3, 2020, issue 1, SAE International, p. 27-37, ISSN 2574-0741, DOI: 10.4271/12-03-01-0003

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Urban, M.; Erbsmehl, C.; Mallada, J. L.; Puente Guillen, P.; Tanigushi, S.: **A Methodology for Building Simulation Files from Police Recorded Accident Data (For ADAS Effectiveness Assessment).**
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Wittig, H.; Engasser, J.; Mentink, P.; Andelko, G.; Bertens, T.: **AEROFLEX Smart Power Dolly: Towards Efficient and Mission-oriented Long-haul Vehicles.**
Published online: http://publica.fraunhofer.de/dokumente/N-581118.html

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In: Conference Proceedings. Piscataway, NJ, USA, IEEE, 2020, 8 pp., ISBN: 978-1-7281-6049-8, DOI: 10.1109/EuroSimE48426.2020.9152657

TEACHING ENGAGEMENTS

Bartholomäus, Ralf
Optimale Steuerung kontinuierlicher Prozesse. TU Dresden, Faculty of Electrical and Computer Engineering, Institute of Control Theory, SS 2020

Robuste Regelung. TU Dresden, Faculty of Electrical and Computer Engineering, Institute of Control Theory, SS 2020

Vernetzte Energiespeicher. TU Bergakademie Freiberg, Faculty of Mechanical, Process and Energy Engineering, Institute of Electrical Engineering, SS 2019

Elger, Gordon
Elektronische Bauelemente. TH Ingolstadt, Faculty of Electrical Engineering and Information Technology, Bachelor Program »Elektromobilität«, WS 2019/20, WS 2020/21

Computer Aided Engineering. TH Ingolstadt, Faculty of Electrical Engineering and Information Technology, Master Program »International Automotive Engineering«, SS 2020

Produktion und Prozesse. TH Ingolstadt, Faculty of Electrical Engineering and Information Technology, Bachelor Program »Mechatronik«, WS 2019/20, WS 2020/21

Digitale Signalverarbeitung (Praktikum). TH Ingolstadt, Faculty of Electrical Engineering and Information Technology, Bachelor Program »Mechatronik«, SS 2020

Festag, Andreas
Einführung in die Car2X Kommunikation. TH Ingolstadt, Faculty of Electrical Engineering and Information Technology, SS 2020

Projektmanagement. TH Ingolstadt, Faculty of Electrical Engineering and Information Technology, WS 2020/21

Car2X Kommunikation. TH Ingolstadt, Faculty of Electrical Engineering and Information Technology, WS 2019/20, WS 2020/21

Software-Entwicklung für sicherheitskritische Systeme. TH Ingolstadt, Faculty of Electrical Engineering and Information Technology, WS 2019/20, WS 2020/21

Group project (Master Automatisiertes Fahren). TH Ingolstadt, Faculty of Electrical Engineering and Information Technology, WS 2019/20, WS 2020/21

Kertzscher, Jana
Berechnung elektrischer Maschinen. TU Bergakademie Freiberg, Faculty of Mechanical, Process and Energy Engineering, Institute of Electrical Engineering, SS 2020

Einführung in die Elektrotechnik. TU Bergakademie Freiberg, Faculty of Mechanical, Process and Energy Engineering, Institute of Electrical Engineering, WS 2019/20, WS 2020/21

Elektrische Energiewandler. TU Bergakademie Freiberg, Faculty of Mechanical, Process and Energy Engineering, Institute of Electrical Engineering, SS 2020

Elektrische Maschinen und Antriebe. TU Bergakademie Freiberg, Faculty of Mechanical, Process and Energy Engineering, Institute of Electrical Engineering, WS 2019/20, WS 2020/21

Einführung in die Elektromobilität. TU Bergakademie Freiberg, Faculty of Mechanical, Process and Energy Engineering, Institute of Electrical Engineering, WS 2019/20, WS 2020/21

Energietechnik (lecture series). TU Bergakademie Freiberg, Faculty of Mechanical, Process and Energy Engineering, Institute of Electrical Engineering, WS 2019/20, WS 2020/21

Grundlagen der Elektrotechnik. TU Bergakademie Freiberg, Faculty of Mechanical, Process and Energy Engineering, Institute of Electrical Engineering, SS 2020

Regelung elektrischer Antriebe I. TU Bergakademie Freiberg, Faculty of Mechanical, Process and Energy Engineering, Institute of Electrical Engineering, SS 2020

Regelung elektrischer Antriebe II. TU Bergakademie Freiberg, Faculty of Mechanical, Process and Energy Engineering, Institute of Electrical Engineering, WS 2019/20, WS 2020/21

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FINAL THESES

DIPLOMA STUDENTS

Ali, Jamal
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Egbert, Jörn
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Kruse, Georg
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Yu, Chunhai
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Zhou, Xiongzun
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Augustin, Beatrix
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Breitlauch, Pascal
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Hilse, Vanessa
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Jäkel, Annika
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Kast, Emily
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Kelemen, Valerie
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Pandey, Amit
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Streller, Martin
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Sunderam, Mohan
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Bahre, Maikel
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Gardke, Jonas
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Brausewetter, Patrick
– JUG Saxony e. V.

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– IRTAD International Road Traffic Accident Database Group

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– IMAPS International Microelectronics and Packaging Society

Erbsmehl, Christian T.
– EVU European Association for Accident Research and Analysis e. V.
– SafeTRANS e. V.

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

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

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Knote, Thoralf
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Klingner, Matthias
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