

# Annual Report 2021

Institut für Unternehmenskybernetik e. V.  
(Institute for Business Cybernetics)



Institut für  
Unternehmenskybernetik

an der RWTH Aachen



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# Preface

Dear readers,

A second year under Corona conditions is coming to an end. Despite all challenges, this situation has also opened up a great opportunity for us: We were able to show again that a highly committed team with a shared vision and the ambition to make the best out of every situation can achieve a great deal -- despite constantly changing conditions for research and creative collaboration.

We are supported in our work by our Board of Trustees, which we newly elected this year. New exciting personalities complement our dedicated trustees. All are enthusiastic about our research mission in the areas of business & social cybernetics and mobile robotics, and we thus very much look forward to rich discussions and idea-filled sessions.

This year, we made plenty of use of hybrid presentation opportunities to showcase IfU's expertise in cybernetics. Two out of many highlights were the DigiSummit, where we were able to demonstrate our strength in shaping systemic innovation behaviors, and the Aachen Machine Tool Colloquium (AWK), where our experts from the Mobile Robotics department demonstrated what today already is possible.

More than today, however, tomorrow is in the focus of our interest. With the successful acquisition of the new AiF projects we can continue the cooperation with our long-standing partners IMA and ITA at RWTH Aachen University. In the RaCPro project (Robot-Assisted Composite PROduction), we are supporting the development of a mobile cobot for robot-assisted draping of fiber composite components. In intelli.line (Reinforcement Learning in Continuous Production Processes using High Modulus Fiber Tape Manufacturing), we develop robust and adaptive control strategies for the tape manufacturing of the future using Deep Reinforcement Learning methods.

Curiosity about projects like these and our knowledge that we can make the world better in little steps remain our strongest incentives in the upcoming year. And we are especially looking forward to the intensive exchange with **you!** Research is particularly fruitful (and fun) when it addresses concrete problems. We would like to devote our energy and enthusiasm to this task again in 2022. So, please contact us if you have any ideas for new, joint projects at IfU!

We are looking forward to an eventful and successful year 2022 together! Cybernetic greetings, *your IfU team*



Dr. rer. pol.  
Kathleen Diener



Christian Gülpen



Prof. Dr. rer. pol.  
Frank T. Piller

# Publicly Funded Research

„Cybernetics is the science of the effective organization.“  
(Stafford Beer, Neuropsychologist)



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# DigiKomp-Ambulant

## Shaping the future of healthcare together



Dr. rer. pol.  
Kathleen Diener

Alexander Redlich,  
M.Sc.



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an der RWTH Aachen

The care sector is facing major challenges in view of the increase in the number of people in need of care, an above-average level of sick leave among employees and an increasing shortage of skilled workers. Physical and mental stress as well as insufficient job satisfaction also have a negative impact on caregivers' ability to work and remain in their profession long-term. Recently, this situation has been further aggravated by the Covid-19 pandemic. In order to secure the future of care in various care settings in Germany, innovative technical solutions should therefore help to maintain the independence, self-determination and quality of life of those in need of care, as well as support and relieve the burden on care professionals or caregivers, as well as family caring for their relatives.

The DigiKomp-Ambulant project, which started in July 2019, aims to develop new user-friendly solutions in close cooperation between developers and users and to enable needs-based support for outpatient care through innovative technology solutions. The starting point is the development of sensor technology that records the data (vital and movement data, etc.) considered essential by those in need of care, their relatives, the nursing staff and the doctors providing care. New networking software provides the basis for making important information available to caregivers even when they are not on site. In this way, the outpatient care workers can acquire competencies for dealing confidently with people and technology: they are better prepared, can carry out upcoming activities in a targeted manner and are in contact with all those involved. This leaves more time for communication and relationship building through personal conversations. In this user-centered technology development process, IfU is particularly responsible for evaluating technology acceptance and user experience.

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Project partners: St. Gereon, Franziskusheim, HTV Security GmbH, MA&T



Project sponsor: IfU, nexus ag, KIT



Funding: BMBF, ESF, EU, Zusammen. Zukunft. Gestalten.



# UrbANT

## An Urban, Automated, User-Oriented Transportation Platform



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Many distances in cities can be covered comfortably by bicycle, on foot and by public transport. However, if large or heavy goods have to be transported, a car often seems indispensable.

The BMBF-funded joint project UrbANT - Urban, Automated, User-Oriented Transport Platform aims to develop, manufacture and test an individual, electrically powered micro-mobility vehicle that allows pedestrians in particular to carry heavy and large-volume goods safely and comfortably. On the one hand, the micro-mobility vehicle will be able to follow the user automatically, but it will also offer the potential for fully automated use without a human operator.

Within the project, the IfU is developing and integrating a follow-up function and the autonomous navigation of the mobile in urban environments. By means of the following function to be developed, the micromobile is to be enabled to automatically follow a user (e.g., carry shopping home) and actively avoid surrounding traffic. With the autonomous navigation function, the Urbant mobile will be able to cover distances automatically without a user. In doing so, it will completely register its surroundings through the sensor technology used and can thus, for example, perceive obstacles such as people and avoid them.

Website : [www.urbant.de/de](http://www.urbant.de/de)

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Project partners: DITF, BE POWER, BAsT, easy2cool, Ford, IfU, ika, im, iTec, neomesh



Project sponsor: VDIVDE-IT



Funding: BMBF



# VerTex 4.0

## Textile Industry 4.0 - Networking of textile process chains



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Dennis Kreuzer,  
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Jan Bitter,  
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Textile process chains - especially across company boundaries - are characterized by a high degree of fragmentation. A (digital) information flow between sub-processes, machines and locations exists only in the rarest of cases. In order to sustainably increase efficiency, the Institute of Textile Technology (ITA), the IMA of both RWTH Aachen University and the IfU are developing an Industry 4.0-based technology transfer concept for the networking of textile process chains as part of the VerTex 4.0 project. This would overcome one of the major current obstacles in the German textile industry.

In most cases, machines from different manufacturers are used in different production processes at distributed locations in the textile industry. This makes the flow of information across the process chain much more difficult. This challenge increases the more actors are involved in these processes. A look at the German textile and clothing industry shows that about 1,200 mainly medium-sized companies are active in different product segments. A large part of the production costs are incurred by resources such as material, energy or personnel. Due to rejects, complaints, wasted energy and inefficient use of labor, German companies lose several million euros every year.

The solution focused on in VerTex 4.0 lies in the networking of textile process chains across machines and locations. The goal is to increase production efficiency in the textile sub-processes on the basis of demand-oriented networking of the information flow between these processes. Demand-driven refers to the accuracy and relevance (quality) of the information that can be extracted using intelligent methods and used for optimization, e.g. with regard to energy consumption. This reduces the probability of errors and thus the costs of downstream processes. The project results ultimately lead to a technology transfer concept that can ultimately be applied not only in textile process chains but also in other industries.

Website : [www.cybernetics-lab.de/projekte/vertex-4-0](http://www.cybernetics-lab.de/projekte/vertex-4-0)

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Project partners: IfU, IMA, ITA

Funding: AiF, IGF, BMWi



# DemoSens

## Robotic disassembly of EV batteries for high-quality recycling



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During the DemoSens project, the recycling of lithium-ion batteries from electric vehicles (hereafter LIB) is to be digitalized and automated along the entire process chain from disassembly to sorting to mechanical processing. Up to now, the disassembly of LIBs is carried out manually and with a low disassembly depth (e. g. removal of the cable harness). Battery modules and cells that have been exposed and crushed for material separation are then processed using classic separation methods such as sifting and screening. In the DemoSens project an automated disassembly with the help of robots and sensor-based mechanical processing will be carried out for the first time. For this purpose, an iterative and mutual adjustment of the process steps disassembly and mechanical treatment will take place.

Within the DemoSens project, IfU e.V. contributes its expertise in the areas of machine learning and adaptive robotic systems. Here, it is focused on the sub-project of developing, testing and implementing machine learning methods for the automated disassembly of EV battery systems by self-learning robotic systems. The research approach pursues the goal of automating different degrees of complexity in disassembly using robotic systems that are capable of learning, while also ensuring transferability to different EV battery systems. The research topics addressed here include the use of deep learning for semantic segmentation of battery components, automated grasping point recognition, and the use of reinforcement learning to learn motion strategies for individual disassembly steps.

Website: <https://www.greenbatt-cluster.de/en/projects/demosens/>

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Project partners: FH Münster, IfU, IME, IWARU, PEM



FH MÜNSTER  
University of Applied Sciences



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IME  
METALLURGIEN | RWTH AACHEN  
UNIVERSITY



IWARU Institute for  
Infrastructure - Water -  
Resources - Environment



RWTH AACHEN  
UNIVERSITY

Project sponsor: PTJ



Projektträger Jülich  
Forschungszentrum Jülich

Funding: BMBF



Forschungsnetzwerk  
Mittelstand

IGF  
Industrielle  
Gemeinschaftsforschung



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## The IfU supports the OecherLab as an associated partner in VR development and science communication in the field of autonomous robot systems.

The OecherLab is a space for participation. Here, the citizens of Aachen, as well as the business community and city administration, can come up with innovative ideas, visions, goals and projects for the development of a smart city strategy and participate in workshops or directly in the exhibition.

As an associated partner, the IfU is involved in making the research results of the "UrbANT" project tangible to the city's citizens.

For this purpose, VR glasses are exhibited in the "OecherLab", in which the Kapuziner-Karree in Aachen can be experienced interactively with several "UrbANT" vehicles driving around. Here, if interested, further information about the project can be conveyed and a feeling for how robot technology can integrate into our environment and help with tasks of everyday life can be created. For this purpose, 3D models of the vehicle were provided by the project partner, the Institute for Motor Vehicles (ika). Based on photographs and basic sections, the Kapuziner-Karree was modeled in virtual reality. Both elements were merged into a 3D world using the game engine Unity.



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Project partners: Stadt Aachen, cowork AG, Dialego AG, Lehrstuhl Informationsmanagement im Maschinenbau der RWTH

Funding: Land NRW

## Peer-to-Peer-Exchange of digital competencies between companies in the Aachen region



Dr. rer. pol.  
Kathleen Diener

Alexander Redlich,  
M.Sc.



The networking of companies, processes, knowledge and competences are crucial components for a successful digital transformation. In the StädteRegion Aachen, there is currently no formally regulated inter- and transdisciplinary knowledge exchange between companies, start-ups and institutions that makes it possible to share relevant experiences and promote digital skills among employees. This is where the joint project "PaiRS" comes in with the development of a pairing recommendation system.

The exchange of competences between companies, start-ups and employees in the Aachen city region in the field of digitalization is promoted with a digitalization platform. The integrated recommendation system determines the digitization needs of employees and, based on this, brings them together with employees from other companies who have precisely the competences, experience and knowledge of digitization that the person seeking help is looking for. This drives the P2P exchange of employees from different companies and promotes learning opportunities for digitization projects. The personal, low-threshold exchange of experiences enables employees to overcome their fears and reservations about digitalization. In order to reward companies for making their own individual competences and experiences available to other members, an incentive and reward system is implemented in the PaiRS platform. Both sides benefit from the cooperation and expansion of their digital competences and knowledge.

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Project partners: DigitalHUB Aachen, Informatik 5 RWTH Aachen, IfU



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Funding: BMWi, Unternehmen Revier



Bundesministerium  
für Wirtschaft  
und Energie



Unternehmen  
Revier

# PaiRS

# CCI Safe AGV Crossing



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## Integration of infrastructure sensors for safe crossing with AGVs

In intralogistics, the use of automated guided vehicles (AGVs) is increasing. The floor-bound conveyors automatically move the goods to be conveyed from the start of the order to the destination. For this purpose, the vehicles use the walkways/corridors of the industrial halls that already exist in the infrastructure. The paths continue to be shared with manually guided forklifts and people. Intersections of the corridors can become danger spots in this case. This is due to visibility restrictions for humans and machines caused by walls, welding curtains or other objects, which prevent a direct view of approaching objects.

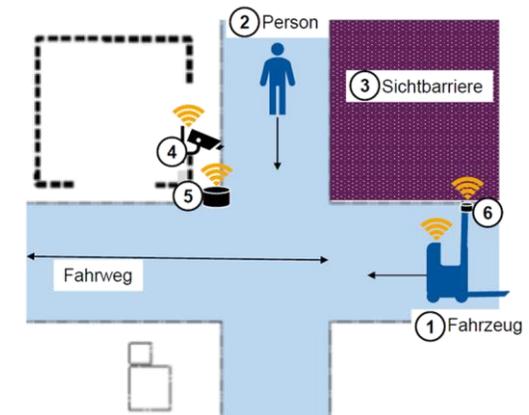
In the "CCI Safe AGV Crossing" project, this problem is to be solved by attaching sensors to crossings. The sensors, in the form of laser scanners and time-of-flight (TOF) cameras, track objects approaching the intersection and determine whether a collision will occur. The AGV receives the braking command via radio link in a dangerous situation or an optimized trajectory with which it does not brake to a standstill in order to ensure a continuous flow of traffic.

The IfU developed the collision prediction and the optimal braking trajectory to reduce the speed of the AGV as energy-efficiently as possible.

Website: <https://connectedindustry.net/angebot/innovationsprojekte/agv-safe-crossing/>

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Project partners: Center Connected Industries (CCI) - EICe Aachen GmbH



Picture: Center Connected Industry

# FLAIR Hong Kong

## Flexible Assembly Line with Collaborative Robotics and Flexible Semi-Automation



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The goal of this project is to develop a robotic demonstrator for the automation of food handling in ready-to-eat food production exploring advanced vision, machine learning and motion planning methods

The work will be performed across the Hong Kong Industrial Artificial Intelligence & Robotics Centre (FLAIR), the Center Connected Industries (RWTH Aachen Campus) and the IfU in order to effectively use the competences of the partners involved to solve the object of investigation as well as to promote the transfer of know-how between the institutes

The proposed approach for performing pick-and-place of food components comprises the object detection and segmentation, the grasp point detection, the motion planning and the evaluation and selection of flexible and food-grade grippers.

As a first use case, it is focused on the pick-and-place of raw meat pieces from a storage container onto an oven tray (see figure to the right). The long-term goal in the project is the handling of various food components.

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**Project partners:** Center Connected Industries (CCI), Hong Kong Industrial Artificial Intelligence & Robotics Centre (FLAIR)

### Hardware:

#### Robotic Arm

- Execution of movement
- UR 5 Robotic arm



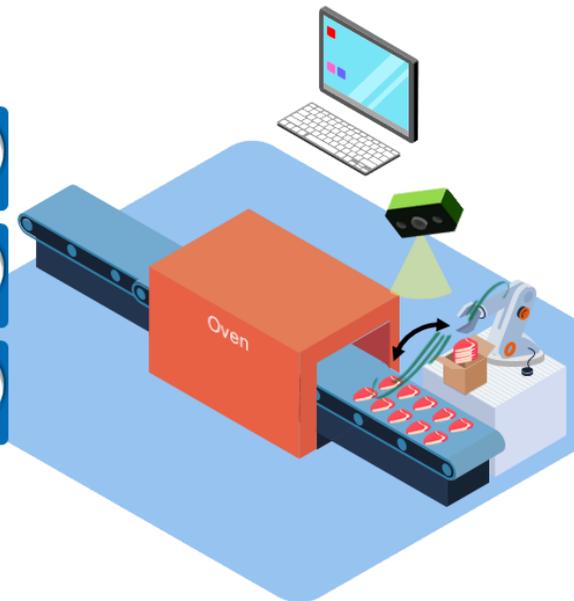
#### Gripper / End effector

- Gripping of meat
- Soft gripper



#### Computer Vision Camera

- Detecting meat
- Depth camera



### Software:



#### Segmentation Meat

- Finding instances of meat
- Conventional methods + information fusion



#### Determination of Grasping Points

- Define grasp points
- Calculate centroid of meat, consider gripper geometry



#### Robot Motion Planning

- Define goal and derive trajectory
- Motion Planning Pipeline and Planner



#### User Interface

- Monitor and control process
- Development based on common UI framework

In corporation with:



CENTER  
CONNECTED  
INDUSTRY



# Events

„The fundamental principle of cybernetic thinking is the idea of circularity.“  
(Heinz von Förster, electrical engineer)



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# MediaPsych Conference 2021



This year we were invited at the MediaPsych conference by our new board member Prof. Dr. rer. nat. Astrid Rosenthal-von der Pütten with our Oscars and were allowed to present our mobile service robots to the scientists.

## Low-Cost Service Robots in the field of Social Robotics

From 08-10.09.2021 the MediaPsych2021 conference took place at the RWTH Aachen University. At the invitation of Professor Astrid Rosenthal-von der Pütten, IfU also participated: Since the focus of the conference this year was on human-machine and human-agent interaction, two of our service robots - the Oscars - visited the event and met interested participants.

Especially in the field of social robotics, scientists often rely on low-cost hardware to perform human-robot interaction studies. The Oscars are such a system and can display emotions by means of an integrated display. At the conference, they moved freely in the room and autonomously avoided people.



Christoph Henke,  
M.Sc.

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"Co-Operate or Die" the motto of the Digital Summit in Aachen

## Co-creation as a success factor: Why we can only master the innovation challenges of the future together

Together with Carolin Häussler, professor at the University of Passau, Frank Piller and Kathleen Diener we did not only present the advantages of cooperation at the Digital Summit, but also the necessity of it in order to meet future challenges.

Innovation means goal-oriented problem solving. The more different actors are involved in the process, the more successful this becomes. In particular, external stakeholders such as customers, users, etc. can make a valuable contribution.

The event was a great hybrid event with lively discussion both on site in the DigiChurch and digitally on the web. Around 1,000 registered participants followed the IfU's impulse at the event, as well as presentations by Minister of State Dorothea Baer, NRW Economics Minister Pinkwart, and applied philosopher Richard David Precht.



Photographie [www.Thomas-Langens.de](http://www.Thomas-Langens.de)



Dr. rer. pol.  
Kathleen Diener

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# Care+Mobility Innovation Conference



At the Care+Mobility Innovation Conference on the 28<sup>th</sup> of September 2021, digital solutions for the two lead markets Digital Health Industry and Intelligent Mobility were presented and further developed. As IfU, we were represented here several times. In addition to other exciting contributions, Dr. Kathleen Diener gave a keynote speech on the topic of "Better together than alone: Combining potentials to shape the future".

In addition, the IfU received the Innovation Partnership Award for the project idea "Park4Care" on behalf of the joint cooperation with the IMA and St. Gereon gGmbH. The core idea of the concept is to enable intelligent short-term parking for service providers in the healthcare sector in the Aachen region. Finally, we participated in workshops on the topics of "Green Mobility", "Tele Care" and "Home Care" and took home many inspiring ideas for future projects.

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Pictures und Graphics: Care and Mobility ([careandmobility.de](http://careandmobility.de))



## Impulsvortrag Frau Dr. Kathleen Diener

„Besser gemeinsam als einsam: Potentiale kombinieren um die Zukunft zu gestalten“



## Bekanntgabe der Innovationspartnerschaften

aus der ersten Bewerbungsphase



Dr. rer. pol.  
Kathleen Diener



Alexander Redlich,  
M.Sc.

At the joint booth in the Cybernetics Lab network between the Machine Tool Laboratory WZL of the RWTH Aachen University, the Institute for Information Management in Mechanical Engineering of the RWTH Aachen University and IfU, we presented mobile and autonomous robot systems to enthusiastic participants

## Mobile Robots in the Assembly

The Aachen Machine Tool Colloquium (AWK) is both a network meeting and an information hub. Participants from a wide range of disciplines traditionally exchange ideas on the production of tomorrow every three years in Aachen. In 2021, the event and trade fair took place in Aachen for the 30th time and opened its doors at the Aachen Eurogress to around 1,400 specialists and managers from various branches of industry. This year the event was held under the motto: Internet of Production - Turning Data into Sustainability.

Against this background, we are even more pleased to be part of the Cybernetics Lab's joint booth and to be able to exchange ideas with the audience in interesting technical discussions about the use of autonomous robot systems in tomorrow's production and assembly.

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Christoph Henke,  
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# Open and User Innovation Konferenz



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The IfU hosts the international conference in Aachen together with the RWTH Institute for Technology and Innovation Management

The central role of customers and users as initiators and contributors in the innovation process was first postulated by MIT professor Eric von Hippel (1978) with the so-called "customer-active paradigm". The contribution of users includes independent development activities that often result in highly innovative solutions. Of particular importance is the fact that users not only create solutions for their own use, but also pass them on to third parties, usually free of charge. Such innovation behavior differs significantly from the behavior within the framework of the traditional supplier-driven innovation paradigm.



An interdisciplinary research community has formed around Eric von Hippel, the Open and User Innovation Society, with the common interest of integrating the phenomenon of user innovation into the classical innovation literature. Researchers from various disciplines (e.g. innovation management, strategic management, organizational design, marketing, intellectual property rights management, entrepreneurship and public policy) meet annually to share current research findings and plans related to open and user innovation. Due to the ongoing challenges posed by the Covid 19 pandemic, OUI2021 was held virtually streamed from Aachen, Germany. A total of 332 people attended the virtual OUI.

There were six tracks with five parallel sessions each. 113 scientists presented their work. As expected, the discourse was very open and development-oriented. In addition, we offered interactive workshops on specific topics to specifically explore new questions and OUI application areas such as: OUI in Times of Crisis | Power of Communities: From Open Sustainability to #RunTheWorld.

The tracks were flanked by keynote speeches on current OUI topics in the plenary. The keynote address was given by Eric von Hippel. In another plenary session, leading OUI researchers were asked about current trends and fields for impact research. From this, a future OUI research agenda emerged in joint discussion with the conference topics.

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Dr. rer. pol.  
Kathleen Diener

# Scientific Transfer

„Cybernetics is the epistemology, which deals with the generation of knowledge through communication.“  
(Gordon Pask, psychologist)



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an der RWTH Aachen





Tobias Müller,  
M.Sc.

## Robotics workshops for citizens

Science communication for citizens of the city of Aachen using mobile autonomous service robots

Robots to touch, experience and steer by yourself. This is the core motto of the OecherLab's robotics workshop, where interested citizens can slip into the shoes of robot experts for an afternoon. The robotics workshop teaches the basics of mobile autonomous robotics using the example of Oscar the mobile service robot, IfU's specially developed learning platform. In an interactive course, the institute's scientists teach the history of robotics and the basics of robot programming. Participants learn, how a robot perceives the world and can experience robotics up close on a real system. The IfU provides an understanding of today's challenges in the development of autonomous delivery robots and automated driving and helps citizens who have often had no contact with the subject to make robotics more tangible and understandable for themselves.



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Project Partners: Stadt Aachen, cowork AG, Dialego AG,

Lehrstuhl Informationsmanagement im Maschinenbau der RWTH

Funding: Land NRW



Science communication is a key instrument for getting future generations excited about scientific work. In this context, we participate on a voluntary basis in the BMBF-funded research exchange.

## Science communication on robotics and AI in schools

The online platform *Forschungsbörse* brings science and schools together in the classroom: Whether for STEM subjects such as biology, mathematics and physics, or for philosophy, German and politics lessons, teachers can use the research exchange to find around 770 researchers from all over Germany, whom they can select and invite for their lessons according to region, subject and school subject. All experts participate on a voluntary basis. The research exchange was launched in 2010 by the German Federal Ministry of Education and Research (BMBF) as part of the Science Years.

This year, as part of the research exchange, we visited the Gymnasium Norf in Neuss. As part of the scientific colloquium held at the high school, we were able to present current research topics in the field of autonomous robotics and AI to the students of the upper school. The lecture conveyed to the students not only current research results from our laboratories, but also the basics of self-learning systems and AI. For example, it led them through the Turing Test and the first efforts of the Dartmouth Summer Research Project on artificial intelligence, into the properties of autonomous systems for decision making and Deep Learning and its structures.

In the subsequent discussion round, the students were able to ask numerous questions and also share and discuss their own experiences, such as with voice assistants or vacuum cleaner robots.

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Christoph Henke,  
M.Sc.

The Institut für Unternehmenskybernetik e.V. participates in the teaching program of the RWTH Aachen University by offering the lecture Robotics and Multiagent Systems in the course Cybernetics for Engineers I. Here we teach students the basics of distributed artificial intelligence and robotics.

## Cybernetics for Engineers I - Robotics and Multiagent Systems

Located in the bachelor program of mechanical engineering and industrial engineering at RWTH Aachen University and lead-managed by the Chair of Information Management in Mechanical Engineering (IMA), the lecture "Cybernetics for Engineers I" imparts knowledge in general, biological and technical cybernetics. In addition to the theoretical input through exciting lectures around topics such as bionics, neuroscience or artificial intelligence, the students also apply the methods learned to current research topics and develop holistic approaches to solutions in teamwork.

Within the lecture Robotics and Multiagent Systems, students are taught the properties and dynamics as well as models of distributed artificial intelligence, starting from bionics to swarm intelligence. Based on the example of the Sense-Think-Act cycle, a structural introduction of autonomous robot systems is given. In this context, autonomous systems perceive their environment on the basis of sensor systems, transfer these into an environment representation suitable for decision-making and derive decisions from this (e.g., control commands for actuators). The lecture leads through the basics of state estimation, heterogeneous sensor systems and robot kinematics, as well as environment mapping and path planning.

Based on this, the presentation topic on Deep Reinforcement Learning was carried out. Deep Reinforcement Learning combines the principle of reinforcement learning with the possibilities of Artificial Neural Networks to learn complex tasks efficiently. The focus is on the generalizability of the systems in order to be able to transfer previously learned knowledge to new observations. The goal of the project was to work out the challenges and limitations of Deep Reinforcement Learning regarding stability and convergence of the methods as well as complexity and data efficiency.

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*Practical example of 3D  
environment mapping  
using low-cost hardware.*



Christoph Henke,  
M.Sc.

# Guest Lecture - Open Source Robotics

Within the lecture "Principles of Management" IfU contributed a guest lecture on Open Source in Robotics. The goal was to give the students an insight into the development of autonomous robot systems using the example of the UrbANT project and the Robot Operating System.

## Open source communities as a new form of organization

The lecture Fundamentals of Management (formerly: Introduction into Business Administration) provides an overview of basic models, theories and principles of business administration. It has been successfully completed by over 10,000 students at RWTH Aachen University to date. The course starts with the questions why companies exist and what is the core of entrepreneurial value creation. It then analyzes what alternatives and theories there are for organizing companies. A focus on the new institutional economics allows an insight into one of the approaches that has decisively shaped modern management. The last two parts deal with principles of operational and strategic planning as well as competitive strategies.

The pandemic-induced switch to digital teaching provided the opportunity to include exciting guest lecturers in each hour. This included Christoph Henke from IfU on the topic of "Open Source" as an alternative form of organization. Within the guest lecture, open source communities were presented using the Robot Operating System as an example. The students were able to gain insight into the development of autonomous robot systems as well as the advantages of using open source code and working in open source communities. The Robot Operating System (ROS) is an open source software framework that provides the basic functionalities of autonomous robot systems (e.g. inter-process communication) and is developed by a large community, which in turn makes autonomy components (e.g. mapping or path planning algorithms) available to the community as open source code. This can significantly accelerate the development of autonomous systems, as it can draw on the existing knowledge base and thus save developers a lot of time, which was demonstrated in particular by the example of the development of an autonomous delivery robot in the UrbANT project.

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# ROS



Dr. rer. pol. Frank  
T. Piller

Christoph Henke,  
M.Sc.

# The People Behind IfU

„Cybernetics is the epistemology, which deals with the generation of knowledge through communication.“  
(Gordon Pask, psychologist)



Institut für  
Unternehmenskybernetik

an der RWTH Aachen



# Board of Directors & Scientific Management



The Executive Board of the IfU steers the work of the Institute in close consultation with the Scientific Board of Trustees and the Management the work of the Institute. It is responsible for the affairs of the association and is elected every three years at the general meeting.



Prof. Dr. rer. nat. Sabina Jeschke

**Chairwoman of the Board**  
Former CTO,  
Deutsche Bahn AG



Dipl.-Ing. Michael Bernas

**Member of the Board**  
Head of Research Production Systems,  
Festo AG & Co. KG, Esslingen



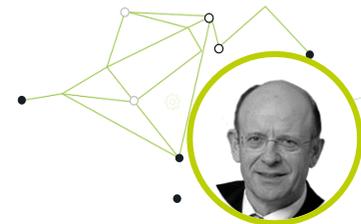
Dr.-Ing. Christian Jacobi

**Member of the Board**  
Managing Director of Agiplan GmbH,  
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Prof. Dr. rer. pol. Frank Piller

**Scientific Manager and  
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Professor and Co-Director,  
Institute for Technology and  
Innovation Management  
RWTH Aachen University



Prof. Dr.-Ing. em. Klaus Henning

**Member of the Board**  
Senior Partner at  
umlaut transformation GmbH

# The IfU Board of Trustees

The members have elected their new IfU Board of Trustees. The Board of Trustees supports the scientific work of the IfU, especially in the areas of enterprise cybernetics and mobile robotics.



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Maren Bennewitz



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der Pütten



Robert Schmitt



Karl Schultheis



Markus Schwaninger



Jean Severijns



René Vossen  
Chairman

# New Staff



Christina Ionescu



since March 2021



Research Associate at the IfU in Mobile Robotics

09/2020-03/2021



Research Assistant at the IfU in Mobile Robotics

08/2020



Master Automation Technology, RWTH Aachen  
Focus on Control Engineering

2016



Bachelor Mechanical Engineering, FH Koblenz

Christian Gülpen



since August 2021



Managing Director at the IfU GmbH

04/2016-today



Managing Director and Board Member, InTIME e.V. Industry transfer company

01/2014-today



Division Manager Digitalization/Industry 4.0 at the RWTH Aachen TIM

01/2010-today



Member of the RWTH Aachen TIM

Alexander Redlich



since September 2021



Research Associate at the IfU in economic and social cybernetics; PhD candidate at TIM RWTH Aachen

02/2020-07/2021



Consultant, P3 Automotive GmbH Wolfsburg

08/2020



M.Sc. in Management, ESCP Europe Paris  
Focus on Innovation Management

08/2017



B.Sc. Business Administration, University of Mannheim

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