Munich University
of Applied
Sciences

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IAMLIS

Institute for Applications of Machine Learning and Intelligent Systems

Content

Greeting

The Institute for Applications of Machine Learning and Intelligent Systems (IAMLIS) was officially founded in October 2020. The current seven members from four departments can point to a very long track record in application-oriented research at several universities. Today the arduous development of a body work has paid off!

The research landscape at Munich University of Applied Sciences is undergoing an enormous period of upheaval and change. Triggered by the new Higher Education Innovation Act of the Bavarian State Government, the university is developing a significantly sharpened research profile. The research institutes and the newly created research professorships make up it's new face and create even more opportunities to intensify research at our university.

Our motto can be reduced to a common denominator: Educate students academically, intensify applied research and offer technology transfer into the region. And all this in a highly innovative artificial intelligence environment.

We are looking forward to the exciting time ahead of us and the cooperation with students as well as partners from science and industry.

Profile

IAMLIS founding team (from left): Andreas Schmitt, Peter Krzystek, Alfred Schöttl, Peter Mandl, Lars Wischhof
Photo: Johannes Lesser

We combine methodological and technical expertise from several areas of applied AI research.
In all application areas, the focus is on building up skills in the field of artificial intelligence, with a focus on AI solutions that bring significant benefits to the digitized society and industry.

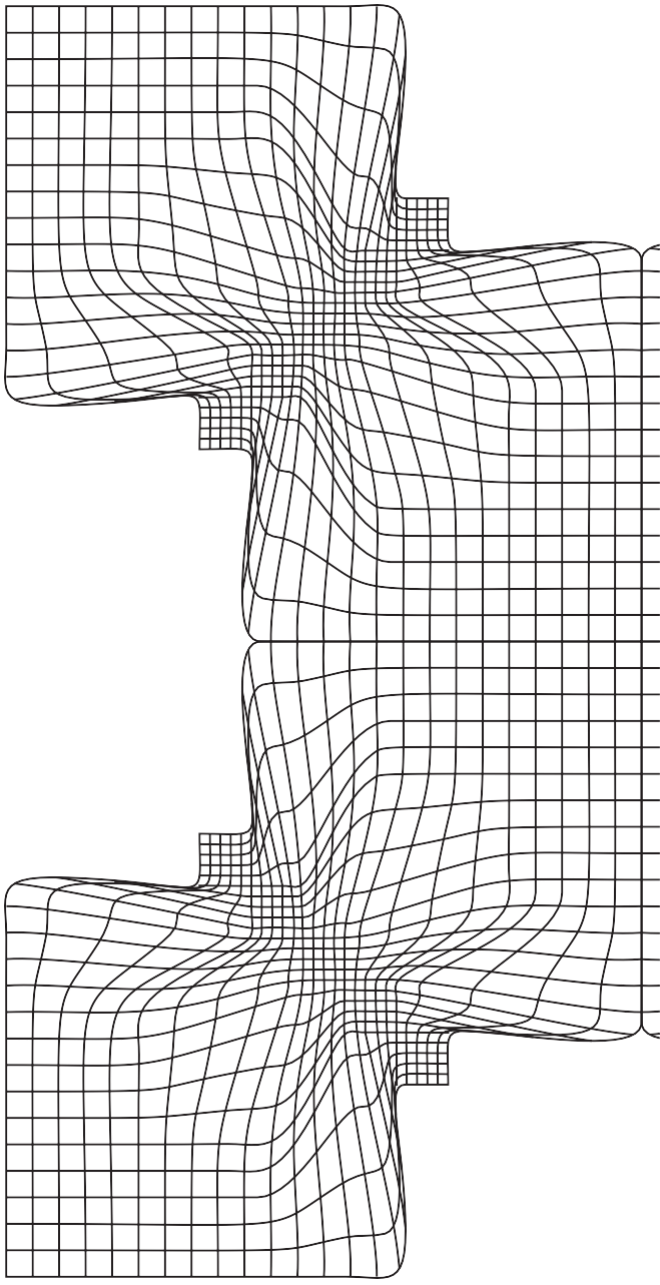
IAMLIS is dedicated to application-oriented research topics in the areas of machine learning and intelligent systems. Strategic goals include the applying research results into practice, increasing third-party funding, qualifying doctoral students, promoting young scientists by integrating students into research projects that funnel results directly back into the classroom.

IAMLIS provides a platform for the integration of teaching, research and practice and focuses on technology transfer in the region and throughout Germany.

Artificial intelligence and in particular machine learning in connection with computer vision/image processing, soft computing, discrete statistics, parameter estimation and navigation currently form the common core of our research activities in the IAMLIS research group - across depantment lines.

The research institute focuses on novel intelligent and adaptive systems for cooperations, administration and industry, but also for start-ups. By combining research in machine learning, common modeling and development methods as well as technology sets are used.

Image Analysis
Computer Vision
Autonomous Systems
Connected Mobility
Remote Sensing
Virtual/Augmented Reality
Distributed Cognitive Computing
Decision Support
Text-/Data-Mining



focused on supporting novel application possibilities and also to explore new intelligent applications.

The various fields of application including image analysis, computer vision, autonomous systems, connected mobility, natural language sensing, remote sensing, virtual reality, decision support in numerous applications such as text mining and data mining already result in an immense range of noteworthy cooperation opportunities. Relevant complex processes are being pursued to the point of concrete implementation in order to be able to make them available to industrial interests in a usable form, in contrast to the basic research of universities. We analyze extensive structured and unstructured data sets by means of clustering and classification with the goal of multi-level decision making in the context of dynamic systems. We research networked intelligent transport systems as well as new solutions in robotics (e.g. assistance robots) and in decision support for complex problems. Furthermore, we use remote sensing data to investigate vegetation structures in the forestry sector and disaster damage.

Portraits

Prof. Dr.-Ing. Peter Krzystek Head of IAMLIS

Research areas:

Remote Sensing Machine Learning Computer Vision Analysis of forest structures

Contact

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089-1265-2617

Peter Krzystek studied geodesy at the University of Stuttgart. After working in software development for ten years, he took over a professorship at the department of Geoinformation in 1998, teaching photogrammetry, remote sensing and image processing. There he leads the course of studies Geoinformatics and Navigation as well as the laboratory for photogrammetry and remote sensing. He teaches within the Bachelor and Master programs for Computer Vision, Advanced Remote Sensing Methods and UAV Photogrammetry and Laser Scanning.

He conducts research in the fields of computer vision, remote sensing, machine learning and airborne laser scanning. The long-term cooperation with the Bavarian Forest National Park aroused his interest in the analysis of forest structures using airborne laser scanning data. Within the framework of several research projects and cooperative doctoral theses, his research team developed new methods for single tree segregation, tree species classification and the detection of lying and standing deadwood. These methods are already ready for practical use and were recently applied in a large-scale project. Furthermore, he is working on UAV-based geodata acquisition methods using lidar and optical sensors. His new research interests are in the area of deep learning to increase the accuracy of forest inventory methods.

Peter Krzystek is involved in the M:University project, in which research personalities from the University of Munich cooperate with partners from science, business, society and politics in order to expand regional networking and networking structures. At the German Society for Photogrammetry, Remote Sensing and Geoinformation Science he heads the working group Forestry and Agriculture. With the foundation of the institute IAMLIS he changed to a research professorship. Peter Krzystek is a founding member of IAMLIS.

Prof. Dr.-Ing. Peter Mandl
Deputy Head of IAMLIS

Research areas:

Distributed systems
Services for intelligent Decision Support Machine Learning
Text mining
Distributed transaction and consensus protocols

Contact

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089-1265-3704

Peter Mandl studied computer science in Regensburg and Dresden and received his doctorate from the TU Dresden on distributed transaction systems. He has been working at the University of Munich since 2002, where he is a professor specializing in distributed systems. Peter Mandl has been a member of the Gesellschaft für Informatik (GI) since 1985 and has been the spokesperson of the Competence Center for Business Informatics (CCWI) at Munich University of Applied Sciences since 2005. He is responsible for the research area "Applied Informatics/Distributed & Cognitive Computing". Peter Mandl's core competencies lie in the area of distributed systems development. His research focuses on intelligent services and platforms, especially on the Internet for decision support in various use cases. With his research team he works on the development of similarity metrics and algorithms. For, among other things, detecting hate speech in web content, matching web pages, classifying legacy software, and efficiently mining social media channels. Further competencies are in the areas of middleware, distributed transaction protocols and consensus protocols.

Peter Mandl was and is an examiner and supervisor in several doctoral procedures and a member of several promotions committees. He supervised about 300 theses and led several research projects. He is active as a reviewer for scientific publishers and journals and has contributed to more than 50 scholarly articles. In addition, Peter Mandl wrote several textbooks (Distributed Operational Information Systems, Fundamentals of Data Communication, Fundamentals of Operating Systems, TCP and UDP Internals, Internet Internals). Furthermore, together with Prof. Nischwitz, he has been organizing and chairing the CC-Partner Symposium (CCPAF) at the Munich University of Applied Sciences for many years. He is also an honorary member of the advisory board of the Business Information Technology (Bachelor/Master) course at Münster University of Applied Sciences. In his part-time job, he supported the management of a Munich software company for many years. Peter Mandl is a founding member of IAMLIS.

Prof. Dr.-Ing. Andreas Schmitt

Research Areas:

Remote Sensing
Geostatistics Data
Fusion Time Series
Analysis
Automatic image interpretation

Contact

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089-1265-2416

Andreas Schmitt studied geodesy and geoinformatics at the University of Karlsruhe (TH) from 2002 to 2008. For his outstanding studies he was awarded the Tulla Medal 2008 of the department BauGeoUmwelt. The topic of his thesis was the "Development of a method for the automatic extraction of flat surfaces from terrestrial laser scanner data". The study was published in the journal "Photogrammetrie, Fernerkundung, Geoinformation" (PFG) and awarded the Hansa-Luftbild-Preis 2010.

From 2008 to 2011, he was a doctoral student at the German Aerospace Center (DLR) in Oberpfaffenhofen. For his dissertation entitled "Change detection in multitemporal and multipolarized radar images", the Karlsruhe Institute of Technology (KIT) awarded him a doctorate. From 2011 to 2016, he was a postdoc at the Earth Observation Center (EOC) within DLR, where he was responsible for the implementation and further development of the radar system developed as part of his dissertation. The project was entrusted with the development of a MultiSAR processor for the processing of satellite images into Analysis Ready Data (ARD), which is indispensable for the use of modern, automatic interpretation processes from the field of artificial intelligence and machine learning.

In 2016, he was appointed Professor of Applied Geodesy at Munich University of Applied Sciences. In addition to his diverse teaching activities and his commitment as internationalisation and internship officer of the Faculty of Geoinformation, he is very active in research, since 2018 also with the support of a doctorand who, in collaboration with Prof. Mandl's team, has been developing their methodologies for the Analysis of messages in social networks in combination with aerial photographs to answer social questions in an urban context. Another doctoral student has been fusing images since the beginning of 2022 of forests from space with forest parameters from aerial surveys and thus complements the knowledge of Prof. Krzystek's research group with innovative data fusion approaches from their own research. For the bundling of ongoing joint research activities In cooperation with DLR, among others, in the form of internships and theses, he founded the Forschungs Forum as an exchange platform for students with an affinity for research as well as alumni of all four courses of study within the Faculty of Geoinformation. Andreas Schmitt is a founding member of IAMLIS and has held a research professorship since 2020.

Prof. Dr. habil. Alfred Schöttl

Research areas:

Autonomous Systems
Image Processing and Pattern Recognition

Contact

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089-1265-3480

Alfred Schöttl studied mathematics/computer science at the Technical University of Munich. After completing his studies, he obtained a doctorate in the field of reliability theory at the Institute of Applied Mathematics and Statistics at TUM and habilitated in the field of stochastic algorithms. He then went to the aerospace industry, where he spent 15 years developing autonomous systems in various projects, most recently as chief engineer and senior expert. His main fields of activity were GNC (steering, control and navigation), simulation, image processing and artificial intelligence.

In 2013, Alfred Schöttl accepted a professorship for Autonomous Systems in the field of Computer Engineering at the Faculty of Electrical Engineering and Information Technology at Munich University of Applied Sciences. He heads the Laboratory for Autonomous Systems as well as the Laboratory for Image Processing and Artificial Intelligence. His research interests include environment perception, path planning and localization of robotic systems with applications in automotive, industrial and assistance systems. From a methodological point of view, Deep Learning and classical nonlinear image processing and filtering methods are often used for various applications.

Current publicly funded projects under his leadership deal with the semantic control of a robotic arm for people with disabilities based on autonomous environment perception and the predictive maintenance of large industrial plants. Current projects in the context of company cooperations deal with the classification of acoustic signals, the non-linear filtering of sensor data and the highly dynamic tracking of image features for various applications.

Since 2014, Alfred Schöttl has built up a cycle of lectures on deep learning methods in bachelor's and master's programs, which teach current network structures and frameworks as well as image processing and computer vision, system theory and path planning of autonomous systems, and the deployment of models. Alfred Schöttl is a founding member of IAMLIS.

Prof. Dr. rer. nat. Alfred Nischwitz

Research areas:

Computer Graphics
Image Processing and
Machine Learning

Contact

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Alfred Nischwitz studied physics at the Technical University of Munich, where he received his doctorate for his work on pulse synchronization in neural networks. He then worked in the industry developing vision systems for driving simulators and headed a department for flight guidance and system simulation. Since 2002 he has been working at the Munich University of Applied Sciences, where he is a professor in the fields of computer graphics, image processing and machine learning. He has headed the Computer Graphics and Image Processing Laboratory since 2002. Alfred Nischwitz has been a member of the Gesellschaft für Informatik (GI) since 1985 and has been the spokesperson for the Competence Center Image Processing (CCBV) at Munich University of Applied Sciences since 2007. He is responsible for the specialization "Visual Computing and Machine Learning" in the master's program in computer science, which he played a major role in establishing in 2006. Between 2007 and 2010 he was Dean of Studies of the department of Computer Science and Mathematics and at the same time also spokesman of the Deans of Studies of the Munich University of Applied Sciences. In 2008, he received the "Prize for Outstanding Teaching" from the Bavarian State Ministry for Science and the Arts.

Alfred Nischwitz's core competencies lie in the area of "Visual Computing and Machine Learning". His research focuses on algorithms for real-time shadow generation in visual and infrared wavelength ranges, tracking and detection, as well as generative, discriminative and reinforcement deep learning. With his research team, which is funded by various companies, he is working on the development of Deep Learning algorithms. Algorithms for, among other things, reconstructing the direction of light from individual images, reconstructing text on medical prescriptions, and the interpretability of the decisions of these algorithms.

Alfred Nischwitz was and is an examiner and supervisor in several doctoral procedures and a member of corresponding doctoral committees.
He supervised about 200 theses and led several research projects. He is active as a reviewer for academic publishers and journals and has contributed to more than 35 scholarly articles. He has also written several textbooks (Computer Graphics, Image Processing, both in the 4th edition). Furthermore, together with Prof. Dr. Peter Mandl, he has been organizing and managing the CC-Partner Conference (CCPAF) at the Munich University of Applied Sciences for many years. In his part-time job, he has been supporting the development department of MBDA Deutschland GmbH in Schrobenhausen for more than 13 years. Subsidiary of Airbus and British Aerospace. Alfred Nischwitz is a member of IAMLIS.

Prof. Dr.-Ing. Lars Wischhof

Research areas:

Connected Mobility (mobile communication between pedestrians, vehicles and infrastructure)
Intelligent mobile communication and mobile applications

Contact

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Lars Wischhof researches in the field of mobile communication applications, in particular intelligent mobility based on a situation-related dissemination of information between pedestrians, vehicles and infrastructure. For this purpose his group is developing a freely available simulation and emulation system which combines motion models for pedestrians and vehicles with models for 5G mobile radio. In this way, the effectiveness of new procedures for informing, warning and guiding pedestrians and vehicles can be evaluated via the simulation of charactical mobility scenarios. A 4G/5G mobile radio test bed in the faculty's fully RF-shielded Mobile Communications Laboratory also allows the simulations to be compared with real life data.

Before his appointment at the Munich University of Applied Sciences as a professor with a focus on networks, protocols and services in the department of Computer Science and Mathematics, Lars Wischhof first studied technical computer science at the Technical University of Berlin and then earned his doctorate in the field of direct communication and networking of vehicles at the Technical University of Hamburg-Harburg. From there, he moved to the pre-development department for electronics at AUDI AG/Audi Electronics Venture GmbH, where he advanced the networks between vehicles and environments within the scope of several projects, helping to set up the Car-2-X Communication department and was in charge of pre-development until his move to the university.

As part of a current, multi-year publicly funded research project together with a local transport company and other colleagues from the department, he is investigating how to increase the performance of transport infrastructures through intelligent, robust networking of road users. A recently completed, industry-funded project together with a telecommunications provider investigated the effects of different transmission situations on the quality of service of applications on smartphones.
Two other projects in recent years, for example, evaluated direct communication between vehicles via WLAN-like radio standards and 4G-/5G mobile radio for an automobile manufacturer.
Lars Wischhof is author/co-author of more than 30 conference and journal papers and 10 national and international patents. He is an active member of the IEEE, ACM, VDE and the program committee of conferences and journals in this area (IEEE VTC, Int. OMNeT++ Workshop, IEEE Trans. on Wireless Comm.). Lars Wischhof is a founding member of IAMLIS.

Prof. Dr. Andreas Humpe

Research areas:

Remote Sensing
Virtual/Augmented Reality
Image Analysis

Contact

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089-1265-2112

Andreas Humpe holds three MSc degrees in Finance and Investment Management, Intelligent Systems and Robotics, and Advanced Manufacturing Systems. He also holds a PhD in Financial Econometrics and worked in the financial industry for over 15 years. Since 2017, he has held a professorship in the department of Tourism teaching Business Mathematics and Finance. As part of his teaching activities, he teaches the subjects of business mathematics, statistics, empirical research, data analytics, artificial intelligence and data mining in the bachelor's and master's programmes.

His research interests lie in the areas of remote sensing, virtual and augmented reality, and image analysis. A current project is concerned with the drone-based investigation of bridge damage. Here, for example, automated image analyses are used to detect cracks. Other research projects deal with sensor data and the prediction of air pollutants such as particulate matter or CO_2 emissions in urban areas by using machine learning methods or modeling. In the field of economics, research topics include demand modelling, macroeconomic capital market modelling and the empirical testing of technology acceptance models. In addition to classical statistical procedures, the field of Deep Learning and classification methods such as decision tree methods are used.

Andreas Humpe is an active peer reviewer for journals, has served as a doctoral reviewer and is currently supervising a doctoral thesis in the field of Smart City and Mobility. In recent years, he has been involved in more than 35 peer-reviewed journal publications in scientific journals. The Institute is also involved in a number of publications on environmental sciences, transportation, economics and finance, computer science and artificial intelligence. He was also involved in a project funded by the German Federal Ministry for the Environment, Nature Conservation and Nuclear Safety on consumer responses to climate change and air pollution in large cities. A current project funded by the Bavarian State Ministry of Health and Care in cooperation with the Technical University of Munich is concerned with systematically assessing the walkability/exercise-friendliness of selected urban districts in the state capital Munich from the perspective of children and young people. Andreas Humpe is a member of IAMLIS.

Employees

Autonomous systems, image processing and pattern recognition

Maximilian Hoh
Predictive maintenance of industrial plants

Henry Schaub
SmartManipulator: Improving the usability of a manipulator for disabled persons

Blockchain computing

Frank Geyer
Benchmarking of blockchain systems

Wilhelm Laschinger
Transaction Concepts in Blockchains

Computer graphics, image processing and machine learning

Tobias Höfer
Deep Learning

Markus Miller
Reconstructive methods based on artificial intelligence for environment modeling

Distributed and Cognitive Computing

Maximilian Also
pattern recognition in software projects

Alexander Döschl
Parallel distributed algorithms and distributed platforms

Martin Häusl Semantic Networks and Ontologies

Eshref Januzaj
Density-based distributed clustering

Max-Emanuel Keller
Autonomous Systems, Image Processing and Pattern Recognition

Jan Vellmer
Crawling and matching in web content

Manuel Weber Occupancy Estimation with Synthetic Environ- mental Data

Maximilian Baluff
Deep learning methods for audio cover detection

Mobile communication

Stefan Schuhbäck
Adaptive information dissemination for intelligent urban mobility

Photogrammetry and remote sensing

Sebastian Briechle
Application of Machine Learning for Detection

Sebastian Dersch
Machine Learning and Deep Learning for Vegetation Mapping

UlloaTorrealba Climate change, social change, demographic change and the unclouded view from space

Sarah Hauser
Spatial, spectral, polarimetric and temporal detection of forest stands from space

Mapping of disaster and risk areas

Octocopter with laser scanner and multispectral camera (Illustration: Norbert Molitor)

Background

On 26 April 1986, the most serious nuclear accident to date occurred at the Chernobyl nuclear power plant. The heavy contamination led to the complete evacuation of an area with a radius of about 30 kilometres. Sadly the pine forest around the power plant, which turned red due to the strong radioactive radiation, became famous going down in history as the "Red Forest".

In affected areas, the contaminated biomass and topsoil were buried in order to reduce the radioactive contamination by orders of magnitude. Since the responsible authorities in the former Soviet Union only documented the storage sites very superficially, there were no reliable maps for targeted disposal to date.

Targets

Currently, the buried inventory is being systematically investigated by the state-owned companies for radioactive waste management. The aim is not only to find the suspected or unknown old deposits, but also to map the biomass that has grown back.

Project name

Detection of radioactive waste deposits in the Chernobyl exclusion zone by means of drone-based laser scanning

Project Manager

Prof. Dr.-Ing. Peter Krzystek

Employees

Sebastian Briechle

In the search for radioactive deposits, drones and laser scanners are used to explore the old deposits in the Chernobyl exclusion zone.

Dr. Norbert Molitor (Pleiades - Independent Experts), who has been working as an expert in the exclusion zone for 20 years, estimates that it will take another 300 years until the currently dominant short-lived radioisotopes Cs-137 and Sr-90 have largely decayed.

Results to date

Some of the old deposits (graves and dumps) are clearly visible, but some are now under regrown trees and have sunk slightly in the centimetre and decimetre range after more than 30 years. For non-contact mapping, drone-based laser scanning, which partially penetrates the vegetation and "sees" the burial sites, is suitable. By registering the reflections and converting them into coordinates, a very dense three-dimensional point cloud is obtained, which contains all the information necessary for mapping the tree landscape and the graves. Prof. Krzystek notes, "Using modern machine learning and computer vision methods, we can recognize and classify individual forest objects. We create a virtual tree landscape in which the tree species and the tree volume are known. We even succeed in detecting standing and lying dead trees." The Treefinder software [1] can calculate an area of any size fully automatically. The data can be used for subsequent simulations of wildfires.

The doctoral student Sebastian Briechle was able to detect the deposits with a high degree of accuracy as part of his dissertation. It was even possible to confirm the location of the detected areas with in-situ drilling on site in the "Red Forest" using a special search meter and radiometer [2].

Outlook

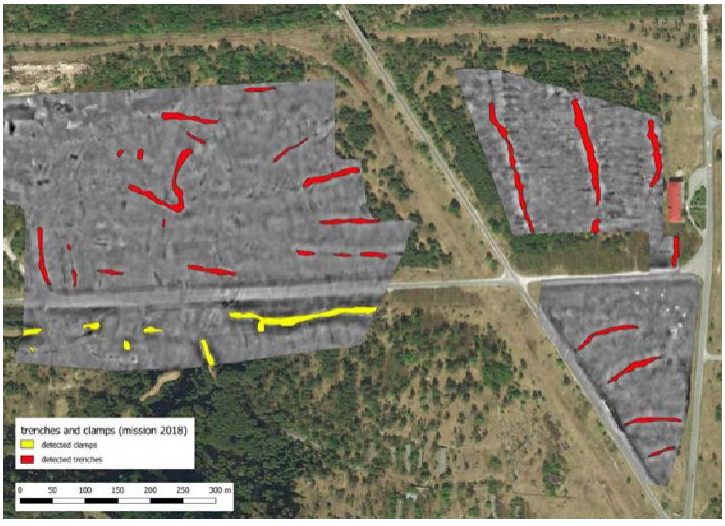
There are already further plans to map the entire exclusion zone. It will take centuries to dispose of the radioactive contaminated area and the inventory of the entire nuclear power plant. The scientific investigations are conducted within the framework of the interdisciplinary research project GeoFlyer "Optimization of the Flight Economy of a Remotely Piloted Aircraft System (RPAS) for the Mapping of Remote Disaster and Risk Areas", funded by the German Federal Ministry of Education and Research (BMBF).

Mapping of biomass and tree species in sector 2.5 (Figure: Peter Krzystek)

Publications

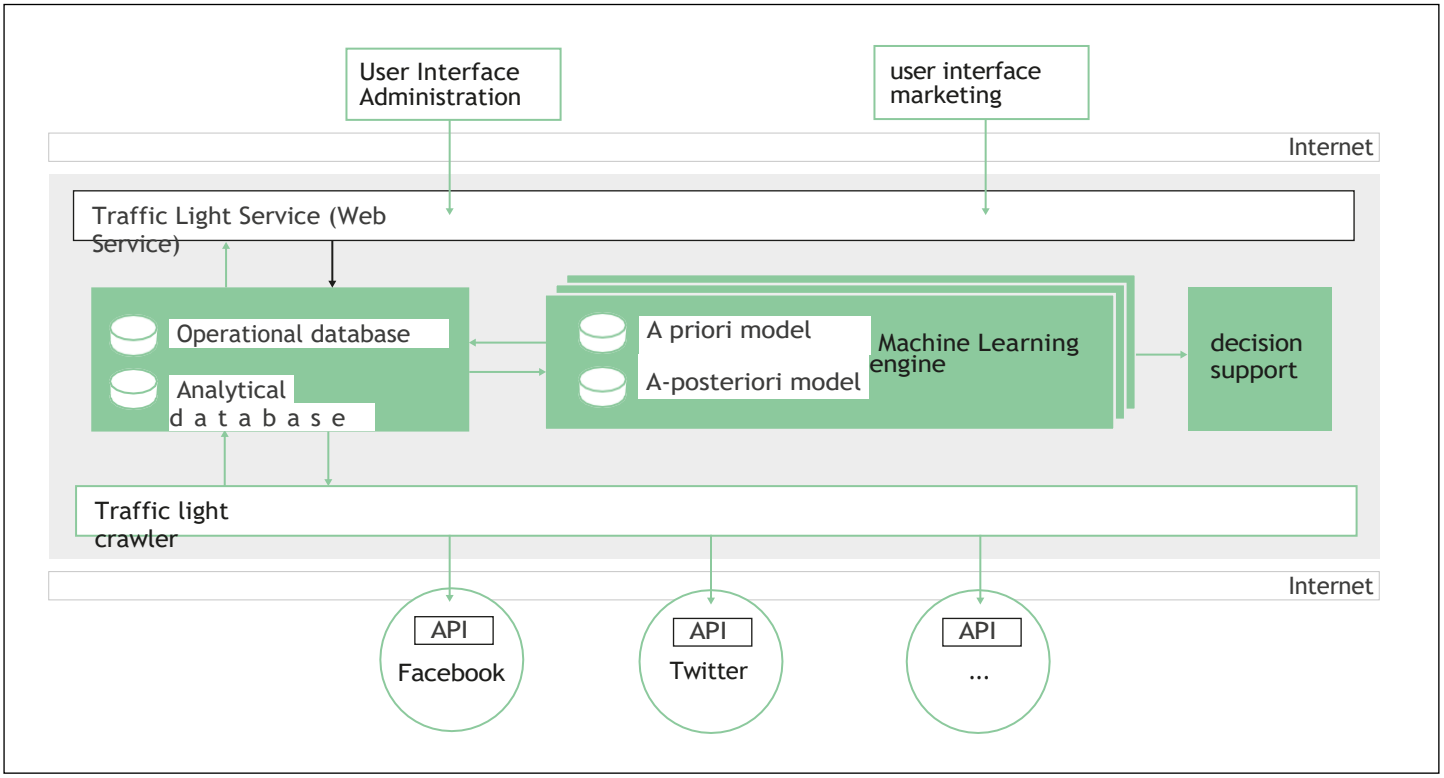
[1] PRIMAVISION Technologies GbR (2017). 3D tree seg- mentation from point clouds (lidar, DSM) for forest inven- tory. http://primavision-tec.de/products/prod_tree-finder. Accessed 2020-05-01.

[2] Briechle, S., Molitor, N., Krzystek, P., and Vosselmann, G., Detection of radioactive waste sites in the Chernobyl exclusion zone using UAV-based lidar data and multispec- tral imagery. ISPRS Journal of Photogrammetry and Remote Sensing. DOI:10.5194/isprs-annals-V-2-2020-203-2020.



Mapped deposits in the "Red Forest" (Illustration: Sebastian Briechle)

Traffic light



Prototypical architecture

Background

Social networks such as Facebook, Twitter, Instagram & Co. are now used by the majority of companies marketing. In some cases, high costs are incurred for social media campaigns. However, the economic success of such campaigns depends on many criteria and is difficult to predict beforehand.

Targets

The question arises as to which tools can be given to a company in order to predict the benefit of social media investments. The aim of our research was to explore the impact of social media channels (SM channels) for companies. The aim was to find a solution that helps to demonstrate benefits when using a limited budget. A new knowledge discovery method was to be developed that automatically recognizes and displays the impact chains in multiple SM channels. A marketing expert should be supported in his decision for the text selection via a success prognosis before posting.

Project name

Traffic light - Knowledge discovery methods and automatic model generation for multichannel marketing

Project Manager

Prof. Dr.-Ing. Peter Mandl

Support programme

Bavarian State Ministry of Economic Affairs, Agriculture and Energy (StMWi)

Information and Communication Technology Programme, funding code: IUK482/002

Duration of the project

01.07.2016 until 30.04.2019

Knowledge discovery methods and automatic model generation for multichannel marketing

Results to date

A new metric was defined for measuring the success of a contribution, called Predictive Social Media Success Metric (PredictiveSMSuccessMetric). The objective was to use this metric to evaluate the expected success of an SM investment a priori, which should be possible for various combinations of SM channels. The PredictiveSMSuccessMetric thus evaluates the potential success of a contribution that is to be published in one or more SM channels. The PredictiveSMSuccessMetric is contrasted with a second metric called Actual Social Media Success Metric (ActualSMSuccessMetric). This is intended to measure the actual success of a SM investment a posteriori, i.e. after publication, and thus enable a comparison of the forecast with the actual result. The data collected from social media channels serve as input parameters for the models to determine the aforementioned output parameters.

Two corpora of contributions form the basis for the classification of contributions according to success. The first corpus comprises a total of 10,684 contributions, of which 6249 contributions were classified by experts. The experts rated the success of the contribution (successful or unsuccessful) and assigned it one of eleven categories that best described the content of the contribution. During the classification process, each of the classified posts was rated by at least one expert. About 10% of the contributions were also evaluated by a second expert, who did not have access to the results of the first evaluation.

For a sentiment analysis, the collected dataset was cleaned and divided into sentence levels. The 6000 examples of the dataset were classified by sentiment into the three levels positive, neutral and negative. Neural networks (CNN and RNN) were used for model building. The developed model provides good accuracy in determining sentiment at the sentence level for texts from SM posts, which are characterized by frequent use of emoticons and very specific vocabulary.
The architecture of the developed demonstrator can be roughly seen in the picture above. Marketers enter a post via a user interface, including post text, additional media (image or video) and marginal information (e.g. planned publication date and industry). They then receive a real-time forecast of the expected number of user actions ("likes", shared posts, comments) and the potential success of the post draft.

Methods, technologies and tools used

CNN, RNN, Support Vector Machine, Logistic Regression, Random Forest, XGBoost, NLP (Bag-of-words, TF-IDF and Doc2vec, Keyword Extraction, Topic Extraction, NER), AlchemyAPI, Watson Vision API, Scrapy

Outlook

The project led to further related research activities and to the use of the results in new projects. In a newly funded follow-up project (Auto Part), the crawling mechanisms are used and further developed and serve as a basis for knowledge extraction, which is ultimately used to develop new matching algorithms. The work is also closely related to a dissertation on idea generation in Open Social Networks. Another research project that benefits from the results of the Ampel project is the detection of hate speech in web pages. In order to optimize the tapping of social media channels, another dissertation project arose from the project, in which new algorithms for a resource-saving tapping are to be found. A large number of final papers and seminar papers were also initiated by the project.

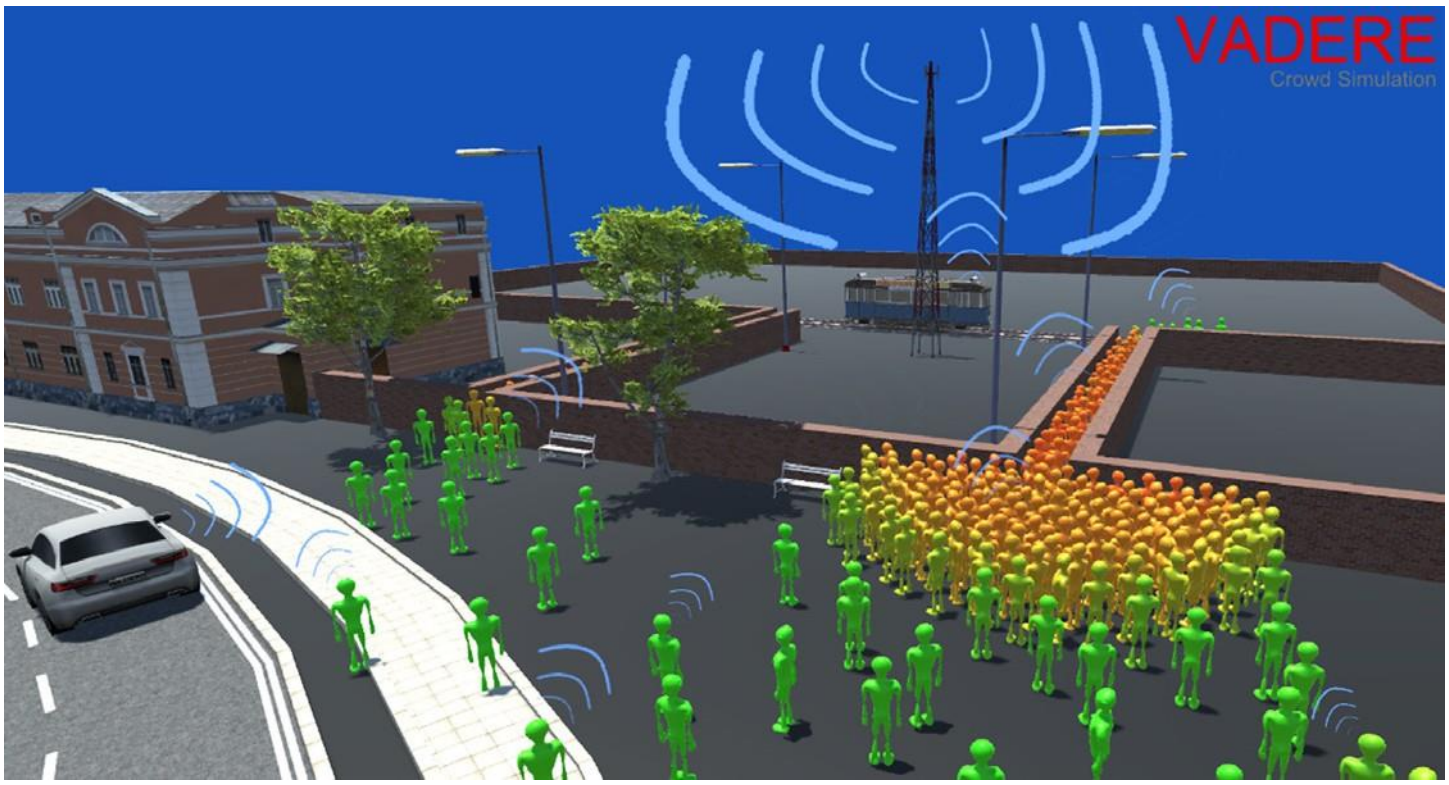
Publications

Keller M.-E., Forster J., Mandl P., Aich F. and Althaller J., A German Corpus on Topic Classification and Success of Social Media Posts. In: Proceedings of the 25th Confe- rence of Open Innovations Association FRUCT. FRUCT'25. Helsinki, Finland: FRUCT Oy, 2019.

Keller M.-E., Stoffelen B., Kailer D., Mandl P. and Alt-haller J., Predicting the success of posts for brand pages on Facebook. In: Proceedings of the 17th International Conference WWW/Internet 2018, Budapest, Hungary: IADIS. 2018.

Häusl M., Forster J., Auch M., Karrasch M and Mandl P. (2018)' An Evaluation Concept for NER and Keyword APIs in Social Media Analysis, Second International Workshop on Entrepreneurship in Electronic and Mobile Business (IWEMP 2018), September 2018, Wiesbaden.

roVer



roVer simulates how networked communication makes traffic information accessible faster and safer.

Project name

roVer

Project Manager

Prof. Dr.-Ing. Lars Wischhof

Prof. Dr. Gerta Köster

Support programme

Federal Ministry of Education and Research, "Research at Universities of Applied Sciences" funding programme

Project executing agency: VDI Technologiezentrum GmbH, Düsseldorf, funding code: 13FH669IX6

Duration of the project

01.10.2018 until 30.09.2023

Cooperation partner

accu:rate GmbH (Institute for Crowd Simulation), Stadtwerke München GmbH (Transport Division)

Background

A central element of intelligent traffic infrastructures and innovative mobility concepts is networking: intelligent vehicles and traffic control systems exchange information to make traffic safer, more efficient and more environmentally friendly. New forms of communication, e.g. via smartphones, enable new mobility concepts such as car and bike sharing. Together with the project partners accu:rate GmbH (Institute for Crowd Simulation) and Stadtwerke München GmbH (Transport Division), the groups of Prof. Dr. Gerta Köster and Prof. Dr.-Ing. Lars Wischhof are researching intelligent traffic infrastructures and guidance systems, especially for pedestrians and public transport users. The project is funded by the Federal Ministry of Education and Research.

Targets

In intelligent traffic systems, road users communicate with each other as well as with mobility service providers and the traffic infrastructure. The information thus distributed via mobile radio thus influences the behavior of the road users.

More efficient transport infrastructures through robust connectivity

At the same time, however, usage behaviour and mobility also affect the communications infrastructure - up to and including a complete breakdown of communications, e.g. during major events or in extreme situations such as the Munich attack in July 2016.

As intelligent transport systems become more widespread, these interactions between transport infrastructure, user mobility and communication infrastructure will continue to increase. The aim of this project is therefore to systematically investigate the interaction between mobility behavior and wireless networking based on characteristic scenarios and to develop suitable methods for robust networking and information dissemination in these mobility scenarios.

Results to date

In the roVer project, state-of-the-art passenger flow simulations are coupled with radio network simulations for the first time. This roVer simulation system is used to investigate selected characteristic scenarios of intelligent traffic systems, such as the provision of mobility information to smartphone users, communication of sensor data between motor vehicles, etc., with regard to the robustness of the networking. Centralised and decentralised communication mechanisms for intelligent transport systems, as they are currently state of the art or proposed in the literature (including cellular and D2D communication via 5G/LTE-A, WLAN-like communication via ITS-G5/WAVE), will be compared and evaluated with regard to their impact on the mobility of users. Improvements and new approaches to ensure robust communication will be derived from this.

In addition to the coupled simulation system developed as open source, which is also made available to other research groups via a public website, a number of other research results have already been achieved and published in the context of specialist conferences and journal articles. For example, a new method for the decentralized creation and dissemination of people density maps based on direct communication has been developed. These density maps are used for the intelligent control of people flow, for which initial control strategies have already been investigated.

In addition, new approaches to network emulation for this type of mobile application were explored and the mobile radio models used were validated using experimental test setups.

Methods, technologies and tools used

Event-driven network and mobility simulation, situation-adaptive data dissemination and aggregation methods, modelling in the tools OMNeT++, vadere, sumo

Outlook

Together with the practice partners, a reference scenario (presumably for the area around Munich Freedom) for the evaluation of information dissemination/aggregation procedures will be modelled in the coupled simulation system. In this scenario, conventional methods will be systematically compared and evaluated with the newly developed approaches. All results including the developed tools and procedures will be published and made publicly available as open source.

Publications

Schuhbäck, S., Daßler, N., Wischhof, L., Köster, G., Towards a Bidirectional Coupling of Pedestrian Dynamics and Mobile Communication Simulation, Proceedings of 6th OMNeT++ Community Summit, EPiC Series in Computing, vol. 66, p. 60-67, 2019, doi: 10.29007/nnfj.

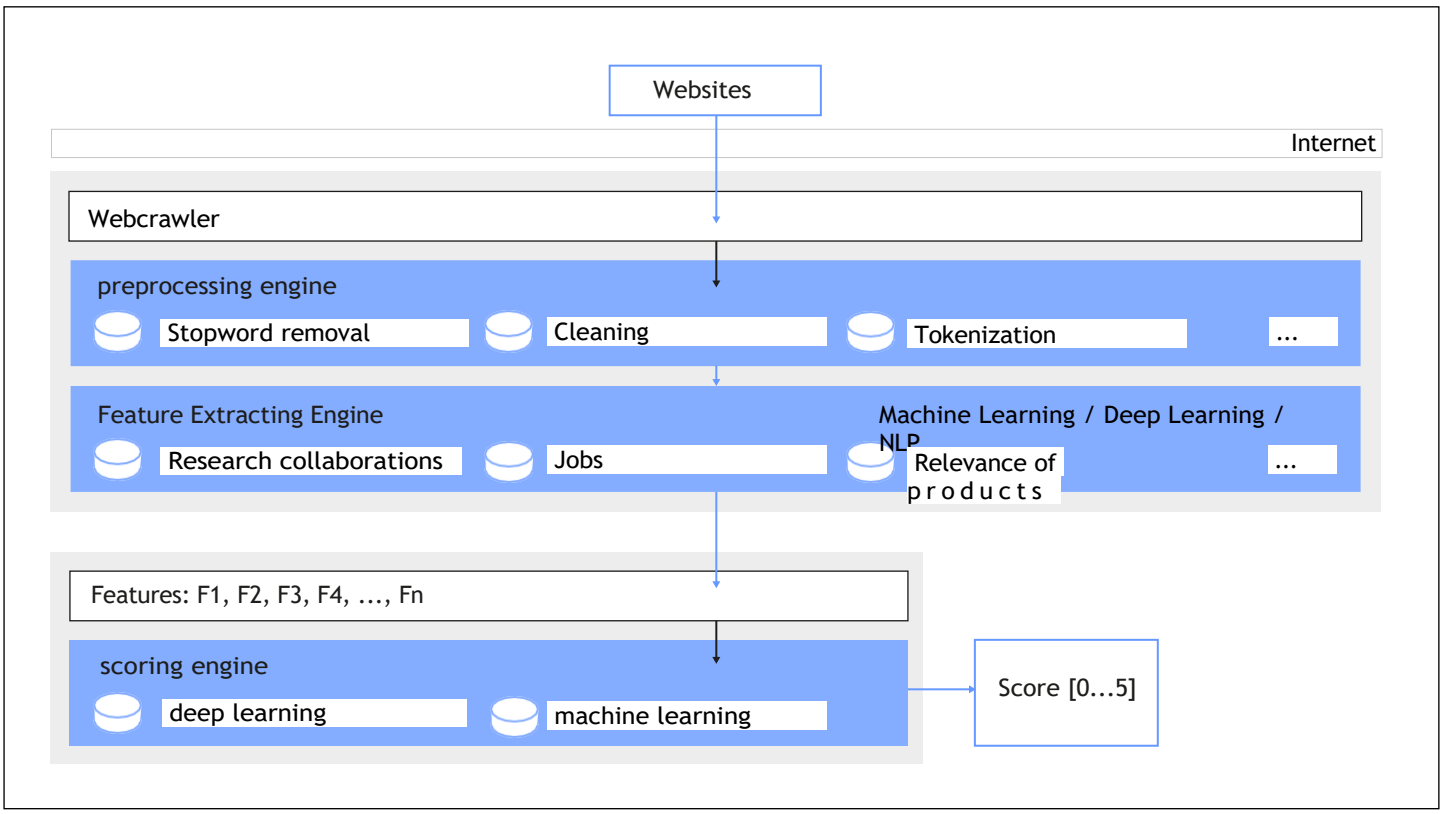
Wischhof, L., Schaipp, F., Schuhbäck, S., Köster, G., Simulation vs. Testbed: Small Scale Experimental Validation of an Open-Source LTE-A Model, Proceedings of the IEEE International Symposium on Personal, Indoor and Mobile Radio Communications (PIMRC 2020), London, UK, Sept. 2020.

Schuhbäck, S., Wischhof, L., Decentralized Pedestrian Density Maps based on Sidelink Communication, Workshop on Communication, IoT, and AI Technologies to Counter Covid-19 (COVI-COM), IEEE International Conference on Communications, June 14-23, 2021, Montreal, Canada.

Rupp, M., Schuhbäck, S., Wischhof, L., Coupling Microscopic Mobility and Mobile Network Emulation for Pedestrian Communication Applications, Proceedings of 8th OMNeT++ Community Summit, Sept. 2021.

Mayr, C., Schuhbäck, S., Wischhof, L., Köster, G., Analysis of Information Dissemination through Direct Communica- tion in a Moving Crowd, Elsevier Safety Science, Volume 142, DOI: 10.1016/j.ssci.2021.105386, Oct. 2021.

AutoPart



Architecture of the matchmaking system

Project name

AutoPart - Semiautomated support of partner search for technology transfer using machine learning methods

Project Manager

Prof. Dr.-Ing. Peter Mandl

Support programme

Federal Ministry of Education and Research DLR, Project Management Agency Society Innovation, Technology, funding code: 01|O1911

Duration of the project

01.07.2019 until 30.06.2022

Cooperation partner

DLR Systems and Control Innovation Lab (SCIL), German Aerospace Center e.V.

Background

Together with the DLR, IAMLIS is researching a tool-based methodology for identifying the willingness to innovate and the need for cooperation among small and medium-sized enterprises in order to semi-automatically identify potential corporate partners for technology transfer.

Targets

The scientific goal of this project is to investigate whether and how modern methods of data analysis using machine learning can facilitate matchmaking between research institutions and SMEs. For this purpose, existing websites, job advertisements and company catalogues are automatically evaluated using machine learning algorithms. The collected data will be used to classify potential partners according to defined criteria regarding their willingness to innovate and their need for digitization.

The complex question of the correct selection criteria is to be answered on the basis of an application example, the technology transfer of simulation and control technology.

Semiautomated partner search support for technology transfer using machine learning methods.

A new type of crawler is to be used that retrieves defined data sources. Selected data sources are searched for unstructured or semi-structured pages, content is extracted, stored and evaluated using machine learning methods.

The new tool should make it possible to automate and simplify the complex relationship-based matchmaking between research institutions and SMEs when initiating research projects. The methodology is designed so generically that it can also be used with new selection criteria for other fields of application outside of simulation and control technology. The entire process is supported, from the preparation and configuration of the search criteria, through the matchmaking process, to the evaluation via standardized interviews. The methodology is initially limited to SMEs, but can in principle also be transferred to large industrial groups.

In practice, the developed method is tested at the match making for the DLR Systems and Control Innovation Lab - a Helmholtz Innovation Lab - in order to find suitable partners for the technology transfer, especially SMEs and industrial companies.

Results to date

The architecture of the overall system consists of a web crawler, a preprocessing engine, a feature extraction engine and a scoring engine. For the data extraction and the feature extraction different approaches from the Natural Language Processing (NLP), from Machine Learning (such as Deep Learning) and Google BERT. The building blocks are implemented in the Python programming language. elasticsearch is used as a database for the raw data and the extracted information.

Methods, technologies and tools used

CNN, Support Vector Machine, logistic regression, random forest, bag-of-words, TF-IDF and Google BERT, elasticsearch, Python, Scrapy.

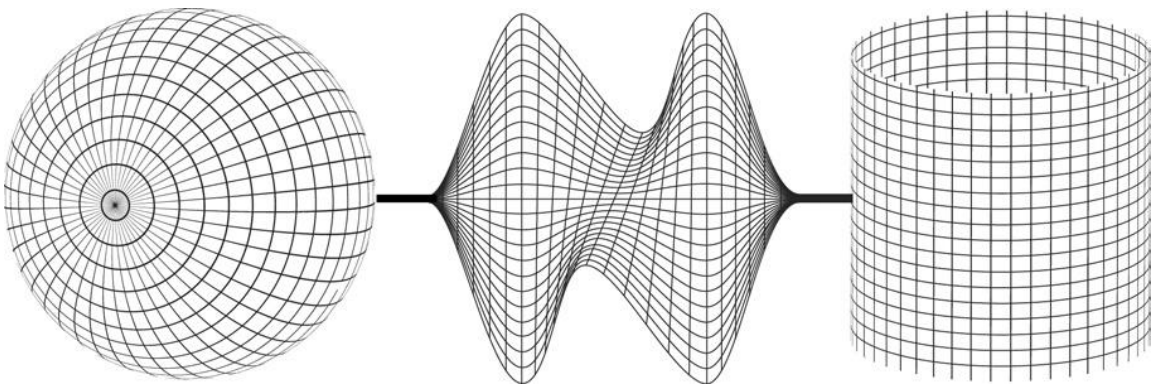
Outlook

The long-term goal of the project is a generic solution for a matching service to reliably find similarities in objects that are essentially described by unstructured web content.

Publications

Döschl, A., Keller, M.-E. and Mandl, P., Performance evaluation of GPU- and cluster-computing for paralleli- zation of compute-intensive tasks. International Journal of Web Information, 2021.

Keller, M.-E., Döschl, A., Mandl, P. and Schill, A., When she posts next? A comparison of refresh strategies for Online Social Networks. 23rd International Conference on Information Integration and Web Intelligence, 2021.



SmartManipulator

Development platform

Motivation

The forecasts for the demographic development of the FRG show a clear trend for the next 50 years. Society is becoming significantly older and the number of people in need of care is rising sharply. At the same time, the number of people in employment is falling, which places tight limits on the desirable expansion of care services.

In the SmartManipulator project, intelligent forms of connecting manipulator arms as execution units to the remaining system components are being investigated. Existing systems require manual control of the arm with the aid of a joystick or similar.

This represents a considerable barrier to use, since precise use of the arm in this way requires a long training period. This user barrier is to be reduced by innovative solutions in the SmartManipulator project.

Targets

The focus of this research project is on people with severe physical impairments and the resulting difficulties in interacting with their environment. Particularly noteworthy are paralyses of limbs and diseases affecting the musculoskeletal system. Due to their special needs, people in this target group involuntarily become dependent on other people. Beginning with vital actions such as the intake of food, the life restrictions extend into the area of social interactions with fellow human beings.

According to a survey by the World Health Organization's "World Report On Disability" [1], 70% of 1505 younger adults with a disability surveyed need support for daily living. 45% of respondents also expressed fear of being too much of a burden on their families. While mobility can be ensured by electric motorization of wheelchairs, there are considerable deficits in the support of motor interactions with fellow human beings and objects of daily life.

New developments of high-quality low-cost management systems will make it possible for implementation within private hoseholds in the next few years. The goal is to enable typical assistance tasks without extensive user interaction.

Project name

SmartManipulator

Project Manager

Prof. Dr. habil. Alfred Schöttl

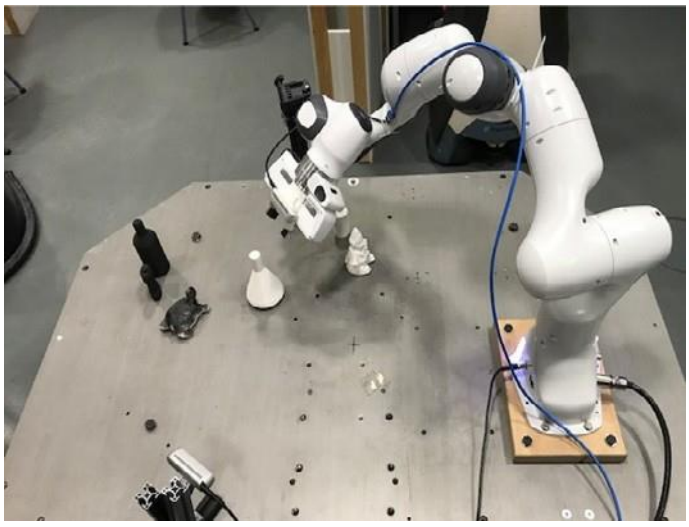
Support programme

Federal Ministry of Education and Research, Young Engineers 2016 Grant no. 13FH755IX6

Cooperation partner

with Automation W+R GmbH

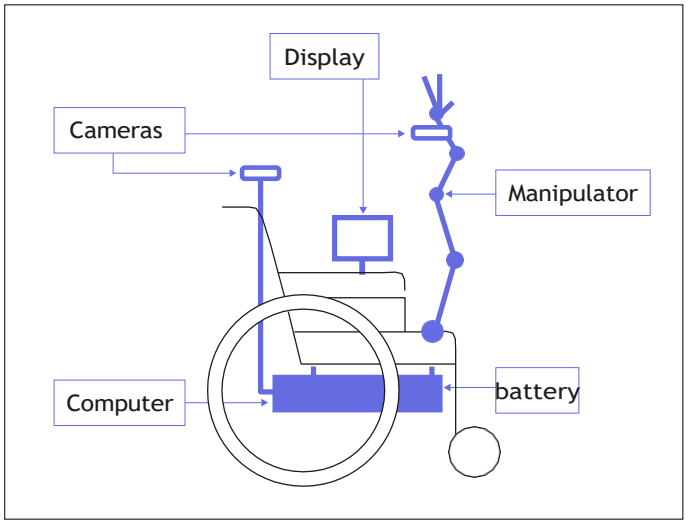
In the future, service robots will make the work of caregivers easier and increase the independence of people in need of assistance.



Test environment

Results to date

The results achieved so far are mainly in the research areas of object recognition, path planning and manipulation, and trajectory execution. Here, an innovative approach for the automated recognition of a grasping pose for unknown objects was developed [2][3]. In this approach, the robot arm first autonomously explores the test environment, reconstructs the 3D surface using algorithms parallelized on the GPU, and identifies graspable objects by using neural networks. Using machine learning methods, reliable grasping poses are determined.



User hardware interface on the demonstration setup

The gripping positions found are then evaluated from a geometric and physical point of view. Boundary conditions such as collisions with objects or the distance to be covered are also taken into account in the quality of the gripping positions. In the next step, a path to the calculated gripping position is determined on the basis of the preceding calculations. Since for this process the objects to be grasped do not have to be contained in the training data sets of the neuronal networks, the interaction of the SmartManipulator with an unknown environment is enabled. The above steps were implemented in a test environment, optimized and evaluated.

Human-machine interaction is a focus of current work. Here, the simplest possible operation with the least possible training effort for the user is being developed. In addition, operation is to be made possible for people with various physical impairments.

Since operation can be severely restricted in many ways due to various impairments [4], various options for commanding the SmartManipulator are planned, such as eye tracking, voice control and operation via a touch display. Work on the creation of a demonstrator is also nearing completion.

In the final project step, the developed solutions are combined and transferred to the demonstrator. In addition, an optimization of the overall system takes place.

Publications

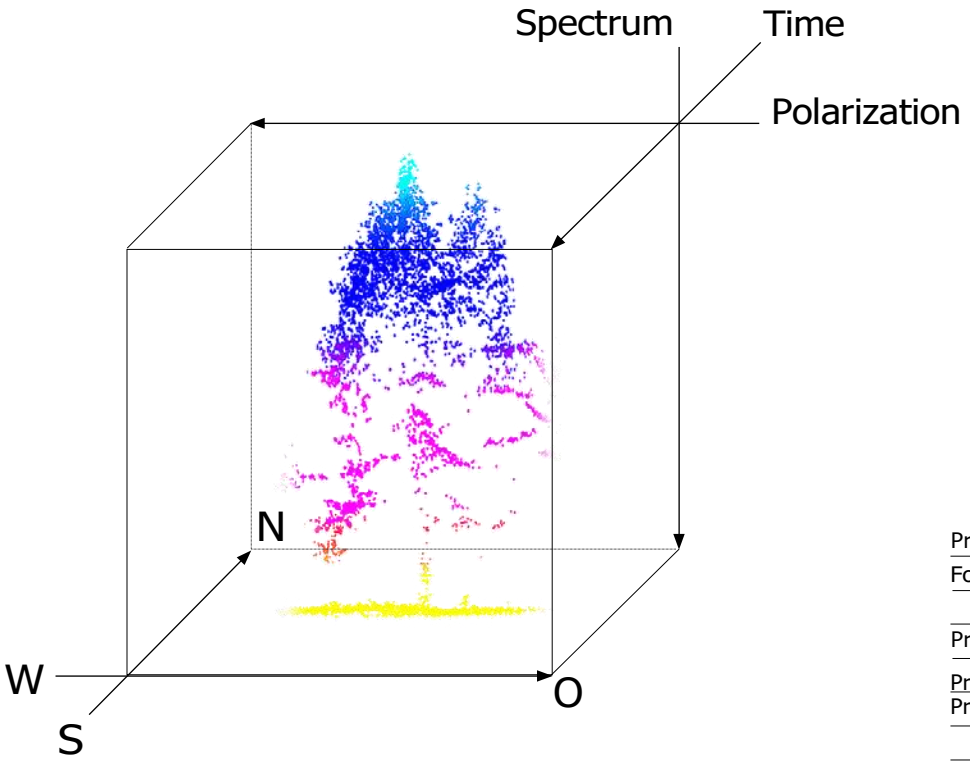
[1] World Health Organization. World report on disabi- lity. http://www.who.int/disabilities/world_report/2011/report.pdf, 2011.

[2] Schaub, H., Schöttl, A., 6-dof grasp detection for unknown objects. In 2020 10th International Conference on Advanced Computer Information Technologies (ACIT), pages 400-403, 2020.

[3] Schaub, H., Schöttl, A., Hoh, M., 6-dof grasp detec- tion for unknown objects using surface reconstruction. In 2021 3rd International Congress on Human-Computer Interaction, Optimization and Robotic Applications (HORA), pages 1-6, 2021.

[4] Schöttl, A., Towards intelligent assistance systems using the example of a manipulator arm, pages 333-350. 08 2019.

Forest5Dplus



The five dimensions of the satellite images used. As a plus, the labels from the LiDAR flights are added.

Project name

Forest5Dplus

Project Manager

Prof. Dr.-Ing. Andreas Schmitt
Prof. Dr.-Ing. Peter Krzystek

Staff

Sarah Hauser

Background

Remote sensing has become versatile. There is neither one sensor nor one platform for all conceivable applications, but a multitude of possible recording systems for each application. The sensors differ in the wavelength used (visible light, infrared radiation, microwaves), in the illumination (active or passive) and in the recording geometry (point cloud, central projection, parallel projection, distance projection). The choice of platforms ranges from fixed cameras to unmanned aerial vehicles (UAV), aircraft and helicopters to satellites and space stations.

The two basic distinctions resulting from the choice of platform are the distance to the observed object and the repetition rate, i.e. the time interval at which exactly the same image can be repeated in order to detect changes. If one wants to use this broad spectrum of data in its entirety, one needs advanced approaches for data fusion and automatic interpretation.

Machine learning methods have been established for this purpose - not only in remote sensing - but in turn require extremely large training data sets in order to learn the syntactic patterns and to compare them with their semantic meaning. Such training data sets are still scarce in the field of remote sensing, since the reference data for the unambiguous assignment of semantics in the form of so-called labels are usually missing. Their acquisition is extremely time and cost intensive and exceeds the usual budget of a remote sensing project.

Targets

The project "Wald5Dplus", funded by the Space Management of the German Aerospace Center (DLR) with funds from the Federal Ministry for Economic Affairs and Energy, creates a syntactic training data set from multitemporal Sentinel-1 and Sentinel-2 satellite images and assigns semantic labels to the individual elements, which have been derived from aerial surveys. The satellite missions Sentinel-1 (C-Band Synthetic Aperture Radar) and Sentinel-2 (Multispectral Imager) are part of the Copernicus program of the European Commission and the European Space Agency. They provide (at Sentinel-2, unfortunately weather-dependent, takes weekly images in a 10-m grid of the whole of Europe, which are freely available to any potential user. In one year, about sixty images per satellite are collected. Within the framework of this project

for three selected forest areas the raster values in north-south direction (first dimension), in east-west direction (second dimension), polarimetrically by Sentinel-1 (third dimension), spectrally by Sentinel-2 (fourth dimension) over time (fifth dimension) were summarized in an Analysis Ready Data Cube and provided with semantic labels ("plus"). The labels originate from aerial surveys of the test areas with airborne or UAV-borne laser scanners and multi-spectral cameras and therefore have a very high spatial resolution. They are intended to provide information on certain forest parameters such as tree species, number of trees, crown area, crown height and initial crown height.
The evaluation of the point clouds is carried out with specially developed, patented algorithms and results in the required semantic labels, which are then aggregated to the spatial grid of the satellite data.

The data cube is used to pre-train machine learning methods for use in other projects. The entire package will be made available as a benchmark dataset to all interested scientists worldwide free of charge via the CODE-DE platform.

Results to date

At the end of the project, Analysis Ready Data Cubes with weekly recordings of Sentinel-1 and Sentinel-2 over a period of two years will be available for three study areas in the Bavarian Forest National Park, in the State Laboratory "Weltwald Freising" and in the Steiger Forest. To reduce storage space and allow easier inter-pretation, the images are polarimetrically, spectrally and temporally fused on hypercomplex bases. In addition, each image element will be associated with a typical forest parameter such as the number of trees, the proportion of deciduous or coniferous forest, the mean crown height, etc.

This dataset is analysed in detail using methods of multivariate statistics and machine learning in order to optimise data processing on the one hand and the transfer of what has been learned to other areas on the other. All results will be published in international journals (open access). The data set, including pre-trained algorithms, will henceforth serve as a benchmark against which new developments in the field of artificial intelligence can be measured. In the optimal case, a sufficiently validated AI algorithm can be offered, which can estimate the forest parameters introduced solely on the basis of recordings from the Sentinel 1 and Sentinel 2 missions.

Outlook

With the help of this benchmark dataset, AI algorithms can be ranked consistently in the future. They all run on the same Analysis Ready Data Cube with the same labels and predict the forest parameters for the same syntactic signatures. Then, only the accuracy of the assignment and the performance of the algorithm determine the respective list position.

In this way, the state can be evaluated objectively for the first time. For example, it would be possible to select the optimal algorithm from the list of possible candidates in order to carry out thematically detailed forest mapping based on the freely accessible data from Sentinel-1 and Sentinel-2. Unanticipated changes such as forest damage due to diseases, pest infestations or storms could also be detected promptly in order to be able to take countermeasures in time to prevent further spread and thus greater financial damage.

Methodologically, the benchmark dataset provides the optimal starting point for both the validation of the already published algorithms for data fusion on hypercomplex bases and for thematic interpretation via histogram classification, as well as for the development of new or the adaptation of existing machine learning algorithms for application in forest remote sensing and far beyond.

Publications

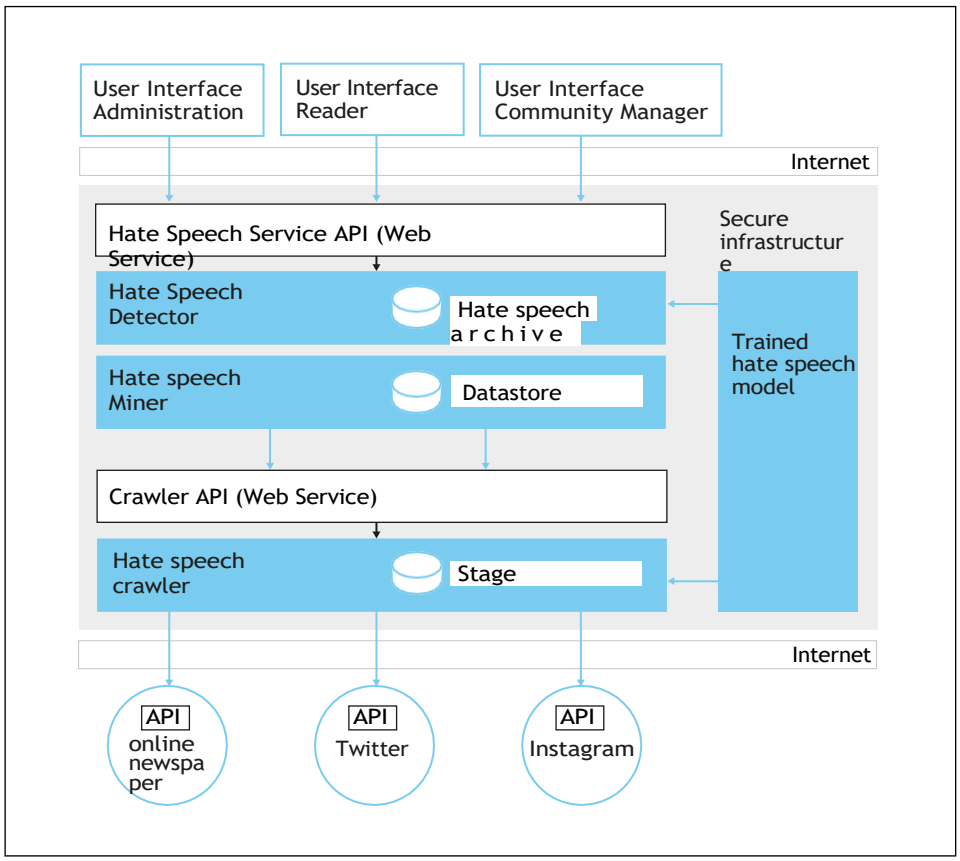
Schmitt, A., Wendleder, A., Kleynmans, R., Hell, M., Roth, A., Hinz, S., Multi-Source and Multi-Temporal Image Fusion on Hypercomplex Bases. Remote Sens. 2020, 12, 943. (https://www.mdpi.com/2072-4292/12/6/943)

Krzystek, P., Serebryanyk A., Schnörr, Cl., Cervenka, J., Heurich, M., Large-scale mapping of tree species and dead trees in Šumava National Park and Bavarian Forest National Park using lidar and multispectral imagery. Remote Sensing 2020, 12(4), 66.1. (https://doi.org/10.3390/ rs12040661)

Schmitt, A., Sieg, T., Wurm, M., Taubenböck, H. , Investi-gation on the separability of slums by multi-aspect TerraSAR-X dual-co-polarized high resolution spotlight images based on the multi-scale evaluation of local distri-butions, International Journal of Applied Earth Observation and Geoinformation, Volume 64, February 2018, Pages
181-198, ISSN 0303-2434. (https://doi.org/10.1016/j.jag.2017.09.006)

HSDetector

Automated detection method for hate speech in online portals



Project name

HSDetector - Development of an automated detection procedure for hate speech in online portals based on a retrainable classifier

Project Manager

Prof. Dr.-Ing. Peter Mandl

Support programme

Bavarian State Ministry of Economic Affairs, Agriculture and Energy (StMWi)

Program BayVFP funding line digitization, funding code: DIK02778/01

Duration of the project

01.09.2021 until 31.08.2024

Cooperation partner

Bival GmbH, Ingolstadt

Ippen Digital GmbH & Co KG, Munich

Background

Hate speech has become a widespread, socially focused phenomenon that increasingly has a lasting negative impact on the sense of security, especially of public figures. Online content containing hate speech such as incitement to hatred, insults, slander and death threats incites people and, in individual cases, even serves as a motivation or trigger for politically motivated crimes, including attacks on people or property. Hate speech is highly context-dependent and can change over time.

Targets

Online newspapers must also take precautions to avoid hate speech in their online content, especially in reader comments. The aim of the HSDetector research project is to develop a new service that detects hate speech in online newspapers with a high probability. The new method finds hate speech in web pages on the basis of an adaptive detection method with the help of a retrainable classifier that can also learn changes in the form of expression.

Outlook

It is intended to further develop the results of the project into a web-based HatesSpeech Detection Service, which can be integrated into editorial systems of online newspapers but also into other content management systems.

Methods, technologies and tools used

CNN, Support Vector Machine, logistic regression, random forest, bag-of-words, TF-IDF and Google BERT, elasticsearch, Python, Scrapy.

Publications

Januzaj, E., Weber, M., Keller, M.-E., Auch, M., Mandl, P., CoSim: An Approach to Calculate Complex Object Similarity. 23rd International Conference on Information Integration and Web Intelligence, 2021.

Partner - Concept of cooperation

The challenges of digitalization are immense. In particular, the use of artificial intelligence methods and processes is only just beginning.

Enormous efforts are required to leverage the diverse AI potential and to successfully use it in innovative intelligent systems. Close cooperation between science, industry and business is needed to equip today's IT systems with AI functions - where it makes sense - and to develop new intelligent and disruptive solutions.

Therefore, the establishment of a regional scientific center in the field of machine learning and the development of intelligent systems is the medium- to long-term goal of IAMLIS. The involvement of corporate partners, especially from the region, is of great importance in order to tackle this task together. Small and medium-sized enterprises are involved just as much as public authorities and large corporations. It is also the aim of IAMLIS to further deepen the cooperation with scientific institutions in the region. The purpose of the cooperation is the intensive scientific exchange combined with a knowledge transfer between university and partners.

In doing so, IAMLIS builds, as is traditionally the case in universities of applied sciences, on the three pillars of research, teaching and practice. The combination of these three pillars results in clear synergies. Practical problems in the context of advancing digitization, which are of great importance for business, industry and administration, can be mapped to research questions and used as case studies in courses. The focus is on the integration of machine learning methods in concrete applications. The integration of practice-oriented topics into teaching via seminars, project studies and final projects also offers our students excellent opportunities to link scientific work with practice-oriented problems.

In order to promote communication between industry, science and students, IAMLIS participates in symposia of the university together with partners. Current topics of our partners as well as research results of our research groups are presented and intensively discussed by means of lectures. New research questions are jointly developed and research results are made available in the sense of technology transfer. IAMLIS also offers workshops for technology exchange with representatives from industry, economy and administration, especially for the discussion and specification of problems from machine learning and the embedding of novel algorithms in intelligent systems.

IAMLIS also supports partners in the preparation of research proposals for third-party funding and offers contract research for concrete practice-oriented research questions. Within the framework of our close cooperation, we also facilitate jointly supervised doctoral projects with application-oriented problems and further research activities via a new tandem program for postdocs.

We will gladly explain the possibilities of cooperation with IAMLIS in a direct conversation.

NuData Campus

Pioneering research combined with teaching

Student projects focused on "Energy Efficiency in Buildings with the Application of Big Data and Data Mining Techniques." Photo: Herz/Decker

IAMLIS is part of the joint research project NuData Campus. Together with the Research Institute for Energy Efficient Buildings and Neighborhoods (CENERGIE), the Faculty of Electrical Engineering and Information Technology, and the TUM Chair for Energy Efficient and Sustainable Planning and Building, the aim is to apply findings regarding energy optimization in complex properties at HM.

This project is an example of how research also serves teaching and vice versa. Those involved in the project at the university are working on the sub-aspects of data collection, identification of user influences, utility energy simulation and optimisation of integral planning processes. Among other things, research is also carried out in collaboration with students in study and

Sponsored by:

Bundesministerium für Wirtschaft und Klimaschutz

on the basis of a resolution of the German Bundestag

In their theses and project studies, students have investigated how the total energy demand of complex building structures can be analysed, evaluated and reduced in an automated, data-based and cost-efficient manner. For example, a complex tool for the integration and analysis of building data was developed together with students.

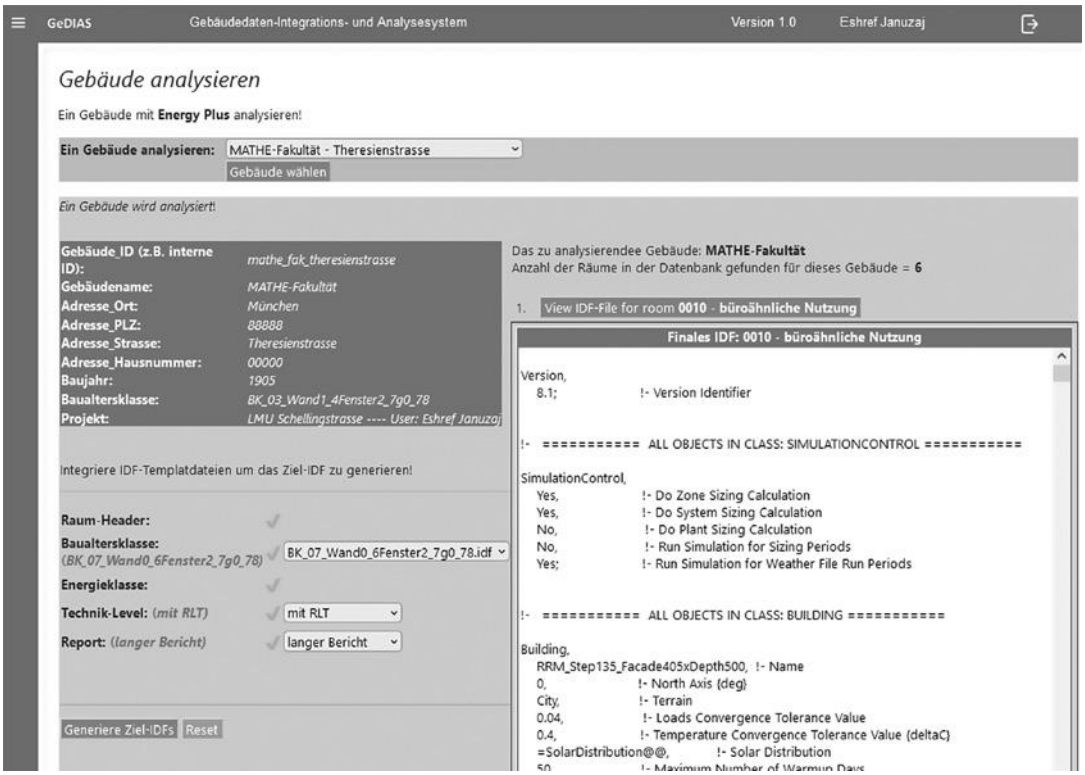
In the field of building management and monitoring, sensors on so-called intelligent buildings constantly generate data and thus also influence the behavior of other networked devices. For example, the outside blinds are automatically raised in strong winds, the lights in the corridors of a building are only switched on when someone is there, and the heating is automatically brought up to the personal operating temperature when people are on their way to the office or home.

The aim of this project is to find the knowledge hidden in all this data and thus achieve an increase in energy efficiency in buildings. In this collaboration, specialist issues are supported by IT-supported analyses.

Well-known software tools for simulating energy concepts in buildings, e.g. EnergyPlus, can be integrated via a web information system developed for managing the data. The required input data (files in IDF format) are dynamically generated from the system and passed on to EnergyPlus for evaluation.

A corresponding model-based concept for energy efficiency in buildings is to be realised on three levels: on level 1, raw data from buildings are collected and stored. By structuring the data on level 2, the resulting information is mapped and managed in database models. By using efficient data mining and big data methods on level 3, the knowledge contained in the data is generated.

For example, the rooms of a building are clustered into different classes based on specific characteristics. This makes it possible to identify and also implement more efficient energy use in buildings. Visualization tools developed for this purpose facilitate the interpretation and evaluation of calculated energy models.



Building data integration and analysis system GeDIAS

Autonomous Garbage Collector

A pile of garbage at a street intersection in Medellín, Colombia.

Aerial view of the same street intersection in Medellín, Colombia

Based on the image analysis recognized and therefore red bordered garbage deposit from the above aerial photo. Photos: Image Service of the Municipality of Medellín, 2021

Background

Landscape hygiene has been a socially relevant topic for years. The "Clean Landscape" campaign will once again be on everyone's minds in Germany in the spring of this year. However, the fact that this is not only about environmental protection, but also about health protection, has only become apparent since the corona pandemic. Carelessly discarded masks pose a risk of infection that has been difficult to assess to date.

As billions of masks were used in the pandemic, the increase of mask waste in the environment is also worldwide and has already reached the oceans. For the environment, they mean an extremely high and additional load of microplastics. Animals get caught in the tapes and are unable to free themselves or mistake the masks for potential food and die from the swallowed tissue. These are just a few striking examples of the danger posed by masks lying around in the wild. While throwing them away is a simple, quick and individual process, collecting the rubbish again is extremely time-consuming.

The use of human waste collectors is on the one hand cost-intensive, but on the other hand also dangerous with regard to the possibly contaminated masks. As long as the discarding of the masks cannot be stopped, the solution to this waste problem can only be designed in a way that is cost-efficient and without health risk with the help of the most modern technologies.

Targets

In the long term, a robotic system is to be developed that automatically detects hotspots, verifies them on site and acts accordingly to dispose of the illegally deposited garbage properly. The project is divided into two major work packages, the Autonomous Garbage Finder (AGF) as a preliminary stage to find the garbage, and the Autonomous Garbage Collector (AGC) as the tangible device to automatically remove the detected garbage.

This means that human contact with the waste is no longer necessary and disease transmission of any kind is completely ruled out. In addition, a 24/7 use of this system is possible, for example, to provide places in the city at night or in the early morning, while they are not busy, which makes the work more difficult. extremely easier compared to collecting during rush hours and also does not interfere with the flow of passers-by.

A long-term flagship project of IAMLIS

Methodology

The Autonomous Garbage Finder (AGF) is designed to search all available media for the presence of localizable garbage. A first approach is to analyze social media for tweets on the topic of garbage, for example, which also allow localization in the form of a direct geo-reference (e.g., coordinate) or indirect geo-reference (e.g., address). Artificial intelligence methods are used here to filter out and evaluate these specific tweets from the almost unmanageable number of daily tweets from 211 million active users (as of 2021).

Another approach combs through recordings of permanently installed surveillance cameras for garbage deposits. The position and orientation of the camera (external orientation) and the projection formulas can then be used to infer the coordinates of the waste. To start with, large-scale aerial photographs from airplanes or unmanned aerial vehicles are used to develop algorithms that automatically detect and classify waste deposits, also with the help of artificial intelligence. The merging of these data sets from Social media and imagery completes the AGF.

The Autonomous Garbage Collector (AGC) is the second stage of development and comprises a robot with sensors for verifying the reported garbage on site, haptics for gripping and collecting the garbage, and a collection container for temporary storage during the cleaning trip. By sensor technology is meant all currently available sensors for localizing the autonomous vehicle itself - such as GNSS sensors for determining position or IMU units for determining orientation in space - as well as sensors for exploring the environment -such as stereo cameras or laser scanners. These sensors must be linked both to the vehicle's control system and to the AGF in order to verify the indications of litter found on site.

With the support of artificial intelligence, the AGC automatically decides whether it can remove the waste with its gripping systems or whether further assistance is required. If, for example, discarded masks are found, the AGC can collect them automatically and deliver them to a specially equipped collection point after the cleaning cycle.

Results to date

The Autonomous Garbage Finder or Collector is a well-considered synergy of various data sources, platforms, sensors and autonomously acting robots, which are trained with the help of algorithms from the field of artificial intelligence to detect garbage collections fully automatically, to remove them automatically and to deliver the collected garbage to a predefined collection point. In the long term, the system will function without any human intervention and contribute to keeping our environment clean as well as to curbing transmissible diseases, since no contact between potentially contaminated waste and the collectors will be necessary anymore.

Outlook

The design of the AGC is by no means limited to the collection of garbage, but can be used multifunctionally. Instead of picking up trash in inner cities, the system can also be trained to detect and mechanically remove weeds.

On the one hand, this can refer to plants in the joints of paved or concreted areas or along the foundations of buildings, which in the long term would destroy the building structure with their roots. On the other hand, a similar system can also be used in organic agriculture to keep crops clean by having a robot drive along the rows and mechanically collect unwanted plants (vulgo "weeds"), which is permitted in organic agriculture. Thus, by retraining and making minor adjustments to the gripper arms, the AGC becomes an Autonomous Weed Collector (AWC).

If the system is also trained to collect the cultivated crops, it could even become an autonomous crop collector (ACC). The fully automated, but targeted collection of ripe crops could even mean a departure from the widespread monoculture with its well-known problems. If harvesting no longer has to be done on a large scale - as is common in today's industrial agriculture - it will be possible to plant a variety of crops in close proximity, which will immensely increase the robustness of the entire crop against all kinds of pests. The return to a mixed cultivated forest is a prime example from forestry. Our flagship AGC therefore provides the basis for the development of numerous wide-ranging applications of an automatic collection system.

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University of
Applied Sciences

Editorial
Prof. Dr.-Ing. Peter Krzystek
(Director of the Institute),
Prof. Dr.-Ing.Peter Mandl
(Deputy Director of the
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