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Digital Technologies and Ecosystems

Project highlights

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Vienna, 2022

Preface

The Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK) has been enabling businesses and researchers to move forward with their breakthrough projects in the field of digital technologies for more than 20 years.

The ICT of the Future programme focuses on topics in which Austria is particularly strong, such as electronics-based systems, robotics, automated driving, trustworthy Internet of Things, big data, and artificial intelligence. It is interesting to note that the returns from the EU research framework programme are above average in these fields at 180%.

The European Next Generation Internet (NGI) Initiative led to the interactive process for the NGI Scenario Report – The Internet for People 2040 in Austria. Participating experts from a broad spectrum of disciplines thus laid the foundation for the calls that are presented in this brochure.

A core guiding principle in this context is the "connected surfer" scenario with the proposal to build and grow flexible ecosystems for collaborative creation among diverse actors. The common objective is to increase the development and deployment of European digital technology solutions in key technological fields, and to expand their use in Austria.

It is obvious that the interactions between these technologies and people, society, and climate protection are playing an increasingly important role. A wide range of disciplines are being involved and sustainable solutions are found for societal challenges such as climate change. The national promotion measures are intended to raise the international profile of companies and research institutions, increase involvement in pertinent European programmes and initiatives such as Horizon Europe, the Green Deal, and the European Partnerships, and thus contribute to shaping Europe's future.

This publication showcases projects that have successfully addressed these challenges.

Mag. Michael Wiesmüller,
Head of Department III/5 –
Key enabling technologies
for Industrial Innovation:
ICT, Production and Nano-
technology
Federal Ministry for Climate
Action, Environment, Energy,
Mobility, Innovation and
Technology

Content

1 ICT of the Future Programme

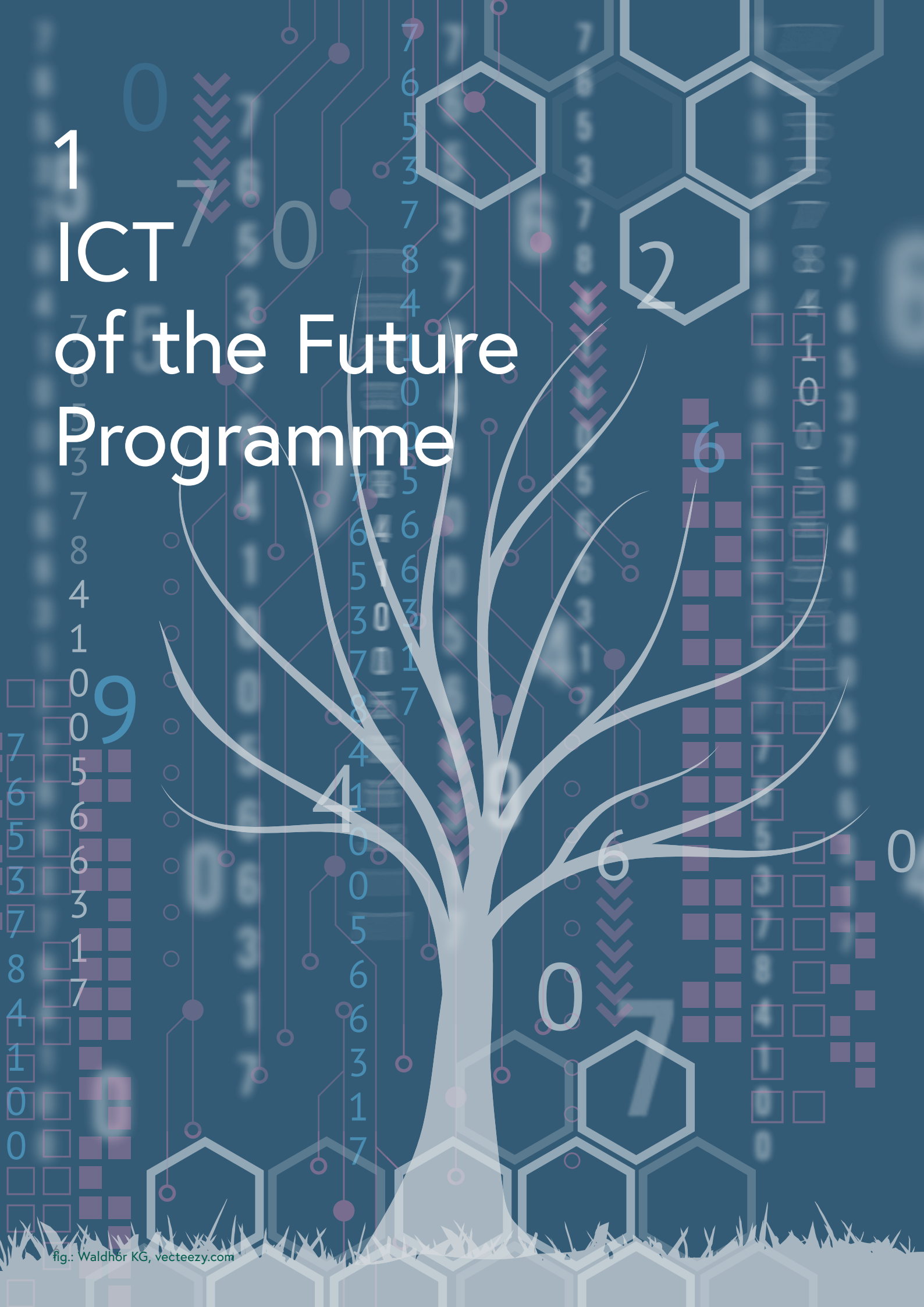


fig.: Waldhör KG, vecteezy.com

As digitalisation has reached into all areas of life, work and production, the focus has increasingly shifted to information and communication technologies (ICT) in recent years. These technologies have the potential to both create huge opportunities, while also facing society with new challenges. The COVID-19 pandemic and its subsequent knock-on effects have only served to accelerate this trend, once more demonstrating the importance of reliable and secure digital technologies in our everyday professional and personal lives. They play a role in everything from home-schooling and working from home, to simple, virtual family contacts. It is therefore essential that we continue to work together with Austria's research community to invest in these technologies and help shape their future development.

The Federal Ministry for Climate Action, Environment, Energy, Mobility, Innovation and Technology (BMK) is fulfilling this mandate by promoting applied research and the development of digital technologies in specific areas of application. The ICT of the Future programme funds and supports digital technology innovations in their widest sense with the aim of supporting Austria in its transformation from an innovation follower to become one of the most innovative countries in the EU.

This brochure invites the reader to explore current technological developments in digital technologies, while simultaneously identifying and playing a role in shaping tomorrow's trends. It also aims to highlight the potential of these technologies across a wide variety of application fields, and the importance of cooperation between the projects which will create many new opportunities in the near future. The projects presented here in the areas of automation, robotics, artificial intelligence, autonomous driving, IoT and interoperability show that we need these technologies in order to manage the energy and mobility transition and to take a further, important step towards protecting the climate.

In 2019, the BMK, together with other stakeholders, developed a series of social and technological scenarios for 2040, titled „Scenario Process NGI – The Internet for People 2040“. The preferred main scenario poses major challenges for responsible technological development over the coming years and decades. While focusing on human needs, the future scenario paints a picture of our life in 2040 in an urban, highly technological, transparent, unpredictable and complex environment. It will only increase our longing for greater security and trustworthy connections. The digital technologies which research institutions and companies will develop over the coming years will accompany us wherever we go, and at all times. They will determine the opportunities and limitations of tomorrow's society. For this reason, the key to achieving a desirable future lies in the formation of a flexible, cooperative and creative ecosystem involving a multiplicity of different stakeholders. In this context, an ecosystem is an open, inclusive framework in which project partners from various disciplines and fields work in symbiotic relationships to jointly develop and implement ideas. The guiding principles of such ecosystems are interdisciplinarity, a focus on needs, openness, transparency, inclusion, diversity, empowerment, social responsibility, self-reflection, new educational approaches, and shared responsibility for the impacts of technology both, on individuals and the environment.

In spring and summer 2020, twelve research projects with a combined project volume of around 9.6 million euros were funded as part of the 8th Call of the ICT programme with a focus on "Ecosystems for Interdisciplinary Information and Communication Technologies". Together, the twelve projects constitute a joint research and development ecosystem involving multidisciplinary cooperation, primarily within the projects. The ICT of the Future programme funding is also intended to encourage the projects to use synergies over and beyond their individual project boundaries.

In addition to the projects from the 8th Call, three exploratory projects are also presented in this brochure. They were funded in 2018 within the framework of the 6th Call of the ICT of the Future programme focusing on an „Internet for the People“. This call aimed at establishing ecosystems to identify future technological demands and the digital infrastructures needed by a networked society from 2025 onwards. These studies were required to highlight conflicting priorities between the future need for regulation and economic opportunities. We expect tomorrow's internet to provide better services, more intelligence, and potential for greater human participation and involvement. At the same time, it should also serve the wellbeing of each of us by taking into account aspects such as freedom, security, privacy, fairness, openness, solidarity, human rights, and democracy.

Consequently, the cooperative R&D projects and exploratory projects are more than simply an end in themselves. They serve as pioneers for networked project proposals which, embedded in the project environment, offer additional value beyond the purely technological.

The projects in detail

The projects presented here from the calls focusing on "Internet for the People" (6th Call, 2017) and "Ecosystems for Interdisciplinary Information and Communication Technologies" (8th Call, 2019) amount to a total of around 10.2 million euros in project costs, with an average project volume of 680,000 euros.

The primary funding instrument of choice is the cooperative R&D project for industrial research, which accounts for ten projects. Five of the projects presented here are exploratory projects. The 15 projects involve a total of 62 participants, with some organisations involved in several of the projects. Table 1 shows the number of participating organisations.

Table 1: Project participations

	Research institutions (incl. university institutes)	Large enterprises	SME	Others
Number of project participants	33	11	12	6

The distribution of project participants is also reflected in the consortium leads: AIT is the dominant organisation, leading five projects, followed by Salzburg Research Forschungsgesellschaft and TU Wien, each leading two projects. The project consortia have up to seven partners, with the majority consisting of three project partners.

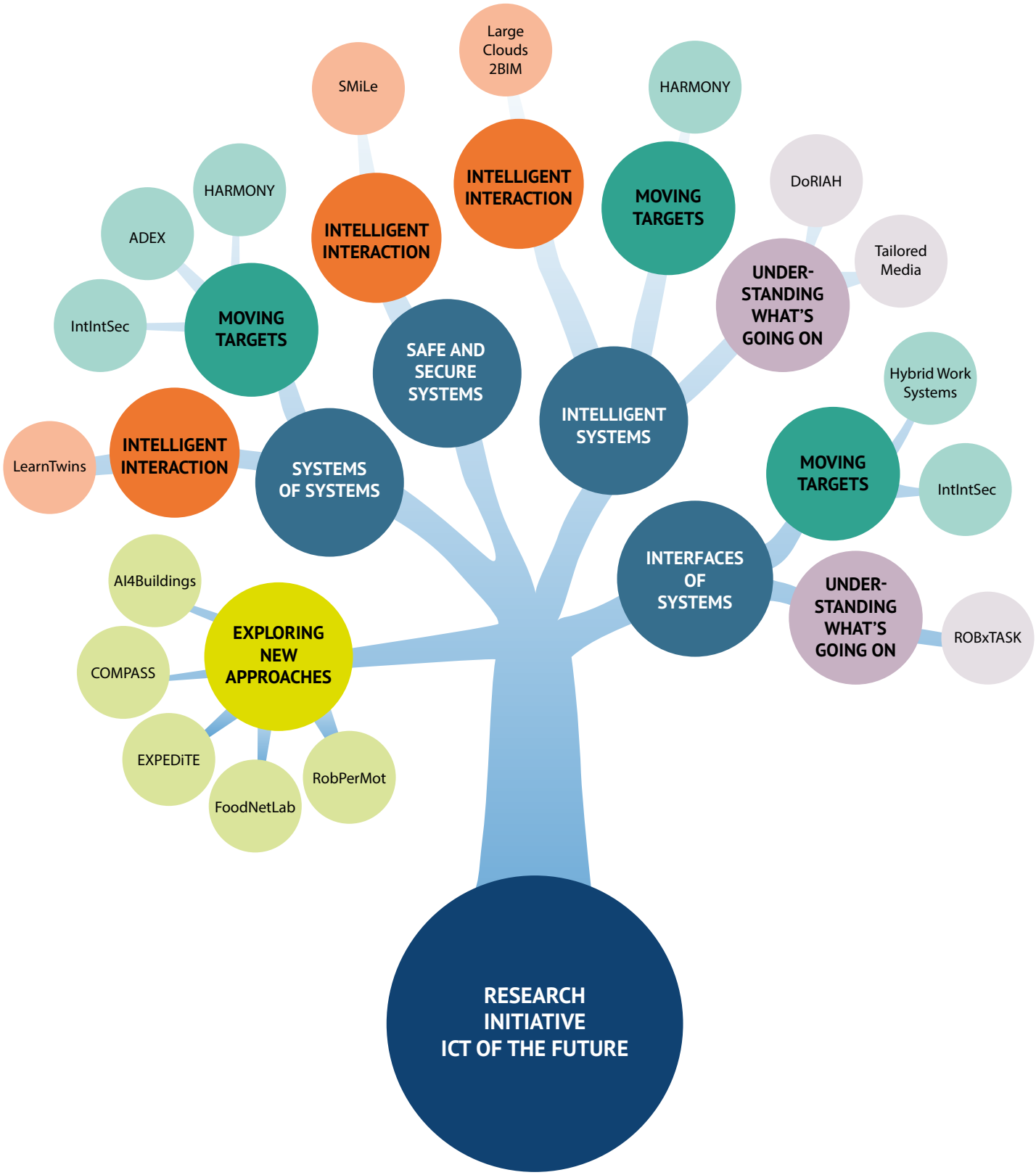
The projects from the 8th Call address the programme's following ICT topic areas (individual projects may cover multiple topics):

- **Mastering Complex ICT Solutions: Systems of Systems**
  - ADEX
  - IntIntSec
  - RobPerMot
  - HARMONY
  - LearnTwins
- **Justifying Trust: Safe and Secure Systems**
  - SMiLe
- **Conquering Data: Intelligent Systems**
  - HARMONY
  - LargeClouds2BIM
  - TailoredMedia
  - AI4Buildings
  - DoRIAH
- **Ensuring Interoperability: Interfaces of Systems**
  - IntIntSec
  - AI4Buildings
  - ROBxTASK
  - Hybrid Work Systems

An evaluation of the application areas being addressed shows that the cooperative R&D projects predominantly focus on surface transport and technology, as well as applications in construction engineering, the workplace environment and space technology.

On the following pages each of the 15 projects offers a glimpse into their research activities, outlining their areas of interest, aims and challenges. The three exploratory projects from the 6th Call which have already been completed can additionally present their results. Further information on the partner organisations, project duration and additional data are all published on the project websites (links provided). According to their content focus and/or application the cooperative R&D projects can be divided into the following three groups:

- **Understanding what's going on:** the projects deal with recording external events and information, and then managing this information appropriately
- **AI-Interaction:** these projects use AI technologies to answer specific project questions
- **Moving Targets:** these projects deal with questions relating to movement in a variety of contexts, from intersections to ergonomics.


RESEARCH INITIATIVE ICT OF THE FUTURE
SAFE AND SECURE SYSTEMS
INTELLIGENT INTERACTION
SMiLe
MOVING TARGETS
HARMONY
ADEX
IntIntSec
SYSTEMS OF SYSTEMS
INTELLIGENT INTERACTION
LearnTwins
EXPLORING NEW APPROACHES
AI4Buildings
COMPASS
EXPEDiTE
FoodNetLab
RobPerMot
INTELLIGENT SYSTEMS
INTELLIGENT INTERACTION
Large Clouds 2BIM
MOVING TARGETS
HARMONY
UNDER-STANDING WHAT'S GOING ON
DoRIAH
Tailored Media
INTERFACES OF SYSTEMS
MOVING TARGETS
Hybrid Work Systems
IntIntSec
UNDER-STANDING WHAT'S GOING ON
ROBxTASK

2 Project highlights from the ICT calls for proposals

FFG project database (only available in German):
projekte.ffg.at/projekt

fig.: Waldhör KG, vecteezy.com

UNDERSTANDING WHAT'S GOING ON

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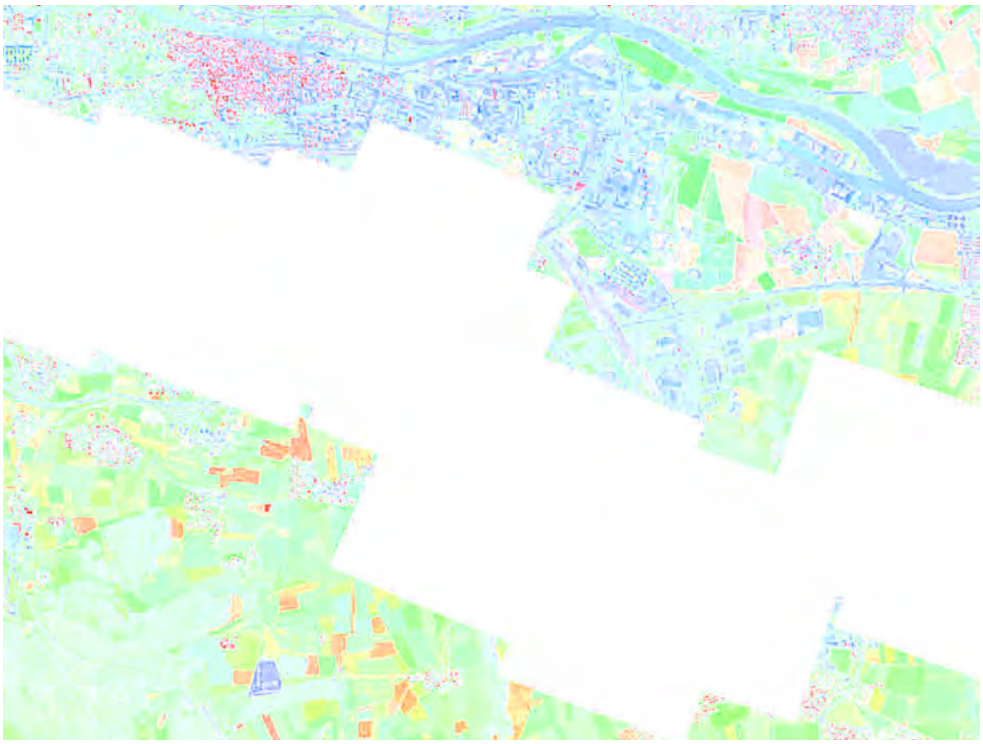
- **EXPEDiTE** 2018 – 2020
  EXPloring opportunities and challenges for Emerging personal DaTa
- **FoodNetLab** 2018 – 2020
  Exploratory Pilot: Food Value Network Innovation Lab
- **RobPerMot** 2021
  Robot embodied persuasion and motivation for sport, post-rehabilitation and work routines

A

DoRIAH

Domain-adaptive Remote sensing Image Analysis with Human-in-the-loop

A project funded under the 8th Call



Georeferencing of aerial images of a flight sequence from World War II
Photo: Luftbilddatenbank Dr. Carls GmbH

Analysing remote sensing images (i.e., aerial or satellite images) on a large scale requires the balancing of two major constraints: accuracy of results and the time it takes to process the images. While human analysts usually provide highly accurate results, manual analysis is often not feasible in large scale scenarios due to the sheer amount of image data to be processed. Fully automatic image analysis approaches are widely considered as a solution, but often lack the accuracy needed for the specific problem domain. Therefore, modern image analysis methods need to be combined with human supervision to cover a wide range of applications.

The DoRIAH research project (Domain-adaptive Remote sensing Image Analysis with Human-in-the-loop) was launched to investigate the analysis of remote sensing images as an interactive process between human and computer (human-in-the-loop). The detection of small-size objects in remote sensing images is a common goal in many different application domains: for instance, detecting bomb craters in aerial images from World War II is essential for carrying out unexploded ordnance (UXO) surveys. In

modern day satellite images, the detection of vehicles provides a rich information source for traffic monitoring or parking lot analysis.

The interactive process for the analysis of remote sensing images involves two basic steps: georeferencing and 3D reconstruction from remote sensing imagery, and interactive detection of objects of interest. DoRIAH implements these two steps as an iterative process with feedback loops designed to introduce human cognitive power into the process. In turn, visual feedback methods allow for the efficient interpretation of intermediate results. DoRIAH is a joint research project conducted by three TU Wien research groups: the Computer Vision Lab, the Centre for Visual Analytics Science and Technology, and the Photogrammetry Research Group. The company Luftbilddatenbank Dr. Carls GmbH is interested in the efficient analysis of historical aerial images and acts as a business partner.

The project is currently in its initial phase. The first, recently completed, user workshop was aimed at analysing future user requirements. This workshop included external user groups from Austria, Germany and the Netherlands and enabled a comprehensive end user requirements analysis. Despite the heterogeneous composition of the user groups, concrete applications have been identified in which DoRIAH can increase the efficiency and quality of the analysis results, for example when creating historical elevation models or analysing changes between two or more successive aerial images.

PROJECT INFORMATION

Duration: 12.2020 – 11.2023
Consortium lead: Computer Vision Lab, Institute of Visual Computing & Human-Centered Technology, TU Wien
Project coordinator: Dr. Sebastian Zambanini
Other consortium partners: Research Group Photogrammetry, Department of Geodesy and Geoinformation, TU Wien; Centre for Visual Analytics Science and Technology, Institute of Visual Computing & Human-Centered Technology, TU Wien; Luftbilddatenbank Dr. Carls GmbH
Project website: cvl.tuwien.ac.at/project/doriah

A

ROBxTASK

Cloud platform for vendor-independent exchange of robot control asks and processes

A project funded under the 8th Call

Robots have highly vendor-specific programming interfaces, requiring special hardware and software development expertise for each type of robotic device and task. However, they **often perform similar tasks** across different domains. A typical example in industrial manufacturing is to pick an object, move it to a destination and place it there - a task that is also common in a social care scenario. At the same time, social robots provide cognitive abilities for human-robot collaboration (HRC), such as gesture recognition or the interpretation of emotions and stress, using camera algorithms and wearable sensors. These capacities are increasingly required when using collaborative robots in industrial production. The **goal of ROBxTASK** is to **decouple** high-level language process models and robot task definitions from the specific robot systems, thus **promoting interoperability by the exchange of structured expertise across different applications**. This is enabled by an interdisciplinary, human-centred and inter-domain approach based on Internet platform technology.

The project is designed to:

- expand an existing **robotic ontology towards new application domains**;
- develop **re-usable translation modules of robot tasks into executable programs for different target systems**;
- offer **web-based services for robot task exchange**;
- enable the **exchange of formalised expert knowledge** via Internet platforms
- **bring together robot and domain experts** across different application domains;
- validate **robot task re-usability** across different social and industrial robotic scenarios in demo labs.

ROBxTASK enables the easy transfer and combination of tasks and capabilities of social and industrial robots.

Domain experts can use ROBxTASK to create templates for robotic tasks including human-machine interaction, which robot programmers can implement with different target systems or in simulation environments. This re-usability **reduces costs**, while also enabling **additional user-centred services** for knowledge transfer, including indexing task modules, step-by-step development of complex task definitions, joint development of

specific robot functions and easy-to-use search functions. The solutions were developed across domains in design fiction and co-creation workshops, where exemplary use cases were defined and subsequently tested on the platform.

PROJECT INFORMATION

Duration: 12.2020 – 05.2023
Consortium lead: Salzburg Research Forschungsgesellschaft mbH
Project coordinator: DI Felix Strohmeier, Salzburg Research
Other consortium partners: AIT Austrian Institute of Technology GmbH; Eberle Automatische Systeme GmbH; Johanniter Österreich Ausbildung und Forschung gem. GmbH; Profactor GmbH; RIC (Regionales Innovations Centrum) GmbH
Project website: www.salzburgresearch.at/projekt/robxtask

top left:
Lehrwerkstätte BRP-Rotax, Photo: BRP-Rotax, Dominik Kusel

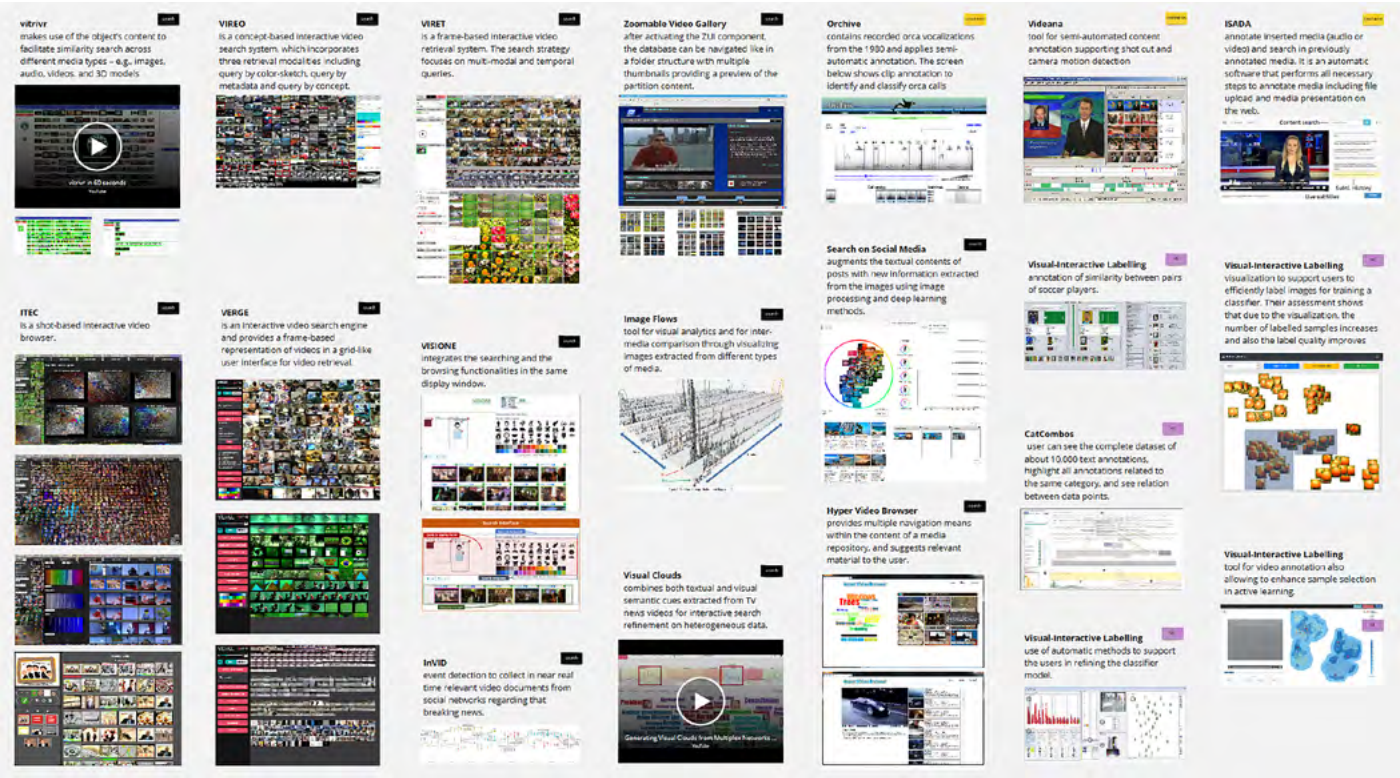
top right:
Qbo_ROBxTASK, PHoto: Salzburg Research

bottom left:
fig.: Salzburg Research, Shutterstock Macrovector Tartila

TailoredMedia

Tailored and Agile enrIchment and Linking fOR sEmantic Description of multiMedia

A project funded under the 8th Call



Visual state-of-the-art in media search and indexing, fig.: Fachhochschule St. Pölten University of Applied Sciences

Film, television and video have become the dominant means of communication in our world today. However, video content must be accurately described so that it can be searched and reused for reprises or as illustrative elements for other purposes. This task is currently performed manually by information specialists, which is very time consuming and only feasible for a limited amount of content. Despite the huge effort, it is still not possible to describe content in detail, e.g., to indicate in which sections of a film or where in the frame a specific politician appears. This situation is further aggravated by the fact that contextual information related to particular content is often distributed across different sources with different structures (e.g., script, journalist's notes) and/or different modalities (e.g., notes as text, audio recording of an interview). Although most content and information sources are already available in digital form, they are often processed independently. This means that information from different sources cannot (or only partially) be combined, making the description incomplete.

The project aims to use state-of-the-art artificial intelligence methods for the automatic analysis of audiovisual content, and to combine them with user interfaces. This enables efficient processes for detailed semantic description and content search, while also addressing the above problems.

The results of the automatic analysis will be used to develop novel methods for fusing multimodal information and storing the information obtained in a knowledge graph. This makes it possible to enrich and enhance content descriptions with semantic metadata (both automatically and involving information specialists) in an intuitive, simple and efficient manner.

The multidisciplinary composition of the consortium led by JOANNEUM RESEARCH ensures the expertise required to achieve the project goal. The project involves two different media organisations, the Austrian Media Library (Österreichische Mediathek) and the Austrian Broadcasting Corporation (ORF). While the Media Library focuses on archiving, the ORF covers the entire media life cycle. Both partners can thus contribute a broad range of workflows, best practices and technical requirements to the project.

St. Pölten University of Applied Sciences will use these inputs to create a user-centred design process for developing user interfaces and workflows. Redlink and JOANNEUM RESEARCH will contribute expertise in semantic technologies and audio-visual content analysis.

The first six months of the project were dedicated to identifying current practices and requirements and exploring methods for automatic analysis together with the two media organisations. These results will be used as a basis to collect and flesh out ideas for user interfaces in a series of co-creation workshops over the next few months.

PROJECT INFORMATION

Duration: 11.2020 – 10.2023
Consortium lead: JOANNEUM RESEARCH Forschungsgesellschaft mbH
Project coordinator: Dipl.-Ing. Georg Thallinger
Other consortium partners: St. Pölten University of Applied Sciences; Austrian Broadcasting Corporation (ORF), RedLink GmbH, Technisches Museum Wien mit Österreichischer Mediathek (Vienna Museum of Science and Technology with Austrian Media Library)
Project website: www.joanneum.at/digital/referenzprojekte/tailoredmedia

B

LargeClouds2BIM

Efficient workflow transforming large 3D point clouds to Building Information Models with user-assisted automatization

A project funded under the 8th Call

The LargeClouds2BIM project explores new highly automated approaches for creating building information models (BIMs) from 3D scans comprising several hundred million points.
fig.: Institute for Interdisciplinary Building Process Management - Integrated Planning and Industrial Building (TU Wien)

On average, a large construction project exceeds the original cost framework by 80%, and takes 20% longer to complete than planned. Digital technologies promise to overcome this unsatisfactory situation. In fact, 3D scanners and building information models (BIMs) have now become common on large construction sites and in building maintenance. With the rapid progress of 3D measurement technology, 3D scanners are delivering more accurate and high-resolution 3D point clouds than ever before. The automated transformation of these datasets – each comprising several hundred million 3D points – to the virtual BIM reality is still an unsolved problem. The main challenges include time-consuming pre-processing steps, the lack of tools for merging 3D recordings, various time and cost-intensive and error-prone manual steps, as well as lack of user-friendly interfaces.

LargeClouds2BIM addresses these challenges by designing a new and efficient workflow for the highly automated transformation of huge, unorganised raw 3D point clouds into BIMs. With an interdisciplinary team and the active involvement of future users, LargeClouds2BIM develops algorithms and data structures for the progressive, real-time visualisation of massive point clouds, allowing the users to work on such data without significant pre-processing time. The robust and precise registration of multiple 3D point clouds with similarity transformations makes data capture more independent of specific 3D scanner technologies. The project combines minimal user input with powerful optimisation methods drawn from geometry processing, following a novel

approach to user-guided reconstruction of BIM objects from 3D point clouds. And finally, LargeClouds2BIM also explores flexible and active interfaces to open and proprietary BIM ecosystems.

At the system level, the project aims to investigate and provide (lab-scale) proof of concept of the proposed innovative workflow for the transformation of huge 3D point clouds to BIMs. At the component level, the interdisciplinary project team is developing theoretical concepts and prototypical implementations of algorithms and data structures for progressive real-time visualisation, similarity transformation registration, largely automated reconstruction of BIM objects, as well as user-friendly, active interfaces to open and proprietary BIM ecosystems. The final evaluation of the entire workflow will investigate to what extent the higher degree of automation, flexibility and accuracy can achieve the expected cost and time savings of an estimated 20-30%.

PROJECT INFORMATION

Duration: 10.2020 – 11.2022
Consortium lead: Rechenraum GmbH
Project coordinator: Dr. Simon Flöry
Other consortium partners: Institute for Interdisciplinary Building Process Management - Integrated Planning and Industrial Building (TU Wien); Institute of Visual Computing and Human-Centered Technology (TU Wien); LN2 Baumanagement GmbH; Point of Measure GmbH
Project website: n. a.

B

LearnTwins

Learning Digital Twins for the Validation and Verification of Dependable Cyber-Physical Systems

A project funded under the 8th Call

Digital twins of the vehicle and the test bed, Photo: AVL List GmbH

Le@rnTwins

Digital twins are realistic digital representations of real-world systems and are mainly used in the industrial sector. They allow system behaviour to be analysed and predicted without the need for access to the system itself. This can be helpful during development when the overall system does not yet exist, and for customer systems that are not accessible, or where downtime should be kept to a minimum.

Digital twins are relatively inexpensive to create where they can be derived and simulated directly from artefacts created during development. In many cases, however, this is not fully possible – e.g., where no artefacts are available for purchased components, or no models have been created for specific physical parameters during development.

The LearnTwins project aims to support the creation of digital twins. Different machine learning techniques are used to contribute the missing parts or aspects for the desired digital twin.

The project will develop new learning methods and recombine existing learning algorithms to address, in particular, the different characteristics of the different system aspects: discrete behaviour, which is based on countable system states (automata learning), and continuous behaviour, which is typical of physical parameters such as temperature, response time or power consumption (classical machine learning, deep learning). The training data include data from operation as well as results from tests carried out specifically for the learning process.

The trained digital twins will be used for quality assurance, safety and security analyses and for predicting the effects of changes such as new functions.

Three use cases have been defined for evaluation: industrial measurement systems for the project partner AVL, electronic systems in modern passenger cars, and smart home control systems.

The key aspects in the development of learning methods are reliability, understandability, and user acceptance of the trained digital twins.

Technical work is therefore embedded in a foresight process. The plan is to involve stakeholders who actively work out desired futures and strategies for the technology. The first such workshop, with 45 participants from different sectors of society, was held in April 2021 and has led to a number of insights which will inform the technical work.

The results of the project will allow high-quality and reliable digital twins to be created faster and more economically, and accelerate the digital transformation of product artefacts. The results relating to the understandability of automatically learned models should encourage greater acceptance and more targeted use of learning-based methods.

PROJECT INFORMATION

Duration: 12.2020 – 11.2023
Consortium lead: AIT Austrian Institute of Technology GmbH
Project coordinator: Dipl.-Ing. Rupert Schlick
Other consortium partners: Graz University of Technology (TU Graz), Institute of Software Technology
Project website: learntwins.ist.tugraz.at

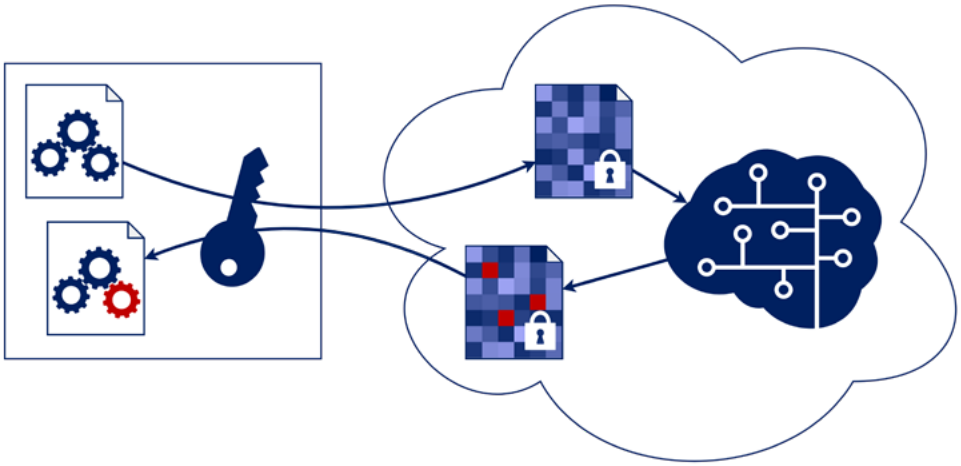
Test bed for electric drives, Photo: AVL List GmbH

B

SMiLe

Secure Machine Learning Applications with Homomorphically Encrypted Data

A project funded under the 8th Call



Homomorphically encrypted data can be shared with another party (cloud to the right) for processing and computations. The results of these computations are also encrypted and thus protected from unauthorised access. Other scenarios may include combining data from different actors or results being used by a third party. fig.: Fraunhofer Austria Research GmbH

Companies increasingly depend on their ability to leverage data to improve their efficiency and create innovative services in order to succeed. Data must be combined across organisational units and beyond company boundaries if the enterprise is to profit from the opportunities offered by machine learning. Data sharing is difficult, however, especially when it comes to sensitive data. Legislation such as the GDPR requires organisations to take appropriate security measures, and essentially restricts the use and sharing of data. Companies also have a strong interest in protecting their intellectual property and are therefore reluctant to share their data. Given this situation, it is not surprising that the potential offered by the data that companies gather and store remains largely unexploited. The researchers involved in the SMiLe project aim to show how, in the future, this potential can be harnessed to a greater extent.

So-called 'homomorphous encryption' offers a promising approach to achieving this goal. Data encrypted in this manner are protected from unauthorised access, but can still be used for computations. The results of these computations are also encrypted and thus protected. To date, this approach has mainly been explored in theoretical studies, with the practical expertise and appropriate software still lacking. By addressing both these factors, **SMiLe** will create an essential basis for the practical use of machine learning on encrypted data

The project investigates the conditions under which solutions using homomorphically encrypted data can help exploit sensitive data for machine learning applications. The focus is on the further development of relevant software components as well as the transfer of relevant know-how. Two use cases will assess the potential of this approach for machine learning: workforce segmentation and predictive machine maintenance. The project will address technical as well as social, legal and economic issues. The researchers will evaluate the solution approaches in terms of their analytical capabilities, performance and scalability, as well as their cost-effectiveness, transparency and ease of use. The advantages and disadvantages of machine learning using homomorphically encrypted data will be compared to alternative approaches.

SMiLe therefore helps to establish a cooperative-creative ecosystem in which different actors interact in a trustful, symbiotic and autonomous manner, realising previously unimaginable solutions which not only guarantee privacy and security, but also exploit hitherto untapped data potentials.

SMiLe

PROJECT INFORMATION

Duration: 04.2021 – 09.2023
Consortium lead: Fraunhofer Austria Research GmbH
Project coordinator: Dr. Daniel Bachlechner
Other consortium partners: MCI Management Center Innsbruck Internationale Hochschule GmbH, Software Competence Center Hagenberg GmbH, VRVis Zentrum für Virtual Reality und Visualisierung Forschungs-GmbH, CORE smartwork GmbH, Fill GmbH, Tributech Solutions GmbH
Project website: fraunhofer.at/de/forschung/digitalisierung_und_ki/SMiLe.html

ADEX

Autonomous Driving Examiner

A project funded under the 8th Call

Smart mobility, using highly automated vehicles, is a top priority for our modern society. It promises the ability to dramatically reduce accidents and fatalities, as well as pollution. At the same time, it also represents one of the greatest technological challenges of our time. While much progress has been made over the past few years, accidents involving automated vehicles clearly reveal the weaknesses in the current state-of-the-art of autonomous driving. The use of machine learning components and the operation of automated vehicles in complex environments, involving pedestrians, cyclists and human drivers, gives rise to serious safety concerns.

This raises the question of whether we will ever be able to fully trust autonomous-driving controllers.

To answer this question, we should first ask ourselves how society has developed trust in human drivers, who must demonstrate their abilities in a driving test before they are allowed to take to the road.

Based on this analogy, the ADEX project aims to develop an examination method for automated driving. At the core of this approach is an autonomous examiner, i.e., a programme unrelated to the specific design of the autonomous-driving controller being tested. The driving test consists of a large set of realistically simulated traffic situations,

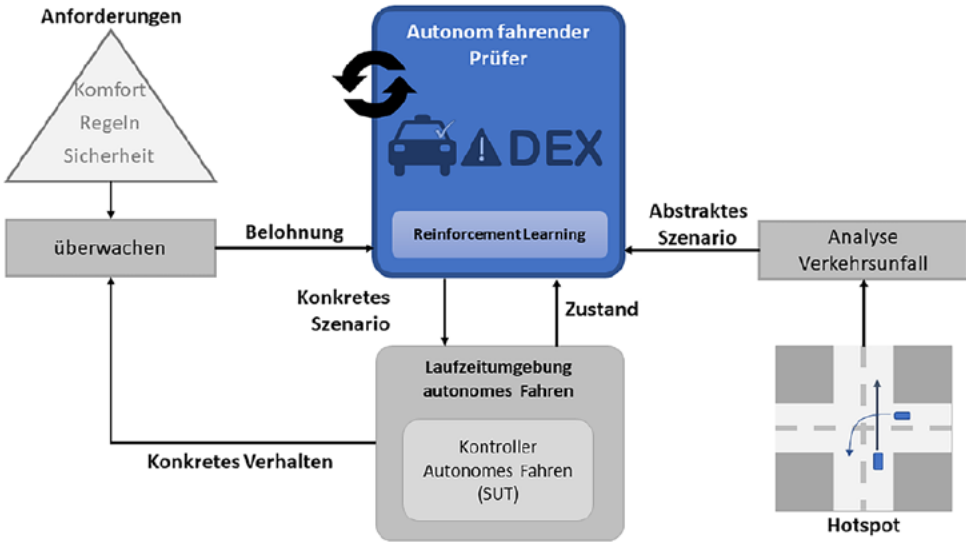


Figure 1: Overview of the ADEX approach

or scenarios, incorporating human behaviour models for pedestrians, cyclists and drivers of other vehicles, and for different weather and road conditions. These scenarios will contain both normal traffic situations and challenging edge case scenarios which allow hidden problems to be detected.

Both the concept of an autonomous examiner for automated driving and the manner in which the examiner is synthesised are highly innovative. The architecture of the proposed solution is shown in Figure 1:

- Real-world traffic accidents at hot spots are analysed using holistic accident analysis and used for synthetically creating new, realistic, and critical traffic scenarios and driving sequences for the test.
- Actions of the autonomous-driving controller are thoroughly quantified in the form of rewards which are used by reinforcement learning algorithms to generate increasingly complex traffic situations.
- In order to assess the behaviour of the autonomous-driving controller and create appropriate rewards, several criteria including safety, traffic regulations, ethical aspects of decision making and passenger comfort are taken into account.

As is the case for human drivers, we, as a society, will have greater trust in the reliability of autonomous-driving controllers which successfully pass this test, making us more willing to accept such systems on our roads. Failure to pass the test, on the other hand, will reveal problems that still exist with autonomous driving and provide engineers with valuable information for improvement.

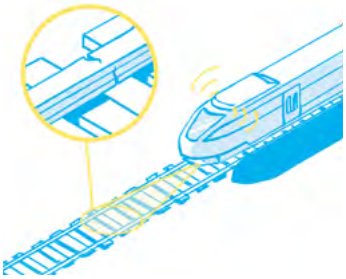
PROJECT INFORMATION

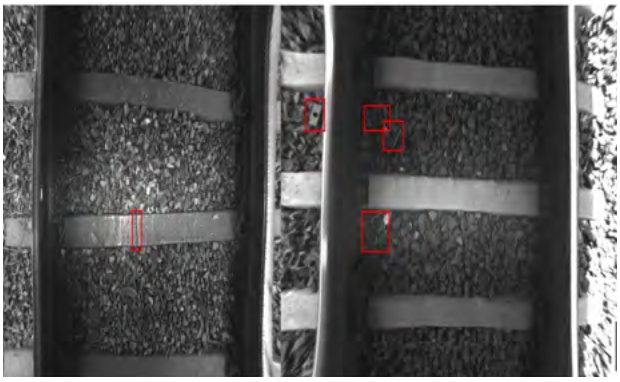
Duration: 11.2020 – 10.2023
Consortium lead: AIT Austrian Institute of Technology GmbH
Project coordinator: Dr. Dejan Ničković
Other consortium partners: AVL List GmbH, Vienna University of Technology (TU Wien), SV Univ.-Prof. DI Dr. Ernst PFLEGER
Project website: projekte.ffg.at/projekt/3851889

HARMONY

Human-Assisted Real-time MONitoring of infrastructure and obstacles from railwaY vehicles

A project funded under the 8th Call





Left:
The cost-efficient and compact onboard monitoring system scans the tracks during regular operation using sensor technology and artificial intelligence.

Right:
The system detects cracks, foreign objects or other anomalies on the track infrastructure.

The railway is the primary mode of transport for tackling the climate crisis without restricting the mobility of people or goods. Safety and reliability play an important role in this context, and can only be guaranteed through careful maintenance of the rail infrastructure. Maintenance methods to date consist of frequent surface checks by the rail operator's staff, and irregular precise monitoring using cost-intensive measuring vehicles. However, this model is reaching its economic limits.

The FFG project HARMONY (Human-Assisted Real-time MONitoring of infrastructure and obstacles from railwaY vehicles) is developing a more efficient and economical method for monitoring rail infrastructure. The new method involves mounting an intelligent sensor system on regular trains, which scans the tracks during normal operation and uses artificial intelligence to automatically detect and report anomalies on tracks, track beds and switches. In this way, potential hazards such as track breaks, track damage or vegetation growth can be detected at an early stage. This helps rail operators to make informed decisions with respect to necessary maintenance work, while also reducing accident risks and downtimest.

Intelligent sensor data processing on the moving train requires solutions for selecting the appropriate data analysis tools, sensor correlation methods, data interpretation and synchronisation methods, while taking into account economic constraints and the stringent demands on robustness, performance, and dependability. The project also addresses human factors to increase end-to-end system security and user acceptance. A key element here is the development of the new role of the remote analyst, providing remote support in the decision-making process. This new role is also relevant for AI applications in other areas where intelligent machines are used.

The research results from this innovative project will provide a sound basis for seamless and cost-efficient track monitoring, as well as safer and more reliable railway operation.

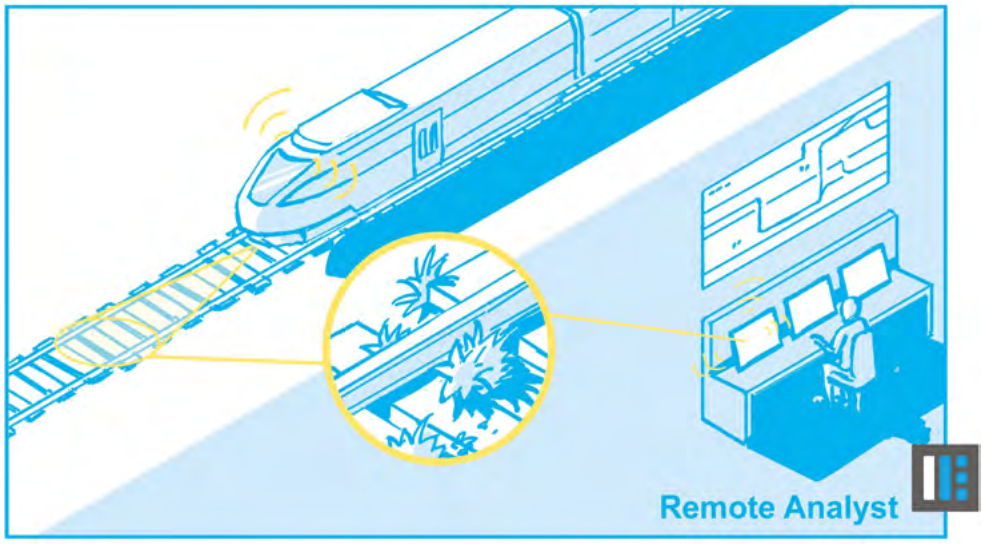
As the consortium leader and pioneer in the field of intelligent sensor and assistance systems for the railway sector, Mission Embedded has the primary responsibility for the technical development of the project.

The TU Wien Institute of Computer Technology is contributing its long-standing research know-how and extensive expertise in embedded systems, sensor technology and embedded machine learning.

Backed by decades of experience in safety-critical environments, Frequentis Control Room Consulting addresses key issues of user acceptance, data visualisation and defining the role of the remote analyst.

PROJECT INFORMATION

Duration: 07.2020 – 12.2022
Consortium lead: Mission Embedded GmbH
Project coordinator: Jenny Vuong, PhD
Other consortium partners: TU Wien, Institute of Computer Engineering; Frequentis Control Room Consulting
Project website: n. a.

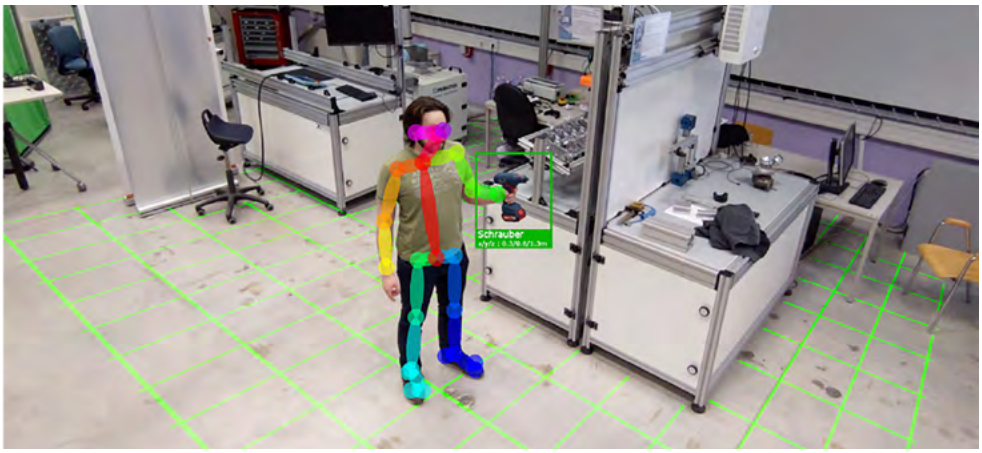


The remote analyst is a new role designed to seamlessly integrate intelligent machines into regular operation.

Hybrid Work Systems

Platform-based AI System for Human Motion Analysis to optimize Ergonomics of Hybrid Work Systems

A project funded under the 8th Call



Video-based activity tracking, fig.: Profactor GmbH

Hybrid Work Systems

Hybrid Work Systems: Safe and ergonomic production

Increasing automation is turning factories into complex socio-technological environments. The workers and their needs should be placed at the centre of a safe and human-friendly production environment. The Hybrid Work Systems project aims to improve the infrastructure, logistics and above all ergonomics of human/machine processes.

Industrial processes are becoming increasingly intelligent, so that more and more people are working with collaborative robots and are assisted in their work by information systems. Many industrial companies are already using complex simulations to model individual production steps and optimise path planning and ergonomics. The results of the Hybrid Work Systems project will be used to automate and simplify video-based motion analysis of production activities and the semantic description of work processes using artificial intelligence. Based on the current state-of-the-art and recent research findings, the project team will develop an extended, standardised, and formal layer model of industrial processes. This model can be used to describe assembly processes, assistive interventions, ergonomic improvement potentials as well as human/machine interaction in collaborative robotics. This allows companies to plan and optimise individual assembly steps and to protect their workforce against long-term health effects. The technology developed in this project will be made available to industrial companies as a digital service via a cloud-based Industry 4.0 platform.

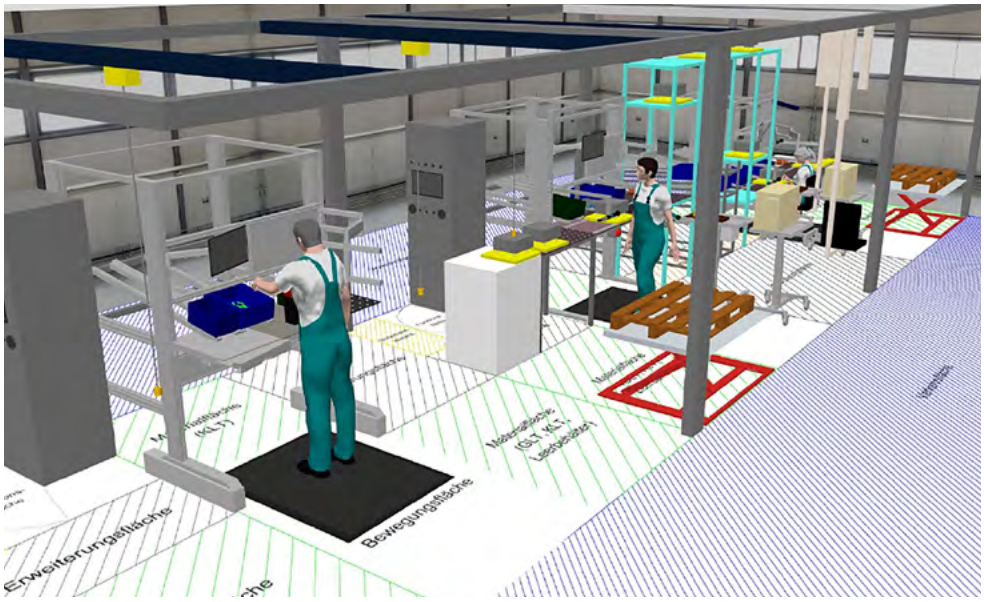
Technological goals of Hybrid Work Systems:

1. Integration profiles and interface engines for hybrid human/machine processes
2. Video-based motion analysis for industrial activity detection
3. Semantic description of industrial processes for detailed process design
4. Interfaces for human-machine situation awareness in production environments
5. Interoperation of motion analysis, cognitive and semantic models
6. Integration into a European production platform and validation

The project leverages the know-how from Austrian flagship projects and establishes interfaces to the EU's EFPF – European Factory Platform, a digital ecosystem for the European manufacturing industry. The results will be directly fed into the Digitising European Industry initiative and will also be applicable to other sectors.

PROJECT INFORMATION

Duration: 03.2021 – 02.2023
Consortium lead: Salzburg Research
Project coordinator: Mag. Wernher Behrendt
Other consortium partners: Fraunhofer Austria Res GmbH (AT); imk automotive GmbH (DE); INNIO Jenbacher GmbH & Co OG (AT); MTM ASSOCIATION e. V. (DE); PROFACTOR GmbH (AT); BRP Rotax GmbH & Co KG (AT)
Project website: n. a.



Workplace design and simulation, fig.: imk automotive GmbH

IntIntSec

Intelligent InterSection

A project funded under the 8th Call

Photo:
chris-dickens/unsplash.com

Increasing volumes of traffic in inner-city areas aggravates the tensions between safety, traffic efficiency and environmental pollution. While intersections are critical nodes in traffic networks, most of them are simplified and only controlled via fixed, pre-defined traffic light phase schedules. Inflexible, sub-optimal traffic light control can lead to unnecessary traffic jams and vehicle emissions. The individual needs, requirements, and possibilities for different road users (e.g., connected vehicles, pedestrians, cyclists, scooters, etc.) are not properly considered. Modern ICT, communication and control concepts offer the potential to comprehensively manage intersection traffic in real time, to consider the requirements of all road users, interpret the situations accurately, and to implement individual, coordinated and cooperative control strategies to achieve a holistic optimum.

The project aims at developing novel, integrated and flexible communication, control and simulation methods to implement the "intelligent intersection" system: available real-time information of the positions, speeds and expected behavior of many different road users will be collected, linked and used in real time in order to simultaneously

1) ensure traffic safety for all road users,

2) regulate the resulting traffic flows efficiently, and thus

3) minimize the overall energy consumption and emissions of the road users due to the intersection passage.

The involvement of the many, heterogeneous relevant stakeholders in terms of human-centered design, the effective technical design and solution of the required optimization, control, and communication approaches, and the evaluation of these solutions go far beyond the state of the art and require the R&D work within this project.

Context information (time of day, weather, regional traffic volume) is combined with real-time data provided by on-board sensors (e.g., from connected vehicles with assistance systems) or innovative traffic monitoring systems (e.g., for pedestrians or cyclists). This comprehensive approach makes it possible to capture the intersection situation in more detail, control traffic more efficiently and resolve dangerous situations or even prevent them from occurring in the first place. To this end, the project also aims to develop new communication methods to enable interaction with the different road users. IntIntSec will not only provide design methods for intelligent intersections but will also quantify the added value for the various groups of road users (including pedestrians), residents, operators, public actors and traffic planners, and develop an interdisciplinary, inclusive methodology for obtaining these findings.

PROJECT INFORMATION

Duration: 10.2020 – 10.2023
Consortium lead: TU Wien, Institute of Telecommunications
Project coordinator: Univ.Prof. Dr.Christoph Mecklenbräuker
Other consortium partners: TU Wien - Institute of Mechanics and Mechatronics, Swarco Futurit Ges.m.b.H, ANDATA, Austrian Road Safety Board (KfV), komobile W7
Project website: nt.tuwien.ac.at/intintsec

D

AI4Buildings

Artificial Intelligence for Digital Planning of Buildings

A project funded under the 8th Call

Project description

The quality of a digitally designed building is determined as early as the planning stage. It starts with a preliminary design, and extends to the detailed design of the architecture and building services. Given that the building stock represents the largest potential for energy savings and the integration of renewable energy sources, two factors have significant leverage when it comes to the energy performance of buildings:

1. Renewable energy and energy efficiency measures are subsidised in Austria. The amount of subsidies is a decisive factor when it comes to implementing these systems and measures, but requires a thorough understanding of the subsidies available for the specific location, building type and other parameters. Our project aims to develop a tool that makes it easier for future building owners to search for subsidies. This requires an AI-based information retrieval system which automatically extracts all subsidies available for the planned project, together with other relevant parameters (funding amount, deadlines, conditions etc.) in real time, via a web-based interface.
2. BIM (building information modeling) is the method of choice in digital planning. The established open standard for BIM is IFC (Industry Foundation Classes). The quality of IFC-based BIM models, however, varies significantly due to different processes. Definitions of important elements such as IFC spaces or relationships between elements (e.g., to which storey a wall belongs) are often lacking, and some relationships are not defined in IFC at all (e.g., which room is directly accessible from another). This information is, however, important for automatically verifying specific parameters, such as the prescribed length of escape routes (OIB Fire Safety Regulations). Our aim is to improve the quality of IFC-BIM models using geometric algorithms and machine learning approaches.

The AI4Buildings exploratory project provides the basis for developing an application for a follow-up project, for which we are constantly looking for potential project partnerswerden.

First results

- We have developed a workflow based on classical geometric algorithms which extracts wall elements from IFC files and calculates the spaces from the geometric parameters. Our prototype is able to write the recognised spaces back to the IFC file, thus enhancing the IFC model with additional information.
- We have developed a graphical user interface (GUI) to demonstrate the program prototype, see Figure.

The GUI (graphical user interface) of our space recognition program, which enhances IFC files with missing space definitions.

- To solve the information retrieval problem concerning funding options, we have written a Python script for importing relevant websites of the individual federal provinces into a local database. We initially focused on the document relevance calculation. The classical TF-IDF algorithm was implemented as a reference and used for testing several vector embedding techniques. These methods map texts extracted from websites to a vector space and subsequently calculate the text similarities of algebraic vectors (using Euclidean distance or cosine similarity) in this vector space. Two neural NLP methods were analysed for vector space mapping (embedding): Fasttext and Google's BERT (Bidirectional Encoder Representations from Transformers). To enable a fast search for similar vectors, we save the embedding vectors to a Milvus database developed specifically for the scalable storage of embedding vectors and fast (nearest neighbour) search functionalities.

PROJECT INFORMATION

Duration: 10.2020 – 09.2021
Consortium lead: AIT (Austrian Institute of Technology GmbH)
Project coordinator: Dr. techn. Adam Buruzs
Other consortium partners: n. a.
Project website: n. a.

D

COMPASS

Cooperative Design Spaces for Next Generation Internet-of-Things Solutions

A project funded under the 6th Call

NGI-Talk,
Photo: Sela Krobath

The Internet of Things (IoT) is driven by technological opportunism, characterised by the promise of ubiquitous connectivity. This makes it a major challenge to create meaningful technology for people. While some applications have succeeded in creating value for people, businesses and society, many others are reminders that not everything that can be done need be, or should be, done.

The COMPASS project has developed a guiding compass to navigate the vast opportunity space provided by IoT in order to create innovative applications that are valuable, meaningful, empowering and trustworthy, to maximise their utility and reflect responsible innovation.

Business-oriented approaches to human-centred and responsible technology innovation and design were investigated based on an analysis of socio-technological negotiation spaces.

Six stakeholder interviews with representatives from industry (large companies and SMEs) and public administration were conducted and evaluated to identify the status quo. The results were compiled in an empirical study on value-based technology development in the field of IoT, taking into account the influence and understanding of social, political and technological values between society and technology.

Another focus was placed on university education by integrating digital humanities and social technology design aspects in topics for Bachelor's and Master's thesis as well as courses in the computer science curriculum.

The project team also explored participative formats designed to create negotiation spaces in the development of IoT solutions. Two of these formats were elaborated and implemented as examples. A technical probe was developed together with a start-up company to enable critical examination of potential fields of innovation. The developed concept shows how companies can drive their innovations in specific target contexts by considering societal aspects and involving potential users.

The project also aimed to address policy makers and make both general and specific policy recommendations for regulating the IoT sector.

A key aspect of the project was to promote public discourse on responsible technology development by organising and participating in relevant events designed to share the topics discussed in the project with the wider public.

PROJECT INFORMATION

Duration: 10.2018 – 11.2019
Consortium lead: AIT Austrian Institute of Technology, Center for Digital Safety & Security
Project coordinator: Dr. Mario Drobics
Other consortium partners: University of Vienna, Cooperative Systems Group; TU Wien, Human Computer Interaction Group; Research Institute; OCG Österreichische Computer Gesellschaft
Project website: compass-project.at

Digital Days, Photo: AIT

D

EXPEDiTE

EXPloring opportunities and challenges for Emerging personal DaTa Ecosystems: Empowering humans in the age of the GDPR — A Roadmap for Austria

A project funded under the 6th Call

Human-centric Roadmap for Digital Economy

Personal data have become a primary economic resource in our increasingly digital society and many Internet users are unaware of the extent to which their data can be traced back to them online. The European Union passed the General Data Protection Regulation (GDPR) in 2018 with the aim of enabling more human-centred governance and defining more explicit rules for the handling of personal data in the business sector. This represents a first step towards a fair and human-centred market for personal data in Europe.

The EXPEDiTE project examined the online processing of personal data in Austria, including potential drivers for data ecosystems, from an interdisciplinary perspective, involving different theories and methods drawn from IT, computer science, cognitive science, digital law, science, technology and society studies, and other social sciences.

The project consisted of six work packages, including project management (WP1):

- WP2 focused on identifying key data processors as defined by the GDPR in Austria using an online field search. A survey was conducted on a representative sample of Austrian Internet users regarding the persons responsible for the processing of personal data and the protection of users' privacy. This provided a human-centred perspective on privacy and online behaviour and the most appropriate controllers from the users' viewpoint.
- WP3 involved consulting the list of target controllers for further GDPR-oriented studies in which the participants requested their data from different data controllers in Austria.
- WP4 aimed to examine the technical fundamentals of human-centred personal data ecosystems (PDEs).
- WP5 investigated the gaps, barriers and opportunities associated with human-centred data ecosystems in Austria by devising a conceptual model of the key stakeholders based on a theoretical literature search and workshops with citizens and experts.
- WP6 focused on establishing the **MyData Hub Austria** in order to ensure the sustainability of the project results by building an interdisciplinary community. In addition to publishing scientific works and organising academic and non-academic events, the project results were combined to develop a Human-centric Roadmap for the Digital Economy which discusses the visions, gaps, barriers and opportunities of a human-centred and sustainable digital transformation, and represents an Austrian/European perspective on digital sustainability.

MyData Austria
From vision to action – future is now

PROJECT INFORMATION

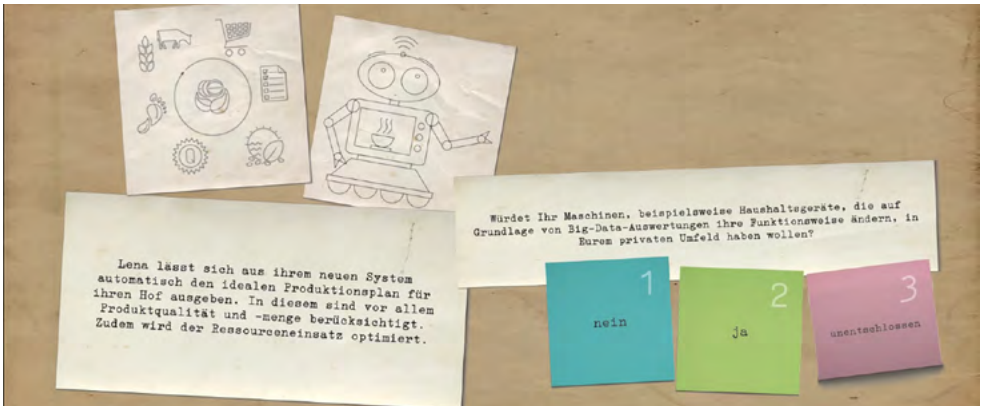
Duration: 09.2018 – 02.2020
Consortium lead: Sustainable Computing Lab, Vienna University of Economics and Business (WU Wien)
Project coordinator: Soheil Human, MSc.
Other consortium partners: TU Wien, Own Your Data
Project website: expedite-project.eu

D

FoodNetLab

Exploratory Pilot: Food Value Network Innovation Lab

A project funded under the 6th Call



Visualisation of the museum installation which is based on the children's show „1, 2 oder 3".

The food industry is of significant economic and social importance to Austria. According to Statistics Austria, in 2016 private households spent around 16 billion euros on food. The new information and communication technologies will bring about diverse changes in the future, e.g., by enabling food personalisation, direct contact between producers and consumers, and the increasing use of smart solutions across the supply chain and by consumers.

The project was designed to develop and discuss future scenarios with representatives of the food supply chain (e.g., food producers), the supporting industry (e.g., refrigeration system suppliers) and experts from politics, education and public relations, which were subsequently evaluated by citizens in a game-based environment. In a first step, potential factors influencing the developments were identified and discussed with some 50 experts in focus group workshops. The participants classified 40 factors as relevant or highly relevant to the future of the food industry. For example, the increasing traceability of logistic processes was considered a central issue. Experts believe that new sensor data and information sharing along the supply chain will create a completely new level of transparency, which goes far beyond current statutory traceability requirements. This approach will give both producers and consumers a clear picture of the condition and quality of raw materials and food products at any point in the supply chain.

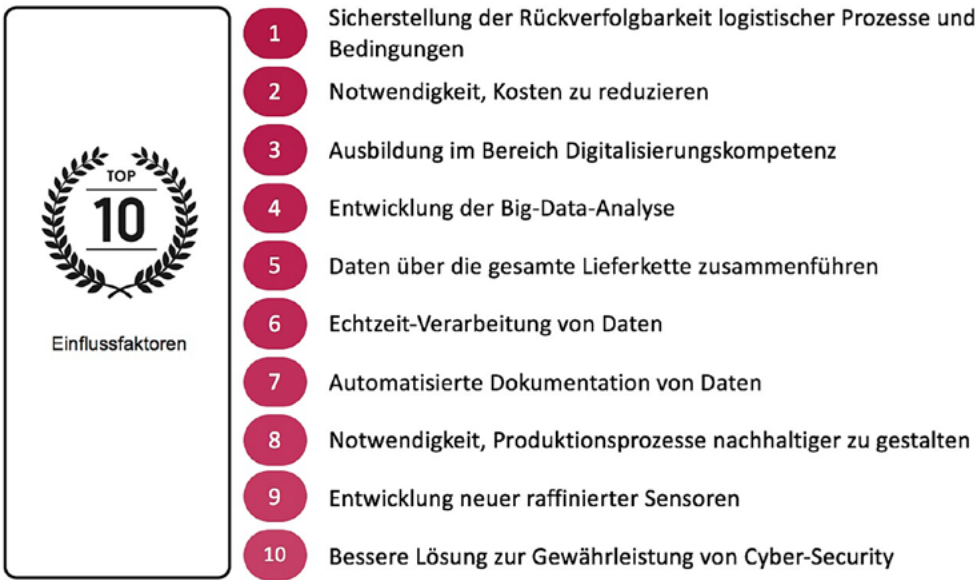
The relevant influencing factors were assessed for mutual relationships in an online survey conducted among employees of the participating organisations. These relationships were subsequently investigated in more detail using network analysis. Four clusters of related influencing factors were identified: (1) online commerce, (2) data integration for the customer's benefit, (3) quality assurance & transparency, and (4) data

integration for increased production efficiency. Experts then designed basic scenarios for each of these clusters, which served as a basis for developing a game-based installation at the Welios museum in Wels. The installation allowed players to implicitly let the research team know what they think about desired developments in the food sector.

The results of the project provide industry representatives with a picture of current opinions on various aspects of the emerging digital transformation in the food sector, thus also supporting them in developing their specific business strategies. The findings also provided a basis for establishing an innovation lab at the Wels Campus of FH Upper Austria, which opened in 2021.

PROJECT INFORMATION

Duration: 10.2018 – 02.2020
Consortium lead: FH OÖ Forschungs & Entwicklungs GmbH
Project coordinator: FH-Prof. Dr.-Ing. Katrin Mathmann & FH-Prof. Dipl.-Wirtsch.-Ing. Dr. Christiane Rau
Other consortium partners: n. a.
Project website: n. a.



At the end of the focus group workshops, the experts identified the ten most relevant influencing factors for ICT developments in the food sector in an anonymous survey.

D

RobPerMot

Robot embodied persuasion and motivation for sport, post rehabilitation and work routines

A project funded under the 8th Call

Photo: SPORTUNION Niederösterreich

While collaborative robot systems are already successfully used in industrial manufacturing, the social qualities of human-robot interaction in private life, sports or at work are not yet widely exploited. The RobPerMot project aims to investigate a potential robot-based implementation of persuasion and coaching strategies (e.g., reward systems) in various contexts.

Existing persuasion strategies and motivation systems used in health, leisure, sport and work contexts rely mainly on screen-based virtual applications, e.g., training apps on smartphones. Practice has shown, however, that such strategies often fail to have a long-term effect on user motivation. The project consortium investigates the effects of robot-based coaching and training approaches on the motivation of end users in different scenarios, starting with the sport and rehabilitation sector.

In order to increase the acceptance of robot-based services, end users must perceive them as useful and in line with their needs. The RobPerMot project therefore evaluates how such persuasion strategies can be leveraged to enhance motivation in sports and ultimately lead to health improvements. The robot should in no way be considered as a competitor to human experts; instead, robot-based coaching and training are designed to support the highly sought-after experts in their work and alleviate some of their burden.

Firt results

Three workshops have already been held to identify the different needs of coaches in the fields of competitive, team and health sports. The workshop participants discussed how coaches and humanoid robots can work together as a team in the future. The workshops resulted in the definition of three use cases which will be further elaborated, implemented as prototypes and evaluated together with coaches and athletes. The three use cases are: reaction training (the robot is used for reaction training in ball sports and is controlled by the coach), children training (the robot is used to provide variety in children training by executing scripted processes, e.g., musical chairs, motivation games, exercise instructions) and circuit training (the robot is used to support circuit training).

PROJECT INFORMATION

Duration: 01.2021 – 12.2021

Consortium lead: AIT Austrian Institute of Technology GmbH

Project coordinator: Dr. Andreas Sackl

Other consortium partners: Profactor GmbH, Sportunion Niederösterreich

Project website: ait.ac.at/themen/experience-measurement/projecte/robpermot

RobPerMot project team © SPORTUNION Niederösterreich
(from left: Andreas Sackl (AIT, Center for Technology Experience), Markus Skorsch (SPORTUNION Niederösterreich), Christian Wögerer (Profactor), Johann Schrammel (AIT, Center for Technology Experience), centre: robot „Pepper".)

3 Contacts

fig.: Waldhör KG, vecteezy.com

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