Press release

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THE AUTONOMOUS FORKLIFT

The Austrian Institute of Technology and its partners are automating a portable forklift. For the first time, it makes automated loading and unloading in outdoor operations possible and should relieve the logistics industry.

In a successful research cooperation lasting several years, scientists: inside at the AIT Center for Vision, Automation & Control, together with industry and research partners, have developed an intelligent automation concept that revolutionises loading and unloading processes in outdoor areas. The automation of a truck-mounted forklift enables the efficient and flexible handling of goods and objects, especially in situations where there is a lack of logistical infrastructure and personnel.

Vienna (AIT): The timely and efficient execution of transport and logistics tasks is the backbone of the flow of goods in companies. The loading of goods often takes place outdoors and is done manually using forklifts or loading cranes. However, the truck drivers do not always find the appropriate infrastructure to load the goods quickly when they arrive. Not infrequently, there is simply a lack of personnel.
Together with their partners at Industrie-Logistik-Linz GmbH, FH OÖ Forschungs & Entwicklungs GmbH, Palfinger Europe GmbH, AGILOX Services GmbH and DB Schenker, the researchers at the AIT Center for Vision, Automation & Control (VAC) set themselves the goal of advancing the automation of loading and unloading processes in order to increase efficiency and flexibility in the logistics and transport industry. The focus of the research cooperation, which lasted several years and has now been successfully completed, was the automation of a portable forklift, the so-called Crayler, which is carried in a transport box under the truck. It can be used anywhere and flexibly, especially where there is no logistical infrastructure.

Autonomous handling of goods outdoors

The development work included solutions in sensor technology, robotics and intelligent software with the result that the Crayler can now act autonomously - in the sense of the task set. It drives to the load, recognises it as such, positions itself, picks it up correctly, brings it safely to the unloading position and deposits it according to the task. The special thing about this is that the whole scenario takes place in an open environment outside. Unlike a computerised warehouse system with clearly defined and measured areas, there are no sensors or markings to help the unit find its way. "This development makes automated handling of goods and objects during loading and unloading processes in outdoor areas possible for the first time. Similar tasks, e.g. in agriculture, construction or municipal services, can also be realised with it. It is particularly intended to

be used where there is a shortage of labour," says Andreas Vrabl, head of the AIT Center for Vision, Automation & Control about future application possibilities.

Intelligent automation concept for reliable operation in open terrain

"Working machines such as forklifts are designed and optimised to be controlled by a human. To enable autonomous operation, intelligent algorithms must compensate for this interaction of cognitive human ability and operation-optimised mechanics. A particular challenge is when the device has to operate in open terrain. Here, novel and holistic automation concepts are needed, where sensor technology, control and artificial intelligence intertwine," says Patrik Zips, project manager at the VAC. For this demand, the experts have implemented a combination of different sensor systems (stereo camera, lidar, GPS, etc), which ensures that the Crayler completely records its surroundings. This allows the truck to create a virtual map of its surroundings and determine its own position. Intelligent algorithms evaluate the data and create a processing plan to accomplish the desired task. "In order for the vehicle to be able to drive a defined trajectory, it needs various sensors that must be coordinated with each other, such as the environment sensor system and the pressure sensor system for the hydraulics. Every little stone distracts from the exact path. These deviations must be measured immediately so that the steering adjusts and the Crayler reaches the destination as planned," explains Zips.

Every palette looks different: training AI systems with synthetic data

"With the help of AI-based methods, the Crayler "learns" to identify the transported goods. For this, we need suitable image data. The difficulty here is that we are dealing with a wide variety of pallet types. They vary greatly in appearance. They can also be new or worn and loaded in different ways. Teaching the system with annotated images, as in the automotive sector, would be too resource-intensive and practically impossible to implement. Therefore, we generate synthetic data," says Csaba Beleznai. He is a scientist at the VAC and an expert in the field of machine learning. In his innovative approach, he starts from the geometric shape of the object - here the pallet. In the background, simulation software creates around 500,000 data sets with different views and variants in a very short time and thus trains the neural network extremely efficiently.

Increase the learning ability of the working machines

At the end of the project in the Large-Scale Robotics Lab, the new AIT-owned outdoor test site in Seibersdorf, the truck-mounted forklift demonstrated its skills and loaded - automatically - pallets onto a truck. "Automating these complex actions, which may involve several large devices that have to be coordinated with each other, is a particular challenge. The implementation requires an operation that is accurate to the centimetre as well as a clear abstraction of the scene including a clear definition of the object relationships within it. We were able to make very significant progress here in the consortium and present pleasing results," says Sebastian Wimmer, ACES Programme Leader at Palfinger.

In the future, the experts want to increase the forklift's ability to learn. Among other things, they plan to expand the interface between man and machine as well as the interaction between machine and machine and to enable the Crayler to react flexibly to changing situations.

"For autonomous mobile robots like the ones we are developing for intralogistics, such AI-based methods offer great potential to deal even better with the most diverse scenarios in warehouses and production environments," says Wolfgang Pointner, R&D Coordinator at AGILOX. "The project has shown that it is possible to solve so-called chaotic situations with automated systems. We assume that this will also generate added value for our customers in the future," he adds.

About the HOPPER project

The HOPPER project (Handling of man-made Objects using automated Positioning, Planning and Enhanced Reasoning methods) was funded by the Federal Ministry for Climate Protection, Environment, Energy, Mobility, Innovation and Technology (BMK) as part of the "ICT of the Future" programme.

About the Center for Vision, Automation & Control / Austrian Institute of Technology

The AIT Austrian Institute of Technology is Austria's largest non-university research institution. At the European level, it plays a key role as the research and technology institution that deals with the central infrastructure issues of the future.
The Center for Vision, Automation & Control (VAC) is one of a total of 7 research units at AIT. It is dedicated to industrial automation and digitalisation with the aim of supporting companies in overcoming diverse challenges and implementing their digitalisation strategy for more sustainability, resource efficiency, adaptivity/flexibility and resilience. To this end, VAC has extensive expertise and technological know-how in the areas of image processing, automation and control, as well as in the use of artificial intelligence methods. The centre covers the entire automation chain, from the acquisition of information by intelligent sensor systems to AI-based decision-making by autonomous systems. In addition to the Large-Scale Robotics Lab, the open-air test site in Seibersdorf for the development of autonomous large-scale robotics such as commercial vehicles, the centre is equipped with a laboratory infrastructure to serve the research areas around industrial image processing and optical inspection as well as automation in aviation.
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