PC-based control technology for automatic guided vehicles used in an automatic car parking system

Optimized use of parking spaces at Düsseldorf Airport saves valuable time

The ability to accommodate significantly more cars in the same space and avoiding the often stressful searches for available spaces are among the benefits for the users of the PremiumPlus parking service based on Serva's automatic parking system at Düsseldorf Airport in Germany. Autonomous parking robots, nicknamed 'Ray' feature PC control from Beckhoff and ensure reliable, error-free parking management.

Ray, the parking robot, uses a laser system to measure the dimensions and the wheelbase of the car, adjusts its width accordingly and then picks up the car by lifting the tires – similar to a forklift.

Who isn't familiar with this situation, particularly during business trips: deadline pressure, not enough time before check-in and departure, and then the tedious search for a free and adequately sized space in the multi-story car park? Since the end of June 2014, this stress factor is a thing of the past for customers of the PremiumPlus parking service at Düsseldorf Airport. At multi-story car park No. 3, they can simply leave their car at the transfer station of the automatic parking system, right by the terminal. The system was developed by Serva Transport Systems GmbH, based in Grabenstätt, Germany. At the transfer station, the car is measured with a laser scanner in a few seconds and then is taken automatically to a free space by Ray, the autonomous parking robot. All passengers have to do is check in using the information terminal at the transfer station and print out a ticket with a QR code or scan it with a smartphone app. The whole process takes less than a minute, after which travelers can relax and walk to the gate.

The initial plan is for 260 such parking spaces at Düsseldorf Airport that are served by six transfer stations and three parking robots, which can handle a wide range of cars from compacts to large SUVs. Passengers benefit not only from the fact that they no longer have to search for spaces, the retrieval of the cars is just as quick

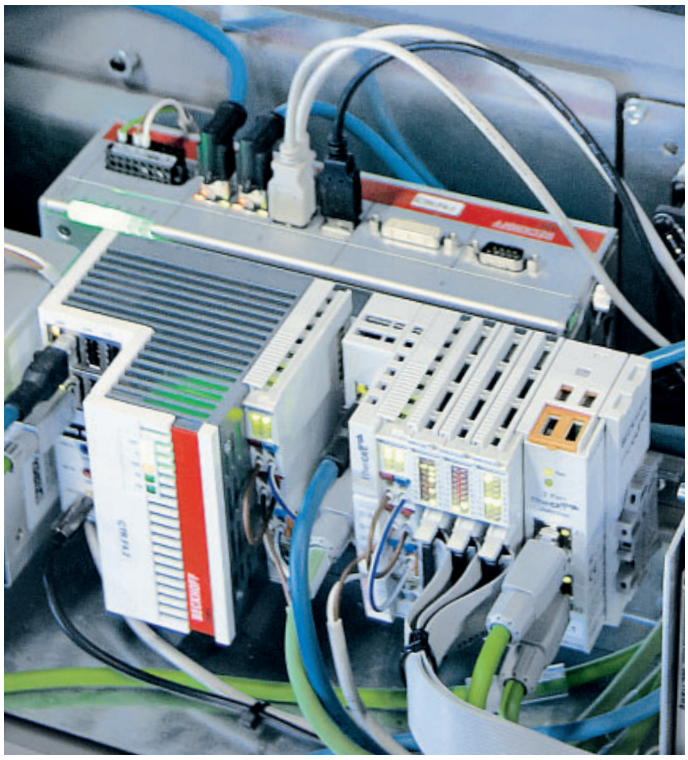
At a glance:

Solutions for transport and logistics
Robot-based parking system

Customer benefit
High-value parking space is approx. 40% better utilized, and the car parking process only takes about 30 seconds for travelers.

Applied PC control
C6920, CX5010 and EtherCAT Terminals: Compact control technology with high processing power
EtherCAT: High-performance, integrated communication system
TwinCAT 3: Simplified engineering through integration in Microsoft Visual Studio®

The PremiumPlus service at car park 3 at Düsseldorf Airport does away with inconvenient and time-consuming searches for parking spaces – cars can simply be dropped off at the transfer station of the automatic parking system.



Despite the fact that the parking robot can handle large executive cars, it is very compact and therefore requires high-performance control technology that is suitable for situations where space is limited.

and convenient. If the required exit time is specified in advance, the car will be ready within 3 to 5 minutes. If a flight number was specified at the time of reservation, the car will be made available automatically after landing, based on the actual flight data.

Using high-value parking spaces in a flexible and optimized manner

This automatic parking system benefits not only the passengers, but also the car park operator. Ray is able to accommodate 40 to 60 % more cars in the same space, depending on circumstances. This is due to the fact that the highly agile parking robot is able to negotiate much tighter bends than cars and can position the cars much closer together. Plus, there is no need to keep lanes free for maneuvering. Serva's managing director, Leopold Meirer, lists further benefits of the system: "The local conditions are stored in the navigation software, so that cars can be parked 'intelligently' and optimally sorted by size. In addition, spaces that can be reached quickly are allocated based on a priority system, in order to minimize the retrieval time. More complex relocation tasks are handled autonomously at less busy times, such as at night."

An additional benefit is the comparatively low installation effort. The parking system consists only of the transfer stations and the parking robots, and can therefore be integrated quite easily in existing car park infrastructures. A further factor is the high operational reliability, as Leopold Meirer explains: "In contrast to other typical automatic parking systems, we don't use an interlinked warehouse system that comes to a complete standstill in the event of a failure of the retrieval technology. Since there are always at least two autonomous parking robots, the system can easily compensate should one of the Rays develop a fault."

Processing large quantities of data reliably and quickly

The high operational reliability is based on the high-performance navigation and control technology, which is able to process huge data quantities quickly and error-free. This starts in the transfer station with the sophisticated measurement of each car using a 3D laser scanner, in order to create a detailed model. Leopold Meirer says: "From analysis of extensive data, a central server determines the precise contours and tire dimensions and transfers them via Wi-Fi to the respective robot, together with the specific parking assignment. A particularly important aspect is that the system is able to pick out the critical information such as length, width, height and wheelbase, so that the size-adjustable Ray is able to pick up each car reliably and undamaged and place it in a free parking space, while optimizing the space utilization of the car park."

Additional processing power is required, since the robot measures the cars again before they are retrieved. The control technology has to ensure precise movements of Ray, which can travel at speeds of up to 3 m/sec, and reliably detect spatial situations via laser reflectors on the car park walls.

PC control is integrated, compact, and powerful

For Leopold Meirer, the compact design and the high processing power were the main arguments for using PC-based control technology from Beckhoff: "Although the parking robot seems large and can handle cars that weigh up to 3 metric tons and are up to 5.5 m long, a compact design was very important to us. Accordingly, the designated installation space in Ray is small, so this is where the compact control technology came in. In addition, we benefit from the high processing power of the Industrial PC, which we need for the 3D calculations."

Serva's managing director, Leopold Meirer (left) and development engineer Max Dohm are convinced by the compact, high performance PC control solution and the efficient engineering environment in TwinCAT 3.

This is supported by the ultra-fast and integrated EtherCAT communication: "In the prototype for Ray, we used several different bus systems. With the flexible and fast EtherCAT this is no longer necessary, simplifying the development enormously. Today we use EtherCAT throughout, especially since all the required components such as sensors and drive technology are available for this established global standard. In addition, there is still plenty of future development potential, such as by using Safety over EtherCAT instead of the current separate safety solution." A further benefit is the user-friendly system handling. When a motor had to be replaced, for example, Ray started working again smoothly and without any extra parameterization as soon as it was switched back on.

Convenient development of redundant control concept

The control system for each individual parking robot consists of a C6920 control cabinet Industrial PC (IPC) with high-performance Intel® CoreTM i7 processor, an additional CX5010 Embedded PC with 1.1 GHz Intel® AtomTM processor, and EL1862 and EL2872 16-channel digital input/output terminals, which are connected via the EK1100 EtherCAT coupler. These EtherCAT Terminals, which feature a ribbon cable connection, ensure simple interfacing with the I/O logging card developed by Serva, e.g. for connecting the Ray laser scanner or for basic functions such as switching on the lights.

All intelligent processes are handled by the C6920 control cabinet IPC. The TwinCAT 3 control software uses the stored navigation and path data for the car park infrastructure, in order to implement all movements reliably. A redundant CX5010 Embedded PC, which monitors all calculated movements and their execution, ensures enhanced safety. In addition, the CX5010 also handles the voice control of the parking robot, for example in case of warning messages.

A key advantage during the development of the control concept was the openness of TwinCAT towards standards from the IT world. Serva development engineer Max Dohm explained: "The integration of TwinCAT 3 in Microsoft Visual Studio® has simplified the development significantly, since we already used this standard IT tool in a wide range of other applications. We therefore have a consistent and integrated interface, for example, for developing control applications with the TwinCAT Controller Toolbox or for simulating controllers via MATLAB®/Simulink®. In the future, we also intend to integrate high-level language C++ for programming." During the test phase, efficiency was very important for Max Dohm: "The control requirements are so complex that testing is only possible with a high-performance tool. TwinCAT Scope performed excellently as a software oscilloscope, so we make extensive use of it for every new function."

Further information:

www.serva-ts.com
www.beckhoff.com/EtherCAT
www.beckhoff.com/TwinCAT3