CAN Newsletter Online

SELF-DRIVING SYSTEM

Robots take over logistics

The Toru picker robot from Magazino features micro drives and motion controllers from Faulhaber. The used motion control system supports CiA 301 and CiA 305 as well as CiA 402.

Magazino wants to create the first self-thinking and self-acting warehouse in the world (Photo: Magazino)

With an eye to the constantly growing sector of online retail, logistics, and material flow are coveted playing fields for technical progress – with the goal of increasing efficiency through automation and digitalization. Magazino from Munich, has set out to combine autonomous driving and robotics with one another. The solution is called Toru. For the self-driving logistics robot Magazino uses drive solutions from Faulhaber with integrated motion controller. The used motion control system supports the CiA 402 CANopen profile for drives and motion controllers. The implemented CANopen protocol stack complies with CiA 301 version 4.02. The transfer rate and node number are set via the network in accordance with the LSS protocol conforming to CiA 305 version 1.11.

The robot is currently proving itself in practical tests with shipping service providers. These use the self-driving system above all for retrieving shoeboxes during order picking. The Toru picker is a so-called perception-controlled robot. Through the use of cameras, image processing, sensors, and artificial intelligence, it is able to perceive and correctly interpret its environment and use this as a basis to make decisions.

The Toru logistics robot combines autonomous driving with handling robotics (Photo: Magazino)

When the robot receives an order to pick a certain pair of shoes, it is first given the warehouse address plus a bar code. Thus, it knows where the target bin must be located and navigates right up to the address. The lifting column at the front of the vehicle then rotates 90 degrees towards the shelf, a gripper moves to the specified bin and now the robot begins to make decisions on its own. Using three-dimensional camera images, Toru first produces a picture of the current situation. "Is there even a shoebox on the shelf? Is the right bar code present? Am I able to grip the carton: perhaps it was moved a couple centimeters to the side and would jam when pulling out?" With these questions, Magazino spokesperson Florin Wahl describes the primary tasks of the visual analysis. If a picking order is linked to a carton that was placed on the shelf somewhat askew by an employee, the robot attempts to adapt its gripper process to the circumstances. If Toru ascertains that gripping is still not possible, the job is returned to the system – and a warehouse employee would need to perform the order picking by hand.

If no problems are detected, it is the drives from Faulhaber that are responsible for handling the shoeboxes. Here, motion controllers, DC-micromotors of type 3242 with graphite commutation, planetary gearheads, and threaded lead screws form a linear drive system that extends and retracts a metal tongue. The task in this case is to close the gap between the vehicle and the bottom of the shelf. The path is thereby leveled, allowing the cartons to be pulled out on the flat surface with negative pressure.

High overload behavior

For the positioning of the suction gripper along a toothed rack, Magazino uses type 3268 drives from Faulhaber. With a power of 62 W, the brushless DC motors deliver rated torques of up to 72 mNm in continuous operation. Interesting for Magazino are the peak torques of up to 96 mNm. The overload capability is decisive for overcoming the breakaway torques when handling the shoeboxes. "We need motors with high power density," explained Raphael Vering from engineering development at Magazino. Because the peak torques are only called for in a very narrow time window, there is no risk of the motors becoming too hot.

The overload behavior of the motors – with their diameter of 32 mm – offers the Munich (Germany) logistics company a number of advantages. The design provides the basis for being able to use smaller motors through the reliable handling of the breakaway torques. The result is that smaller drives are inherently lighter. "The mass of the gripper needs to be as low as possible because, of course, we also need to move along the vertical axis with Toru," explained Raphael Vering. The heavier the gripper unit, the greater the required motor power of the vertical axis. Then there is the question of the center of mass when Toru needs to grip a shoebox located on the top level of a two-meter rack.

Using a vacuum, the goods are taken off the shelf. A metal tongue closes the gap between the shelf and the logistics robot. Both the extension of the tongue and the movement of the gripper arm are handled by brushless DC servomotors (Photo: Magazino)

Without question: the center of mass can be shifted downwards by using a thicker base plate. This, however, makes the travel unit heavier. As a result, a stronger drive motor is needed. This, in turn, requires more power from the battery, thereby reducing the range. A lightweight design is also necessary because the robot is to be used not only on solid concrete on the ground floor, but also on more delicate ceiling constructions of intermediate levels. "Here in particular, the surface loads are very limited. We want to make Toru as versatile as possible, however," noted Florin Wahl.

Larger motors would also inhibit handling – especially when cartons are stored just a few centimeters above the floor and it is necessary that the drives simply not be in the way. With the Faulhaber solution, Magazino is able to move down low and up again. "This is extremely important when we consider the capacity of a warehouse with respect to the floor area. Every additional shelf space is worth gold," summarized Florin Wahl.

The idea behind lies in the implementation of a sophisticated system of automation, robotics, vision, and autonomous driving. When evaluating the drives, Magazino was therefore in search of solutions with optimum power density. These in, turn, must be capable of being integrated in the existing automation concept. "Support of CANopen communication was decisive for us," reflected Raphael Vering. Because the Munich firm was also able to use a complete motion control system from Faulhaber, the development department had more freedom for further optimizations of the logistics solution.

Brushless DC servo motor series 2368 BX4 with 32-mm diameter, 85,4-mm length, and maximum torque of 99 mNm (Photo: Magazino)

"We don't need to invest any time in our own controllers or in the integration of encoders," emphasized Vering. With the DC micromotors, the Faulhaber motion controllers of the V2.5 generation form positioning systems. For feedback control, Magazino uses analog hall sensors, thereby eliminating the need for a separate encoder for feedback. The integrated current control of the motion controllers limits the torque and thereby protects the electronics and motor from overload. Magazino, in turn, uses this function to detect faults in material flow – such as if a shoebox has jammed in a shelf compartment, causing the removal unit to stop.

The current employment situation in Germany makes the potential offered by this invention clear. Labor is in short supply – especially at night and on weekends. But this is when most online shopping takes place. The use of autonomously acting logistics robots would be a way to at least prepare order picking at the start of the week. For this purpose, Toru is equipped with a travelling shelf into which the removed boxes are inserted. Centering units with Faulhaber drives help to position the boxes.

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