Asparagus Pioneer

AvL Motion is breaking new ground – with a machine for the selective harvesting of white asparagus, 'garnished' with high precision sensors as well as RFID and fieldbus technology from Turck

Spring time is asparagus time. Hardly any other seasonal vegetable enjoys so much widespread popularity among restaurant goers and supermarket customers. Even in 150 BC Cato the Elder devoted himself to the cultivation of the "gourmet delight". For Sun King Louis XIV the delicacy also had to be on the menu at Christmas. Many centuries later, the culinary enthusiasm for these precious shoots still appears to be unwavering. In Germany alone around 122,000 tons of asparagus were harvested in 2019 – The Federal Republic is the largest producer in Europe with over 22,000 hectares of cultivation area.

»Turck impressed us with the outstanding quality and fast delivery of their product. «

Arno van Lankveld | Managing director of AvL Motion

However, this fresh vegetable normally has to be painstakingly retrieved from the soil by hand before it reaches the plate. For the harvest in Germany between March and the end of June, farmers in Germany rely on harvest workers from Eastern and Southern Europe. However, a significant problem has appeared over recent years: farms are finding it increasingly more difficult to find seasonal workers. This caused the Dutch engineering consultants AvL Motion to undertake the development of a machine solution for harvesting white asparagus. Around three years later, the startup company from Noord-Brabant has now announced the development of the world's first fully autonomous, selective harvesting robot. A high-tech prototype was produced with a finely tuned sensor and control technology. Customers can already use it in the coming season.

Wanted: a selective harvesting machine

Company founder Arno van Lankveld grew up on an asparagus farm and is therefore well aware of the considerable challenges involved in harvesting this much loved vegetable: "An asparagus plant develops many shoots that can grow in different directions. This makes the process more difficult." Normally only those spears that have broken through the soil are cut off and picked – the remaining tips are initially left in the raised beds in order to mature underneath the black and white insulation foil.

Up to now detecting which asparagus spear was ready for market could still only be done with the human eye. Harvesting machines were either able to cut all shoots at the same height and at the same time or were simply too slow. AvL Motion has now solved this problem with a robot which, at a constant speed of up to 3.6 kilometers per hour, autonomously detects asparagus tips, cuts the shoots, pulls them from the ground and takes them away on a conveyor belt. Only one worker is required for the operation; this person is required to sort the crop on a loading

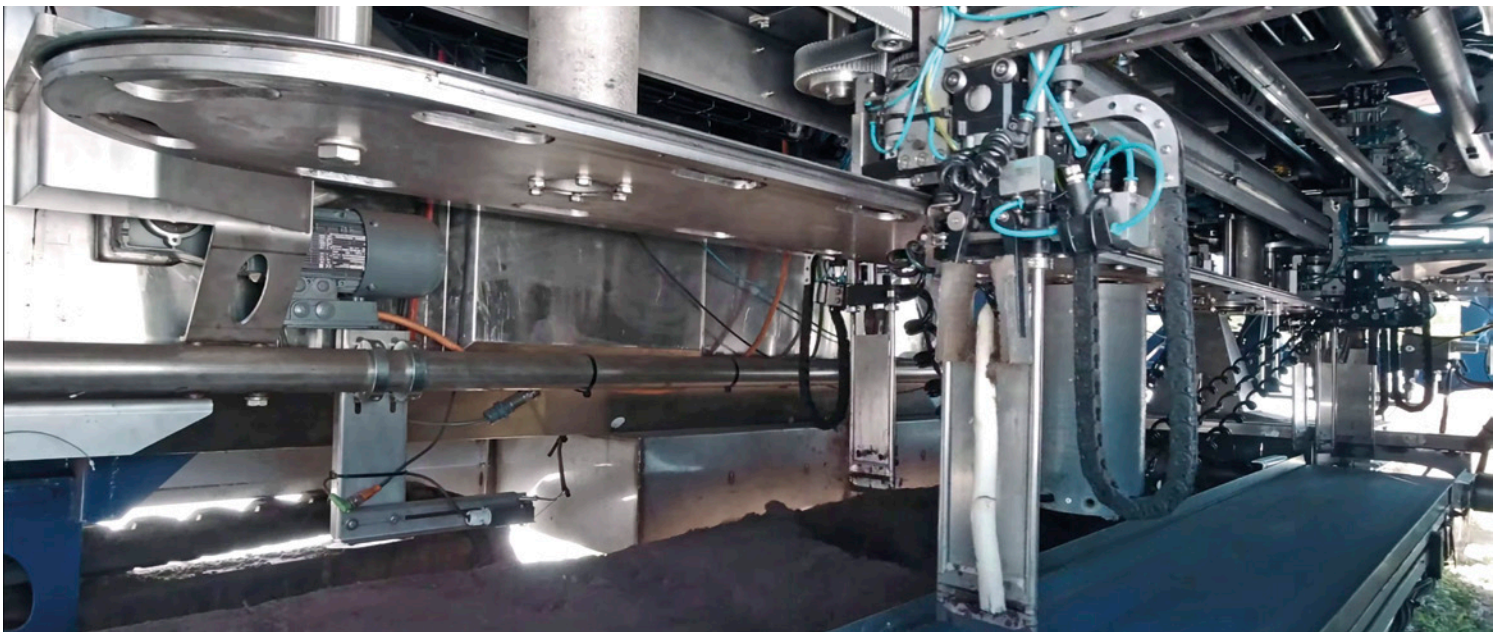
Selective harvesting at the push of a button: The AvL Compact S1560 moves at up to 3.6 kilometers an hour over the field and pulls asparagus spears automatically from the soil

area into crates, turn the machine by remote control at the end of a row and insert the insulation foil cover in the winder of the machine. "Growers are able to reduce their workforce by 83 percent," van Lankveld estimates.

Height control via ultrasonic sensor with IO-Link
Besides the pioneering spirit of the seven co-workers, the automation of such a complex operation particularly required the right technology. With one ultrasonic sensor causing problems in practical application, electrical engineer and software developer Jordi Hutjens found an alternative solution in the RU40U model from Turck. AvL Motion now uses two of the ultrasonic sensors with IO-Link to measure the distance between the asparagus bed and the pneumatically controlled internal frame of the machine. In spite of the partly dusty or rain-slicked subsoil, the sensors enable a stable measurement of the height, which

QUICK READ

The Dutch startup company AvL Motion put on the market a machine for the fully autonomous selective harvesting of white asparagus. In its search for an ultrasonic sensor for height control, the Dutch startup came across the IO-Link compatible RU40U from Turck. Through the subsequent collaboration more sensor technology was integrated in the vehicle, including miniature inductive proximity switches, precise encoders as well as LE550 laser sensors from Banner Engineering and the robust Li500-Q25 linear position sensor. AvL also uses the TN-Q14 RFID read/write head for the identification of harvesting modules, while the TBEN-S2-4IOL compact I/O module transfers IO-Link signals to the PLC.



Six to twelve harvesting modules are located on the machine, the controller uses the data from sensors to bring them in the right position

users can set on an HMI. "Turck impressed us with the outstanding quality and fast delivery of their product. We therefore stayed with the manufacturer for other components," says AvL CEO van Lankveld.

Optical process replaces trained eye

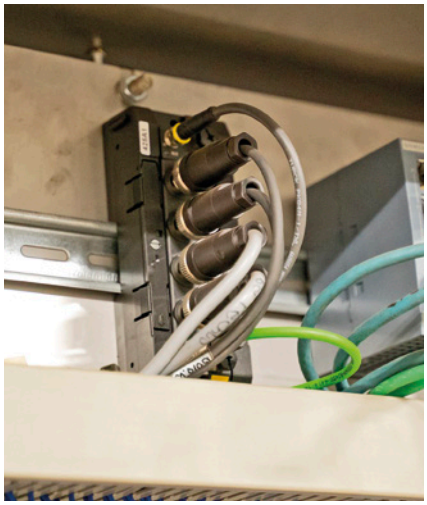
The harvesting process of the AvL Compact S1560 is very dynamic. Once the machine is positioned and set in motion, the surface of the soil is scanned. The precise location of an asparagus tip is detected by the main controller through the use of laser sensors, together with an additional optical process. The details of this remain the well-guarded secret of the inventors; the only basic requirement for it is that the soil is free of weeds. A variable number of harvesting modules move in the process round a circular track inside the robot. At present, this consists of twelve of the around 25 centimeter high cassettes. They are adjusted to the speed of the robot and control the entire process of inserting, cutting and gripping.

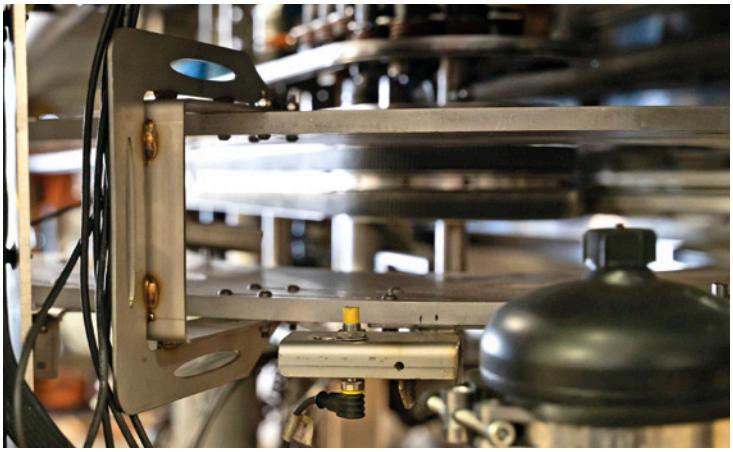
Fine tuning between target and harvesting module

The controller not only needs the coordinates of the selected asparagus spears to fine tune the harvesting process, but also a continuous flow of information on the position and movement of the modules. This starts with the query of how many cassettes are currently located in the buffer, i.e. how many are in park position, and those currently detecting an asparagus shoot in the circuit. For this AvL uses the tiny BI3-M08K inductive sensors. The exact identification of the harvesting modules is implemented with RFID – using the TN-Q14 HF read/write head, which reads the individual code of each cassette.

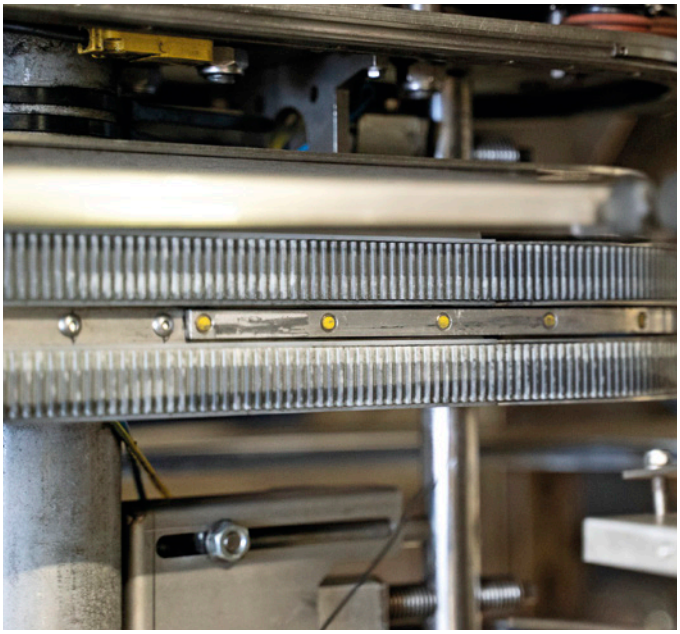
Added to this is the position detection provided by a rotary encoder. "The encoder rotates in the buffer area. This shows us for example, that a cassette is located at millimeter 20 or 30, AvL developer Hutjens explains. Once a harvesting machine starts its circuit, this passes a type NI10U-M12 uprox proximity switch, which sets the running of the timer for the harvesting

Fast I/O module with four IO-Link inputs: The TBEN-S2-4IOL compact multiprotocol device is used as an interface between sensors and PLC





Inspector with large detection range: When a cassette passes the NI10U-M12 proximity switch, the PLC starts the timer for a harvesting operation



The fully flush BI3-M08K miniature sensors in the buffer area detect with a high switching distance the number of harvesting cassettes

process in the PLC. This multi-layered preparation is necessary in order to synchronize the movement of the cassettes when the machine is fully in motion.

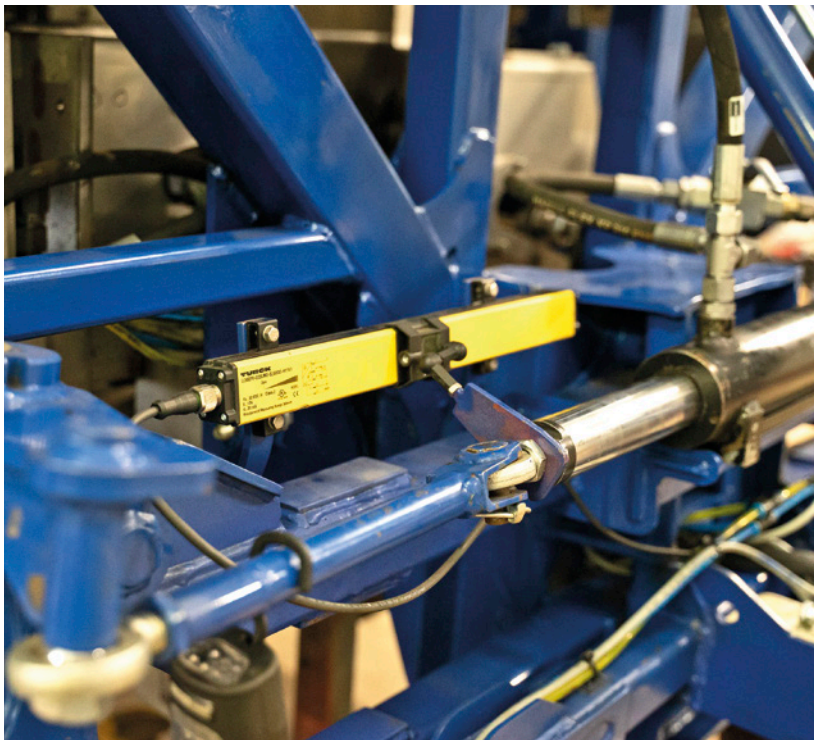
As the asparagus spears do not grow in tidy rows, the harvesting modules can also move left or right in addition to their movement round the circular track. This is driven with compressed air and is therefore always delayed by a few tenths of a second. In order to nevertheless ensure the correct alignment of the cassettes, the PLC obtains information about the distance between the initial and target position of the modules, measured with LE550 laser sensors from Turck's optoelectronics partner Banner Engineering.

Turning maneuver by joystick

Operators use an external control module to control the speed and the hydrostatic steering of the harvesting machine. Two Turck encoders measure the wheel revolutions; AvL uses an inductive linear position sensor to measure the wheel position. For this the positioning element of the LI500-Q25 sensor is linked with the piston of the steering cylinder. In this way, the main controller calculates the angle of both wheels using only one value – and operators can turn the machine easily with a joystick. Unlike the models offered by the competition, farmers do not have to attach the AvL Compact S1560 to a tractor.

Compact I/O module for rapid data exchange

The engineers at AvL decided to use IO-Link communication both for the LE550 laser sensors as well as for the RU40U ultrasonic sensors. The interface supplies additional information in the data exchange and also simplifies the parameterization of the sensors. Turck's compact TBEN-S2-4IOL I/O module routes the IO-Link signals in the control cabinet quickly to the PLC. The communication to the controller is implemented with Profinet.



Thanks to its robust design and IP67 protection, the Li500-Q25 inductive linear position sensor can also be fitted outside above the front axle, in order to measure the piston position of the steering cylinder

Deliveries at the start of the season

AvL Motion is proof that startups don't just have to operate only in the software sector or in the relevant digital hotspots. At the same time, however, the company shares the feelings and experiences of many startups – beginning with the solving of a customer requirement, through to the pressure of the expectation to present a functional end product in time. For AvL in time means: in time for the asparagus season. After months of meticulous work, the engineering consultants supplied the first harvesting machine to Neessen B.V., a company based in the Venlo area. According to company boss Arno van Lankveld the robot will be used in future without any operator control. “For the time being we are firstly focusing on what asparagus farmers need acutely”.

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