Application Report

3D laser navigation on a hall ceiling

The new dimension for driverless transportation systems

Driverless transportation systems (DTS) perform transport tasks fully automatically and, for reasons of cost, can be found in logistics applications in a wide range of industries. The scanner systems employed in such vehicles for optical navigation usually scan horizontally, using reflector marks mounted on building or system parts. With the innovative ROD 4 laser scanner from Leuze electronic, SIEMENS guides such systems by means of 3D laser navigation on the hall ceiling, thereby reaching a new dimension: both navigationally and economically (Figure 1).

Figure 1: With innovative 3D laser navigation on the hall ceiling, SIEMENS driverless corridor supply vehicles operate reliably and safely.

In addition to the optimization of transport processes, cost is the main reason that driverless transportation systems (DTS) are used in production and logistics areas. Their cost effectiveness stems primarily from the automatically operated transport vehicles, i.e. with no human operator. At the same time, however, the expenses associated with the planning of systems that utilize conventional technologies are relatively high. Usually, depending on the navigation system that is used, structural measures are necessary in the surrounding environment. These may be carriages, induction loops or magnets in the floor, or laser scanners that normally scan over an area, i.e. two dimensionally, and require reflectors on walls, shelves, machines etc.

Depending on the technology that is used, the possible flexibility with respect to changes to transport tasks is more or less limited. Furthermore, production-related or structural changes to the surroundings, such as modified machines and systems or moved shelves and similar, lead to disturbances in the transport process, necessitating structural modifications. In addition to this is the latent risk of damages caused by installed navigational aids, which also brings the entire DTS transport of goods and production processes to a standstill. With the innovative Autonomous Navigation System (ANS), SIEMENS takes driverless corridor supply vehicles to new dimensions. This applies both to the spatial plane used for

navigation, namely the hall ceiling, as well as to the cost effectiveness, achieved through lower installation costs, as no navigation aids need to be installed on the floor, walls or system parts. Last, but not least, ANS also facilitates maximum flexibility for route changes in today's rapidly changing production environments.

The navigation system developed by Siemens division Industry Automation and Drive Technologies is based on laser distance measurement technology from Leuze electronic. For years, area scanning distance sensors have been developed and produced here that supply 2D depth information with a detection angle of 190°. They facilitate the detection of width, position and orientation of disruptive objects, for example during overshoot detection in high-bay warehouses over distances of up to 50 meters. Furthermore, such devices are typically used for 3D contour measurements, gripper positioning, access controls or collision detection, as well as for the positioning of traveling transport systems.

Figure 2: ROD 4 laser scanners from Leuze electronic, with their laser distance measurement technology for 3D contour measurement, serve as the basis for the innovative Autonomous Navigation System (ANS) from SIEMENS.

Detection of 3D profiles

The fast, pulse propagation time technology of the ROD 4 enables the detection of 3D profiles that can be generated by means of swiveling or a linear feed motion of the measurement object or of the laser scanner relative to one another. For the navigation of driverless transportation systems, the laser scanner is mounted on a swivel motor on the top of the vehicle (Figure 2). This is used to capture a spatial representation of the surrounding environment, in this case, the hall ceiling, which then serves as the basis for free navigation.

The measurement principle used here is the pulse propagation time technique, which emits individual light pulses in short intervals. The time difference between the transmission and reception of a light pulse can be used to calculate the distance to an object that reflected the light. The evaluation occurs nearly independent of the shape, color and structure of the scanned object. The ROD 4 are also characterized by high immunity to interference against environmental influences. The captured data is directed via a high-speed interface to the primary computer for the position calculation.

"The new 3D laser navigation system can be installed on a wide range of different types of indoor vehicles, from high-lift trucks to industrial trucks," explains engineer Walter Beichl, the project manager responsible for ANS

at Siemens. *"We are able to attain a navigation quality that is sufficient for most logistics requirements,"* Beichl adds. The precise values for positioning and travel accuracy are, however, always dependent on the surroundings and on the used vehicles. With forklifts, for example, a positioning accuracy of ±30 millimeters can be achieved, for industrial trucks, an accuracy of ±5 millimeters.

DTS navigation with teach-in

Compared to conventional DTS installations, the installation effort associated with the Autonomous Navigation System with the ROD 4 laser scanner is much lower. This system requires absolutely no structural measures and can be quickly commissioned, because the route is defined by means of 3D laser navigation on structural contours present in the vicinity of the hall ceiling. Even the integration of individual vehicles into existing production- and logistics processes is an economical possibility, independent of the current production layout. Travel routes are taught by means of a so-called teach-in concept, i.e. a manual teach-in journey. In this way, route changes can be integrated on short notice and in just a few minutes. Flexibility in a future-proof logistics plan is, thus, no longer bound by any limits.

Absolute operational reliability included

Almost as a byproduct of the navigation system, the swiveling laser scanner ensures high operational reliability, as it also performs obstacle detection for the vehicle and load. While this is not a "secure" obstacle detection system in the sense of personnel protection, static obstacles are detected and a braking operation is initiated as a result. Furthermore, load carriers, such as pallets, are automatically detected and recorded within a defined range without requiring that they be precisely positioned.

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