SICK insight MAGAZINE

: FOCUS **MOBILE APPLICATIONS**

EFFICIENCY IN MOTION

AUTOMATION GOES MOBILE

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Dear Readers,

Mobile machines in the construction, agricultural, and transport industries require the same kind of automation solutions as machinery in factory buildings and logistics centers. However, the sensor technology faces additional challenges because of the particular outdoor conditions. This is where SICK's experience of developing innovative and intelligent sensor solutions for factory, logistics, and process automation pays off. As one of the world's leading sensor manufacturers, we can provide technologies that have not only been valued for their rugged design and high levels of availability in indoor applications for decades, but also offer significant benefits in tough ambient conditions.

Industry knowledge and a wide-ranging portfolio of sensor technologies make SICK the ideal partner for the automation of mobile machines. By integrating sensors and sensor systems into agricultural and forestry machines, for example, it is possible to develop intelligent solutions that are suitable for everyday use and meet customers' expectations in terms of both increased earnings and lower process costs.

Our global sales and support network enables us to provide customers with local application-specific support and technological knowledge wherever they are in the world – be it in Europe, Asia, or America. Because of this organizational structure we can also ensure optimal support for large manufacturers of mobile machines who, like us, do business globally.

Together with our customers, we develop new mobile automation solutions and adapt existing products and technologies. In this issue of our customer magazine, you will find a variety of different examples of intelligent application solutions and forward-looking products and systems developed for use in smart automation solutions and IoT applications.

I hope you enjoy reading this issue of SICKinsight.

Dr. Robert Bauer
Chairman of the Executive Board of SICK AG

SMART MOBILE MACHINES

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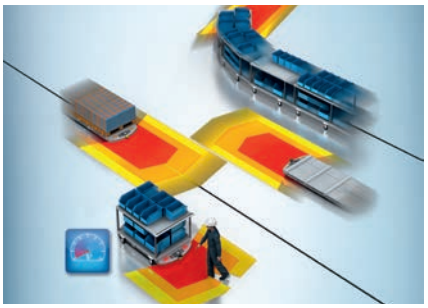

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INDUSTRY IN MOTION

INTELLIGENT SENSORS FOR SMART MOBILE MACHINES

The rapid pace of progress in electronics and sensor technology is determining the level of innovation in mobile machines today. The manufacturers and users of agricultural and forestry machines, construction and mining machines, as well as special and municipal vehicles are harnessing the potential of intelligent sensors. Integrating sensors and sensor systems makes for intelligent solutions suited for daily use that meet expectations both in terms of increased productivity and lower process costs. Processes are being made more efficient, more precise, and more environmentally friendly. This development makes SICK an important partner on the way towards highly automated and even autonomous mobile machines.

>> Agriculture – and therefore the food industry – and construction enterprises are constantly faced with new challenges on a regional, national, and global level. Population growth is constantly increasing the demand for food, while cultivation areas are dwindling. In the construction sector, the expansion of infrastructure must be promoted, and existing spaces must be used much more efficiently. The range of technical requirements for the automation of municipal vehicles such as street cleaners, salt or fire trucks is wide and highly varied. Due to the variety of application possibilities, a broad range of tasks has been opened up with respect to operation, control, and networking of special functionalities. In order to overcome these challenges, forward-thinking technologies and system solutions are indispensable elements for the automation of mobile machines.

With knowledge and experience from factory and logistics automation

SICK can draw on the broad technology portfolio it offers as well as its experience in the automation of machines and vehicles. The range of mobile solutions for the material flow within factory buildings extends from cellular conveyor systems and pallet shuttles to freely navigating automated guided vehicles, narrow aisle trucks, and indoor cranes. Moreover, solutions for mobile outdoor applications, where changing weather conditions are a primary concern, and solutions for underground applications are not new challenges for SICK sensors either. They have proven effective for many years in ports, mines, and many other demanding environments. SICK knows the industries and their processes inside out, with hundreds of thousands of installations and implemented applications to prove it. Every industry has special procedures. And yet, in principle, the tasks of the sensors are identical: measuring, detecting,

controlling and monitoring, protecting, networking and integration, identification, and positioning. This puts the SICK specialists in the position where they are able to transfer successful automation solutions to other applications and across different industries. Nevertheless, it is still important to adapt sensors to the requirements stipulated for mobile machines if necessary.

Manufacturers and users of mobile machines are watching the current trends in the automotive industry very closely. Many of these developments are transferable to mobile machines. This includes telematics solutions, which are already found in cars under the umbrella term “connectivity.” These kinds of remote data transfer systems can be used for Smart Services such as fleet management or early detection of wear. As, in contrast to factory automation, there are no buildings or any other infrastructure in mobile automation that enable grid-bound networking of the individual process participants, cloud-based networking as well as cable-free machine-to-machine communication are particularly important in this sector.

As a sensor manufacturer, SICK is a data provider for intelligent machines. SICK already offers globally leading products for many of the tasks in this sector and also relies on solutions based on the clever linking of hardware and software. The main tasks of sensors in mobile automation include solutions for driver assistance. With these in mind, SICK offers a comprehensive portfolio ranging from standard sensors and intelligent sensors with integrated application algorithms through to complex system, IoT, and cloud-based solutions. In the development of 3D streaming cameras LiDAR sensors or, laser scanners, ultrasonic sensors, inclination sensors, encoders, and inductive proximity sensors, as well as intelligent assistance systems and Safety Solutions, SICK applies a wide range of technologies. Sensors and systems are key technologies for many of the major technology-driven future markets. Thanks to “Sensor Intelligence.”, products can perform so many more tasks combined than they could alone. *(as)*

MOBILE CONNECTIVITY

IoT: SMART DATA IN THE OPEN COUNTRYSIDE

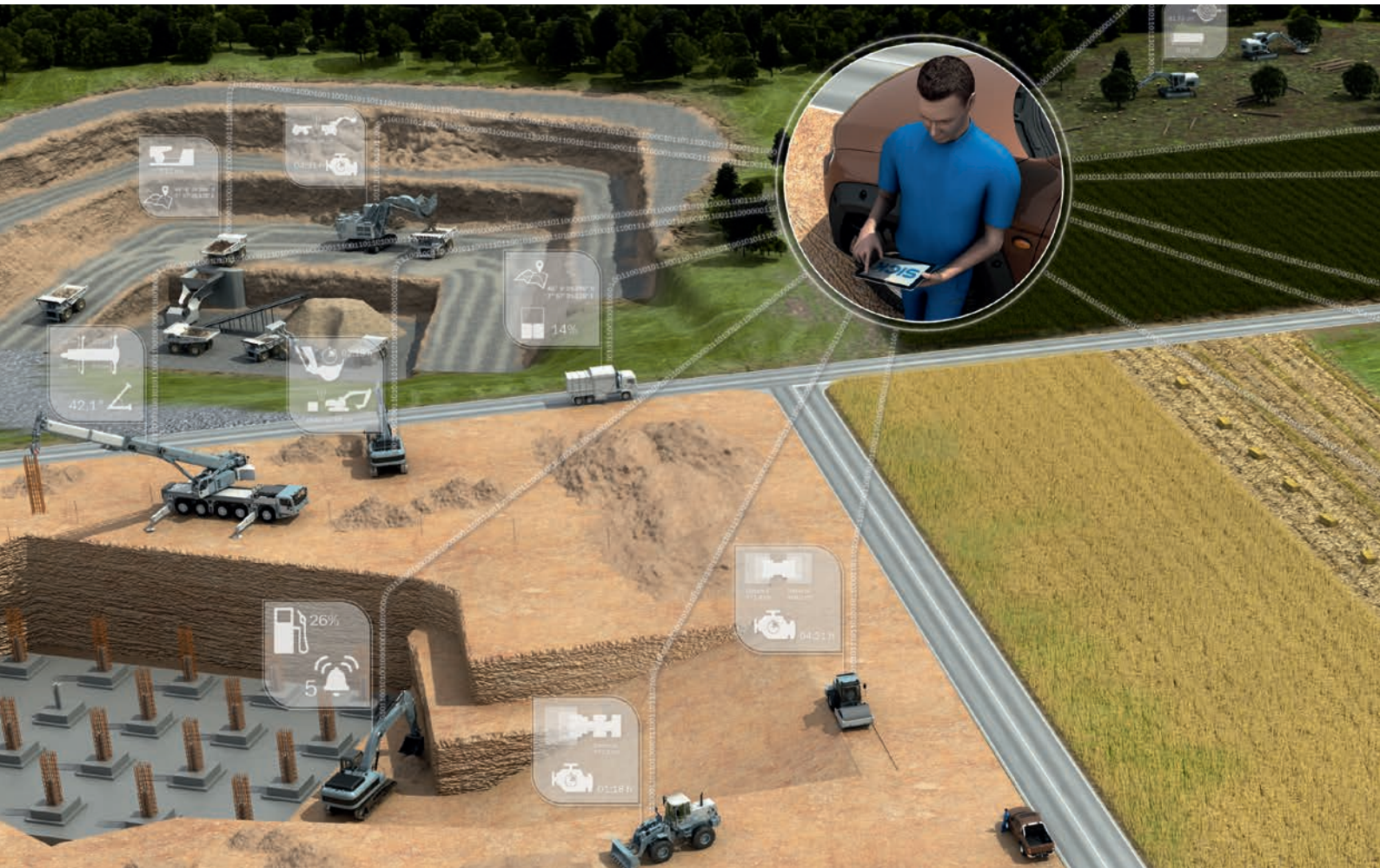
Mobile agricultural and forestry machines, construction and mining machiness, as well as special and municipal vehicles are all driving innovation in the field of automation. The importance of intelligent networking and digitization inside and outside the machines is growing continuously.

>> Networked sensors and the provision of additional data regarding status and temporal modifications to parameters enable users to detect any potential machine failure in good time. As, in contrast to factory automation, there is no building and no other infrastructure in mobile automation that enables grid-bound networking of the individual process participants, cloud-based networking as well as cable-free machine-to-machine communication are particularly important with regard to mobile automation.

In automated garbage trucks, excavators, harvesters, or other mobile machines mobile controllers process all operating functions including the sensor data and ensure quick and precise control of complex functions. Sensors and other devices use a range of protocols to supply the required data in a reliable manner. But how does this data or additional data get from the mobile machine – i.e., from the field – to the office?

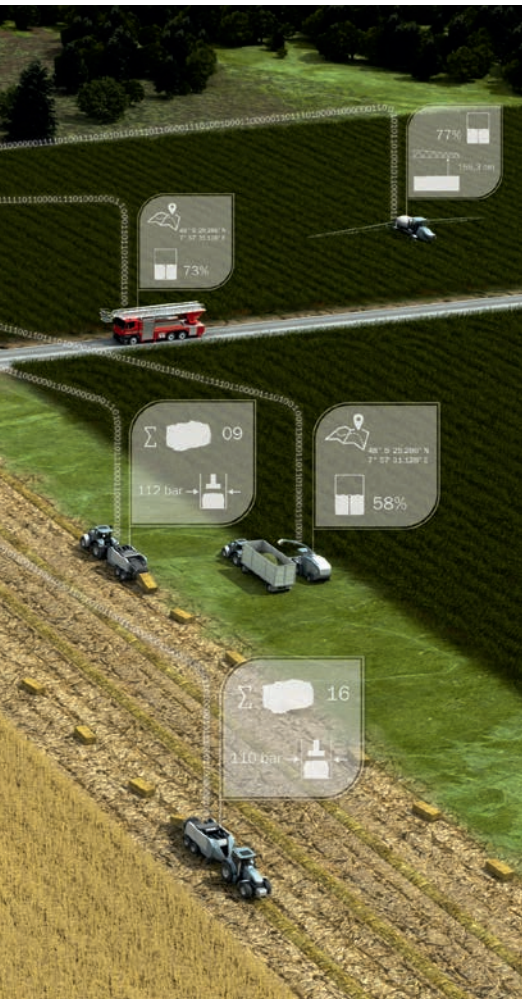
Telematic Data Collection solution – TDC gateway system from SICK

Not only does SICK use sensors to provide real-time data for ongoing function automation, it also provides access to smart data as a service for the detection of machine or vehicle conditions, for predictive maintenance, and process organization and optimization. The TDC (Telematic Data Collector) gateway system allows data from sensors to be gathered, stored, and exchanged via



mobile communication. TDC features all standard interfaces and provides a SaaS cloud platform with an API interface. The Telematic Data Collector sends the data to a defined server. The data can be displayed via the user interface and is transmitted via M2M SIM card. The GPS- and GSM-tested high-performance system is easy to install on all objects and offers machine and vehicle operators real-time monitoring of machine conditions, e.g., fluid levels, pressure, power consumption, and other parameters that are important for process quality. In this way, smart data enables the operator to keep an eye on the process and the process on track. Maintenance that can be predicted and planned in advance improves efficiency. M2M communication enables information to be exchanged automatically between technical devices such as machines, vehicles, or attachments with a centralized control center.

Systems of the TDC (Telematic Data Collector) product family collect and transmit sensor data from mobile and stationary systems.



This means that data from mobile and stationary systems can be displayed, monitored, recorded, and analyzed from any location in next to no time. Thanks to this access to smart data, the operator is able to respond in a strategic, economically appropriate manner and improve business performance.

Integrating sensors and sensor systems into mobile machines makes for intelligent solutions suited for daily use that meet customer expectations both in terms of an increased throughput and lower process costs. By providing access to Smart Sensor data, telematic solutions enable machine-to-machine communication and create interaction within the Internet of Things. *(as)*

DRIVER ASSISTANCE SYSTEMS FOR HARVESTING VEHICLES

AUTOMATED PROCESSES FOR MORE YIELD

Time savings, efficiency improvements, and easing of the burden on tractor drivers when bringing in the harvest and mowed material – all these are advantages offered by the WGS driver assistance system from SICK. It is used to detect and measure windrows of straw, crops, and mowed material on the fields. Thanks to the integrated tracking function, the system provides precise information on the position and size of the windrows. Once integrated in the vehicle control, this data allows the agricultural machine to be positioned and controlled automatically while also regulating its speed and optimizing the overall harvesting process.

>> As Johann Wolfgang von Goethe once put it himself, “sowing is not as difficult as reaping.” Since then, much has changed owing to the motorization and mechanization of agriculture. And yet, harvesting crops is still an activity in which every helping hand is appreciated. Solutions for improving the efficiency in the harvesting process are therefore like a seed ready to flourish. One instance of this “technological seed” is the WGS (Windrow Guidance System) from SICK.

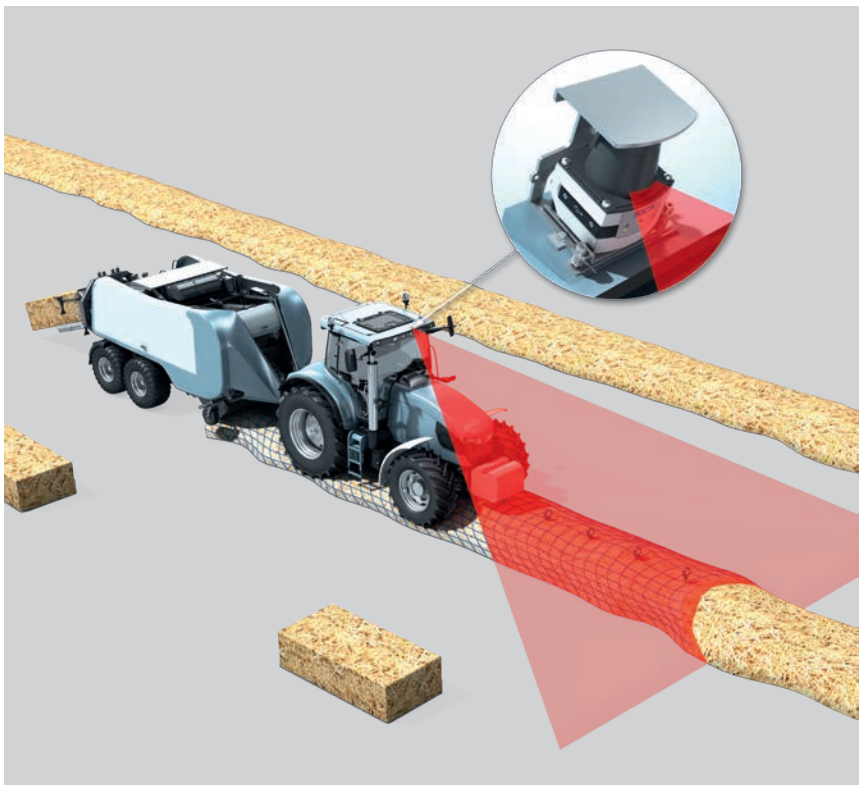
Tracking of windrows by tractor

After the cutting of grains and other crops or the mowing of grass and meadow herbs, the loose material is piled into windrows with a hay turning machine. In order to then gather this material or feed it into a baler, the tractor must be driven over the windrow as efficiently as possible. Gaps, varying curvatures, and heights of the windrows are all irregularities which can lead to the mobile processing machines gathering too much material and thus becoming clogged or being filled in an inefficient way. The result is wasted time and a great deal of work needed in order to put the machine back in order – a bad scenario especially

during the harvest with its often tight schedules and the sometimes unpredictable weather patterns.

WGS driver assistance system – the intelligent harvesting assistant

Previously, the driver of the agricultural machine was required to maneuver the vehicle in such a way that the windrows were gathered up perfectly, milled, or pressed into round or square bales that can be transported and put into storage even when the volumes and windrow curves varied. Now, however, the driver has an intelligent harvesting assistant in the form of the WGS. The system consists of a TiM351 2D LiDAR sensor (also 2D laser scanner) as well as an integrated software application for windrow detection which provides its measurement results directly to the vehicle automation system while also being able to process the guidance and speed information of the machine. The LiDAR sensor is mounted to the roof of the machine and scans the ground in front of the vehicle perpendicularly to the direction of travel. From the data collected, the WGS first generates a profile of the ground, then calculates the position of the windrow relative to the vehicle, and tracks the profile of the windrow. Using the machine movement data collected, the system detects the windrow, whereupon it saves and tracks the position. Equipped with this windrow trajectory information, the vehicle control system can automatically steer the tractor along the windrow and maneuver it to the perfect position for gathering the material. At the same time, the windrow volume calculations provide the necessary basis for automated speed regulation – faster travel for smaller windrows, slower travel for higher ones.



The WGS driver assistance system determines the position and the height profile of the windrow.

The WGS driver assistance system is based on the TiM 2D LiDAR sensor.

Integration-friendly system concept

The clear advantages of driver assistance systems for agricultural machines and processes are prompting more and more manufacturers to integrate systems such as the WGS into their vehicles. A major benefit is that the complete processing of measurement and vehicle data is carried out in the WGS sensor itself, and a CAN bus provides the measurement data to the automation system of a tractor or a mobile harvesting machine. The automation system uses the results without any additional resource-intensive processing directly on the dedicated assistance platform for lateral and speed control.

A great relief for drivers and more efficient use of vehicle capacity

The WGS eases the burden on drivers enormously. Particularly when there are long working hours to deal with, it ensures that driving the vehicle is largely free of stress. The system prevents time-consuming and costly faults from occurring, e.g., in forage harvesters or balers, while also optimizing their capacity utilization and thus reducing the time spent working on the fields. *(as)*

CAUTION ON THE APRON

ACCIDENT AND COLLISION AVOIDANCE WITH THE APS DRIVER ASSISTANCE SYSTEM

Multimillion-dollar damage that occurs during aircraft ground handling leads to high insurance payouts every year. As a result, ground handling services are encumbered with higher insurance premiums.

>> In order to avoid damage, Lufthansa LEOS GmbH relies on SICK's experience in laser scanners when tugging aircraft and is putting the APS driver assistance system from SICK to the test for its aircraft tractor fleet.

At sites in Frankfurt and Munich, LEOS operates a fleet totaling 38 aircraft tractors. Each aircraft tractor deals with an average of eight to 15 tugs or pushbacks a day. During these maneuvers, collisions with objects on the runway or in the hangar, or even with other aircraft are possible.

Collision warning and driver assistance for aircraft tractors

In collaboration with LEOS, SICK has developed the APS (Aircraft Protection System) driver assistance system to help aircraft tractor drivers to move aircraft safely. This takes some of the strain off the drivers and reduces the risk of collisions and accidents, thereby avoiding high repair, maintenance, and aircraft downtime costs. In brief, using the APS facilitates smooth and efficient pushback, maintenance, and maneuver towing procedures.

Determining the aircraft type

The aircraft tractor without tow bars grips the nose wheel and lifts it up. The nose wheel and its weight then rest on the center of the tractor and the tractor driver assumes control of the aircraft. The LMS511 2D LiDAR sensor (also 2D laser scanner) is mounted on the tractor facing backward and monitors the entire area under the aircraft parallel to the ground. "The laser scanner detects the wheels of the main landing gear of the aircraft; the APS driver assistance system then determines the aircraft type using the landing gear geometry. The APS features a database where the various aircraft types are stored and suggests all possible aircraft types that match the corresponding landing gear geometry to the aircraft tractor driver by a selection list on the display. The driver selects the correct aircraft and confirms the selection," explains Michael Doll, project engineer for Lufthansa LEOS GmbH.

Invisible carpet under the aircraft

The APS driver assistance system monitors the towing corridor, shows drivers any obstacles, and warns them of possible collisions in good time. The system comprises an LMS511 2D LiDAR sensor and a touch display with an integrated processing unit including application software. The integrated installation wizard makes it easy to commission and configure the APS. "The LiDAR sensor detects virtually everything that is underneath, to the left of, to the right of, or behind the aircraft. The warning zones can be individually defined. The scanning area lies underneath the aircraft like an invisible carpet," says Thomas Killmaier, COO of Lufthansa LEOS GmbH, explaining the principle. "Everything intruding into this area – the driving path of the aircraft – is marked on the display in red. The driver is informed in accordance with a defined warning strategy and sees that there may be a collision between the aircraft and an object."

The LMS511 measures the wheels of the aircraft in order to identify the type.

The APS driver assistance system helps aircraft tractor drivers to move aircraft.

Moving aircraft presents great challenges for an aircraft tractor driver. Aircraft can be pushed or pulled, but doing so may block the driver's view in some circumstances. And then there are the weather-related obstacles, as aircraft need to be moved in all weathers. "The task of an aircraft tractor driver is very complex. They have plenty of other tasks to complete. The driver assistance system provides support, but never intervenes. Drivers see immediately that the system works and that the sensors detect every object. They have to be able to say 'It's helped me today.' However, it has to be manageable for the driver," comments Michael Doll. SICK developers are working with the aircraft tractor drivers to configure the optimum acoustic warning frequency so that driver and driver assistance complement each other perfectly.

Besides in airport operations, SICK sensors are also successfully used in a wide range of applications, such as outdoors, for collision avoidance purposes. For example, LiDAR sensors from SICK ensure the collision-free operation of cranes and containers in container terminals across the world.

Lufthansa LEOS (Lufthansa Engineering and Operational Services GmbH) is a wholly owned subsidiary of Lufthansa Technik AG which specializes in ground handling services at major German airports. LEOS's core competences primarily include tugging aircraft, crew transports, and maintaining devices and vehicles from the ground handling sector. *(as)*

3D SNAPSHOT – TWO-EYES PRINCIPLE FOR EFFECTIVE USE OUTDOORS

FOCUSING ON THE BLIND SPOT: ACTIVE COLLISION WARNING FOR MOBILE AUTOMATION

With mobile machines – including construction and mining machines used in surface and underground mining, agricultural and forestry machines, as well as special and municipal vehicles – accidents often occur when maneuvering or backing up. The Visionary-B CV 3D vision sensor from SICK is suitable for outdoor use and is designed to monitor the areas next to and behind mobile machines that are invisible to the driver. It is an active driver assistance system which reliably identifies people and objects in the driver's blind spot and issues collision warnings.

>> Many collisions and accidents can be avoided if the machine operator is supported by suitable technology. Active warning functions are not enough. The assistance system must also be able to distinguish between different objects depending on their importance for collision warning purposes.

Visionary-B CV has been designed as an active system: As soon as an object appears within a defined detection zone, the system issues an acoustic and visual signal. In contrast to passive monitoring solutions, the driver does not need to look at the monitor constantly. Instead, he can concentrate on driving the vehicle, safe in the knowledge that the system will warn him in good time if a potentially critical situation occurs.

The Visionary-B driver assistance system for collision warning in harsh environments.

Visionary-B CV: 3D collision warning as plug and play system solution

The system consists of at least one sensor head, an evaluation unit, a 2D monitor, and all the mechanical and electrical components needed for installation. It is also a two-in-one solution, because it combines an active 3D sensor for collision warning with an integrated 2D live camera. This means that the driver can also see a 2D live image and access recordings of the machine's previous few hours of operation. When the system is installed at a height of between 1 m and 2.4 m, the detection angle of 105° x 90° enables it to cover an otherwise blind area behind the vehicle of 6 m in length and 4 m in width. The evaluation unit processes the 3D image data, assigns the objects to different classes on the basis of the measured values, and uses intelligent algorithms that enable it to ignore objects which are not likely to cause a collision. At the same time, it transmits the 2D live image and the alarm signals to the monitor in the machine's cab, which issues both an acoustic and a visual warning.

Stereoscopic principle and 3D snapshot technology

To ensure that the collision warning is reliable and accepted by drivers, it is essential that the assistance system consistently identifies hazards and distinguishes them from the machine's normal working environment. The object detection system, which is based on the stereoscopic principle, is what makes this possible. It can identify the presence of people and objects and measures their distance from the vehicle. Two cameras in the sensor head take images of the vehicle's surroundings from slightly different positions. The evaluation system combines these two perspectives and calculates the depth of the images – the third dimension. Using this 3D image information, the 3D vision sensor can identify the width and height of objects. This allows the system to distinguish between people and objects that could cause a collision and those that cannot, for example, curbs or uneven ground. This means that the driver assistance system only warns the driver in truly critical situations.

The integrated data evaluation unit reliably detects two classes of objects in an outdoor environment. All small objects fall under object class 1. Object class 2

covers larger objects, but not those which are very elongated, such as walls. These are ignored in object class 2. Configuring the system only to warn the driver about objects in class 2 is an ideal solution for narrow entrances or exits, for example, as it will prevent unnecessary and irritating warning signals from being issued.

The flexible configuration of alarm zones also makes it possible to distinguish between different types of warnings so that the driver can respond accordingly. This means that the Visionary-B CV system reliably prevents faulty alarms. The driver is only notified if the situation is genuinely critical.

In addition to evaluating and classifying the objects that are detected, Visionary-B CV has a modular concept that enables the driver assistance system to be designed to suit the vehicle and the purpose it is used for. A range of different system configurations is available. These include variants with one sensor head for monitoring the direction the vehicle is traveling in, with two automatically alternating sensor heads for forward and backward movement, and with two sensor heads operating simultaneously to cover the area around and behind particularly large and bulky vehicles.

Designed for high availability in tough outdoor environments

The Visionary-B CV driver assistance system is highly rugged and designed for outdoor use in the many different types of environments where mobile machines operate. The sensor housing has an IP69K enclosure rating and can withstand ambient temperatures between −40 °C and +75 °C. It also meets high standards of shock and vibration resistance. The evaluation unit, which can often be installed in the safer setting of the driver's cab, has an IP67 enclosure rating and a temperature range of −20 °C to +40 °C. It has also been designed for a long service life and can withstand challenging conditions. The algorithms have been tested in practice and therefore ensure that direct sunlight, rain, road surfaces that are damp and shiny, and other environmental influences do not prevent the unit from detecting objects reliably or the system from issuing collision warnings.

Mobile machines offer a wide range of possible applications

The different types of mobile machines provide a variety of interesting applications for the Visionary-B CV outdoor driver assistance system. For example, the version with two alternating sensor heads can be used in excavators to monitor the area behind the machine and the area to the side where the driver's view is blocked by the excavator arm.

The Visionary-B 3D vision sensor reliably detects people and objects in the driver's blind spot and issues a warning.

Collision warning on the roller.

Front loaders, dump trucks, and rollers are typical examples of construction and mining machines that can be operated much more safely using SICK's active driver assistance system. Visionary-B is also a valuable addition for drivers of agricultural and forestry machines. It can detect possible hazards and sources of accidents in good time and send an active warning to the driver. A reduction in the damage caused to vehicles also means reduced downtime and high levels of availability, which is particularly beneficial during crucial times of the year, such as harvest. In special and municipal vehicles, such as those used for collecting recycled materials, for example, Visionary-B CV constantly monitors the driver's blind spot and provides active support when the vehicle is maneuvering.

In addition to the examples described, there are many other possible applications for this advanced driver assistance system. Visionary-B can be installed at any time in existing vehicle models. All the variants can be fitted in new vehicles by the manufacturer, but they are also available as easy-to-configure complete solutions for retrofitting or as dealer options.

The Visionary-B monitors the area behind the reach stacker in the port.

Visionary-B PS for even greater flexibility

Visionary-B CV delivers the very data required for effective driver assistance and is tailored to collision avoidance for mobile machines. With Visionary-B PS, the Visionary-B product family will soon include another variant which allows customers to also tackle other applications according to their needs. In terms of data quality and ruggedness, the Visionary-B PS possesses the same qualities as the Visionary-B CV. However, it also provides the 3D raw data, object classes and positions, as well as the 2D camera image, which the evaluation unit provides as a data stream via Ethernet. A monitor is thus not required with this variant. The combination of the 3D raw data, 2D camera image, and the pre-processed data in the form of object positions and classes means that it can tackle a multitude of applications – such as positioning, object tracking, or providing guidance through the grapevine. As a result, particularly processes carried out under rough outdoor conditions can be designed to be more efficient, precise, and environmentally friendly. *(as)*

Collision warning on the forage harvester.

SENSORS FOR DRONES

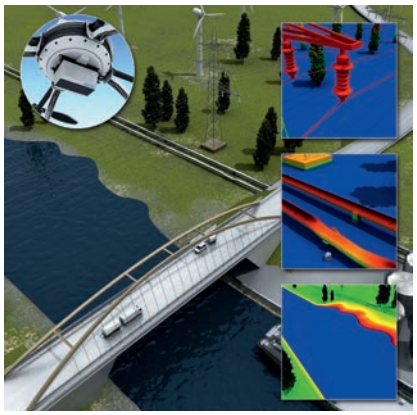
THE LD-MRS 3D LiDAR SENSOR DETECTS THE PENGUIN EVEN IN ITS BLACK TAILS

The darker the object, the harder it is to detect as the distance increases. But penguins in the Antarctic can now keep their black tailcoats on when a drone hovers overhead and the integrated LiDAR sensor (also laser scanner) detects them. For researchers and scientists who map and count penguin colonies in order to collect urgently required information about the effects of global climate change, the combination of a LiDAR sensor and flight robotics is a new technology that certainly is highly welcome.

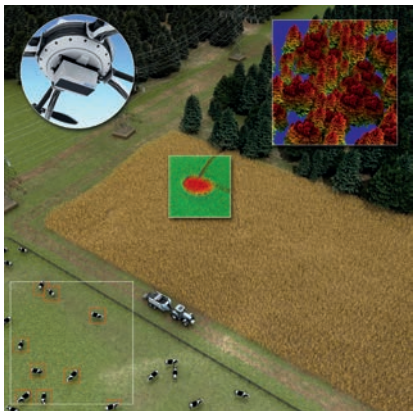
>> The LD-MRS 4-Layer UAV 3D LiDAR sensor from SICK which is connected to the drone demonstrates a very large working range of 300 m despite its lightweight design. Even with black objects (10 percent remission), its working range is still 50 m. This means that even when the penguin has its back with the black tailcoat turned toward the drone, it will still be registered by the sensor. The 3D LiDAR sensor detects its environment without any gaps and, thanks to the integrated object tracking feature, reduces the time taken to count the animals across the large population area from several weeks to just a few hours.

However, it is not just science that is showing a great deal of interest in the diverse application possibilities of the new technology. Most of the measuring and monitoring tasks that previously demanded the expensive deployment of helicopters can now be completed with ease by the more cost-effective UAVs (unmanned aerial vehicles). Pipelines, power lines, yet also wind power plants that are emerging as part of the energy

The lightweight LD-MRS 3D LiDAR sensor helps to observe penguins.



In combination with a multispectral camera, the intelligent measurement sensors on board UAVs collect all the necessary data.



In conjunction with measuring technology, UAVs carry out measuring and monitoring task, such as mapping.

revolution, can be monitored and maintained successfully using this technology. In the forestry industry, for example, tree populations can be studied in terms of their height, spacing, number, and diversification with minimal effort thanks to the large working range and high resolution of the measurement technology. Precise 3D mapping to create an inventory of bulk materials on coal, ore, and waste stockpiles becomes just as simple as the measurement and mapping of rivers, canals, and coastal areas. In combination with a multispectral camera, the intelligent measurement sensors on board UAVs collect all the necessary data to determine the biomass and fertilizer requirements on banana plantations, to name one example.

Originally developed for the automotive market, the LD-MRS 3D LiDAR sensor was initially kitted out for the industrial market. “The sensor is ideal for use in harsh ambient conditions found in ports and surface mining, as with its multi-echo technology it is able to reliably scan through dust and rain as well. Due to the growing demand from the market for drone deployments, we started to develop the product further – initially focusing on the software,” explains Sandra Wienbeck, Product Manager, Identification & Measuring, at SICK AG in Hamburg. Working in conjunction with the Robotics Innovation Center at the German Research Center for Artificial Intelligence (DFKI), a ROS (robot operating system) driver was created for the LD-MRS, which enables the sensor to easily be integrated in robotics applications.

When it comes to the specific use of the sensor in a UAV, however, the main challenge is to drastically reduce its weight. With this in mind, the device hardware was optimized further – a process that involved evaluating suitable materials that would still be able to comply with the ruggedness required of an industrial product. With a current weight of 770 grams and an enclosure rating of IP69K, the LD-MRS is, first of all, one of the lightest sensors with the largest working range available on the market. Secondly it is so rugged that it “still carries on working even after plunging into a swamp,” as Sandra Wienbeck states.

During flight, a drone generates considerable vibrations, which can lead to significant problems with measurements in an integrated sensor. “With the aid of simulations and data from a wide range of applications, we were able to get rid of these risky resonances. Although it is an industrial product, design, look, and feel were also important to us during the development phase. Based on the principles of aerodynamics and by making a number of adjustments, we have arrived at the perfect compromise between stability and lightweight design,” reports Sandra Wienbeck. The successful deployment among the penguins in the Antarctic shows that this effort has paid off. *(as)*

AUTOMATED CONTAINER EMPTYING – RELIEVING THE LOAD ON GARBAGE TRUCK DRIVERS AND URBAN TRAFFIC

SMART GARBAGE DISPOSAL – GARBAGE COLLECTORS RIDING ON THE OUTER STEP IS A THING OF THE PAST

A garbage truck driver is faced with challenges on a daily basis, including illegally parked cars, narrow roads, irritated motorists, heat, cold, and thunderstorms. It does not have to be like this any longer. The new smart garbage collection truck used in Asti, Northern Italy, makes life easier for garbage truck drivers and urban traffic while reducing costs for the operator thanks to a higher throughput and less need for loading personnel. Automation and digitalization are gathering pace in the field of waste management.

>> Integrating sensors and sensor systems in special and municipal vehicles makes for intelligent solutions suited for daily use that meet expectations both in terms of increased throughput and lower process costs. Asti Servizi Pubblici S.P.A. (ASP), which is responsible for waste management and city cleaning in Asti, uses the so-called 2Side System for the collection of municipal waste as part of a pilot project. 2Side System consists of a garbage truck with a robotic arm and automated gripping-arm technology in addition to the appropriate waste containers with Kinshofer gripping-arm technology. The complete solution is the product of cooperation between the Italian company Ecologia Soluzione Ambiente (ESA) and the Spanish manufacturer of waste containers CONTENUR, S.L. Sensors from SICK ensure the perfect automated positioning of the gripping arm.

“We have developed a vehicle which can pick up waste containers from both sides of the road automatically and empty them into the collection truck. The

driver does not have to exit the vehicle to do this, so there is no need for additional personnel to do the job," explains Giovanni Bertozzi, project manager at Ecologia Soluzione Ambiente (ESA).

The process

The driver approaches a container on his service route. A distance sensor alerts the driver to the distance of the vehicle from the container. The driver then uses a joystick to start the emptying process. The rotating gripping arm moves toward the side of the road with the container, swivels automatically to the correct container gripping position, lifts the container above the vehicle, and opens the flaps in the base of the container. The gripping arm then returns the empty container to its original position, after which the garbage truck continues on its way, leaving the road clear. The entire process takes no longer than 80 seconds.

All operating functions, including the sensor data, are processed in a central controller. The software which was further optimized in the pilot phase ensures quick and precise control of complex functions. Sensors with CANopen interface are used for reliable data provision.

The happy and successful project team (from left to right): Valentini Alessio (Ecologia), Mirco Dibenedetto (SICK), Maurizio Laiolo (ASP) (from left to right), and Giovanni Bertozzi (Ecologia).

The sensors

"One special feature of our system is its speed, which necessitates precise measurement data from the sensors," adds Giovanni Bertozzi, explaining the prevailing requirements. "In the 2Side System, we use distance sensors which detect the exact distance between vehicle and container. This information is used by inclination sensors, wire draw encoders, and absolute encoders, which provide the corresponding sensor data for the inclination of the telescopically extendable boom and the extension of the gripper."

Precise inclination measurement in a compact design

The TMS61 one-dimensional inclination sensor from SICK provides information regarding the specified or required inclination of the telescopically extendable boom with gripping arm. Its measuring range of 360° and the freely adjustable zero point allow flexible application of the sensor in various installation situations. The TMS61 inclination sensor is setting new standards in relation to size, flexibility, and performance. In its small, rugged plastic housing, it offers excellent resolution and accuracy – achieved over the entire measuring range and in an extremely wide range of ambient conditions. The CANopen interface enables a whole host of device parameters to be adapted, allowing the sensor to be perfectly tailored to the application.

For the automated emptying of waste containers, the exact position of the gripping arm must be determined. In the 2Side System, the compact AHS/AHM36 CANopen absolute encoder pinpoints the rotational movement of the gripping arm. The rugged and slim EcoLine wire draw encoder determines the extension

The slim EcoLine wire draw encoder determines the extension of the gripping arm reliably.

of the gripping arm reliably thanks to the high repeatability. The sensor data captured is used to position the gripping arm with high accuracy.

The angle and the position of the 360-degree rotating gripping arm relative to the lower carriage must be known in order to carry out repeating movement sequences. The AHS/AHM36 absolute encoders are the right sensor solution thanks to their compact and rugged design as well as their high repeatability.

Modular EcoLine wire draw encoder in miniature design

The slim design of the EcoLine product family is ideal for applications with limited space. Its modularity makes it suitable for a large selection of measuring lengths, interfaces, and encoders. Due to the spring integrated in the drum and adaptation without coupling, it is possible to achieve high precision and stability. The special nozzle serves to protect the measuring wire from damage caused by vibration.

AHS/AHM36 CANopen absolute encoder

The AHS/AHM36 CANopen absolute encoders are setting new standards in flexibility and diagnostics. With their rotatable male connector and a variety of mounting options, these encoders are suitable for almost any application. Encoder parameters such as resolution or counting direction and the output of diagnostics data can be adapted in the CANopen network or via the PGT-12-Pro hand-held programming tool. Thanks to the large operating temperature range from –40 °C to +85 °C and enclosure rating up to IP67, this encoder family can be used even in harsh ambient conditions.

Regardless of angle, position, or speed – SICK encoders and inclination sensors make movement measurable. They immediately turn received signals into data and transfer this data to a process controller or cloud.

Supplying the basic information: Dx50-2 distance sensor.

„One special feature of our system is its speed, which necessitates precise measurement data from the sensors.“

Giovanni Bertozzi, project manager at Ecologia Soluzione Ambiente (ESA)

The aesthetically appealing containers blend into any urban environment.

The perfect combination of measurement performance and size: the Dx50-2 distance sensor

Based on the patented and further enhanced HDDM™ time-of-flight technology, the sensors of the Dx50-2 product family measure accurately and reliably, with ranges of up to 10 m on black targets and up to 30 m on white targets. The Dx50-2 sensors feature an intuitive display, saving time during installation and commissioning. The high output rate of the sensors delivers up to 3,000 distance values per second for maximum throughput and process quality. The Dx50-2 sensors have a rugged housing and can be relied upon to operate even at extreme temperatures and in harsh ambient conditions. Since the settings for speed and sensing range can be flexibly adjusted, the Dx50-2 sensors can be perfectly customized to suit every possible application.

Convenience in the driver's cab

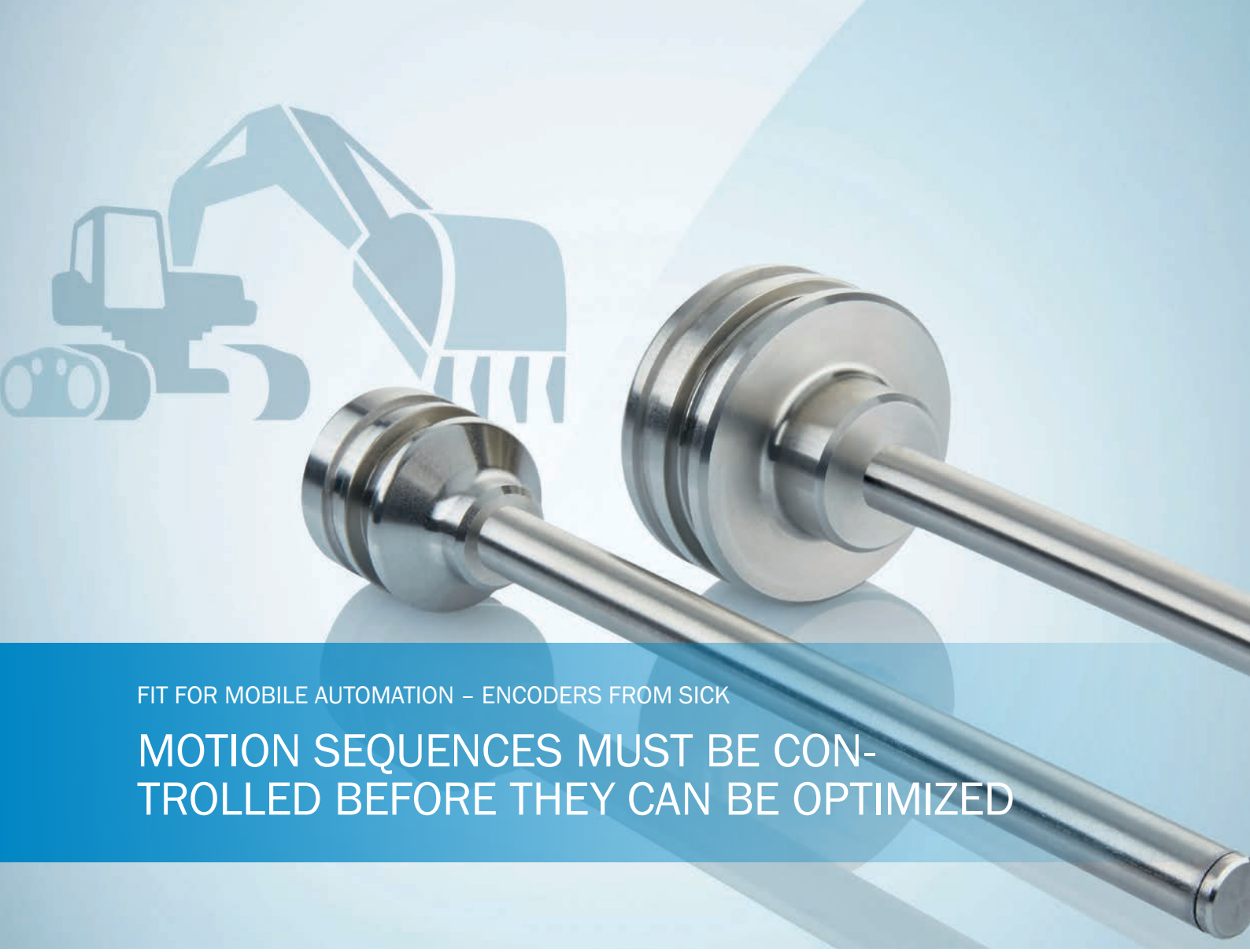
A monitor in the driver's cab displays the process via an external camera and a process data indicator. The display shows the operational status of the system and where any corrections might need to be made by the driver. If a pedestrian comes too close to the movement area of the gripper, for example, the driver can intervene and stop the process in its tracks.

What's more, the driver does not need to leave the vehicle in order to carry out container emptying. Asti Servizi Pubblici S.P.A. has deployed its most experienced driver for the pilot project involving the 2Side System, achieving cycle times of 80 seconds and less. The driver is also pleased that, in this way, he does not put an unnecessary strain on urban traffic.

The 2Side System complete system is an example of state-of-the-art waste disposal.

With its aesthetically pleasing containers, it adapts to any urban environment and offers an economical and time-saving alternative to conventional garbage removal in the field of waste management. Because the vehicles are operated by a single person, technology must provide optimum support for the work of the driver. This is where sensors from SICK help. *(as)*

A monitor in the driver's cab displays the process.



FIT FOR MOBILE AUTOMATION – ENCODERS FROM SICK

MOTION SEQUENCES MUST BE CONTROLLED BEFORE THEY CAN BE OPTIMIZED

Wanna bet that ...
... you can use an excavator shovel to place the tone arm of a record player precisely between two songs on a record, or hang up six socks with two excavators in the space of four minutes? Yes, you can. Several candidates on the German TV show “Wetten, dass..?” (“Wanna bet?”) won their bets thanks to their skills with an excavator. But what these clever contestants tried out for fun – namely operating a commercial vehicle with high precision – is now an established automated process in agriculture and forestry, road construction, mining, etc.

>> Mobile machines are increasingly becoming high-tech systems which perform their tasks in an automated, precise, and highly efficient manner. Even a single wrong move can be expensive in such situations. So how can you ensure that the motion sequences in your automated processes really are precise and efficient? With encoders from SICK. They will detect the exact speed, rotation, path, or angle of a movement and deliver the result to the process control or to the cloud as data that is ready for further processing.

Magnetostrictive technology rounds off SICK’s portfolio

The encoder portfolio from SICK comprises high-resolution optical encoders and extremely rugged magnetic encoders for exact measurements in a wide range of applications. Rotary encoders are available as incremental and absolute encoders. The range is rounded off by inclination sensors that enable non-contact detection of angles in one or two axes. Magnetostrictive linear encoders for measuring and positioning hydraulic cylinders are available in linear measuring technology.

Absolute encoders of the AHS/AHM36 CANopen product family .

TMS/TMM88 inclination sensors – for high precision measurement in harsh ambient conditions.

The demand for linear sensor technology is growing for hydraulic machines in particular. SICK meets the need among customers for rugged and highly accurate hydraulic measuring technology with the MAX linear encoder developed specifically for mobile automation. The measurement techniques based on magnetostriction enable a non-contact, and therefore wear-free and absolute measurement. In addition, the pulses are resistant to ambient conditions such as temperature, vibrations, contamination.

The right feedback for precise positioning

SICK is once again setting new encoder standards with the MAX48 and MAX30 linear encoder. MAX30 features the smallest housing currently available on the market with a diameter of 30 mm and a length of 21 mm.

The added value of linear measuring encoders in the field of mobile machines increases even more in combination with other sensor solutions (systems for angular and inclination measurement). Collecting machine status and process information makes it possible to carry out more detailed analyses, derive preventive measures (Predictive Maintenance 4.0), and support assistance systems.

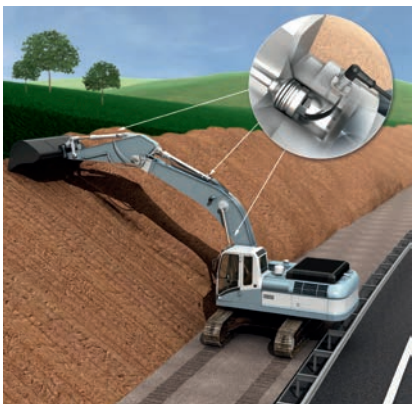
The automated waste container emptying system in Asti, Italy, provides an example of the successful combination of different sensors with encoders (see article on pp. 18–21).

Other examples include the leveling of excavator arms and the detection of ring mount positions on mobile cranes. AHS/AHM36 absolute encoders, TMS/TMM88 inclination sensors, and EcoLine wire draw encoders immediately turn received signals into data and transfer this data to a process controller or cloud.

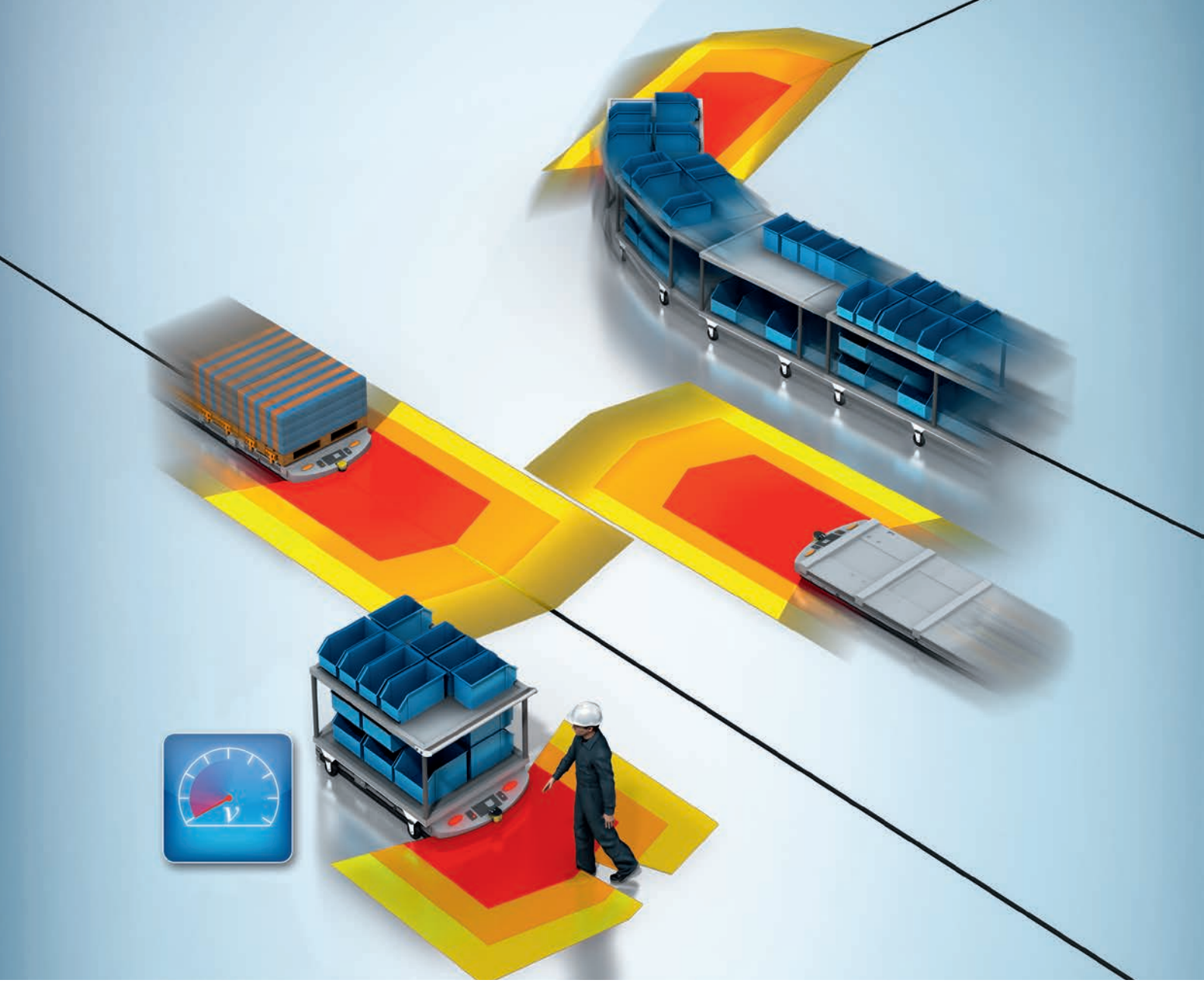
Fully automated lane guidance: an important step towards an autonomous tractor.

Wanna bet that you can empty a bottle container at the side of the road in 80 seconds or less in the middle of traffic? And at different collection points? Or that you can use an excavator to automatically apply gravel with centimeter precision? Or accurately level the surface of a kilometer-long highway embankment, without the excavator arm touching an overhead line or hitting a gas line? Yes, you can do all that and much more besides with rugged and intelligent sensor technology for demanding applications in mobile machines. *(as)*

Depth control: avoiding damage to cables.



Leveling the surface of highway embankments: fully automated with centimeter precision.



NEW CHALLENGES IN THE USE OF AUTOMATED GUIDED VEHICLES

THINKING AHEAD INTELLIGENTLY

Automated guided vehicles (AGVs) and automated guided vehicle systems (AGVSs) play a major role in increasing the flexibility of production and logistics processes. Used individually or in groups, these mobile helpers are the technical pioneers of cyber-physical production systems in the Industry 4.0 and Smart Factory framework – with the AGVs driving and working autonomously and AGVSs serving as self-organizing and self-optimizing units.

>> Implementing AGV and AGVS functionality involves the use of safety components as well as the completion of appropriate hazard analyses in advance. This is the only way to ensure the necessary level of accident prevention while also eliminating potential liability risks for manufacturers and operating entities. In this setting, safety is certainly the most important aspect, but not the only one to consider. Protective devices should not impair the vehicles' use, and adding intelligent functions can provide users with additional benefits.

For example, the S300 and S3000 compact safety laser scanners not only monitor the path of an AGV, they do so while also supplying measurement data. This data gives vehicles the ability to autonomously lift and place pallets or containers and keep their cargo in the correct position. In addition, the measurement data can be used for localization in the vehicle's navigation support. With the excellent scanning range of an S3000 Expert, it is also possible to detect position reflectors within a plant, and thereby determine the distance and angle in relation to the vehicle and use this measurement

data for localization. Safety technology combined with measurement technology – the two examples described above show how intelligent measurement data evaluation functionality eliminates the need for additional sensors.

Flexi Soft safety controller: the safety control center that comes along for the ride

Flexi Soft is a powerful modular safety controller that is easy to put into operation. Thanks to its scalability and user-friendly software, it can be adapted efficiently to suit the requirements of all kinds of safety applications. For this purpose, its features include function modules that can be flexibly combined, software-supported logic functions, and extended options for fieldbus integration via gateways for all common fieldbuses. When used on an AGV, Flexi Soft coordinates all of the sensors and functions used to ensure the vehicle's safety. With EFI (enhanced function interface), up to four safety sensors can be connected at a time. Thus, the all-around AGV protection that is particularly important for larger vehicles, for example, can be provided by using multiple safety laser scanners. In addition to areas lying in the path of the vehicle, the laser scanners also identify objects located next to the vehicle that can pose hazards during swivel movements or curve maneuvers.

In order to switch the protective fields of safety laser scanners based on the vehicle speed, Flexi Soft uses the data supplied by safety encoders like the DFS60S from SICK. If information such as the steering angle or the height of the load-carrying unit are relevant for safety and control, safe inductive sensors can also be connected to Flexi Soft. Aside from safety data, Flexi Soft is able to also process information from non-safety sensors to deliver even more added value.

Monitoring and controlling AGV drive units safely

Thanks to the modular Flexi Soft concept, the safety of AGV drive units can also be monitored using the appropriate modules. For this task, SICK offers a number of different options, including the "Flexi Soft Drive Monitor" Motion Control safety controller, which can be used to perform many safe drive-monitoring functions on an AGV. For example, with the SSM (safe speed monitor) and SLS (safely-limited speed) safety functions, the speed of an AGV can be monitored safely via encoders on the wheels. Based on the speed, the warning and protective fields of the safety laser scanners installed on the vehicle can be switched. If the warning fields are violated, a safe reduction of speed is automatically triggered. If a protective field is violated, the SBC (safe brake control) and SS1 (safe stop 1) or SS2 (safe stop 2) drive monitoring functions intervene to activate and monitor a safe stop function for the vehicle. Once the control has activated a stop function for the AGV, the SDI (safe direction) blocks the rotational direction just having been used by the drive. As a result, the vehicle is only able to move in the unblocked direction, and thus distances itself safely from the obstacle. This means that a fully integrated solution for drive safety monitoring is available in the "Flexi Soft Drive Monitor" Motion Control safety controller.

AGV safety technology as a data collector for Industry 4.0

Especially when networked to provide complete safety solutions, safe sensors and safety controllers supply a wide range of additional data that can optimize the availability of individual automated guided vehicles and even an entire AGVS. Data for current consumption, operating hours, accumulated contamination, and operating temperatures are just a few examples of the information that can be directly relevant to preventative or operational maintenance as part of a condition monitoring system. This information is provided by sensors, evaluated and processed by the control unit, and sent to the vehicle control system via the gateway. From there, it is made available in higher-level or cloud-based applications by radio data transmission, Bluetooth, or NFC. *(tm)*

Localization on Contour: navigation without reflector marks

The synergy effect of using an array of highly diverse sensors can be seen from the example of „Localization on Contour (LOC)" on the basis of the NAV-LOC concept. Here, 2D LiDAR sensors (also 2D laser scanners) and safety laser scanners supply measurement data. Actual vehicle positions are calculated based on both this ambient data and a reference map, created beforehand. When the sensors are combined with intelligent hardware, like the Sensor Integration Machine (SIM) from SICK, and the algorithm of the SICK Contour Localization app, the vehicle position is determined and sent to the AGV.

AGVs light – ensuring safe movement in collaborative operation

The young Danish company Mobile Industrial Robots (MiR) has developed the MiR100, a mobile transport robot that works like clockwork. Built-in S300 safety laser scanners, 3D cameras, and ultrasound ensure that the robot stops automatically as soon as it encounters a person or a static object.

Read the full report at:
www.sickinsight.com/mir

3D LiDAR SENSOR FOR MOBILE MACHINES

MORE LAYERS OPEN UP MORE PERSPECTIVES

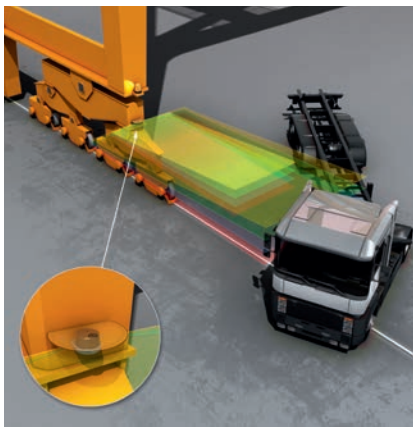
Driver assistance systems based on 3D LiDAR sensors (also 3D laser scanners) or 3D vision sensors from SICK reliably detect blind zones around mobile machines and warn the operator of potential sources of danger or accidents in good time. Beside intelligent 3D assistance systems with the Visionary-B 3D vision sensor, the MRS1000 3D LiDAR sensor provides navigation and maneuvering support.

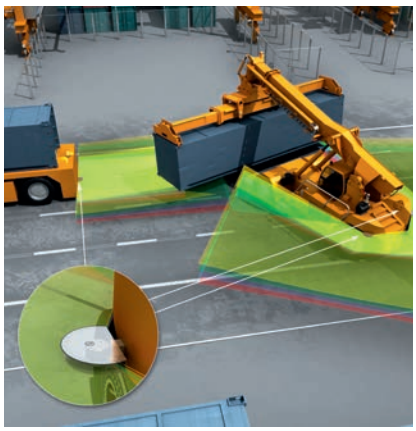
>> Maneuvering and driving in reverse are frequent causes of accidents on construction sites and in surface and underground mining, but collisions also occur in locations where cargo is handled, such as ports.

Moreover, in agriculture, imprecise fertilization or harvesting processes result in losses if harvesters do not correctly recognize the contours of the windrows, for example.

At the same time, these industries are also under a high level of pressure to ensure efficiency: While agriculture must produce an increasing amount of food for an increasing number of people, the costs of some raw materials are hitting rock bottom. In order to continue extracting raw materials in a profitable manner, work processes must become more efficient. Building projects are always faced with huge time pressure and also involve a higher risk of accidents due to the fact that humans collaborate closely with machines.

However, many collisions and accidents can be avoided if the machine operator is supported by suitable technology. Simple warning functions are often not enough. The system must also be able to distinguish between different objects depending on their importance for collision warning purposes. In order to make this distinction, it is essential that objects are detected in terms of volume. The at times harsh ambient conditions in the fields of application also pose an additional challenge.





Loading situations in the port: The MRS1000 supports the crane operator with reliable monitoring of the surrounding ground and assists the reach stacker driver when loading containers.

Surroundings monitored – danger averted

Based on decades of laser technology expertise from SICK, the MRS1000 3D LiDAR sensor is now opening up a broad spectrum of perspectives for driver assistance systems “in the field.”

The sensor detects up to 55,000 measurement points across four layers. The MRS1000 emits three echo signals per measuring beam, thereby increasing the number of measurement points to up to 165,000 per second. The layers are arranged horizontally, one on top of the other, and fan out from the sensor. At a distance of 20 m, for example, the MRS1000 covers a height of 2.70 m.

With simultaneous measurement on four levels, the MRS1000 also detects objects which are on the floor or obstructing the path. Even when operating merely medium-sized excavators, the driver’s view is limited.

Excavators, too, benefit from the various application possibilities afforded by the MRS1000. It controls the movements of the excavator arm, for example. The sensor monitors the absolute positioning of all moving elements in relation to one another, and the machine operator can adjust, accelerate, or decelerate the movement accordingly.

A guaranteed view

The MRS1000 uses the innovative HDDM+ technology. It enables measurement across long distances and is characterized by low measuring value noise as well as multi-echo capability.

Thanks to the individually configurable echo filter, the 3D LiDAR sensor screens out unwanted measurement data and signals caused by rain, dust, snow, and other disruptive ambient conditions, for instance. The field evaluation takes place directly in the sensor, with high scan speed and wide measurement field coverage.

With its large, vertical aperture angle of 275 degrees, the MRS1000 covers a working range of up to 64 m. Within this working range of up to 64 m, the MRS1000 reaches all the areas surrounding the vehicle – even those that the machine operator cannot see.

Even when visibility conditions are difficult or objects are moving, the MRS1000 provides reliable measurement data thanks to three echo signals which are emitted for each measuring beam. Depending on the operating conditions, additional filters are available – increasing the availability of the MRS1000 even further.

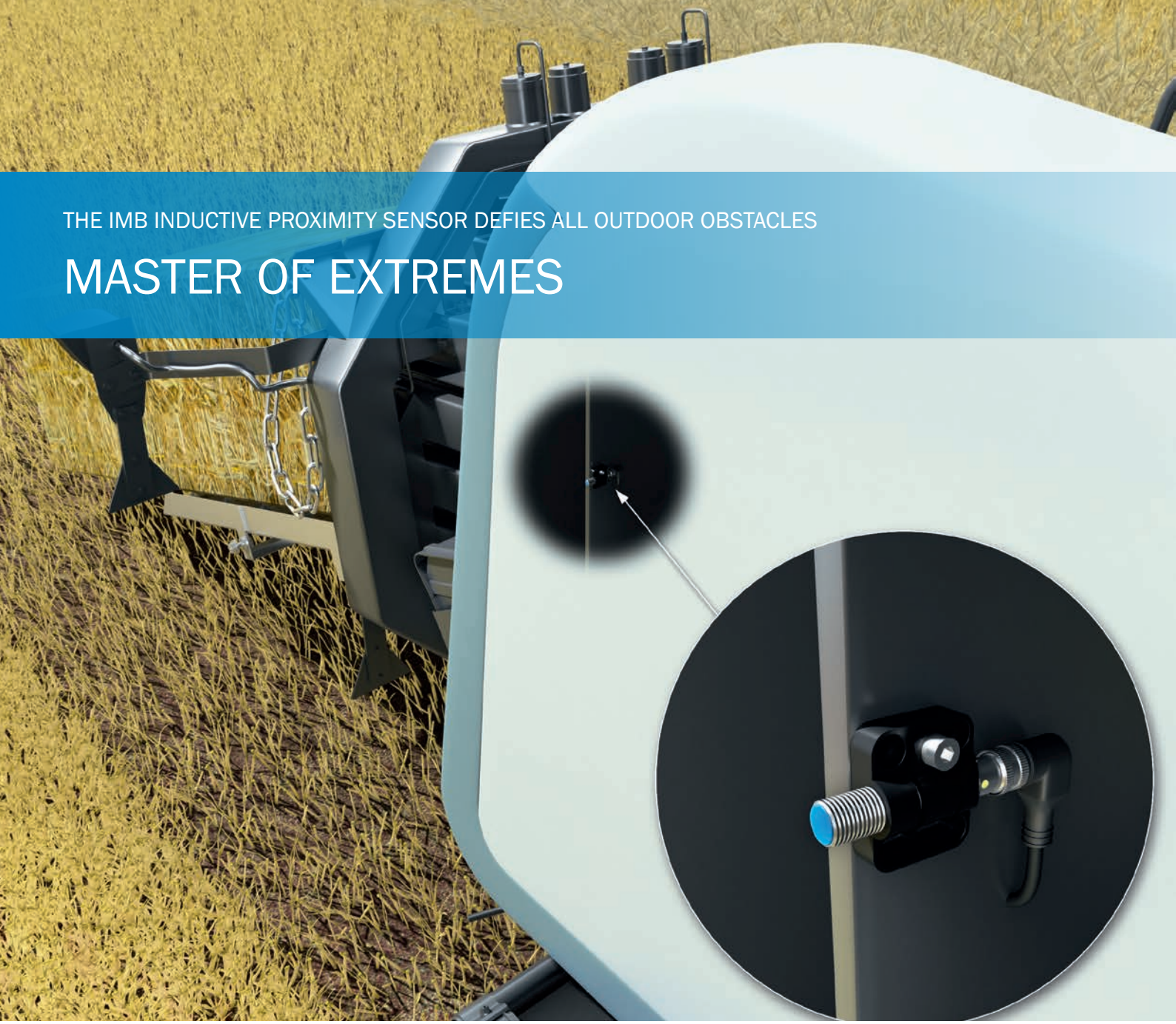
In ports, for example, a fog filter can be used. This enables the 3D LiDAR sensor to eliminate unwanted echoes at close range which can otherwise result in the sensor being triggered incorrectly. An additional particle filter blanks irrelevant reflection pulses, such as dust particles, in dusty and harsh environments found during surface mining and on construction sites, for instance.

Flexible for use outdoors

The MRS1000 is designed in such a flexible and rugged manner that it can operate in many different fields of application. With an enclosure rating of IP67, its housing is not only able to withstand dirt and unfavorable weather conditions, but also temperature fluctuations ranging between –30 and +50 degrees Celsius. What is more, the MRS1000 has connections which can be positioned flexibly, meaning that there are virtually no limits when it comes to mounting the multi-layer scanner. The field outlines can be adapted to the task at hand. Specific configurations can also be applied to each of the four layers. The MRS1000 can be configured using the proven SOPAS ET software from SICK. The sensor data is visualized via the web server in a convenient and customer-friendly manner. *(hs)*

THE IMB INDUCTIVE PROXIMITY SENSOR DEFIES ALL OUTDOOR OBSTACLES

MASTER OF EXTREMES



Agricultural machines are exposed to extreme situations which require a high degree of ruggedness to withstand. Only the tough – and the giving – prevail. IMB inductive proximity sensors make a major contribution to this. With a rugged stainless-steel housing, special seals, the latest ASIC technology from SICK, and a the wide temperature range currently unique to the market, they ensure process stability, even under very difficult conditions – and cover a wide variety of applications while doing so.

>> Inductive proximity sensors from SICK withstand icy cold and extreme heat, and work reliably even in the event of strong vibrations. The sensors effortlessly resist both frequent contact with water and aggressive oils. When push comes to shove, inductive proximity sensors from SICK achieve top performances.

The sensors are characterized by a high processing quality, a long service life, and extreme ruggedness. Modern ASIC technology guarantees the highest level of precision and reliability in their performance. Metallic objects are detected entirely without contact via a high-frequency electromagnetic alternating field. The IME inductive sensor from SICK has already been established as an economically efficient standard in industrial environments.

A rugged design is essential

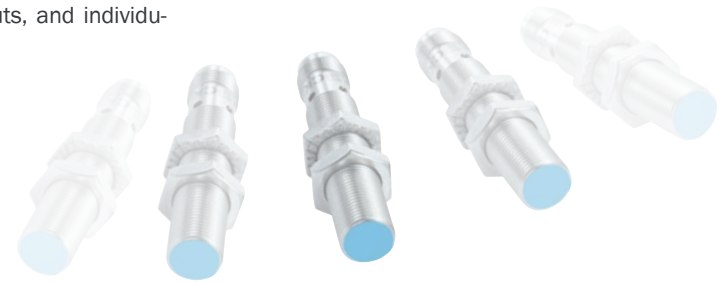
What the IME has started on a small scale in factory automation, the new product family of IMB inductive proximity sensors is continuing on a large scale – with a combination of properties which specifically tailors the sensor to the challenges of outdoor mobile automation. In addition to the rugged stainless steel housing, the catalog of features includes self-locking nuts with O-rings for protection from ambient conditions. Another feature is the temperature range which is currently unique to the market and allows for the IMB to be used in temperatures between –40 °C and +100 °C. It is armed against all eventualities: It

withstands extreme temperatures and weather, is resistant to lubricants, oils, and fertilizers – and is unyielding against mechanical loads.

Exact process control

In practice, numerous sensors master the complex field of detection and positioning tasks – up to 30 IMB inductive proximity sensors are used on a baler, for example. Pressing straw into a bale requires many process steps which the IMB monitors – from the pre-press to the press shaft to the main press, and from axis monitoring to the position query of all dynamic components and end positions.

In all this, the IMB takes advantage of its properties with consistency: Wide and high-precision sensing ranges enable exact process control. Thanks to its stable and long-lasting housing, the inductive sensor reduces machine downtime, which is important in peak harvesting phases, for example. A visual adjustment indicator, self-locking nuts, and individually-designed connectivity ensure quick and easy sensor installation on-site. Last but not least, the IMB is available off the shelf worldwide on short notice, and the maintenance work for the sensor is minimal. All this makes the IMB the ideal partner for countless automation applications. *(fg)*



High-performance, rugged, and reliable: the IMB inductive proximity sensor.

Customized, application-specific connectivity from SICK

A reliable and consistently high performance when used in rough environments begins with the sensor and ends with its optimal integration into the (mobile) machine. Which is why SICK delivers everything from one source: sensors, male connectors, and cables which can be adapted to the customer's requirements. A broad portfolio of ready-to-assemble male connectors provides the ideal basis for customized wiring solutions. Different lengths and qualities of cable can be combined quickly and smoothly to suit the requirements. The connecting cables offer the highest level of flexibility during wiring. SICK can therefore offer a perfect solution tailored to customers' requirements for any application.

ULTRASONICS IN MOBILE AUTOMATION

PROVEN DETECTION PRINCIPLE FROM NATURE FOR COMMERCIAL VEHICLES AND AGRICULTURAL MACHINES

Bats and dolphins do it: They orient themselves quickly and reliably using ultrasonics. This versatile technology has been established in industry for many years: It is used for object detection, position determination, and distance measurement. And ultrasonic sensors also show their worth in a variety of tasks in mobile automation.

>> Ultrasound is the term for sound in a frequency band beyond the human hearing range – starting at approximately 16 kHz. Ultrasonic sensors use this physical operating principle by generating such high-frequency sound waves. If the sound waves hit objects, they can penetrate them or be absorbed or reflected by them, depending on the nature of the object surface.

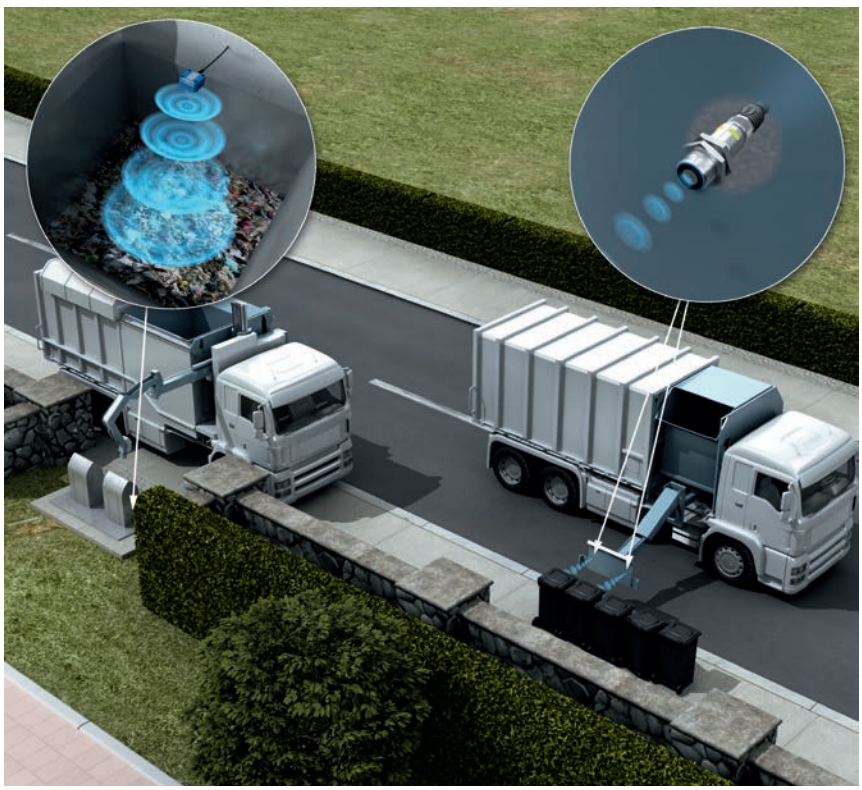
The reflection from a surface can be used for object detection, position determination, and distance measurement. The ultrasonic sensor calculates the distance from the object from the time span between the emission of the sound waves and the reception of the echo signal.

Ultrasonics offer many advantages for mobile automation

In contrast to sensors with other physical operating principles, ultrasonic sensors are able to detect objects regardless of their color, surface, and ambient conditions. That is a decisive advantage for the use of commercial vehicles or mobile agricultural machines. For instance, the color of a recycling bin which is automatically picked up and emptied by a collection vehicle is as unimportant for detection as is the restless surface of a corn field or the foliage of a fruit tree. Sun and rain also hardly affect the reliability of ultrasonic sensors: Their housing with high enclosure ratings withstand dust, fog, and rain. The influence of different temperatures on hot or cold days is automatically balanced out by the integrated temperature compensation.

Complying with special requirements and standards

The SICK product range of ultrasonic sensors with different housing variants, operating ranges, and interfaces provides solutions for a very wide variety of tasks in mobile automation. These include agricultural and forestry machines, construction and mining machines, as well as special and municipal vehicles. SICK designs all sensors relevant for



Level measurement in underfloor containers and position detection of recyclable materials containers.

mobile automation in such a way that they can withstand the high requirements on impermeability, chemical resistance, temperature influences as well as shock and vibration resistance in their typical rough operational environments.

Added value for recyclable material collection vehicles

The use of ultrasonic sensors considerably increases efficiency when collecting recyclable material. For example, the compact UM18-2 in a cylindrical metal housing is used for positioning the automated container gripper arms of the collection vehicle to the fixing points of the recyclable material containers with millimeter accuracy. It is also possible to control the speed of the gripper arms during the approach using the IO-Link or analog output of the sensor. A UM12, which needs even less space, checks whether the position of the collecting container is correct before the recyclable materials are poured in, thereby ensuring a smooth emptying process. Depending on the vehicle, ultrasonic sensors of this product family are also used to report the allocation of an uptake and tilting mechanism and to monitor the temporarily empty area under the container during emptying.

In order to optimize the trips to underfloor containers, it is helpful to inform the driver when the containers are sufficiently full and should be approached. The contamination-resistant UC30 mounted in the underfloor container detects the critical filling level of the container and then triggers an emptying request or delivers the relevant information for optimal trip planning.

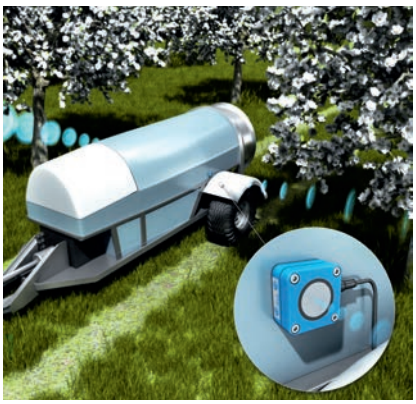
Every time a recyclable material container is emptied, the level in the vehicle container rises. A UC30 ultrasonic sensor in the compact cubic housing mounted inside continuously measures the increasing level and detects when the critical filling state has been reached. The driver then receives the information that emptying at the disposal site will soon be necessary.

More efficiency in agriculture

Ultrasonic sensors also offer countless fields of application in mobile agricultural machines such as harvesting vehicles. For example, the UC30 is well-suited for level monitoring in the collecting containers on harvesting vehicles due to its large operating range and compact installation dimensions. The UC30 solves another task with spraying devices for fruit growing. In this application, the sensor detects different tree spacings in groves. The sensor stops the spraying process as soon as the vehicle passes a gap in the trees or when the line of trees has come to an end. Automated detection of trees for controlling the sprayer makes things easier for the driver, and the output of fertilizer or plant protection products is minimized in an efficient way. The lowest possible consumption of spray is also an important goal when applying ultrasonic sensors for the fully-automatic guidance of crop-spraying rod constructions used for cultivating grains and field crops. Depending on the type of construction, up to four UM30 devices are installed. The ultrasonic sensors monitor the working height of the two side sprayer booms and, if needed, adjust it to the plant height of different crops. That is how they ensure as little fertilizer and plant protection products as possible are used. At the same time, the sensors prevent the rod construction from damaging the crop and colliding with areas of uneven ground or other possible obstacles on the field.

Smart automation solutions suited for daily use are created by the integration of ultrasonic sensors in special and municipal vehicles, in construction and mining machines as well as in mobile agricultural and forestry machines. They improve productivity while at the same time lowering operation and material costs. And if the ultrasonic technology is not an optimal fit for the task, the extensive sensor portfolio from SICK offers a wide range of efficient solution alternatives for mobile automation. *(as)*

UM30 ultrasonic sensors ensure the correct working height of the crop protection sprayers.



To optimize the spray output, UC30 ultrasonic sensors detect the crop in fruit-growing applications.

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