

SICK AG WHITEPAPER

FOCUSING ON THE BLIND SPOT: ACTIVE 3D COLLISION WARNING SYSTEM FOR MOBILE MACHINES

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Active collision warning system for Mobile Machines

Maneuvering and reversing are the most frequent causes of accidents involving mobile machines used on construction sites, in open-cast and underground mining and in agriculture and forestry, as well as municipal and special vehicles. The Visionary-B active driver assistance system developed by SICK is designed to monitor the area around and behind mobile machines that is invisible to the driver. It consists of a 3D vision sensor suitable for outdoor use which identifies different objects in the driver's blind spot and issues a warning.

Sensor-based automated systems for agricultural and forestry vehicles, mobile construction machines in building construction, civil engineering and mining and municipal and special vehicles are becoming increasingly important. One area where sensors are used in mobile machines is to provide reliable systems that detect the risk of a collision and warn the driver. The main driving force behind this development is the fact that a large number of collisions and accidents can be prevented if suitable technology is available to support the driver or machine operator. 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. The particular challenges involved in these applications not only concern detecting and evaluating objects. The sensor solutions must also be designed to withstand the rough outdoor environments where the machines are used.

Visionary-B from SICK is a product that meets all of these requirements and also has another special feature. It has been designed as an active system. This means that as soon as an object appears within a defined detection zone, the system gives an audible and visual signal. In contrast to passive monitoring solutions, the driver does not constantly need to look at the monitor. 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.



Figure 1: This system is a driver assistance system designed to enhance collision awareness, it should be used to support drivers. This product is not a safety component as defined in the Machinery Directive.

Visionary-B: Plug and play 3D collision warning system

The role of the Visionary-B intelligent driver assistance system is to minimize the risk of collisions when mobile machines pull away, maneuver and turn, by monitoring the driver's blind spots. 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 warnings with an integral 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 one and 2.4 meters, the detection angle of $105^{\circ} \times 90^{\circ}$ enables it to cover an area behind the vehicle, not visible to the driver, that is six meters long and four meters wide. The evaluation unit processes the 3D image data, assigns the objects to different classes on the basis of the measurement data, saves the recordings of the most recent period of operation and uses intelligent algorithms that enable it to ignore objects which can be irrelevant for collision warning. At the same time, it transmits the live image and the alarm signals to the monitor in the machine's cab, which issues collision warnings in the form of both audible and visual signals.

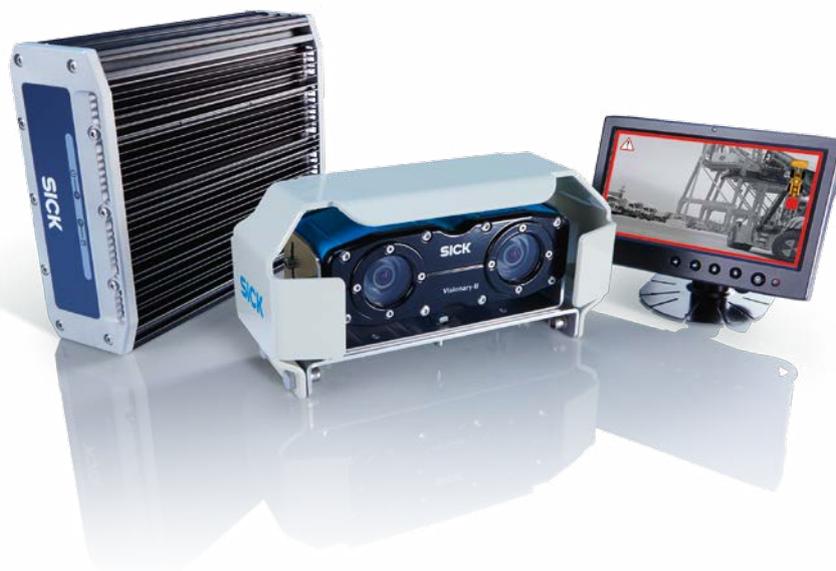


Figure 2: The Visionary-B driver assistance system provides collision warnings in challenging environments.

Stereoscopic principle and 3D snapshot technology

To ensure that the collision warning system is reliable and is accepted by drivers, it is essential that it consistently identifies hazards and can distinguish 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 different objects and measure their distance from the vehicle. The 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 information, in other words, the third dimension. On the basis of the 3D image information, the 3D vision sensor can identify the width and height of the objects. This allows the system to distinguish between different objects that could cause a collision and those that cannot, for example curbstones and uneven ground. SICK's integral data evaluation unit reliably detects two classes of objects in an outdoor environment. The first class consists of smaller objects than those that make up the second class. Wide objects, such as walls, do not fall into the second class and are ignored for the purposes of this class. Configuring the system only to warn the driver about objects in class 2 is an ideal solution in narrow passages, 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 system will not send 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 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 that cover the area around and behind particularly large and bulky vehicles.

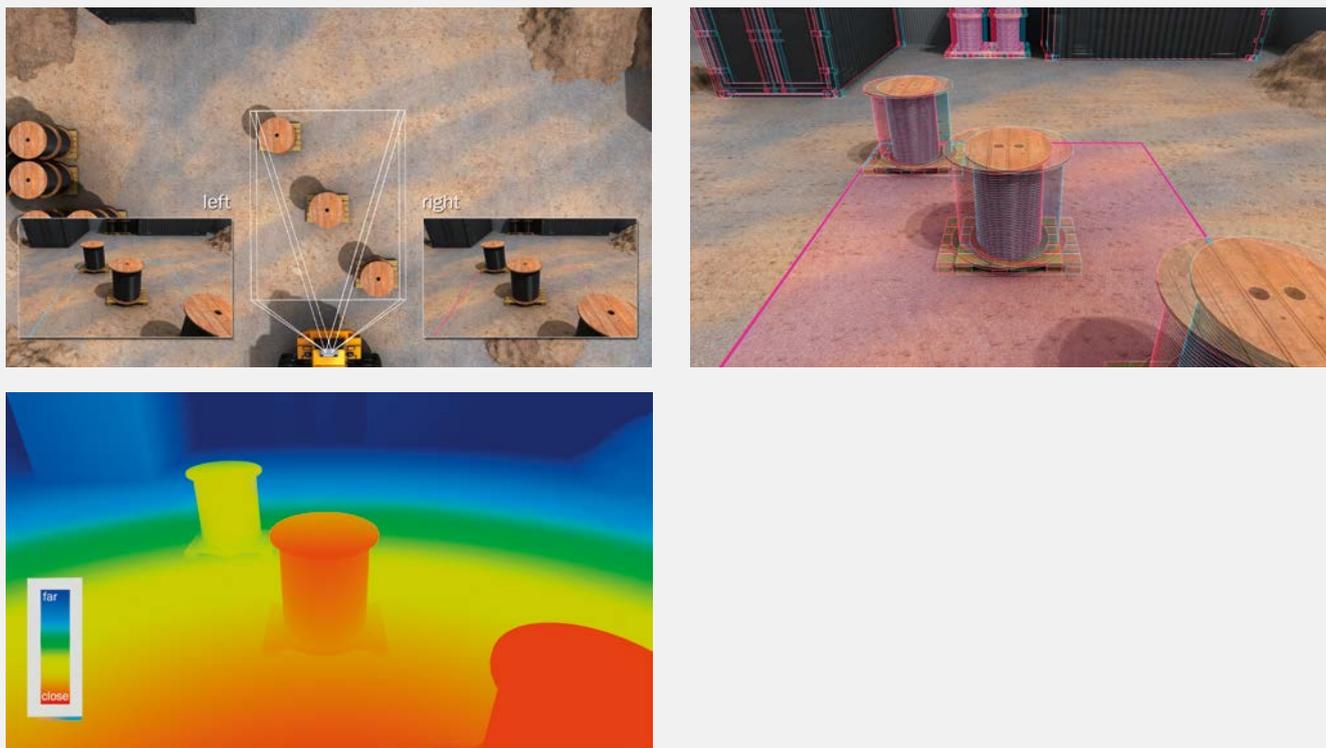


Figure 3: Principle of operation of stereoscopic vision technology.

Designed for high availability in rough outdoor environments

The Visionary-B driver assistance system is highly rugged and is 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 operating 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 evaluation unit uses algorithms that have been tested in practice to 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.

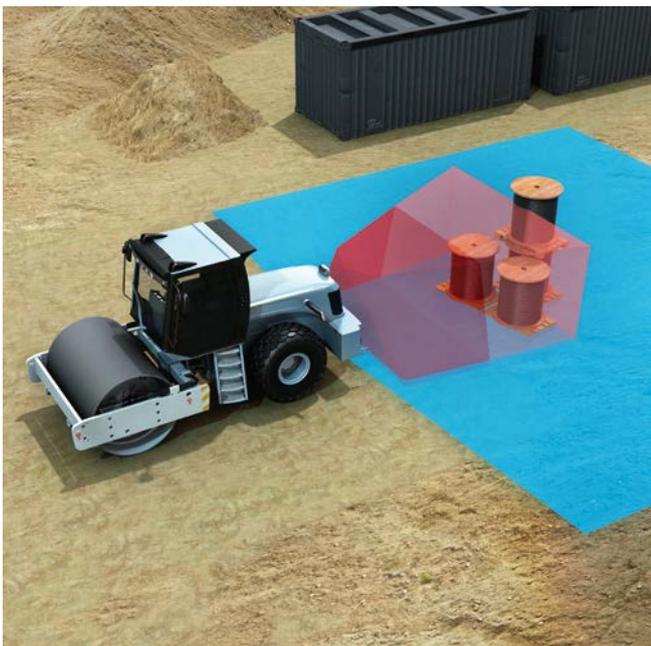


Figure 4: The role of the Visionary-B intelligent driver assistance system is to minimize the risk of collisions when mobile machines pull away, maneuver and turn, by monitoring the driver's blind spot.



Figure 5: The Visionary-B 3D vision sensor reliably detects relevant objects in the driver's blind spot and issues a warning.



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 outdoor driver assistance system. For example, the version of Visionary-B that makes it possible to switch between two 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. 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. In all types of environmental and light conditions, it can monitor areas in the machine's direction of travel that are not visible to the driver. This reduces the risk of collisions and accidents to a minimum and also helps to prevent damage to the vehicle, together with the accompanying downtime and costly repairs. Visionary-B is also a valuable addition to agricultural and forestry machines. It can detect possible hazards and accidents in good time and send an active warning to the driver. A reduction in the damage caused to vehicles also means shorter downtimes and high levels of availability, particularly during crucial times of year, such as harvest. In municipal and special vehicles, for example the trucks used for collecting recycled materials, Visionary-B constantly monitors the driver's blind spot and provides active support when the vehicle is maneuvering.

In addition to these examples, 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 by the manufacturer in new vehicles but they are also suitable as complete solutions for retrofitting or as dealer accessories and can easily be configured.



Figure 6: Visionary-B is also a valuable addition to agricultural and forestry machines. It can detect possible hazards and accidents in good time and send an active warning to the driver.

Figure 7: Visionary-B is also in use in ports.

