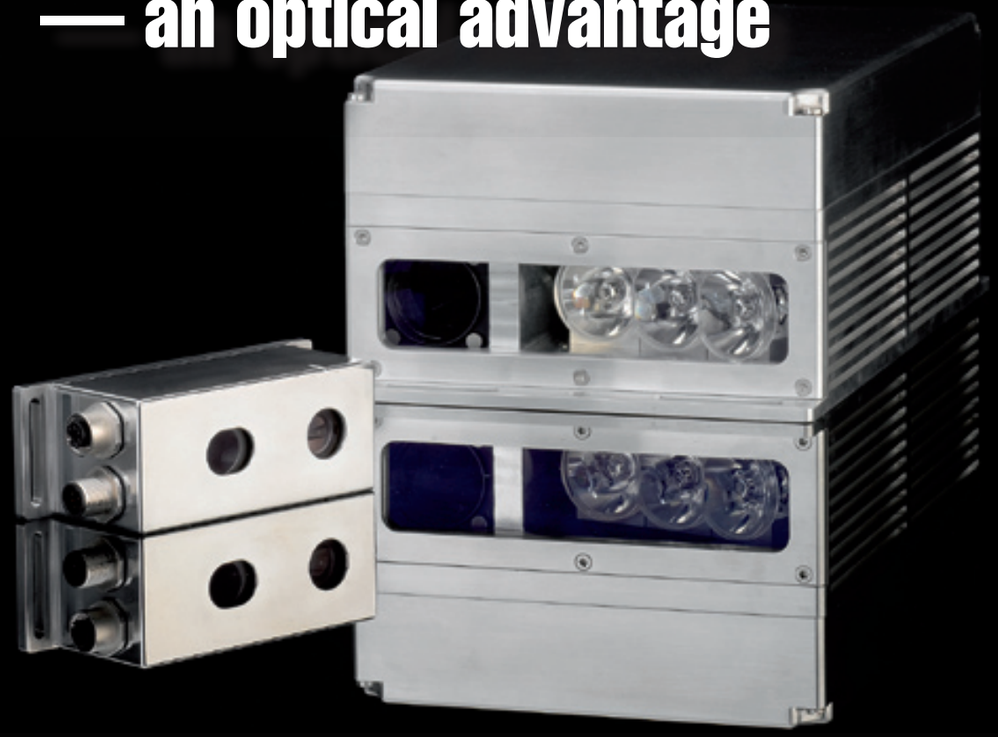
Noncontact motion sensors
— an optical advantage



Some motion sensors are based on optical measurement technologies to provide accurate velocity and position measurements without requiring physical contact with the object or surface being monitored.

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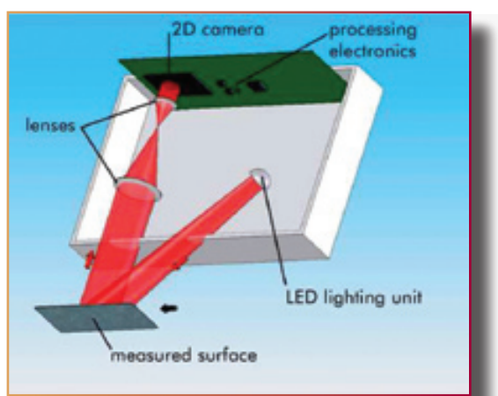
Noncontact sensors are suitable for applications involving hot, wet, soft, or sensitive materials. They have been used successfully in myriad manufacturing and process industries. More specifically, some optical motion sensors are designed to be mounted a specified distance from the surface they are monitoring, with a light source (most often a red LED) that shines a spot of light on the surface. Its light is reflected back into an optical system that includes a lens and a photo-sensors array that monitors the optical image of the target surface as it moves across the field of view. These motion sensors make use of two basic measurement technologies.

One technology: Image correlation

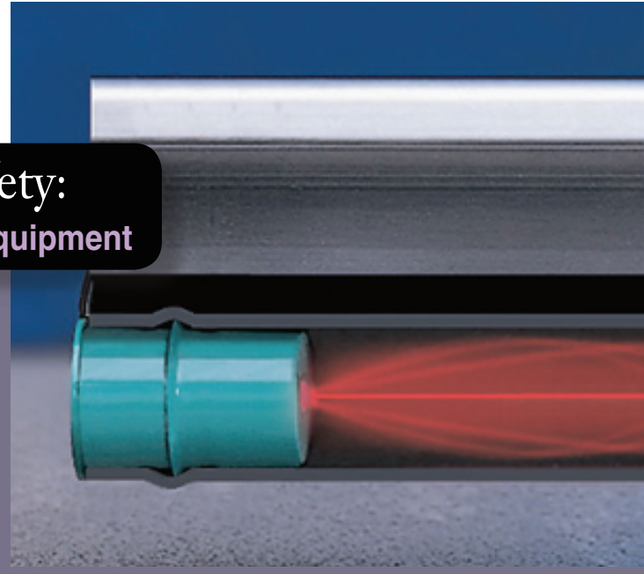
In some units, the optical system behaves much like a digital camera, taking a series of snapshots of the measured surface at intervals Δt. A microprocessor in the sensor compares successive images, using an image correlation algorithm to determine how far the image moves between shots. The system is capable of monitoring displacements in two dimensions (Δx, Δy) and calculates velocities by dividing the measured displacement by the shot-to-shot time interval. ($V_x = \Delta x/\Delta t$, $V_y = \Delta y/\Delta t$). Note: The relationship between the focal length of the optical system and the standoff distance between the sensor and the target object are needed to translate the shift in the position of the image on the photo-sensor into an estimate of the movement of the observed surface.

These motion sensors are compact, robust, reasonably accurate (to 1%), and relatively affordable. Depending on the configuration, they are capable of measuring speeds of up to 4 m/sec (780 fpm). They can also handle a variety of surfaces, including those that are rough, smooth, and shiny. In addition, the sensors can recognize part edges and surface markings. Due to this versatility, these sensors have been successfully used in production processes for materials such as woven and nonwoven fabrics, paper, metal foils, and plastic films. With their ability to track movements in two dimen-



This optical motion sensor contains a light source that shines a spot of light on the surface. This light is reflected back into an optical system that includes a lens and a photo-sensors array that monitors the optical image of the target surface as it moves across the field of view. INTACTON Gmbh, a member of the FRABA Group of sensor technology companies, has developed motion sensors of this type for use in industrial automation and similar applications.

Optical technology boosts safety:
Safety edges protect people and equipment



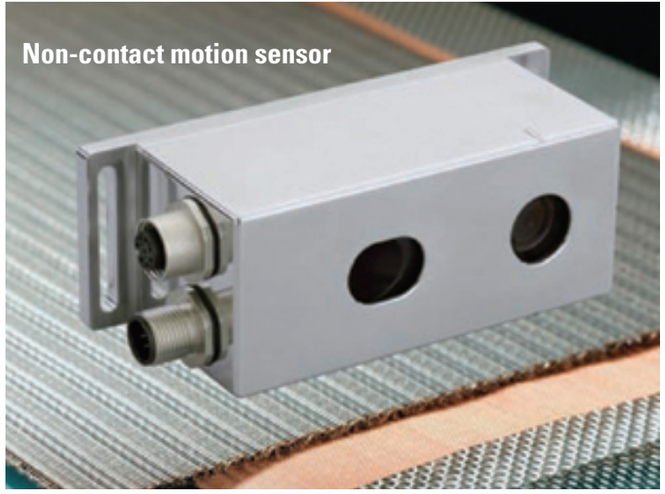
Safety edge light source: The VITECTOR unit of the FRABA group manufactures safety edge products based on two technologies. (Shown above is the company's infrared-based design.) These safety edges reduce risks associated with the movement of large, heavy objects and help designers and operators meet demanding safety standards.

Safety edges are devices that are mounted on the edge of large moving objects — such as doors or automated guided vehicles — to provide an instant warning signal to a control system when the object collides with a person or another object in its path. In response to this signal, the control system can stop or reverse the motion and avoid harming the person or object.

Two safety-edge technologies exist: The first version is based on an optical system. A hollow rubber tube is mounted on the edge of the moving object with an infrared light source mounted at one end and a sensor at the other. If the tube is deformed because of contact between the moving edge and another object, the light path is partially blocked and the optical sensor sends a warning to the control system. Because of the internal reflection of light inside the tube, gradual bending of the edge (for example, due to wind pressure on a large door) won't trigger the alarm. In this way, the system is able to distinguish between insignificant events and potentially dangerous collisions. The system is also failsafe. The receptor is designed to recognize only light from the source, so that stray light entering the system (as from a tear in the rubber tube) will not give a false-positive response.

The second safety-edge technology relies on air pressure. Here, the hollow rubber profile mounted on the edge of the moving object is sealed and connected to a sensitive pressure switch. When the edge contacts another object, the switch is activated and sends a warning to the control system. The pneumatic system lacks the failsafe feature, but is less expensive and suitable for noncritical installations.

Both safety-edge technologies are easy to install, as the rubber tube that lines the edge can be cut to any length. Finally, a malfunction anywhere in the system causes a warning signal to be sent to the controls.



A key advantage of optical motion sensors is that they measure velocity and displacement without any physical contact with the target object so there is no possibility of damage to sensitive materials and no problems with slippage due to wet, dirty, or oily surfaces. The lack of moving parts in the OPTIPACT motion sensor shown here also boosts life and reliability.

sions, they have also proven useful for the production of paper tubes and coating of steel pipes. Pairs of these sensors positioned at the input and output ends of a process stage can measure material shrinkage or elongation of a continuous strip of material. These sensors are also useful in specialized applications, such as guidance systems for automated guided vehicles and speed measurement in wind turbines.

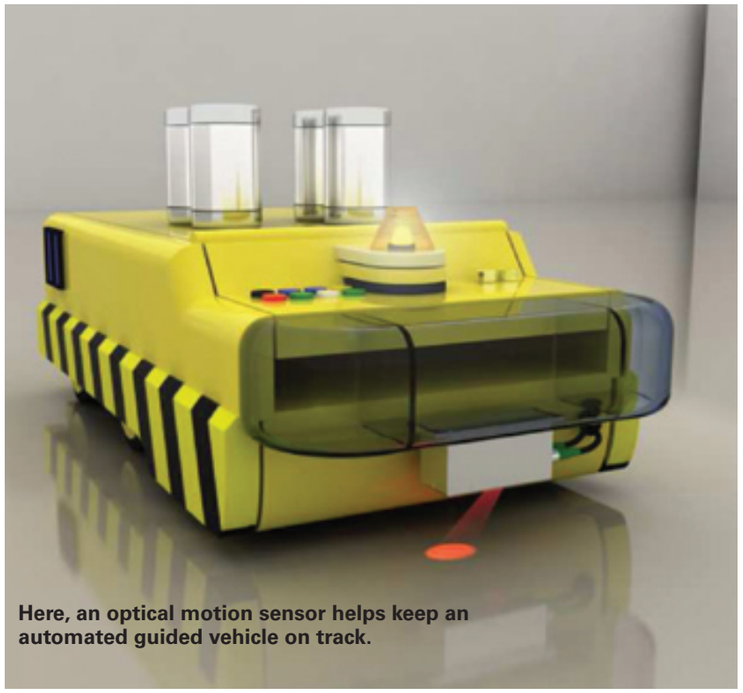
Another technology: Spatial filtering

A different measurement technology also exists — spatial filtering. Here, a high-speed line scan camera detects light reflected from the object being measured. A grid structure is superimposed over the moving image viewed by the camera, creating a periodic output signal, the frequency of which is directly proportional to the velocity of the moving object. The powerful microprocessors built into these devices calculate this frequency many times per second, providing an accurate estimate of the velocity of the object or surface moving across the sensor's view. The displacement of the object is calculated by numerically integrating the velocity signal.

Motion sensors operating in this way measure movement along a single axis. They feature accuracy to ±0.05% and dynamic response — making them useful in applications requiring precision or where accelerations and decelerations can degrade accuracy.

Typical applications where these sensors have been especially useful include high-quality wire production and precision coating applications. In these situations, the accuracy of these sensors means significant reductions in both material waste and overall production costs.

For more information on optical motion sensors, visit intacton.com or call (609) 750-8705. Otherwise, visit fraba.com.



Here, an optical motion sensor helps keep an automated guided vehicle on track.

Optical technology in safety:

SIL 3-compliant encoders suit safety-related applications

Motion systems can pose serious risks to people and property if they spiral out of control following an equipment or system failure — particularly in elevators, cranes, and mobile lifting platforms. Robots and conveyer systems can also become dangerous because of the size of the moving objects and the speeds that they reach.

The international standard IEC 61508 provides a framework for assessing the required safety levels of electrical, electronic, and programmable electronic equipment and systems. This standard defines four degrees of Safety Integrity Level (SIL). Equipment that meets SIL 1 is acceptable only in circumstances where the likelihood of a dangerous situation arising is relatively low and the consequences of failure reasonably mild. As the likelihood of a dangerous situation increases and the consequences become more severe, the equipment and systems operating in this environment are required to meet higher standards (SIL 2, SIL 3, and ultimately SIL 4). At each level, the equipment must be more reliable and include comprehensive failsafe features (for example, an orderly shutdown to a safe condition in the event of a loss of control). SIL 3-compliant components and systems are recommended in industrial automation applications such as control of robots, press lines, or injection molding machines. Other areas where SIL 3-compliant systems should be used include chemical plants, elevators, and construction equipment.

Some SIL 3-compliant rotary encoders contain two redundant measurement systems that feed a microprocessor, which in turn interprets the output of the optical arrays and manages a CANopen Safety communications link. When the processor detects a difference in the readings from the two measurement systems (which signals a problem with one of the readings), it sends an error condition to the CANopen controller. In this way, even internal malfunctions are registered.

POSITAL OCD encoders are certified for use in SIL 3-compliant systems by the independent German test organization TÜV Rheinland.