Unique Requirements Attractively Met

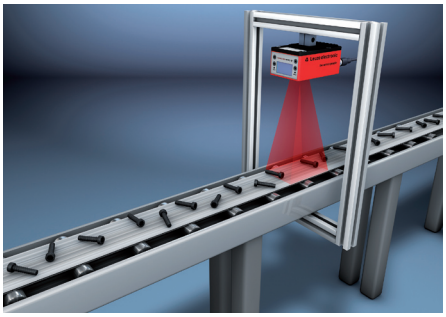
Micro Video Lenses Increase Machine Vision Applications Range

At one time micro video lenses for compact machine vision systems supported only low resolution applications. Reductions in the size and cost of optical sensors along with increases in pixel count now allow high resolution in compact systems. New optical designs are yielding micro video lenses with increased resolution to match today's sensors, increasing their applications range.

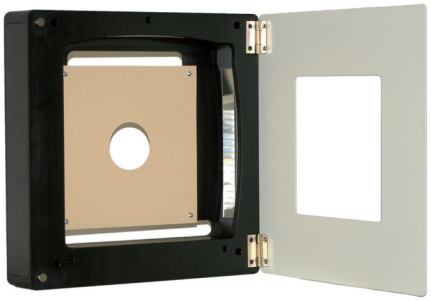
The digitalization of machine vision has resulted in increased resolution and lower cost for sensors, but the optics typically remained basically the same. Most video lenses for machine vision use a C-mount and are designed for a sensor size of 2/3″ covering an image circle of 11 mm. Now, however, high resolution CCD and CMOS sensors are available in sizes around 1/3″, creating a need for optical manufacturers, such as Edmund Optics, to reduce lens size and price accordingly.

These micro video lenses are approximately 15–25 mm long with an outer diameter of 14–18 mm. The mount is usually an S-mount (M12x0.5-thread). This compact size provides an advantage over traditional C-Mount lens and camera systems not only in terms of smaller assembly dimensions but also reduced costs.

The cost reductions do not come primarily from the lens, however. To maintain high quality the lenses are made of glass and metal only; no plastics. Glass costs do reduce slightly with smaller lens diameters, but other cost reductions come from the mechanical design. For instance, micro video lenses can avoid use of an expensive helical focusing mechanism and use the mounting thread to adjust position. Another cost reduction design step is to control aperture by using a spacer of the proper diameter between the lens elements instead of iris leaves.



For screw sorting the Leuze LSIS 412 vision sensor can be easily used. (Courtesy of Leuze electronic)



Two micro video lenses track the bullet in the shot-scoring system OpticScore.
(Courtesy of Knestel Elektronik)

Micro Video Lens Selection

A wide variety of micro video lens designs are now available from stock to meet different requirements. Basic infinite conjugate imaging lenses, for instance, are suitable for standard resolution cameras with a working distance of dozens of centimetres. Such lenses are available to cover a wide range of focal lengths from 1.7 mm to 50 mm, enabling angular horizontal fields of view between 6.8° and 134°. There are also high resolution versions available with a recommended working distance of 40 cm or more.

For vision applications that require close-in operation, finite conjugate imag-

A micro video lens keeps the optical document reader in this Desko MPR 7100 e-Passport reader small, lightweight and cost effective. (Courtesy of Desko)

ing lenses provide recommended working distances of 15–25 cm with focal lengths between 5 mm and 25 mm. Typically even shorter working distances can be achieved. Resolution performance can be as high as 200 lp/mm.

When choosing a micro video lens look first at the sensor size and resolution. For sensors with more than 1M-pixels a high resolution lens is best. The next parameter to consider is the (angular) field of view, which is easily calculated from working distance, sensor size, and object size.

If there are no standard lenses available for a given application, the optical manufacturer may be able to help with a modification of a standard product or with a custom design. Manufacturers can modify lenses to include filters to reduce camera cost or to change apertures to increase the depth of field. Increasing the depth of field can allow an otherwise standard lens to operate at a closer-than-specified working distance and is also helpful in applications where an object's z-position might change. Barrel changes are another modification option when standard housings do not fit a given camera.

A typical custom design will consist of three to six lens elements and will depend on the target price and optical performance requirements in terms of modulation transfer function, distortion, relative illumination, and other such factors. Customers also need to specify mechanical constraints such as mounting style, sensor size, and working distance. The manufacturer's optical designers are often able to make helpful design suggestions to optimize cost and performance. Manufacturing can start with just 50–100 pieces.

Applications Abound

Micro video lenses serve best in applications where the classical camera/objective lens combination is too expensive and too bulky. Often these are new applications that use a micro video lens together with a more-or-less specialized vision sensor. In more and more cases the sensor has the lens built in, as with the Leuze LSIS 412 vision sensor. The result is an imaging system that can be integrated almost anywhere.

With a wide angle (>90° horizontal) micro video lens, for example, it is possible to place a vision sensor in one corner of a rectangular space and monitor if something passes through that space. This can be used to replace safety light curtains in workshops, with the system shutting down the machinery if the danger zone is entered.

The OpticScore electronic shot evaluation system from Knestel Elekronik GmbH uses two high-speed sensors with micro video lenses to capture images of a bullet in flight. Working at 40,000 frames per second, the system captures multiple images of the bullet as it passes through the light curtain. This system offers users more reliable and accurate measurements compared to existing scoring systems.

Other applications for micro video lenses can be found in fruit detecting scales in supermarkets, automated contour measurement in manufacturing, lottery scanners, and passport readers at customs stations. The MPR 7100 e-Passport reader from Desko GmbH, for instance, uses a custom micro video lens as part of a multi document reader for security and passenger service stations at airports. The optical reader module is no larger than a matchbox.

Micro video lenses thus allow compact imaging solutions for large quantity production at a favorable price. This is making imaging systems more affordable and easier to use within severe spatial restrictions. And with the help of the lens manufacturers, even unique system requirements can be met without compromising cost or performance.

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