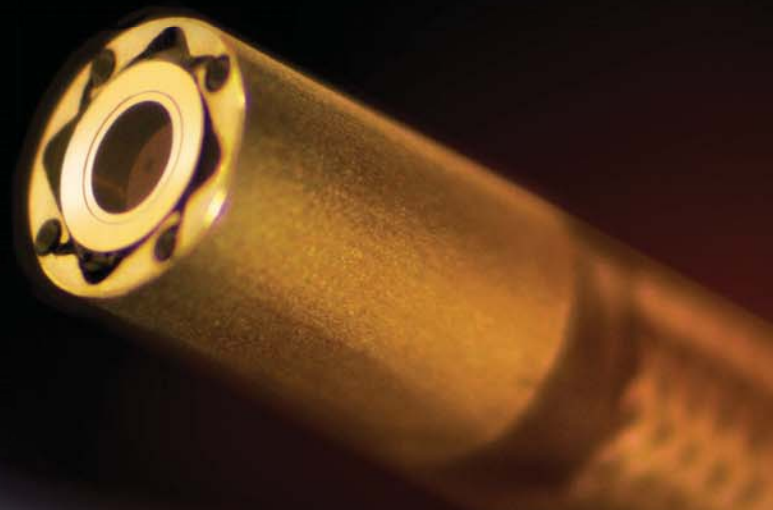
March 2017

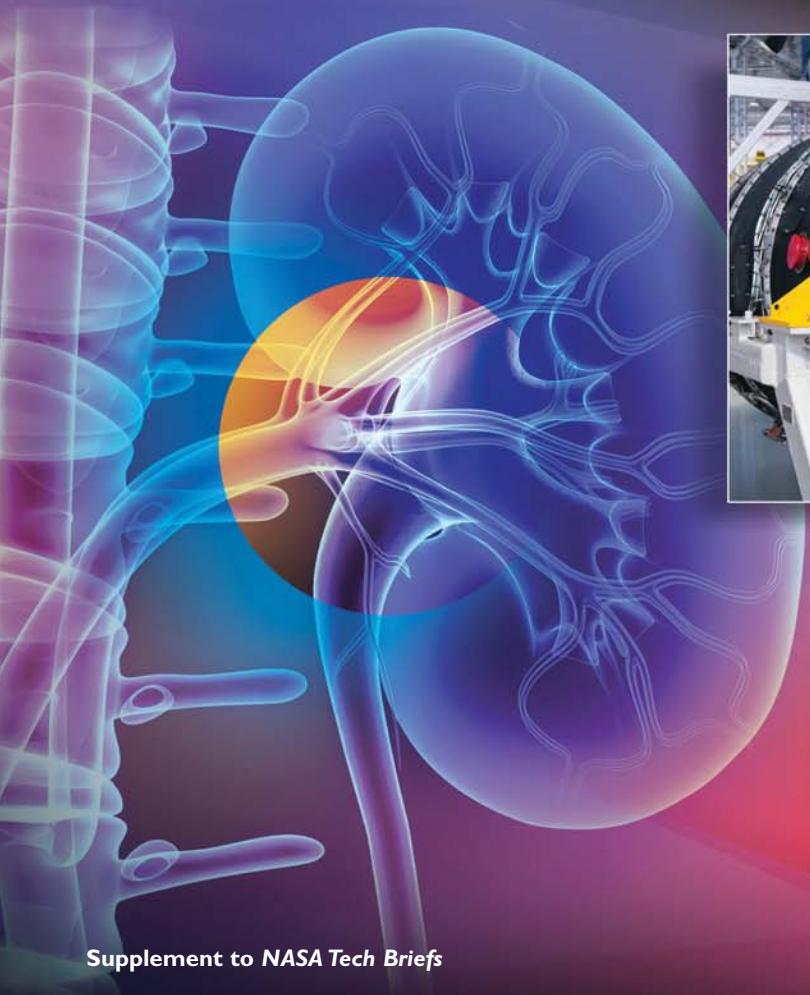
PHOTONICS & IMAGING TECHNOLOGY



High-Power Fiber Lasers

Infrared Cameras Support Advanced 3D Printing Efforts

Finding the Right Chip-on-Tip Camera Technology



SPECIAL SECTION:
Technology Leaders in Cameras & Imaging Systems

Supplement to *NASA Tech Briefs*

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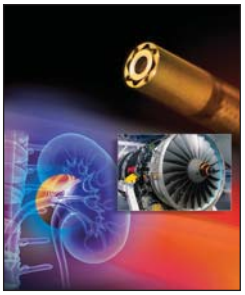
ON THE COVER

Toshiba Imaging's new ultra-small, high-performance IK-CT2 chip-on-tip (COT) camera head (0.7 x 0.7 mm backside-illuminated CMOS sensor) can be used for both medical endoscopes and industrial inspection. To learn more about COT technology and how to select the right sensor and the best vendor for any small diameter, flexible, and/or rigid scope application, see the feature story on pg. 6.
(Images courtesy of Toshiba Imaging Systems Division)



Finding the Right Chip-on-Tip Camera Technology

You have a great idea that could potentially revolutionize your industry: a new surgical technique, diagnostic solution, or inspection system. You already know getting there will require the latest video imaging technology from an incredibly small, sub-millimeter, package; in other words, a distal chip-on-tip (COT) video camera. The COT needs to integrate into an elegantly designed, flexible device and allow video imaging into anatomy that was previously inaccessible, or image into the tiny dark crevices of our mechanized world. The technology has to be inexpensive, yet video performance needs to be competitive with larger sensor video products with which the market is already familiar. (Figure 1). So, where do you start to identify appropriate video technologies and vendors?

Selecting a vendor for COT technology can be a daunting task. While there are not so many sensor options available, the combination of a sensor, image processing, electro-optical characteristics, and mechanical specs makes for a serious challenge. When choosing a vendor partner for your visualization project, it is essential to consider the core requirements of your application, such as device size, length, re-use/sterilization, optics, and importantly, video performance. In addition to the properties of the camera module or sensor, you must also factor in the capabilities, history, strength, and quality of your vendor.

You are on a QUEST — an acronym for Quality, Use, Externals, Supplier, Technology. Through these five steps, you can define your specific device requirements and select the best technology and supplier for your application. The relative importance for each component will be driven by your application, so the list is not a step-by-step progression as much as it is a reminder of the core elements to consider.

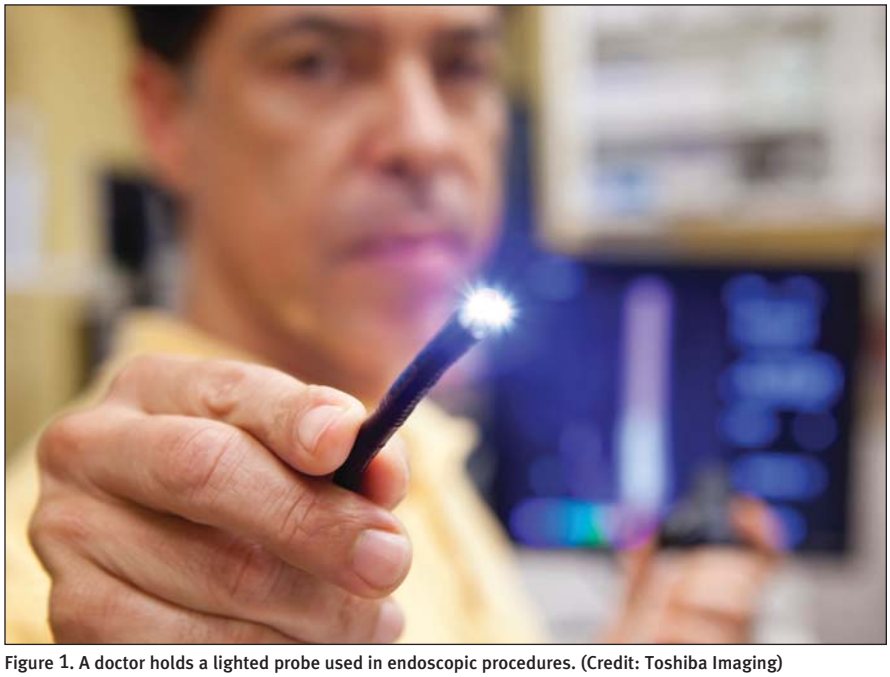


Figure 1. A doctor holds a lighted probe used in endoscopic procedures. (Credit: Toshiba Imaging)

Quality

Quality is always important, but in this context, the characteristic is not intended to refer only to meeting particular industry standards, such as ISO 13485 or 9001 quality management systems. Quality also involves the intended application and use. Will the proposed chip-on-tip imaging technology perform reliably and consistently to meet your end-customer's expectations? Quality, in this context, is a relative term; the expectations for a single-use device will likely be less than one which is intended for multiple uses, with respect to materials, build quality, and durability. Does your vendor provide adequate procedures and test tools for verification of product performance, with incoming inspection and documentation of its own testing results? How will discrepancies be resolved? These are important vendor qualifications to evaluate in the decision-making process.

Use

Use refers to your vision of how the device will be employed, how many times it should be operated, and how it will be processed. Use affects many facets of the design, cost, materials, and construction. If your target device is intended for single use (in other words, disposable), are there any materials, assembly, or performance criteria which could be lowered to reduce costs? Today there are single-use video components available for certain laparoscopic, arthroscopic, urological, and intubation applications. The video quality and performance of these single-use systems may be moderately or substantially below those of more conventional multi-use alternatives, but the single-use technologies may perform "good enough" to meet your internal performance requirements and the clinical needs of the users. For example, a camera that includes a hard sapphire front lens element may be perfect for durability, but the costs may out-

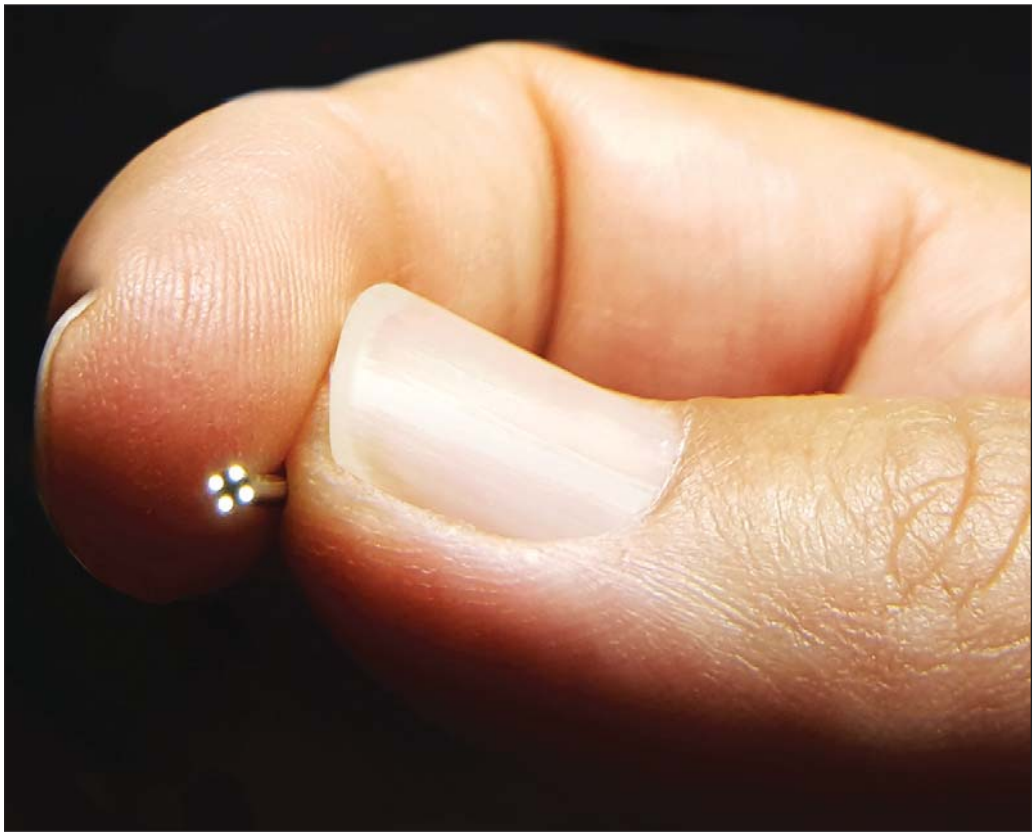


Figure 2. Toshiba Imaging's IK-CT2 is an ultra-small COT video camera system with a 0.7 x 0.7 mm back-side illuminated CMOS sensor featuring 220 x 220 pixel resolution. Shown with LED lighting option. (Credit: Toshiba Imaging)

weigh its advantages if the target device is intended for single use. What will the application tolerate for a single-use expense, based on procedure reimbursement rates? Alternatively, if the device cost and design quality allows for its re-use for some number of cycles, what return-on-investment (ROI) calculations are needed to support this approach? If a product will be subjected to multiple sterilization cycles, then additional validation may be required to determine if sterilization is not only effective, but that the product design is rugged enough to successfully clear the given number of re-use cycles.

Externals

Externals encompass all the requirements imposed by those outside of your organization, including regulatory requirements for documentation, labeling, testing, and manufacturing. Does the market already have existing options to perform the procedure? What are the key requirements in terms of optical performance expectations, field of view, focal range, device integrity for liquid incursion, illumination, bend radius for navigation, or user interface? What mechanical and optical properties are needed from the chip-on-tip technology and the vendor to ensure the intended application is viable? Does the proposed product offer the market improved accessibility, smaller size, and enhanced imaging performance? For example, if moving from a 1.7 mm diameter sensor to a 1.0 mm sensor drops the catheter design from 3.4 mm to 2.7 mm while maintaining the same-sized working channel, will this size reduction allow access into additional regions in the lung, gastrointestinal, or urinary tracts? Perhaps a smaller device size, featuring appropriate improvements in image quality, may allow a change in procedures, such as lung biopsies, which are typically performed percutaneously by using CT imaging to guide a needle. A smaller-sized video instrument could permit comparable access into the lung with direct visualization, potentially reducing risks and providing improved patient care (Figure 2).

Suppliers

A supplier for COT technology can be sensor only, a complete turnkey camera system, or a hybrid camera-component solution. If your organization has the internal capabilities to manage the entire development program and integration, a sensor-only option may provide the greatest flexibility and design control. The downside, however, is that the sensor requires an experienced development team for optics, electrical, mechanical, materials, image processing, assembly, and quality.

On the other hand, a supplier that can provide a turnkey module as an out-of-the box camera, ready for immediate use, eliminates the internal development resources but may also limit your abilities for customization to ideally meet your application requirements. A middle-ground option is to work with a supplier that provides a video camera module or components. The choice is best suited for organizations that have a clear understanding of their target market and wish to focus on the integration of a mostly complete camera design within a package that fits the application. Regardless of the type of supplier that best meets your requirements, remember that the vendor's technical support, quality system, design flexibility, and its manufacturing processes are crucial to ensure product consistency and reliability, and to minimize long-term risks. Selecting the cheapest sensor may not adequately protect your overall product success if the product is inconsistent, poorly supported, or has intermittent failures (Figure 3).

CMOS Sensor Configurations

VENDOR	MODEL	SENSOR	DIAGONAL	PIXEL MATRIX	CAMERA TIP	FRAME RATE	LENS FOV	LENS DOF
Toshiba	CT2	0.7 x 0.7mm	1.0mm	220 x 220	Ø1.0 x 2.4mm	59.94	120°	3-50mm
Cmosis	naneye	1	1.7mm	249 x 250	Ø1.41 x 1.4 - 1.74	42 - 55fps	90° / 120° / 160°	3.5-30 / 5-35 / 3-50
Medigus	Microscout cam 1.2	Ø1.2mm	1.2mm	220 x 224	Ø1.2 x 5mm	30fps	100° / 130°	5-50 / 2-6
Omnivision	OVM6946	0.95 x 0.94	1.3mm	400 x 400	1.05 x 1.05 x 2.27	30fps	Sensor Only	Sensor Only

Source: Company Data Sheets

Figure 3. Comparison chart showing 5 COT vendors and specifications from their respective company data sheets. (Credit: Toshiba Imaging)

Technology

Technology has progressed substantially in recent years. The latest generation of ultra-compact CMOS sensors can provide exceptional sensitivity. With a complete end-to end digital data path, from sensor through image processing, these new sensors permit the development of ultra-small, sub 1.5 mm flexible scopes (including illumination fibers) and sub 3 mm scopes, including working channels. Integrated lenses featuring wide fields of view of 120° and reasonably long depths of field of 3-50 mm are adequate for providing low-distortion visualization inside narrow structures. Image processing is often an area that differentiates one vendor solution from another. What image processing tools are available and how well they can be integrated within your system are important considerations. The components from your vendor should be easily adaptable for integration within your opto-mechanical and electrical requirements.

Remember your QUEST will help guide you to identify the best COT imaging technology, vendor, and development partner to bring your vision to life.

This article was written by Paul Dempster, Director of Sales, Toshiba Imaging Systems Division (Irvine, CA). For more information, visit ***http://info.hotims.com/65849-225****.*