GigE Vision Gets Moving — by John Phillips, Pleora Technologies

Performance, cost, and ease-of-use advantages have made machine vision invaluable to the manufacturing floor. Today, machine vision technologies perfected to monitor and automate manufacturing processes are increasing insight, safety, and productivity across a widening range markets. In the **Intelligent Transportation Systems** (ITS) market, increasingly sophisticated vision expertise is being integrated into monitoring and inspection systems for highways, rail lines, shipping ports and more.

As transportation specialists turn to more advanced vision systems, manufacturers and integrators are under increasing pressure to provide simple solutions that are fast to deploy and easy to maintain. This article outlines how Gigabit Ethernet (GigE) is helping drive deployment, usability, and cost advantage for ITS applications. Specifically, we'll focus on how choosing the right video interface — the hardware and software used to format imaging data and send it to a computer or display — can positively impact the design and performance of imaging systems for traffic monitoring and railway inspection.

GigE: A Natural Choice for ITS

As machine vision branches into wider markets, the video interface is of increasing importance to help support interoperability, design flexibility, and cost advantages. The video interconnects commonly found in machine vision systems, including analog, Camera Link, GigE Vision®, and USB3 Vision™, are also found in ITS applications.

Many of the advantages that have made GigE Vision the most widely deployed video interface in machine vision — extended-reach cabling, ubiquitous computing support, and networking capabilities — are clearly beneficial in ITS applications. However, manufacturers should consider how these advantages help meet the unique requirements of ITS applications.

Cabling: With the longer reach of Ethernet — 100s of meters over standard copper cabling and 1000s of meters over fiber, versus just 10 meters for Camera Link — processing equipment can be more conveniently located. Depending on the ITS application requirements, this means processing equipment can be moved off of weather-exposed gantries to a more protected, easily accessed roadside enclosure, or centralized in an operations center.

Ethernet cabling is also more flexible, with field-terminated connectors helping speed installation and maintenance. In addition, Power over Ethernet (PoE) enables "one-cable" installations, further simplifying deployment and reducing costs by freeing systems from hard-wired power requirements for cameras. More recently introduced GigE Vision over 802.11 wireless video interfaces eliminate cabling altogether, reducing bill of material, setup, and maintenance costs.

Ubiquitous Computing: With GigE Vision, video is transmitted with low, consistent latency over less expensive cabling directly to existing ports on most computing platforms, including laptops, single-board computers, and tablets. In comparison, Camera Link interfaces require frame grabbers to capture imaging data at endpoints. This restricting designers to desktop PCs and limits the use of compact embedded platforms.

Networking: When GigE video interfaces were first introduced, they were valued primarily for their longer reach in umbilical camera-to-computer connections. Today, designers are taking advantage of Ethernet's inherent networking flexibility to build real-time switched video networks connecting cameras and endpoints, including analysis computers, display screens, and storage devices.

GigE Vision brings a whole new dimension to applications, allowing one camera to send video to multiple endpoints, multiple cameras to send video to one endpoint, or combinations of the two. If the primary PC is taken offline, ITS functions can be assumed by the backup PC without the need to switch cables or change software settings. In multi-camera applications, integrators could potentially use a series of networked lower cost cameras in place of a single higher-performance, more expensive model. With 10 GigE interfaces — which support ten times the bandwidth of GigE — multiple image sources can be transmitted simultaneously over a switched Ethernet network.

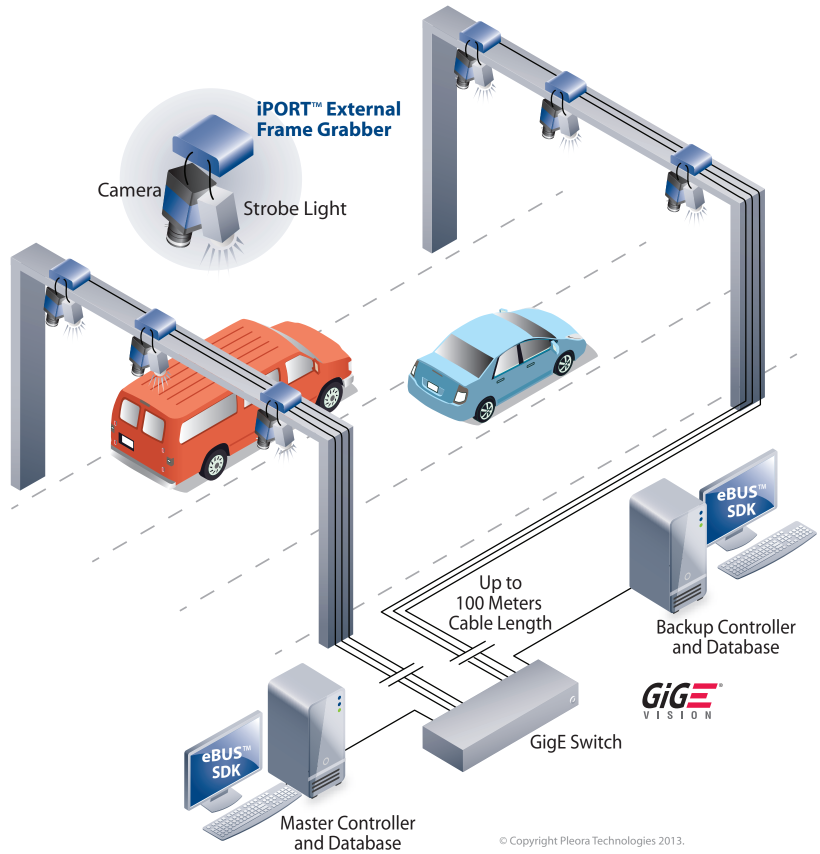

Diagram 1: In a free flow tolling system, external frame grabbers convert image feeds from existing Camera Link or analog cameras into a GigE Vision-compliant video stream.

GigE in Free Flow Traffic Tolling

Traffic monitoring, included automated tolling and enforcement, is one area where manufacturers and integrators can apply machine vision products and expertise to simplify design and enhance performance.

Increasingly, traffic tolling is evolving from RFID-based transponders towards image-based free flow systems that track when a vehicle enters and exits a road. In these "highway speed" tolling systems, cameras on an overhead gantry capture a series of images as vehicles pass through a checkpoint. Time-stamped images are sent to a processing unit, where license plate recognition software identifies the vehicle and a toll charge is sent to the owner.

GigE cameras are useful in these virtual tollbooth systems, but may not be practical in installations where video transmission is already designed around analog or Camera Link interfaces. Similarly, new systems are often based on existing designs where changing the camera, sensor, or optics is not desirable. In these situations, designers and integrators can use external frame grabbers to simplify system implementation and maintenance, extend the life of legacy systems, future-proof designs, and enhance performance.

As illustrated in Diagram 1, external frame grabbers convert image feeds from existing Camera Link or analog cameras into a GigE Vision-compliant video stream. Ethernet's long cabling reach allows designers to move processing computers off the gantry and place them at the side of the road, where they are protected from harsh weather locations and more conveniently located for maintenance.

Video is received at the processor via an existing GigE port, eliminating the need for a computing platform with an available peripheral card slot. As a result, system designers can reduce system size, cost, and power consumption by using smaller form factor computing platforms, such as embedded PCs.

To enhance reliability, the external frame grabbers can multicast image data to multiple computing platforms simultaneously, using an off-the-shelf GigE switch. If the primary PC is taken offline for maintenance or live testing of new image processing algorithms, the license plate recognition and billing functions can be assumed by the backup PC without the need to switch cables or change software settings.

Emerging GigE over 802.11 video interfaces present designers with an opportunity to quickly and easily integrate high-speed wireless connectivity directly into cameras and eliminate expensive video cabling, setup, and networking components.

The embedded video interface streams uncompressed GigE Vision-compliant video with low, consistent latency at sustained throughputs of more than 150 Mb/s over an IEEE 802.11n wireless link. Like a wired GigE solution, video is sent directly to an existing port on a computing platform, eliminating the need for a PC with an expensive frame grabber card and allowing the use of compact, lower power processing solutions.

In applications where there is no real-time image processing and analysis requirement, such as traffic tolling, image data can be stored in the video interface's frame buffer and metered out over the wireless link during downtime. The wireless link can also be used to upgrade video interface firmware, simplifying and speeding in-field maintenance.

Railway Inspection

Railway inspection is a complex ITS application, where multi-camera, multi-spectral imaging systems monitor train cars, track freight, and examine the rail and components. Advanced vision systems can provide more detailed, faster inspection and greater intelligence for operators to help maximize efficiency and reduce downtime.

In an automatic wayside inspection system, as illustrated in Diagram 2, a series of cameras along the track and in an overhead gantry capture images of key components of a moving train. Camera Link Full cameras are typically deployed in these systems due to their high-bandwidth, but designers must compensate for the camera's complex, limited reach cabling and lack of networking support.

Alternatively, 10 GigE external frame grabber transforms Camera Link Full cameras into GigE Vision-compliant cameras, enabling their integration into multipoint, real-time video networks using low-cost, long-distance Ethernet cabling and off-the-shelf switching.

In this example, the external frame grabber's integrated programmable logic controller (PLC) synchronizes multiple position sensors, cameras, and lighting sources and triggers the image acquisition process. The external frame grabber converts images from the Camera Link Full cameras into a GigE Vision-compliant video stream. The uncompressed video is then transmitted at the maximum Camera Link Full rate of 6.8 Gb/s with consistent end-to-end latency over industry-standard fiber cable directly to ports on a computer. With the long 1000+ meter reach of 10 GigE, processing and image analysis equipment can be moved from the trackside or centralized in an operations center.

If a defect is detected, the system delivers a message along with images detailing the failure to a centralized operations center. Inspectors are alerted of any issues and can halt the train or, in the case of non-critical issues, schedule maintenance.

In a mobile railway inspection system, Camera Link Full cameras are installed on railcars or service vehicles to detect damage to the rail and track components. Deploying an external frame grabber, image feeds from Camera Link Full cameras are converted to a GigE Vision-compliant video stream, aggregated onto a single on-vehicle network, and transmitted to an onboard workstation for analysis. If defects are identified, image data is overlaid with corresponding GPS information and transmitted wirelessly to an operations center.

The Right Design Choice

While many products used successfully in machine vision can be adapted for the transportation market, the ever-changing nature of traffic, variable environmental conditions, and application-specific requirements can pose design and deployment challenges. Understanding these risks, GigE Vision video interfaces deliver clear advantages that help manufacturers and integrators develop easier-to-use, less expensive solutions for ITS applications. ✸

John Phillips *is senior manager of product management with Pleora Technologies, a leading supplier of video interfaces for high-performance vision systems.*
Learn more at www.pleora.com.

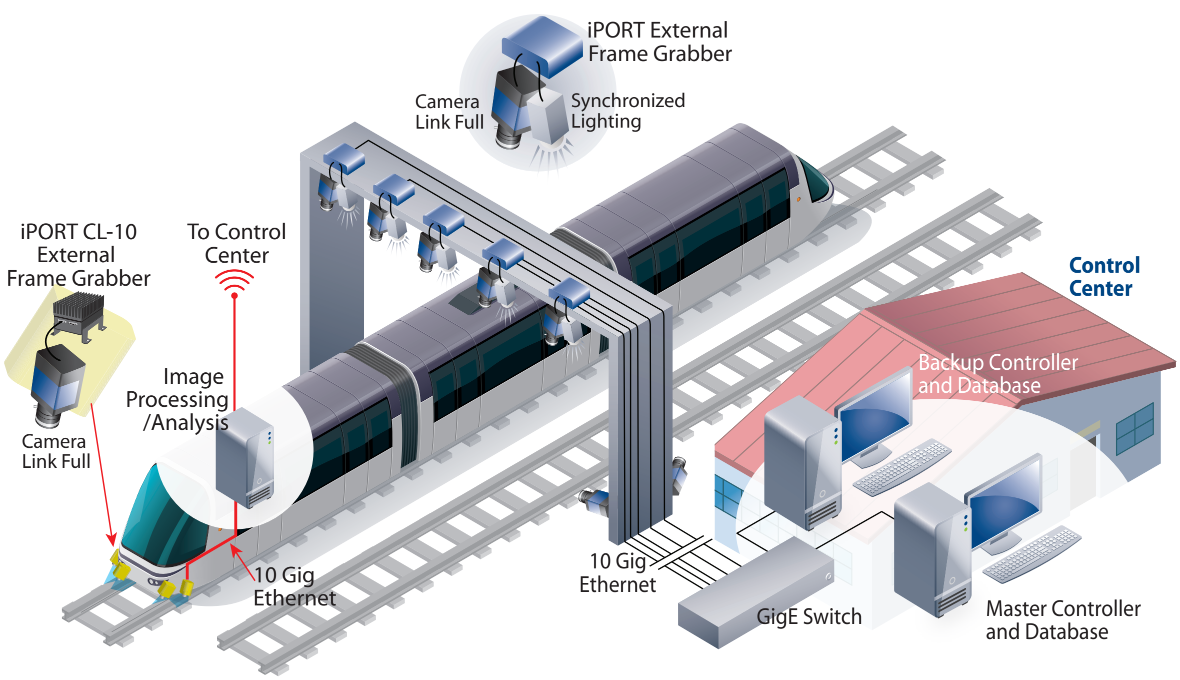

Diagram 2: In railway inspection systems, 10 GigE external frame grabbers improve reliability and lower costs to help maximize efficiency and reduce downtime.