Imaging Systems on the Move

— by John Phillips, Pleora Technologies

Advances in imaging technologies have made machine vision invaluable on the manufacturing floor, with cameras, sensors, and processing platforms working together to help improve quality, lower costs, and increase productivity. Today, imaging technologies perfected to monitor and automate manufacturing processes are being designed into a widening range of applications.

In the **Intelligent Transportation Systems** (ITS) market, vision expertise is being integrated into monitoring and inspection systems for railway applications. By adopting Gigabit Ethernet (GigE) systems widely deployed in manufacturing automation, ITS designers can provide solutions that deliver sophisticated analysis, while also being faster to deploy, easier to maintain, and simpler to use.

This article outlines how 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 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 standard in machine vision — extended-reach cabling, wider computing platform choice, and networking capabilities — are clearly beneficial in ITS applications.

Cabling: With Ethernet's longer reach — 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. In a railway inspection system, processing equipment can be moved off of weather-exposed gantries to a more protected, easily accessed enclosure, or centralized in an operations center.

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.

Computing Platform Choice: With GigE Vision, video is transmitted with low, consistent latency directly to an existing port on most computing platforms, including laptops and compact embedded platforms. In comparison, Camera Link and many other interfaces require frame grabbers to capture imaging data at endpoints, limiting designers to tower PCs.

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 inspection 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, inspection 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.

GigE in Railway Inspection

Railway inspection is a complex ITS application, where multi-camera, multi-spectral imaging systems monitor cars and freight, and examine the rails, couplers, wheels, brakes, and other components. Advanced vision systems can provide more detailed, faster inspection and greater intelligence to improve safety while also maximizing efficiency and reducing downtime.

In an automatic wayside inspection system, as illustrated in Diagram 1, 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, a 10 GigE external frame grabber can transform 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 a port on a computer. With the 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 into 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. With recently introduced transcoding technology, the GigE video can be converted into the widely used H.264 compression format and wirelessly transmitted to an operations center for viewing.

The Right Design Choice

For vision system designers, the ever-changing nature of moving traffic and variable weather conditions 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. ✹

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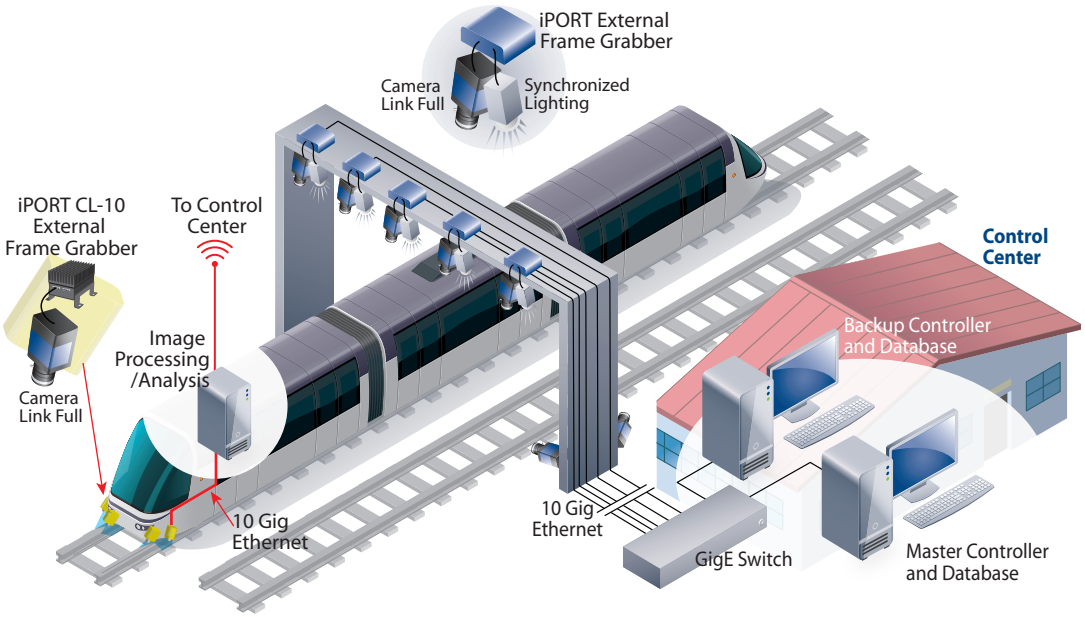

Diagram 2: In railway inspection systems, 10 GigE external frame grabbers improve reliability and lower costs to help maximize efficiency and reduce downtime.