Best of Both Worlds?

FireWire and GigE Racing for the Pole Position

The GigE Vision standard is rapidly gaining market share over other machine vision camera interfaces. Does that mean that FireWire, the currently leading digital interface, is bound to disappear? If not, which interface is best for which application?

Since the introduction of the GigE Vision standard, Gigabit Ethernet is rapidly gaining market share against other camera interfaces and there seems to be a consensus on the fact that it will play an important role in the future. However, sales figures of digital cameras for machine vision applications still put FireWire as the leading digital interface. The acquisition of Prosilica by Allied Vision Technlogies demonstrates a clear commitment to GigE from the worldwide leading manufacturer of FireWire cameras. Does that mean that Gigabit Ethernet will replace FireWire and maybe other interfaces as the leading standard of the industry? Or will both technologies complement each other so that they will still coexist in the market?

Cost-effective Standards

Both interfaces have one thing in common: FireWire and GigE use highly standardized hardware and data transmission protocols, offering true plug-and-play compatibility of the components and easy integration in a system. The IIDC/DCAM standard guarantees easy integration of compatible IEEE 1394 devices from various vendors while the GigE Vision and Gen<i>cam standards ensure the compatibility of Gigabit Ethernet components. This saves developers time and money in the design of their imaging systems.

This exhibition demo illustrates the principle of a daisy chain network with direct FireWire connection from camera to camera

The relatively low cost of the hardware components and accessories makes both interfaces a good choice for cost-sensitive applications. FireWire being originally a consumer electronics interface, it is widely available in the market and many PCs have an IEEE 1394 port on board. Plugs, cables and other accessories are affordable and easy to purchase from any local retailer. This is even more true with GigE Vision, as this interface uses Ethernet connectivity (Cat5), which has been used as the most common standard in IT networks for years. Mass produced cables and components are extremely easy to find and even

Smallest GigE Vision camera available: Prosilica GC

counts, an AVT Guppy, one of the smallest FireWire cameras available, takes even less space (48.2 x 30 x 30 mm).

An often considered aspect in the choice of the interface is the possible transmission range between the system PC and the camera. In that respect GigE Vision clearly is the interface of choice as it allows for up to 100 m cable length, or up to tens of kilometres using low-cost fiber optic media converters. However, the possibilities of FireWire in terms of cable length are often underestimated. It is true that the IEEE 1394 standard only guarantees data transmission over 4.5 m, but this by far does not mean that longer distances cannot be bridged in practice. For example, Allied Vision Technologies has intensively investigated the matter and, based on extensive tests, commits to cable length of up to 10 m with IEEE 1394b and 17 m with IEEE 1394a interfaces. Should longer distances between PC and camera with FireWire interface be required, repeaters offer a practicable solution. It is even possible to bridge very long distances using optical fiber (GOF). With its Pike and Stingray models, Allied Vision Technologies is the only vendor offering FireWire cameras with an optional GOF port, which


Source: Flickr/Dave Sherret

cheaper than FireWire accessories.

The prices for the cameras themselves are still about 10 % higher for GigE than for FireWire products. It is therefore recommended to consider the global cost of the system, including all peripherals and accessories such as cables, repeaters, switches or PC-cards. Depending on the architecture and the complexity of the system, either FireWire or GigE Vision may turn out to be the more economic solution.

When Size Matters: Form Factor and Cable Length

The physical size of the camera can be very important for specific applications. Because Gigabit Ethernet components are less miniaturized than FireWire, GigE cameras still suffer from a slightly larger form factor than their FireWire competitors. The smallest GigE Vision camera in the market is the Prosilica GC Series. This camera has an extremely compact form factor (33 x 46 x 51 mm). However, when each millimetre

makes it possible to transmit image data over up to 500 m.

Bandwidth and Reliability

With up to 125 MB/s, GigE Vision clearly offers the highest bandwidth. Among GigE Vision camera vendors, Prosilica has proven to be extremely efficient in making the most out of this bandwidth running sustained data rates of 124 MB/s. In FireWire, Allied Vision Technologies achieves higher bitrates than specified by the standard with up to 84 MB/s with IEEE 1394b.

Both interfaces being digital, they offer a high reliability of the data transmission. Lost or corrupted data is nearly impossible. The Gigabit Ethernet standard guarantees for additional safety since data packets can be resent if necessary, which is not possible with FireWire. However, the event that streaming packets become lost or corrupt during transmission is extremely unlikely in a properly designed system.

Power Supply and Heating

The FireWire and GigE Vision interfaces are quite different as far as the power supply of the devices is concerned. FireWire cameras are usually powered directly over the FireWire port, which highly contributes to the plug-and-play ease of installation: just plug in the cable and the camera runs! Power over Ethernet has now become available too, but it is not a standard feature of the interface and is therefore not very easy to implement yet. Most GigE cameras do not support power over Ethernet and even if it is the case, it is very likely that the Ethernet port of the PC will not, so additional accessories such as a new Ethernet card or a powered switch have to be purchased.

Gigabit Ethernet cameras tend to consume more power than FireWire cameras. This may turn out to be a disadvantage in mobile applications powered with batteries. Related to this higher energy consumption is also a higher heating of the camera which might be problematic in some specific applications. However, some GigE Vision cameras perform very well compared to FireWire. For example, the power consumption of Prosilica's GC750 is 2.5 Watt, which is as low as that of comparable competitive FireWire cameras.

Multi-Camera Operation: Network versus Bus

Industrial image processing systems often rely on several networked cameras.

The capabilities of an interface in the area of multi-camera operation are therefore often crucial for the choice of the most appropriate one.

IEEE 1394 and GigE Vision have two different philosophies: FireWire is a bus standard, while GigE Vision is based on an Ethernet network. According to the strict communication protocol of the FireWire standard, devices on the bus can only transmit data on the bus after each other within clearly allocated timeslots. As a result, system developers can very precisely calculate and plan which data from which camera is to be transmitted when to the processing computer. Using a Resource Manager, it is possible to make sure that the bus cannot be saturated with image data sent by several cameras at a time.

In a Gigabit Ethernet network, all devices can send data at the same time, which means that the limits of the bandwidth may be reached. A bottleneck risk exists specifically when a switch connects several cameras to the network. If the capacity of the switch is saturated by a too high amount of data, the data will not necessarily be lost, but delivery delays can occur and, more importantly, it is not predictable which data will be delivered when to the PC. With their unique StreamBytesPerSecond function, Prosilica Gigabit Ethernet cameras feature a sophisticated bandwidth management function which can be considered best in class in the GigE Vision camera market. It ensures that image data is reliably and predictably delivered in multi-camera operation.

However, as a standard, FireWire still offers the more structured communications protocol for multi-camera applications requiring precise prediction of data input into the processing computer.

Another unique benefit of the FireWire interface is the possibility of "daisy-chain" connectivity. Cameras equipped with two IEEE 1394 ports such as AVT's Pike or Stingray series can be connected directly with each other like pearls on a necklace. That way, it is possible to easily build a multi-camera bus with only one FireWire connection on the PC side and no hub or accessories others than standard cables.

The GigE Vision standard does not limit the number of cameras that can be operated in one network. There is a limit of up to 63 cameras on a FireWire bus but this limit is far higher than the vast majority of machine vision applications require. Even if a system required more, it only takes a standard four-port PCI card to operate up to 252 cameras with one PC. In fact, both for FireWire and GigE Vision, the total amount of cameras that can be operated simultaneously is rather limited by the available bandwidth than by the standard itself.

Reviewing these different criteria, it becomes obvious that the choice of the better interface really depends on the requirements of the specific application: for some systems the form factor is key, for others the cable length or power supply. Users of complex multi-camera systems will probably value the advantages of the FireWire bus standard as they did before, while GigE Vision is the interface of choice for applications requiring long distances between camera and processing computer such as traffic monitoring. Both interfaces complement each other and together, they will surely dominate the machine vision market of the future.

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