

Technical Support

Technical Bulletin

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Title:	VisionPro and Image Acquisition Technologies	

PURPOSE

This document presents a very high level overview of the various image acquisition technologies available in the marketplace. This document is meant to serve as a guide and to list the benefits and limitations of the various image acquisition technologies.

Cameras using CCD and CMOS chips produce images that are used in machine vision applications. Over the years several image transportation methods have been designed to serve specific application markets. Each of these methods has its benefits and limitations. The following document may help to identify which acquisition technology is the best for your application.

TECHNICAL DETAILS

Here is a list of the image acquisition technologies this document will discuss:

- Analog
- Camera Link
- FireWire (IEEE 1394 A/B)
- USB
- GigE Vision

Analog cameras

Analog cameras are the oldest on the market. They send their camera signal as an analog signal over a shielded cable. The cable can have a length of up to 100 ft without any significant signal degradation. The cables typically connect with 12-pin Hirose connectors which also carry the power, trigger and strobe signals.

There are 3 speeds in which analog cameras operate:

- Single (14 MHz Pixel clock)
- Double (28 MHz Pixel clock)
- Quad (40 MHz Pixel clock)

Quad cameras were intended to resurrect analog cameras for the high speed application market. There are only 2-3 Sony quad-speed cameras on the market.

Benefits of Analog cameras:

- Best in noisy environments (i.e. robot welding lines)
- Best when acquisition determinism is important
- Cost for analog cameras is low

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Limitations of Analog cameras:

- Largest camera supported is 2 MPixel
- ROI's are not as flexibly programmable compared to direct connect cameras

Cables and connectors:



Camera Link cameras

Camera Link was designed to transport lots of image data in a short time. Camera Link is a serial interface. Cables can have a maximum length of 30 ft. For longer distances, repeaters are required for cable extension. Trigger, strobe and power are on a separate Hirose connector. Lately, there are PoCL (Power Over Camera Link) cameras available.

Camera Link operates in 3 possible configurations:

- Base (255 MByte / sec)
- Medium (510 MByte / sec)
- Full (680 MByte / sec)

Camera Link is #1 for high speed acquisition. It is the first choice for Line Scan applications. Special Frame Grabbers are required. In a Medium / Full configuration, 2 cables are required to connect the camera.

Camera Link Base configuration competes with GigE Vision since both operate in the bandwidth of 100 MByte / sec. This is often sufficient for single camera applications with high speed. One and two K wide Line Scan cameras also work well on Camera Link.

When to use Camera Link cameras:

- Line Scan
- High speed large frame cameras
- If acquisition determinism is vital
- If your customer has enough money

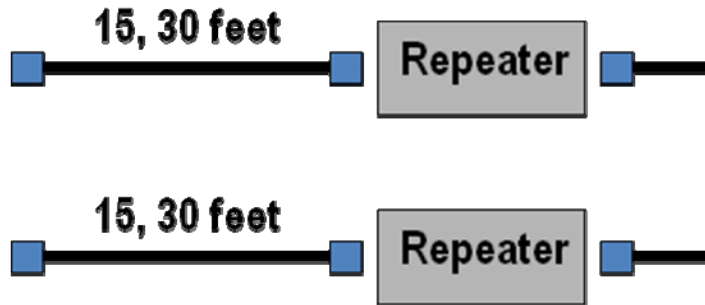
Where is Camera Link today:

- It's in strong competition with GigE, on price and performance
- Nice new small cameras with PoCL will keep Camera Link as a player for high end applications
- Will continue to stay on the market until direct connect cameras can surpass the 680 MByte / sec bandwidth

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Cables and connectors:



FireWire cameras

FireWire was originally designed to communicate with consumer products such as hard drives and printers. The cable length is limited to 4.5 meters. Extension is possible through repeaters. FireWire works on a broadcasting type of bus architecture which gives it deterministic behavior. FireWire A reaches about 30 MByte/second and FireWire B about 60 MByte/second bandwidth. Windows 7 now supports FireWire B which might give the cameras some boost, since Vista did not support FireWire B. FireWire cameras are powered through the cable and have a separate trigger and strobe connector. Often the cameras often have general purpose I/O's. These are I/O's are accessible through the camera vendor's SDK. FireWire's protocol is called DCAM.

When to use FireWire cameras:

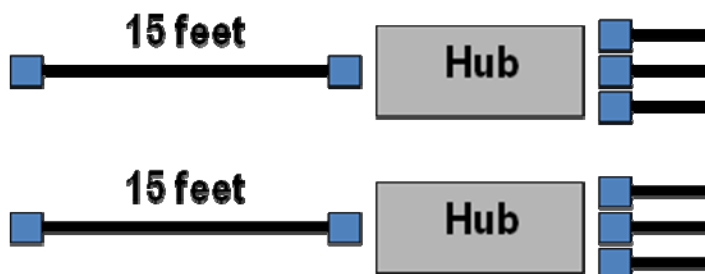
- If acquisition determinism is important
- If your customer looks for cheap cameras

When not to use FireWire:

- Short cables are really limiting in industrial applications. Adding repeaters makes the solution as expensive as using GigE cameras.

FireWire cameras will stay on the market, but with the new low GigE pricing, FireWire may decline in popularity. OEMs that have a very controlled environment might remain the last users of FireWire.

Cables and connectors:



FireWire A



FireWire B

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USB cameras

USB cameras are known for their extraordinary low price. The cheapest cameras one can buy are Web Cams. One has to keep in mind, though, that those low-cost USB cameras can only stream live images. This means that whenever you do an acquisition, you get the latest image out of the stream. No trigger possible. The more advanced cameras can also trigger and strobe.

The weakness of USB is the unknown determinism. In particular, when more than one camera is used, then there is really no thing such as determinism. Using USB for advanced industrial applications requires caution. It is possible to make it work, but one must know what one is doing.

Cables for USB are short: 2- 5 meters. USB cameras use Direct Draw or TWAIN as drivers.

When to use USB cameras:

- Cheap models with high resolution are available
- Easy to try. Plug and play is available in many SDK's
- If one needs live display only

When not to use USB:

- If one requires high image quality. Large sensors are cheap since they often are CMOS with lesser image quality

Cables and connectors:



GigE cameras

Gigabit Ethernet (GigE) is the latest direct connect acquisition technology. It meets the demand for low-cost, long cables of lengths up 100m. Hubs are available at reasonable cost. GigE claims to have a bandwidth of 100 MByte / s which makes it the fastest direct connect camera. There are camera models available with 2 ports that can even double the throughput.

A standard communication framework for GigE cameras is GigE Vision. If a camera is GigE Vision compliant, it will work out of the box with GigE Vision compliant software such as VisionPro or CVL. For maximum performance, special performance drivers are available that lower the CPU load when using multiple cameras on one GigE network interface card. There are 2 different types of performance drivers: the universal performance driver which works with any GigE card, and the Intel performance driver which achieves the best performance on Intel Pro adapters.

GigE cameras traditionally are powered through a separate connector. Newer models are available that offer power over Ethernet (PoE). Most GigE cameras have a GigE Connector and a separate power/ IO connector that also has trigger and strobe. This connector is used for general purposes I/O's. These are I/O's are accessible through custom properties, which are available through the GigE Vision interface.

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Are there any concerns about using GigE cameras? Yes, there may be issues if acquisition determinism is important. If multiple cameras are on the same bus, then there is a chance that packages may collide with others and therefore need to be resent. This will increase the time for the acquisition to complete. This delay might be small, but in high speed applications it could be crucial. In a worst case scenario, one might lose a frame and not even notice. For this reason, camera vendors have added a time stamp to every image to allow tracking. However, use of this time stamp requires synchronization of the PC/PCL clock and the camera clock, which is difficult. Because of this determinism issue, acquisition over the company network would produce very unreliable results. A separate GigE card is required for image acquisition.

Why to use GigE cameras:

- Long camera cables
- Best choice for direct connect cameras
- GigE Vision offers nice interface to access many special camera features
- 100 MByte /s is sufficient for most applications

Why not to use GigE:

- If acquisition determinism is important
- Environments such as welding streets can reset the cameras
- GigE is still the most expensive direct connect camera, but prices have dropped significantly

Cables and connectors:



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Table 1 summarizes the various image acquisition technologies for a variety of application factors.

	Analog	CL BASE	CL MED	CL FULL	1394 A	1394 B	GigE Vision	USB
Max number of cameras	4	1	1 MED or 2 BASE	1 MED or 1 FULL	63	63	255	127
Line Scan camera ?	-	yes	yes	yes	-	-	yes	-
Data throughput Mbyte / s	160	255	510	680	32	64	100	64
Max cable length in m	30	10	10	10	5	5	100	5
Hubs / repeaters available	no	yes	yes	yes	yes	yes	yes	yes
Max area resolution in Mpixel	2	16	16	16	5	5	16	11
Price range camera	low	high	higher	highest	low	low	moderate	very low

Table 1: Acquisition technologies overview

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	Analog	Camera Link	FireWire	GigE	USB 2.0
Single camera		yes	yes	yes	yes
Multiple camera	yes	yes	yes	yes	
High resolution		yes	yes	yes	yes
High Speed	yes	yes	yes	yes	
Advanced triggering	yes	yes			
Master / Slave	yes	yes			
Line Scan		yes		yes	
Harsh environment	yes	yes			
Long cables	yes			yes	

Table 2: Acquisition preferred usage lookup table

MOVING FORWARD

VisionPro software supports a wide variety of image acquisition technologies. You should read the documentation that comes with VisionPro software to determine what image acquisition technologies are supported for a specific release.

For more specific information about VisionPro software, and to help determine what image acquisition technology is right for your application, please contact your local Cognex sales representative or visit www.Cognex.com.