GigE Vision and GenICam

Gigabit Ethernet for Machine Vision (GigE Vision) is the new interface standard for cameras and makes use of the reliable, economical Ethernet network technology for PC-camera connections. This standard was developed to ensure high-performance, secure data transfer, the rapid adaptation of cameras to the image processing software (camera Plug&Play) and the cross-hardware programming of the image processing software, i.e. the software no longer has to be customized to the user's specific hardware configuration.

This standard defines not only the automatic component registration but also the allocation of the IP address, the configuration and control of the cameras, the connection-oriented data transfer operations and error handling.

Version 1.0 of the GigE Vision standard was ratified by the members of the Automated Imaging Association (AIA) (http://www.machinevisiononline.org) in May 2006 and offers the image processing industry an open-ended framework for the transfer of images and control signals between cameras and PCs via standard Gigabit Ethernet lines.

However, since it is not enough simply to agree on a hardware standard which defines the connecting cable and the transfer protocol an additional standard was created. GenICam now represents a standard which decouples software development from the properties of the camera being used. This standard is maintained by the European Machine Vision Association (http://www.emva.org).

The main aim of GenICam was to define a generic camera control interface for all camera types which is independent of both the interface and the properties of any given camera and which can be used with a huge diversity of transfer media such as GigE, Camera-Link, FireWire, etc. This is possible through a general description of how camera or other device functions can be addressed without it being necessary to use the device manufacturer's software. The aim for the camera is to log into the system itself, notify the system of the possible configuration and ensure uniform access to both the configuration and image capture.

STEMMER IMAGING and GigE Vision / GenICam

Ever since the constitution of the GigE Vision board in late 2003, STEMMER IMAGING has played a leading, defining role in the standardization process as an independent representative of system users and has helped give birth to the GenICam concept. As one of the five companies that have implemented the standard, STEMMER IMAGING chaired the software group which works in parallel with the hardware group over an extended period. On the one hand, STEMMER IMAGING, the producer of the Common Vision Blox image processing software library, considers connections and implementation quality to be of crucial importance. On the other, we consider it to be our duty to offer our customers optimized, state-of-the-art technology at all times.

GigE Vision and GenICam will help simplify the development, utilization and support of image processing systems. The new standards guarantee stability and compatibility and offer advantages to all participating companies. It simultaneously makes it possible to reduce hardware, integration and support costs.

We continue to play an active role in promoting this important issue which directly benefits our customers in the form of the developments we are able to offer

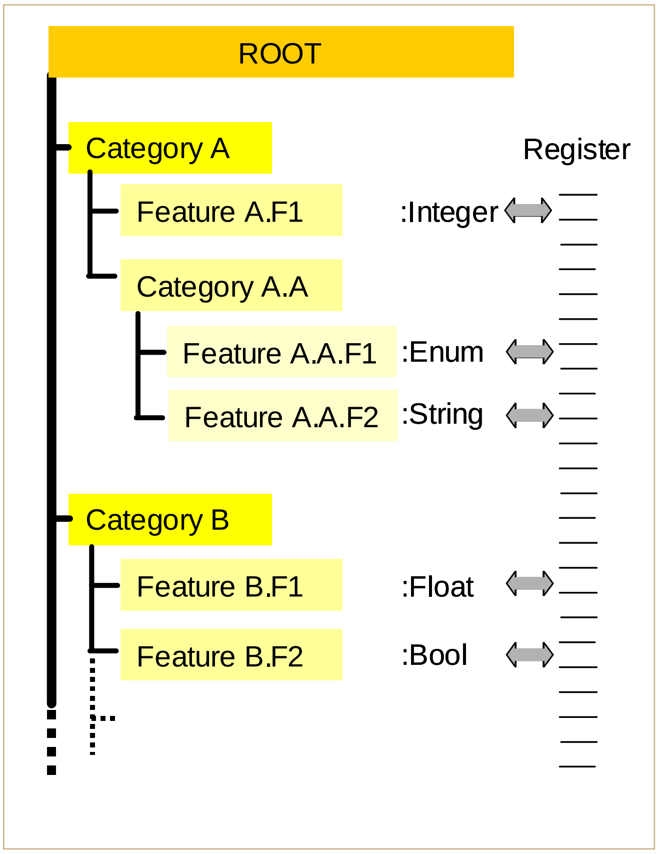
The GenICam modules

GenICam is an extremely general hardware/software interface description which defines cameras in terms of their specific features. One feature, for example, might be the possibility of modifying the amplification (gain) of the analog sensor signal. All cameras must possess 7 fixed standard features without which image capture is not possible. These are:

- *Width*, the width of the image
- *Height*, the height of the image
- *Pixelformat*, the format of pixels, e.g. 8-bit monochrome
- *PayloadSize*, the number of bytes for a complete image
- *AcquisitionMode*, the capture mode, e.g. triggered capture
- *AcquisitionStart*, start image capture
- *AcquisitionStop*, terminates image capture

In addition to these, GenICam defines a large number of standard names and notations for frequently used features. Camera manufacturers may of course define their own proprietary features and such specific cameras are also catered for.

The GenICam standard simply describes the syntax for an electronic camera manual in the form of an XML file which is read when a GenICam program is run. This XML file is made available by the camera manufacturer. GenICam provides functions which map this description of features to the camera's actual registers. The XML file defines the camera features in clear text and establishes a link between the feature and the camera register. As a result, a feature may impact on multiple registers.



Alongside its value, a feature may possess one or more attributes which depend on the value of the feature. All features have the following attributes:

- Name
- Tool tip
- Display name
- Access mode

An integer feature, for example, also possesses the following attributes:

- Maximum
- Minimum
- Increment

Features can be combined within categories. For example it is possible to combine the image width and height in the image size category. A category may contain both features and sub-categories. This makes it possible to map a camera's features to a hierarchical tree structure. Moreover, it is easy to link features to application controls, for example an integer with a scroll bar. The following illustration indicates this type of hierarchical structure and the connection with the registers.

Access to the XML descriptions and the underlying registers is performed via the so-called GenAPI.

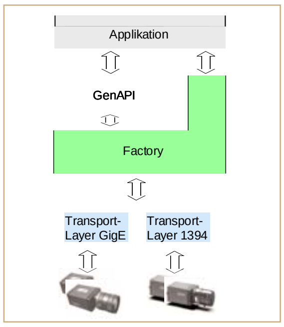
This means that GenAPI register access is performed only at the logical level with physical access being performed via the so called "transport layer". This is responsible for the actual data transfer to the camera and implements a protocol defined for any given hardware standard for communication with the connected devices. Depending on the transport medium employed (e.g. Gigabit Ethernet), GenAPI may use a software interface defined in the transport layer. The transport layer also defines interfaces for image capture and the streaming of image data. This makes it possible to support a wide variety of bus systems without any major adaptations to the system being required on system change. It is also possible to configure the transport layer via XML file and GenAPI.

The connection between the transport layer and GenAPI is set up via a so-called "factory". The factory administers all the installed transport layers and associated camera and uses this information to generate the GenAPI instances for the connected cameras. The factory is configured by means of the XML file and GenAPI in the same way as the transport layer and the camera. The figure opposite illustrates the relationship between the camera, transport layer, factory, GenAPI and the application.

GenICam therefore consists of the following three modules which all have counterparts in the CVB implementation:

- GenAPI
- Factory
- Transport Layer

Here, the GenAPI is part of the GenICam standard whereas the transport layer is typically provided by the camera or software vendor. The XML files are provided by the relevant vendor.

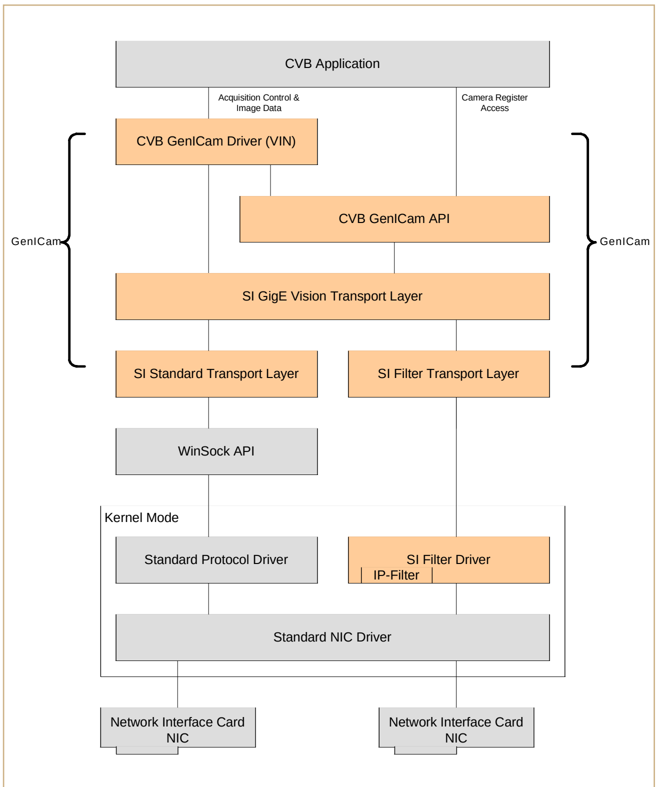


► GenICam and GigE Vision support in CVB

Core components

One crucial question is how can the transport of image data via Ethernet be implemented in the best possible way in terms of performance? If the standard Windows facilities are used then the image data has to pass through a number of software layers before being ready for use. Considerably better performance can be achieved using a so-called filter driver. A filter driver works in the same way as a firewall. The data packages from any given source are handled in a specific way. If a firewall is implemented then this data can be ignored, i.e. not transferred, or, if the STEMMER IMAGING GigE Vision transport layer is active it can be sent directly as top priority data to the CVB driver. Data packages from other sources are transferred using the standard Windows protocol driver as usual. The system is therefore able not only to perform the usual network services but also to transfer image data to the CVB GenICam driver while assuring a high level of performance.

The STEMMER IMAGING GigE Vision transport layer supports the overall specification including the Packet Resend mechanism which forms part of the GigE Vision standard. A standard CVB driver and the CVB GenICam API use this transport layer. Within this context, the CVB driver uses the transport layer's streaming interface whereas the CVB GenICam API represents the interface from the application to GenICam and, consequently, the transport layer. The illustration indicates the relations between the individual CVB GigE Vision/GenICam components.



Common Vision Blox Support for GenICam

Configuration components

The illustration clearly shows that the STEMMER IMAGING GigE Vision transport layer supports multiple network cards to which multiple cameras may be attached. The configuration for each of these cameras must be stored and must be recognizable even if the camera is disconnected and reconnected.

This task is performed by the CVB GenICam Device Configurator in conjunction with the CVB GenICam Bindings Editor. Here, the Bindings Editor specifies which cameras can be addressed via which transport layer and via which network cards. If it is only necessary to configure a single network card to which multiple cameras are connected then the operation is very simple. In the case of more complex network topologies, the definition of the connections is more complex. Once the connections have been defined and stored, each individual camera is configured using the CVB GenICam Device Configurator. The camera's categories and features are displayed along with the live images.

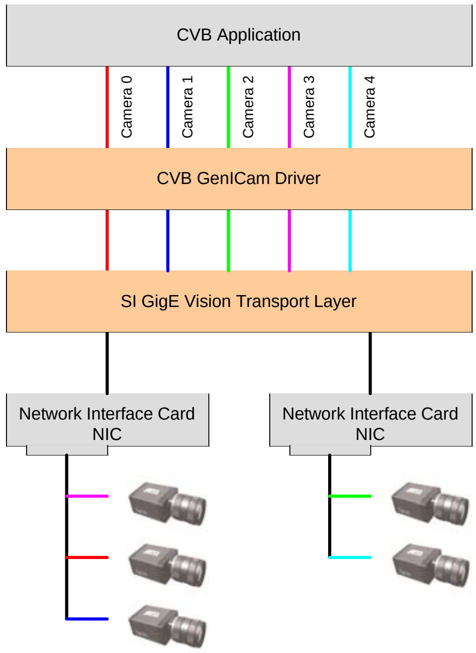
► Continued: GenICam and GigE Vision support in CVB

The configuration is stored and loaded by the CVB GenICam driver. It is possible to access the cameras using standard CVB commands. It is also possible to address the camera features via the CVB GenICam interface. This means that the GenICam driver acts as a "normal" Frame Grabber or FireWire driver while also incorporating the advantages of the new technology.

For CVB users, this means a transparent connection to an enormous variety of capture technologies with their individual advantages which can be exploited irrespectively of specific requirements. The illustration indicates the tasks undertaken by the Binding Editor. A color indicates the camera assignment.

Runtime components

At runtime, it may be necessary to modify individual camera features or present these to the end user. This can be achieved, on the one hand, using the CVB GenICam API functions for accessing the CVB GenICam interface and, on the other, the Common Vision GenICam Grid Control. This ActiveX control can be integrated in users' own applications and makes it possible to display and edit the camera features.



Common Vision Blox GenICam Bindings Editor

► Benefits

GenICam represents a new technology which can be used in the newly created GigE Vision standard. Because the product caters for self-descriptive camera hardware, camera vendors can combine standard features with their own specific expertise in the form of special in-camera features. To ensure GenICam support, they simply need to provide an XML description of the device functions in order to benefit from significant advantages when it comes to interfacing their hardware with a variety of different software packages. The most important thing, however, is that GenICam permits direct user access to individual device configurations without the requirement for any specific software.

At the same time, GenICam allows software suppliers to support a wide range of hardware products using a standard, generic software solution.

Finally, GenICAM enables users in the image processing industry to reduce their implementation work and change their camera hardware flexibly and easily in response to different application requirements. It supports both special and standard features, thus resulting in a high level of camera transparency.

Moreover, the integration of GenICam in Common Vision Blox establishes a link between the hardware environments. For CVB users, it makes no difference whether FireWire, analog or digital frame grabbers are employed. They can adapt their hardware to meet their application requirements and not the other way round.

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