THE CAMERA ACQUISITION SYSTEM IN THE SPARC CONTROL SYSTEM

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Abstract

One of technical challenge in many physics experiments is to capture and process images. There are many solutions in this domain. In the SPARC injector we use mainly IEEE1394 cameras but we also start to introduce some gigaVision Ethernet cameras. Both types of cameras are easily connected with the PCs. We present solution about cameras' integration into the SPARC control system to allow the development of high level program without know the type of camera used.

INTRODUCTION

The SPARC (Sorgente Pulsata e Amplificata di Radiazione Coerente, Self-Amplified Pulsed Coherent Radiation Source) (fig.1) project is to the develop of a high brightness photo injector to drive SASE-FEL experiments at 500 nm and higher harmonics generation. Proposed by the research institutions ENEA, INFN, CNR with collaboration of Universita` di Roma Tor Vergata and INFM-ST, it has been funded in 2003 by the Italian Government. The machine is installed at Laboratori Nazionali di Frascati (LNF-INFN).

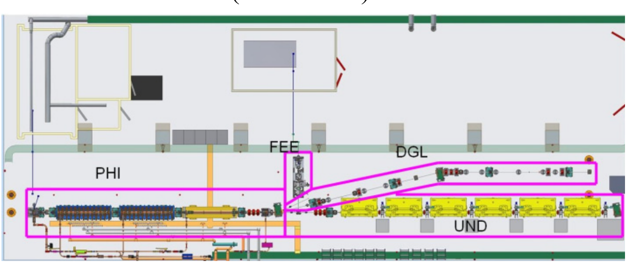

Figure 1: SPARC.

The use of cameras as a diagnostic tool has been used since the first test with the gun and more intensely in commissioning and in operation. To achieve the objectives proposed the use of images becomes crucial to perform all the measures that characterize the beam of electrons and photons generated.

The system of image acquisition has to be adaptable and flexible so you can monitor the machine during the various phases.

IMPLEMENTATION

In an accelerator, the cameras can be of different types of performance, number of bit per pixel, etc... Then the camera system must easily integrate different types of camera as needed.

The first choice was to use digital cameras that provide a variety of choice enough to have the correct camera for the acquisition.

The market today, there are several types of digital cameras with standard interface with different characteristics. The most common are: Camera Link, 1394 and, more recently, Giga Ethernet vision in Table 1 shows the characteristics of the three bus…

As seen from Table 1 one of the problems is the maximum distance reached from the point of acquisition of the camera to the computer display and analysis.

Table 1: Interface Characteristic

Type	CPU Interface	Speed (MB/s)	Cable length (m)	Connected camera
IEEE1394 a	Standard board	400	4.5	Max 63
Camera link	Frame grabber	700	10	Point to point
GigaVision	Standard board	1000	100	128 +

The solution to this problem is to use a client server for acquisition of cameras.

The control system of SPARC is based on architecture of distributed client-server type that helped us to easily integrate the camera system this choice has partly solved the problems of distance and allowed us to develop fully integrated software in the control system.

The choice between various buses is linked to the characteristics of cameras required. Acquisition of images is necessary to have a camera with the following characteristics:

- Size of Senor least ½ inch
- Trigger
- Black and White color
- 8 or 16 bit per pixel
- More than one camera in acquisition per controller

These features of the camera led us initially to base the solution on the IEEE1394 bus.

The IEEE1394 allow us to choose between a high numbers of cameras with different characteristics from standard camera but you can find also streak camera.

From the table we see that the maximum distance that can be achieved between the camera and the server and 4.5m this distance is certainly too small for the installation of cameras along the machine. The possible solution is to use a series of hubs but we find some problem the number to reach a camera can be raised eg. for a distance of about 10 m requires a minimum of 3 hubs with standard lengths. Our previous experience in the FLASH machine [4] we understand that can use cables of 10m, even if they are not standard, with no loss of performance. The dimension of SPARC bunkers near 40m this allows usdecided to use maximum 2 10m cables and 1 hub. We have installed more servers in order to minimize the number of hubs.

The release of GigaVison Ethernet cameras that have the same characteristics as IEEE1394 completely solve the problem of distance and will lead to a gradual replacement of existing cameras with the equivalent based on this standard.

Software

The acquisition system, as mentioned, is based on the control system of SPARC. In the case of the cameras we have a server that is reserved image acquisition, and setting the main parameters gain, shutter and brightness and possibly and simple filtering a second part is reserved implemented on the console where there are display and analysis. Another advantage of integration in the control system is the possibility to easily increase the number of cameras.

In the control system of SPARC should define the main parameters that enable the management and acquisition of the camera, are shown in Fig.2, the static and dynamic cluster for the cameras, also defined an array that contains the scanned image.

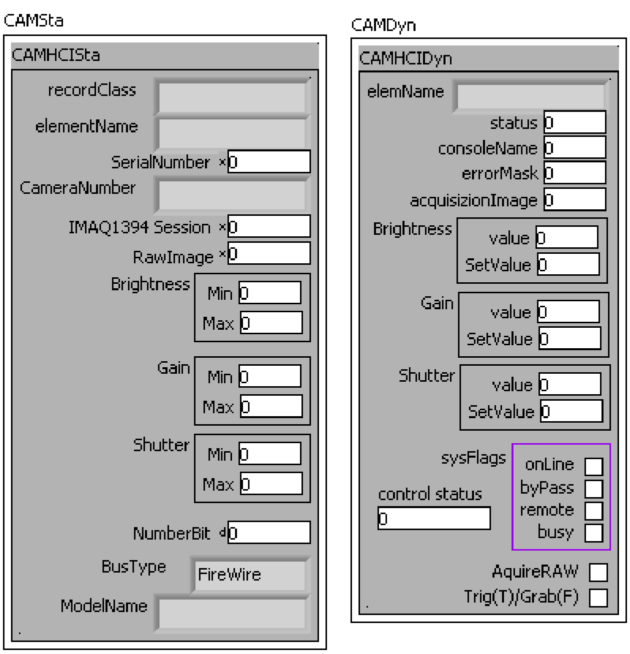

Figure 2: Cluster type.

Both the cluster and the matrix can be obtained on request from the console via TCP / IP.

The static cluster contains the following variables:

- Serial number allows unique identification of the camera be defined when the camera is installed on the machine
- Camera number is the number of the camera inside the PC, is obtained at initialization
- Bus type identifies the type of bus for the communication of the camera Allows to use the program check the appropriate drivers
- Number bit number of bits per pixel (0 8bit BW, 1 16bit BW and 2 color
- The minimum and maximum value of gain, shutter and brightness. These values are acquired from the camera.

The dynamic cluster contains the following variables:

- Acquisition image is increased every acquisitions image
- Read and set value of gain, shutter and brightness
- Camera is in acquisition
- Triggered or free grab the camera must acquire without trigger

The front-end Software

In Figure 3 shows the scheme of principle of a program for front-end control system of SPARC.

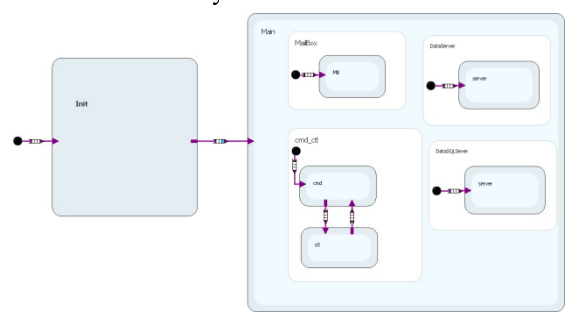

Figure 3: Front-end software.

In the init there are all the operations of initializing the program and the cameras. . First of all require, from the database of the control system, information on the cameras that should be under control, this information is written in the static cluster. The program acquires serial numbers of cameras linked to computers and its parameter. The correlation between the serial numbers in the cluster and those of the cameras allows us to check and assign the correct reference number of the camera

In the next phase the program wait for one of the commands allowed.

- ACQR <cameraname> GRAB/TRIG put the camera in image acquisition with or without trigger.
- CHNG <cameraname> stop acquisition camera
- SETP <cameraname> shut/gain/brigh <value> set the shutter, gain or brightness value

Console Software

For the acquisition of information from the console have been developed three functions for static dynamic and image.

A first program as an example and performance monitoring has been developed in Fi. 4 is block diagram of the program.

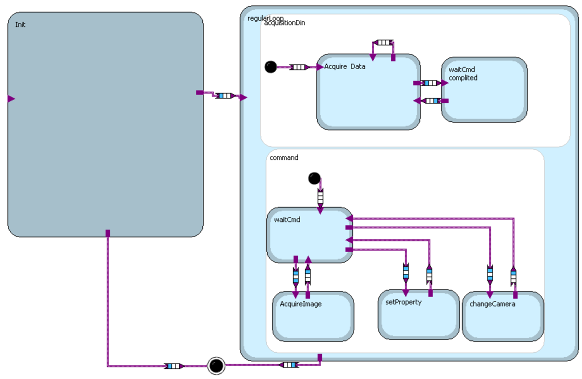

Figure 4: Diagram camera control.

During the initialization phase are found, the addresses of servers that have charge of the different cameras. In the main program we have the part of acquisition and control, in Figure 5, the window on the console.

The performance in the acquisition and display ranges from 25ms for the acquisition of one camera from one console, to 70ms when 5 console acquire the same camera (image 8bit 640x480).

This software has been used as the basis for the development of high-level software for the analysis of images. In particular, programs have been developed for the calculation of the emittance, energy, length, centroid etc.

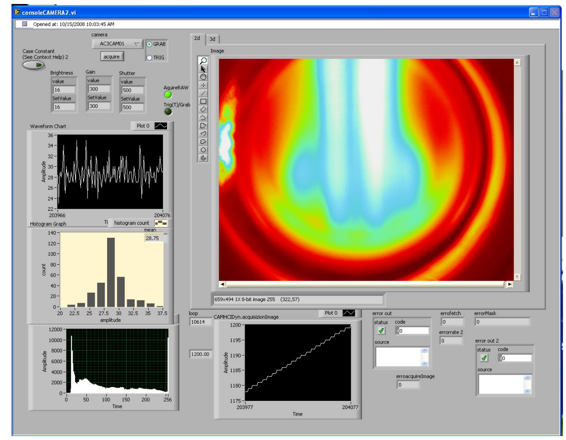

Figure 5: Control display window.

CONCLUSIONS

The use of IEEE1394 cameras has proven very effective. Currently in the control system were installed about 15 cameras controlled via 2 computers. As mentioned currently going through a camera gigaVison Ethernet.

REFERENCES

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