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A Flexible Graphic Display System for Accelerator Control

Cheol On PAK
Photon Factory, National Laboratory for High Energy Physics (KEK)
Oho, Tsukuba, Ibaraki 305, Japan

Abstract

A flexible graphic display system for controlling the KEK Photon Factory storage ring has been developed.

A VME computer locally controls the graphic display system and communicates with the host control computer through a RS-232C link. Graphic pictures are prepared in the local system by an interactive operation using either a tablet or a keyboard. The host control computer is free from any load due to graphics processing. In an on-line operation, pictures are displayed and modified by simple command strings from the host computer.

A "picture stack" method has been developed for this graphics system. The latest demanded picture always has top priority to be presented on each display monitor. Previous pictures are saved in a stack and can reappear when the current picture has been freed.

1. INTRODUCTION

Since colorful graphic displays can provide us with much useful information, even at a glance, they have become one of the indispensable tools needed for modern control systems. However, it often requires many man-hours to prepare a graphic display system, since graphics software is usually complicated and difficult to use. Furthermore, such graphics processing puts a heavy load upon control computers.

We have developed a flexible graphics display system (FGS) for controlling the Photon Factory storage ring. FGS has the following features:

- Host control computers are free from graphics processing load.
- Graphics are easily prepared without programming.
- Co-ordinate-free location method is possible.
- Any picture can be presented on any display monitor.
- Several pictures are kept in a stack manner for each monitor.
- Co-operative work with FTS (flexible touch screen system [1]) is possible.

2. SYSTEM OVERVIEW

A schematic of the FGS architecture is shown in fig. 1. The control system uses four minicomputers (FACOM S-3500 from Fujitsu) linked to each other by a token ring-type network [2]. The FGS control task (FGSCT) resides in one of the control computers. Many application tasks for control are distributed over four control computers. The application task sends a request to display a necessary graphic picture to FGSCT by DSM (Data Stream Manager, inter-task communication utility based on network [2]). FGSCT manages those requests from various application tasks. When it accepts a display request, it establishes a connection path between the application task and a proper display monitor. Hereafter, the application task is able to make modifications on a displayed picture. The connection path is valid until the application task frees this picture.

An intelligent graphic display station (DP-1000 from Digital) receives commands from FGSCT and draws pictures. One DP-1000 can handle three independent display monitors. The link between S-3500 and DP-1000 is RS-232C.

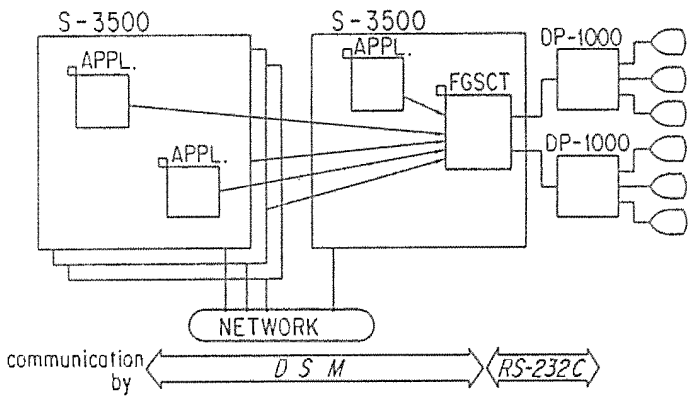

Fig. 1. Schematic of the FGS architecture.
APPL.: Application Task
FGSCT: FGS Control Task
DSM: Data Stream Manager (Inter-task communication based on token ring network)

3. FUNCTION OF FGS

A basic concept of FGS is that intelligent graphic display stations can present pictures by commands from control computers. Since the display stations perform all of the graphic processes, the control computers have only to send short command strings. Graphic pictures are prepared beforehand by the display station in a stand-alone manner.

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Pictures are drawn interactively using a tablet, like a CAD; completed picture data are saved into static memories of the display station. A graphics screen consists of a basic picture and additional modifications of graphic element attributes such as color, blinking, or a new plot on a graph. Application tasks can choose any monitor to display. Usually, the FGS control task automatically assigns the nearest display monitor to the touch screen which made the application task start.

Another feature of FGS is a "picture stack" method. Fig. 2 schematically shows how the picture stack works. When an application task requests a new picture on one of the monitors, the old picture, if already there, is pushed into the picture stack. The last requested picture always has the highest priority to be displayed (it is called to be "active"). The pushed-in picture is not displayed, but can still be modified by commands from the application task. It is restored when the active picture is removed by a free command. Each display monitor has its own stack of eight layers. Graphic display stations have no responsibility with stack management, though the FGS control task in the control computer does. The FGS control task keeps all information concerning picture stacks and applied modifies.

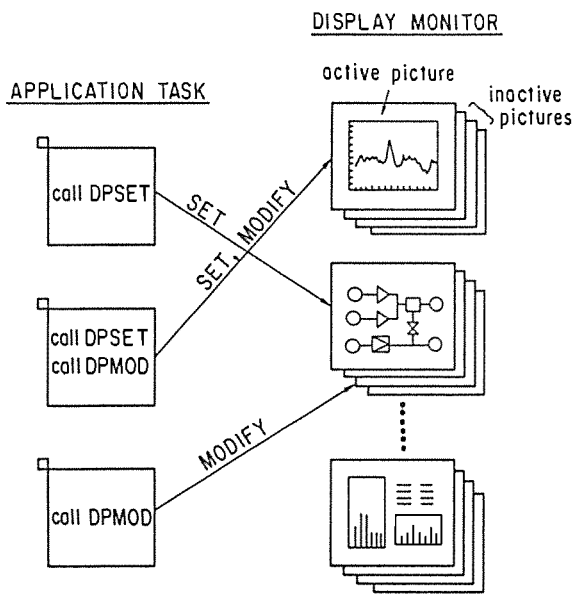

Fig. 2. Picture stack method of the FGS.

4. Intelligent Graphic Display Station

DP-1000 is a VME computer system that was specially made for graphics processing by Digital Electronic Corporation. It has 4 Mbyte screen memories and drives three independent 20" CRT, each with a resolution of 1280 (horizontal) by 1024 (vertical) dots and 64 colors. It also has 5.5 Mbyte static memories for storing graphic picture data; this capacity corresponds to 550 standard pictures.

DP-1000 has two operation modes, local and remote. In the local mode, pictures can be drawn interactively using a tablet; no programming is required. Completed pictures are saved into memories. One of the unique features of DP-1000 is a "tag method", a co-ordinates-free location method. By tagging a graphic point(s) with a name, it is possible to point out pre-defined locations only by calling the tag names. Tag names can also include informations concerning graphic attribute, such as color, blinking and font type in addition to co-ordinates. In the remote mode, the host computer is able to select reserved picture data and to display it on a CRT by sending a simple command string to DP-1000 through an RS-232C link. Modifications on a displayed picture are also easily done by sending commands; the tag method is effective in this case.

5. Software Description

5.1. *Software Interface to Application Program*

One feature of FGS is that an application program is simply and easily built. FGS serves several FORTRAN subroutine modules as follows:

- DPINZ initializes the FGS environment, called once at the start of the real-time system.
- DPSET selects a reserved picture and displays it on a monitor. The FGS control task sets pointers of the control tables, allocates the parameter area and establishes a bind between the application task and selected monitor.
- DPMOD modifies the picture. Modifications are effective for both active pictures (now on display) and inactive ones (pushed into a stack).
- DPFRE terminates a picture display and sets the monitor free to other inactive pictures, if any.

Only these four subroutines are sufficient for application programs to use FGS.

5.2. *Installation of New Pictures*

The way to install new pictures into FGS is as follows:

- Make basic picture on DP-1000 in the local mode using a tablet, and save completed picture data into memories.
- Develop modifications on the basic picture using an interactive test tool on a host computer, and store the final command strings into a modification record file on the host.
- Define a picture name and add the modification record file made in a previous step to the FGS command file.
- Install the FGS process into the application program using FGS service routines.

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6. CONCLUSION

FGS has given us an easy and speedy development of graphic presentation in the control system. It has also realized an effective use of limited resources of display monitors, owing to its picture stacking architecture.

We now have three display monitors with a single DP-1000, and are planning to add one more DP-1000; six monitors will eventually be available.

The FGS mechanism is strongly dependent on our hardware and software environment such as computers, display stations, network, operating system or programming language. Although it will therefor be difficult for other control systems to adopt FGS as it is, its conception may be useful for them.

7. REFERENCES

[1] Paper is in preparation.
[2] C. O. Pak, "The Control System of the Photpn Factory Storage Ring", Nucl. Instr. Meth. A277 (1989) 501.