EASY AND EFFECTIVE APPLICATION PROGRAMS USING DATAVIEWS

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Abstract: The commercially-available product DataViews [1] is being used for a simple and effective applications program builder for the new Fermilab Linac Control System [2]. This product consists of a "view" editor, a thorough set of object-oriented graphics subroutines and a convenient method for incorporating your own data acquisition into the system. There are many advantages to this package, most significantly the modularity and effectiveness of the graphics and of the data acquisition schemes.

First, the programmatic structure of the DataViews product is described. Then a brief description of the Fermilab Linac control system is presented. A few of the programs developed using DataViews are described, especially a simple application-builder program. Finally, some operational experience is presented.

THE DATAVIEWS PACKAGE

Quoting from the VI Corporation manuals on DataViews:

> DataViews is a set of tools for building graphical user interfaces for complex software applications. The main tools are DV-Draw, the graphical editor for building the visual interface, and DV-Tools, the library routines for building the programmatic control of the interface [3].

The DataViews package is available on virtually all workstations, in particular, Sun and VAX (VMS).

DV-Draw is used to edit the following aspects of the view: the character of the interface; the method by which the data are obtained; the graphs which are displayed; the way in which the graphs and the geometry of the graphics change according to the values for the data (the dynamics); user-input methods; and some limited prototyping methods. DV-Draw creates a binary file commonly referred to as a view.

DV-Tools provides the programmatic interface to the package. Anything which can be done in DV-Draw can be accomplished through DV-Tools. The use of the DataViews package which seems the most robust and useful is to generate the layout of graphs, geometry, input objects and dynamics in DV-Draw, and to use the DV-Tools routines to respond to the user interrupts, do some special data gathering and act on the various events the program encounters.

The DataViews package has been extended, through their Function Data Source methodology, to include data acquisition from the Fermilab Linac control system. "Linac Scalar Devices" appears on the DV-Draw Data Source menu under the "Function Data Source" data source type and allows the user to observe these data in DV-Draw (for quick plotting without programming) or from a more sophisticated application using DV-Tools. It is not, in general, necessary for the DV-Tools programmer to worry about data collection.

A measure which some people use to determine the the level of sophistication of a software system is the time it takes to modify that system. It required approximately two weeks of effort for one physicist to learn the DataViews Function Data Source methodology and implement "Linac Scalar Devices" into the system. VI Corp provides two examples of Function Data Sources with their product, which helped this physicist very much.

The performance of an application program which uses DataViews is generally limited to 5 Hz or slower, depending on the complexity of the view. (This is observed on a Sun SPARCstation 2 workstation with GX graphics.) It is believed that a true graphics accelerator would greatly enhance this performance.

THE LINAC CONTROL SYSTEM

The Linac control system is fully documented elsewhere [2]. Briefly, we have twenty VME local control stations (LCSs), connected together on the IEEE 802.5 (4 MB) Token Ring communicating with each other, with Macintosh consoles and with Sun Microsystems workstations (running, among other things, DataViews).

A large set of C^{++} classes for Linac data acquisition and control have been built at Fermilab. Acquisition of large amounts of data (in excess of 500 frames of 100 bytes of answers per second) has been demonstrated on a single SPARCstation 2 using these classes.

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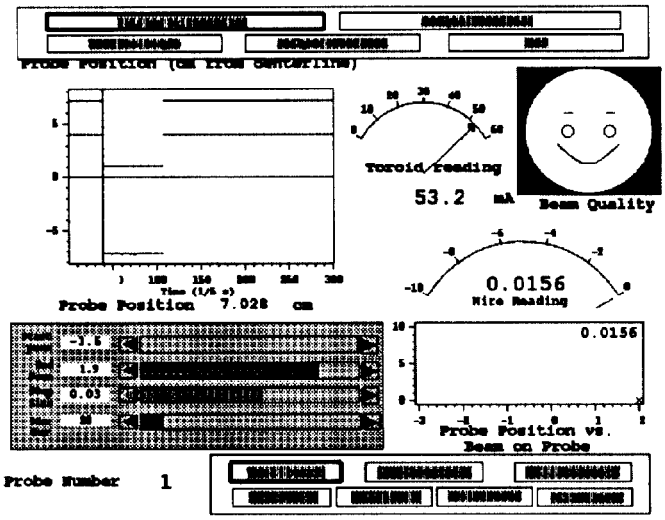

Figure 1, The low-energy emittance control program.

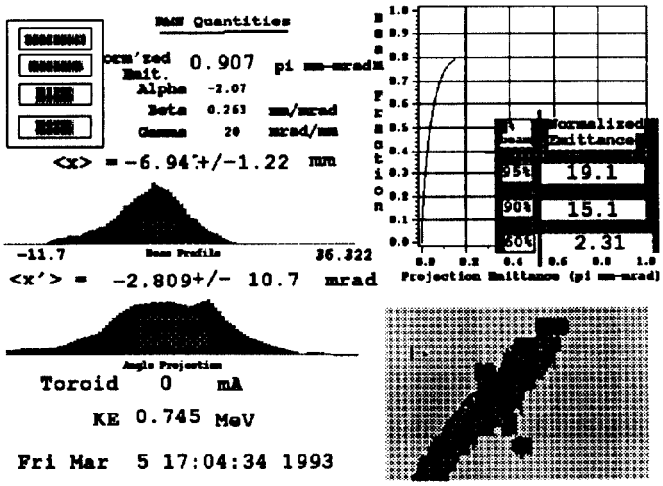

Figure 2, The low-energy emittance display program

The pertinent classes to mention here are the *Device* and the *Request* classes. A *Device* instance handles all of the information connected with the 16-bit analog devices in the Linac control system, for example, the reading, setting, nominal, tolerance, title, units, conversion constants, sibling channels, etc. The *Request* class handles everything associated with getting data back from a LCS at a repetitive rate. In particular, a *Request* instance can handle 15 Hz data returned from an LCS for a *Device* or for a list of *Devices*.

The DataViews "Linac Scalar Data" uses the *Device* and *Request* classes to return the scalar data for that device or those devices to the DV application, either DV-Draw or DV-Tools.

THE DATAVIEWS/LINAC PROGRAMS

Two of the more sophisticated applications written using the DataViews package are described here.

The first application is for the low-energy emittance measurement and calculation programs (`emit` and `show_analysis`, respectively) [4]. When the program begins, the screen shown in Figure 1 is displayed. (Note: These program are normally viewed on a color monitor; some of the quality of the display has been lost in the translation to a form suitable for this paper.) From there, the user can select the emittance probe to run and the limits on the motion of the probe. The progress of the probe and some information on the returned data are displayed. The C++ program is responsible for (1) responding to user interrupts and setting the emittance run parameters and for (2) launching the emittance measurement program (another C++ program on the SPARCstation 2). DataViews is responsible for gathering the data for the displays and for making the displays. When the emittance measurement is completed, the user asks to analyze the data. The `emit` program then launches an analysis program and, when that completes, it launches `show_analysis`. A screen for `show_analysis` is shown in Figure 2. This program is essentially a DataViews example program supplied with the product, modified for the 4-button input field in the upper left corner of the display. The C++ program only reacts to user input; DataViews handles the rest. (These program was conceived and initially written by M. Allen, presently of the SSC, with substantial modifications by the author and by J. Palkovic, also now at the SSC.)

The second program is intended to be a general program for a synaptic display for a system. The user would set up a view with DV-Draw to graphically represent his/her system in any way desired. There are some restrictions on the names of the graphical and data objects in the view. When the user interrupts on an object which is bound to a piece of data obtained from the Linac control system, the program creates a popup box containing the information on this datum as provided by the *Device* structure. The program also shows database information for binary information.

The program can switch the view from one rf system to another (there are eleven rf systems in the new Linac) by changing the value of a datasource variable called "System Number." This change is made possible by the fact that all database names for the 805 MHz Linac systems have a digit in the second character position of the name field which is the RF system at which

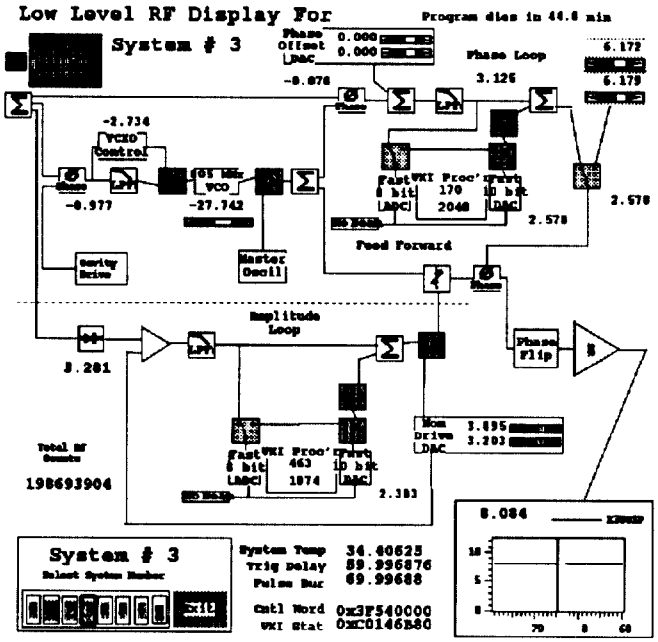

Figure 3, The low-level rf display program

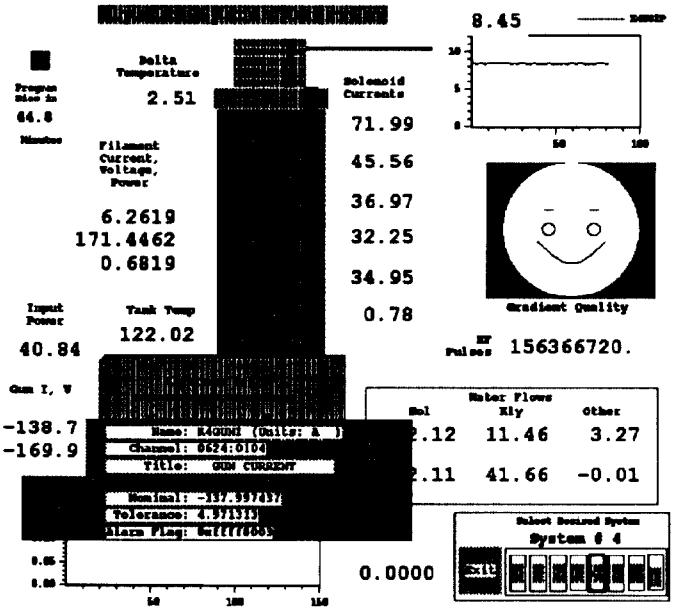

Figure 4, The klystron-overview display program; note the popup database description.

that device is located. For example, M5MODV is the MODulator Voltage at system 5.

The clever user can add dynamics to the objects which have binary data for their dynamics, for example, show a closed switch when the value is greater than 0.5 (e.g., a value of 1), and an open switch when the value is less than 0.5 (e.g., a value of 0).

Five applications have been built using this applications builder for the 400 MeV Linac Upgrade. The most complicated application is for the low-level RF system, and the image of this program is shown in Figure 3. This view takes advantage of the dynamics possible with this program: note the switches which change position according to the value of a binary datum. Also (not shown), readings which are out of tolerance are red. The same application with a view for the overview of a single klystron is shown in Figure 4. Note the database description box. The other three programs are synaptic displays for the cavity water system, an overview of ten of the klystron systems and a simple flow-diagram for the modulator sub-system.

OPERATIONAL EXPERIENCE

The DataViews package has been very useful and effective. There has only been one physicist/programmer working on this project. DataViews makes it possible for a small group to produce high-quality graphical applications quickly and easily.

The engineers in the Linac Upgrade project have been particularly happy with these applications. This is because they have produced Macintosh-generated block diagrams for their systems, which were easy to cast into DataViews with the dynamics attached.

The major limitation on the production of these displays has been (1) the artistic complexity of creating a satisfactory display and (2) the fact that very few people in the Linac Dept. have learned to use DV-Draw.

The Controls Group in our Accelerator Division does not have the liberty to experiment with these sorts of products on-line. Their top priority is to present a coherent and integrated look-and-feel to the Operations Staff. This sort of integration of the DataViews package would require a lot more effort than has been put in so far.

CONCLUSION

DataViews has been demonstrated to provide a simple and powerful means by which a small group of applications programmers can produce a very sophisticated graphics user interface for an accelerator.

REFERENCES

[1] DataViews is a registered trademark of V.I. Corporation, Northampton, MA 01060.

[2] "Upgrading the Fermilab Linac Control System" E. McCrory, et al., in Proceedings of the 1990 Linear Accelerator Conference, Albuquerque, pp 474-477.

[3] DV-Tools Reference Manual for Release 8.0, September 1, 1990, VI Corporation, page Introduction-1.

[4] Part of the work for John Palkovic's Dissertation: "Gabor Lens Focusing and Emittance Growth in a Low Energy Proton Beam," University of Wisconsin-Madison, July 22, 1991