INTERACTIVE GRAPHIC APPLICATIONS AT CARLETON UNIVERSITY

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ABSTRACT

The paper describes the interactive computer graphic facilities available to users of the Xerox Sigma 9 computer at Carleton University and presents some of the existing and projected applications of the system. These facilities consist of a raster scan television display system capable of supporting, simultaneously, up to 16 independent graphic users, interfaced to a large time-shared digital computer. This system may be of interest to participants of the seminar in that it offers low cost computer graphics to users in a large time-shared environment. The use of a large central computer with a sophisticated operating system has made the graphics facility available to users with a minimum of programming experience. Due to this ease of accessibility and the diverse interests of the users at Carleton, the system has been applied to a wide range of problems from continuous simulation and polynomial regression to computer games. The final presentation will concentrate on the applications of the system which will be illustrated extensively by slides and videotapes.

ABRÉGÉ

Dans cette communication on décrit les caractéristiques de l'appareil de représentation graphique interactive disponible pour les utilisateurs de l'ordinateur "Xerox Sigma 9" à l'université de Carleton et l'on discute aussi certaines applications actuelles et projetées. L'equipement englobe un système de représentation d'images balayées de télévision pour 16 utilisateurs indépendant au maximum, relié à un gros ordinateur à temps partagé. Il est possible que les participants à ce colloque s'intéresseront au système parce qu'il offre la représentation graphique par ordinateur, au bas prix, aux utilisateurs d'un gros ordinateur à temps partagé. L'installation d'un gros ordinateur central avec un système d'exploitation ingénieux a permi l'utilisation de possibilités graphiques par des personnes n'ayant qu'un minimum d'expérience de la programmation. À cause de l'accessibilité facile et des intérets différents des utilisateurs à Carleton, on a appliqué le système à de nombreux problèmes divers qui englobent la simulation continue, la régression polynômiale, et les jeux par ordinateur. À la représentation finale, on mettra l'accent sur les applications et on les illustrera avec des diapositives et des bandes magnétiques video.

The Sigma 9 is a large digital computer capable of supporting extensive on-line and batch service. The Carleton installation is presently servicing 65 on-line users, 4 batch streams and 2 remote batch terminals with plans to increase the number of time-sharing ports in the near future. Time-sharing users have access to the full computational power of the machine through a sophisticated file management system for building and storing programs, a fortran IV compiler for compilation and a load and run subsystem for execution.

One important consideration in selecting a graphics display system to operate in this environment is that if offers reasonable response to plot requests while placing minimum demand on the resources of the main computer. The data disc series 6500 graphics display system has satisfied this requirement. Information is transmitted in blocks by the channel processor from the main computer to the graphics display system where it is recorded on a user specified track pair on the disc memory. This information constitutes the entire specification for the 512 x 512 matrix of picture elements on a monitor assigned to it. Each track pair has its own read head and associated circuitry which refreshes the monitor at a rate of 30 frames/second. Since there are 16 such track pairs on the disc, the system can display independent pictures on up to 16 monitors. At the present time only 6 channels are in operation, but as demand increases the others can easily be implemented. The present configuration of the system does not include any direct input devices but we hope to add a trackball sometime in the future. In any case the lack of one has not proven to be a hindrance due to the flexibility and sophistication of the main computer.

Two libraries of Fortran callable subroutines are available to users who wish to display their information on one of the 6 operative television monitors. One of these, TVLIB, contains the routines that implement the basic instruction set of the display system, while the other, TVPLIB, contains routines that implement the Calcomp compatible software used on the hard copy plotter. In addition to the basic software, the libraries also contain subroutines for manipulation and display of 3-dimensional functions and data with hidden line removal and routines for plotting contours.

The most popular and profitable use of the television display system to date has been as an effective tool for de-bugging programs to be run on the hard copy X-Y plotter. Though this application is less impressive than those which involve analysis and design, it has proven invaluable in reducing considerably the load on a heavily used plotting facility which is slow, expensive and subject to mechanical breakdown. At Carleton, we have found that a large number of computer users are interested in obtaining a hard copy plot of a defined set of data in a prescribed format. They may have no need to interact with the data either at the computational level or at the display level; nevertheless, the interactive system has played an important role in substantially reducing the time and effort required in the development stage of the plot program. Using the television monitor, the user can quickly spot such typical programming errors as incorrect specification of axes and titles and incorrect scaling of data. These savings in time and effort have made the hard copy plotter accessible to many users who would have otherwise been deterred by the expense and long turn-around time.

The staff at the Computing Centre have included graphic capabilities in general purpose programs for continuous simulation (SIMUL8) and polynomial regression (POLYFIT). These packages are fully interactive and their users need have little or no knowledge of programming. SIMUL8 is a block diagram oriented continuous simulation program, principally used for solving differential equations and problems in quadrature. POLYFIT is a program which calculates the coefficients of an orthogonal ploynomial which best fit a set of X-Y data. Both programs have subsystems which allow the user to define and modify a model, save it on a permanent disc file and perform an analysis. Use of these packages has been extensive and the graphic output has proven to be an attractive feature. We hope in the near future to include graphic capabilities in time-sharing interactive programs for electronic circuit analysis and multiple linear regression.

As users become more familiar with the capabilities of the graphic display, they realize its potential as a tool for interactively investigating the response of a system to varying input values rather than solving a specific case and plotting the output. Some users in Chemistry have used the interactive display system to study theoretical potential

energy surfaces of hydrogen molecules during reactions, while others have used it to plot stereoscopic pairs of molecules for 3-dimensional viewing. In Mathematics, interactive graphics is useful in displaying perspective views of surfaces, visually representing the use of Fourier series to approximate a curve, and for plotting temperature contours in an ideal fluid flowing past various heat sources.

In conjunction with the Mathematics department, a pilot project is currently underway to produce a videotape illustrating simple curve sketching, numerical integration, and some aspects of polynomials for use in elementary mathematics courses. Should this project prove successful it is probable that similar projects will be undertaken. Users in the Chemistry department have expressed an interest in using this capability of the graphics display as a supplementary instructional aid.

In addition to these more serious applications, the graphics display system has been put to a number of less important, but interesting uses. The Systems group at the Computing Centre use one television monitor to display up-to-date performance statistics for the system. A student in Journalism, using time-lapse photography, has made a film which effectively utilizes rotation and translation of character strings and symbols. Finally, the graphics display system has received considerable usage among students and faculty alike as a recreational facility. Games have been developed for playing 3-dimensional Tic Tac Toe, Checkers and Naval Warfare. Though it might be argued that computer games benefit only those who write them, they have the added value of introducing students to a computer terminal. How to turn it on, how to log on, and how to load and run a program can pose seemingly insurmountable problems to the uninitiated student. At the end of it all to find, not an incomprehensible stream of numbers, as had been expected, but an interesting opponent who is complementary when defeated ("Well done!") and humble when victorious ("Better luck next time.") goes a long way toward encouraging an understanding of the machine.