A Supplement to *Computer*

looking .forward

The IEEE Computer Society's Student Newsletter

Summer 1995 Vol. 3, No. 2

Message from the Editor-in-Chief

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Dear Colleagues:

This issue of *looking .forward* is the first to be produced outside of America, and we at Hiroshima University are greatly honored to host this edition. The articles in this issue reflect the international nature of our discipline and outline technologies that will have global impact in the near future. We hope that *looking .forward* will continue to be a success with student members from around the world.

I would like to thank all the student volunteers and faculty advisors who through their tireless efforts have made *looking .forward* such a success. In particular, Prof. Grace Wei of California State University of Fresno, Prof. Jon T. Butler of the Naval Postgraduate School, and Prof. C. V. Ramamoorthy of the University of California, Berkeley, were instrumental in the production of this issue. I'd also like to thank Narayanan Vijaykrishnan for sharing the wisdom of experience.

The continued success of *looking .forward* depends on the contributions of student volunteers. I urge potential authors to submit their articles for future issues of this newsletter. The Editor-in-Chief of the Fall 1995 issue (Vol. 3, No. 3) is Gisela Fischer of GMD-IPSI, Germany. E-mail your articles or ideas to:

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If you have any comments or suggestions for future issues, or if you would like to volunteer your services, please write to:

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We hope that you enjoy reading this issue, and we hope to have your continued support in the future.

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The complexity of the system will depend on the available resources. Even though expensive hyper-media machines will not be feasible, less expensive and less powerful personal computers can serve as the platform for CIA programs. CAI software usually uses a graphical user interface and thus implementation in languages with non-ASCII character sets would not be very difficult.

Need for a National Policy

Incorporation of computers at a national level is an important national policy. Several factors must be considered prior to implementation. First, we must discard expectations of immediate results. Computer technology is relatively new in developing nations, especially in their educational system. It will take time to adopt the current technology to penetrate beyond the misconceptions. The system must simply wait at least eight to twelve years before the so called ``computer literate" generation joins the work force. Only then can we compare, contrast, and evaluate the system. A number of programs in developing nations have lost track and been distracted in an effort to reach final results quickly.

Secondly, we must find ways to deal with cross-cultural diffusion. Currently, computers represent an aspect of Western culture in developing nations. The majority of parents have little or no knowledge of computers, yet their children will use them on a daily basis. This can create a cultural shock. The most effective way of dealing with this problem is through education. People must be taught what the machine is and why it is used in schools. People must be assured that their children will benefit from computer-aided instruction and that the delicate teacher-student relationship will be maintained.

Lastly, we should not expect magic. We create our own solutions to our own problems. The computer will do as much as we want it to do. Educators in each country must create educational software for themselves. This requires an evaluation of the student population. What are their strengths and weaknesses? How will they approach computers and how can the computers make the greatest impact on the educational system without sacrificing the teacher-student relationship?

Conclusion

An overview of computer-aided instruction (CAI) has been provided. Several factors related to computer integration in developing nations has been examined and a draft proposal is drawn. Technological advancement relies on effective usage of machines, including the computer. The proposed plan is a start to utilize computers towards improvement of the educational system, and thus contribute to further enhancement of technology itself.

Research in 3D User Interfaces

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Introduction

The rapid development of 3D hardware and software has brought revolutionary changes in 3D technology. Expensive supercomputers and state-of-the-art workstations which were absolute requirements in the early days of 3D computing have been substituted by low-cost 3D workstations and powerful personal computers. Tremendous progress in stereoscopic output devices started the move of Virtual Reality from research laboratories to industry, arcades and the home. All this has significantly expanded the user base of 3D computing from limited groups of technological "outfits" - elite groups of scientists and engineers - to an enormous audience of researchers and practitioners in such areas as CAD/CAM, medicine, engineering, etc. [Kornbluh 1994; Wichansky, et. al. 1994]

Software vendors have responded to the new opportunities in this market by developing interactive 3D applications oriented towards end-users. A survey of the commercial end-user systems for science and engineering conducted by Kornbluh [1994] shows that at least twenty-seven out of forty-three surveyed systems provide 3D imaging functions. This orientation towards the end user is a shift from the old days of 3D computing when using 3D facilities required special knowledge, skills, and funding.

However, this new orientation towards a broad and rather heterogeneous user base imposes extremely high requirements on the user interface. The user should be able to start using applications with a minimal background in 3D computing [Wichansky, et. al. 1994], without qualified assistance, optimally even without reading the manuals. Generating 3D objects and interacting with them should be as easy as possible - at the tip of your fingers. The usability of 3D applications and developing effective 3D interfaces, therefore, has become one of the most important directions of research and development in 3D technology.

Usability of 3D graphics applications

Unfortunately, the usability of present day 3D computer graphics software is far from being perfect. The report from "The Challenges of 3D Interaction" workshop, which was held in April 1994, states that present 3D graphics applications are "significantly more difficult to design, implement and use than their 2D counterparts" [Herndon, et. al. 1994]. Evidence of this can be found in Luczak's [1991] studies of usability of 2D and 3D CAD systems. They show that users' performance with 2D CAD systems was better than with 3D - the average time spent on test tasks was about 55% longer for users of 3D CAD systems than 2D.

Software, however, is not bad or good in itself - it's just developed that way. Because there are very few guidelines and no accepted standards on how to organize 3D interaction, application programmers develop 3D software ad hoc, sometimes even without consideration of basic principles of human depth perception. The report from Silicon Graphics [Wichansky, et. al. 1994] describes how adding shadows to Showcase 3.0 on the recommendation of Silicon Graphics' Product Usability Group has significantly improved the user interface of the application. The shadows had not been used in the application before the usability test, even though shadows are one of the most important depth cues of the human visual system and improve comprehension of 3D scenes considerably [Wanger, et. al. 1992; McAllister 1992]. It is not fault of programmers, however, it is just an example which shows that developing 3D user interfaces is much more difficult than 2D ones and requires a great deal of special knowledge from developers.

Another serious problem is a lack of software tools and programming environments for developing 3D user interfaces. Most of the present 3D applications were developed for a particular GUI environment, such as X Windows or Microsoft Windows. The reason being is the availability of powerful interface developing tools such as UIM/X for X Windows. Using such tools increases the performance of developers a great deal and provides a guarantied quality of the interface [Shneiderman 1992; Mayers et. al. 1992]. These toolkits do not provide, however, any specialized 3D widgets nor interaction techniques specific for 3D interfaces, such as selecting in 3D, moving in 3D, etc. Each developer implements his or her own techniques, which violates one of the most attractive advantages of windowing environments - consistency between interfaces of different applications developed for the same windowing system. Generally speaking, the applicability of these tools, and more generally the whole WIMP paradigm (Windows, Icons, Menu and Pointers), for 3D interfaces is still an open research question [Herndon, et. al. 1994]. This is especially true in the case of stereoscopic output devices, where a "universally accepted paradigm for interaction" has yet to be developed [Hodges 1992].

We can no longer develop 3D user interfaces in an ad hoc manner. Improperly chosen stereoscopic computer graphics algorithms can cause health problems [Hodges, et. al. 1994]. In an age when people are suing computer manufactures for improperly developed keyboards, lack of attention to usability factors can cause huge financial losses. Instead, serious research should be undertaken to study the phenomena of 3D user-computer interaction.

Research in 3D interaction and interfaces

The goals of research in 3D interface and interaction coincide with the general goals of human-computer interaction as stated by Shneiderman [1992]: "(1) influencing academic and industrial researchers; (2) providing tools, techniques, and knowledge for commercial systems implementers and (3) raising the computer consciousness of the general public."

Studies in 3D interfaces and interaction is an interdisciplinary field and relies heavily on computer graphics, cognitive studies, human factors in computer systems, and psychology. Researchers can borrow a great deal from conventional 2D interfaces, especially when it comes to general concepts such as direct manipulation [Herndon, et. al. 1994].

There are enormous amounts of problems to be solved, but generally they can be classified into problems which are more theoretical than applied and problems which are more applied than theoretical.

Theoretical studies should form and suggest paradigms, models, general principles of 3D user interfaces and contribute to the fundamental understanding of how we interact in 3D [Strong 1994]. General guidelines and standards on interaction techniques should emerge as result of this research.

Applied research should use the results of this theoretical research and produce efficient 3D user interfaces, identify new application fields which need 3D interfaces [Herndon, et al. 1994], develop interaction techniques for certain input and output devices, create 3D user interface programming tools, and develop engineering methods for the effective design and development of 3D interactive applications.

Who will benefit from this research?

Users will benefit from this research as friendly 3D user interfaces will allow them to work more effectively, spend less time on routine procedures, and be creative. Users of the systems are not only people who directly work with the program, they are also employers who will benefit as less mistakes are made and better results in less time are achieved.

Application developers will also benefit as research will provide them with the guidelines, standards and tools for developing 3D interactive systems easier, quicker, and within budget. Software vendors will benefit because the popularity of the programs will increase when usability factors have been improved [Nelson 1994]. In addition to this, software vendors will save money on toll-free customer support telephone lines [Wichansky, et. al. 1994].

Hardware manufactures will benefit as developing 3D hardware does not make sense without applications which can be used with this hardware. Developing tools for user interface implementation will increase the amount of applications and influence the popularity of hardware platforms and peripherals.

Conclusion

3D user interfaces are not absolutely new and undiscovered things. As elements of interaction exist in almost any computer program [Nelson 1994], the very first 3D user interface was created when the very first program performing 3D output was developed. What is new is that 3D applications are becoming more accessible and popular and more oriented to the average user. Certainly this popularity and accessibility will grow tremendously in the future. With this increase the importance of providing effective interfaces with 3D computer generated environments is particularly important.

However developing 3D user interfaces is significantly more difficult than 2D interfaces. The step from 2D intèrfaces to 3D will require more research and effort than the step which was taken from the 1D interfaces of line editors, teletypewriters and card perforators to the modern 2D Graphical User Interfaces. The goal of research is to make this transition to effective, consistent, easy to learn and easy to use 3D user interfaces. So easy that "even a full professor can use it" (Brook, cited in Whitehouse 1994).

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Optical Memories

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1 Introduction

Since the appearance of the first electronic computer in the mid-1940s we have witnessed a constant growth not only of the processing power but of the primary and secondary memory a computer uses. Approximately 15 years ago when the first personal computer made its debut in the market, a 64KBytes Random Access Memory (RAM) was state-of-the-art, and a hard disk was beyond the functionality of the system. Today, a standard personal computer is loaded with at least 8 MBytes of RAM and a 300 MByte hard disk. More advanced systems such as the Alpha AXP™ system series from Digital Equipment Corporation can use up to 256 or 512 MBytes of RAM. It is expected that the need for primary and secondary storage will continue to increase constantly through the years, and some controversial predictions suggest that the growth may be exponential. There is a very good reason behind this need for more memory space: approximately 95% of humanity's information resources are still stored on paper, and the remaining 5% is available in electronic form.

Electronic memories such as Dynamic RAMs (DRAMs) are now available in packages of 16Mbits per chip, and 64Mbit chips are expected within 1995. Secondary storage devices continue to improve their storage density.