Hybrid Workstations in Geoinformatics: Requirements and Potential

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ABSTRACT

The paper describes the advances in workstation technology for the use with geodata. These developments are seen as a catalyst for an integrated approach to spatial data handling. Consequently, boundaries between traditional disciplines such as photogrammetry, cartography, and land surveying are beginning to break down. This trend is accelerated by new technologies such as remote sensing, digital image processing and geographic information systems (GIS). The surveying and mapping disciplines will have to respond to these challenges in technology and integration. First efforts to stablish an integrated 'geoinformatics' approach to spatial data handling are presented. Hybrid geoinformatics workstations are defined by their capabilities to address the various requirements in the new evolving field of geoinformatics.

INTRODUCTION

In the past decade, developments in computer science, electronics and computer design have resulted in a meteoric growth of digital techniques for the disciplines concerned with geoinformation processing. Initially, these techniques evolved in specialized disciplines, each with its own perspective on the earth, and resulted in parallel developments of different types of spatial data handling technologies, the most important being remote sensing and its associated image analysis, digital photogrammetry, digital cartography and much heralded geoinformation systems (GIS).

In spite of the evident differences, it is crucially important to recognize that these disciplines all share a common base in the sense that they make use of digital techniques and concentrate on various aspects of acquisition, storage and retrieval, processing and analysis, production, and dissemination of geo-data. Despite this common base, a clear process of integration which is to a large degree forced by technological developments such as common hardware platforms is just in the beginning (Ehlers and Blesius, 1991). Recent progresses in geo-sciences, however, indicate that integration of these capable data acquisition, analysis and presentation technologies is becoming increasingly important. For example, Ehlers et al. (1989) discussed strategies for the integration of remote sensing with geographic information systems which would also encompass digital (softcopy) photogrammetry as part of the image processing component. More recently, a special issue of Photogrammetric Engineering and Remote Sensing was devoted to issues related to the integration of remote sensing and GIS (Star et al., 1991).

Consequently, it does not come as a surprise that the same general purpose workstations are being used as platforms for software packages in remote sensing, GIS, digital photogrammetry, digital cartography and CAD. This technological pressure has already begun to force scientists in the highly specialized surveying and mapping disciplines to rethink and redefine their field in a much more integrated manner (Barwinski and Petersohn, 1991). With a common and digital technology, it seems that many of the traditional boundaries are beginning to break down and a new integrated approach to spatial data handling is needed. What is emerging in its place may be the beginning of a broad perspective interdisciplinary science of Geomatics (Groot, 1989) or Geoinformatics (Ehlers and Amer, 1991) dealing with the acquisition, processing, production and dissemination of geoinformation.

1. WORKSTATION TECHNOLOGY

Advances in computing technologies have been so rapid that it is difficult to evaluate the many alternatives offered today for high speed interactive computing. We have witnessed that the processing power of desktop workstations has nearly doubled every year. This development was coupled with decreasing hardware costs, the development of high resolution graphical screens with true colour and/or stereo displays, the introduction of storage devices in the Gigabyte (Gb) domain and improved network capabilities. It is predicted that only a few years from now CPUs capable of processing of more than 1000 MIPS (million instructions per second) will be common as desktop workstations (Faust et al, 1991). The recent introduction of Hewlett-Packards (HP) 700 series with its peak performance 66MHz RISC processor of 76 demonstrates that we are only 3-4 'doubling cycles' away from this technology.

The rapid advances in computing power were accompanied by the (sometimes 'painful') evolving of standards for operating systems, network protocols, graphical interfaces and programming languages.

Nearly all workstations feature a UNIX operating system (with C as the standard programming language), high-resolution graphics screen, comply with the X-windows standard and the TCP/IP network protocol. However, UNIX still has a variety of dialects and wether new manufacturers efforts to establish a unified UNIX standard will be successful remains to be seen.

Nevertheless, these emerging standards have to be viewed as catalysts for improved systems integration. This trend is also illustrated by the fact that the development of high end graphic boards such as super VGA and the introduction of UNIX operating systems for PCs and Macintoshes are beginning to diminish the boundaries between personal computers and workstations.

2. REQUIREMENTS FOR HYBRID GEOINFORMATICS WORKSTATIONS

Hybrid workstations for geoinformatics may be defined by their capabilities to handle geo-information in an integrated manner. It can be seen from the above description that the technological developments in the workstation domain are indeed addressing almost all the geoinformatics requirements. As it is hardly possible to meet all of these requirements with just one software package, we have to set standards for general purpose workstations and for geinformatics software which allows for most efficient geo-data handling.

Standards for hybrid workstation should include: (i) high resolution graphics display (e.g., 2000 x 2000 pixels with true color and graphics overlay capabilities); (ii) processing power that allows interactive manipulation of spatial data (e.g., polygon overlays, georeferencing, resampling); (iii) random access memory (RAM) to handle large data files of hundreds of megabytes (Mb), eventually allowing real-time pan and zoom in a digitized aerial photograph scanned in at Nyquist frequency; (iv) stereo display capabilities necessary for softcopy photogrammetry workstations; (v) on-line disk storage devices capable of handling gigabytes (Gb) of data; (vi) standard UNIX operating system to permit software sharing; (vii) highly intuitive graphical interface complying with standards such as X-Windows; and (viii) network capabilities with high-speed data transfer rates (e.g. megabits/sec) to efficiently access and process geodata from decentralized databases.

It may be safe stating that the major manufacturers of workstation (e.g., Sun, HP, DEC or IBM) are well on their way to meeting these product requirements. The only exception may be the stereo display function which is currently only addressed by customized manufacturing (Ehlers, 1991). It is, however, of great interest to observe development efforts in the field of Virtual Reality where stereo is produced by independent screens in a head-mounted display (HDM) where the human interface may be provided by a *dataglove* or even a so-called *bodysuit* (Anderson, 1991). It should be noted that virtual reality is still very much a 'ghee whiz' operation and far away from practical applications. With the ever increasing speed of progresses in processing power, graphics display and imaging technology, and the amount of R&D money spent in the United States and Japan, this field should be worth watching.

Recently, *Advanced Imaging* presented a survey of vendors that offer products for the acquisition, processing, display, storage and output of digital imagery. Its list contained about 600 addresses, most of them from the United States (Advances Imaging, 1990). Of these 600, 52 were listed with special applications in GIS and remote sensing. Surveys on GIS and remote sensing software were recently published by Parker (1989), Sader and Winne (1991) and Ehlers and Blesius (1991). Table 1 summarizes specifications and characteristics for a variety of commercial software packages which address some components in geoinformatics. Special emphasis was put on remote sensing, GIS, and mapping packages. It can be observed that most systems run on workstations or PCs (or both). It should also be noted that the major software houses such as ESRI, ERDAS, or Intergraph are using workstations as development platform. Mainframe and mini solutions are given less and less priority. The Vax as standard for geoinformatics software platform has been replaced by the UNIX workstation.

Table 1: Characteristics for Selected 'Geoinformatics' Software

System	Host Computer	Operating System	GUI [1]	Purpose [2]	Networking	Functionality [3]	First Introduced
Alexander	Archimedes	RISC-OS	yes	E	yes	RS	1991
ARC/Info	Mainframe VAX Workstation PC	 VMS UNIX MSDOS		P	yes	GIS (RS: ERDAS)	1982
ARGIS 4GE	Mainframe Mini Workstation	 UNIX		P	yes yes	GIS	
Cart/O/Graphix	Macintosh				yes	DM	
CATLAS	PC	MSDOS		P		GIS (+RS)	
DIPIX	VAX	VMS		P		RS	1979
DIRIGO	Macintosh	MacOS	yes	E		RS	1989
DMS	PC PS/2	MSDOS OS/2	yes	P/E		RS+DM	1987
Decision Images	PC	MSDOS		P		RS	
Dragon	PC	MSDOS		E		RS (+GIS)	1985
Easy Pace (PCI)	Mainframe Mini Workstation PC	 VMS UNIX MSDOS	yes	P	yes	RS (+GIS)	
ELAS	VAX PC	VMS MSDOS		E/P E		RS RS	
ERDAS	VAX Workstation PC	VMS UNIX MSDOS		P	yes	RS +Raster-GIS (Vector-GIS: Arc/Info)	1979
GDS	DEC	VMS		P	yes	CAD (+GIS)	1980
Gems36	Workstation	UNIX	yes	P	yes	IP toolbox	1989
GeoBlocks	VAX Sun PC	VMS UNIX MSDOS	 yes	P	yes	GIS	1990
GIMMS	Mainframe VAX PC PS/2 Macintosh	 VMS MSDOS OS/2 MacOS		P		GIS (+RS)	
GRASS	Workstation	UNIX		P		GIS	
Idrisi	PC	MSDOS		E		GIS	1987
I^2S	VAX	VMS		P		IP+RS	
ILWIS	PC	MSDOS		P/E		GIS + RS	1988
LaserScan	VAX	VMS		P		GIS	1985
MapInfo	PC	MSDOS		P/E		GIS	1986
MicroStation (Intergraph)	Clipper PC	UNIX MSDOS	yes	P P/E		GIS + RS GIS + RS	1989
PCIPS	PC	MSDOS		E		RS	1984
SICAD	Siemens Workstation			P	yes	GIS + RS	1978
Spans	PS/2	OS/2	yes	P/E		GIS	1985
Strings	PC	MSDOS		P	yes	GIS	1979
TCL image	Mini Workstation Macintosh	 UNIX MacOS	 yes yes	P	yes	IP Toolbox	1982 (TIPS) 1986 (TCL)
Terra-Mar	PC Workstation	MSDOS UNIX	no	P		RS (+GIS)	1980
Tigris (Intergraph)	Clipper (Workstation)	UNIX	yes	P		GIS + RS	1988

1) GUI - Graphics User Interface

2) P - Professional System, E - Educational System

3) GIS - Geographic Information System, DM - Digital Mapping, RS - Remote Sensing, CAD - Computer Aided Design, IP - Image Processing, GIS + RS - Integration of GIS and RS, e.g. in terms of number of functions or level of integration, GIS (+RS) - Integration not yet achieved, though on its way; includes few RS functions under same interface as GIS or good conversion possibilities to a RS package.

CONCLUSION

Advances in computer hardware and software for GIS, image processing, digital photogrammetry and digital cartography are leading to the development of systems for integrated geoinformation processing. Boundaries between remote sensing analysis and digital photogrammetric image processing are already hard to define. The same holds true for remote sensing/GIS or digital cartography/GIS. The emergence of standards and the ever-increasing processing, storage and display capabilities of modern RISC based CPUs is sees as a catalyst for the development of integrated geoinformatics workstations.

REFERENCES

Advanced Imaging, 1990. "Buyers Guide 1991", December 1990, 78 p.

Anderson, P., 1991. Virtual Reality: is it for Real? "Advanced Imaging", June 1991, pp.46-48.

Barwinski, K. and F. Petersohn (Eds.), 1991. "Surveying Education in a Global Environment", Atlantic Institute Think Tank, berlin, Germany (to be published).

Ehlers, M., 1991. Digitization, Digital Editing and Storage of Photogrammetric Images. "Photogrammetric Week", Stuttgart, Germany (in press).

Ehlers, M. and S. Amer, 1991. Geoinformatics: an Integrated Approach to Acquisition, Processing and Production of Geo-Data. "Proceedings, EGIS '91", Brussels, Belgium, pp.306-312.

Ehlers, M. and L. Blesius, 1991. Progress in Image Processing Workstations for Remote Sensing. "ISPRS Conference on Digital Photogrammetric Systems", Munich, Germany (in press).

Ehlers, M., G. Edwards and Y. Bedard, 1989. Integration of Remote Sensing with Geographic Information Systems: A necessary Evolution. "Photogrammetric Engineering and Remote Sensing", Vol.55, No.11, pp. 1619-1627.

Faust, N.L., J.L. Star, and W.H. Anderson, 1991. Integration of Remote Sensing and GIS: Future Computing Environment. "Photogrammetric Engineering and Remote Sensing", Vol. 57, No. 6, pp. 655-668.

Groot, R., 1989. Meeting Educational Requirements in Geomatics. "ITC-Journal", No.1, pp.1-4.

Parker, H.D., 1989. GIS Software 1989. A survey and Commentary. "Photogrammetric Engineering and Remote Sensing", Vol. 55, No. 11, pp.1589-1591.

Sader, S.A. and J.C. Winne, 1991. Digital Image Analysis Harware/Software Use of U.S. Forestry Schools. "Photogrammetric Engineering and Remote Sensing", Vol. 57, No. 2, pp. 209-211.

Star, J.L., J.E. Estes and F. Davis, 1991. Improved Integration of Remote Sensing and Geographic Informations Systems: A Background to NCGIA Initiative 12. "Photogrammetric Engineering and Remote Sensing", Vol. 57, No. 6, pp. 643-645.