Commercial And Publicly Available Digital Image Processing Systems

Introduction

Many commercial companies provide and actively market digital image processing systems. Some companies provide only the software, while others provide both proprietary hardware and software. Public Government agencies such as NASA, NOAA, and the Bureau of Land Management as well as universities such as Purdue and Clark Universities have also developed digital image processing software. Most public systems are available at minimal cost. Several of the most widely used and commercial and publicly available digital image processing systems and their associated capabilities are summarized in Table 1.

Selected Commercial and Public Digital Image Processing Systems and their Functions

(X = moderate to significant capability; O = moderate capability; no symbol = little or no capability)

Systems	Operating System	Preprocessing	Display & Enhancement	Information Extraction	Lineage
Commercial Systems					
Adobe Photoshop	DOS/Mac/UNIX	O	X		
CAD Overlay GIS	Dos	O	O		
CORE HardCore	Dos/UNIX	O	O	O	
Core ImageNet	Dos/Unix		O	O	
Decision Images	Dos	X	X	X	
EarthView	Dos	X	X	X	
EIDETIC	Dos	O	O	O	
ESRI Arc-Info GRID	UNIX	O	O	O	
Dragon	Dos	X	X	X	
ERDAS Imagine	Dos/UNIX	X	X	X	X
ER-Mapper	UNIX	X	X	X	
GAIA	Macintosh	O	O	O	
GENASYS	Dos/UNIX	X	X	X	
GenIsis	Dos	O	O	O	
Global Lab Image	Dos		X	O	
GRASS	UNIX	X	X	X	X
IDRISI	Dos	X	X	X	
Intergraph	UNIX	X	X	X	X
PCI	Dos/UNIX	X	X	X	
R-WEL	Dos	X	X	X	
MacSadie	Macintosh	X	X	X	
MicroImages	Dos/UNIX	X	X	X	X

MOCHA Jandel	Dos/Windows	X	X	X	
Orthoview	UNIX	X	X		
SPANS GIS/MAP	Dos/Mac	O	O	O	
VISILOG	Dos/UNIX	X	X	X	
Public Systems					
C-Coast	Dos		X	X	
Cosmic VICAR-IBIS	UNIX	X	X	X	
NOAA	UNIX	O	O		
EPPL7	Dos	O	O	O	
MultiSpec	Macintosh	X	X	X	
NASA ELAS	UNIX	X	X	X	X
NIH-Image	UNIX		O		

Consultants & Software Distributors (Old Information)

Active Imaging, Inc.
Aerial Images, Inc.
AeroAstro Corporation
The Alaska SAR Facility
AM Productions
Analytical Spectral Devices, Inc.
Atlantis Scientific Systems Group
Autometric, Inc.
F.G. Bercha & Associates Ltd.
DataQuest, Inc.
Earth Resource Mapping
Earth Satellite Corporation
EarthWatch, Inc.
ENVI Software
EOSAT
ERA-Maptec
ERDAS, Inc.
ERIM
Eurimage
Finnish Remote Sensing Ltd.e
GDE Systems, Inc.
Geospace
Hegyi GeoTechnologies International, Inc.
IDL Software
ImageNet
Image-Pro Plus
Intergraph
Intermountain Digital Imaging

Khoros Software
Kongsberg Spacetec
MacDonald Dettwiler
MicroImages, Inc.
MultiSpec Image Processing Software (Purdue Univ.)
NORUT Information Technology Ltd.
Opto-knowledge Systems, Inc.
Orbimage
PCI
RADARSAT
Satellite Observing Systems Ltd.
Satlantic, Inc.
SeaSpace Corporation
Christian J. Stewart Consulting
The Stock Solution
Technicla Research Associates, Inc.
TIMWIN Image Processing Software
Tromsoe Satellite Station
Vexcel Image Information Engineering
VICAR Image Processing System
VYSOR Integration, Inc.

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Image Processing System Considerations When working with or selecting a digital image processing system the following factors should be considered:

- the number of analysts who will have access to the system at one time
- the mode of operation
- the central processing unit (CPU)
- the operating system
- type of compiler(s)
- the amount and type of mass storage required
- the spatial and color resolution desired

Figure 3-1 depicts a typical networked digital image processing laboratory configuration and peripheral devices for the input as well as hardcopy output of remotely sensed data. These elements are discussed in further detail throughout this module.

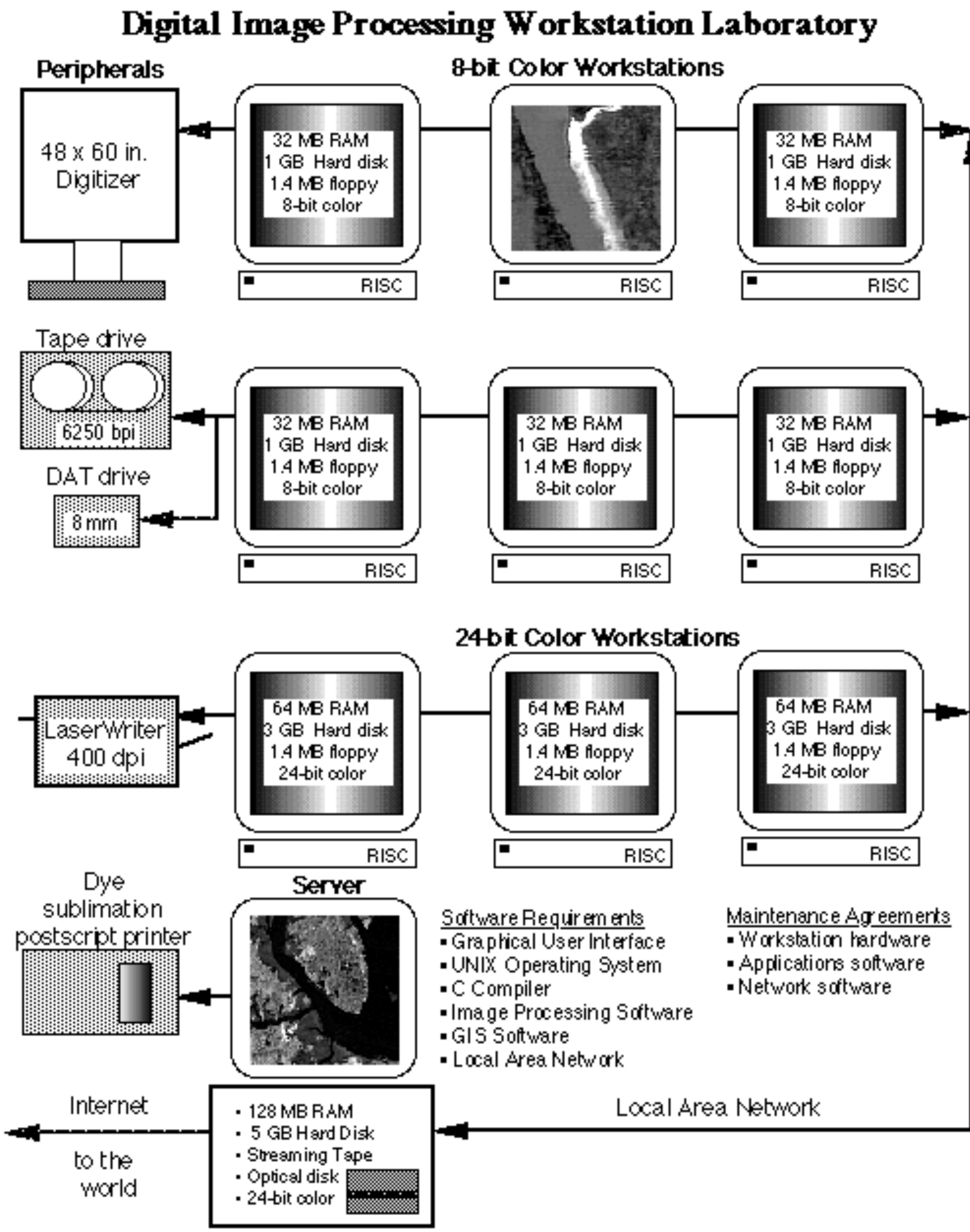

Figure 3-1. A hypothetical digital image processing laboratory consisting of 8-bit and 24-bit color workstations. Reduced instruction set (RISC) computer workstations and peripheral devices (e.g., digitizer, tape drives, dye sublimation printer) communicate via a local area network (LAN). Communication with the outside world is via Internet. Each workstation has sufficient random access memory (RAM) and hard disk space. UNIX is the operating system of choice in this

workstation environment. Digital image processing and GIS software ideally reside on each workstation (increasing the speed of execution) but may reside on the server. Compilers and network software normally reside on the server. Large remote sensing data sets may be placed on the server and accessed by all workstations, minimizing redundant data storage (Jensen, 1996).

Number of Analysts and Mode of Operation

A number of analysts must often have access to the image processing facilities, especially in an educational or research laboratory environment. Consequently, the number of analysts assigned to each workstation may range from one, which is exceptional, to perhaps five, which is inadequate (Sader and Winne, 1991). Furthermore, it is ideal if the image processing takes place in an interactive environment where the analyst selects the processes to be performed using a graphical user interface, or GUI (Campbell and Cromp, 1990). Most sophisticated image processing systems are designed with a friendly, point-and-click GUI that allows rapid selection and deselection of images to be analyzed and the appropriate functions to be applied.

In most work environments, digital image processing workstations are networked to each other. This configuration allows the analyst at a workstation to (1) obtain a copy of the remote sensor data and applications programs from the file server and process it independently at the workstation and (2) access any peripheral on the local area network. Each workstation has its own central processing unit (CPU) and image processor memory that stores the remotely sensed displayed on the CRT screen. This allows very rapid digital image processing to take place.

Central Processing Unit (CPU)

Digital image processing of remote sensor data requires a large number of central processing unit (CPU) operations. The CPU is burdeneed with two major tasks: numerical calculations and input-output to peripheral mass storage devices, color monitors, printers, and the like. Therefore, it is necessary to have a CPU that can manage data efficiently.

Operating System and Compiler

The operating system and compiler must be easy to use yet powerful enough so that analysts may program their own algorithms and experiment with them on the system. It is not wise to configure an image processing system around an unusual operating system because it becomes difficult to communicate with certain devices and to share applications with other scientists. Most workstations use the UNIX operating system, while most personal computers use DOS, Windows, or Windows NT. UNIX has exceptional networking capabilities and allows wasy access to a variety of peripherals.

The compilers most often used in the development of digital image processing software are BASIC, Assembler, C, and FORTRAN. Many digital image processing systems provide a toolkit that more sophisticated analysts can use to compile their own digital image processing algorithms. The toolkit usually consists of primitive subroutines, such as reading a line of image data into core, displaying a line of data to the CRT screen, or writing the modified line of data to the hard disk.

Mass Storage

Digital remote sensor data are usually stored in a matrix format with the various multispectral bands (e.g., blue, green, red, and reflective infrared) in geometric registration one to another. Each picture element (pixel) of each band is usually represented in the computer by a single 8-bit byte (a value from 0 to 255). It is often desirable to make the remotely sensed data available to the CPU for immediate processing. The best way to do this is to plce the data on a ard disk where each pixel of the data matrix may be accessed at random and at great speed. For example, it is common to place a full SPOT multispectral scene consisting of three bands (each 3000 x 3000) on the hard disk. This requires 27Mb of storage space on the hard disk. Most workstation systems are now routinely configured with gigabytes of hard disk storage.

Image analysts have discovered that optical storage technologies now provide high-capacity, removable, direct-access, mass-storage devices.Optical disks can be written to, read, and written over again at very high speed. The technology used in rewritable optical systems is magnetooptics (MO), more accurately described as magnetically assisted optical recording. Optical disks can store gigabytes of data and represent an efficient storage media for archiving large collections of scanned aerial photgraphy or other types of remote sensor data. Much of the remote sensor data provided by SPOT Image Corporation and EOSAT are now distributed on optical disk media.

In addition to optical and hard disks, it is possible to use 9-track tapes (1600 and 6250 bpi), 1/4" tape, 4 or 8mm tape, or floppy disks to:

1 provide data input to the system

2 back-up the hard or optical disks

3 transfer data between workstations when a network is not in place

4 archive image data sets or applications software once a project is completed

CRT Screen Display Resolution

The image processing system should be able to display at least 512x512 pixels and preferably more (e.g., 1024x1024) on the CRT screen at one time. This allows larger geographic areas to be examined at one time and places the terrain of interest in its regional context. Most Earth scientists prefer this regional perspective when performing terrain analysis using remote sensor data. Furthermore, it is disconcerting to have to analyze four 512x512 images when a single 1024x1024 display provides the information at a glance.

CRT Screen Color Resolution

This refers to the number of gray-scale tones or colors (e.g., 256) that may be displayed on a CRT monitor at one time out of a palette of available colors (e.g., 16.7 million). For many applications, such as high-contrast black-and-white linework cartography, only 1 bit of color is required [i.e., either the line is black or white (0 or 1)]. For more sophisticated computer graphics for which many shades of gray or different color combinations are required, up to 8 bits (or 256 colors) may be required (Preston, 1991). Most thematic mapping and GIS applications may be performed quite well by systems that display just 64 user-selectable colors out of a palette of 256 available colors.

Image Processor Memory Required to Produce Various

Numbers of Displayable Colors.

1	2 (B&W)
2	4
3	8
4	16
5	32
6	64
7	128
8	256
9	512
10	1,024

11	2,048
12	4,096
13	8,192
14	16,384
15	32,768
16	65,536
17	131,072
18	262,144
24	16,777,216