STRATEGIES FOR DEVELOPING PC-BASED EDITORIAL IMAGING SYSTEMS

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ABSTRACT

Editorial image systems have to be low-cost and easy to use in order to be accepted by editorial staff. This favours PC-based workstations in spite of their capacity limitations. This paper outlines strategies which have guided the development of such image systems for several clients at the Graphic Arts Laboratory of VTT. The benefits of close cooperation with user customers are pointed out. The bottlenecks inherent in PC-based image processing as opposed to large-scale CEPS-systems are analysed. The paper concludes with descriptions of two current systems and their development: an image archiving system (FINSCA) and a videoprint system for videograbbed still pictures (TOTI-VIDEO).

1. INTRODUCTION

The history of digital image processing at VTT/GRA is fairly straightforward - i.e. about 11 years starting in 1978 with a TAGA paper [1] and with the purchase of the first system (an Optronics output scanner and a PDP 11/34 minicomputer). We used the system jointly with with the Graphic Arts Technology Laboratory of the Helsinki University of Technology (HUT).

The system was later completed with image software, commercially available and produced in-house, communication interfaces, peripherals (scanners, including Hell DC300, videocameras and videoprinters) and, finally, with new computers - a Comtal Vision 1/20 image workstation and a Vax 11/750 as the host.

A lot of systems research and software development was performed by the staff of VTT and HUT. Research work was published for academic credit in many cases [1-6]. There was very little interest and courage to use digital image processing in the graphic arts industry in the late 1970s but we hoped and thrusted that things would change.

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From 1981 to 1988 around 60 CEPS systems were installed in Finland alone - a very high density for a nation of 5 million. Now that the sales of CEPS systems are rapidly decreasing, the future seems to be with smaller and more standard systems. Especially the editorial office and its multi-expert staff need PC-based workstations, which they already know from text input and info-graphics applications.

We started the development of PC-based image systems about three years ago, i.e. in 1986. Experience in minicomputers and a number of existing coded algorithms were the starting points. MS-DOS computers were at that time becoming a standard and the recently emerged image processing boards were easily attached to the PC-bus.

The first prototype of the videoprint/archiving system called KALEIDO [7] was demonstrated in the middle of 1987. After this stage we offered the system for commercializing to the two companies presented at the end of this paper. Needless to say that major companies were less interested in such special applications as editorial videoprint and archiving. The obvious reason for this is that the product is too small (cheap) and the market unscreened.

During the development of the systems between 1986 and 1989 the bottlenecks of the mid 1980s have disappeared one by one. The processor power, low-cost scanners, portable video camcorders, page description languages, digital fonts, optical mass memories (WORM) and videoprinters allow a moderate-priced approach using highly standardized and available modules. We do not claim that everything has become very easy, but it is now possible to approach the *ultimate goal* - a cheap, standard, easy-to-use and easy-to-tailor image system.

2. MODULES FOR IMAGE SYSTEMS

Today the choice of various modules and systems architectures seems enormous. The main problem with system integration is the selection of the most viable and compatible components in each case. Typical systems and modules include.:

* Components of and interfaces to the existing CEPS systems
* Dedicated workstations (e.g. Quantel, Graphex)
* Unix workstations (Unda, CCI, Crosfield)
* PC-based image stations (NPS, Lightspeed, Avalon, Cambridge Computer, Quark Xpress, TOTI-VIDEO, FINSCA)
* Page-makeup systems (Ventura Publisher, PageMaker)
* Font systems (Bitstream, Compugraphic, Ikarus)
* Page description languages (PostScript, Interpress, ACE)

Typical hardware components are various peripherals, processing and networking tools:

* Input scanners (Howtek, Datacopy, Eikonix)
* PostScript printers (Varityper/AM, Agfa, Autologic)
* PostScript imagesetters (Autologic, Compugraphic, Linotype,

Varityper/AM, ECRM)
* Image processing boards (Truevision (VISTA, TARGA), Imaging Technology, Data Translation, Matrox)
* Parallel processor boards (Data Translation, Matrox)
* Optical WORM memories (ISI, OSI, Toshiba, Sony)
* Magnetic DAT memories (Gigatape)
* PC networks (Ethernet, IBM Token Ring, Starlan)

The above lists are typical examples rather than a complete survey. This product spectrum keeps developing and widening at a very promising pace. A suitable combination of the central modules has to be found for system development almost every year.

3. USER REQUIREMENTS

The editorial staff works under hard time pressure. Therefore, their tools have to be easy to learn and to use. Traditional CEPS systems have been much too cumbersome in this respect. The PC-based solutions give great promise, because they can draw on the advanced graphical user interfaces of the machines.

The *response time* has to be short enough not to interfere with the working rhythm. This is hard to achieve in image processing, because of the huge amount of data to be handled. In CEPS systems, the normal solution is to run the heavy processing in the background and to operate on a minified display version of the picture in real time. The serious PC-systems will have to adopt the same strategy until the processing power has grown tenfolds.

Other important user requirements are *easy interfacing* and *expandability*. Both features depend on how well the workstation adapts to official and *de facto* standards. The PC is here in a favourable position because of the dominance of the giants IBM and Apple which set the practical standards.

4. CAPACITY AND QUALITY BOTTLENECKS IN PC IMAGING

4.1 Resolution

In the beginning PC imaging was limited to video resolution both in image capture, processing and output. This has changed, however. There are now flatbed scanners on the market which digitize variable-sized originals with up to 4,400 lines. This is about the same as the resolution of the CEPS drum scanners. Even so, video is still a plausible image source in low-quality printing, e.g. in newspapers. The coming HDTV technology with its fivefold resolution will bring video into high-quality work as well.

You can also get programs for your microcomputer - both in the IBM and Mac world - that handle this huge amount of scanned pixels. Some programs deal with as many as 32,000 x 32,000 pixels. The second-generation image memory boards hold tens of MB of RAM storage, which speeds up the processing.

PC-based imaging systems usually output to a type of phototypesetters called imagesetters. The resolution of these devices is at least the same as drum scanners. Altogether, the resolution bottleneck has disappeared from the PC imaging scene.

4.2 Speed

Speed is a critical factor in all the phases of PC imaging. At high resolutions flatbed *scanners* are still clearly slower than drum scanners. The *processing* of big images is mostly slow, because special processors are seldom used and because of the limited speed of the internal buses and the hard disks. Therefore, some CEPS systems process images considerably faster due to the special hardware architectures.

Nonetheless, PCs are catching up - the bottleneck of the AT-bus bandwidth is removed with image boards which have their own bus connections to additional memory and processing boards.

Outputting on PostScript-controlled xerographic printers and imagesetters is also time-consuming, even if faster Raster-Image-Processors (RIPs) speed it up to the point where the raster process is in real time.

4.3 Output quality

The outputting of b/w halftones on 600 dpi xerograhic printers is almost feasible for newspaper quality. Imagesetters are required for higher quality (1000 - 4000 dpi). This works well for black and white, but colour still causes problems. The screening of colour separations in PostScript is currently not accurate, because arbitrary angles and line densities cannot be selected. Only a few screen dot shapes are available in colour PostScript.

In addition, imagesetters have problems in registering the colour separations accurately. However, there is no doubt that these quality defects will be overcome in the near future, which means that the CEPS drum output scanners really will be challenged.

Another factor affecting the quality is the matching of the colours on the monitor to the colours printed. Unlike the CEPS systems, the current PC systems lack procedures for this matching. The adoption of selfinspecting monitors, type Barco, into PC imaging will bring solution to the problem.

4.4 Communication networks

Fast and reliable image transfer between the image workstations is important. All PC networks (Ethernet, Starlan, Token Ring) are baseband solutions, which means that one data stream consumes the full frequency bandwidth of the wire. The bandwidth of

Ethernet is 1.25 Mbyte/s. Current Ethernet cards with related software do not utilize the entire bandwidth - the real may be as low as 100 KByte/s. As a typical IBM AT or compatible reads/writes data through DMA with the bandwidth of about 2 Mbyte/s, the bottleneck of PC networks is not within the PC's structure but in the networking board. This separate board will be replaced in the near future by motherboards with inbuilt network capability.

All in all PC networks will be in a few years' time as efficent as the Unix-based workstation networks.

4.5 Operating systems

The *MS-DOS* operating system has a strong position in PC imaging because of the great availability of hard- and software drivers. Some of its former limitations, like the small adress space of the physical mass memory (32 MBytes), have been removed from the recent 4.0 version. The limited CPU memory is still a problem, but it is relieved by using second-generation image prosessing boards with big memories. The image processing software can be downloaded into the image memory of these boards.

A third classical limitation of MS-DOS has been the lack of multiprocessing. MS-Windows have already relieved this to an extent and *OS/2* will offer a more complete solution. *UNIX* is another solution already used in engineering workstations and in new innovations like Steve Jobs' NeXT-machine.

The user interface has been the hallmark of Mac machines. It has an attractive graphical user interface that in the near future will evolve into full colour through the extension of QuickDraw from 8 bits to 32 bits.

4.6 Application software

The software of conventional CEPS systems includes several hundred man-years of programming. PC imaging software has been created with much less effort. On the other hand, standard programs, e.g. graphical user interfaces and data management, can be used as building blocks in the PC environment. In this way, CEPS performance can be reached with considerably less programming.

5. TWO CASES OF DEVELOPMENTS

Our laboratory prototype, KALEIDO, demonstrated the capabilities of PC imaging to such an extent that two Finnish companies, *Finlandia-Arkisto* and *Monigraaf*, decided to commercialize it in the beginning of 1988. Our laboratory was contracted for the product development. The first products will be available in May 1989.

5.1 FINSCA image archiving system

FINSCA, the product of the picture publisher Finlandia-Arkisto, is a system for storing and retrieving large amounts of electronic images. It is based on a 32-bit supermicro equipped with a 330-MByte hard disk (*Fig.* 1). Images are entered from video sources as well as from a Datacopy scanning camera capturing up to 4,460 lines from variable-sized originals - both reflective and transmissive. TIFF- and TARGA-coded digital images are also accepted.

The images are processed - sized, tone-adjusted and pixel-edited - before being put into the archive. A modified DAT-recorder from Gigatape is currently used as the main mass storage medium. An optical videodisk station is also connected. An optical WORM system will be added in the near future.

The image is verbally indexed by filling a predefined form. This text description attached to the image is the basis of image management. Every word in the description is indexed. This enables full text retrieval, that has proven to be convenient in editorial use. Boolean search logic is used in the queries. The images that fit the query are laid out as mosaics on successive pages on the screen.

By pointing with a mouse at a minified image in the mosaic, it is enlarged up to the screen format. The verbal picture description is also displayed by pointing at the related picture.

Interesting pictures from subsequent retrievals are displayed for final selection. Pictures can be linked, which allows for browsing through the image database in a very intuitive way. Selected pictures are output on PostScript printers or forwarded to other systems using the TIFF-format.

Finlandia-Arkisto has set up a pilot digital archive containing around 40.000 photos - half of the collection of historical pictures from Finland (1942-1962). Most of the photos document the years of the Second World War. They were shot by the best Finnish press photographers and represent an important cultural heritage.

5.2 TOTI-VIDEO system

The TOTI-VIDEO system developed for Monigraaf gives the picture editor a possibility to incorporate video images into the printed products. A press photographer can then use a portable camcorder as a supplement to his film-based camera, thus trading picture quality for picture quantity and speed. Images may be captured from TV broadcasts as well.

For video capture, the TOTI-VIDEO uses the new Super-VHS technique, offering 400 vertical lines, good dynamics and separate luminance and chrominance. The digitized video signal is geometrically corrected, the greylevels are optimized and the faulty pixels are edited. The editing is done conveniently in the zoomed mode. Finally, the image is cropped and output on a PostScript printer in a selectable size.

Using 600-dpi printers and a 30 l/cm newspaper screen, 50 grey levels are reproduced. A higher-resolution output will be optional.

5.3 Experiences from the system development

Our experiences from these two cases show the importance of close cooperation between the research laboratory and the client company. The combination of different skills - in our case those of the image publishing business (Finlandia-Arkisto) and system development (VTT) - created a challenging atmosphere for the work.

6. CONCLUSIONS

The current development of imaging systems at VTT/GRA relies on three strengths - the algorithmic knowledge developed during the past decade, the knowledge about system components and their integration, and cooperation with vendor companies. Efficient work requires a dynamic environment for development consisting of the latest available tools. The success of research and development in this rapidly changing field depends primarily on an active interaction of major forces both in the scientific and business communities. An isolated researcher, albeit a genius, is in for troubble.

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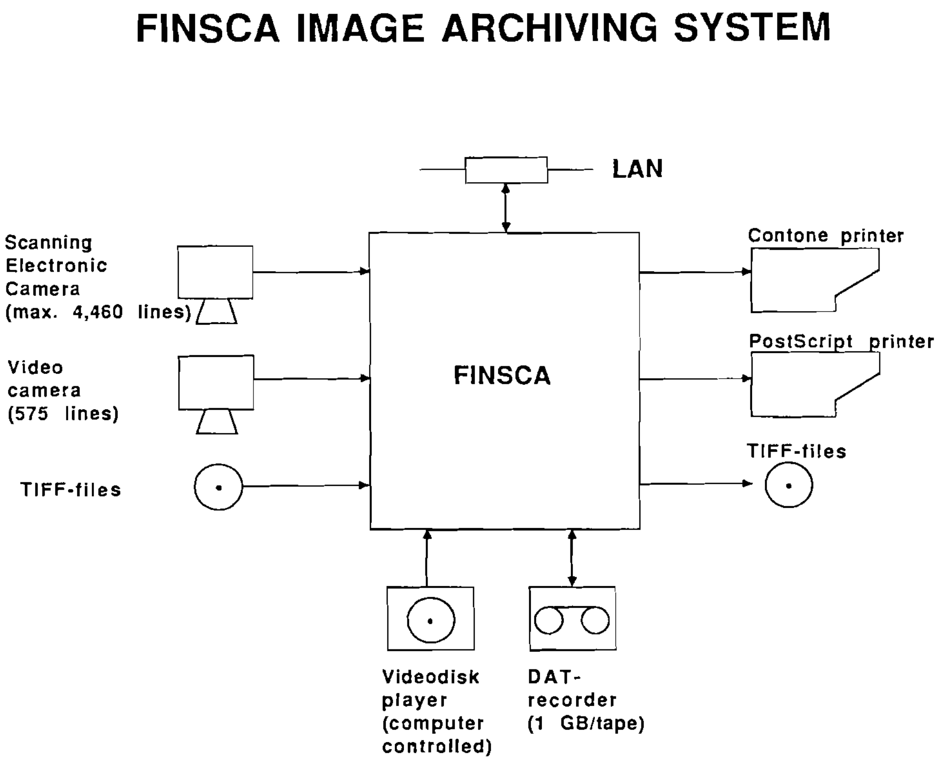

Figure 1. Scheme of the FINSCA system