A MULTIMEDIA SYSTEM FOR FILING AND PRINTING VIDEO PICTURES AND FOR AUTOMATIC ILLUSTRATION OF NEWS TEXTS

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Abstract: *A low-cost multimedia system KALEIDO has been constructed. The PC-based system manages electronic pictures gathered from different media and filed in the system. The system operator retrieves pictures from analog and digital optical memories in an interactive and visual way. The pictures are digitally processed and output on phototypesetters or as colour separated screened films on CEPS systems. Pictures may also be retrieved automatically from the storage to illustrate news texts on the basis of text analysis. KALEIDO enables editors in graphic arts companies to use video sources, like TV broadcasts, videotapes and videodisks in their printed products. In addition to being a part of a graphical production process, KALEIDO can be used as an electronic picture store by museums, audiovisual companies, video producers, schools and a like.*

1. INTRODUCTION

Processing of images on computer was a few years ago a luxury for big organizations. Now, image processing is rapidly becoming a moderately priced add-on capability to commonly used personal computers. The progress made in semiconductor memories and optical storage is the main force behind this development. Coupled with rapid digital telecommunications, this opens up new patterns of image communication. Still pictures and video sequences will in the near future be accessed from databases and exchanged between PC owners with equal ease as text is handled today.

Electronic image databases are likely to be at first applied in the editorial work with newspapers, magazines and books, in TV and in video production. Some media houses have already started in this direction with computer based referential archives and videodisk based image catalogues. In a longer time perspective, companies, public institutions and households will retrieve video sequences both for informational and recreational purposes from central image banks. Parallelly, private electronic image archives will grow with downloaded material, computer graphics creations and pictures captured with private video cameras. The

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exchange between these different types of image databases will create unpredictable hobby activities and business opportunities.

Our image processing system, called KALEIDO (from the word "kaleidoscope" = rapidly changing scene), is an effort to set up a media experiment guided by a scenario of future communication tools /Söd 87/. Its purpose is to make the ideas explicite and more easy to communicate to potential users, developers and political descision makers. In short, KALEIDO manages electronic pictures gathered from different sources and stored in the system. The system operator retrieves pictures from the store, processes and outputs them primarily to a production scanner or to a phototypesetter for printing (*fig. 1*). Alternative output media are videotape and slide. Picture retrieval may also be automatic to illustrate texts obtained from a videotex data base.

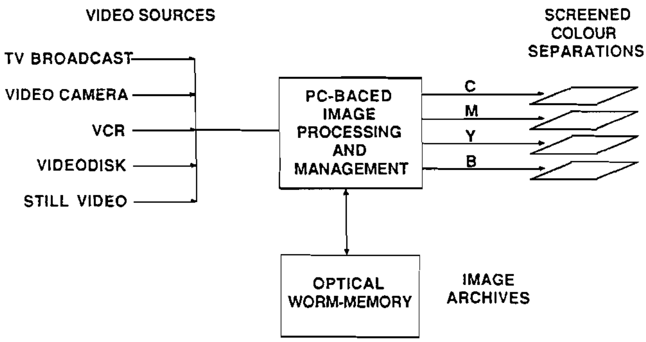


Figure 1. The principal elements of KALEIDO.

2. MULTIMEDIA COMMUNICATION

2.1 Definitions

The concepts relating to multimedia communication are oftenly used in a confusing way. When we call KALEIDO a *multimedia* system, we mean that it gathers and outputs information in two or more mass media. A multimedia system has to be distinguished from *multisensory* systems, that adress several human senses using a single medium like a videodisk. We further distinguish multimedia systems from *multipresentation* systems, in which certain sensory information has several presentations, e.g. audio information is presented as speech and music.

Multimedia systems can be divided into three categories - *media converters, retrieval systems* and *production systems*. The simplest category is media conversion, where information is gathered from one mass media and output into another as in a video printing process. Multimedia retrieval systems, that retrieve data from, e.g., videotex and videodisks, have multimedia input, but not necessarily multimedia output. A rather esoteric but very familiar example of this category is made up by a radio and a TV receiver with the sound turned away simultanously reporting, say, a sport event. Systems for multimedia production, which sometimes is called parallel publishing, have outputs into at least two media, e.g., to a phototypesetter and to an on-line database. KALEIDO embodies all three categories - (1) it converts video to print, (2) it retrieves picture data from several videosources and textual data from a videotex service and (3) it outputs pictures on phototypesetters, as screened film separations and on video tape.

2.2 Video to print converters

A conversion of special interest to the graphic arts industry is the transition from video to print. Video printing opens up a range of opportunities - news gathering with camcorders, publishing TV-pictures and other video material and as an input device to colour electronic production systems (CEPS). Dainipppon Print pioneered this development 1982 with their *VPS system*, which is implemented on proprietary hardware /VPS 82/. After this a couple of much cheaper *video copiers* have has emerged on the market from manufacturers like SONY /Mavi 86/, Hitachi /CTI 87/, Javelin /Jav 86/, Advance Images Devices Inc /Rin 85/ and Polaroid /Pol 86/. These printers are not designed explicitely for graphic arts applications and do not subsequenly produce professional quality nor offer possibilities for interactive quality improvement. The *add-on frame grabbers* to the CEPS, e.g. Newsframe from Crosfield, are bound to a certain equipment. The *design stations* from companies like Quantel, Networked Picture Systems and Imapro use video in an innovative way, but do not claim to compensate for the video coding errors.

KALEIDO aims to a be a converter, that is open for extensions, handles the video signal properly, offers on-line connections to CEPS, employs both automatic and interactive image correction and enhancement. In addition, it includes management of recorded video pictures.

2.3 Systems for multimedia information retrieval

NewsPeek constructed in the *Media Laboratory* at the Massachusetts Institute of Technology is an innovative system for multimedia information retrieval /Lip 85/. It continously scans public databases for text material according to a personalized search profile. Pictures of persons and maps illustrating the news are automatically called up from a local videodisk. The material is presented in a format similar to that of a newspaper.

The *information kiosks* used for tourist and hotels and points-of-purchase in warehouses and travel agencies are typical multimedia informational retrieval systems applying videodisk and videotex media. /IL 86/ gives several French examples of kiosks linking videodisks to the Minitel videotex service.

Several multimedia retrieval systems have been built for advicing in professional and hobby activities, see e.g. /EPR 85/, /John 86/.

KALEIDO differs from the information retrieval systems mentioned above, because it employs a high degree of PC based image processing. This enables KALEIDO to create more informative displays than if analog video was used.

2.4 Systems for parallel publishing

More and more publishers are becoming parallel publishers by offering their typesetting database as an on-line service or as CD-ROM. Annual volumes of magazines, like Canadian *Globe and Mail* and *Data Times* in Oklahoma, U.S.A., are available both on optical CD-ROM and on-line.

The electronic delivery of newspapers and magazines for local printing will in the future become a more and more realistic supplement to physical distribution. A current example of this trend is the pilot experiment SELFAC (SElective FACsimile), that the European newspaper association *IFRA* (INCA-FIEJ Research Association) and *IPTC* (International Press Telecommunications Council) have launched /IPTC 86/.

KALEIDO is an instrument for parallel publishing, because the images are output both in print media (paper,film) and on videotape, which can be used for producing a videodisk. This feature will be utilized in a spin-off project together with Finlandia-Arkisto Oy (see Section 8).

3. PICTURE FILING IN KALEIDO

The picture management in KALEIDO is based upon text descriptions of the pictures. It is made up of a commercial information retrieval package, a carefully prepared picture indexing scheme and a image processing unit.

3.1 Image retrieval software

Micro-STATUS from UKAEA (United Kingdom Atomic Energy Agency) /Mic 85/ was selected to form the base of the picture management in KALEIDO This program makes free text retrieval possible.

The database is handled as a continuous piece of text divided by markers into chapters, articles, named sections and paragraphs. The scope of the search can be limited to these parts. The location of every word in the text is brought to an inverse index and can therefore be searched for in the retrieval. Boolean retrieval is used. Sorting of attribute values, positional queries, synonyms and command macros are provided for in STATUS.

3.2 Indexing

The indexing in KALEIDO is designed both for visual retrieval and referential archives. Even if the attributes are the same in both cases, the picture descriptions have to be more detailed in the referential database than in visual databases, where the picture can be inspected.

Every image is described by an *article* in the STATUS text database (*fig. 2*). Pictures with common features are collected into *chapters*. Picture attributes are represented as *named sections*. Attributes are logically divided into *fields* separated by comma even if STATUS does not recognize this division and the field names are not prompted. Fields to be sorted are declared as *keyed fields*.

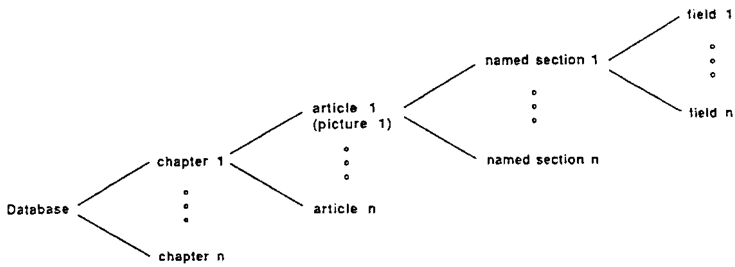


Figure 2. The organisation of the STATUS based image database.

The following attributes were selected in the picture description (*fig 3*). All attributes are expressable in free text, even if consequent indexing usually demands a fairly restricted vocabulary. The fields with an asterisk are sortable keyed fields.

- IDENTIFICATION PATH *)	A unique address of the picture also expressing the storage method. Form: /storage de<vice/memory identification (nr,side)/address.
- TOPIC CLASS	A modificated UDC classification is adopted.The classes are expressed either as words or as numerical codes or both. Free format information may be supplemented.
- EVENT	The context of the snapshot giving the meaning to it.
- PERSON(S)	Fields like name, profession, nationality,

sex.

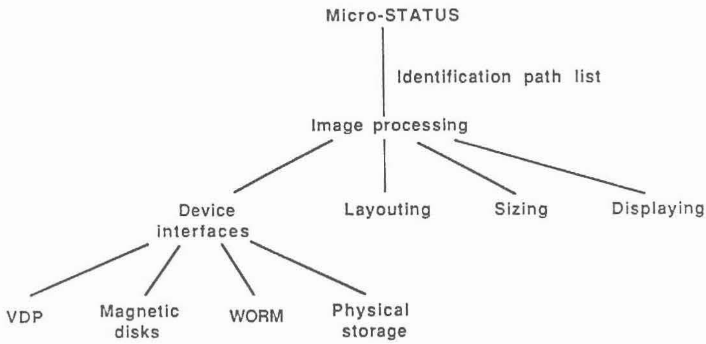
- GROUP	The social groups, that the persons belong to, e.g. profession.
- IMAGE DETAILS	A description of picture content centering on concrete objects.
- PLACE	Geographical location like country, town, part of the town.
- TIME	Fields like date*, time, week, day and holiday.
- PHOTOGRAPHER	Name, profession, address, telephone.
- PICTURE TYPE	Notations like b/w, colour, negative, chart, drawing, aerial, paper proof, dimensions, material (e.g. glass).
- COPYRIGHT	The copyright holder. Fields like name, address, telephone, fee.
- ORIGINAL	The owner of the original.
- DATE OF LOANING	The date, when the picture was borrowed.
- BORROWER	Name, adress, telephone.
- FILING DATE	The date, when the picture arrived to the store.
- COLLECTION	A collection of pictures like a theme in a video sequence. Fields like collection name, video theme duration, number of scenes, the adress of the private collection.
- PUBLICATIONS	The publications in which the picture has been published. Fields like publication name, number, date, article name, article writer and captions.

Figure 3. The attributes used in the picture descriptions in KALEIDO.

3.3 Displaying the retrieved pictures

When STATUS has retrieved the set of picture descriptions defined in the query, it passes the identification paths mentioned in the descriptions to the image processing program (*fig. 4*). This module calls up the corresponding pictures on the screen in minified form so that all retrieved pictures fit into a 'checker-board' pattern. Any displayed picture may be chosen for closer inspection by pointing on it with the cursor after which it is displayed in full size by rereading it from the storage.

The relevant pictures from one query can be brought to an intermediate storage waiting for a final visual comparision, when all queries have been done. The finally selected picture can be processed and output.



4. TECHNICAL DESCRIPTION OF KALEIDO

4.1 Overview

KALEIDO is based upon an enhanced standard personal computer, IBM AT, with a set of interfaces to image and text sources and output devices (*fig. 5*).

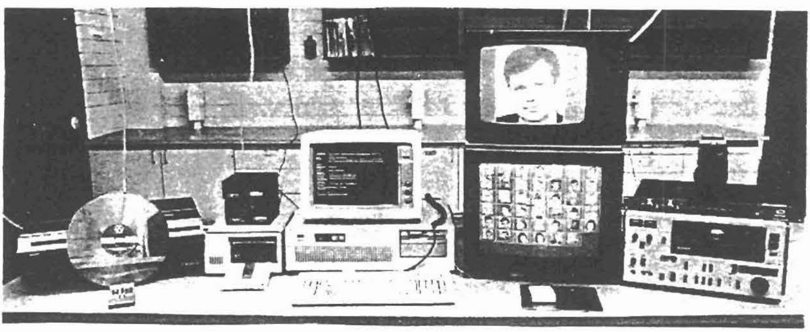


Figure 5. Photograph of the KALEIDO system.

Colour images are fed into the system from four video sources; television broadcast, videocassette recorder, videodisk player and video camera. The videodisk player and the videocasette recorder are under computer control (*fig. 6*). Text, mainly news text, is accessed from a videotex service in Helsinki.

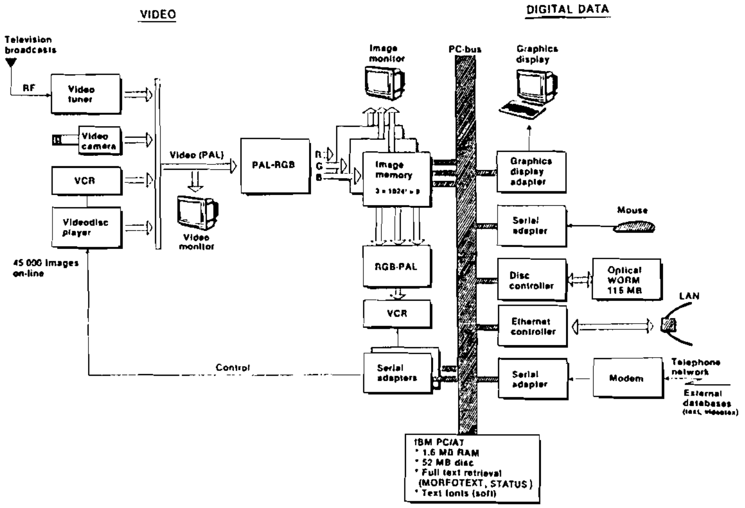


Figure 6. A functional diagram of KALEIDO.

The composite video signal is decoded into red, green and blue signals in a PAL-RGB decoder. The signals are then parallelly digitized in real time and put into the image memories. The digitized picture is after D/A-conversion displayed on a RGB-monitor, which is connected to the three frame store boards. Text retrieved over telephone lines as well as graphics are written into the image memories and displayed together with the images.

Digital pictures can be input from other image processing systems via local area networks (Ethernet or AppleTalk). The pictures are stored on magnetic winchester disks or on a write-once optical disk.

After processing, the image is output either on a PostScript printer (xerographic or typesetter) through the AppleTalk interface, or through the Ethernet network on the Hell DC 300 scanner as screened film separations, from which a Cromaline proof or a printing run is made. In summary, the total process is the following (*fig 7*).

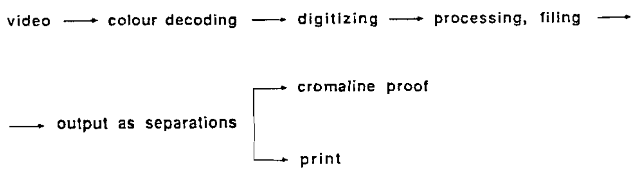


Figure 7. The image flow in KALEIDO.

Some video pictures are printed in this publication.

4.2 Image processing

The image processing modul consists of three identical PIP-1024 plug-in cards from Matrox Electronics /PIP 85/. Each card holds an image of 1024 x 1024 pixels 8 bits deep. The PC controls the operations of the PIP through read and write accesses to the PIP's internal registers.

The cards are put to work in parallel by assigning the green card as the master and the two others as slaves (*fig. 8*). The master gets its syncronization pulse from either the green video signal or from a separate syncronization input and passes the sync on through the sync bus to the two other cards. In this work separate syncronization has been found to give better results.

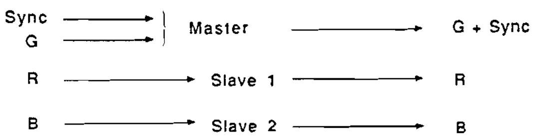


Figure 8. The combination of three PIP-1024 cards for colour operation.

The analog input is in the A/D converter subject to an adjustable DC offset voltage, that along with the gain parameter allows the user to centre any portion of the video signal in the operational range of the A/D converter. The gain adjusts the amplitude of the input signal.

The determination of gain and offset values turned out to be a laborous task. The TV test chart was an important calibration tool, as it states the RGB-balance in different parts of the picture /YLE 76/. Unfortunately , the values got in this way for the TV broadcasts could not be used for the three other video sources. The video recorder signal was calibrated from a recorded TV test chart. The video camera and the videodisk signal had to be calibrated heuristically.

After A/D conversion the signal is fed through an input lookup table (LUT) into the image memories. No tone rendering is normally done in this stage. Similar LUTs are on the output side. In fact, there are three output LUTs per card enabling pseudocoloring, but in this work only one of these is in use.

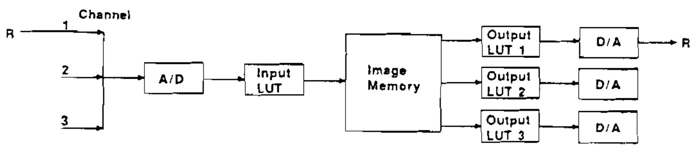


Figure 9. The pixel flow in the PIP card. In this example the red signal is fed into channel one.

Both the PC and the CRT controller have simultaneous transparent access to the frame buffer. This prevents the screen going black, when the frame buffer data is manipulated. The image memory area shown by the CRT controller is programmable. During this work, it was found, that all visible 575 lines of the PAL picture plus one unvisible line are shown in the 512 x 576 display window. The display window can be positioned in the 1024 x 1024 memory horizontally with 8 pixel and vertically with 16 pixel precision. The normal display area is upperleft, the remaining memory being work space (*fig. 10*).

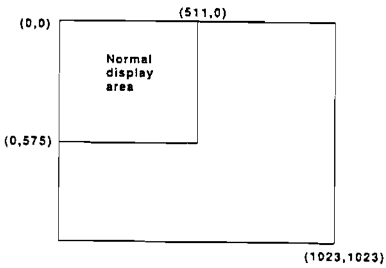


Figure 10. The allocation of the PIP-memory.

The frame grabbing always operates upon the picture displayed i.e. the grab and display functions are interlocked by using common memory adresses. Thus the resolution of the digitized picture is also 512 x 576 pixels. This interlocking of grabbing and display makes it impossible to perform frame grabbing as a background task to avoid annoying visual interrupts.

Data that are written from the PC bus to the PIP pass through a bit mask. This mask is set up through software and enables the user to selectivly write data from the PC to any combination of the eight bit planes of the image memory. In this work this mask function was used to form the cursor and text/graphics overlays.

The PIP-unit does not include explicit capabilities for handling graphic overlays and cursor, that are compulsory for any image processing system. The image memories have to be specially configured for this.

Each of the three image memories has been organized into three parts - two graphic overlay planes (bitplane 0 - 1), the cursor plane (bitplane 2) and the image (3 - 7) (*fig. 11*). This organization allows for 2^{15} = 32768 shades of colour to be used for the image.

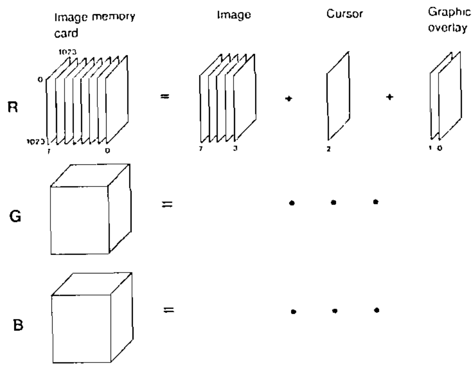


Figure 11. The organization of the image memories.

4.3 Peripherals

To expand the picture filing space behind the 52 MB of the two hard disks an *optical WORM disk drive* ISI 525 from Information Storage Inc. is included. The memory resides in a separate box connected to the PC-bus by a plug-in controller card. The removable 5.25'' disk holds 115 MB of formatted and error-corrected digital data on each side. The transfer time is about the same as with hard disks, i.e. a 512x575x24 video picture is read from the disk into PIP in 13 seconds. The writing time is considerably longer.

In order to rapidly exhange picture data with external systems interfaces to *local area networks (LAN)* are needed. Interfaces both to *Ethernet* and *AppleTalk* networks have been built. In our laboratory images are sent from KALEIDO through the Ethernet to a VAX 750 computer for further processing and to a PDP 11/34 for output on a colour separation scanner. The AppleTalk interface is used for outputting images to PostScript compatible xerographic printers and phototypesetters.

The *videodisk player* is put under computer control through a serial RS232 port, that allows for remote searching for a certain frame. Each frame is found within 5 seconds. The picture found is frozen into the PIP framebuffer for display. A Low Band U-Matic *videocassette recorder* is operated from the computer through its parallel port. Single frames are adressed with the aid of a time coder, that marks the number of the frame into one of the two audio tracks. The time coder communicates with the PC through the serial interface. When the picture with the requirred frame number is on play, the picture is grabbed.

A modem card is used for downloading texts from a videotex database. The videotex message is stripped from graphics in the processing.

4.4 Image output

The images are converted to two kinds of hardcopy - to black and white output from phototypesetters or xerographic printers and screened colour component films on the Chromagraph DC 300 B from Dr.-Ing. Rudolf Hell GmbH. This scanner is originally a stand-alone device, that has been interfaced at the research institute to the PDP 11/34 computer /Tuo 83/. In addition, the video image can dumped on tape at a computer determined location.

4.5 Software

The operation system is MS-DOS Revision 3.2 from MicroSoft. The software is mainly written in MicroSoft C. Computationally heavy operations like size changes are in IBM Assembler, which allows for execution times in the range demanded by interactive applications. In addition, some auxiliary programs are coded in Pascal.

The KALEIDO software seen through the user perspective offers the following main options, which are selected from menus on the RGB monitor *(fig 12)*.

Figure 12. The main commands in KALEIDO.

5. VIDEO PRINTING

The video printing process is divided into three stages - digitization, removal of video coding errors and matching of print colours to video colours.

5.1 Calibration of the digitization

The digitization is calibrated by setting appropriate values for the offset and gain parameters of the A/D conversion for the three RGB signals. For TV and VCR-taped TV pictures, the calibration goal is to achieve the standardized RGB values of the received TV test chart signals /YLE 76/. The standard states the RGB values as voltages, but as the A/D-conversion is very near to linear, the digitized values are valid measures of the signal amplitude. The calibration is performed iteratively by inspecting the content of the image memories and adjusting the PAL-RGB decoder settings and the A/D-parameters correspondingly.

5.2 Removal of video coding errors

In order to remove the luminance crosstalk, an adaptive algorithm is used. This algorithm detects severe crosstalk errors in the picture and remove them by summing information from two successive fields. Owing to the adaptivity, resolution is only lost in some "lively" parts of the picture.

5.3 Matching video and print colours

Once the video signals are correctly digitized, the film output is calibrated. The work on colour reproduction carried out at the Helsinki University of Technology is relied upon /Lai 87/. Without going into details, the steps in the calibration process are the following:

0) The untransformed test picture is the starting point.

1) The picture is output on film as four screened separations (cyan, magenta, yellow and black using 100 % under-colour removal) and a Cromaline proof is made.

2) The CIE (Commission Internationale de l'Eclairage) colour coordinates of the red, green, blue and gray fields of the test bars are measured from the Cromaline proof and compared to the values stated in the TV standard.

3) The RGB values are transformed to the psychometric LABHNU colour space /Saa 87/.

4) The psychometric coordinates of the picture are transformed to minimize the deviations in step 2.

5) The transformed colour space is compressed, so that the inverse transform does not cause overflow.

6) The psychometric values are transformed back to RGB-values.

7) Steps 4 - 7 are repeated until the deviations in step 2 are minimized.

This procedure grants that the reproduced colours are good approximations of the objects pictured by the TV camera. This is because the TV cameras are tuned to produce the standardized CIE-coordinates for the saturated R, G and B colours and for gray. However, a weak point is the unlinearity of the colour LABHNU space. This introduces colour errors, when as little as three correcting vectors are used. By measuring the CIE values from the monitor with a spectroradiometer, more correcting vectors would be obtained and the unlinearity less disturbing.

6. IMAGE RETRIEVAL

A typical image retrieval run is depicted in *fig. 13*. For demonstration purposes, we uses a videodisk produced by the Finnish Broadcast Corporation holding the pictures of about 2.000 Finnish politicians. In addition, we have some tens of digital pictures grabbed from TV broadcast recordings and filed on the WORM disk.

The picture retrieval is activated by selecting the command "smselect" from the menu in *fig. 12*. The query is in this case restricted to the attribute TOPIC, which is required to contain the words 'politiikka' (politics). KALEIDO retrieves 1023 images satisfying this criterium. The response time is 2 seconds for a database of 1100 images.

a

IDENT	#Ident (f:Ö1Ö1ÖIiikanen)
AIHELUOKKA	Politiikka (2), Sisäpolitiikka (24). Talouspolitiikka (50)
TAPAHTUMA	Liikanen neuvottelemassa pohjoismaiden päättäjien kanssa
NIMI	Erkki Liikanen
VIITE	Eduskunta, Hallitus, SDP
KOHDE	Liikanen puhumassa
KUVAKULMA	Lähikuva
PAIKKA	Smolna, Helsinki
AIKA	#Aika 19:6:1986
KUVAAJA	MTV
COPYRIGHT	Tiedusteltava MTV:ltä
OIKEUDET	Tiedusteltava MTV:ltä
ORIGINAALI	Tiedusteltava MTV:ltä
LAINAUSAIKA	
LAINAAJA	
KUVATYYPPI	Videonauha, väri
KOKOELMA	
ARKISTOINTIAIKA	#Aika 23:6:1987
JULKAISTU	MTV:n uutiset 24:10:1986

b

c

d

Figure 13. A typical image retrieval run with KALEIDO .

By adding "hallitus" (government) to the query as an additional restriction, the number drops to 7. These images are displayed in a checker board fashion *(fig. 13 a)*. Four of these candidates are videodisk pictures (the pictures on dark background). Two displayed images are grabbed from recorded TV-broadcasts, then cropped and filed on the optical WORM. One retrieved picture is not available in electronic form - it is displayed as a grey square.

The times for calling a minified picture on the display are the following ones:
- from videodisk: approximately 2 seconds
- from hard disk : 28.1 seconds (512 x 576 pixel image)
- from WORM disk: 28.2 seconds (512 x 576 pixel image)

The display time for a digital picture of any size is proportional to the amount of pixels and can therefore be calculated from the numbers above.

By pointing with the mouse, a picture may be selected from these candidates to be displayed in full size on the RGB monitor. The verbal description of a picture pointed upon may be called up on the IBM screen *(fig. 13 b)*. The most interesting pictures are marked for later use *(fig. 13 c)*. In the end, the marked pictures from successive retrievals are displayed for final selection *(fig. 13 d)*.

The selected picture can be processed, e.g. cropped before outputting.

7. AUTOMATIC ILLUSTRATION

The automatic illustration feature in KALEIDO is an aid for the picture editor to rapidly find illustrations of persons and/or places relating to items retrieved from a news database service. After downloading the news text through the modem, the inflected words of the Finnish text are returned to their basic forms with the MORFO language analysis program /Jäp 85/. Compound words are also split into their constituents. This stage is compulsory, because of the highly inflected nature of Finnish. In the following stage, the names of persons and places occuring in the news are determined by applying a set of syntactical rules. These named are then used as queries directed to the "PERSON" or "PLACE" attributes in the STATUS database. Finally, the pictures matching the query are called up from the store and laid out on the screen together with the news text (fig. 14).

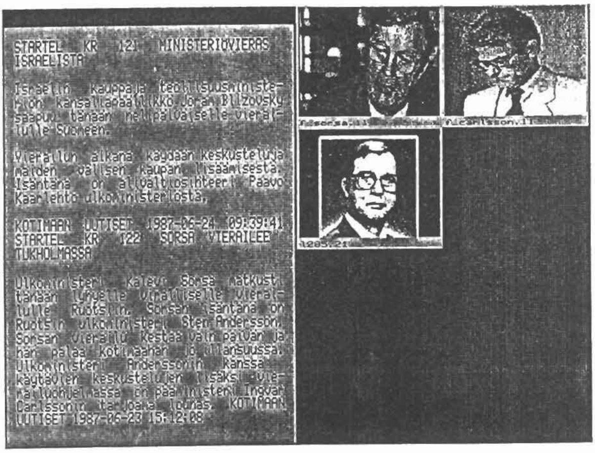


Figure 14. Automatic illustration of persons and places occuring in a news text.

8. CONCLUSIONS AND FURTHER DEVELOPMENT

KALEIDO is a first step towards a new kind of tool in the media industry giving the editor in print media convenient access to video sources and stored video pictures. It demonstrates that managing and processing video pictures and converting them to printable form are capabilities within reach for a low-cost PC-based system. In addition to video archives, pictures stored in any form can be managed by the software.

The results obtained in this work show that digitizing frames from the U-Matic recorder gives video prints, that are satisfactory for publishing in moderate size. The calibration procedure, video image filtering and colour matching in KALEIDO are key methods in achieving this.

In the course of the work with KALEIDO, it turned out that the journalistic use of image archives demands free text retrieval. The strictly formatted attributes of DBMS systems are too rigid for an exhaustive content description. At the same time it was recognized that the ambiguity inherent in pictures demands a consequent attribute structure guiding both indexing and retrieval. The result was a retrieval system that applies subdescriptions within the attributes.

The KALEIDO prototype is now going into the product development stage in cooperation with two Finnish companies. *Monigraaf*, an established manufacturer of PC-based text processing systems for newspapers and magazines, will adopt KALEIDO to expand its TOTI-system to include pictures. *Finlandia-Arkisto* will exploit the archival features of KALEIDO to file 50.000 historical negatives both on WORM disks and on videodisk for electronic distribution. In these projects, KALEIDO will be scaled up to more powerful 32-bit hardware. A high resolution electronic camera will be included as well as high capacity WORM disks and continuous tone printer.

ACKNOWLEDGEMENTS

The author is indebted to the image communication group, that in a collective effort made KALEIDO possible. Ari Siren has made the programming together with Martti Korhonen and Eeva-Liisa Kauranne. Harri Vanhala has been responsible for collecting the hardware and designed algorithms for image size changes and video signal filtering. Tiina Saukkonen has calibrated the equipment, carried out the outputting of pictures and taken part in the technical finishing of this report.

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