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FROM WORD PROCESSING TO IMAGE PROCESSING IN OFFICE SYSTEMS

Brian R. Gaines

CADRE Information Transfer Systems,
339, Canarctic Drive, Downsview, Ont. M3J 2P9.

Summary

Future office systems will be able to capture, store, process and communicate increasingly general forms of 'document' in electronic form. There will be a move from the **word processing** of current systems towards generalized **image processing.** Diagrams, charts, sketches and photographs will be combined with text to allow any form of structured image to be handled. This paper is concerned with the technologies necessary to support this move from word processing to image processing in office systems, particularly handwriting recognition, digital cameras and laser imaging output units.

Introduction

Current office information systems started with **numeric data processing** and then moved on to **textual data processing.** The future trend is towards generalized **image data processing,** subsuming numeric and textual data in a variety of formats together with diagrams, freehand handwriting and sketches. The key to this trend is seen to be twofold: that technologies are available to do so cost-effectively; that the marketplace requires systems that are simple and natural to use and **fit into existing office operations** and **use existing skills.**

The word processor has had a great impact on office information systems. Going over to the integrated electronic office with complete databases of records and correspondence seems the next logical step, and not too great a one beyond word processing. However, the potential of current systems is limited in a number of fundamental respects. Firstly, only text is captured not figures, diagrams or other structured images. Secondly, the information captured has to be entered through a keyboard. Thirdly, incoming correspondence cannot be captured at all so that the database formed reflects only what is generated not what is received. Fourthly, conventional printers are limited in their capabilities to generate hard copies of general images.

This paper considers the technologies that have been developed to overcome these problems and enable a transition from current word processing to future image processing. The discussion is based on work being undertaken by CADRE with Canadian Government funding to develop office information systems capable of carrying a wide range of documents in electronic form.

Overall System Architecture

The overall structure of future office information systems will be that of a family of modules interconnected through standardized communication networks. The modules will include telephones, visual displays, data capture devices, printers, databases, and so on. The range of technologies involved is such that very few companies will be able to encompass the complete set of requirements. Hence the standardization of the interconnection network is becoming very important. Many different types of equipment from many different manufacturers will have to be able to integrate together simply and smoothly to form a system. They can do this essentially by the equivalent of **joining a club** where the membership requirement is conformity with a hierarchy of protocols for interconnection and data interchange.

Figure 1 shows the structure of CADIM, a modular image processing system for office applications. The key sub-systems are:-

Local Area Network

The core of the system is an industry standard local area network with a bandwidth of 1Mbits upwards. General image representation involves larger data blocks than the equivalent text and hence the loading on the network is higher. Image compression becomes very important where photographic or facsimile images are in use.

Database Module

The database module is a standard unit for structured file storage and access. However, again, the increased size of image data files has to be taken into account. The database structure needs to reflect the modularity of much image data, that the final image is generated from a set of subfiles containing text, sketches, facsimile, and so on, all under the control of a layout file.

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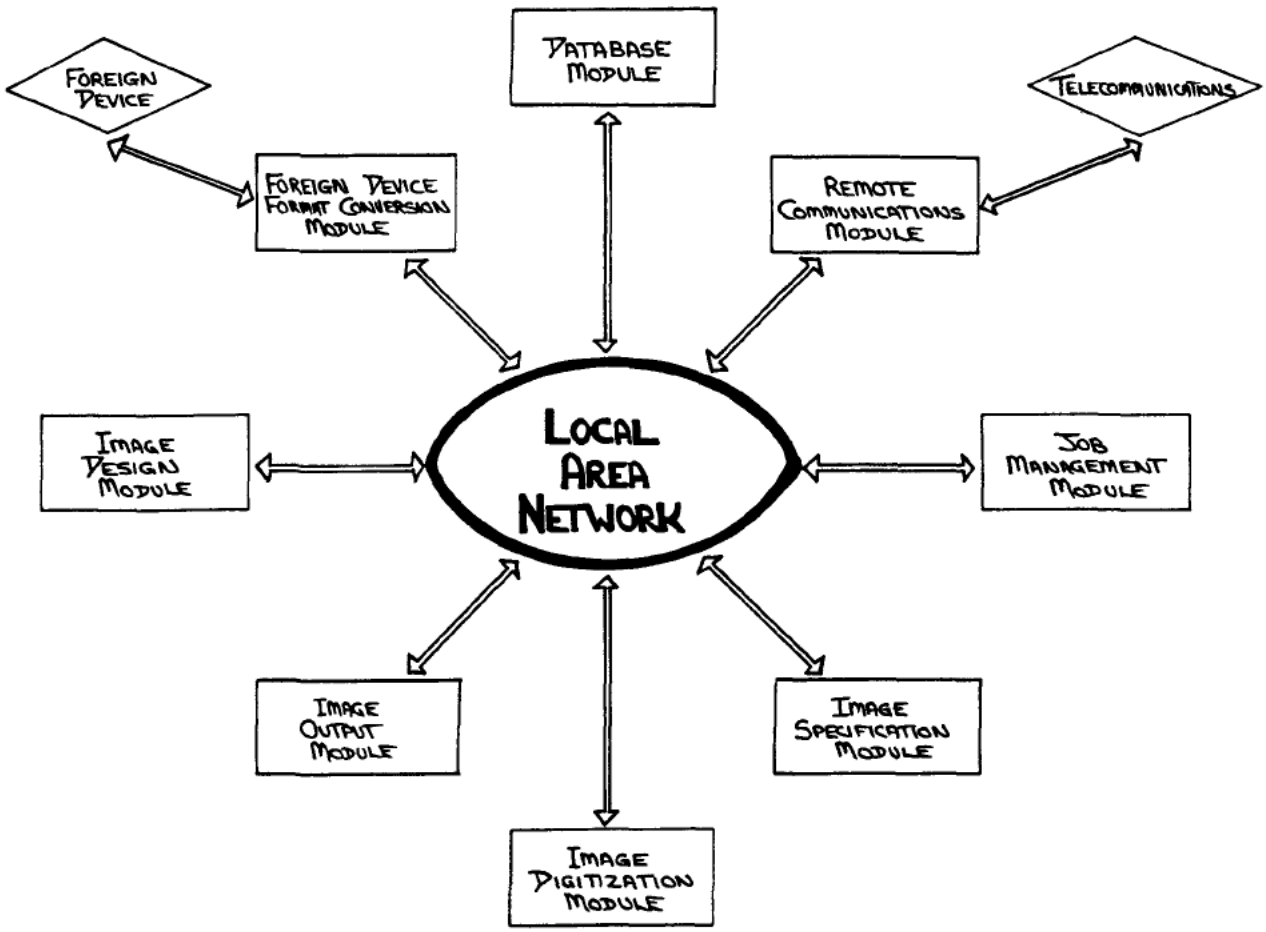

Figure 1 CADIM Modular Image Processing System

Remote Communications Module

The remote communications module is a standard unit for network interconnection and remote access.

Job Management Module

A major problem with large databases is remembering what information is where. When a variety of structured documents are involved in a wide range of formats the problem becomes worse. Early newspaper front end systems for example suffered from information loss and lack of control because the indexing of the data was too primitive. Image systems in the office environment will have similar problems unless adequate management information sub-systems are part of their design concept. The job management module provides a user interface to information about, and control of, the overall data structures and the relationships between them at each level.

Image Specification Module

If every image that was required had to be generated from zero base then the workload would be impossibly high. In practice most documents follow one of a limited set of formats and these can be

designed and stored away as **generic documents.** When a particular instance of one of these preset formats is required the generic document is called up through the image specification module and its residual parameters specified. For example, a sales visit report or an expense report involves a number of standard fields and some variable data. The generic forms of these documents make provision for these fields to be laid out as required and for the variable data supplied to be merged into the layout.

Business forms have provided a model of such generic documents in the past, and modern image processing technology may be seen as enabling more flexible versions of such forms to be generated as needed. It is now possible to provide generic forms of a wide variety of company documents such as stationery, sales literature, technical manuals and financial reports. The use of these preset layouts not only simplifies document production but also ensures a consistency of style in all company literature, normally achieved in large organizations by adherence to a **corporate image manual.**

Image Digitization Module

The capture of general image data has presented a number of problems that have slowed the development of image processing systems for the office. Past technology for handwritten data entry and for image entry from documents and photographs has been too expensive for all but very specialized requirements. However, in recent years advances in low-cost graphic tablets, digital cameras and character recognition algorithms has led to the development of a new generation of image capture units. Two of these, for handwritten data entry and incoming correspondence capture, are described in later sections.

Image Output Module

It was once supposed that the office of the future would be a paperless office. This seems unlikely in the next generation of systems at least, and the capability to produce on demand high quality hard copy of any document is a major customer requirement. The main source of high quality output from word processors has been impact printers using some variant of the golf ball or daisy wheel printing head. However, these are unsuited to general image output involving rules, line art, photographs and sketches. This has led to the development of a new range of non-impact printers using a variety of technologies, some based on laser discharge of an electrostatic field that is then used to carry a toner, and others on thermal bonding of a toner carried on a plastic ribbon

These new technologies allow an image to be generated on paper as a matrix of dots, or pixels, which can be black or white (or colored in some recent systems). If the resolution is adequate then any image can be generated through such a matrix. To use these systems for text production digital typography is required in which fonts are held as computer data. To make use of their full capabilities of pictorial image generation many other techniques used in the print industry for the reproduction of line art, half tones and facsimile data have also to be incorporated. This requires expensive technologies designed for phototypesetting to be brought down-market for office applications.

The CADRE GRAC development is a typographic computer taking an image specification encoded as text, typography, line art and continuous tone pictures, and outputting it to raster scan output devices of varying speeds and resolutions. The technology has been developed for the printing industry but it also impacts the office information market as a generalized image output system.

Image Design Module

The generic documents described above and special-purpose documents do need an origination station that can specify images from zero base. Fortunately high resolution graphic systems have become sufficiently low in cost that it is feasible to use them in the office. The resolution required is of the order of one million pixels, similar to that of the Xerox Star. Black and white graphic systems at this resolution are now in the few thousand dollar range. Color terminals at about one quarter this resolution are comparable in price.

Foreign Device Conversion Module

The capability to connect devices to the system which were not designed to be members of the club is very important for the next generation of systems, and probably forever. Protocol convertors will constitute a high proportion of the modules used. The foreign device format conversion module is a microcomputer with table driven protocol conversion to enable arbitrary devices to be made members of the club with the minimum of effort.

A similar approach can be taken to the protocol conversions required within the system. For example an image may be sent to an output device that cannot decode it in the form sent. A protocol convertor on the network can note that this has happened, accept the data itself, convert it to a suitable form and send it again to the output device. The output device under these conditions can ignore data

sent to it in an inappropriate format.

Handwritten Data Capture

The most natural system for people to generate images of all forms is through handwriting. Writing a letter, filling in a form and drawing a sketch are still the most common ways of capturing information, but, until recently, they were unsuitable for direct computer data entry. Text and forms have had to be processed through a separate keypunching operation which is expensive and error prone. Sketches have been restricted to specialist markets such as CAD/CAM where expensive graphic tablets can be justified.

In recent years there have been two major technological breakthroughs that have made direct handwritten data entry feasible. Firstly, algorithms have been developed for handwriting recognition in real-time on microprocessors and applied in a number of commercial products. The recognition is limited to separated block characters rather than cursive script, but this is adequate for a wide range of applications such as capturing data at source as it is written on business forms. Secondly, low-cost graphic tablets have been developed that can track the movement of a ball-point pen as it writes on a form with sufficient precision for handwriting and sketches.

Inforite is a low-cost 8 by 11 desktop pad currently available which records in a microcomputer information written with an ordinary pen on a sheet of paper placed on it. The Z80 microcomputer in the pad incorporates block handwriting character recognition software for the full range of alphanumerics and special symbols. It also incorporates form definitions so that the field and type of the data captured can be recognized and communicated. The product is being used in the forms data capture market where it enables a separate keypunching operation to be avoided when data is already being written on forms.

The next stages of development are firstly a portable, battery-operated version of the pad, and, secondly, a new version of the pad allowing a variety of image formats, drawings and sketches as well as handwriting that communicates using the Telidon/NAPLPS protocol. A typical application showing the use of the pad is that of fire insurance rating where a document is filled in with three different types of data: a) handwritten characters for variable alphanumeric data; b) ticks against preset boxes to select a range of possibilities; c) a sketch of a building and its location. The characters written are recognized and sent to the computer as if they had been keyboarded. The tick boxes are also sent as marked and generate sentences in the computer output. The sketch is sent as a compressed image which is not processed by the computer but can be recalled on a screen or output in a document.

Digital Camera, Correspondence File

The use of word-processing systems makes the filing of outgoing material simple but this is useless as the basis of a correspondence database unless it is correctly linked with incoming material. The advent of low-cost digital cameras using CCD arrays to digitize images at resolutions of about four million pixels in two seconds makes it possible to take incoming correspondence into the computer. Such facsimile (fax) input is useful in enabling the incoming material to be stored and reproduced, but it has two major problems. Firstly, it requires over 20 times the storage of the same material in text form. Secondly, and more seriously, the data is not in computer searchable form -- the facsimile data can only be retrieved as images not analysed by its content.

Optical character recognition (OCR) systems overcome both these problems. However, they can only deal with a very restricted range of incoming documents not including most business correspondence. What is required is a system intermediate between fax and OCR which uses optical character recognition on those parts of the document where it is possible but otherwise takes in the image as facsimile. For retrieval and linkage purposes a high error rate in character recognition is acceptable and an OCR system with 10% errors is adequate. Given such a system, incoming typed documents occupy only about twice as much storage space as outgoing documents and some 90% of their content is recognized in computer analysable form. This level of optical character recognition is easy to achieve and yet adequate for both data compression and for key-word analysis of incoming material.

Conclusions

The hardware and software technologies necessary for a new generation of office information systems in which word processing is enhanced to be generalized image processing already exist and are now low enough in cost. What is needed is their integration into modular systems capable of being configured to match a wide range of customer requirements. This paper has outlined the basic technologies and given some feel for the system configurations.