Communications Research Centre

A GENERAL DESCRIPTION OF TELIDON:–
A CANADIAN PROPOSAL FOR VIDEOTEX SYSTEMS

by

H.G. BOWN, C.D. O'BRIEN, W. SAWCHUK AND J.R. STOREY

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COMMUNICATIONS RESEARCH CENTRE

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ABSTRACT

Videotex systems allow easy access, by the general public, to large computer-based information sources which contain pages of information to be displayed on suitably supplemented television receivers or newly designed Videotex terminals. Each page of information may contain both textual and graphic images.

Organizations in a number of European countries are promoting standards for Videotex systems based on an alpha-mosaic approach which limits the resolution of graphic images to a format far below the resolution capabilities of the display medium. With this approach, the future development of Videotex systems will be constrained, because images at the information source are described in a terminal-dependent manner with the same alpha-mosaic format used for their displays. Once this format is adopted it will be difficult, if not impossible, to update information source files in a manner suitable for both present and future, more advanced, Videotex terminals.

A new terminal-independent method of describing images is suggested in this report on the Canadian Telidon Videotex system. Images are described as either alpha-geometric or alpha-photographic images by means of Picture Description Instructions (PDI's). This new approach permits the growth of large information bases, through terminal independence, which would not have to change to accommodate new developments and improvements as new technologies become available in the foreseeable future.

1. INTRODUCTION

Videotex is a name used to refer to public-accessed, interactive, information retrieval services which use domestic television receivers, suitably modified or supplemented, as terminal equipment. Users of Videotex systems will be able to retrieve, via the common-carrier telephone lines, or other interactive networks, information stored in computer-controlled data bases and have it displayed on their augmented TV receivers or video business terminals. They will be able to access textual information or graphic images from vast data banks by conducting systematic searches using simple numeric keypads. Individuals with slightly more complex terminals will be able to compose their own information to be stored in the data banks for access by others. In the future, when mass production reduces the cost of producing electronic components, individuals will be able to communicate with each other and interact by being able to see the same images displayed on their individual television screens. These various capabilities, which bring advanced technologies to the home user, could have a profound effect on communications and on our society. Such systems allow the introduction of many different services for home and business applications. Electronic newspapers, electronic mail, electronic advertising, electronic games, business transactions and many other services are all possible with the new communication technology. The possibilities are only limited by our imagination once these systems come into widespread use.

Videotex terminals are already being introduced in Europe. Both Great Britain and France have proposed Videotex systems and other European countries are interested in one or the other of these two systems. Both systems are also being introduced in Canada and the USA. However, these European systems are character-oriented which restricts the information displays to fixed format textual messages and the display of rudimentary graphic images. Moreover, once a large number of terminals using these character-oriented communication and display techniques are in peoples' homes or businesses, it will be difficult, if not impossible, to change to new communication methods which would allow the transmission and display of higher quality images in the future.

The growth of character-oriented systems is restricted, not so much by their display methods but, by their image description techniques. They transmit images as sequential pieces of a picture consisting of 24 rows of 40 characters based on the European 625-line TV formats. Graphic images are constructed from specially identified coded graphic characters, fitted together as individual pieces of the complete picture, as in a mosaic. Terminals employing this image description and display technique might be referred to as "alpha-mosaic" terminals. Once this technique is accepted, it is impossible to send higher resolution images without knowing the display capabilities of the receiving terminal. Moreover, information banks may have to store multiple versions of each image to suit a proliferation of various terminal-configurations which may evolve as technology advances and demands for better quality graphics are made.

Through hindsight, perhaps, one begins to realize the problems of introducing a Videotex system which is suitable for today's technology and yet allows for future expansion. One needs to describe images at the central data banks in such a way that they are completely independent of the data access arrangements at the central computer, the characteristics of the communication medium and, what may be most important, completely independent of the display terminal construction and resolution capabilities.

One solution to this problem, proposed by the Canadian Department of Communications, is outlined in this report. In Section 2, an overall description of Telidon, the Canadian approach to Videotex Systems design is presented. Section 3 has a brief description of the proposed Picture Description Instructions (PDIs) designed in the Communications Research Centre of the Canadian Department of Communications. These PDI's describe graphic images as images containing geometric shapes. The PDI's also include a means of describing photographic-like images. Textual messages are transmitted by means of standard procedures using 7-bit ASCII characters. Thus, terminals capable of receiving and displaying structured geometric shapes and text might be described as "alpha-geometric" terminals. Those capable of displaying photographic-like images would be called alpha-photographic terminals.

Two different terminal designs are outlined in Section 4. Both terminal designs include circuitry to interpret PDI codes and display the captured image. One terminal includes a character-oriented memory, similar in many ways to the display memories used in European Videotex terminals, but in this case, the terminal equipment does not constrain the communication code to a rigid format. This terminal is an alpha-geometric terminal even though the display has an alpha-mosaic format, as its input circuitry interprets geometric image descriptors before forming the output display. The second terminal contains a high resolution display memory with a location associated with each pixel (picture element) displayed on the screen. This terminal is capable of displaying photographic-like images as well as the alphanumeric characters and graphic images of the first terminal. With this terminal, however, the graphic images could be displayed with a much finer resolution.

It is important to consider the limitations a proposed method of communication may have on future developments. We believe there are no foreseeable constraints to the Canadian Telidon proposal. Initially, the proposed communication method pertains to public access to large information bases, but in the future, as technological developments continually decrease the cost of terminal equipment, we may wish to transmit visual images from subscriber to subscriber, or to create an environment in which any member of the public can become a "publisher" and create his own images for insertion into central information-banks. These ideas for future developments are outlined in Section 5 where it is shown that the basic PDI's can still be used to describe images even though other means may be developed for picture creation and manipulation. We conclude by stating positively that this picture description concept, or one very similar to it, must be considered as the only sensible way of implementing Videotex systems which can grow and be adapted without constraint, as technological developments bring complex equipment within the buying range of the average consumer.

2. OVERALL SYSTEM CONCEPTS

Videotex systems are public access information systems which provide any subscriber the opportunity to access, and display on his home television receiver, computer-stored data such as news, sports, holiday or educational material, etc., received via common carrier communication lines or other interactive networks. Electronic equipment is required between the communication lines and the television display unit in order to receive this data and convert it into a form suitable for display. Various terminal configurations which may be possible are shown in Figures 1 to 4.

The Videotex decoder and display generator of Figure 1 is shown connected to the Red, Green and Blue (RGB) inputs of a modified television receiver. This connection permits full use of the resolution capabilities of the display medium. In Figure 2, the television receiver has not been modified, instead, the Videotex display generator output drives a channel modulator and the signal is fed to the antenna input of the television receiver. In this case, the Videotex signal is restricted by the video bandwidth of the television receiver so that the maximum resolution of the display medium cannot be realized. Videotex decoders and display generators, connected via the antenna terminals, would probably have to format textual messages to provide no more than 32 characters to a line. Line drawings also would have to have sufficient line thickness to allow the transmission of clear images via the limited bandwidths of the television receiver. Figure 3 shows a Videotex terminal connected to a two-way cable television output. In this case, signals to request information modulate a simple transmitter which transmits signals in the upstream direction. The response is shown as being received via a Teletext decoder, but other means of receiving downstream data transmissions could be used. The use of a different type of data decoder is shown in Figure 4. As an example, the data decoder might be a special device which sorts out frequency-multiplexed signals transmitted on a full channel of the cable television system. The use of a different request channel also is shown in Figure 4. In this arrangement, request signals are transmitted via a telephone connection and return signals are transmitted via an existing one-way cable television system. Of course, arrangements other than those shown in Figures 1 to 4 are also possible, which indicates the diversity of communications media which may be employed. This emphasizes the need for independence between the Videotex drawing instructions and the communication channel characteristics.

A public access information system would provide general access to very large information banks, stored in central computers, and organized as numerous display pages. The system makes use of the home television receiver as a still picture display medium. The revolutionary departure from the regular television service is that the viewer has much more control over what information is presented on the television screen.

One method of accessing information is through a tree-structured search technique as proposed and implemented by the British Post Office (1). This method certainly provides easy access to information for the user. Starting from an index page which lists the major categories of selectable information items, the user selects an item using a simple numeric keypad and follows successive index pages to the information of interest. As an example, a user might initially select "sports" and follow successive branches in the tree-structured search technique to obtain statistics on an individual football player. Similarly, he may obtain a list of airplane flight times by starting with "travel", or display a detailed weather map which the user may obtain by first selecting "news", or through direct access if he already knows the access number of a desired page.

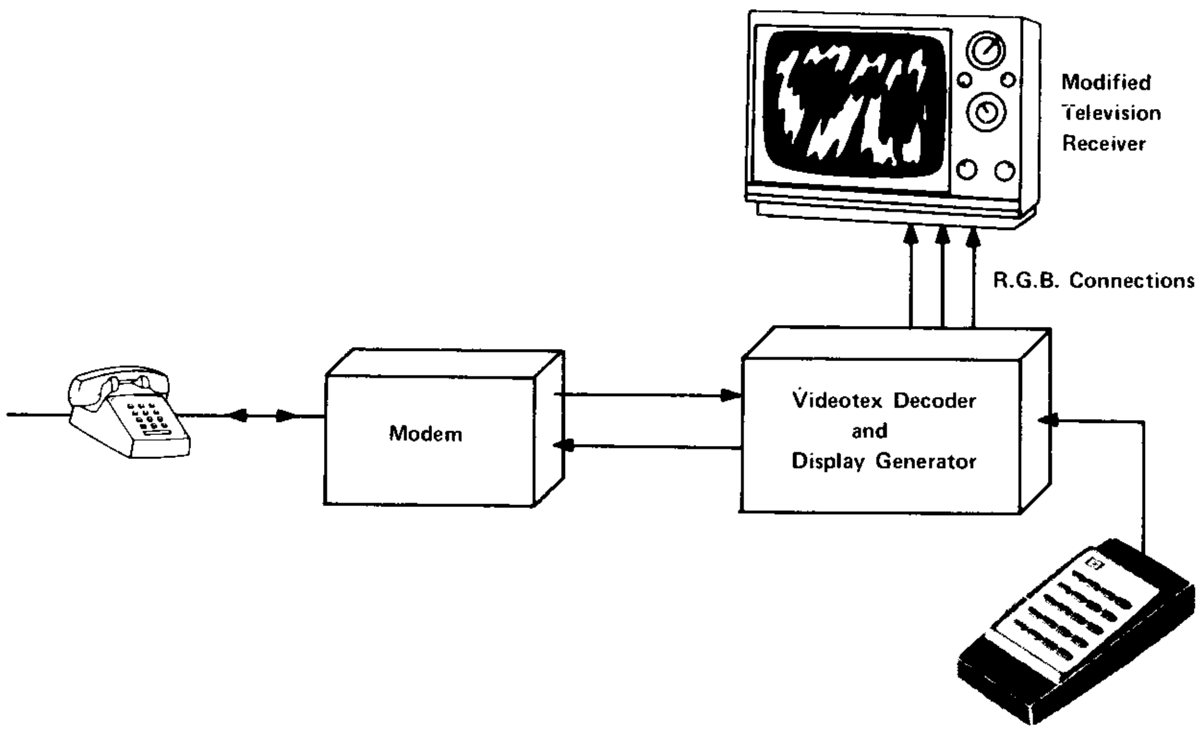


Figure 1. Videotex Decoder for Interactive Services

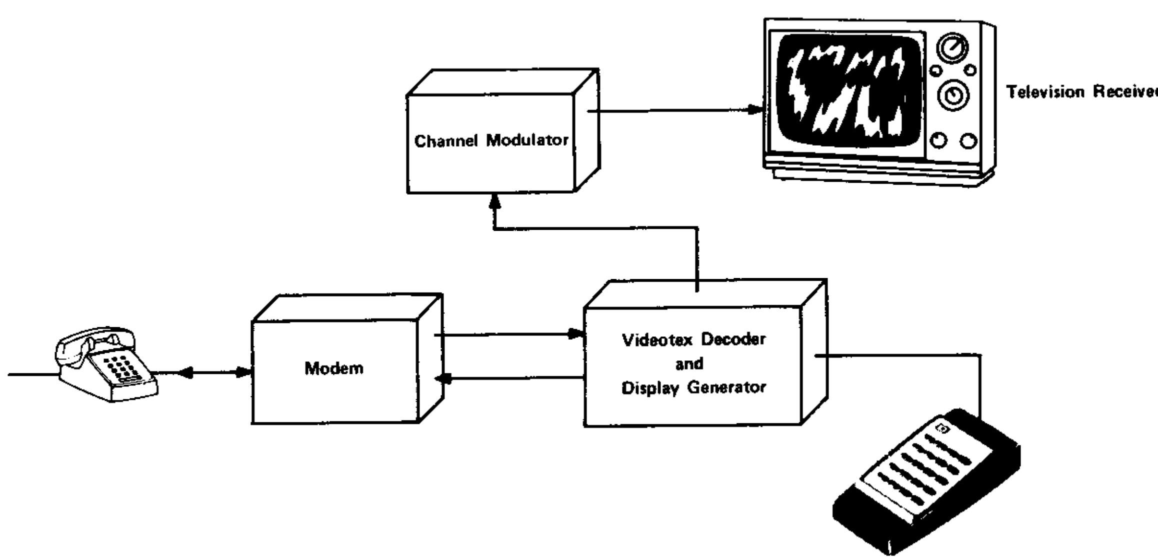


Figure 2. Lower Cost Videotex Terminal

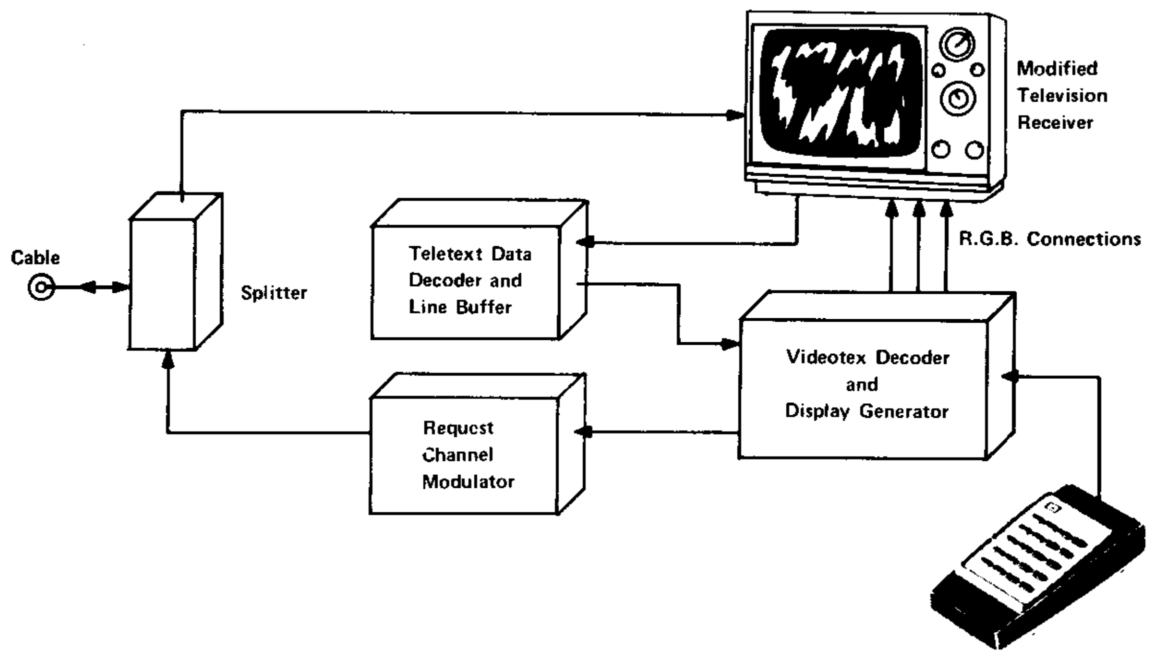


Figure 3. Teletext Decoder and Page Selection Transmitter for Videotex Services Via Cable

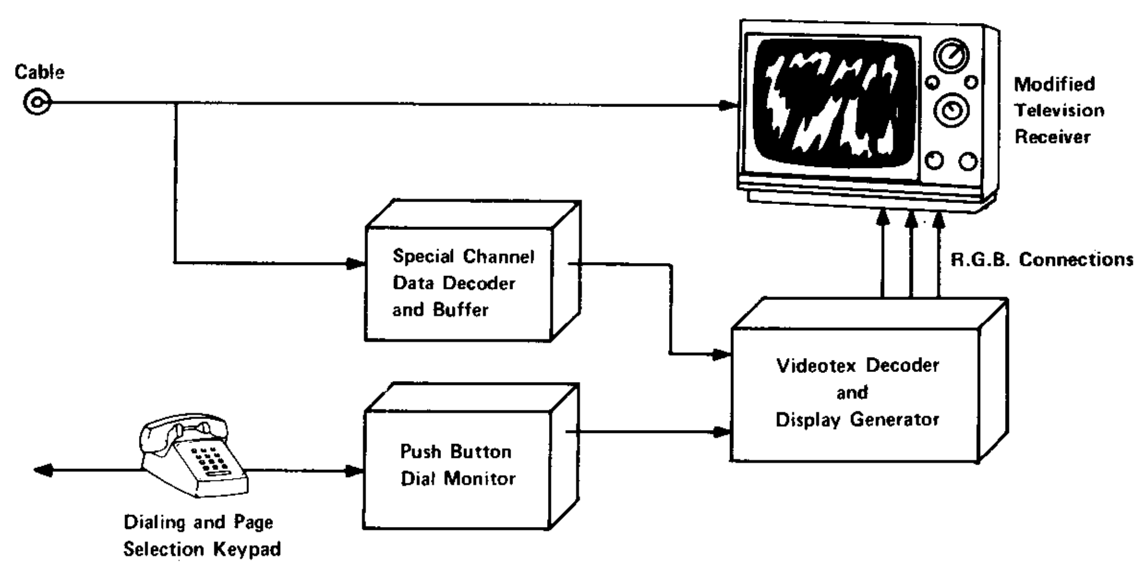


Figure 4. Possible Hybrid Videotex Arrangement

The information contained in the large data banks is prepared by information suppliers who, in most cases, would obtain payment each time their information is accessed. Other information suppliers, such as advertisers, may provide their information free of charge. Governmental bodies might also supply free information as a service to the public.

The interface unit in the home or office, which converts the television receiver or monitor into a Videotex terminal, performs the task of receiving and converting the communication codes from the central data-store computer into a form suitable for display. An interface unit of this sort may be simple or complex; may have low resolution or high; depending on the price a user is willing to pay for terminal equipment. One of the major features of the Canadian Telidon system is its use of codes which are suitable for interpretation by a variety of different terminals, and in fact, permits terminals to grow in complexity far beyond what can be achieved with today's display technology. These "communication" codes, which incorporate such very high resolution geometric descriptive capabilities, need not be confined to describing pictures for Videotex systems. Future facsimile, or word and form processing equipment also could use these codes, because the codes incorporate, among other features, run length encoding for digitally-encoded facsimile images.

Images and textual information for the Canadian Videotex system are coded through a specially designed code called Picture Description Instructions (PDI's). This code describes images in terms of commands to draw basic graphical primitives such as line, arc, polygon, etc., at specific positions in the overall picture. This coding form is suitable for describing images with sufficient resolution for monitors capable of displaying 960X1280 picture elements. These display monitors have recently become available for text editing systems. On the other hand, the home colour television receiver can typically resolve 240X320 elements, and an interface unit would automatically drop excess information bits before interpreting the command codes at this lower resolution. In other words, a Telidon terminal interprets and displays the data to whatever degree of resolution has been incorporated in its design. In this way manufacturers can select and incorporate features into their terminals which they feel are worthwhile.

3. PICTURE DESCRIPTION INSTRUCTIONS

The proposed method of storing and communicating visual images and textual information is through the use of Picture Description Instructions (PDI's), and associated data such that the resolution of stored images is virtually independent of terminal configurations, communication networks and data base construction. The proposed method describes the contents of composed images with graphic descriptors of each object in the image. Each object, and its position in the image, is usually described with an accuracy of one part in ±2048 and thus the display resolution of the final image should be suitable for most applications in the foreseeable future. This resolution is about ten times what is required for present day television receivers, but present day high resolution word processing equipment can resolve images approaching half the defined resolution. In the future, even higher resolutions could be defined without affecting present day equipment. The extra bits required to define images with such high resolutions fit naturally into the construction of the PDI set and can be used to define images for facsimile or form processing equipment. In other words, the PDI set is not necessarily restricted to Videotex systems, but of course, new terminal equipment would be required which could interpret the PDI codes.

Essentially, pictures are dsecribed with a set of geometric drawing primitives, such as line, polygon and arc, specified in various positions in the total picture to be displayed. Similarly, text is described as a group of characters to be displayed at certain positions on the screen. In this way, the PDI's can describe practically all textual and graphic type images. Images, or parts of images which cannot be described in terms of logical drawing primitives can be specified in the photographic mode of operation.

Only seven basic instructions, each followed by high resolution data, are needed to describe practically all graphic images. Four of these instructions describe objects of structured images in a geometric mode where the objects are lines, circular arcs, rectangular areas or polygons. These basic geometric primitives were chosen because of their simplicity. Complex graphical drawing entities, such as elipses, were not chosen as basic primitives because they require excessive computational power in the terminal. Thus, pictures containing elipses, for example, cannot be drawn directly with a single drawing primitive, but would be approximated and described by a number of basic instructions. A fifth instruction indicates the data following is in "Bit" form, that is, photographic mode, for images where the structure cannot be defined even by numerous logical drawing primitives. A sixth instruction defines the position of an object. This instruction may merely indicate a movement of the display beam prior to transmitting one of the primitive commands or may be used to plot points in random fashion on the display. This difference is indicated with a specific bit in the command word structure. The other commands also can use this special bit to indicate the positioning command is combined with the primitive instruction. The last or seventh instruction is used for control and generally sets a status register prior to sending other instructions. For example one control command may be to set the value or colour of an object.

In summary, the list of command instructions are LINE, ARC, AREA, POLYGON, BIT, POINT and CONTROL. Thus, by means of these instructions, combined with high resolution data, practically all graphic images can be described in data banks and transmitted in a compact form to Videotex, or other terminals which interpret these data, to whatever resolution has been built into the terminal equipment.

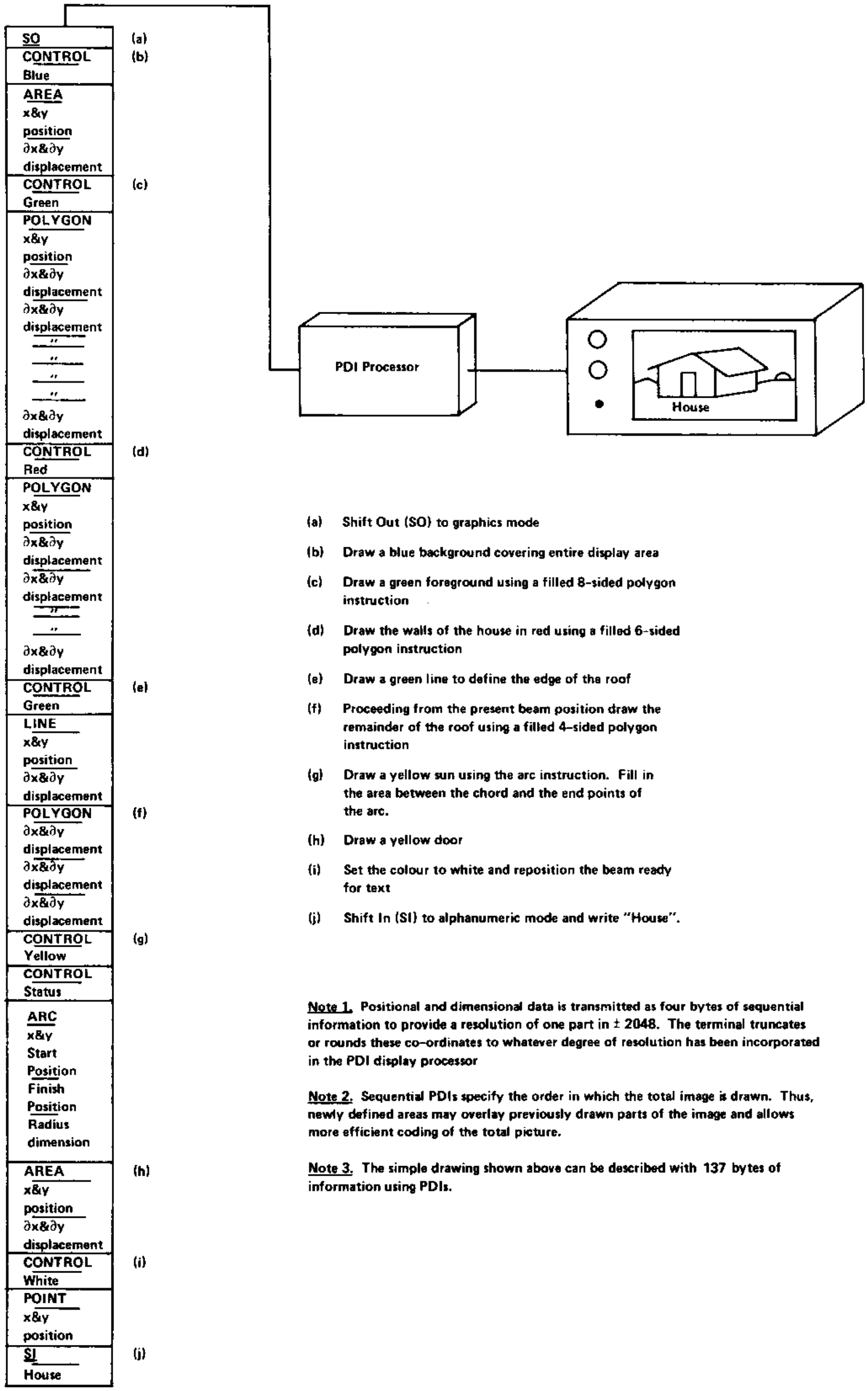
A command is also required to change from graphic to alpha-numeric mode for textual messages. This function is performed by the Shift In (SI) command from a set of control codes universally used in the transmission of textual messages. Similarly the Shift Out (SO) control code is used to change back to the graphics mode. The alpha-numeric mode is the mode of operation entered by default, or the way in which a terminal should operate when first switched on. In this way, a subset of the PDI code can be used for business, or simple alphanumeric terminals which may only respond to textual information.

The PDI instructions, associated data words and alphanumeric characters are contained in 8-bit bytes with one bit of each byte used for parity to comply with present standards of transmission over conventional data networks. Figure 5 shows a list of PDI codes needed to describe a simple picture. A brief description of the PDI format is given in Appendix A of this report. A more detailed description will be given in other reports.

4. TERMINAL DESIGN

There are a number of ways in which terminals may be designed to operate from the proposed PDI codes. The two most likely designs result in terminals which incorporate either character-oriented, or bit-map, display memories. As the PDI codes are intended to be terminal-independent it means that the codes must be interpreted before the contents of the two different display memories are generated. For this reason, it is most likely that all Telidon terminals will contain a microprocessor to perform the interpretation and generate appropriate display memory code. Block diagrams of the two types of terminal are shown in Figures 6 and 7.

Based on the above two approaches to the design of terminals there is a large number of terminal configurations which could be manufactured. The various configurations will depend on what features manufacturers consider important for the sale of their product, after considering the cost and complexity of incorporating special features in their terminal design. One manufacturer may aim his product at the consumer market and limit its display capabilities in order to sell at the lowest possible price. Another may design business terminals capable of displaying, or printing, business forms with shaded rectangular areas and 80 characters to a row. Still others may think there is a market for terminals for the Hi-Fi enthusiast who is willing to pay for high-resolution graphic-display terminals. It is important to realize that the display terminal is not necessarily tied to the medium resolution display capabilities of a 525-line television receiver. Nor is it limited to Videotex applications where one only has access to information stored at central locations. The PDI codes were initially designed for the Videotex application but incorporates features which may be used for many other purposes and can be made compatible with proposed Teletex (business) terminals.



(a) Shift Out (SO) to graphics mode

(b) Draw a blue background covering entire display area

(c) Draw a green foreground using a filled 8-sided polygon instruction

(d) Draw the walls of the house in red using a filled 6-sided polygon instruction

(e) Draw a green line to define the edge of the roof

(f) Proceeding from the present beam position draw the remainder of the roof using a filled 4-sided polygon instruction

(g) Draw a yellow sun using the arc instruction. Fill in the area between the chord and the end points of the arc.

(h) Draw a yellow door

(i) Set the colour to white and reposition the beam ready for text

(j) Shift In (SI) to alphanumeric mode and write "House".

Note 1. Positional and dimensional data is transmitted as four bytes of sequential information to provide a resolution of one part in ± 2048. The terminal truncates or rounds these co-ordinates to whatever degree of resolution has been incorporated in the PDI display processor

Note 2. Sequential PDIs specify the order in which the total image is drawn. Thus, newly defined areas may overlay previously drawn parts of the image and allows more efficient coding of the total picture.

Note 3. The simple drawing shown above can be described with 137 bytes of information using PDIs.

Figure 5. Sequential PDIs Defining an Image

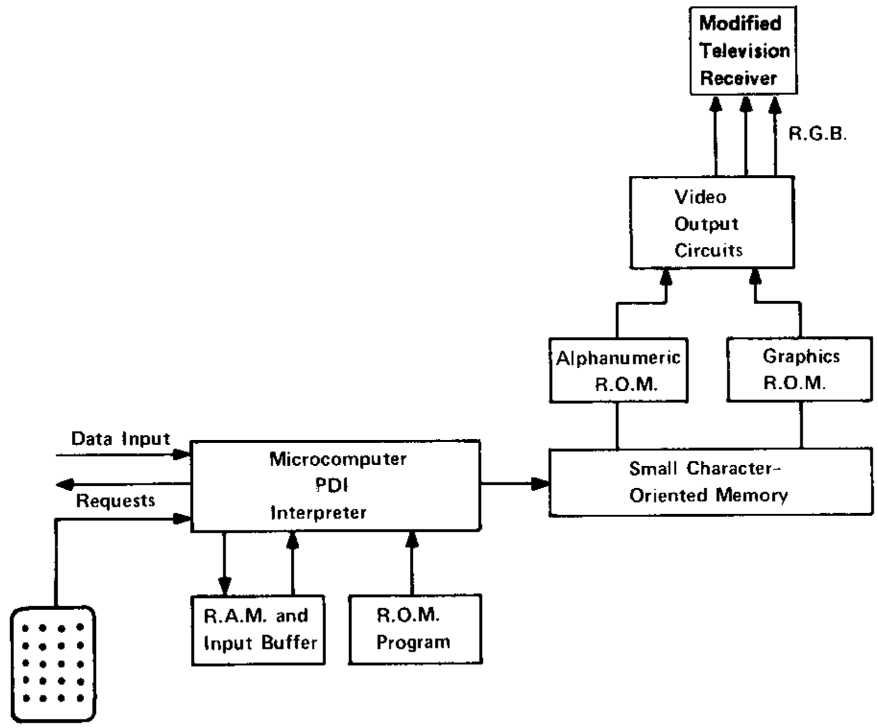


Figure 6. Telidon Terminal With Character-Oriented Memory for Good Quality Text but Limited Graphics

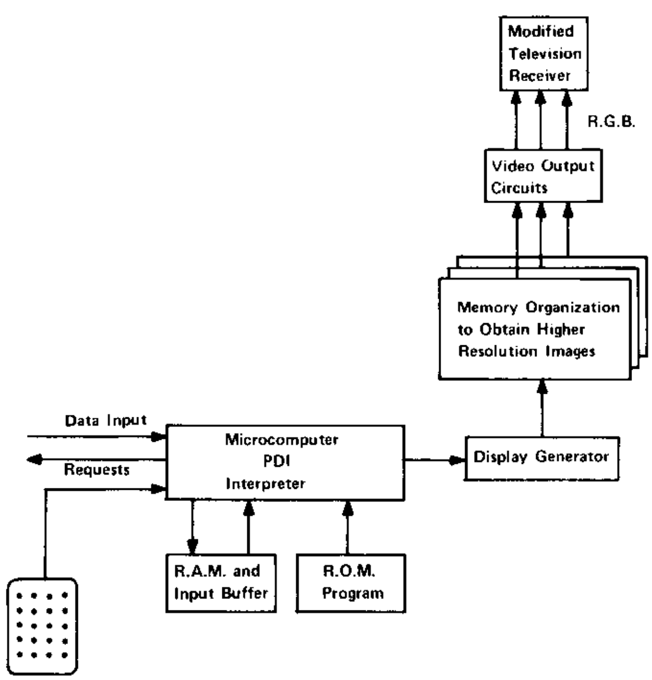


Figure 7. Telidon Terminal With Bit-Map Memory for High Quality Graphics

Terminals incorporating bit-map display memories are capable of displaying much higher resolution images than terminals with character-oriented memories but require more memory elements which, for the present at least, increases the cost. However, the cost of implementing terminals with bit-map memories capable of displaying medium or high resolution images must be balanced against the undesirable features of character-oriented displays with their inherent display limitations. In the longer term, the cost differential between bit-map and character-oriented display technologies should become less as advances in integrated circuit techniques allow more and more memory elements to be included on single Very Large Scale Integrated circuits (VLSI) (2).

Pictures of a map of Canada are shown in Figures 8 and 9. Figure 8 shows the resolution which can be displayed on a terminal incorporating a bit-map display memory. About 1500 bytes of information are required for PDI codes to describe the picture. Figure 9 shows the type of resolution which could be expected from a character-oriented terminal capable of displaying 20 rows of 40 characters. Other pictures showing the powerful drawing capabilities of PDI's are included in Appendix B.

4.1 P.D.I. INTERPRETATION AND EXECUTION

It is most likely that all terminals will require a small input buffer to allow PDI processing to proceed as other PDI's are received, and a small microcomputer to interpret the PDI instructions and generate and deposit a suitable code in the display memory. The final contents of the display memory depend on whether the terminal contains a character-oriented or bit-map display memory. In character-oriented terminals the display memory contains an address in each character position. The address code is used to address Read Only Memories (ROMs), the contents of which contain patterns of the elements that are finally displayed. In terminals with bit-map display memories, the memories contain the values of each pixel finally displayed on the screen.

The input buffer does not have to store all of the PDI codes received by a terminal. It is used, instead, as a buffer to equalize the input data rate and the rate at which the processor interprets and implements the PDI codes. Typically the input buffer need contain only 256 bytes of information as, on an interactive communication channel, it is possible to temporarily stop the flow of information if the rate of processing is too slow. Of course, larger input buffers could be incorporated in the terminal design and may be required for a number of reasons. One reason could be to permit the manipulation of images on more advanced terminals. Another reason might be to alleviate communication problems which could occur if too many subscribers access the Videotex data base for long periods of time. In this case, larger input buffers could store several pages of a document transmitted as a single burst of information instead of on a page-at-a-time basis with the communications lines held, but not used, as subscribers peruse each page.

The PDI processor interprets incoming instructions and generates the appropriate code to be inserted in the display memory. The way in which these instructions are implemented will depend not only on whether the terminal is bit or character oriented, but on what features and what resolution the terminal is capable of displaying. One terminal may simply display all images as black images on a white background, or vice versa, while another more complex terminal may provide both coloured and grey scale images, as well as providing features to "blink" individual objects in the final display.

The processor could, of course, consist of specialized integrated circuits to perform the various functions but would most likely consist of a micro-computer, with perhaps 12K bytes of Read Only Memory (ROM) containing the computer instructions and a 4K byte Random Access Memory (RAM) which is used both as an input buffer and as a working space in processing the incoming data. The computer could also generate all the points to be placed in the display memory after interpreting the PDI codes, but this function is better handled by a specialized, but simple, hardware display generator. In this way, the speed of generating points for the display can be optimized to allow the processor to keep pace with incoming data. In general, the micro-computer would determine whether incoming data were text, or graphic instructions with associated x, y coordinates. It would have to interpret command functions; mask off extra bits to obtain information related

Figure 8. Map of Canada Display on Telidon Terminal Containing Bit-Map Memory

Figure 9. Map of Canada Display on Videotex Terminal Containing Character-Oriented Memory

to the display resolution; and perform calculations to provide data to the hardware display generator. Typical calculations would be to add positive or negative x and y displacements to previously received locators to determine the end points of a line; determine point positions from an ARC command; or calculate starting and finishing positions when areas are to be filled in. The processing is relatively simple and can be easily performed with an 8-bit micro-computer. In a character-oriented display terminal, the interpretation of commands would be similar, but the hardware or software display generator would be very much different.

4.2 CHARACTER-ORIENTED TERMINALS

Character-oriented terminals are suitable for displaying low to medium resolution graphic images. In these terminals, the display memories are relatively small and contain codes which represent alpha-numeric characters or mosaic symbols to be displayed in fixed positions on the display. This type of system is ideal for textual messages with a fixed format as the character shapes and locations are pre-determined and can be coded efficiently. Symbols for graphic images such as lines and areas are not pre-determined and billions of different codes would be required to represent all symbol configurations for good quality images capable of resolving 240X320 picture elements. The number of codes required depends on the number of character positions in the display. This depends on their readability and is limited to about 20 rows of 40 characters for text on displays using 525-line television receivers as the display device. Providing billions of codes is obviously impractical and, for this reason only coarse graphics, or images composed of a limited number of predetermined symbols, are normally displayed.

A block diagram of a character-oriented terminal was shown in Figure 6. In its simplest realization the display memory would contain 800, 8-bit words for a display of 20 rows of 40 characters on North American television receivers. In this case, each 8-bit word contains an "address code" to indicate individual textual or mosaic characters held in Read Only Memories (ROM). In operation, the display memory is scanned in synchronism with the 525-line television display generators and, as each 8-bit address code is accessed, it refers to a particular character position in the ROM which outputs a sequence of dots corresponding to the character to be displayed.

The displayed output is severely limited for graphic images in character-oriented terminals containing memories with only single 8-bit words to describe each character position displayed on the screen. One limitation is in the terminal's ability to change from one colour to another as additional memory space is required to encode the colour change. When colour changes occur, and only single 8-bit code words are used, a gap is likely to occur in the information displayed on the screen. A further consequence of using only one 8-bit word for each character position is that some words must be recognised as command words, which reduces the number of bits used to address the read-only memories containing alphanumeric or mosaic characters. The remaining 6 or 7 bits can address only 64 or 128 different symbols, and in the graphic mode of operation, the mosaic characters are typically constrained to combinations of dots in a 3 X 2 dot matrix. This provides a resolution of 60 X 80 elements on a 20 X 40 character display.

Both of the above limitations can be partially solved by extending the length of each word contained in the display memory to more than eight bits. Extra bits in a word of greater length could indicate colour changes for background and foreground colours for each character position. Other bits could extend the resolution of graphic images by providing addressing for 256 different graphic characters defined in a 4X2 dot matrix. This would provide a final resolution of 80X80 picture elements for graphic images, but the individual spots would no longer have a square outline if the 3:4 aspect ratio of the television screen is maintained. Further extension of this technique to provide much finer resolution is generally impractical but other techniques are possible. One technqiue is to increase the number of display positions for graphic images to 40 rows of 80 characters and the 4X2 spot matrix would now provide a resolution of 160X160 elements. In this case, of course, the display memory size would have increased from less than 1K byte to 6.4K bytes of memory, if 16-bit words are used, to accommodate the graphic mode of operation. The 800 bytes of memory for the alphanumeric mode of operation might still be required to overlay textual characters as 20 rows of 40 characters are needed to make text readable. Another technique is to define 256 predetermined mosaic symbols with a much finer resolution than the 3 X 2 or 4 X 2 dot matrices and trust that most images can be constructed from these predetermined mosaic symbols. Character-oriented terminals capable of displaying medium resolution images by these means also require higher speed logic elements in the memory scanning circuits and more complex PDI processors than the simpler low resolution displays.

4.3 BIT-MAP DISPLAY TERMINALS

Terminals incorporating bit-map display memories are capable of displaying much higher resolution images than terminals with character-oriented display methods. In bit-map display terminals each spot or picture element displayed on the screen has a corresponding position in the display memory. Thus, for a terminal with a resolution of 320X240 picture elements a memory containing 76,800 positions is required. If each pixel position requires 4 bits to represent both grey scale images and simple colour displays then 40K bytes of memory is required. This size memory requires about twenty, 16K bit, random access memory circuits for implementation. Alternatively, the display memory could be built from the much larger CCD (charge coupled device) memory chips now available. These chips are serial devices and contain 64K bits on a chip, but they are expected to increase in size to 256K bits within the next few years. This size is almost large enough for a 320X240X4 bit display memory, but the suitability of a single chip memory will depend on its internal organization and speed. A CCD memory looks promising for obtaining cheaper terminals in the future but due to its serial nature, it takes longer to access individual points in memory when generating stored images. In reading the output of CCD memories and displaying the signals on a television screen, its serial nature is of little consequence. Either random access or CCD memories could be used equally well. In either case, the output signals to the Red, Green and Blue (RGB) inputs of a display are read in synchronism with the 525-line television signal.

5. FUTURE DEVELOPMENTS

The Picture Description Instructions described in this report provide a means of coding graphic images for storage, transmission and interpretation such that the coding is virtually independent of the terminal configuration and communications channel. Pictures described by these means allow both forwards and backwards compatibility; that is, terminals need not immediately become obsolete if a system is upgraded to provide more precise data for specialized terminals. Older terminals merely interpret data in the best way they can, and newer terminals are not constrained by the design criteria of older terminals.

The initial use of Telidon terminals which receive PDI codes will be to access data contained in large information banks. The Telidon terminals are not intended to generate data nor communicate with each other, but these are future possibilities. There are a host of possible scenarios through which terminals originally designed for Videotex services might evolve to provide additional future capabilities. Some of the areas in which development might occur are;

- direct access to large blocks of data containing many pages of information for off-line perusal.
- downline loaded computer programs for entertainment or other purposes.
- subscriber generation of pictures and,
- subscriber-to-subscriber communications with textual messages and graphic images.

The PDI codes are specifically designed to describe pictures in terms of geometric drawing primitives. The PDI set is an extensible code which allows the introduction of additional features. The first codes envisaged for extension are in the area of manipulating a displayed picture. Manipulation features would entail selective erasure, and additions and modifications to previously generated images. An extension beyond this would be the introduction of even more powerful graphic-modifier instructions to permit rotation, scaling and transposition of portions of the displayed image. Instructions for generating images might be called Picture Manipulation Instructions or PMIs, and will be needed by information suppliers to generate the images for storage in information banks. These instructions would allow information suppliers, or others with appropriate terminals, to generate and manipulate their own images using interactive devices such as a joy-stick or light-pen.

In the future, even higher level instructions might be used for communication between two people in an interactive subscriber-to-subscriber mode of operation. Instructions at this level might consist of communicating interactions with specified objects. Research into this form of communications is being actively pursued at the Communications Research Centre (3) and many of these principles are already being used by Norpak Limited, a Canadian manufacturer of sophisticated image communications terminals. One example of interactive communication between two people would be interactions between an architect and a client, perhaps, in the design of a house. Objects such as walls, doors, windows, etc. could be described in terms of PDIs. After transmitting the PDIs for each object, only interactions with each displayed object need be transmitted between the terminals. Thus, the house plan can be created with both client and architect seeing and having the ability to manipulate the same image on their individual display screens, by modifying and repositioning individual objects at various positions on the screen.

The scenarios presented above are only a few of the many possible extensions to a Videotex service which may evolve. Since it is difficult to predict future needs it is impossible to provide an all-encompassing code set which will serve all future purposes. More powerful command codes could have been included but these coding schemes would not be cost effective for Telidon terminals at the present time. For this reason, the PDI codes include extension procedures to allow for future developments which could build on the present concept of terminal independent communication codes.

6. CONCLUSIONS

A method of describing images for storage in large information banks has been described. This method of representing images for Videotex systems is virtually independent of terminal configurations which means that future terminal design is not constrained by present day technologies. Similarly, stored information pertaining to today's terminal technology will still apply to future innovations in terminal design. In this way, the amount of information stored in large data banks can increase without having to be reformatted and possibly stored in numerous ways to accommodate both old and new terminal configurations.

The PDI codes are very efficient. The final resolution of displayed graphic images may vary from 60X80 (4800) picture elements for a character-oriented terminal, through 240X320 (76,800) elements for a medium resolution image displayed on a home TV receiver, to 960X1280 (1,228,800) elements, or more, for a high resolution business terminal. In each case the PDI codes describing the image are the same and may consist of less than 500 bytes for a simple picture, or only 3000 for quite a complex image. As can be seen, the efficiency improves as the resolution of the displayed output increases.

In our opinion, these Picture Description Instructions, or PDIs very similar to them, should be used to describe images in large information banks and should be used as the basis to transmit information, not only for local or national usage, but also for the transmission of information between data banks at the international level.

7. REFERENCES

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2. Altman, L. and Cohen, C.L., *The Gathering Wave of Japanese Technology*, Electronics, June 9, 1977.

3. Bown, H.G., O'Brien, C.D., Warburton, R.E., and Thorgeirson, G.W., *System Independence for Interactive Computer Graphics Applications Programs*, Proceedings, 4th Man-Computer Communications Conference, Ottawa, May 26 and 27, 1975.

APPENDIX A

Picture Description Instructions (PDI's)

This appendix provides a brief introduction to the Picture Description Instructions developed at the Communications Research Centre of the Canadian Department of Communications. It should be emphasized that this document provides preliminary information about a coding system which is undergoing experimental testing and therefore the details of these PDI codes may be altered and improved.

The Picture Description Instructions (PDI's) of the proposed code set are based on the premise of independence from specific terminal implementations. Although originally designed to provide good resolution images for Videotex applications, the instruction set may also be used for newly designed form processing equipment; digitally encoded facsimile systems; or other new equipment requiring the transmission of graphic images.

In its graphic mode of operation the PDI set describes images in terms of simple drawing primitives such as line, area, arc, etc.. Each drawing primitive consists of a number of 8-bit bytes (7 bits plus parity) of information which defines its function and associated co-ordinate parameters. As an example, a line is stored by specifying its end points. It is the responsibility of the terminal to decode this high level description and to draw the best line possible between the two end points. On a high resolution display terminal, finer increments are used to draw the same line than would be displayed on a low resolution terminal.

The seven instructions supported in the PDI set are POINT, LINE, ARC, AREA, POLYGON, BIT and CONTROL. There is room for one spare command which has not yet been defined. The first five instructions describe geometric primitives for alpha-geometric terminals. The "BIT" instruction is included as a means of describing photographic or facsimile-like images. The CONTROL instruction is used to control the attributes of the basic instruction set for the geometric and photographic modes of operation. Alpha-numeric text information is described in a manner similar to current communication practices. The seven PDI codes and the textual mode of operation are outlined below.

POINT – sets the drawing beam to any position in the display space and optionally draws a point.

LINE – draws a line based on its end points.

ARC – draws a circular arc based on the end points of the arc and its radius. The end points of the arc may be joined by a chord or by lines to the radius point and the area so defined optionally filled in.

AREA – draws a rectangular outline or fills in an area of specified length and width.

POLYGON – draws a polygonal outline or fills in the circumscribed area based on a series of defined vertices.

BIT – draws an image point-by-point, or run-length encoded, in a similar manner to the operation of facsimile equipment.

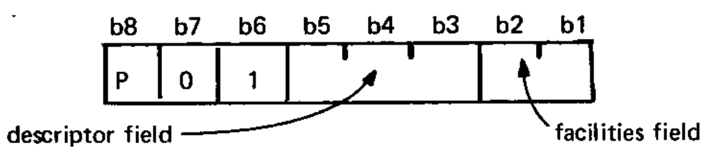
CONTROL – provides control over the modes of the drawing commands. One of its major functions is to set up a value or colour of an object.

The textual mode of operation is compatible with most business terminals. This is accomplished by switching from graphics to a textual mode of operation through an SI (Shift In) control code as defined in IS0646 and IS02022 standards for messages consisting of 7-bit character sets. The graphics control mode is re-entered by an SO (Shift Out) command. The textual mode of operation can be made compatible with future Teletex business terminal standards currently under discussion at international meetings on text communications.

An international coding standard, IS0646, defines the seven bit positions of a character code as b1 to b7 with b1 designating the least significant bit. An eighth bit may be used as a parity bit for error checking purposes. The bit values of bits 5, 6 and 7 are coded octally to provide a table of eight colums from 0 to 7 with 16 character positions in each column (bits 1 to 4). A table of designated character positions, taken from IS0646, is shown in Figure A1. In this table, columns 0 and 1 are reserved for designated control codes which are called a Co set. Two of the remaining 96 characters of the 128 character set is reserved for SPACE and DELETE. Designated characters of the Latin alphabet and other symbols are defined for the remaining 94 positions.

PDI graphics are analogous in many ways to the sentence structure of textual messages. That is, a number of sequential characters forming each instruction "word", each object may require a sentence for its description, and each picture is composed from a number of graphic sentences. Words may be short or long depending on the requirements of each particular graphics instruction. The first "character" in each work defines an operation code such as LINE, ARC, AREA, etc. These operation codes are identified by having b7=0 and b6=1. The remaining "characters" in each code word contain numeric data relevant to the PDI operation code, that is, relevant to the first character of each word. These data are identified by having b7 set to a "one". The length of a PDI code word is determined by monitoring the status of the most significant bit, b7. An example of a graphics message with variable length words was shown in Figure 5 in the body of the report and is reproduced as Figure A2 in this appendix.

PDI operation codes always have b7=0 and b6=1. The remaining five bits are subdivided into a three bit descriptor field and a two bit facilities field as shown below;

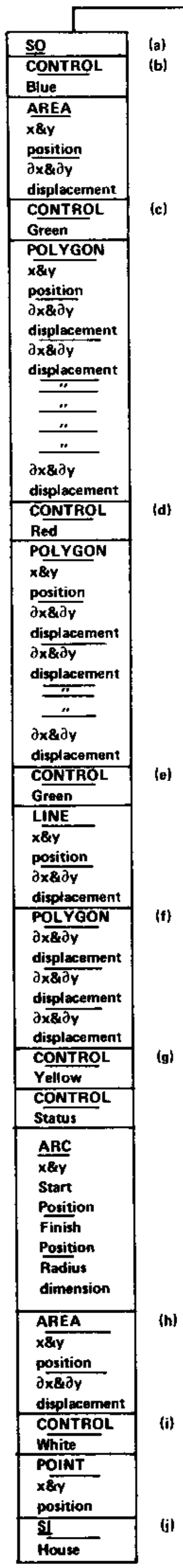


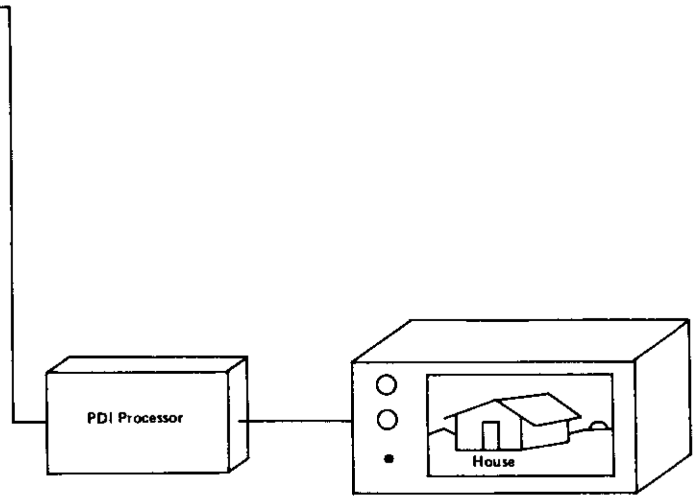
The descriptor field, consisting of bits b5, b4 and b3, contains a numeric identifier for each of eight possible opcodes. The eight opcodes are divided into six drawing commands, POINT, LINE, ARC, AREA, POLYGON and BIT, a seventh opcode is used for CONTROL which leaves one spare for further extensions to the PDI code set. An opcode is not needed for the TEXT mode of operation as this mode is invoked by the SI (Shift In) control word as defined in IS02022. The positions of PDI operation codes can be represented in tabular form and are shown in Figure A3. Each PDI code occupies four rows of the table, as each code has four variations which depend on the coding of the facilities field. The two bit facilities field is located in bits b2 and b1. The high order bit, b2, is used in each of the six drawing commands to indicate whether the command includes positioning information in the accompanying data. The low order bit, b1, has a different meaning for each drawing instruction.

Each drawing instruction includes co-ordinate data which immediately follows the opcode byte. These data are identified by having the most significant bit b7, set to a "one". Any number of bytes of co-ordinate, or other data, may follow a drawing command. The sequence is terminated when another opcode instruction is recognized. Each byte of co-ordinate data contains both x and y information in 3-bit "nibbles". Four bytes are needed to represent co-ordinate information to an accuracy of 12 bits. This is the default mode of operation, but other accuracies requiring more or less 3-bit nibbles can be used by specifying the required accuracy in a status word.

				b	0	0	0	0	1	1	1	1
				b_6	0	0	1	1	0	0	1	1
				b_5	0	1	0	1	0	1	0	1
b_4	b_3	b_2	b_1	column / row	0	1	2	3	4	5	6	7
0	0	0	0	0	NUL	TC_7 (DLE)	SP	0	@	P	`	p
0	0	0	1	1	TC_1 (SOH)	DC_1	!	1	A	Q	a	q
0	0	1	0	2	TC_2 (STX)	DC_2	"	2	B	R	b	r
0	0	1	1	3	TC_3 (ETX)	DC_3	#	3	C	S	c	s
0	1	0	0	4	TC_4 (EOT)	DC_4	¤	4	D	T	d	t
0	1	0	1	5	TC_5 (ENQ)	TC_8 (NAK)	%	5	E	U	e	u
0	1	1	0	6	TC_6 (ACK)	TC_9 (SYN)	&	6	F	V	f	v
0	1	1	1	7	BEL	TC_{10} (ETB)	'	7	G	W	g	w
1	0	0	0	8	FE_0 (BS)	CAN	(	8	H	X	h	x
1	0	0	1	9	FE_1 (HT)	EM	)	9	I	Y	i	y
1	0	1	0	10	FE_2 (LF)	SUB	*	:	J	Z	j	z
1	0	1	1	11	FE_3 (VT)	ESC	+	;	K	[	k	{
1	1	0	0	12	FE_4 (FF)	IS (FS)	,	<	L	\	l	|
1	1	0	1	13	FE_5 (CR)	IS (GS)	−	=	M	]	m	}
1	1	1	0	14	SO	IS (RS)	.	>	N	^	n	‾
1	1	1	1	15	SI	IS (US)	/	?	O	_	o	DEL

Figure A1. Column and Row Format of Alphanumeric Character Set from IS0646





(a) Shift Out (SO) to graphics mode

(b) Draw a blue background covering entire display area

(c) Draw a green foreground using a filled 8-sided polygon instruction

(d) Draw the walls of the house in red using a filled 6-sided polygon instruction

(e) Draw a green line to define the edge of the roof

(f) Proceeding from the present beam position draw the remainder of the roof using a filled 4-sided polygon instruction

(g) Draw a yellow sun using the arc instruction. Fill in the area between the chord and the end points of the arc.

(h) Draw a yellow door

(i) Set the colour to white and reposition the beam ready for text

(j) Shift In (SI) to alphanumeric mode and write "House".

Note 1. Positional and dimensional data is transmitted as four bytes of sequential information to provide a resolution of one part in ± 2048. The terminal truncates or rounds these co-ordinates to whatever degree of resolution has been incorporated in the PDI display processor

Note 2. Sequential PDIs specify the order in which the total image is drawn. Thus, newly defined areas may overlay previously drawn parts of the image and allows more efficient coding of the total picture.

Note 3. The simple drawing shown above can be described with 137 bytes of information using PDIs.

Figure A2. Sequential PDIs Defining an Image

<table>
<tr><td colspan="4"></td><td>b7</td><td>0</td><td>0</td><td>0</td><td>0</td><td>1</td><td>1</td><td>1</td><td>1</td></tr>
<tr><td colspan="4"></td><td>b6</td><td>0</td><td>0</td><td>1</td><td>1</td><td>0</td><td>0</td><td>1</td><td>1</td></tr>
<tr><td colspan="4"></td><td>b5</td><td>0</td><td>1</td><td>0</td><td>1</td><td>0</td><td>1</td><td>0</td><td>1</td></tr>
<tr><td>b4</td><td>b3</td><td>b2</td><td>b1</td><td>Row \ Col.</td><td>0</td><td>1</td><td>2</td><td>3</td><td>4</td><td>5</td><td>6</td><td>7</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>0</td><td>0</td><td colspan="2" rowspan="16">Co Control Codes</td><td rowspan="4">SPARE</td><td rowspan="4">AREA</td><td colspan="4" rowspan="16">Numeric Data</td></tr>
<tr><td>0</td><td>0</td><td>0</td><td>1</td><td>1</td></tr>
<tr><td>0</td><td>0</td><td>1</td><td>0</td><td>2</td></tr>
<tr><td>0</td><td>0</td><td>1</td><td>1</td><td>3</td></tr>
<tr><td>0</td><td>1</td><td>0</td><td>0</td><td>4</td><td rowspan="4">POINT</td><td rowspan="4">POLY</td></tr>
<tr><td>0</td><td>1</td><td>0</td><td>1</td><td>5</td></tr>
<tr><td>0</td><td>1</td><td>1</td><td>0</td><td>6</td></tr>
<tr><td>0</td><td>1</td><td>1</td><td>1</td><td>7</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>0</td><td>8</td><td rowspan="4">LINE</td><td rowspan="4">BIT</td></tr>
<tr><td>1</td><td>0</td><td>0</td><td>1</td><td>9</td></tr>
<tr><td>1</td><td>0</td><td>1</td><td>0</td><td>10</td></tr>
<tr><td>1</td><td>0</td><td>1</td><td>1</td><td>11</td></tr>
<tr><td>1</td><td>1</td><td>0</td><td>0</td><td>12</td><td rowspan="4">ARC</td><td rowspan="4">CONTROL</td></tr>
<tr><td>1</td><td>1</td><td>0</td><td>1</td><td>13</td></tr>
<tr><td>1</td><td>1</td><td>1</td><td>0</td><td>14</td></tr>
<tr><td>1</td><td>1</td><td>1</td><td>1</td><td>15</td></tr>
</table>

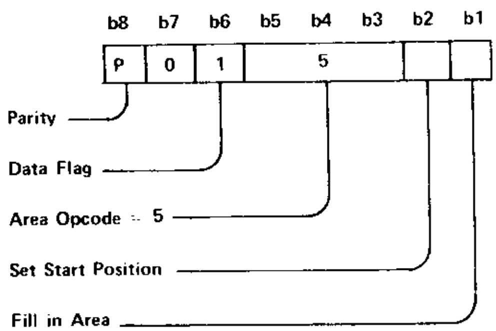
Figure A3. Tabular Representation of PDI Allocations

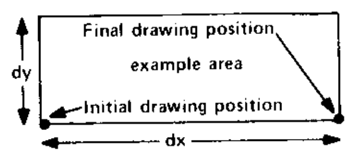
As stated previously, each drawing instruction has a two-bit facilities field. This means that each instruction can have four forms. The four forms of a PDI command are shown in Figure A4 with the AREA command used as an example. Detailed information on the PDI instructions will be published in future documents.

The CONTROL command has two major uses which are identified by one of the bits in the two-bit facilities field. The CONTROL command is used to indicate the Value, either grey scale or colour, of an object, and is also used to control Status functions. The Status functions are described by a second byte and are, in effect, extended opcodes.

The Value form of the CONTROL command indicates values for the three primary colours, Red, Green and Blue, or a Grey scale value for tonal images. The colour or grey scale function is identified by a previously specified status function. Data bytes following the Value command contain two bits for each colour, or 6 bits of grey scale, and any number of bytes may be included to obtain progressively increasing accuracy in colour or grey scale specifications. Normally, however, one byte would be sufficient as a single byte can specify 64 different colour combinations or 64 grey levels.

The status code of the CONTROL command is contained in the byte immediately following the control code. This byte may or may not be followed by extra bytes of data depending on its function. An example of a CONTROL status command is the command which specifies the texture of an object. The command, defined before an object is described, sets up one of four textures – solid, dotted, dashed or dot-dashed – and any of these textures may be used in drawing a line or filling a defined area. More detailed information on this command and other PDI codes are described in another report to be published in the near future.





- Draw a rectangular area of dimensions dx by dy where dx and dy are relative displacements
- If bit b1 = 0 only the outline of the area is drawn. If bit b1 = 1 the area is filled in. The fill pattern and colour are contained in previously specified status words. After drawing the area the resulting drawing position will be at the diagonally opposite corner of the area from the starting position.
- If bit b2 = 1 the starting drawing position is set to the positioning coordinates, included as part of the instruction, before drawing the rectangular area specified by the relative displacement coordinates. If b2 = 0 the area is drawn from the beam position resulting from the execution of the preceeding PDI.

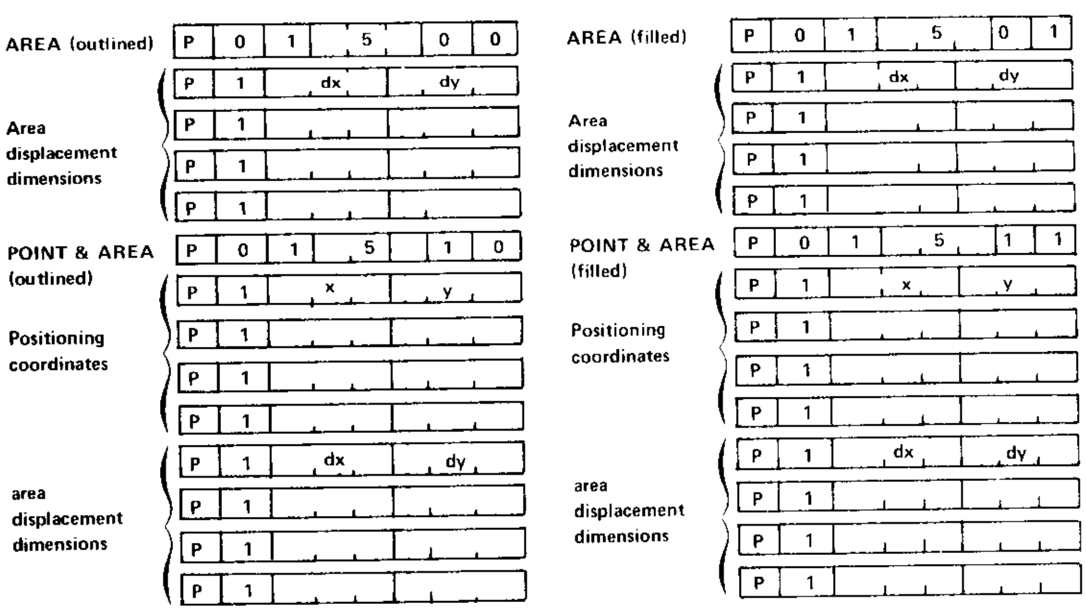
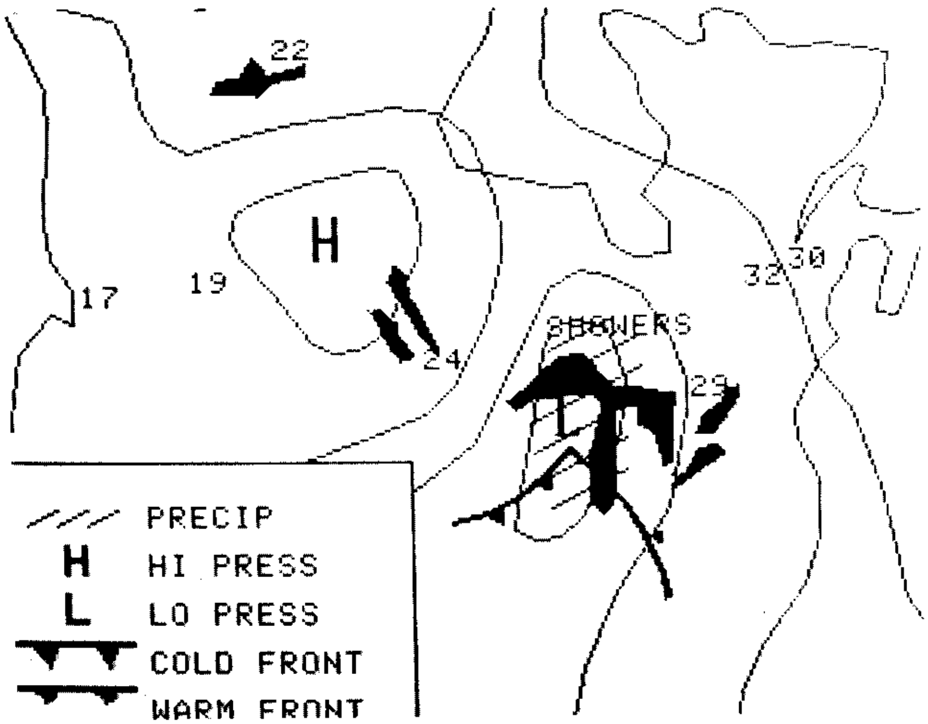


Figure A4. The Four Forms of an AREA PDI Sequence

APPENDIX B

Example Videotex Pages



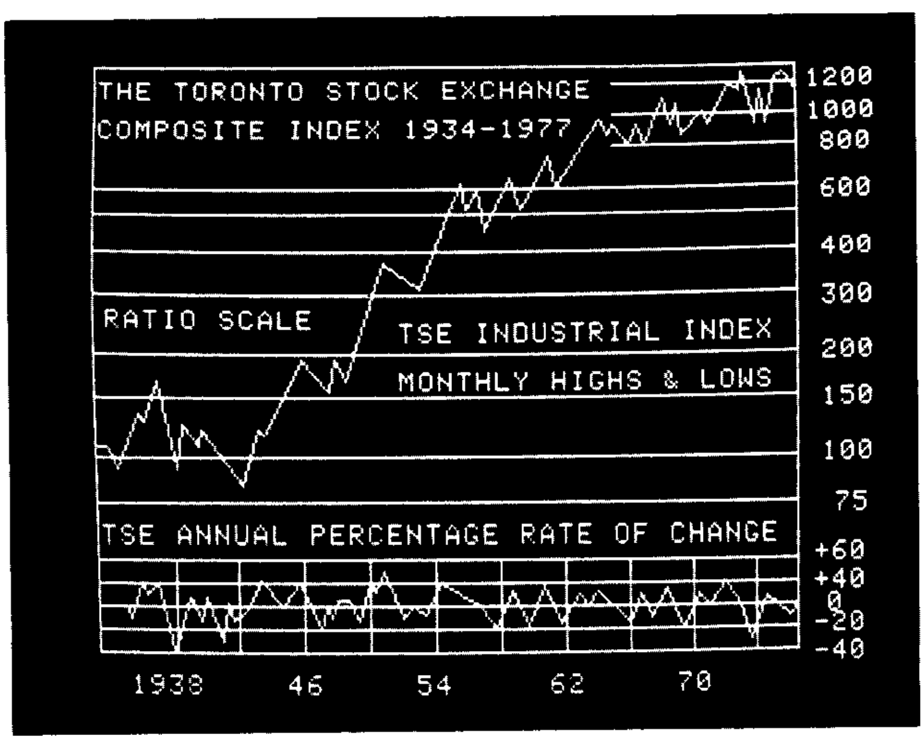
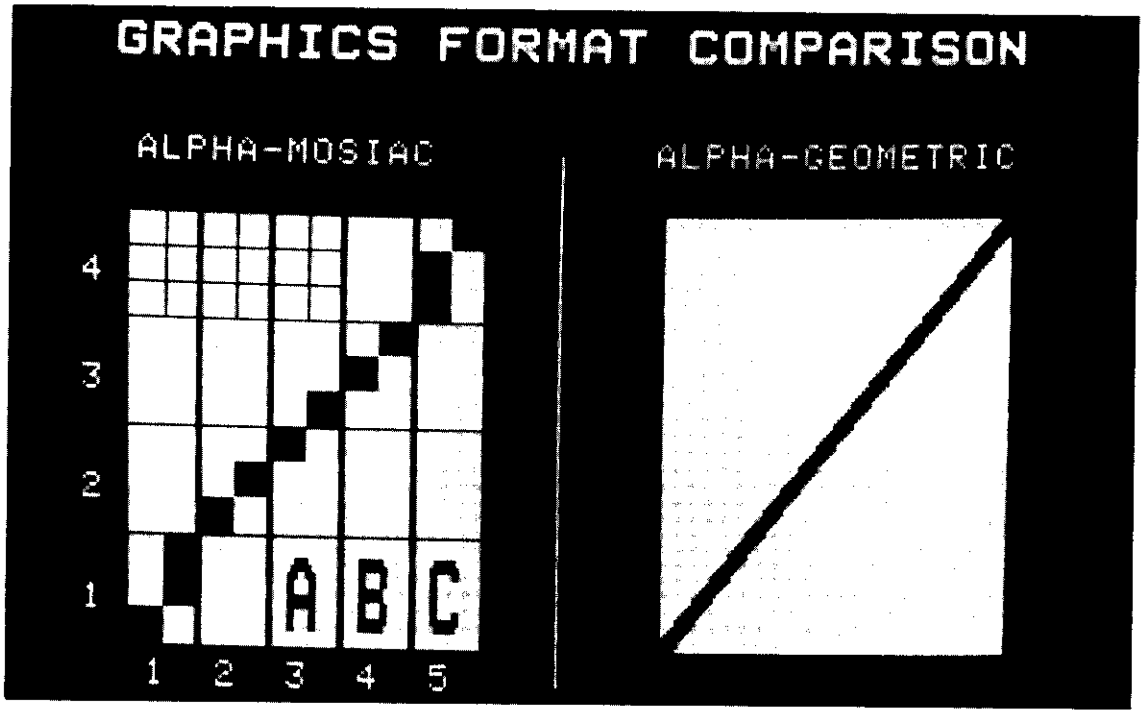


Figure B1. Examples of Descriptive Power of Alpha-Geometric Technique. (Black and White Photographs of Colour Television Display).



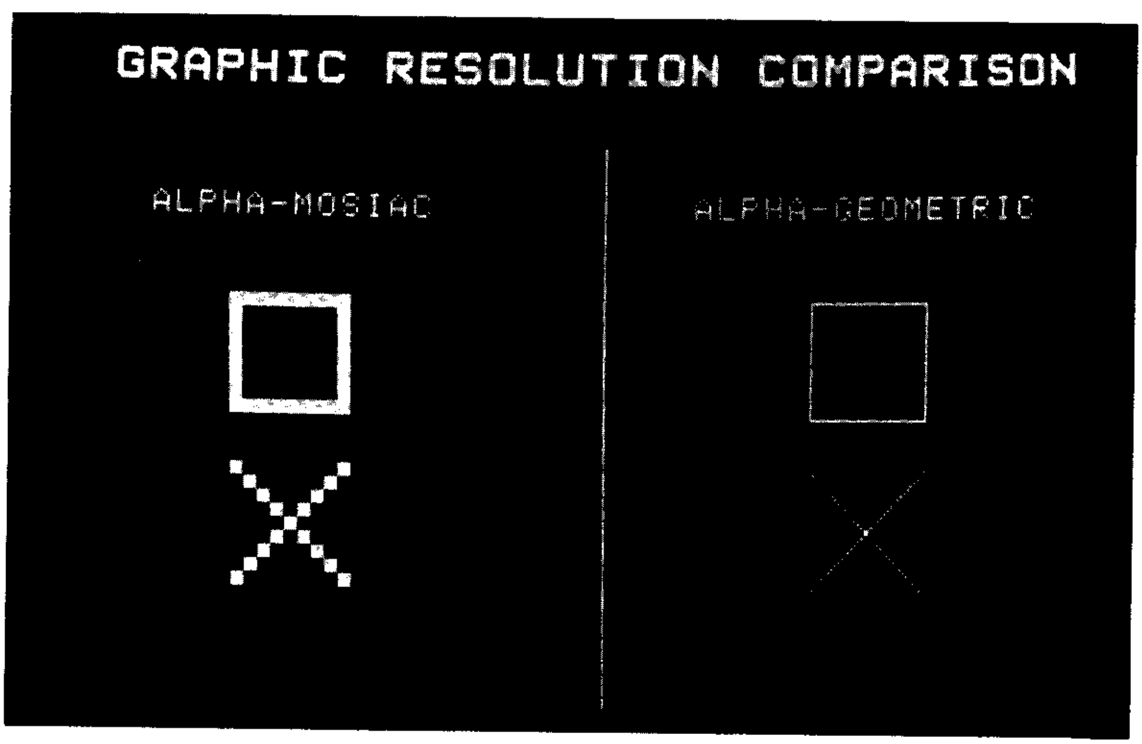


Figure B2. Comparisons of Terminal Display Capabilities for Images Described by Alpha-Mosaic and Alpha-Geometric Descriptors. (Photographs of Actual Display).

CRC DOCUMENT CONTROL DATA

1. ORIGINATOR: Department of Communications/Communications Research Centre

2. DOCUMENT NO: CRC Technical Note No. 697-E

3. DOCUMENT DATE: December 1978

4. DOCUMENT TITLE: A General Description of Telidon:— A Canadian Proposal for Videotex Systems

5. AUTHOR(s): H.G. Bown, C.D. O'Brien, W. Sawchuk and J.R. Storey

6. KEYWORDS:
(1) Videotex
(2) Telidon
(3) Canadian

7. SUBJECT CATEGORY (FIELD & GROUP: COSATI)

14 Methods and Equipment

14 07 General Concepts

8. ABSTRACT:

Videotex systems allow easy access, by the general public, to large computer-based information sources which contain pages of information to be displayed on suitably supplemented television receivers or newly designed Videotex terminals. Each page of information may contain both textual and graphic images.

Organizations in a number of European countries are promoting standards for Videotex systems based on an alpha-mosaic approach which limits the resolution of graphic images to a format far below the resolution capabilities of the display medium. With this approach, the future development of Videotex systems will be constrained, because images at the information source are described in a terminal-dependent manner with the same alpha-mosaic format used for their displays. Once this format is adopted it will be difficult, if not impossible, to update information source files in a manner suitable for both present and future, more advanced, Videotex terminals.

A new terminal-independent method of describing images is suggested in this report. Images are described as either alpha-geometric or alpha-photographic images by means of Picture Description Instructions (PDI's). This new approach permits the growth of large information bases, through terminal independence, which would not have to change to accommodate new developments and improvements as new technologies become available in the foreseeable future.

9. CITATION: