IMAGE UNDERSTANDING WORKSTATION

Status and Documentation Report

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1.0 INTRODUCTION AND PURPOSE

Under DARPA contract number F-33615-76-C-1203, the Image Processing Institute at the University of Southern California has undertaken the responsibility to purchase and integrate the system and generate the necessary software and documentation to provide an IU Workstation for DARPA. The purpose of the IU Station is to provide the latest hardware necessary to analyze and study images. A previous status report was written on March 31, 1980. This report includes more details on the hardware peripherals, and software which have been implemented, and its operation in order to serve as a user's manual.

2.0 GENERAL SPECIFICATION AND DESCRIPTION

This section discusses the specification and general description of the hardware and system software components as shown in figure 1.

2.1 PDP11/34A Processor

The 11/34 contains a memory management hardware feature which allows addressing up to 248K bytes, although the system currently has only 192K bytes of MOS memory. The uppermost 8K bytes (above 248K to 256K) is predefined as an I/O page for control and transfer of data to external devices. Addressing can be done at the byte (8 bit) as well as the word (16 bit) level. The MOS memory actually contains 18 bits per word since two bits (1 bit/byte) is used for parity. Parity is generated and checked on all references between the CPU and the MOS memory. The front panel console (KY11-LB) contains a 20-key keypad which can be used for displaying and addressing data, depositing data, examining the contents of the UNIBUS addresses and registers, and single-stepping the processor one instruction at a time. An automatic bootstrap loader allows restarting the operating system from an external device (terminal).

2.2 RL01 Disk Drive

The RL01 is a top loading, cartridge disk drive with a capacity of 5 megabyte per drive. The system contains two drives although it has a capacity of four drives. The storage medium is a 5440 type disk cartridge which has one platter with two recording surfaces, each containing 256 tracks. The average and maximum seek time is 55 and

100 milliseconds respectively.

2.3 RSX11M-V3.1 Operating System and Utilities

The RSX11M is a multi-user, real-time executive operating system (O/S) for PDP11 processors. The version of the O/S being used is V3.1 although the latest version currently available from DEC is V3.2.

The utilities implemented on the system for use by the user are:

(1) Peripheral Interchange Program (PIP)

PIP is a file transfer program used primarily to transfer files from disk to disk. It also provides a means for listing, copying, renaming, deleting, and unlocking files.

(2) File Transfer Program (FLX)

FLX is a file conversion program for transferring DOS-11 or RT-11 files to Files-11 volumes and vice versa, but the primary use of FLX on this system is for transferring files between disk and tape drive.

(3) Text Editor (EDI)

EDI is an interactive editing program for creating and maintaining text files.

(4) Librarian (LBR)

LBR is a library maintenance program for creating, modifying, updating, listing, extracting, and maintaining library files.

(5) Macro-11 assembler (MAC)

MAC is a 2-pass assembler for use by source programs written in assembly language to be converted to an object (code) module. It also generates a list file.

(6) FORTRAN Compiler (FOR)

FOR compiles a program written in FORTRAN and converts it to an object module.

(7) Task Builder (TKB)

TKB links the object module (generated by the Macro assembler or FORTRAN compiler) with other object modules, resolves any system library references, and produces a single executable task.

(8) Disk Save & Compress (DSC)

DSC is used to copy files from disk to tape for backup and storage.

Additional information and use of the utility programs can be obtained by referring to the respective DEC RSX11M reference manual. A set of manuals bound in six binders are available covering the following topics:

(1A) Beginner's guide, introduction to RSX11M, system generation, executive, crash dump analyzer

(1B) Macro-11, task builder, system library routines

(1C) I/O drivers, I/O operations

(2A) Utilities procedures, operator's procedure, ODT

(2B) Guide to writing I/O drivers, error logging, user mode diagnostics, disk save and compress, preserve, editor

(4C) FORTRAN Language, FORTRAN IV user's guide, FORTRAN IV installation

2.4 9300 Tape Drive

The Kennedy 9300 is a 9 track, 800/1600 bpi, synchronous digital magnetic tape drive with a tape speed of 125 ips. The data transfer rate is 100 kHz at 800 bpi and 200 kHz at 1600 bpi. Tape width is 0.5 inch and capacity is 2400 feet. The reel diameter is 10.5 inches maximum. The tape controller (by Western Peripherals) has a capacity of four drives, although currently, the system has only one tape drive.

2.5 Vision One/20 Digital Display

The Comtal Vision One/20 contains three 512 by 512 by 8 bit RAM memories which can be displayed as three monochrome images or one color image. The image can be zoomed by a factor of 2 or 4 and also roamed. The four 512 by 512 by 1 bit graphic planes can be overlaid individually or together on any image, or it can also be displayed independently without an image. Three 256 by 8 bit function RAM memories can be used to transform the true image (i.e., equalized function). The function memory can also be used to display the result of an image histogram, etc. A red, green, and blue pseudo color

memory (256 by 8 bit each) are used to translate a monochrome image into a pseudo (false) color display. The trackball target provides a means for operator interaction with the display. Control and processing within the Vision One/20 is performed by the DEC LSI-11/2 micro-computer and its associated firmware (version G). Access to the firmware is via the Vision One/20 keyboard or from the PDP11/34 through a Comtal DMA interface. Additional information can be obtained by referring to the Vision One/20 users manual.

2.6 Digital Video Image Processor (DVIP)

The Comtal DVIP and a Hamamatsu TV camera are used to digitize images in real-time. The DVIP sums and averages up to 64, 128, 192 or 256 (selectable) video frames, thereby reducing the random noise. The noise figure is reduced by (approximately) the square-root of the number of frames integrated. The DVIP can also acquire a single frame in 1/30th second. Bias (dark level) and gain (shading) correction are performed on the acquired image. The summing image RAM memory is 512 by 512 by 12 bit/pixel, but the final averaged image is converted to log and stored as 8 bit/pixel. The bias and gain are stored as a 256 by 256 by 7 and 6 bit values respectively and interpolated back to a (nearly) 512 by 512 by 6 bit value when used. The Hamamatsu C1000-01 camera has a chalnicon pickup tube and was selected for its high sensitivity, resolution, and geometrical stability. More detailed information can be obtained by referring to the DVIP manual and the Hamamatsu instruction manual.

2.7 TIP Data Link

The data link to the TIP port LIU is used to receive images over the ARPANET at a band rate of 1200. The interface within the PDP11/34 to receive the image uses a standard DEC DL11/W asynchronous line interface card.

2.8 ECL Data Link

The ECL data link is used to transfer images between the ECL DEC Ten and the Vision One/20 or the PDP11/34 RL01 disk. Data is transferred as a 16 bit word using a DR11C I/O card on both ends.

3.0 HARDWARE CONFIGURATION

3.1 System Configuration

The system hardware configuration is shown in figure 1 and a photograph of the system is shown in figure 2. Referring to figure 1, the PDP11/34A standard peripheral devices have a 2-character device name and an optional 1 or 2 digit octal number followed by a colon as follows:

TT0: Terminal #0 or console

TT1: Terminal #1

DL0: RL01 disk dive #0

DL1: RL01 disk drive #1

MT0: 9300 tape drive #0

TT0 is used as the console device and is required by the PDP11/34 processor, while TT1 is an optional CRT terminal using a DL11W asynchronous interface card. DL0 is assigned as the system disk and stores the RSX11M-V3.1 operating system, utility software, and user drivers. DL1 stores user programs and a limited number of images, and serves as a temporary working storage area for editing, compiling, etc. Since images are normally stored on mag tape, the Kennedy tape drive (MT0:) serves as a medium to transfer images to (or from) the Vision One/20. Each peripheral device has an I/O card or controller mounted in the PDP11/34 processor box and must be assigned a unique address (in the I/O page) and an input or output (or both) interrupt vector. The assignments for this system are as follows:

Vector	CSR Address	I/O Card	Device or Driver Name
60	177560	DL11	TT0: Console
160	174400	RL11	DL0: &DL1: Disk Drive
224	172522	TC130**	MT0: Tape Drive
300	167770	DR11C	ZC0: ECL Data Link
310	167760	DR11C	ZM0: Muirhead (not used)
320	167750	DR11C	ZC1: (not used)
330	162710	VRG*	ZB0: Vision One/20
340	167740	DR11C	ZP0: DVIP
370	176540	DL11W	TY0: TIP Data Link
400	176510	DL11W	TT1: Terminal
410	176520	DL11C	TT2: Terminal
430	167730	DR11C	ZH0: HP Multi-Programmer

Note: *VRG is a Comtal DMA controller equivalent to the DEC DR11B.
**TC130 is a Western Peripherals tape controller equivalent to the DEC TM11.

3.2 Vision One/20

Figure 3 is a system block diagram of the Vision One/20 with all possible options. The IU system at USC-IPI contains only the CSIO/VRG option to interface the Vision One/20 to the PDP 11/34, the PMEM program (actually an EPROM) card which stores the Vision One/20 operating system (version G), and the trackball. The block diagram shows a 3 bus system in which the Q-bus is a standard LSI11/2 address/data bus, the P-bus is an internal hardware address/data bus,

and the Data-bus transfers high speed data such as from memory to memory. Figure 4 shows the cable interconnection as well as the Vision One/20 cards and their connector locations. REFM at location J21 is a graphic refresh RAM memory card, while image memory 1, 2, and 3 are at locations J13, 14, 15, 16, 17, and 18. SYSC card at J01 contains the DEC LSI11/2 microcomputer. ANDV card at J05 serves as an interface to the trackball and keyboard. CSIO at J07 is a standard interface card to an external processor. It requires a VRG DMA card in the PDP11/34. A set of switches on this card is used to select the proper address and vector. DAC at J30 contains three 8-bit digital to analog converters. The composite sync is also generated on this card and can be re-positioned by use of straps. More detailed information can be obtained by referring to the Vision One/20 users manual.

3.3 Digital Video Image Processor (DVIP)

The DVIP and the interconnection with its peripheral devices is shown in figure 5. The Hamamatsu C1000 control unit is externally synchronized from the DVIP via the vertical and horizontal sync signals which also drive the CRT monitor. If a monitor requiring composite sync is used, the comp sync is available.

In the DVIP box, the camera video is digitized by the 8 bit VIDC A/D converter card at location J14, summed in the DVPACQ card at J16 and stored in the image memory REFM at J18, J20, and J22, but the final image is stored as a 512 by 512 by 8 bit image in J18 and J20. The bias and gain values are stored as a 256 by 256 by 7 and 6 bit array in the REFM card at J16, and interpolated back to a (nearly) 512

by 512 by 6 bit array in the DVPINT interpolate card at J28. Five toggle switches were added to the back of the DVIP control panel. One switch sets the DVIP in the local or remote mode while two other switches select the number of image frames (64, 128, 192, or 256) to be acquired in the local mode. Two additional switches allow a single frame to be acquired, either in linear or log density magnitude.

The 8 bit D/A converter DAC at J32 converts the image to a video signal to be displayed by the CRT monitor. The gain and bias values can also be viewed as a 3-dimensional image or in chart form. DVPIO at J10 is a special interface card designed at USC-IPI to allow direct random read or write access to the image memory and transfer it to (or from) the PDP11/34 via the transceiver cards in the interface card cage and the DR11C I/O card in the PDP11/34.

3.4 Data Link

The data link which uses a DL11-W asynchronous line interface card in the PDP11/34 must be connected to a TIP LIU port via a jumper which reverses the data send and receive lines and the enable lines. A separate TIP LIU port must be used to send commands to transfer the image data over this line. This DL11/W card uses a special (TY:) driver rather than the normal terminal (TT:) driver in order to increase the data transfer rate to 1200 baud.

3.5 ECL Data Link

The ECL data link uses a DR11C I/O card in the PDP11 and a set of differential line drivers and receivers in the interface card cage on both the PDP11/34 and EC1 end to transmit 16 parallel bits over the 150 feet cable. A diagram of the ECL data link and its relationship with interface card cage is shown in figure 6. The DR11C card on the PDP11/34 side uses the ZC driver.

4.0 USER SUPPORT SOFTWARE

4.1 TOP

This program is intended to provide a work station environment for the image oriented user. Processing functions, analysis aids, and utility routines are included in a single package.

4.1.1 Initiating TOP

Before running TOP, the user should power on and reset the Vision One/20 and any other peripherals that will be needed. The program is run by typing:

>TOP <CR>

at the monitor level. The user should then see the command prompt:

command>>>>

Commands are then entered as combinations of the keywords detailed in Section 5.3. Note that as each keyword is entered, only enough characters are accepted to identify the unique command. Improper or unnecessary input will be ignored. The magic terminator in this system is the space bar, which will work in any situation which requires a terminator. The carriage return and escape serve to abort the command line being input, and will work at any time input is being accepted.

4.1.2 TOP Command Lines

Command lines are formed by entering combinations of keywords. Once a command keyword is entered, other keywords will be accepted

only if they combine with the previous entries to form a defined command. Often typing a space will insert a default keyword for the next entry. In case the wrong keyword is entered, the user can escape to the command prompt level by typing an escape or carriage return. In the following command line summary, all the acceptable keyword combinations are listed. Note that <sp> indicates a user typed space, <n> represents a user typed single digit number, <nnn> represents a multiple digit number (terminated by a space), and any other strings enclosed by angle brackets <> indicate some type of user response. User typed characters are represented in upper case, while computer prompting is shown in lower case. While running the program, all text is seen as upper case.

Command Line Summary

ADd Constant <nnn><sp> to image <n>

ADd Image <n> to image <n>

CLear Graphic <n>

CLear Image <n>

COLor graphics channels:
graphics 1: <COLOR>
graphics 2: <COLOR>
graphics 3: <COLOR>
graphics 4: <COLOR>
target: <COLOR>

COMpliment Graphics <n>

COMpliment Image <n>

DISplay Function memory <n>

DISplay Image <n>

DISplay Image <n> Function memory mapped

```
DISplay Image  <n> Function memory mapped Pseudo color mapped

DISplay Image  <n> Pseudo color mapped

DISplay Pseudo color memory

DISplay TEst pattern BArs

DISplay TEst pattern BLack screen

DISplay TEst pattern Dots

DISplay TEst pattern Grey scale

DISplay TRuecolor

DISplay TRuecolor <COLOR> <COLOR> <COLOR>

DISplay TRuecolor <COLOR> <COLOR> <COLOR> Function memory mapped

DIVide image  <n> by constant <nnn>

EDge     sobel edge (3x3)
         horizontal edge magnitudes
         vertical edge magnitudes
         choice: <any of the above>

EXit

FIll Image  <n> with value <nnn>

FIll Graphics  <n> with value <n>

FUnction memory utilities
     options are:
             brightness control
             draw
             linearize
             map image
             negative linearize
             segment
             threshold
             window
     option: <any of the above>

HIstogram image  <n>

HElp

MASk utilities:
      mask and:
               Fill with value <nnn>
               Insert in image  <n>
```

```
                Move and insert in image  <n          Output
      mask and: <any of the above>

MAGnify image  <n> by Interpolation by factor <n>

MAGnify image  <n> by Replication by factor <n>

MInify image  <n> by Averaging by factor <n>

MInify image  <n> by Sampling by factor <n>

MOve Image  <n> to Image  <n>

MOve Image  <n> to Graphics  <n> threshold value: <nnn>

MOve Image  <n> to Tape

MOve Image  <n> to Tape Size option:
          width: <nnn>
          length:<nnn>

MOve Image  <n> to TEnex file <file.ext>

MOve Image  <n> to TEnex file <file.ext> Size option:
          width: <nnn>
          length: <nnn>

MOve Image  <n> to DISk file <file.ext>

MOve Image  <n> to DISk file <file.ext> Size option:
          width: <nnn>
          length: <nnn>

MOve Image  <n> to DIGitizer

MOve TApe to Function memory  <n>

MOve TApe to Pseudo color memory  <n>

MOve TApe to Graphic  <n>

MOve TApe to DISk file <file.ext>

MOve TApe to Image  <n>

MOve TApe to Tenex file <file.ext>

MOve TApe to DIGitizer

MOve TEnex file <file.ext> to Image  <n>

MOve TEnex file <file.ext> to Graphic  <n>
```

```
MOve TEnex file <file.ext> to Function memory  <n>

MOve TEnex file <file.ext> to DISk file <file.ext>

MOve TEnex file <file.ext> to DIGitizer

MOve TEnex file <file.ext> to Tape

MOve TEnex file <file.ext> to Pseudo color memory

MOve DISk file <file.ext> to DISk file <file.ext>

MOve DISk file <file.ext> to Function memory  <n>

MOve DISk file <file.ext> to Graphic  <n>

MOve DISk file <file.ext> to Image  <n>

MOve DISk file <file.ext> to Pseudo color memory

MOve DISk file <file.ext> to DIGitizer

MOve DISk file <file.ext> to TApe

MOve DISk file <file.ext> to TEnex file <file.ext>

MOve Function memory  <n> to TApe

MOve Function memory  <n> to Disk file <file.ext>

MOve Function memory  <n> to TEnex file <file.ext>

MOve Pseudo color memory to TApe

MOve Pseudo color memory to Disk file <file.ext>

MOve Pseudo color memory to TEnex file <file.ext>

MOve DIGitizer to Disk file <file.ext>

MOve DIGitizer to Graphic  <n> threshold value: <nnn>

MOve DIGitizer to Image  <n>

MOve DIGitizer to TApe

MOve DIGitizer to TEnex file <file.ext>

MUltiply image  <n> by constant <nnn>

PRint pixels from Tape
          first row: <nnn>
          number of rows: <nnn>
```

```
          first column: <nnn>
          Number of columns: <nnn>

PRint pixels from Image  <n>
          first row: <nnn>
          number of rows: <nnn>
          first column: <nnn>
          number of columns: <nnn>

PRint pixels from Disk file <file.ext>
          first row: <nnn>
          number of rows: <nnn>
          first column: <nnn>
          Number of columns: <nnn>

Pseudo color utilities:
           choices are:
                   insert
                   fill
           map to truecolor
  option: <any of the above>

Quit

SEquence images  <<n> or <sp>>   <<n> or <sp>>  (etc.)

SMooth image  <n>

STatistics for image  <n>

SUbtract Constant from image  <n>

SUbtract Image  <n> from image  <n>

TApe utilities:
        rewind
        space files <n>
        space blocks <n>
        map
        write eof marks    =<n>
        choice: <any of the above>

Unsharp mask image  <n> with constant <n.nn>
```

4.2 Vision One/20 Operating System

The current version of the Vision One/20 operating system (O/S) is version G. The O/S is stored in an EPROM, therefore it can be

easily updated with a newer version at a future date. The O/S is uniquely configured for the specific hardware/software options in each user's system. Therefore, the O/S knows what physical refresh memories for the images and graphics exist, what hardware option cards are included, and what software options the user requested. When the system is powered on, the O/S checks to see which memories are physically in the system. For example, if one image memory is physically removed from an original three image memory system, the O/S will define only two images and it will know it cannot define a trucolor image. User interaction with the system is through a keyboard-oriented command language featuring a standard vocabulary of over 150 commands as listed in Appendix B.

4.3 Digital Video Image Processor (DVIP)

The DVIP software is discussed only briefly since it is covered in detail in the DVIP manual. The 'ZP' driver for the DR11C card consists of the ZPDRV.MAC driver code and the ZPTAB.MAC data table. VP.MAC is a set of FORTRAN callable subroutines which consists of:

1) CALL VPSTAT(SYBUSY, RDBUSY, WRBUSY, VERT)
   to read the DVIP status word

2) CALL VPCTL(XSTRT, XLEN, LSTRT)
   to write the DVIP control word

3) CALL VPRDD(BUFF, XLEN)
   to read the DVIP memory

4) CALL VPWDD(BUFF, XLEN)

to write to the DVIP memory

5) CALL VPACQ(MODE[,FCNT])

to write the DVIP acquire command word

DVIP.FTN is a FORTRAN program to transfer a 512 by 512 by 8 bit image between the DVIP and the Vision One/20 via the PDP11/34. Operation of the DVIP program is discussed in section 5.3.5.

4.4 Arpanet Image Transfer

The following programs are required for the transfer of an image from a directory on the ECL TEN to the Vision One/20 via the Arpanet. The method for running the programs are discussed in section 5.3.6.

(1) DL11W 'TY' Driver

TYDRV.MAC and TYTAB.MAC are the driver code and the data table for the 'TY' nonresident device driver. Instead of using DEC's standard 'TT' driver for the DL11W asynchronous interface card, the 'TY' driver was written to increase the overall transfer baud rate. The baud rate was increased from 600 to 1200 by having a dedicated driver for the DL11W card and eliminating nonessential software options in the 'TY' driver which are standard in the 'TT' driver. The 'TY' driver uses a CSR address of 776540 and a vector of 370.

(2) RTTV34 User Program

RTTV34.FTN is a FORTRAN program on the PDP11/34 which is used to

receive a 256 by 256 or 512 by 512 pixel image or graphic, or a 256 byte function memory data, from a TIP port via a D111 card, and transfers the image to the Vision One/20.

(3) CRTTV Transfer Program

CRTTV.FOR is a FORTRAN program (by James Wiedel) on the ECL TEN which is used to transfer an image from a directory on the ECL TEN to the TIP port.

5.0 OPERATING PROCEDURES

5.1 Bringing the System Up and Down

5.1.1 Bringing the System Up

5.1.1.1 PDP11/34 System

(1) Turn on power to Decwriter Terminal (TT0:)
Note-should be in FDX (up), on-line (up), 300 baud rate (down), and cap-lock (down)

(2) Turn on power (DC-ON switch) to 11/34
Note-this power may be left on continuously during the weekdays if the air-conditioner is working properly

(3) Depress LOAD switch on DL0 and DL1 disk drives (only after they have lit)
Note-LOAD switch lamp will turn off immediately and READY lamp will turn on after several seconds

(4) Depress CNTRL/HLT followed by CNTRL/BOOT on the 11/34
Note-CNTRL/HLT implies CNTRL must be depressed while HLT is pushed

(5) After the TT0 prompts with an '@' sign, type the following on TT0:

DL <CR>

where <CR> is the carriage return key

(6) Wait until TT0 ask for the time, then enter the time. For

example:

8:15 20-NOV-80 <CR>

Note-typing <CR> without the entering time will default to the sysgen time

(7) Wait until the startup task logs out and TT0 types the system monitor prompt '>', then login at TT0 or at a CRT terminal TT1 (or TT2) by typing:

HEL GUEST<CR>

Password:GUEST<CR>

Note-HEL is short for HELLO

Log out is done by typing:

BYE<CR>

5.1.1.2 Kennedy 9300 Tape Drive

(1) Turn on (depress) the POWER switch

(2) Set the DENSITY SELECT switch to 800 or 1600 cpi

(3) Mount the tape on the upper reel hub assembly and thread the tape as shown on the diagram on the inside of the front cover. Close the front cover.

(4) Depress the LOAD switch and wait until the tape stops at the load point

(5) Depress the ON-LINE switch

Note - the switches under the top cover are not used for normal

operation - only the STOP switch should be in the depressed position and the tape drive number switch should be set at 1

5.1.1.3 Vision One/20

(1) Turn on the POWER (red lamp switch on the front panel)

(2) Depress the space bar on the keyboard

Note-after several seconds of warm up, straight vertical white and black bars will appear on the Conrac monitor and a green asterisk prompt will appear at the bottom line of the monitor. The Vision One/20 O/S can be restarted by typing SHIFT/TILDA followed by an R (or space bar) key.

5.1.1.4 DVIP

(1) Turn on the POWER (red lamp switch on the front panel) to the DVIP

Note-this will also turn on the monitor power

(2) Turn on the POWER to the Hamamatsu camera control unit - allow several minutes of warm-up time

(3) On the DVIP control panel box, set:

(a) system input rotary switch to CAMERA

(b) system output rotary switch to INPUT

(c) system output IMAGE/CHART switch to CHART

(d) toggle switch on rear of box to REMOTE

(4) Turn on the power to the light table if it is being used for

input

(5) The +5V power supply to the horizontal pulse width adjust box should (always) be on

(6) Check to see that the camera video noise level displayed on the monitor chart is within 0% to 25% of full scale
Caution-no external adjustments are to be made (only an internal camera pedestal adjustment will affect this level)

(7) Remove the camera lens cap and with the camera focussed on a uniform field corresponding to the maximum brightness level check to see that the camera video level displayed on the monitor chart is within 75% to 100% of full scale. Adjust first by changing the camera lens f-stop and/or by placing neutral density filters in front of the lens. If its still out of range, adjust the camera control unit BEAM voltage knob (this should not be necessary normally)

(8) Switch the IMAGE/CHART switch to IMAGE, and focus the camera on the object to be digitized.
Note - it may be necessary to increase the brightness on the monitor

(9) CAUTION - keep the lens cap on whenever the camera is not being used; also turn off the power to the camera control unit when removing or exchanging camera lens

5.1.2 Shutting the System Down

5.1.2.1 PDP11/34 System

(1) While logged in, type:

RUN SHUTUP<CR>

When asked for minutes to wait before shutdown, type:

0<CR>

Wait until the system types

***DL0:--Dismount Complete

and ***DL1:--Dismount Complete

Note-a faster but not recommended method is to depress the CNTRL/HLT switch

(2) Depress the LOAD switches on DL0 and DL1

Note-the READY lamp will turn off immediately and the LOAD lamp will turn on after several seconds

(3) Turn off the power to the Decwriter terminal and any other terminals in use

(4) After the LOAD lamps have turned on in step 2, turn off the power (DC-OFF) to the 11/34

Note-this power need not be turned off during the weekdays, if the air-conditioner is working properly.

5.1.2.2 Kennedy 9300 Tape Drive

(1) Depress (turn-off) the ON-LINE switch

(2) If a tape is mounted and is not at the load point, depress the REWIND switch and wait for the tape to rewind and stop at the load point.

(3) Depress REWIND again and wait until the tape rewinds again and is out of the vacuum chamber

(4) Turn off the POWER

5.1.2.3 Vision One/20

(1) Turn off the POWER (depress red lamp switch on the front panel)
Note-this will also turn off the monitor power

5.1.2.4 DVIP

(1) Turn off the power to the light table if it is in use

(2) Turn off the POWER to the Camera Control Unit
Note-insure that the camera lens cap is on and the camera is not stored with the lens pointing down

(3) Turn off the POWER to the DVIP
Note-this will also turn off the monitor power

5.2 PDP11/34 Operating Procedures

5.2.1 File Specifier

The RSX-11M O/S has a standard format for referring to files and has the form:

dev:[g,m]filename.type;version/switch

where:

dev: is the physical or logical unit on which the volume containing the file is mounted. The device unit is expressed as a 2-character alphabetic ASCII device name and an optional 1 or 2-digit octal number, followed by a colon. If no number is included, the default number will be 0. For example;

DL0: for the system disk

DL1: for the programmer or user disk

MT0: for the tape drive number zero

TT0: for the Decwriter console terminal

[g,m] is the User Identification Code (UIC) that specifies the User File Director (UFD) in which the file is listed. g and m are octal numbers from 0 to 377 that represent the user's group and member number. A privileged user has a group number less than or equal to 10. The brackets are required as part of the UIC. For example, when logging in as GUEST, the user UIC will be [200,2]. Note that GUEST is a non-privileged user

filename is the name of the file which is an alphanumeric string from 1 to 9 characters in length. A dot must always separate the filename from the file type

type is a 3-letter mnemonic that identifies the nature of the file's contents. For example;

MAC for a macro source file

FTN for a FORTRAN source file

OBJ for an object (compiled) file

LST for a list file

TSK for a task (executable) file

version is an octal number that differentiates among different versions of a file

/switch consists of an ASCII switch name that identifies a switch option which generally modifies the task's function or provides information required by the task to respond correctly to the command line. For example, the MCR (Monitor Console Routine) command

SET /LOWER=TT1: <CR>

specifies that lower-case characters from terminal TT1 are not to be converted to upper case, while

SET /NOLOWER=TT1: <CR>

resets the terminal characteristics so that lower-case characters from TT1 are converted to upper case.

An example of a file specifier is:

DL1:[7,77]ZPDRV.MAC;1

The user log-in device is normally DL1. Therefore, DL1: can be omitted. The default UIC is the UIC in which the user is logged-in under. Therefore, if the user's current UIC is [7,77], the UIC can be omitted. If the version number is deleted, the default will be the latest version. Therefore, if the latest version is 1, the version

number can be omitted. The file specifier can then be simplified to;

ZPDRV.MAC

5.2.2 Special and Control Characters

A brief definition of the special and control characters are listed below. Refer to the RSX/11M Operator's Procedures Manual for a complete explanation.

<CR>	Carriage return terminates a line of input
DELET OR RUBOUT	Deletes the last character typed at a terminal
CTRL/C	Causes the MCR (Monitor Control Routine) prompts and waits for command input
CTRL/I	Horizontal tab of every eighth position
CTRL/K	Vertical tab of four line feeds
CTRL/L	Form feed
CTRL/O	Alternatively suppresses and resumes terminal output display
CTRL/Q	Resumes terminal output which was previously suspended by a CTRL/S
CTRL/R	Retypes current line
CTRL/S	Suspends terminal output

CTRL/U Delete current line

CTRL/Z Terminator break used to exit system task such as PIP, MAC, or FOR and get back to MCR

5.2.3 Logging In and Out

The system monitor will be prompt with a right angle bracket character '>'. The general form for logging-in is;

HEL[LO] USERNAME <CR>

password:PASSWORD <CR>

where the user types in the capital characters and the system monitor types the lower case characters. The <CR> is the carriage-return key. The characters inside the square angle bracket is optional. The angle brackets, of course, are not to be typed. If you do not have an account on the 11/34, you may log-in with username GUEST and password GUEST. For example;

HEL GUEST <CR>

password:GUEST <CR>

To log-out type;

BYE <CR>

5.2.4 MCR Commands

The MCR (Monitor Console Routine) commands provide the language interface between the user and the system. Only several of the more commonly used MCR commands are listed in the following examples. Refer to the RSX-11M Operator's Procedures Manual for a complete list.

Some MCR commands are privileged. Privileged commands can only be executed by a user with a privileged UIC and/or a privileged terminal (TT0:). Logging in as GUEST specifies a non-privileged UIC. Normal operation will not require access to the privileged commands.

ABO[RT]TASKNAME

To abort a task. This is the complement of RUN TASKNAME.

For example, to abort a task named PIP, type:

ABO PIP <CR>

Note: it may be necessary to first obtain the MCR prompt by typing:

CTRL/C <CR>

ACT[IVE]

To list all active tasks. Type:

ACT <CR>

CAN[CEL]TASKNAME

To cancel a time-based initiation request for a task (such as listed under RUN TASKNAME/RSI).

For example, type:

CAN DVIP <CR>

Note: it may be necessary to first obtain the MCR prompt by typing;

CTRL/C <CR>

DEV[ICES]

To list all devices known to the system. Type:

DEV <CR>

DMO[UNT] DEV:[VOLUME-LABEL]

To dismount a device. No further access can be made to a dismounted device. For example, from a privileged terminal (TT0:) type:

DMO DL1: <CR>

to dismount disk drive DL1.

INS[TALL] FILESPECIFIER[/KEYWORD]

To install a task, which makes the task known to the system. This is a privileged command. For example:

INS DL0[1,54]DVIP <CR>

will install the latest version of task DVIP.TSK from disk DL0 with a UIC of [1,54]. This installed task can now be executed from any UIC by typing 'RUN DVIP'.

Note: this is the system UIC for installed task, loadable drivers, etc., and should not be used for other purposes.

LOA[D] DD:[/PAR-PARNAME]

To load a non-resident device driver into memory. This is a privileged command. For example:

LOA ZB: <CR>

will load the 'ZB:' driver for the Vision One/20 DMA card into the 'DRVPAR' driver partition in memory. The partition name was omitted since it has already been defined during the taskbuilding (linking) of the driver.

MOU[NT] DEV:[VOLUME-LABEL][/KEYWORD]

To mount a device to allow access. For example:

MOU DL1:PROGRAMMER <CR>

will mount disk drive DL1 which has a disk pack with a volume-label name of PROGRAMMER. If the name is not known, or the volume has no name, it can be overridden by the /OVR keyword switch as:

MOU DL1:/OVR <CR>

PAR[TITIONS]

To display a description of each memory partition in the system. Type:

PAR <CR>

Note that the DRVPAR driver portion will indicate all non-resident drivers which has been loaded.

REM[OVE] TASKNAME

To remove a task which was previously installed. This is a privileged command. For example:

REM DVIP

will make the previously installed task DVIP unknown to the system

RUN TASKNAME[TIME][/RSI-MAGU]

To initiate execution of a task. The task can be started immediately, at an absolute time of day, or at a delayed increment of time.

Examples;

RUN DVIP <CR>

initiates execution of task DVIP immediately.

RUN DVIP 10:45:15 <CR>

will start execution at an absolute time of 15 seconds after 10:45 AM

RUN DVIP 24S/RSI=5M <CR>

will start execution 24 seconds from now and reschedule execution every 5 minutes. Note that the CANCEL TASKNAME command must be used to abort the rescheduled task.

SET /KEYWORD=VALUE

To allow the user to alter dynamically, a number of system and local terminal characteristics. Only a few examples will be shown. Examples;

SET /BUF=TT0: <CR>

displays the current default buffer size of terminal TT0.

SET /BUF=TT0:132 <CR>

will set the buffer size of TT0 to 132.

SET /CRT=TT1: <CR>

will set terminal TT1 as a CRT device.

SET /NOCRT=TT1: <CR>

will delete the CRT device status.

SET /UIC <CR>

displays the default UIC

SET /UIC=[100,2] <CR>

sets the default UIC to [100,2]. Note that the brackets are required.

SET /PRIV <CR>

will display all terminals with privileged status.

SET /PRIV=TT2:

will set terminal TT2 with privileged status.

TAS[KLIST]

To display a description of all installed tasks. Type:

TAS <CR>

TIM[E] [HH:MM:[SS]][DD-MMM-YY]

to set or display the time of day. For example;

TIM <CR>

will display the time of day.

TIM 12:15 24-NOV-80 <CR>

will set the time of day and date.

UNL[OAD] DD:

to unload a non-resident device driver which was previously loaded. For example;

UNL ZB: <CR>

This is a privileged command and is the complement of LOAD.

The following table lists some of the commands, its complement command and a command to obtain information or status regarding the task or device

Command	Complement	Info or status
RUN TASKNAME	ABO TASKNAME	ACT

RUN TASKNAME/RSI	CAN TASKNAME	
MOU DEV:	DMO DEV:	DEV
INS FILESPEC	REM FILESPEC	TAS
LOA DD:	UNL DD:	PAR

5.2.5 PIP Commands

The Peripheral Interchange Program (PIP) is a utility program used for file transfer, listing, copying, renaming, deleting, etc. Only a few of the more commonly used commands will be listed in the following examples. Refer to the RSX/11M Utilities Procedures Manual for a complete list. Before executing any PIP commands, first invoke PIP (while under MCR) by typing;

PIP <CR>

PIP will respond with the 'pip>' prompt. After completing all desired PIP commands, return to MCR by typing;

CTRL/Z

The general form for use of a switch on a file is;

pip>FILESPEC/SWITCH

where /SWITCH is the function to be performed on the FILESPEC. The prompt 'pip>' is not typed by the user. For example;

pip>DL1:[200,2]/LI <CR>

will list the directory file of device Dl1 in UIC [200,2]

pip>/LI <CR>

will list the directory file of the current default device and UIC.

pip>DL1:[200,2]DVIP.*;*/LI <CR>

will list all types (i.e., .FTN, .OBJ, .TSK, etc.) and all versions of

file DVIP in device DL1 in UIC [200,2]. The asterisk is a wild card.

pip>DL1:[*,*]IMAGE.DAT/LI <CR>

can be used to identify the UIC in which the latest version of file IMAGE.DAT is located.

Note that in the four examples above, the /LI switch can be substituted with the switch /BR for brief format listing, /FU for full format listing, or /TB for total block format listing. Also note that unless specified, the listing device defaults to the entering terminal.

pip>DL0:/FR <CR>

will display the amount of free blocks on device DL0.

pip>DL1:IMAGE.DAT/PU

will purge all older versions of file IMAGE.DAT on device DL1 in the default UIC.

pip>DL1:IMAGE.DAT;2/DE

will delete version 2 of file IMAG.DAT on device DL1 in the default UIC.

Use caution when using wild cards and the /DE switch. For example;

pip>*.*;*/DE

will delete all versions of all files in the default directory.

The general form for a file transfer is;

pip>OUTFILE=INFILE[/SWITCH]

where OUTFILE is the output file specifier and INFILE is the input file specifier followed by a switch, if any. For example;

```
pip>TT0:=DL1:[200,2]DVIP.FTN
```

will type the latest version of the DVIP source file on device DL1 in UIC [200,2] to terminal TT0.

```
pip>TI:=DVIP.LST;2
```

will type version 2 of the DVIP list file to the entering terminal. It is assumed that the file is in the current default directory.

```
pip>DL0:[100,1]=DL1:IMAGE.DAT
```

will copy the latest version of file IMAGE.DAT on device DL1 in the default UIC to device DL0 in UIC [100,1].

```
pip>NEW.DAT;3=OLD.DAT;3/RE
```

will rename file OLD.DAT;3 to NEW.DAT;3 in the default directory.

5.3 User Support Software

5.3.1 TOP

This program is intended to provide a work station environment for the image oriented user. Processing functions, analysis aids, and utility routines are included in a single package.

5.3.1.1 Initiating TOP

Before running TOP, the user should power on and reset the Vision One/20 and any other peripherals that will be needed. The program is run by typing:

```
>TOP     <CR>
```

at the monitor level. The user should then see the command prompt:

```
command>>>>
```

Commands are then entered as combinations of the keywords detailed in

Section 5.3. Note that as each keyword is entered, only enough characters are accepted to identify the unique command. Improper or unnecessary input will be ignored. The magic terminator in this system is the space bar, which will work in any situation which requires a terminator. The carriage return and escape serve to abort the command line being input, and will work at any time input is being accepted.

5.3.2 TOP Command Lines

Command lines are formed by entering combinations of keywords. Once a command keyword is entered, other keywords will be accepted only if they combine with the previous entries to form a defined command. Often typing a space will insert a default keyword for the next entry. In case the wrong keyword is entered, the user can escape to the command prompt level by typing an escape or carriage return. In the following command line summary, all the acceptable keyword combinations are listed. Note that <sp> indicates a user typed space, <n> represents a user typed single digit number, <nnn> represents a multiple digit number (terminated by a space), and any other strings enclosed by angle brackets <> indicate some type of user response. User typed characters are represented in upper case, while computer prompting is shown in lower case. While running the program, all text is seen as upper case.

Command Line Summary

ADd Constant <nnn><sp> to image <n>

```
ADd Image  <n> to image  <n>

CLear Graphic  <n>

CLear Image  <n>

COLor graphics channels:
      graphics  1:  <COLOR>
      graphics  2:  <COLOR>
      graphics  3:  <COLOR>
      graphics  4:  <COLOR>
      target:  <COLOR>

COMpliment Graphics  <n>

COMpliment Image  <n>

DISplay Function memory  <n>

DISplay Image  <n>

DISplay Image  <n> Function memory mapped

DISplay Image  <n> Function memory mapped Pseudo color mapped

DISplay Image  <n> Pseudo color mapped

DISplay Pseudo color memory

DISplay TEst pattern BArs

DISplay TEst pattern BLack screen

DISplay TEst pattern Dots

DISplay TEst pattern Grey scale

DISplay TRuecolor

DISplay TRuecolor <COLOR> <COLOR> <COLOR>

DISplay TRuecolor <COLOR> <COLOR> <COLOR> Function memory mapped

DIVide image  <n> by constant <nnn>

EDge     sobel edge (3x3)
         horizontal edge magnitudes
         vertical edge magnitudes
         choice: <any of the above>

EXit
```

```
FIll Image  <n> with value <nnn>

FIll Graphics  <n> with value <n>

FUnction memory utilities
     options are:
             brightness control
             draw
             linearize
             map image
             negative linearize
             segment
             threshold
             window
     option: <any of the above>

HIstogram image  <n>

HElp

MASk utilities:
      mask and:
               Fill with value <nnn>
               Insert in image  <n>
               Move and insert in image  <n          Output
      mask and: <any of the above>

MAGnify image  <n> by Interpolation by factor <n>

MAGnify image  <n> by Replication by factor <n>

MInify image  <n> by Averaging by factor <n>

MInify image  <n> by Sampling by factor <n>

MOve Image  <n> to Image  <n>

MOve Image  <n> to Graphics  <n> threshold value: <nnn>

MOve Image  <n> to Tape

MOve Image  <n> to Tape Size option:
          width: <nnn>
          length:<nnn>

MOve Image  <n> to TEnex file <file.ext>

MOve Image  <n> to TEnex file <file.ext> Size option:
          width: <nnn>
          length: <nnn>

MOve Image  <n> to DISk file <file.ext>
```

```
MOve Image  <n> to DISk file <file.ext> Size option:
          width: <nnn>
          length: <nnn>

MOve Image  <n> to DIGitizer

MOve TApe to Function memory  <n>

MOve TApe to Pseudo color memory  <n>

MOve TApe to Graphic  <n>

MOve TApe to DISk file <file.ext>

MOve TApe to Image  <n>

MOve TApe to Tenex file <file.ext>

MOve TApe to DIGitizer

MOve TEnex file <file.ext> to Image  <n>

MOve TEnex file <file.ext> to Graphic  <n>

MOve TEnex file <file.ext> to Function memory  <n>

MOve TEnex file <file.ext> to DISk file <file.ext>

MOve TEnex file <file.ext> to DIGitizer

MOve TEnex file <file.ext> to Tape

MOve TEnex file <file.ext> to Pseudo color memory

MOve DISk file <file.ext> to DISk file <file.ext>

MOve DISk file <file.ext> to Function memory  <n>

MOve DISk file <file.ext> to Graphic  <n>

MOve DISk file <file.ext> to Image  <n>

MOve DISk file <file.ext> to Pseudo color memory

MOve DISk file <file.ext> to DIGitizer

MOve DISk file <file.ext> to TApe

MOve DISk file <file.ext> to TEnex file <file.ext>

MOve Function memory  <n> to TApe
```

```
MOve Function memory  <n> to Disk file <file.ext>

MOve Function memory  <n> to TEnex file <file.ext>

MOve Pseudo color memory to TApe

MOve Pseudo color memory to Disk file <file.ext>

MOve Pseudo color memory to TEnex file <file.ext>

MOve DIGitizer to Disk file <file.ext>

MOve DIGitizer to Graphic  <n> threshold value: <nnn>

MOve DIGitizer to Image  <n>

MOve DIGitizer to TApe

MOve DIGitizer to TEnex file <file.ext>

MUltiply image  <n> by constant <nnn>

PRint pixels from Tape
          first row: <nnn>
          number of rows: <nnn>
          first column: <nnn>
          Number of columns: <nnn>

PRint pixels from Image  <n>
          first row: <nnn>
          number of rows: <nnn>
          first column: <nnn>
          number of columns: <nnn>

PRint pixels from Disk file <file.ext>
          first row: <nnn>
          number of rows: <nnn>
          first column: <nnn>
          Number of columns: <nnn>

Pseudo color utilities:
           choices are:
                    insert
                    fill
            map to truecolor
  option: <any of the above>

Quit

SEquence images  <<n> or <sp>>   <<n> or <sp>>  (etc.)

SMooth image  <n>
```

```
STatistics for image  <n>

SUbtract Constant from image  <n>

SUbtract Image  <n> from image  <n>

TApe utilities:
        rewind
        space files <n>
        space blocks <n>
        map
        write eof marks     =<n>
        choice: <any of the above>

Unsharp mask image  <n> with constant <n.nn>
```

5.3.3 TOP Command Documentation

ADd — These commands perform two functions. Either one image can be added to another, or an integer constant can be added to an image plane. Values above 255 are made 255, values below zero become zero. When typing a value, terminate with a space.

CLear — Either an image or graphic plane is filled with zeroes. This clears the entire 512x512 area.

COLor — Initially, the graphics channels are all colored black, target included. This command prompts for each of four graphic channels and the target, and the user selects one of the following colors for each:

White

Red

Green

BLUe

Yellow

Magenta

Cyan

BLAck

COMpliment

When applied to an image plane, this operation replaces the image with its linear negative. For graphics, bits turned "on" become "off", and those "off" are turned "on."

DISplay By selecting the proper variation of this command, almost any display mode of the Vision One/20 can be set up. These modes are obvious from the list of display commands in Section 5.3.2. The exception is the display of graphics planes. This can only be accomplished using the Vision One/20 keyboard (see Section 5.3.4).

DIVide Any image plane can be divided by an integer constant. Terminate input of the constant with a space.

EDge Several edge detection algorithms are available, and are listed when you enter this routine. Select your choice by typing the first character. Prompting will occur for any additional information needed, such as image number.

EXit Exits the program, returning to monitor level.

FIll This fills an image plane with a constant integer value from 0 to 255. Remember to terminate with a space!

FUnction memory utilities

This set of routines manipulates the function memory lookup tables. The options are presented, then the user selects the desired option by typing the first character of that option. Draw sets up the Vision One/20 to draw a curve using the trackball. Plotting in this mode is controlled by the black numbered keys on the left of the Vision One/20 keyboard. Switch 1 toggles the trackball to plot or not plot. Switch 4 toggles an option to interpolate between points so a continuous curve is drawn. Linear segments can be drawn by toggling the interpolator on, then toggling the plot enable on and off at each point you wish connected by straight lines. When exiting this routine, the escape key on the Vision One/20 keyboard must be pressed to free the display.

Brightness control allows the user to shift the entire function memory curve upward or downward to change the apparent brightness of the mapped image. The routine enters routine in idle mode, where the curve remains unchanged. If the user types a 1 to the keyboard, the curve begins to shift upward. A 2 shifts it downward. Typing 3 returns to idle, and 4 restores the curve that existed when the routine was entered. This routine is exited by typing a space, returning to the command decoder level. In most cases, the user should preload the function memory using the LINEARIZE option.

The Linearize function loads a one-to-one look up table into the desired function memory. Negative linearize is similar, but loads a negative slope version.

Map takes the lookup table in any function memory and applies it to any image, storing the change back in the image plane.

Window and threshold are very similar. They both prompt for an upper and lower clip level (remember to terminate these with spaces). Everything outside of the window specified by these values is set to zero. Threshold sets everything within the window to value 255, binarizing the image. Window stretches a line across the window specified, rescaling the image in that range.

HIstogram

The user can generate a histogram with scaling labels on the graphics channels. This means destroying the contents of the graphics channels. An alternative is to use the Vision One/20 command, but the resulting plot is not labelled with pixel values or frequency information.

HElp The help command types the command summary seen above.

MASk utilities:

The mask utilities allow the user to apply masks created on a graphic channel to an image. Fill replaces the image data with a constant wherever the corresponding graphic bit is turned "on". Insert performs a logical "AND" between one

image and the graphics channel and inserts the result over a second image. Move and insert does the same thing, but you can reposition the masked image before inserting. All input will be prompted.

MAGnify The user can specify magnifying either by simple replication or linear interpolation. The magnification factor is limited to integer values.

MInify The compliment to magnify, minify reduces the size of an image by either sampling every nth pixel or averaging an n by n block of pixels into a single pixel (n is the reduction factor).

MOve Basically, all the possible move syntaxes are listed in the command summary. The package includes all transfers that are logically possible (i.e. transfer from image to function memory is nonsensical). The user simply identifies the devices desired, and in some cases has a choice of terminating with a space, giving a default size of 512x512, or typing an "S", which will cause prompting for other sizes. Remember to use the space when in doubt.

MUltiply The user specifies an image number and enters a constant to multiply point by point across that image. Remember to terminate the constant with a space.

PRint These operations dump integer pixel values of user-specified windows from an image to the console listing device (usually

the DECwriter, but this can be altered). Remember to terminate each numerical entry with a space.

Pseudo color utilities:

The desired option is selected by typing the first character of the option. Insert places a user-specified value in a single location. Fill places a value in a range of locations within the color table. Locations are numbered 0-63, and values are entered as a red component, a green, and a blue. Remember to use spaces to terminate! Mapping to truecolor applies the color table to an image plane, the result being a color image filling all three image planes.

Quit Exits the program, returning to monitor.

SEquence The user may specify a list of images, and the routine will switch the display from one to the next. The rate of change is variable, specified while the routine is running by typing numbers from 0 (slowest) to 9 (fastest). Exit by typing a space. When typing in the list, a space as an entry will stop prompting for the list.

SMooth By passing a three by three window across the image and averaging within that window, this routine smooths an image. This is also called by the unsharp masking routine

STatistics

This returns values for the mean and standard deviation of an image.

SUbtract The user may select to subtract either an integer constant from an image, or subtract two images. The operation is done point by point, and values are clipped at 0 and 255.

TApe utilities:

The tape utilities provide manual manipulation of the tape drive. The user may space files, space blocks, rewind, write end of file marks, or map the tape.

Mapping provides the user with a file-by-file output of the number of records and the size (in bytes) of those records.

Spacing files counts actual file marks. In spacing backwards n files, the user must space back n+1 file marks, then space forward one mark (unless the beginning of the tape is reached).

Spacing blocks will stop if an end of file is found.

EOF marks serve several purposes. One indicates the end of a file. Two (or more) indicate the end of a volume. Writing two EOF marks at the beginning of the tape (called weffing the tape by ECL people) serves to initialize a virgin tape to make it acceptable to TPS.

The option desired is selected by typing the first letter. Remember to end numerical entries with a space.

Unsharp mask

This performs an unsharp mask on the specified image. It requires a second image to store the smoothed version of the

original. This second image number is user specified, and will be prompted. A constant for the masking is also prompted and must be between 0.5 and 1.0.

5.3.4 TOP Keyboard Macros

5.3.5.3 Executing Keyboard Macros

The Vision One/20 has a special set of keys that are assigned to execute pre-defined macros (strings of keyboard commands). These keys are labelled with the letters A through O (15 keys) arranged in five rows of three. Each key can represent two distinct macros, one pre-defined by the Vision One/20 hardware, and the other either defined by the user or downloaded from the host computer. Hardware defined macros are executed by simply typing the correct macro switch. User or software defined macros are executed by first typing a backslash (/), followed by the macro key, on the Vision One/20 keyboard. Note that there are two slashes and a backslash on the Vision One/20 keyboard. The proper key is next to the RETURN key. TOP defines the keys A through I, leaving J through O for temporary or user macros.

5.3.4.2 Keyboard Macro Assignments

Macro Key	(Alone)	(with \ and TOP)
A	DISPLAY IMAGE 1	DISPLAY IMAGE 1
B	DISPLAY IMAGE 2	DISPLAY IMAGE 2
C	DISPLAY IMAGE 3	DISPLAY IMAGE 3
D	(A)+ADD PSUEDOCOLOR	ADD GRAPHIC 1

E	(B)+ADD PSUEDOCOLOR	ADD GRAPHIC 2
F	(C)+ADD PSUEDOCOLOR	ADD GRAPHIC 3
G	(A)+ADD F.M. 1	SUBTRACT GRAPHIC 1
H	(B)+ADD F.M. 2	SUBTRACT GRAPHIC 2
I	(C)+ADD F.M. 3	SUBTRACT GRAPHIC 3
J	DISPLAY F.M. 1	For use by TOP
K	DISPLAY F.M. 2	For use by TOP
L	DISPLAY F.M. 3	For use by TOP
M	DISPLAY IMAGE 8	For use by User
N	(M)+ADD F.M. 8	For use by User
O	DISPLAY PSUEDOCOLOR	For use by User

5.3.5 DVIP

The four steps in operating the Digital Video Image Processor is; (1) acquire bias with camera lens cover on, (2) acquire gain with camera lens cover off and light table on, (3) acquire image with camera lens cover off, light table on and film on light table, (4) transfer image to the Vision One/20. Steps (1) and (2) need not be repeated when acquiring subsequent images; provided that the bias or gain characteristics do not change.

First set up the Digital Video Image Processor as described in section 5.1.1.4, then start the program by typing;

RUN DVIP <CR>

The program will respond with;

```
select dvip mode
acquire [1], read [2], write [3], exit [4]:
```

Select acquire mode by typing;

1 <CR>

the program will respond with;

acquire bias [1], gain [2], image [3]:

Select bias by typing;

1 <CR>

When the bias acquire is completed, the program will respond with;

-bias acquire complete-

Then remove the camera lens cap and acquire the gain by typing the appropriate number after the colon followed by <CR> as follows;

select dvip mode

acquire [1], read [2], write [3], exit [4]: 1<CR>

acquire bias [1], gain [2], image [3]: 2<CR>

-gain acquire complete-

Then set up the image to be digitized and acquire the image as follows;

select dvip mode

acquire [1], read [2], write [3], exit [4]: 1<CR>

acquire bias [1], gain [2], image [3]: 3<CR>

frame count 64 [1], 128 [2], 192 [3], 256 [4]: 2<CR>

-image acquire complete-

The frame count select can be 1, 2, 3 or 4. Next transfer the image to the Vision One/20 as follows:

select dvip mode

acquire [1], read [2], write [3], exit [4]: 2<CR>

select vision one channel [1,2,3]: 1<CR>

-dvip to vision one image transfer complete-

The channel number can be 1, 2 or 3. If no further images are to be acquired, exit the program;

select dvip mode

acquire [1], read [2], write [3], exit [ ]: <CR>

-don't forget to cover the camera lens-

dvip--stop exit

Note that entering no number or selecting any number other than 1, 2 or 3 in response to select dvip mode will cause an exit. The write mode is used to transfer an image from the Vision One/20 to the DVIP.

5.3.6 RTTV34

Before running this program, connect a TIP port to the "TY" line connected to the DL11W card. From a terminal connected to a second TIP port, set the line characteristics of the first TIP port. For example, if the first TIP port number is 23 type:

@23S D W

@23B O S

@23O T

@23D R 503

The forth entry sets the line baud rate to 1200. Now execute the RTTV34 program on the PDP11/34. The following example shows a graphic transfer. (Note that upper case letters are typed in by the user and lower case letters are typed by the program)

RUN RTTV34

exit (0), image (1), graphic (2), function (3): 2

```
do you want to swap bytes? no (0), yes (1): 1
do you want to reverse bits/ no (0), yes (1): 0
image size 256 (0), or 512 (1): 1
select channel on Vision One/20 (1, 2, or 3): 1
   did you display and color the graphic channel using the
   comtal keyboard?
                                no (0), yes (1): 1
09:35:24
ready for crttv input
--image transfer complete--
09:41:09
exit (0), image (1), graphic (2), function (3): 0
tto--stop--exit--
```

When the program types "ready for crttv input", and waits, the user must log-in at the terminal on the second TIP port and execute the CRTTV program as follows for a graphic transfer.

```
RUN CRTTV
load function memory? (1=yes, 2=no): 2
load graphic memory? (y or n): Y
graphic size? (256 or 512): 512
enter graphic data filename:
                        <PRICE>COMTAL.NEW
```

Note that the RTTV34 program will type the time before and after the image transfer in order to calculate the total transfer time.

5.4 Vision One/20 Keyboard Operation

5.4.1 Keyboard

The keyboard consist of a standard alpha-numeric key switches, five function key switches on the left side labeled 1 through 5 (which are defined as FS1 through FS5), and a 15 key alpha pad on the right side marked A through O. The 15 alpha keys default to the following functions when the O/S is started or restarted.

A=Display Image 1

B=Display Image 2

C=Display Image 3

D=(A)+Add Pseudocolor memory R

E=(B)+Add Pseudocolor memory G

F=(C)+Add Pseudocolor memory B

G=(A)+Add Function memory 1

H=(B)+Add Function memory 2

I=(C)+Add Function memory 3

J=Display Function memory 1

K=Display Function memory 2

L=Display Function memory 3

M=Display Image 8

N=(M)+Add Function memory 8

O=Display Pseudocolor memory

By depressing the respective 15 alpha key, the function defined on the right will be performed. The O/S defines image 8 as a truecolor image if images 1, 2 and 3 are available. Switch N adds function memories

1, 2 and 3 to truecolor image 8. Refer to example 6 in section 5.4.2 before using switch M to display image 8.

The five function switch have a number of interactive uses. The more common uses are as follows:

FS1=Activate target trackball after entering an interactive command. See Example 5 in section 5.4.2

FS2=Generate profile of X if set after a profile command. Write white if reset and write black if set after a trace command. See example 9 and 10 in section 5.4.2

FS3=Generate a profile of Y if set after a profile command. Enter or exit a roam command while in another interactive command. See examples 9 and 10 in section 5.4.2

FS4=Indicate upper left corner if set on a set corners command and lower right corner if reset. Interpolate between endpoints if set when tracing a function, graphic or image memory. See example 10 in section 5.4.2

FS5=Reset memory to 0,0 coordinate. See example 5 in section 5.4.2

5.4.2 Command Language

The commands are listed in appendix B. The commands marked with the double asterisk (**) are optional and therefore are not applicable to the current USC-IU system. The two exceptions are (1) Define

Target x KK y MM and (2) Image N=Zoom Image M by factor 0. Note that only the capital letters and numbers need to be typed in followed by a space bar. The space bar prompts the O/S to fill in the remaining lower case letters up to the next capital letter or number to be entered by the operator. A final space bar after the last entered character initiates execution of the command. Some commands require a double space bar before execution of the command. If the O/S responds with a question mark (?), this usually indicates that an illegal character or number was entered. Respond by re-entering the correct character or type 'ESC' to abort the command. A character can be deleted with the 'BS' key. If a command that the O/S doesn't recognize is entered, it will respond with an aborted message. The following examples will serve as exercises to assist in learning the use of the command language and other keyboard operations.

Example 1

To display three additional annotation lines, enter:

(1) Add Annotation characters

where the capital characters are typed in followed by a space bar. That is, type A<space bar>A<space bar>

To delete the three additional annotation lines, enter:

(1) SUbtract Annotation characters

Displaying the additional three annotation lines will prevent viewing several lines at the bottom of the image, but it is sometimes helpful since the previously executed command will be viewable and if it was aborted, the error message generated by the O/S will also be viewable.

Example 2

To restart the O/S enter:

(1) depress 'SHIFT/TILDA' key

(2) depress 'R' key

that is, depress the 'SHIFT' key and the 'TILDA' key at the same time, then type R. The O/S will re-initialize the definition of the images but the content of the image memories will not be changed.

Example 3

Image to image transfer:

(1) Display Image 1

(2) Image 1=Constant 150

(3) Display Image 2

(4) Image 2=Image 1

Note that the display image 1 and 2 commands can also be done by depressing alpha switch A and B respectively. Step 2 places a constant value of 150 octal into image 1 and step 4 transfers the 512 by 512 (8 bit) pixels of image 1 into image 2.

Example 4

To define image corners:

(1) Display Image 1

(2) DEfine Corners Image 1 x1 50x2 300 y1 100 y2 400

(3) Set Flag Image 1

(4) Clear Image 1

(5) Display Image 2

(6) Image 2=Image 1

(7) Clear Flag Image 1

(8) Image 2=Image 1

the O/S initially defines all image corners as 0, 511, 0, 511. Step 2 defines a new set of corners and step 3 sets the flag for image 1 which enables the operator defined corners. Clearing the flag for image 1 in step 7 disables the operator defined corners and reverts back to the O/S defined corners.

Example 5

To zoom and roam an image

(1) Display Image 1

(2) Display Zoom Image by factor 2

(3) ROam Image

(4) depress 'FS1' Key

(5) Move trackball to roam image

(6) depress 'FS5' key

(7) depress 'ESC' key

(8) Display Zoom Image by factor 1

Allowable zoom factors are 1, 2 and 4. FS1 activates the trackball, FS5 moves the image back to the original position, and ESC terminates the roam command.

Example 6

To assign trucolor image 8

(1) ASsign Truecolor 8 red 1 green 2 blue 3

(2) depress alpha switch M

(3) depress alpha switch N

The O/S initially defines truecolor 8 as 512 by 512 if images 1, 2 and 3 are available. The operator must make the image assignments as in step 1 before using alpha switch M to display image 8 and switch N to add function memories 1, 2 and 3 to image 8.

Example 7

Define and assign a 1024 by 1024 image

(1) DEfine Image 6 x 1024 y 1024

(2) ASsign Image 6 w1 1 w2 2 w3 3 w4 3

(3) Display Image 6

(4) ROam Image

(5) depress 'FS1' key

(6) move trackball to roam image

(7) depress 'FS5' key

(8) depress 'ESC' key

Note that in step 2, image 3 was assigned twice since the current system contains a total of only 3 images. Number 6 was arbitrarily chosen for the image number, but it cannot be 1, 2, 3, 8 or any other previously defined image number.

Example 8

To obtain image pixel values:

(1) Display Image 1

(2) Add Target

(3) DUmp Image

(4) move trackball to obtain new x, y value

(5) depress 'ESC' key

Note that example 8 and 9 would be more meaningful with an image in image memory 1.

Example 9

To obtain a profile of an image

(1) Display Image 1

(2) Add Target

(3) COlor Graphic 1 YEL

(4) Add Graphic 1

(5) Graphic 1=PRofile of image 1

(6) move trackball target to desired location

(7) depress (set) 'FS2' and 'FS1' for x profile

(8) depress (set) 'FS3' and 'FS1' for x and y profile

(9) depress (reset) 'FS2' and 'FS1' for y profile

(10) depress 'ESC' key

Note that in step 8, both FS2 and FS3 are set, therefore both the x and y profile are obtained when FS1 is depressed.

Example 10

To trace and fill a graphic:

(1) Display Image 1

(2) Clear Image 1

(3) COlor Graphic 1 CYN

(4) Display Graphic 1

(5) Clear Graphic 1

(6) Add Target

(7) TRace Graphic 1

(8) move trackball target to desired starting location

(9) depress (set) 'FS1' to write the first point

(10) depress (reset) 'FS1' to deactivate the trace

(11) depress (set) 'FS4' for interpolate mode

(12) move trackball target to a second point

(13) depress (set) 'FS1' to trace from point one to point two

(14) depress (reset) 'FS1' and move the trackball target to a third point

(15) depress (set) 'FS1' to trace from point two to point three

(16) depress (reset) 'FS1' and move the trackball target back to point one

(17) depress (set) 'FS1' to trace from point three to point one to form a triangle

(18) depress 'ESC' to terminate the trace command

(19) FIll Graphic 1

(20) move the trackball target inside the triangle

(21) depress 'FS1' to fill the triangle

(22) depress 'FS3' and move the trackball to roam

(23) depress 'FS5' to reset graphic 1 to its original position

(24) depress 'ESC' to terminate roam

(25) depress 'ESC' to terminate the fill command

When FS1 is set, tracing is activated. FS1 is set if zeros are to be written and reset if ones are to be written. FS4 is set if interpolation is to be done. The trace command starts with FS1, FS2 and FS4 reset.

Example 11

To obtain histogram and equalize a function memory: (This example would be more meaningful with an image in image memory 1)

(1) Display Function memory 1

(2) INItialize Function memory 1

(3) Function memory 1=Histogram of image

Wait at this point until the histogram of image 1 is obtained

(4) Equalize Function memory 1

(5) depress alpha key A to display image 1

(6) depress alpha key G to display image 1 + function memory 1

Note step 2 is not required prior to obtaining the histogram. It was included only to demonstrate the initialize command.

5.4.3 Macros

A macro stores a series of commands which can be executed at any later time. Up to 15 macros can be created and each macro can store up to 64 words. The macros are labeled Macro A through Macro O. The macro (for example Macro A) is executed by typing the command 'Execute Macro A' or type '\' followed by alpha key A. A macro can branch to another macro by using the 'BRanch Macro A' command. The Vision One/20 users manual gives a number of examples on page 61 and 62 on how to create a macro. The macro can be created from the keyboard or loaded from the external host computer as explained in the Vision One/20 users manual on page 74, section 5.2.4.3.

5.5 DVIP Manual Operation

For manual operation as well as manual test procedures of the DVIP, refer to the Digital Video Image Processor Manual dated Nov. 1980.

6.0 IMAGE TRANSFER RATES TO THE VISION ONE 20

6.1 ECL Data Link

The link to the Tenex PDP KL-10 is treated as a logged in user by the Tenex operating system. Therefore, transfer rates between the KL-10 and the PDP 1 series lab processors depends heavily on the system load. The following times apply for transfers to or from any peripherals on the 11/34 or 11/40, with the Tenex load approximately 3.5:

Image Size	Transfer Time
256x256	2 min. 15 sec.
512x512	3 min. 50 sec.

6.2 TIP Data Link

The maximum transfer rate in which an image is received over the Arpanet via the TIP data link is 1200 baud. The total image transfer time will vary depending upon such factors as system load average, channel buffer size, and image size/type. The approximate transfer times are as follows:

Image Type	Transfer Time
8 bit x 256 function	1 sec
1 bit x 512 x 512 graphic	4 min
8 bit x 256 x 256 image	20 min
8 bit x 512 x 512 image	50 min

6.3 Tape/ Vision One Transfers

Image Size	Transfer Time
256x256	5 sec.
512x512	11 sec.
1024x1024	21 sec.

6.4 RL-01 Disk / Vision One Transfers

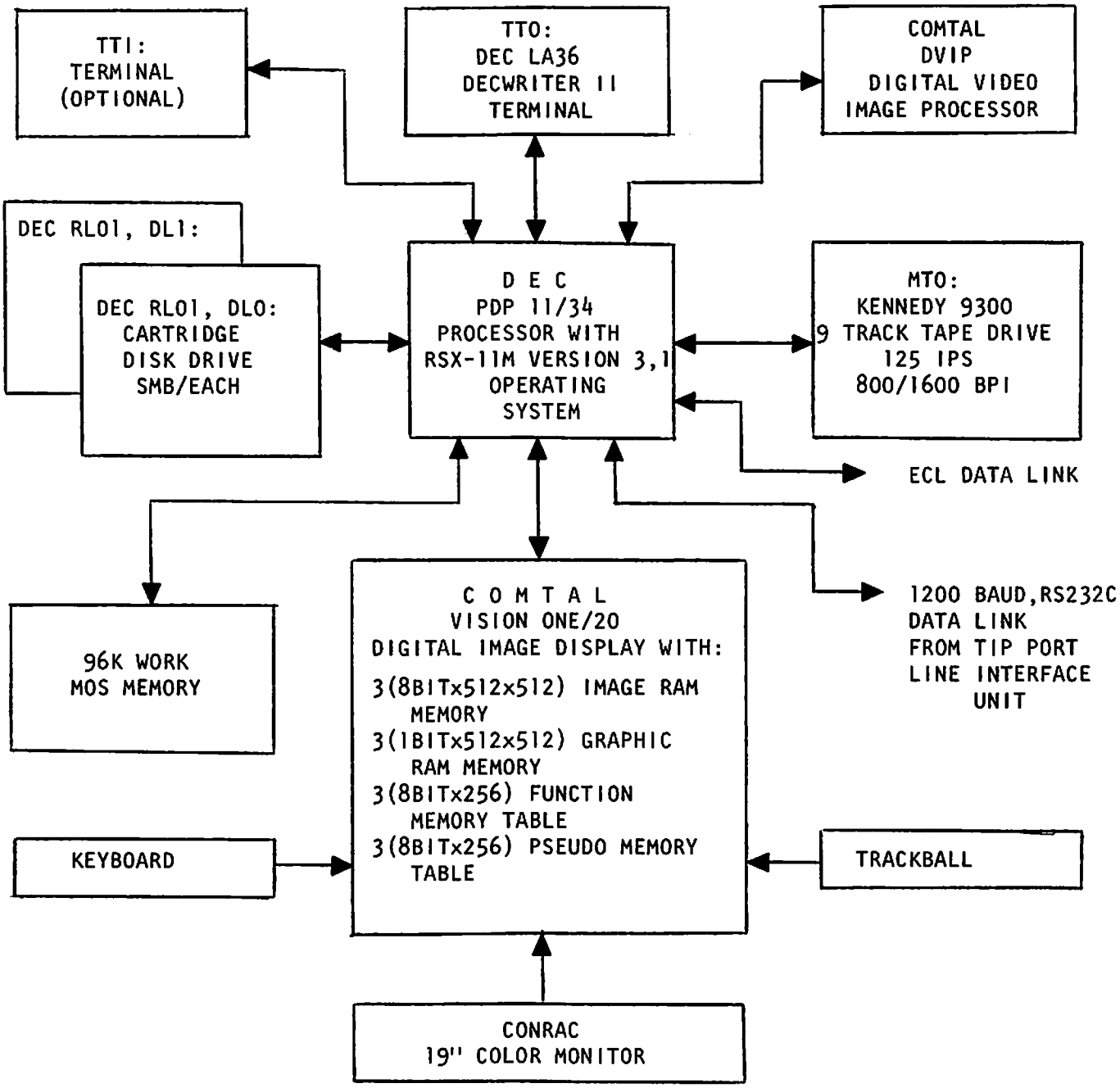
Image Size	Transfer Time
256x256	4 sec.
512x512	9 sec.

6.5 DVIP

The transfer of a 512x512x8 bit image from the DVIP to the Vision One/20 via the PDP11/34 requires approximately 30 seconds. Transfer of the same size image from the Vision One/20 to the DVIP also requires 30 seconds. The majority of the transfer time (26 sec) is due to the DR11C I/O card since it is not a DMA device.

APPENDIX A

List of Figures



NOTE: DEC = DIGITAL EQUIPMENT CORP.

FIGURE 1.
IU WORK STATION
HARDWARE CONFIGURATION

FIGURE 2.

PHOTOGRAPH OF IU WORKSTATION.

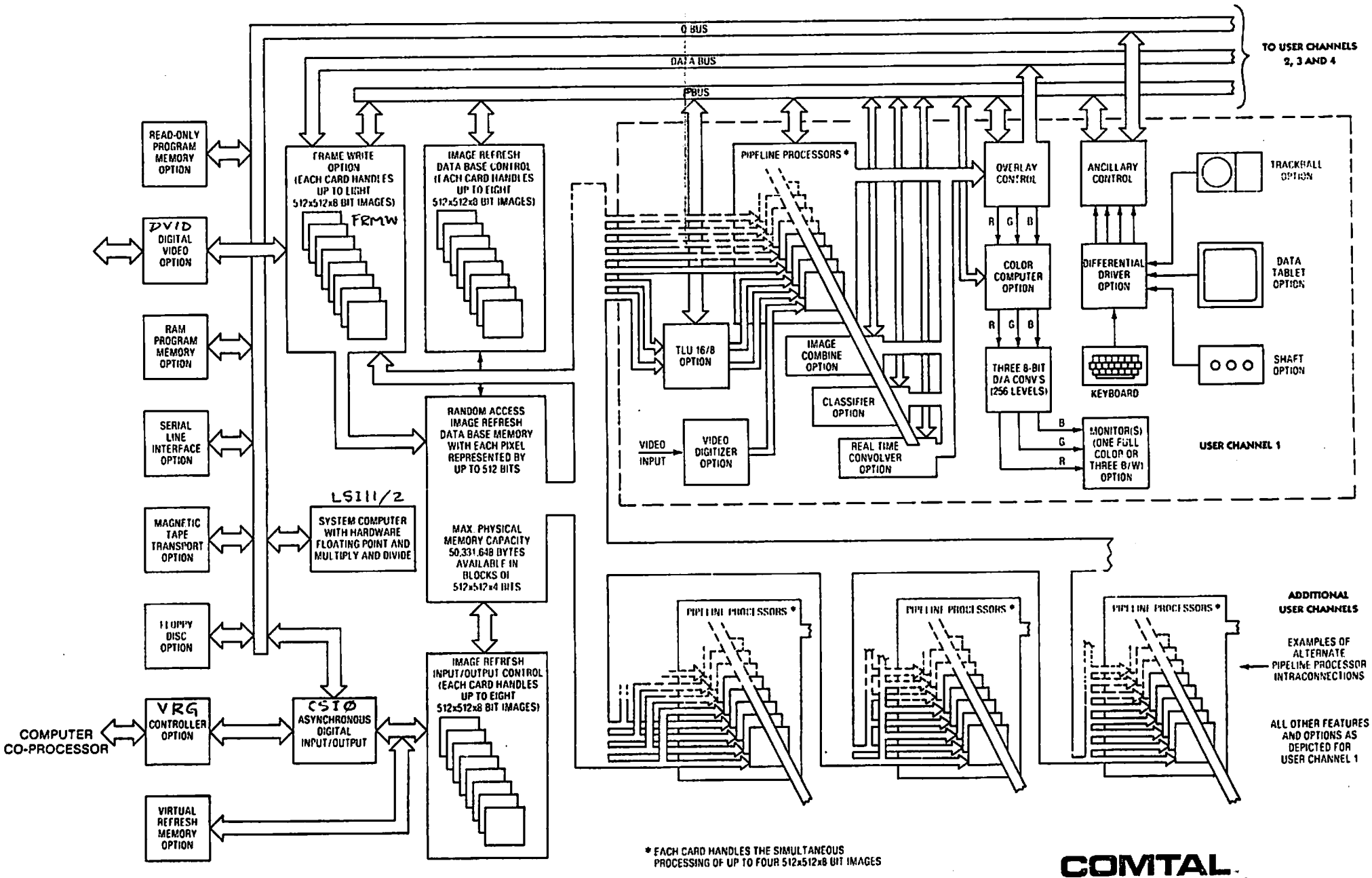

Q BUS
DATA BUS
PBUS
TO USER CHANNELS 2, 3 AND 4
READ-ONLY PROGRAM MEMORY OPTION
DVID DIGITAL VIDEO OPTION
RAM PROGRAM MEMORY OPTION
SERIAL LINE INTERFACE OPTION
MAGNETIC TAPE TRANSPORT OPTION
FLOPPY DISC OPTION
VRG CONTROLLER OPTION
COMPUTER CO-PROCESSOR
VIRTUAL REFRESH MEMORY OPTION
FRAME WRITE OPTION (EACH CARD HANDLES UP TO EIGHT 512x512x8 BIT IMAGES)
FRMW
IMAGE REFRESH DATA BASE CONTROL (EACH CARD HANDLES UP TO EIGHT 512x512x8 BIT IMAGES)
RANDOM ACCESS IMAGE REFRESH DATA BASE MEMORY WITH EACH PIXEL REPRESENTED BY UP TO 512 BITS
LSIII/2
SYSTEM COMPUTER WITH HARDWARE FLOATING POINT AND MULTIPLY AND DIVIDE
MAX. PHYSICAL MEMORY CAPACITY 50,331,648 BYTES AVAILABLE IN BLOCKS OF 512x512x4 BITS
CSIØ ASYNCHRONOUS DIGITAL INPUT/OUTPUT
IMAGE REFRESH INPUT/OUTPUT CONTROL (EACH CARD HANDLES UP TO EIGHT 512x512x8 BIT IMAGES)
PIPELINE PROCESSORS *
TLU 16/8 OPTION
IMAGE COMBINE OPTION
CLASSIFIER OPTION
REAL TIME CONVOLVER OPTION
VIDEO INPUT
VIDEO DIGITIZER OPTION
OVERLAY CONTROL
ANCILLARY CONTROL
COLOR COMPUTER OPTION
DIFFERENTIAL DRIVER OPTION
THREE 8-BIT D/A CONV'S (256 LEVELS)
KEYBOARD
TRACKBALL OPTION
DATA TABLET OPTION
SHAFT OPTION
MONITOR(S) (ONE FULL COLOR OR THREE B/W) OPTION
R G B
B G R
USER CHANNEL 1
ADDITIONAL USER CHANNELS
EXAMPLES OF ALTERNATE PIPELINE PROCESSOR INTRACONNECTIONS
ALL OTHER FEATURES AND OPTIONS AS DEPICTED FOR USER CHANNEL 1
* EACH CARD HANDLES THE SIMULTANEOUS PROCESSING OF UP TO FOUR 512x512x8 BIT IMAGES
COMTAL
Vision One/20
SYSTEM BLOCK DIAGRAM
96

Figure 3

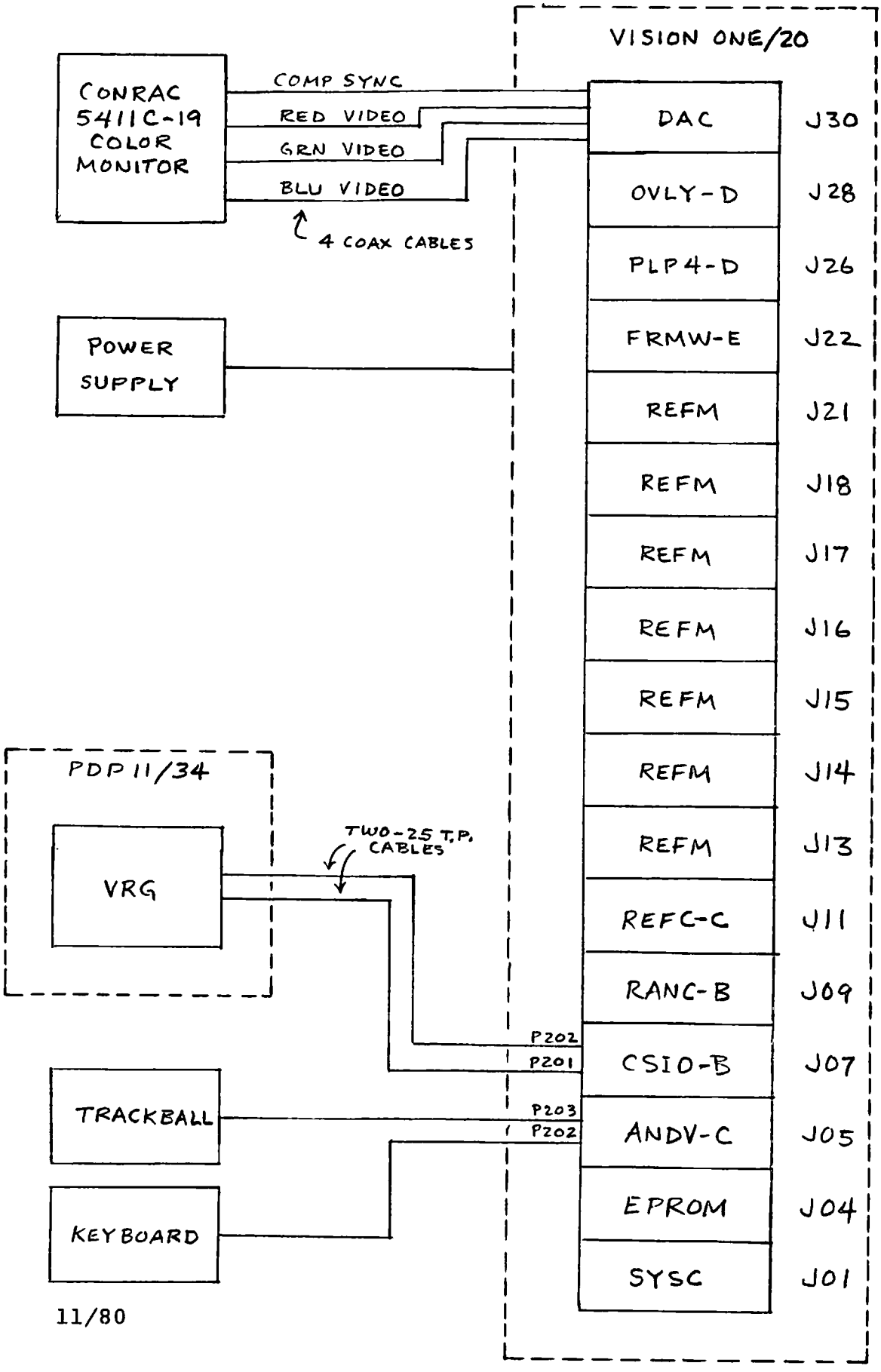


FIGURE 4
VISION ONE/20
INTER-CONNECTION CABLE DIAGRAM

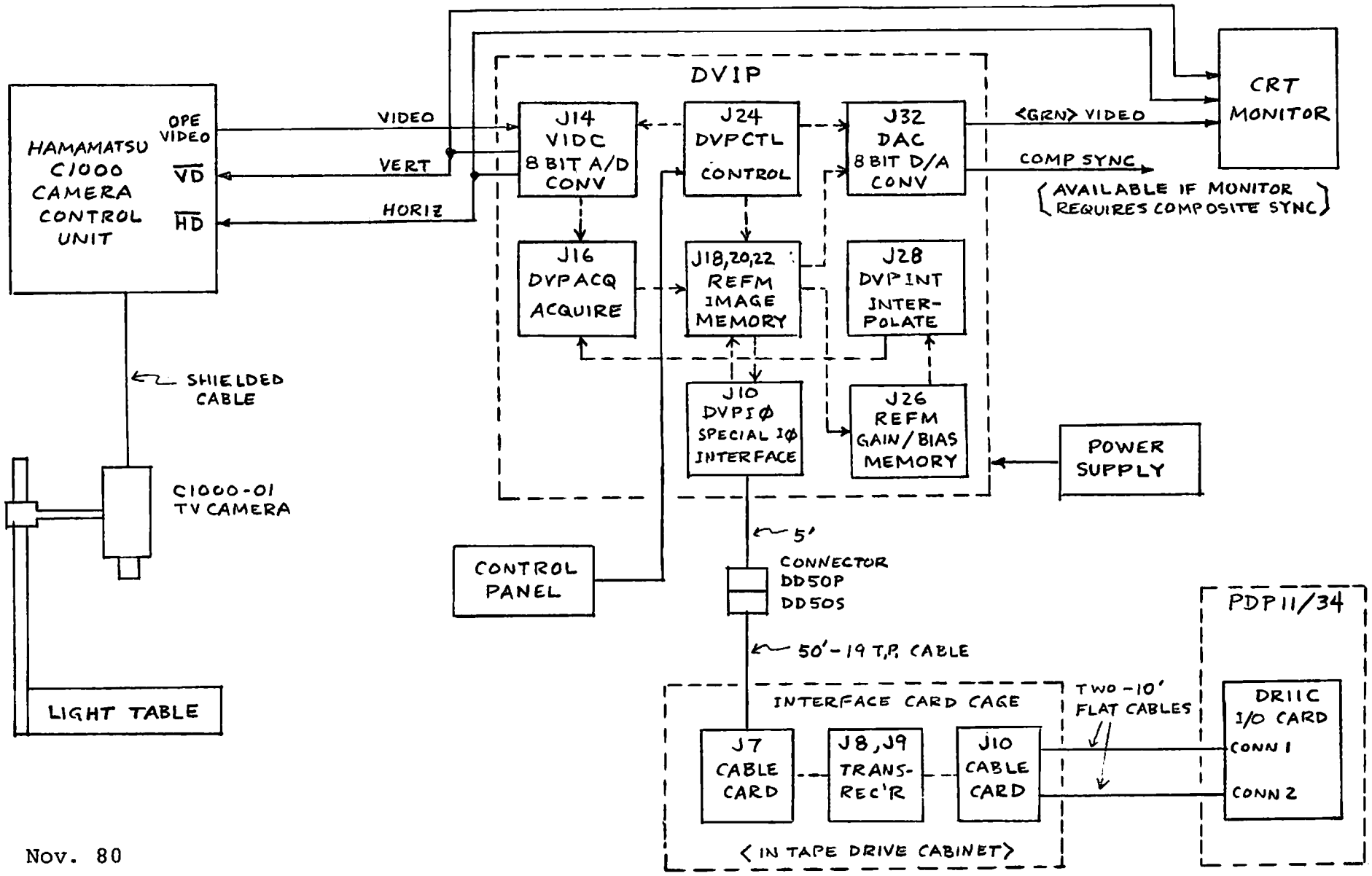


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FIGURE 5
DVIP INTER-CONNECTION & BLOCK DIAGRAM

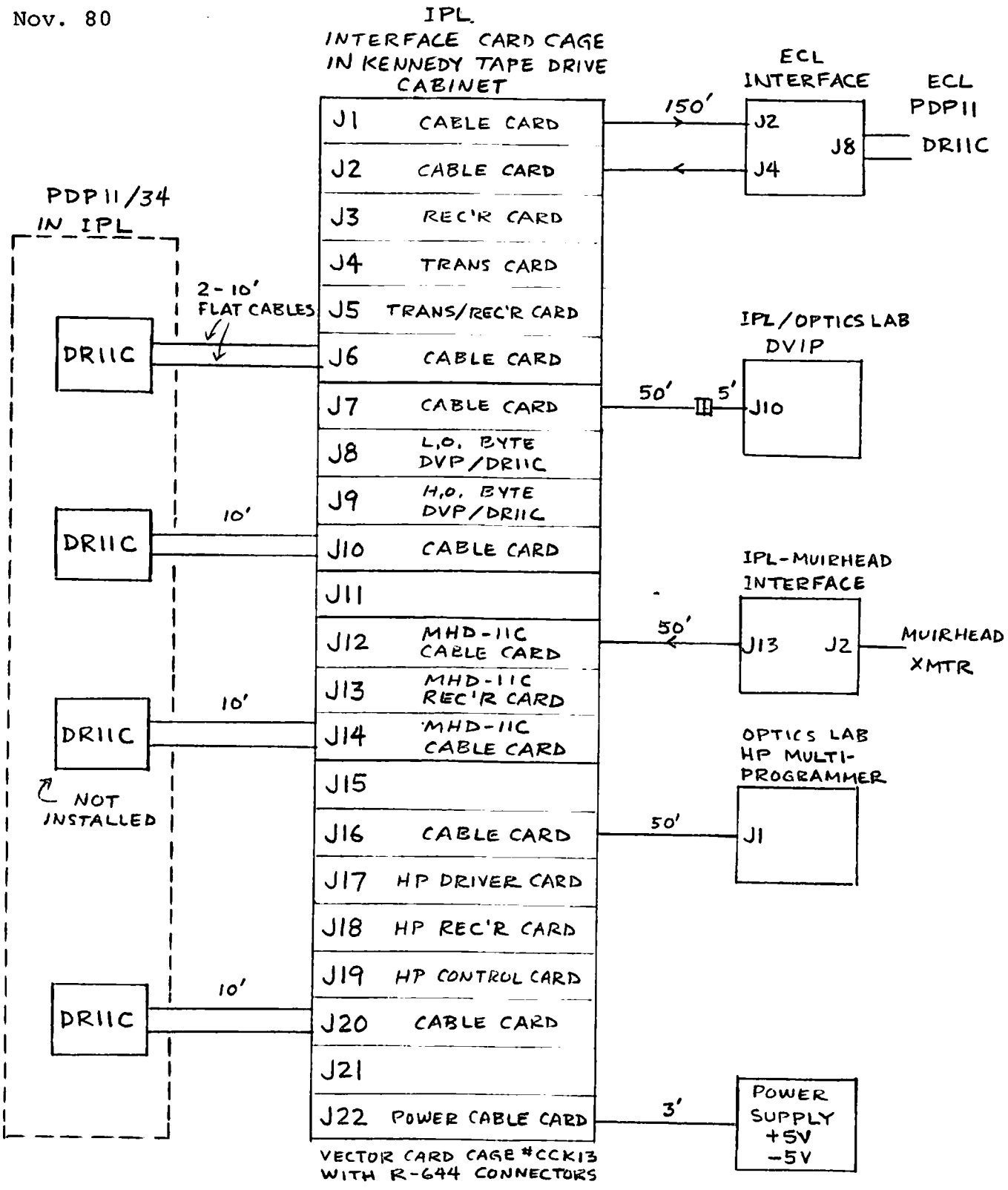

FIGURE 6

INTERFACE CARD CAGE

APPENDIX B

Vision One/20 Keyboard Commands

Release Commands

To deallocate various system resources.

Roam Commands

To enable real-time translation (roam) of the display window over the image data base.

Roll Commands

To enable interactive modification of various processing memories.

Set Commands

To allocate specific system resources.

Shift commands

To enable interactive modification of processing memories.

Smooth Commands

Provide interactive pixel averaging to smooth out blemishes.

Spin Commands

To roll processing memories under system computer control, or to start display of loop-movie.

Table Command

To affect contents of temporary storage tables.

Tape Commands

To control operation and contents of attached magnetic tape unit(s).

Tint Commands

To interactively affect displayed color values for truecolor image.

Trace Command

To use trackball/data tablet to interactively trace values into various memories.

Unassign Commands

To terminate relationships established in assign commands.

Miscellaneous Commands

Useful commands unrelated to above modules.

4.4 Command Quick Reference List

This section has two listings of the Vision One/20 command language, which is the interface between the user and the Vision One/20 operating system. The first list is organized alphabetically according to command module (grouping by function.) The second list represents a useful condensed command language presentation for experienced users. It is important to realize that not all commands are available on every system. Architectural configuration, options, refresh memory size, number of users/channels, host or mag tape or other interfaces, all affect the final commands composition for any specific Vision One/20.

4.4.1 Command Language (Alphabetical by Command Module)

**denotes Command that relates to specific hardware/software option.

Each command is entered by typing the bold face letter(s) of the command word, then pressing the space bar, which will cause the O/S to fill in the remaining letters of the command word. The following abbreviations are used in the command language list:

RGB = ENTER R OR G OR B FOLLOWED BY A SPACE, FOR THE RED OR GREEN OR BLUE COMPONENT.

RGBA = ENTER R OR G OR B FOLLOWED BY A SPACE, FOR THE RED OR GREEN OR BLUE COMPONENT, OR ENTER JUST A SPACE FOR ALL THREE COMPONENTS..

MMMMMM = AN OCTAL ADDRESS.

K,L,M,N,O = AN IMAGE NUMBER FOR AN IMAGE KNOWN TO THE CURRENT SYSTEM CONFIGURATION.

NN = AN OCTAL NUMBER.

XXXXXX = A FILE NAME KNOWN TO THE HOST CO-PROCESSOR.

UASF = USER ARITHMETIC STATEMENT FUNCTION. SEE NOTE 15 IN SECTION 4.5.34.

A,B = A DECIMAL INTEGER NUMBER.

SEE SECTION 4.5.34 FOR DETAILS ON OTHER ABBREVIATIONS.

ADD COMMANDS

ADD/SUBTRACT ANNOTATION CHARACTERS

ADD/SUBTRACT BARS

ADD/SUBTRACT BOTTOM LINE

****ADD/SUBTRACT COMBINE**

****ADD/SUBTRACT CONVOLVER RGB**

****ADD/SUBTRACT CORRECTOR**

ADD/SUBTRACT DOTS

ADD/SUBTRACT FUNCTION MEMORY N

ADD/SUBTRACT GRAPHIC N

****ADD/SUBTRACT SMALL AREA GRAY SCALE N**

****ADD SMALL AREA IMAGE N IF GRAPHIC M**

ADD/SUBTRACT TARGET

ADD/SUBTRACT TRANSPARENCY OF GRAPHIC

ADD/SUBTRACT TRANSPARENCY OF TARGET

ADMINISTRATIVE COMMANDS

DUMP CODE MMMMMM BYTE/WORD

DUMP IMAGE

DUMP INTEGER FUNCTION N

DUMP MEMORY MMMMMM BYTE/WORD

DUMP REAL FUNCTION N

**DUMP SMALL AREA

MODIFY CODE MMMMMM BYTE/WORD

**MODIFY COMBINE

**MODIFY CONVOLVER

MODIFY MEMORY MMMMMM BYTE/WORD

**MODIFY PATTERN PAGE NP (1, 2, 3, OR 4)

ASSIGN COMMANDS

**ASSIGN CHANNEL N

ASSIGN IMAGE N W1 K W2 L W3 M W4 O

**ASSIGN TAPE [L]

ASSIGN TRUECOLOR N RED K GREEN L BLUE M

CLEAR COMMANDS

CLEAR FLAG GRAPHIC N

CLEAR FLAG IMAGE N

CLEAR FUNCTION MEMORY N

CLEAR GRAPHIC N

CLEAR IMAGE N

CLEAR PSEUDOCOLOR MEMORY RGBA

**CLEAR SMALL AREA FUNCTION MEMORY N

CLEAR TABLE N

CODE COMMANDS

**CODE = FILE XXXXXX

**CODE = TAPE [L] FILE K RECORD M

COLOR COMMANDS

COLOR ANNOTATION CHARACTERS NN (00-17)

COLOR BARS NN (00-77; DOTS SAME COLOR)

COLOR GRAPHIC N CNAME

COLOR TARGET CNAME1

DEFINE COMMANDS

DEFINE CORNERS GRAPHIC N X1 K X2 M Y1 O Y2 P

DEFINE CORNERS IMAGE N X1 K X2 M Y1 O Y2 P

DEFINE IMAGE N X KKKK Y MMMM

DEFINE TRUECOLOR N X KKKK Y MMMM

**DEFINE TARGET X KK Y MM

LINE 001 NNNNNN

●

LINE 0MM NNNNNN

DISPLAY COMMANDS

DISPLAY BLACK SCREEN

**DISPLAY COMBINE

DISPLAY FUNCTION MEMORY N

DISPLAY GRAPHIC N

DISPLAY IMAGE N

**DISPLAY PATTERN PAGE NP (1, 2, 3, OR 4)

DISPLAY PSEUDOCOLOR MEMORY RGBA

**DISPLAY SMALL AREA FUNCTION MEMORY N

**DISPLAY SMALL AREA IMAGE N

DISPLAY ZOOM IMAGE BY FACTOR NZ (1, 2, OR 4)

**DISPLAY ZOOM SMALL AREA IMAGE BY FACTOR NZ (1, 2, OR 4)

EQUALIZE COMMANDS

EQUALIZE FUNCTION MEMORY N

EXECUTE COMMANDS

EXECUTE CODE

EXECUTE MACRO A (A-O)

FILE COMMANDS

**FILE XXXXXX = CODE

**FILE XXXXXX = FUNCTION MEMORY N

**FILE XXXXXX = GRAPHIC N

**FILE XXXXXX = IMAGE N

**FILE XXXXXX = PSEUDOCOLOR MEMORY RGB

**FILE XXXXXX = SMALL AREA FUNCTION MEMORY N

FILL COMMANDS

FILL GRAPHIC N

FUNCTION COMMANDS

**FUNCTION MEMORY N = FILE XXXXXX

FUNCTION MEMORY N = FUNCTION MEMORY M

FUNCTION MEMORY N = HISTOGRAM OF IMAGE

FUNCTION MEMORY N = INTEGER (UASF)

FUNCTION MEMORY N = LOG (UASF)

FUNCTION MEMORY N = PSEUDOCOLOR MEMORY RGB

FUNCTION MEMORY N = REAL (UASF)

**FUNCTION MEMORY N = SMALL AREA FUNCTION MEMORY N

FUNCTION MEMORY N = SQRT (UASF)

FUNCTION MEMORY N = TABLE M

**FUNCTION MEMORY N = TAPE [L] FILE K RECORD M

FUNCTION MEMORY N = X [*/A] [+-B]

**SMALL AREA FUNCTION MEMORY N = (SAME LIST AS FOR FUNCTION MEMORY N)

GRAPHIC COMMANDS

**GRAPHIC N = FILE XXXXXX

GRAPHIC N = FUNCTION MEMORY N [,RGB]

GRAPHIC N = GRAPHIC M

GRAPHIC N = IMAGE M LEVEL O

GRAPHIC N = LABEL BY FACTOR M

GRAPHIC N = PROFILE OF IMAGE M

GRAPHIC N = PSEUDOCOLOR MEMORY RGB

**GRAPHIC N = SMALL AREA FUNCTION MEMORY N

GRAPHIC N = TABLE M

**GRAPHIC N = TAPE [L] FILE K RECORD M

IMAGE COMMANDS

IMAGE N = CONSTANT M

IMAGE N = DISPLAYED IMAGE RGB

**IMAGE N = FILE XXXXXX

**IMAGE N = FREEZE RGBA

IMAGE N = IMAGE M

IMAGE N = INTEGER (UASF)

IMAGE N = LOG (UASF)

IMAGE N = REAL (UASF)

IMAGE N = SQRT (UASF)

**IMAGE N = SUPERIMPOSE IMAGE M IF GRAPHIC K SET/CLEAR

**IMAGE N = TAPE [L] FILE K RECORD M

**IMAGE N = ZOOM IMAGE M BY FACTOR O

INTEGER COMMANDS

INTEGER FUNCTION N = INTEGER (IASF)

INITIALIZE COMMANDS

**INITIALIZE CORRECTOR

INITIALIZE FUNCTION MEMORY N

**INITIALIZE PATTERN

INITIALIZE PSEUDOCOLOR MEMORY RGBA

**INITIALIZE SMALL AREA FUNCTION MEMORY N

INITIALIZE TABLE N

MACRO COMMANDS

**MACRO A = FILE XXXXXX

**MACRO A = TAPE [L] FILE K RECORD M

CREATE MACRO A

EXECUTE MACRO A

SET MACRO

RELEASE MACRO

PSEUDOCOLOR COMMANDS

**PSEUDOCOLOR MEMORY RGB = FILE XXXXXX

PSEUDOCOLOR MEMORY RGB = FUNCTION MEMORY N

PSEUDOCOLOR MEMORY RGB = INTEGER (USAF)

PSEUDOCOLOR MEMORY RGB = LOG (USAF)

PSEUDOCOLOR MEMORY RGB = PSEUDOCOLOR MEMORY RGB

PSEUDOCOLOR MEMORY RGB = REAL (UASF)

**PSEUDOCOLOR MEMORY RGB = SMALL AREA FUNCTION MEMORY N

PSEUDOCOLOR MEMORY RGB = SQRT (UASF)

PSEUDOCOLOR MEMORY RGB = TABLE M

**PSEUDOCOLOR MEMORY RGB = TAPE [L] FILE R RECORD M

PSEUDOCOLOR MEMORY RGB = X [*/A] [+-B]

REAL COMMANDS

REAL FUNCTION N = REAL (RASF)

RELEASE COMMANDS

RELEASE CODE

RELEASE GRAPHIC N

RELEASE IMAGE N

RELEASE INTEGER FUNCTION N

RELEASE MACRO

RELEASE REAL FUNCTION N

RELEASE TABLE N

ROAM COMMANDS

ROAM IMAGE

**ROAM SMALL AREA

ROLL COMMANDS

ROLL FUNCTION MEMORY N

ROLL PSEUDOCOLOR MEMORY RGBA

**ROLL SMALL AREA FUNCTION MEMORY N

SET COMMANDS

SET CODE SIZE NNN (128 word blocks)

**SET COMBINE (RGB +-*/ RGB) [*/ SCALE] [+- OFFSET]

**SET CONTROL CHANNEL N

**SET CONVOLVER A B C D E F G H I

SET CORNERS IMAGE

**SET CORNERS SMALL AREA

SET DISPLAY COORDINATES X KKKK Y MMMM

SET FLAG GRAPHIC N

SET FLAG IMAGE N

SET GRAPHIC N X KKKK Y MMMM

SET IMAGE N X KKKK Y MMMM

SET INTEGER FUNCTION N

SET MACRO

SET REAL FUNCTION N

**SET SMALL AREA DISPLAY COORDINATES X KKKK Y MMMM

SET TABLE N

**SET TAPE BYTE N

**SET TAPE GRAPHIC TAPEPARMS

**SET TAPE IMAGE TAPEPARMS

SET TARGET COORDINATES X KKK Y MMM (0-511)

**SET VIDEO IMAGE N

SHIFT COMMANDS

SHIFT FUNCTION MEMORY N

SHIFT PSEUDOCOLOR MEMORY RGBA

**SHIFT SMALL AREA FUNCTION MEMORY N

SMOOTH COMMANDS

SMOOTH IMAGE

**SMOOTH SMALL AREA

SPIN COMMANDS

SPIN FUNCTION MEMORY N

**SPIN IMAGE BY FACTOR N

SPIN PSEUDOCOLOR MEMORY RGBA

**SPIN SMALL AREA FUNCTION MEMORY N

TABLE COMMANDS

**TABLE N = FUNCTION MEMORY N

TABLE N = INTEGER (UASF)

TABLE N = LOG (UASF)

TABLE N = PSEUDOCOLOR MEMORY RGB

TABLE N = REAL (UASF)

**TABLE N = SMALL AREA FUNCTION MEMORY N

TABLE N = SQRT (UASF)

TABLE N = TABLE M

**TABLE N = TAPE [L] FILE K RECORD M

TABLE N = X [*/A] [+-B]

TAPE COMMANDS

**POSITION TAPE [L] FILE K RECORD M

**REWIND TAPE [L]

**WRITE FILEMARK TAPE [L]

**TAPE [L] FILE K RECORD M = CODE

**TAPE [L] FILE K RECORD M = FUNCTION MEMORY N

**TAPE [L] FILE K RECORD M = GRAPHIC N

**TAPE [L] FILE K RECORD M = IMAGE N

**TAPE [L] FILE K RECORD M = MACRO A

**TAPE [L] FILE K RECORD M = PSEUDOCOLOR MEMORY RGB

**TAPE [L] FILE K RECORD M = SMALL AREA FUNCTION MEMORY N

**TAPE [L] FILE K RECORD M = TABLE N

TINT COMMANDS

**TINT IMAGE

**TINT SMALL AREA

TRACE COMMANDS

TRACE FUNCTION MEMORY N

TRACE GRAPHIC N

TRACE IMAGE N

TRACE PSEUDOCOLOR MEMORY RGBA