BMOMNI -- FORTRAN INTERFACE PROGRAM FOR THE RTPP BUFFER MEMORY, QUANTIMET AND CONTROL DESK

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ABSTRACT

BMOMNI is a low level graphics and hardware control package for the Real Time Picture Processor (RTPP) written in FORTRAN II.

T A B L E O F C O N T E N T S

SECTION 1

Introduction

BMOMNI is a low level graphics and hardware control package for the Real Time Picture Processor (RTPP) written in FORTRAN II. The RTPP hardware is discussed in ([1], [2], [3], and [4]). Reference [3] discusses the RTPP programming structure in detail.

1.1 Discussion of Terms used in BMOMNI

The RTPP, a single user (not time-shared) display and image computing system, is controlled from the PDP8e computer. It consists of a 32K PDP8e computer; eight 16-bit 256x256 pixel buffer memories each capable of acquiring and displaying two 8-bit digitized video images (although not simultaneously); a Quantimet (QMT) TV rate image analyzer; a GraphPen graphics tablet; a control desk and other hardware. The PDP8e may read, write, and control many of these devices. BMOMNI is a software interface between the hardware and the programmer. The hardware is discussed in ([1], [2], [3], [4]).

Each buffer memory (numbered 0, 1, ..., 7) stores 16-bit data. The data may be interpreted both in hardware and in software as 8-bit data. Thus a single buffer memory (BM) may store 2 images. The image in the low half of the BM is called the LOW byte image and the other the HIGH byte image. Thus a BM image is specified by a pair: (BM#,byte#). Only one of the two halves may be used to acquire gray scale video from the QMT camera or display gray scale video on the QMT TV monitor. However, the other half not being displayed as gray scale video may be used to generate a QMT live frame (See [3]).

The eight BMs are divided into two groups: A(0,1,2,3), and B(4,5,6,7). PDP8e I/O may proceed with one group without intefering with the display on the QMT with the other group because each group has its own memory controller.

BM data may be posted (displayed) on the QMT display which is a 860 pixel by 720 line non interlaced 10 frame/second display. A logical coordinate system (LCS) is defined over the QMT camera and display, graphpen table, and other hardware (see [4]). The LCS is a positive integer coordinate system with (x,y)=(0,0) at the upper left hand corner of the window, (1023,1023) is the lower right hand corner of the window. For display of the contents or for acquisition of images, each BM may be positioned independently anywhere in the LCS by specifying its "BM WINDOW" coordinates (upper left hand corner). BMs intersecting the same LCS space will be displayed on a priority basis with BM0>BM1>...>BM7.

In addition to posting images on the QMT, it is possible to acquire BM images at 1/10 second intervals from the QMT TV camera (vidicon or Plumbicon).

Movies are created by posting all BMs in the same BM window and successively unposting old frames while posting the new frames. In BMOMNI, a movie may consist of up to 16 different frames (JMEM,JBYTE) which may be cycled any number of times.

The GraphPen is a spark tablet (see [3]) mapped to the LCS or [0:255]. A cursor corresponding to the pen position may be displayed on the QMT. The intensity of the cursor may be varied by use of the QMT "SCALE" control. If the [0:255] pen range is used, then the user must also specify an (x,y) BM WINDOW offset so that the cursor may be positioned relative to an associated BM. The GraphPen has a switch at the tip of the pen which may be sensed. The pen (x,y) coordinates are is also available through BMOMNI.

The Quantimet hardware is capable of making simple measurements, at TV frame rates, of well defined objects in the image. An object is specified in the QMT system by a set of adjacent pixels whose density range is the same. The density range is specified as a slice range [C<B] from a in [0:255] where the thresholds C and B are hardware comparitors located in the QMT Detector Module and loadable via BMOMNI. A hardware module called the DETECTOR module computes so called detected video such that a pixel having density within [C:B]. Data from the DETECTOR module is then used in other parts of the QMT (including the display with an optional continuous mixing control) to compute various object specific features. The two function computers (FC1, FC2) compute object specific data every QMT frame. In addition, the total FC1 data is available each frame. Along with the object specific data (total density, area, perimeter, projections, Ferets - as 6-digit data) the last (x,y) points for each object (in a raster scan) are also available. These points are called the Anti-Coincidence Points (ACP).

The QMT has a computing window called the Variable Frame and Scale (F&S) under which QMT data may take place. The F&S may be moved remotely from the PDP8e using the four F&S keys or may be read/loaded from the PDP8e. It is possible to program various Boolean combinations of an effective frame for computing QMT data using the two frames: F&S, BM mask data. This is discussed in detail in [3] in the section on QPROG2, QPROG7.

SECTION 2

Arguments used in BMOMNI calls

A sample BMOMNI call is:

```
CALL BMOMNI(JMEM, JBYTE, JX, JY, JG, LINEBUF, IOPR)
```

There are 34 operations available in BMOMNI. The 7 arguments specified in a BMOMNI call have the following meaning:

ARG	function
JMEM	Buffer memory number to be used in the operation in the range of 0 to 7.
JBYTE	Buffer memory byte (low=0, high=1) to be used in the operation.
JX	Reference value for x (usually in the range of 0:255).
JY	Reference value for y (usually in the range of 0:255), or a flag for some operators.
JG	Reference gray value (or flag for some operatons).
LINEBUF	Reference 1-Dimensional array of variable size. Depending on the operation, it may vary from size 1 to 512. It is used as a general purpose I/O buffer between BMOMNI and the user program.
IOPR	operation to be performed specified by an integer in the range of [1:34]. Numbers outside of this range are trapped and OS8 called. OS8 is also called if there are not 7 arguments.

The 34 operators might be assigned mnemonics in the calling program. In the following list of operators, mnemonics are suggested which begin with the letter "M". This is because IOPR is an integer variable. Generally, the user would assign a subset of BMOMNI commands to such mneumonics for use in subsequent calls to BMOMNI.

SECTION 3

List of BMOMNI functions

IOPR	FUNCTION
1	MTEXT - DISPLAY TEXT CONTAINED IN LINEBUF[1:20] 20A2 FORMAT AT (JMEM,JBYTE,JX,JY, COLOR JG). THE A2 FORMAT IS USED TO BE COMPATIBLE WITH THE "TEXT" OPERATOR IN FORTRAN/SABR.
2	MMOVE - MOVE THE START OF VECTOR COORDINATE (X0,Y0) TO (JX,JY). DO NOT DISPLAY.
3	MDRAW - DRAW LINE OF DENSITY JG [0 TO 255] FROM (X0,Y0) TO (JX,JY) IN THE BM SPECIFIED BY (JMEM,JBYTE). THE NUMBER OF POINTS GENERATED IS RETURNED IN JG AND THE SETS OF (X,Y) POINTS GENERATED ARE IN LINEBUF. IF MDRAW IS CALLED WITH JG < 0 THEN THE VECTOR IS GENERATED BUT NO POINTS ARE DRAWN IN A BUFFER MEMORY. DATA OUTSIDE OF (X,Y) RANGE [0:255,0:255] ARE CLIPPED.
4	MCOLOR - COLOR THE ENTIRE BM (JMEM,JBYTE) DENSITY JG.
5	MPOST - POST BUFFER MEMORY (JMEM,JBYTE). TO POST THE OTHER 1/2 OF <BMI> AS (MASK VIDEO&(F&S)) SET JY=1 ELSE JY=0.
6	MUNPOST - UNPOST BUFFER MEMORY SPECIFIED BY (JMEM,JBYTE).
7	MWINDOW - MOVE BM WINDOW COORDINATE (BMXj,BMYj) FOR BUFFER MEMORY JBM TO LCS (JX,JY).
8	MNUMBER - DISPLAY THE NUMBER CONTAINED IN JG AS 4 DIGIT SIGNED DECIMAL AT (JMEM,JBYTE,JX,JY).
9	MGET - GET A VIDEO IMAGE FROM THE QMT INTO THE BUFFER MEMORY SPECIFIED BY (JMEM,JBYTE). TO GET DETECTED VIDEO IN THE OTHER 1/2 OF JBYTE OF THE BM SET JY=1 ELSE JY=0. THE MEMORY MUST BE POSITIONED AT THE DESIRED BM WINDOW PRIOR TO THE MGET. THE MGET IS PERFORMED INDEPENDENTLY OF THE POST STATUS FOR THE SPECIFIED BM.
10	MFETCH2D - READ BM PIXEL (JMEM,JBYTE,JX,JY) ==>JG
11	MPACK2D - WRITE BM PIXEL (JMEM,JBYTE,JX,JY) <==JG

12 MRDLINE - READ BM LINEBUF[1:256] <== (JMEM,JBYTE,JY)

13 MWTLINE - WRITE BM LINEBUF[1:256] ==> (JMEM,JBYTE,JY)

14 MCLRMOVIE - CLEAR MOVIE LIST (SEE IOPRS # 15, 16).

15 MINSMOVIE - INSERT BM SPECIFIED BY (JMEM,JBYTE) INTO MOVIE FRAME JG (1:16). TO USE MASKE(F&S) VIDEO (IE. JBYTE') FOR THIS FRAME THEN SET JY=1 ELSE JY=0.

16 MRUNMOVIE - RUN MOVIE JG TIMES (MINIMUM OF 1 TIME). TYPE ^O TO RETURN BEFORE JG TIMES RUNS OUT. JY IS USED TO SPECIFY THE NUMBER OF TIMES A BM FRAME IS SHOWN (IN TERMS OF QMT FRAMES OF 1/10 SEC) BEFORE THE NEXT FRAME IS SHOWN. BOTH JY AND JG DEFAULT IF 0 TO 1.

17 MGRFPEN - GET (JX,JY) FROM GRAPHPEN AFTER PEN SPARKS. NOTE: PUT THE GRAPHPEN CONTROLLER SWITCH IN "RUN" MODE. ALSO THE "RESET" SWITCH MUST BE PRESSED WHEN THE PDP8E IS RESTARTED. IN ADDITION TO RETURNING THE (X,Y) PEN COORDINATES, THE PENSWITCH (FBW12[11]) IS RETURNED IN LINEBUF[1]. THE CURSOR ON THE QUANTIMET DISPLAY (USING THE SCALE CONTROL) IS MOVED WITH THE PEN REGUARDLESS OF WHETHER DATA IS ACQUIRED OR NOT. IF THE LCS (1024X1024) COORDINATE SYSTEM IS DESIRED INSTEAD OF THE 256X256 SYSTEM, THEN CALL MGRFPEN WITH JG=1 OTHERWISE SET JG=0. WHEN USING THE (256X256) COORDINATE SYSTEM, (JX,JY) MUST BE SET TO THE POSITION OF THE 256X256 WINDOW OVER WHICH THE DATA IS TO BE MAPPED FOR THE QMT CURSOR. DATA IS IN THE RANGE OF (0:255).

18 MLDCURSOR - LOAD QMT CURSOR FROM (JX,JY) INTO LCS COORDINATES. THE QMT "SCALE" CONTROL CONTROLS THE INTENSITY OF THE CURSOR.

19 MLDFS - LOAD QMT FRAME AND SCALE QMT WINDOW SPECIFIED BY THE 4-TUPLE: (HORIZONTAL POSITION, HORIZONTAL SIZE, VERTICAL POSITION, VERTICAL SIZE) FROM LINEBUF[1:4] SPECIFIED AS LCS (0:1023]) COORDINATES.

20 MRDFS - READ THE QMT FRAME AND SCALE QMT WINDOW (HP,HS,VP,VS) LCS COORDINATES INTO LINEBUF[1:4].

21 MRDKBD - READ THE CONTROL DESK KEYPAD 6-DIGIT SWITCHES AND RETURN FLOATING POINT NUMBER IN LINEBUF[1:3]. PRESSTHE KEYPAD "C" TO CLEAR THE KEYPAD BEFORE READING BY THE PDP8E, PRESS "S"

TO SEND THE CONTENTS OF THE NUMBER ENTERED INTO THE KEYPAD TO THE PDP8E.

22 MRDFBW - READ THE CONTROL DESK "FBWi" SWITCHES NUMBERS 1 THROUGH 12 OCTAL AND PUT THE RESULTS INTO LINEBUF[1:12 OCTAL]. SEE [3] FOR DETAILED SWITCH DESCRIPTION.

23 MLDQMT - LOAD LINEBUF[1:2] (LOW,HIGH) 3 DIGIT DECIMAL (POSITIVE) NUMBERS INTO THE RIGHT QMT NUMERAL DISPLAY.

24 MLDCDLIGHTS - LOAD JG==>CONTROL DESK COMMAND KEY (FBW2) LIGHTS. THE 12-BIT JG BIT PATTERN CORRESPONDS TO THE 12 COMMAND KEYS.

25 MLDDISP - LOAD LINEBUF[1:2] DATA INTO DISP1, DISP2 CONTROL DESK LIGHTS. THE LIGHTS DECODED THE 12-BIT DATA INTO BOTH BCD AND OCTAL NUMBERS.

26 MRUNQMT - RUN THE QMT WITH "QMT FUNCTION COMPUTERS FC1 AND FC2 PROGRAMMED BY (JX,JY). THE NUMBER OF OBJECTS FOUND RETURNED IN JG (SEE [3]). QMT FULL FIELD DATA FOR FC1 IS RETURNED AS A FLOATING POINT NUMBER IN LINEBUF[1:3]. FC1 IS PROGRAMMED BY JX, FC2 BY JY RUNQMT.

VALUE	FUNCTION
1	DENSITY
2	AREA
3	PERIMETER
4	HORIZONTAL PROJECTION
5	VERTICAL PROJECTION
6	VERTICAL FERET
7	HORIZONTAL FERET

27 MRDFCT - READ THE NEXT QMT OBJECT (ACP) DATA FROM THE SHIFT REGISTER STACK. DATA INCLUDES [FC1,FC2,(X,Y)ACP] GENERATED WITH THE LAST MRUNQMT. DATA IS RETURNED AS:

JX=XACP,
JY=YACP,
LINEBUF[1:3]=FLOATING FC1 DATA,
LINEBUF[4:6]=FLOATING FC2 DATA.

28 MQSTAT - LOAD JG INTO QSTAT QMT STATUS REGISTER (SEE [3]).

29 MQPROG - LOAD LINEBUF[1:8]==>QPROG[1:8]. THE QPROG WORDS ARE THE QMT HIGH LEVEL PROGRAM WORDS DISCUSSED IN [3].

30 MCLOCK - WAIT JG*0.05 SECONDS BEFORE RETURN (REAL TIME 200HZ CLOCK). IF JG=0 THEN WAIT 0.05 SEC.

31 MSAMPLE - SAMPLE THE PDP8E 16 CHANNEL A/DS AND RETURN THE A/D DATA IN LINEBUF[1:16] IN THE RANGE OF 0:1023.

CHANNEL	FUNCTION
0	GALVANOMETER SCANNER DATA
1	" " REFERENCE
2:7	-SPARES
8:15	CONTROL DESK KNOB POTS 0:7

32 MRD3LINES - READ 3 BM LINES STARTING AT (JMEM,JBYTE,JY) INTO LINEBUF[1:512] PACKED 3/2 3-BYTES/2PDP8E(12-BIT) WORDS. IF JY=254 OR 255 THEN THE DATA WILL WRAP AROUND TO LINE 0 OR 0,1.

33 MWT3LINES - WRITE 3 BM LINES FROM LINEBUF[1:512] INTO (JMEM,JBYTE,JY) PACKED 3/2 3-BYTES/2PDP8E(12-BIT) WORDS. IF JY=254 OR 255 THEN ONLY LINES 254:255 OR 255 WILL BE WRITTEN OUT TO THE BM (I.E. THE BM IS PROTECTED AGAINST WRAP AROUND).

34 MLDETBC - LOAD THE QMT DETECTOR MODULE THRESHOLDS B AND C THB<==JX, THC<==JY (SEE [3]). NOTE: THE VALUES ARE IN THE RANGE OF [0:255].

SECTION 4

References

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