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## LISP DISPLAY FUNCTIONS

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**Abstract:** A set of LISP display functions are available on DTA7. They provide a general capability for displaying points, lines and text. Objects may be named and manipulated individually.

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### SUBFRAMES

To provide convenient use of displays in LISP, a set of display functions is available. These functions are oriented to constructing subframes (i.e., parts of the frame to be displayed) which together make an entire frame. Subframes may be named and operated upon individually, but the components of a subframe may not be operated upon. In order to change a part of a subframe, it is necessary to regenerate the entire subframe, making appropriate changes to those parts of interest. Parts of subframes which are modified frequently should be changed to separate subframes.

### COORDINATE SYSTEM

The positioning of objects in the display specified by a vector  $(X, Y)$  starting at the origin. The absolute scaling of the X and Y axes is controlled by the global variables DISPHSCALE, DISFVSCALE, respectively, which specify the number of resolution elements on the display per unit in the coordinate system. For instance if DISPHSCALE = 5 and DISFVSCALE = 1, the vector (3 .-7) designates the point 15 resolution elements right of the origin, and 7 resolution elements down. When the scaled location of a vector is non-integral, rounding to the nearest resolution element occurs.

### FUNCTIONS

The following control functions are implemented.

- A) (DISPINIT L S) where L specifies the number of words to be allowed for the display buffer, and S the maximum number subframes to allow.

This function must be executed to initiate the display and set up the display buffer. It should be called only once for a given core image, since it steals storage from binary program space.

- B) (GENERATE S X) where S specifies the subframe to be generated and X is a list of display functions. This function is used to generate and display a subframe. If that subframe had existed previously, the storage previously used is recovered, and the subframe is regenerated as specified.

## DISPLAY FUNCTIONS

Display functions are normally used as arguments to generate. They are:

1) (POINTS P1 P2 P3 ... Pn)

where each of the P<sub>i</sub>'s is a point specifier. This function generates a point at each of the specified locations.

A point specifier is any expression which evaluates to a dotted pair of 2 numbers.

Examples of legitimate point specifiers:

(1 . 3.97)

Q1

where previously we did (SETQ Q1 (1 . 3.97))

(CON 1 3.97)

(A . A)

where A and B were previously SETQ'D to numbers.

((PLUS A 1) . (TIMES B 5)) where A and B were previously SETQ'D to numbers.

2) (DRAW P1 P2 P3 ... Pn)

where each P<sub>i</sub> is a point specifier.

This function draws lines between the points P<sub>i</sub> and P<sub>i+1</sub>. Lines are generated by a sequence of points sufficiently close together to give the illusion of a line. The number of resolution elements between these points is controlled by the global variable DISPINC.

3) (LINES (P<sub>11</sub> P<sub>12</sub> ... P<sub>1n</sub> (P<sub>21</sub> ... P<sub>2n</sub>) ... (P<sub>m1</sub> ... P<sub>mn</sub>))

where each P<sub>ij</sub> is a point specifier.

This function performs DRAW on each list of points, that is it draws line between

P<sub>ij</sub> and P<sub>ij+1</sub> for each i and j.

4) (TEXTQ P1 (THIS IS TEXT))

where P1 is a point specifier.

TEXTQ displays the text (in this case "(THIS IS TEXT)")

starting with the lower left side of the left most character at the point P1. The following global variables control text generation:

DISPLL controls the number of characters on a line.  
DISPCHSIZ controls the character size.  
DISPLSPACE controls the vertical spacing between lines; in resolution elements.

5) (TEXT P1 T)

where P1 is a point specifier and an expression which evaluates to an s-expression.

TEXT displays the text specified by the s-expression T, starting at point P1 as with TEXTQ.

For both TEXT and TEXTQ, the text is displayed exactly as PRINT would type it.

6) (PTGEN X Y) plots a point at (X Y).

OTHER CONTROL FUNCTIONS

C. (BLANK S) where S is the name of a subframe. (S is evaluated, so usually it must be (QUOTE FOO))

This function erases (stops displaying) the subframe S, but does not destroy it.

D. (UNBLANK S) as with BLANK, but UNBLANK redisplay a previously BLANKED subframe.

E. (DESTROY S) as with BLANK but DESTROY gets rid of the display buffer for S and recovers its storage.

F. (RESTART)

If it is necessary to reenter the LISP system from the TS system using START, you must call (RESTART) to turn the display back on.

EXAMPLES

To draw a unit square centered at the origin whose name is UNITSQUARE:

```
(GENERATE UNITSQUARE (DRAW (-.5 . -.5)(-.5 . .5)
                          (.5 . .5)(.5 . -.5)
                          (-.5 . -.5)))
```

To remove UNITSQUARE from the screen:

```
(BLANK (QUOTE UNITSQUARE))
```

To plot points at the vertices of UNITSQUARE, and call them VERTICIES:

```
(GENERATE VERTICIES (POINTS (-.5 . -.5)(-.5 . .5)
                             (.5 . .5)(.5 . -.5)
                             (-.5 . -.5)))
```

To plot the point P1 = (-5 . 0) and label it with its name and coordinates:

```
(GENERATE P1 (POINTS(-5 . 0))(TEXT (-4.5 . 0)
                                     (LIST (QUOTE P1)(QUOTE (-5 . 0)))))
```

To plot the function  $f(x)$  from A, B ( $A < B$ ) with an increment of I, we may define the function plot:

```
(DE PLOT (F A B I)
          (COND((LESSP B A) NIL)
                (T(PROG2(PTGEN A (F A))(PLOT F (PLUS A I) B I )))))
```

(PTGEN X Y) is a function which plots a point at (X . Y).

To plot the function  $f(x) = x^2 - 5$  from -5 to 5 with increment .1:

```
(PLOT (QUOTE (LAMBDA (X)(DIFFERENCE(TIMES X X) 5)))
      -5
      5
      .1)
```

## SUMMARY OF DISPLAY FUNCTIONS

### GLOBAL VARIABLES

<u>NAME</u>	<u>INITIAL VALUE</u>	<u>RANGE</u>	<u>PURPOSE</u>
DISPVSCALE	1 res. elem.	arbitrary	Vertical scale
DISPHSCALE	1 res. elem.	arbitrary	Horizontal scale
DISPCHSIZ	2	0 to 3	Character size
DISPLSPACE	40 res. elem.	0 to 500	Line spacing
DISPINC	4 res. elem.	1 to 500	Line generator increment
DISPINTENSITY	0	-4 to 3	Display intensity
DISPLL	30	1 to 100	Line length

### CONTROL FUNCTIONS

(DISPINIT L S) initializes the display.

(GENERATE S L) generates a subframe using display functions.

(BLANK S) removes subframe from screen.

(UNBLANK S) restores subframe to screen.

(DESTROY S) destroys subframe and recovers its storage.

(RESTART) restarts display after ↑C,..., S.

## DISPLAY FUNCTIONS

(POINTS P1 P2 ... Pn) plots points

(DRAW P1 P2 ... Pn) draws connected lines

(LINES (P11 P12 ... P1N)(P21 ... P2n)...) draws connected and unconnected lines

(TEXTQ P1 (THIS IS TEXT)) displays text (quoted)

(TEXT P1 LIST) displays text

(PTGEN X Y) plots a point

## TO USE THE DISPLAY FUNCTIONS

To load the display functions into your LISP core image, use the following procedure:

- 1) Be sure to provide sufficient binary program space in your core image.
- 2) When ready to load functions type: (INC (INPUT DTA7: DISPKY))
- 3) When ready to use the display type: (DISPINIT L S) to initialize the display. ( L is # words of buffer, S is # subframes).
- 4) You should now be able to use the display, using the control functions described.
- 5) If you must reenter the LISP system type (RESTART) after reentering.