CROTX: A subroutine to plot alphanumeric stimuli on an oscilloscope

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Researchers in the field of experimental psychology often require a means of displaying visual stimuli to subjects under controlled conditions. Tachistoscopes and slide projectors have traditionally been the principle devices used for this purpose. In recent years, however, there has been a trend toward the use of visual-display devices that are controlled by computers. The advantages of using computers include more precise control of the parameters associated with experimental events, and a considerable reduction in the routine labor involved in administering individual trials throughout an experimental session. The cathode-ray oscilloscope is frequently used as the device upon which stimulus information is plotted by computer. This is because of the relative ease and flexibility with which stimuli can be programmed for display via a digital-to-analog (D/A) converter, the clarity of the resulting display; and the precision with which rise, dwell, and decay times can be controlled.

A major difficulty in using computer-controlled devices for stimulus presentation, however, concerns the construction and storage of stimulus material. It is usually necessary to digitize visual stimuli in order to produce coordinate files which may be stored on disk. Stimulus presentation requires that these coordinate files be retrieved from disk, loaded into memory, and then fed to a D/A converter for oscilloscope display. The process of digitization and subsequent editing can be tedious and time-consuming, and the storage of resultant coordinate data may make excessive demands upon disk and memory space. These problems may be unavoidable where unique stimulus displays are required by an experiment, but may be ameliorated by character-generating graphics hardware where standard alphanumeric characters are acceptable, as in instructions to subjects and in some types of stimulus displays. Suitable character-generating hardware for computer-controlled oscilloscope displays, however, still is relatively complex and expensive. Subroutine CROTX provides a software alternative to such hardware by generating displays from a standard set of built-in alphanumerics and punctuation symbols.

Program Description. CROTX is a MACRO-11 subroutine that operates on the Digital Equipment Corporation's PDP-11 family of processors, interfaced to an oscilloscope via a D/A converter. The subroutine is designed to be linked into FORTRAN programs and ac-

cessed via a call that requires from four to six arguments. CROTX provides a character set that includes all letters and digits and a selection of special symbols and punctuation marks. Lines of text may be formatted on the screen using the slash (/) symbol as a carriage return. Each line is automatically centered on the screen, but may be displaced to the right or left by the insertion of leading or trailing blanks. An optional pair of arguments permits the coordinates of the center of the top line to be specified as the reference point upon which the display is positioned. If not specified, these arguments default to coordinates (0,0). The plotting density of the display is automatically computed to ensure maximum resolution consistent with a steady image. Display characters are transmitted to CROTX in an argument that may take the form either of a character string enclosed in quotes or of an array of any type which has been loaded with the appropriate ASCII data.

There are three ways of determining the duration of the display. If the DURATION argument is positive, the value is interpreted as representing the required duration in milliseconds. A KWV11-A programmable real-time clock must be available for use in the system if this mode is selected. If the DURATION argument is negative, the absolute value of the argument is interpreted simply as the number of required plotting repetitions of the display. This mode may be useful where a real-time clock is not available for use and display durations are not critical. A third method of determining display duration, which may be used in combination with the first two methods, permits the display to be terminated by a signal input to a DRV11 parallel-line unit. If the LISTEN argument contains a value of one, CROTX exits to the calling program upon any bit's being set in the input buffer of the DRV11. Having the input buffer connected to a switch available to the subject provides a means by which the subject may terminate the display and permit the calling program to proceed to the next event.

CROTX has been used extensively in perceptual and cognitive experiments to display simple instructions and messages to subjects, construct fixation points and trial signals, feedback information on performance, and to create stimulus displays consisting of letters, words, or numbers. It has also been used to display geometric stimulus forms constructed from concatenated symbols.

Program Operation. The subroutine may be invoked from a FORTRAN program by issuing the instruction CALL CROTX (DISPLAY, BUFFER, DURATION, LISTEN, XCENTRE, YCENTRE). The first two arguments may employ array variables of any type. As indicated earlier, the DISPLAY argument can transmit display characters as Hollerith constants enclosed in quotation marks. If, however, an array of ASCII data is used to transmit display information, the last character in the array should be followed by an element containing

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the value zero. The **BUFFER** argument is used to provide a working buffer for **CROTX**. **CROTX** requires six bytes of temporary storage for each display character in order to maintain plotting-control information. The **BUFFER** argument therefore should specify an array which contains at least six times the number of bytes as there are display characters, including slash symbols. In fact, because plotting control includes an implicit terminating character, the minimum buffer size in bytes should equal the number of display characters plus one, multiplied by six. As an example, a 20-character display would be adequately served by a one-dimensional **REAL** array of 32 elements. The final four arguments in the call to **CROTX** must be integer variables or constants. The two trailing arguments, **XCENTRE** and **YCENTRE**, are optional but, if omitted, default to coordinates (0,0), as noted earlier.

The following examples illustrate the use of CROTX. The statement CALL CROTX ('end/of/session', BUFF, 4000, 1, 1000, 1500) produces a three-line display with the top word 'end' centered on coordinates (1000, 1500). The display persists for 4 sec, unless terminated earlier by setting a bit in the DRV11 parallel-line unit. Note that BUFF is the name of a declared array which, in this case, is at least 90 bytes in length. The statement CALL CROTX ('+', BUFF, 1000, 0) displays a cross centered on coordinates (0, 0) for 1 sec. CALL CROTX ('..... /.. /.. /.....', BUFF, 500, 0, 2000, 2000) displays for 500 msec a square constructed of five-dot

sides. The middle dot of the top side lies at coordinates (2000, 2000). Array BUFF should be dimensioned to contain at least 180 bytes.

Optional Modifications. Several simple modifications may be made to tailor CROTX to the requirements of a particular installation. The modification sites are clearly marked on the program listing, and CROTX may be easily modified and reassembled by users having no MACRO-11 programming experience. Alterations may be made to device addresses to accommodate nonstandard addresses; default settings other than (0,0) may be installed for arguments XCEN and YCEN; and processor interrupts may be disabled during beam intensification to prevent possible flicker on some systems.

Hardware Required. CROTEXT occupies approximately 1.2 Kbytes of memory and uses the standard PDP-11 instruction set. Floating-point facilities are not required. CROTEXT has been used on a variety of installations, ranging from a PDP-11/20 running under DOS to an LSI-11/73 running under RSX-11M. Device addresses are configured for the standard slots on the AAV11-A 12-bit D/A converter, DRV11 parallel-line unit, and KVV11-A programmable real-time clock.

Availability. A program listing, containing 264 lines of code plus comments may be obtained free of charge from the author.

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