COMPUTER TECHNOLOGY

An experiment control system for the Amiga microcomputer

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The Commodore Amiga microcomputer, with its powerful and versatile hardware features, is well-suited to many areas of behavioral research. The complexity of the hardware and software, however, creates considerable difficulties for the researcher who wishes to construct real-time experiment-control programs. The present article describes a coordinated package of routines that have been designed to support experiment-control programs written in FORTRAN 77. The package was constructed specifically for cognitive research on verbal processes, but is sufficiently flexible to be useful in a variety of other applications. The functions performed by the program include the construction of stimulus displays, response detection, and timing operations.

The Commodore Amiga microcomputer is a powerful machine for its size and cost, and includes such features as fast processing speed, high-resolution graphics incorporating up to 4,096 different colors, and sophisticated sound generation. Such features are potentially very useful to investigators who need to present complex stimulus displays in laboratory experiments. Unfortunately, there are serious obstacles to the use of the Amiga, such as the paucity of suitable software and adequate documentation, and meager and obscure system-error diagnoses. The present article focuses on a library of coordinated routines that permit FORTRAN 77 programs to control experiments to be written relatively easily. The routines are contained in a package named EXP.LIB and are designed to allow such entities as screen displays, mouse buttons, keyboard, and timers to be manipulated simply and easily by calls from within a FORTRAN 77 main program. The package has been extensively tested and refined in the author's laboratory, and is intended to operate within the environment provided by the Absoft Corporation's AC/FORTRAN 77 compiler and Amiga Interface System.

The package listing is accompanied by a sample FORTRAN 77 experiment-control program that demonstrates the way calls to EXP.LIB routines can be used to carry out a typical experiment in cognitive psychology. The program has been deliberately simplified so that the way EXP.LIB routines may be implemented can be easily understood. The program executes experiment sessions based on a priming paradigm using a GO-NOGO lexical-decision task. On each of 180 trials, the program presents two consecutive strings of letters separated by an inter-stimulus interval of 250 msec. Subjects are instructed to

press a mouse button whenever the second string of letters (target) corresponds to an ordinary English word. When the target is a nonword, as it is on a random 50% of trials, the subjects simply withhold their responses. The program measures and stores response times in milliseconds. At the end of a session, the data and parameters for each trial are written to a disk file for later analysis. The program calls the routines described below to set up and define an output window, install text fonts, display instructions to subjects, control a timer, generate stimulus displays, randomize display sequences, record and time responses, provide performance feedback, and release system resources when they are no longer required.

ROUTINES AVAILABLE IN EXP.LIB

From both a functional and a structural point of view, EXP.LIB divides naturally into three modules: the interface control module, the timer module, and miscellaneous routines. A description of each of these modules follows.

Interface Control Module

This module consists of the routines OPEN and PORTS, which control the Amiga Interface System responsible for organizing screen displays and detecting inputs. The FORTRAN INCLUDE statement is invoked at the beginning of OPEN to read in six support files for the Amiga Interface System. These files (GRAPH.INC, DOS.INC, EXEC.INC, INTUIT.INC, LAYERS.INC, and DSKFNT.INC) are an integral part of the AC/FORTRAN 77 package supplied by the Absoft Corporation, and should be located in the LIBS directory of the system disk when compiling.

PORTS supports only a single call, but OPEN has several entry points, as described below. In the entry calls

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listed below, all unnecessary trailing arguments have been omitted. Unnecessary leading arguments, which must be included in each call for positional reasons, are identified as "n/a."

OPEN (fontsize, windowclose, fontname, height). This is the main entry to OPEN, and for that reason it includes all arguments, whether used in this entry or not. As it stands, OPEN activates a 640×200 pixel window on the Workbench screen, free of distracting borders and other visual devices usually found in Amiga displays. It should be noted, though, that the source of this routine may easily be modified to alter the dimensions of the window or to include any of the normal Amiga window facilities. This window constitutes the display field used by EXP.LIB for stimulus presentation. Setting "windowclose" to 1 causes OPEN to include in the display the Amiga icon used for closing windows with the external mouse. "Height" allows the lower edge of the window to vary in position over a range of 1 to 200 pixels. This provides a facility whereby the normal CLI window can share the screen with the stimulus window. The specified font type and size is retrieved from the FONTS directory of the system disk, and is set up for use in all subsequent text output to the window. A variety of fonts are available on Amiga system disks. However, custom fonts for particular experimental purposes can easily be constructed using one of the several font editors available commercially or from public domain software. We have recently created a font consisting of 128 Chinese characters, each representing a simple concept (e.g., fish, bird, ocean, etc.), for use in a priming study involving bilingual subjects.

CLOSE (). This command closes the display window, releases the font resources, and ensures that the timer has been stopped.

NEWFONT (fontsize, n/a, fontname). This command allows an extra font to be installed for use in the opened display window.

SETFONT (fontnumber). By setting "fontnumber" to 1 or 2, the initial or extra font, respectively, may be invoked for use in text operations.

BACKW (). BACKW moves the current output window to the back of the screen, allowing the normal CLI window to occupy the display field temporarily. This is useful, for example, in presenting progressive performance summaries to subjects during rest periods, as the sample control program does. The material written to this window using normal FORTRAN I/O statements is left undisturbed by stimulus presentation in the window created by OPEN.

FRONTW (). This command reverses the effect of BACKW, allowing a return to the stimulus-display window.

APEN (color). APEN allows the color of material written to the display window to be selected from among four alternatives. The system program PREFERENCES may be used to preset these alternatives to any one of 4,096 different colors.

BPEN (color). BPEN is similar to APEN, except that it refers to the setting of the background color.

PIXELS (numpixels, n/a, string, numchars). This call returns the horizontal length of a specified text string in pixels. The sample control program uses this information to center stimulus presentations and directives to subjects on the screen.

PRINT (X, Y, string, numchars). This call prints a text string "numchars" long, starting at the pixel indicated by the X and Y coordinates. If the X coordinate is less than zero, the text string is automatically centered on the screen. To ensure that stimulus exposure durations are as consistent as possible, printing is always delayed until the start of the first vertical-blanking period.

CLEAR (X, Y). CLEAR erases all screen information from the specified pixel to the end of the line.

INPUT (inputcode, deadline). This call permits the keyboard or mouse to send input signals to the program. "Deadline" specifies how long, in milliseconds, the routine should wait for a key closure before returning to the calling program (if "deadline" is set to zero, INPUT waits indefinitely). If a key is pressed, "inputcode" returns a code identifying that key. If the window-close icon was selected by the mouse, "inputcode" is returned as a -1. If no input event occurs within the specified deadline, "inputcode" is returned as a zero. It should be noted that since the keyboard buffer is scanned only once every 16.67 msec, this is the limit of resolution with which response times can be measured. If greater resolution is required, the PORTS routine should be used to poll responses on gameport switches (see below).

INPUTQ (inputcode, deadline). This command is the same as that for INPUT, except that the message queue is not cleared on entry to the routine. Thus, any input event that may have been detected and queued prior to the call will result in an immediate return to the calling program.

FLASH (). This call momentarily flashes a different color on the screen. The sample control program uses this call to warn subjects of erroneous responses.

PORTS (f3, f4, r3, r4). This routine reads Pins 3 and 4 of the front and rear gameports, and returns the switch states in the arguments (closed=1, open=0). Repeated calls to this routine will effectively "poll" the switches, providing more precise response-time measurement than is possible with INPUT.

Timer Module

The timer module consists of four subroutines written to configure and control the 8520 CIAB chip A and B timers as a general timing device with a resolution of 1 msec. The maximum timing duration is 65,535 msec, after which the timer will wrap around to zero. It should be noted that the Amiga system executive uses Timer A for serial communications and Timer B for beam-synchronized blitter control. Care should be taken to ensure that the timer is not used in conflict with requests to the executive for serial communications or complex graphic operations.

CSTART. This routine clears and starts the timer.

CREAD (). This routine is called as a function, and returns the current value of the timer in milliseconds.

CSTOP. This routine stops the timer.

CDELAY (delay). This routine returns to the calling program following the delay specified in the argument. This routine does not interfere with timer values, and may be used concurrently with other timing operations.

Miscellaneous Routines

The final component of EXP.LIB comprises a collection of routines that perform a variety of functions required in experiment-control programs. These routines will not be detailed, as they are unlikely to be as generally applicable as those described above. However, some of the functions performed may be useful, including pseudorandom number generation, determining the number of characters in text strings, displaying initial instructions to subjects, and updating a list of data files for later analysis.

EXP.LIB was constructed specifically for a range of experiments that require text displays as output, and manual responses as input. However, there are many func-

tions in the Absoft Amiga Interface System not accessed by EXP.LIB that could support a variety of other experimental manipulations. Within the environment and sample program provided by EXP.LIB, these routines should be quite easy to implement. Furthermore, experiment programs based on EXP.LIB have been used to collect vocal reaction-time data, rather than manual responses, by simply connecting the output of a voice-operated relay to the input connectors normally used for receiving signals from a mouse button.

Availability

A source and compiler listing of EXP.LIB, plus the sample control program, may be obtained free of charge from the author. If a disk copy is required, please enclose a blank 3.5-in. diskette with the request.

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Announcement

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