Behavior Research Methods & Instrumentation
1979, Vol. 11 (1), 64-66

COMPUTER TECHNOLOGY

The presentation of visual stimuli: An inexpensive microcomputer-based system

WAYNE M. KASHINSKY, RAYMOND G. ROMANCZYK, and ALAN TREIBER
State University of New York, Binghamton, New York 13901

The presentation of visual stimuli and subject response recording are integral to many experimental paradigms. A microcomputer-based video display system is described that is extremely versatile and less expensive than slide projector systems.

Perhaps one of the most common psychological experiments with humans, as well as infrahumans, involves presenting a visual display to the subject and recording the subject's response. There has, therefore, evolved a plethora of devices for presenting visual stimuli, each with its own positive and negative aspects. Often, the equipment used, such as a random-access slide projector, although serving the needs of the experimenter, tends to be expensive and bulky and requires a great deal of support programming hardware. Further, stimulus preparation is not usually an easy or rapid process.

In a recent project involving investigation of cue saliency with psychotic children, we required an apparatus that could present three visual stimuli simultaneously, each of which could vary with respect to position, size, and shape. The capability of colored displays as well as black and white was also necessary.[1] Further, the device had to be portable, easy to operate, capable of providing the experimenter with trial-by-trial data on response choice and latency, able to present several hundred stimuli in a predetermined or random order, and capable of providing feedback to the subject regarding the correct response. After evaluating a number of possible methods, we decided upon a specialized microcomputer, the RCA visual information processor (VIP), as the unit of choice. There are numerous microcomputers on the market (see the special issue of *Behavior Research Methods & Instrumentation*, August 1978, on microprocessors and minicomputers), many of which can generate video displays. However, the RCA unit has certain unique characteristics that make it particularly well suited for this type of research.

THE MICROCOMPUTER UNIT

The VIP is a single-board microcomputer that contains a unique graphic display generator coupled with a simple but extensive control language. The computer contains 2,048 words of static memory that can be expanded to 4,096 on-board. Powered by a 5-V low-current supply, the VIP can be battery operated for field operation. The VIP interfaces directly to a video monitor or an inexpensive TV using a radio-frequency modulator. Input and output are accomplished through two 8-bit buffered and latched ports terminating on 44 pin connectors, providing communication lines to the subject station. An integral keypad is used to program the unit, and function keys allow TAPE READ, TAPE WRITE, MEMORY READ, and MEMORY WRITE operations. Programs and data tables are loaded into the computer at 100 cps using an inexpensive audio cassette recorder.

VIP uses an interpreted language called CHIP-8, which is random-access memory (RAM) resident (512 words) and is loaded by cassette. Similar to BASIC in structure, the language has all operations written as hexidecimal operation codes referring to 16 variables (0-F). Graphic patterns are defined in memory as 8-bit words (each bit represents a square composed of four raster-scan lines). A single command (Dxyn) will display at a location specified by variable X, variable Y an N-word pattern up to 15 words in depth. Thus, complex shapes in a matrix of up to 8 by 15 squares can be manipulated with one instruction. The screen resolution is limited to 64 squares across by 32 down in a single-density mode. VIP uses the top pages of RAM as a direct memory access (DMA) controlled memory-mapped video field. The resolution is a function of the amount of memory and refresh code in the DMA service routine.

VIP's internal timer is crystal controlled. Timing is in increments of 1/60 sec, to a maximum of 255 such units. A simple software routine can extend timing to the minutes range without loss of accuracy. Two CHIP-8 commands allow one to set and read the timer, making latency recording straightforward.

As an example, assume that two shape patterns (a cross and a square) have been entered into memory at 300H and 320H, respectively. To display them on the screen for a simple two-choice experiment and to record response latency, the code shown in Table 1 can be used.

This project was supported by a biomedical research support grant from the Research Foundation at State University of New York, Binghamton. Program listings are available from the authors at no cost.

  0005-7878/79/010064-03$00.55/0

Table 1
Sample Program and Memory Map for Displaying Two Shapes (Square and Cross) and Collecting Response Latency

Instruction	Operation	Comments
00E0	ERASE DISPLAY	Clear screen
A300	I = 300	Point to shape at 300H (cross)
6100	v1 = 00	X location for cross (left side)
6210	v2 = 10	Y location for both shapes
6338	v3 = 38	X location for square (right side)
D127	DISPLAY @x,y	Show shape pointed to by I (cross)
A320	I = 320	Point to shape at 320H (square)
D327	DISPLAY @x,y	Show shape pointed to by I (square)
6400	v4 = 00	Variable for timer
F415	TIMER = v4	Zero the timer
F50A	v5 = key	v5 is set to value of key response (waits)
F407	v4 = TIMER	v4 is set to timer value (1/60 sec)

Cross			Square		
Address	Binary	Hex	Address	Binary	Hex
300-	00010000	10	320-	11111110	FE
301-	00010000	10	321-	11111110	FE
302-	00010000	10	322-	11111110	FE
303-	11111110	FE	323-	11111110	FE
304-	00010000	10	324-	11111110	FE
305-	00010000	10	325-	11111110	FE
306-	00010000	10	326-	11111110	FE

APPLICATION

For our purposes, the subject response station was constructed using a metal panel with three equally spaced cut outs. A hinged Plexiglas panel with a microswitch behind it was mounted behind each cutout. The completed panel was positioned in front of the TV screen. To minimize programming, the three response buttons were wired in parallel with key-pad Buttons 1, 2, and 3 on the computer, providing switch debouncing and allowing a single CHIP-8 command to input the response.

In our experiment, 16 complex stimulus patterns, each in a 16 by 15 matrix [two successive Dxyn (n = 15, x = x + 8) commands were used], were defined in memory. An index table with pattern pointers and correct response data provided control of the sequence of stimulus presentation. Displays of one, two, or three patterns were selected and presented for a predefined period or until a response key was pressed. Correct or incorrect responses were obtained by matching the key pressed with the data table. If a correct response was obtained, the VIP output a pulse, through a relay driver, to an M&M dispenser, providing a reward. At the same time, latency, response choice data, and the trial number were displayed on the experimenter's video monitor in an area masked to the subject by the response panel. These data were displayed on a trial-by-trial basis, as well as stored in memory until the end of the session. Using the TAPE WRITE function, these data could be stored on cassette tape for later analysis.

RELIABILITY

Two RCA VIP units have been used in our laboratory on a daily basis by both undergraduate and graduate students for a period of over 6 months. There have been no difficulties with the units, which appear remarkably stable and maintenance free.

COST

The cost of the unit is shown in Table 2. The cost of video monitors or radio-frequency converted TVs vary considerably. We have successfully employed modified standard TV sets (12-in. diagonal black and white) at a cost of $90 each, and a SONY Trinitron with a radio-frequency converter for color displays at a cost of approximately $300.

Clearly, the unit is very inexpensive when compared to such items as a random-access slide projector with a simple solid state or electromechanical stimulus and response programming unit. Further, with the VIP, stimulus preparation requires no materials cost. Thus, excluding stimulus preparation (which can be time

Table 2

RCA VIP (assembled)	$249
Interface Integrated Circuits	15
Audio Tape Recorder	29
Response Panel (approximate)	15
Total	$308

consuming and expensive in a slide-based system), the cost of a typical random-access slide projector with associated programming equipment is at least three times that of the VIP, and the projector system does not offer comparable flexibility or portability.

DISCUSSION

The RCA VIP unit is small (8.5 x 11 x 1 in.) and light (2 lb). As such, it is an ideal unit for field research. The use of video monitors for visual display not only allows the experimenter to see exactly the same display as the subject, but also allows great flexibility with respect to the distance the subject console may be from the unit itself. Further, the choice of video screen size permits the display to be varied in size, so that, with large monitors, group testing is possible.

However, the unit's most important characteristic is that it is the stimulus generator as well as the programming and response processing device. It is a complete self-contained unit that does not require the experimenter to customize the circuitry for a specific application or to add expensive interfaces. The software language is easily mastered in a short period of time. This integrated unit has proved extremely cost efficient and versatile.

NOTE

1. A simple interface was designed and built in our laboratory to program the color of each shape on the screen. RCA has recently announced the availability of an inexpensive commercial adapter for color operation.

(Received for publication September 13, 1978;
revision accepted December 28, 1978.)