The Dust Writer

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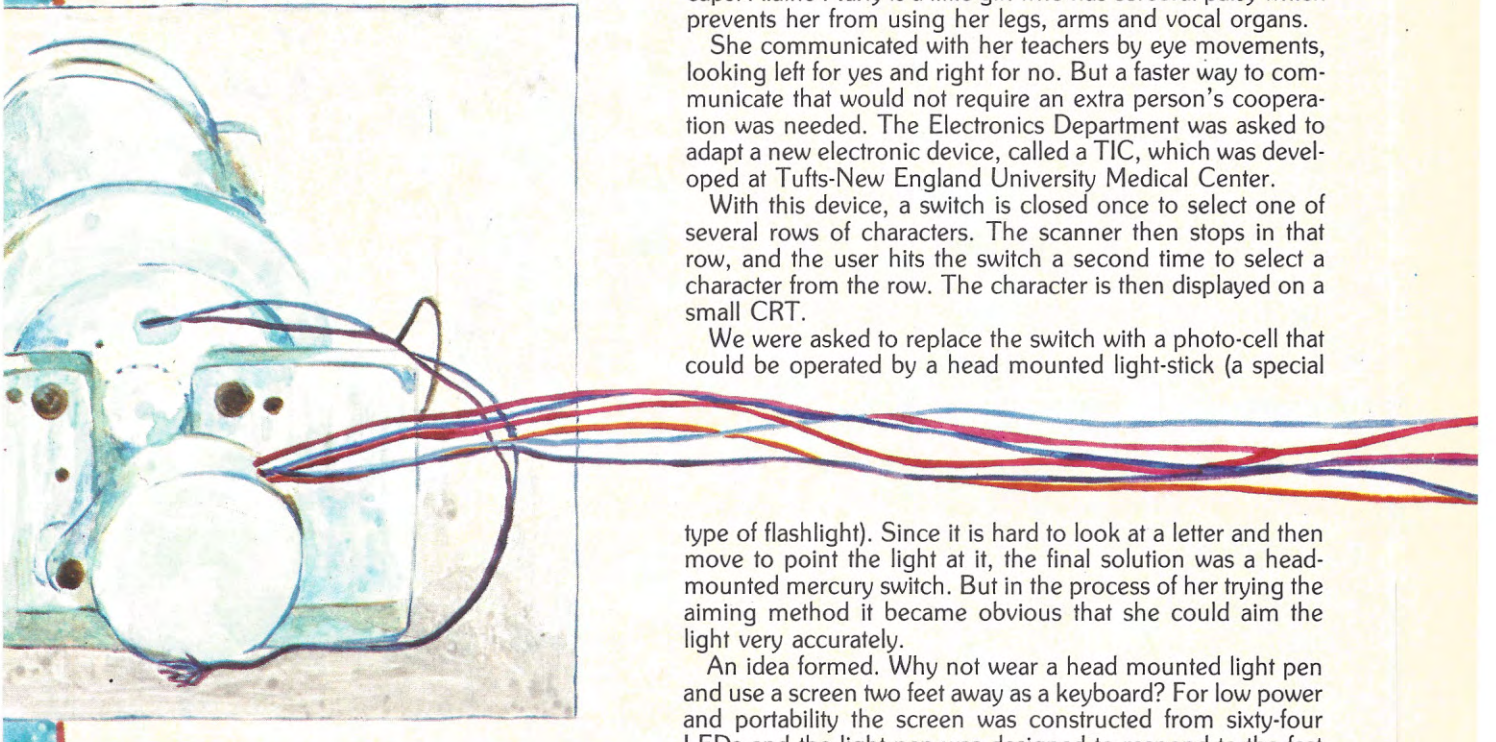

At the University of Tennessee Rehabilitation Engineering Center in Memphis, we work with severely handicapped children to find ways to get around the effects of their handicaps. Alaine Marty is a little girl who has cerebral palsy which prevents her from using her legs, arms and vocal organs.

She communicated with her teachers by eye movements, looking left for yes and right for no. But a faster way to communicate that would not require an extra person's cooperation was needed. The Electronics Department was asked to adapt a new electronic device, called a TIC, which was developed at Tufts-New England University Medical Center.

With this device, a switch is closed once to select one of several rows of characters. The scanner then stops in that row, and the user hits the switch a second time to select a character from the row. The character is then displayed on a small CRT.

We were asked to replace the switch with a photo-cell that could be operated by a head mounted light-stick (a special type of flashlight). Since it is hard to look at a letter and then move to point the light at it, the final solution was a head-mounted mercury switch. But in the process of her trying the aiming method it became obvious that she could aim the light very accurately.

An idea formed. Why not wear a head mounted light pen and use a screen two feet away as a keyboard? For low power and portability the screen was constructed from sixty-four LEDs and the light pen was designed to respond to the fast rise time of the light from the pulsed LEDs. This new device permits her to communicate much faster than ever before and she may compose messages or school work on an output device without anyone else helping. She calls the unit Aunt Martha.

Aunt Martha uses a CRT terminal for output and is not portable. For the system to be portable, a lightweight device is needed. It must also draw very little power, be readable in

daylight and must be low in cost. For this purpose it should display at least three or four lines of thirty-two or more characters. In the interest of safety, voltages should be kept below thirty volts. The device should have the potential for graphics display as well as upper and lower case characters.

Let's look at the technology available.

1. Cathode-Ray Tube Terminal
   Too much power consumption, weight and size. Also a CRT uses high voltages, and washes out in daylight.
2. Neon
   Again too much power consumption, high voltage and daylight washout.
3. Vacuum Fluorescent
   Power consumption is lower in small displays but daylight washout is still a problem and large displays are not readily available.
4. Light Emitting Diode
   Power consumption is too high and daylight viewing is not good. Also the cost for a large display is excessive.
5. Liquid Crystal Display
   Someday this may be the answer but for now the cost, availability, and driver complexity make it impractical.

To give the system some mobility, we designed a device that is lightweight and draws very little power. It can be mounted on the front of a wheelchair with little trouble.

The Dust Writer draws no power except when actually writing a new character. It is lightweight, small, inexpensive, and may be viewed in bright light.

The principle of operation is the same as that of the Etch-A-Sketch® toy made by Ohio Art. We actually used the powder from an Etch-A-Sketch toy in our device. The configuration is that of a drum plotter with the stylus on the inside of a glass drum. A stepping motor drives the stylus horizontally with a threaded shaft. Another stepper drives a cam for vertical motion and a solenoid lifts the stylus from the glass when necessary. Line feed is accomplished with a small D.C. gearmotor that turns the drum. The powder in the bottom of the drum erases the old printing so that fresh media is always fed up to the drawing field.

Many mechanical arrangements are possible and we plan to try some others to increase the speed of the device. The present system is fast enough for our purpose but a dot matrix print head would make the device useful in applications requiring greater speed.

The electronic drive circuit is extremely simple and uses only nine packages. Software controls every move of the device through seven bits of an eight-bit output port and two bits of an input port. The input bits are used only to initialize the vertical and horizontal positions. The print head starts at the left and bottom positions as determined by a sensing switch and LED — photo transistor device respectively. After initialization the position of the stylus is maintained in the microcomputer.

The device will be used with a C-MOS 1802 micro when the system is finished. An 8080 based system is being used for testing until the cross assembler is finished which will make the 1802 more convenient to use.

CONCLUSION

The system will eventually control a powered wheelchair, making mobility and communications available through microcomputer technology.□

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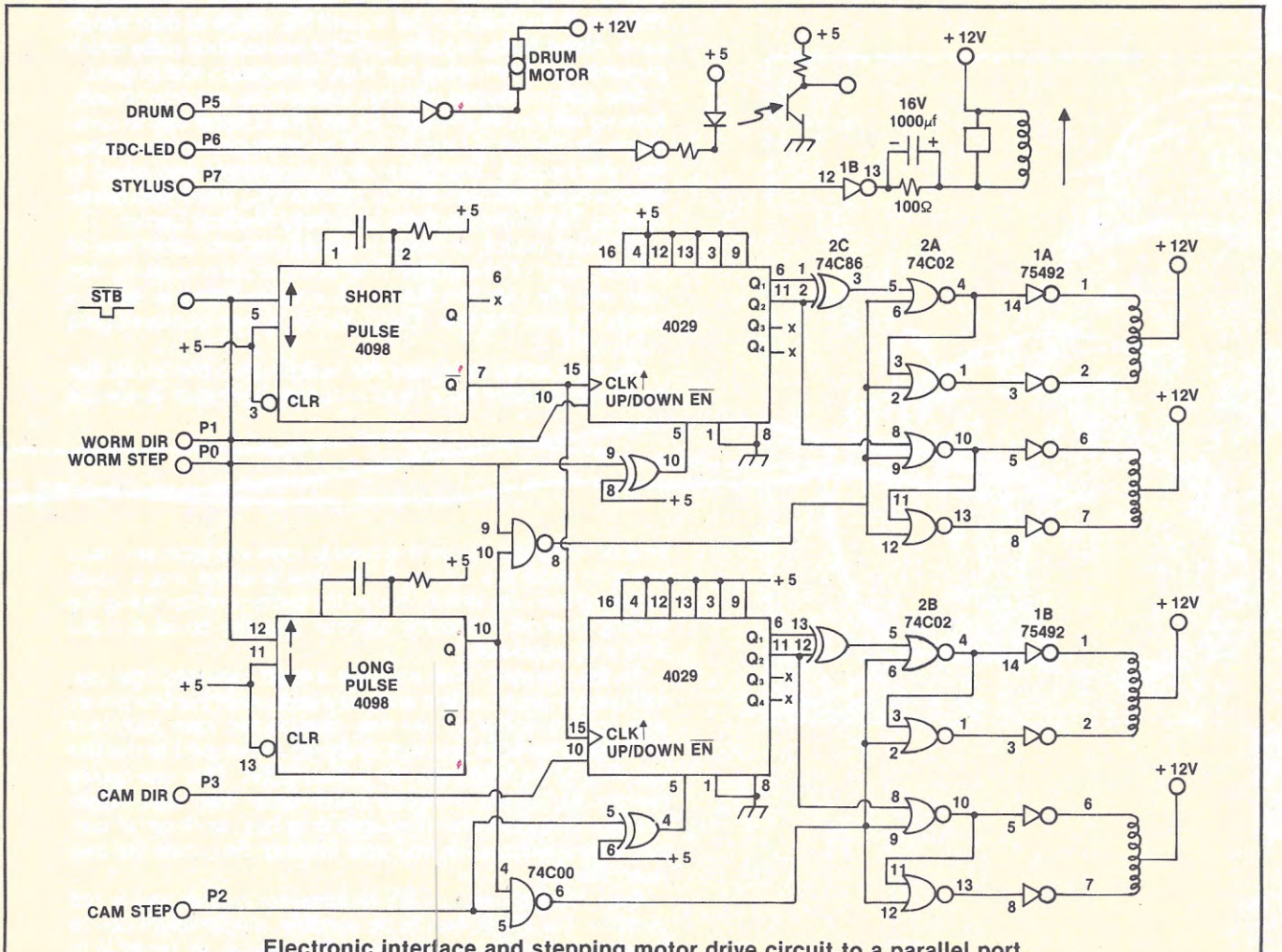

Electronic interface and stepping motor drive circuit to a parallel port.

THE DUST WRITER
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PROGRAM LISTING

```
  ?EDI
START INPUT
*L
FILE NAME=EC2
*W
        ORG 8000H
        ORR 2C00H
CIN     EQU 2010H
DOS     EQU 2028H
        LXI SP,9000H
        XRA A
        STA POS
TEST:   CALL CIN
        CPI 3
        JZ DOS
        CALL PRINT
        JMP TEST
BASIC:  MOV A,E
TABLE   EQU 8200H
LENGTH  SET 208
PRINT:  PUSH H
        PUSH D
        PUSH B
        LXI H,TABLE
        ANI 7FH
        CPI ODH
        JZ RETURN
        CPI 20H
        JC EXIT
        JZ SPACE
        MVI C,LENGTH
TLOOP:  CMP M
        INX H
        JZ MATCH
        DCR C
        JNZ TLOOP
        JMP EXIT
MATCH:  LDA CURNT
        MOV B,A
        CALL LIFT
        CALL INDEX
PLOOP:  MOV A,M
        ANI 40H
        CNZ LIFT
        MOV C,M
        CALL MOVE
        CALL DROP
        INX H
        MOV A,M
        RAL
        JC PLOOP
        MOV A,B
        STA CURNT
EXIT:   POP B
        POP D
        POP H
        RET
;
SPACE:  LXI H,SPCS
        INR M
        JMP EXIT
;
INDEX:  XCHG
        LXI H,SPCS
        MOV C,M
        MVI M,0
        INX H
        MOV A,M
        ADD C
        INR A
        MOV M,A
        XCHG
        MVI E,203Q
        MOV A,C
        CPI 1
        CNC HPOS
        MOV A,B
        ANI 7Q
        ORI 350Q
        MOV C,A
        MOV A,M
        ANI 100Q
        JNZ INSKP
        MOV A,C
        ANI 370Q
        MOV C,A
INSKP:  CALL MOVE
        MOV A,B
        ANI 207Q
        MOV B,A
        MOV A,M
        ANI 40H
        CZ DROP
        RET
;
LIFT:   MVI A,80H
        OUT 24
        ORA B
        MOV B,A
        MVI A,20
        CALL DELAY
        RET
;
```

```
DELAY:  PUSH B
DLOOP1: MVI C,80
DLOOP2: DCR C
        JNZ DLOOP2
        DCR A
        JNZ DLOOP1
        POP B
        RET
;
MOVE:   MOV A,B
        SUB C
        ANI 77Q
        RZ
        CALL MOVEX
        CALL MOVEY
        CALL MOVEX
        CALL MOVEY
        CALL MOVEX
        CALL MOVEY
        CALL CNTY
        CALL MOVEX
        CALL CNTX
        JMP MOVE
;
DROP:   XRA A
        OUT 24
        ORA B
        RP
        MOV B,A
        MVI A,0
        CALL DELAY
        RET
;
MOVEX:  MOV A,C
        RAL
        ANI 80H
        MOV E,A
        MOV A,B
        ANI 70Q
        MOV D,A
        MOV A,C
        ANI 70Q
        SUB D
        RZ
        JC REVX
        INR E
        INR E
REVX:   INR E
        MVI D,2
MXLOP:  MOV A,E
        OUT 24
        MVI A,20
        CALL DELAY
        DCR D
        JNZ MXLOP
        RET
;
MOVEY:  MOV A,B
        ANI 7
        MOV D,A
        MOV A,C
        ANI 7
        SUB D
        RZ
        MOV A,E
        JC REVY
        ADI 8
REVY:   ADI 4
        ANI 374Q
        MOV E,A
        OUT 24
        MVI A,14
        CALL DELAY
        RET
;
CNTX:   MOV A,E
        ANI 3
        RZ
        DCR A
        MVI A,-8
        JZ CNSKP
        MVI A,8
CNSKP:  ADD B
        MOV B,A
        RET
;
CNTY:   MOV A,E
        ANI 12
        RZ
        SUI 4
        MVI A,-1
        JZ CNYSKP
        MVI A,1
CNYSKP: ADD B
        MOV B,A
        RET
;
RETURN: LDA POS
        CPI 1
        JC EXIT
        MVI E,201Q
        CALL HPOS
        OUT 24
        STA POS
        JMP EXIT
;
HPOS:   MOV D,A
HLOOP1: MVI C,40
HLOOP2: MOV A,E
        OUT 24
        MVI A,18
        CALL DELAY
        DCR C
        JNZ HLOOP2
        DCR D
        JNZ HLOOP1
        RET
;
SPCS:   DB 0
POS:    DB 0
CURNT:  DB 0
        END
*E
  ?EDI
START INPUT
*L
FILE NAME=TBL
*W
        ORG 8200H
        ORR 2E00H
```

```
TABLE:  DB "0",324Q,222Q,232Q
        DB 233Q,243Q,245Q,236Q
        DB 216Q,205Q,201Q,210Q
        DB 240Q
        DB "A",204Q,226Q
        DB 244Q,240Q,302Q,242Q
        DB "B",206Q,236Q,245Q
        DB 243Q,203Q,243Q,241Q
        DB 230Q,200Q
        DB "C",345Q,236Q,216Q
        DB 205Q,201Q,210Q,230Q
        DB 241Q
        DB "D",206Q,236Q,245Q
        DB 241Q,230Q,200Q
        DB "E",340Q,200Q,206Q
        DB 246Q,333Q,203Q
        DB "F",206Q,246Q,333Q
        DB 203Q
        DB "G",332Q,242Q,240Q
        DB 210Q,201Q,205Q,216Q
        DB 246Q
        DB "H",206Q,346Q,240Q
        DB 303Q,243Q
        DB "I",310Q,230Q,320Q
        DB 226Q,316Q,236Q
        DB "J",301Q,210Q,230Q
        DB 241Q,246Q
        DB "K",206Q,346Q,213Q
        DB 240Q
        DB "L",340Q,200Q,206Q
        DB "M",206Q,224Q,223Q
        DB 224Q,246Q,240Q
        DB "N",206Q,205Q,241Q
        DB 240Q,246Q
        DB "O",301Q,205Q,216Q
        DB 236Q,245Q,241Q,230Q
        DB 210Q,201Q
        DB "P",206Q,236Q,245Q
        DB 244Q,233Q,203Q
        DB "Q",301Q,205Q,216Q
        DB 236Q,245Q,242Q,220Q
        DB 210Q,201Q,322Q,240Q
        DB "R",206Q,236Q,245Q
        DB 244Q,233Q,203Q,213Q
        DB 240Q
        DB "S",301Q,210Q,230Q
        DB 241Q,242Q,233Q,213Q
        DB 204Q,205Q,216Q,236Q
        DB 245Q
        DB "T",320Q,226Q,306Q
        DB 246Q
        DB "U",306Q,201Q,210Q
        DB 230Q,241Q,246Q
        DB "V",306Q,202Q,220Q
        DB 242Q,246Q
        DB "W",306Q,200Q,222Q
        DB 223Q,222Q,240Q,246Q
        DB "X",201Q,245Q,246Q
        DB 306Q,205Q,241Q,240Q
        DB "Y",320Q,223Q,205Q
        DB 206Q,346Q,245Q,223Q
        DB "Z",306Q,246Q,245Q
        DB 201Q,200Q,240Q
        DB 0
        END
```