A graphical technique for numerical input

By W. M. Newman*

This paper describes the Light Handle, a programming technique which simulates the action of a shaft encoder, using a display and light pen. It can also be used in place of a typewriter for entering numerical information. The program occupies very little memory and is easy to operate.

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Most display consoles nowadays include a teleprinter as standard equipment, and the on-line input of numerical data is normally a matter of hitting the right keys in the right sequence. There are a few situations where this method is unsatisfactory. For example, the teleprinter keyboard may be awkwardly placed, and the user may spend much of his time moving between it and the display screen. A more serious drawback of keyed numerical input is that it cannot be used to achieve continuous variation of parameters in the manner of a shaft encoder or a tracker-ball. Many display installations do not include any input devices of this type, and a graphical technique has been developed to achieve a similar effect using a light pen. This technique has been called the *Light Handle*, as it simulates the effect of winding a handle or rotating a knob. Any coordinate-input device such as the RAND Tablet (Davis and Ellis, 1964) or the SRI Mouse (English, Engelbart and Berman, 1967) may be used to control the Light Handle.

Using the Light Handle

The appearance of the Light Handle is as shown in **Fig. 1.** The user simply points the light pen somewhere within the border and swings it in an approximately circular path. Rotation in a clockwise direction causes the displayed value to increase, and anticlockwise to decrease. Any movement outside the border has no effect. Each time the value changes it may be passed to the main program as an input parameter. Alternatively the Light Handle may be used to set up a constant, by disregarding all but the final value.

The rate at which the value alters depends on the horizontal position of the centre of rotation. It can be made to change rapidly by rotating in the region of the left-hand border, as shown in **Fig. 2.** For slower variation, the centre of rotation can be transferred to the right-hand side, as in **Fig. 3.** Extreme accuracy can be achieved by moving the pen up or down the right-hand column: here one inch of movement changes the value by four units.

Except in the right-hand column, the rate of change of the value is also dependent on the speed of movement of the pen. This "square-effect" was first suggested by I. E. Sutherland (1966) for use with shaft encoders, and has been found to give an added degree of control to the Light Handle. Thus a single, fast rotation through 360° near the left-hand edge can change the value by 50,000 units or more, and by this means large constants can be set up very rapidly.

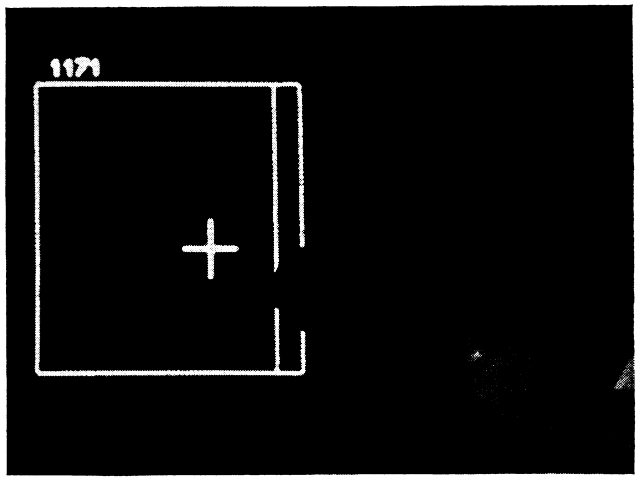

Fig. 1. General appearance of the Light Handle

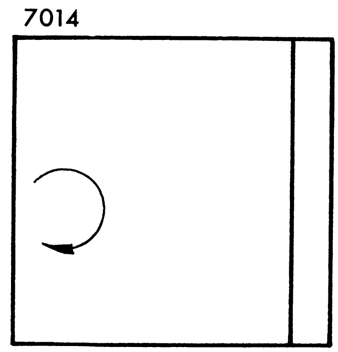

Fig. 2. Clockwise rotation near left-hand edge causes rapid increase in value

Internal details of the Light Handle

The Light Handle was developed on a Digital Equipment Corporation PDP-7 computer and Type 340 display. The display has a screen size of approximately

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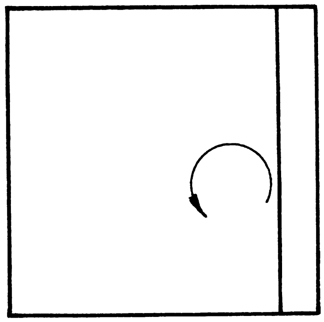

Fig. 3. Anticlockwise rotation near right-hand edge causes slow decrease

10 × 10 inches, and a raster unit of about 0·01 inch. An area of 256 × 256 raster units, or approximately $2\frac{1}{2} \times 2\frac{1}{2}$ inches, is devoted to the Light Handle. A fresh pen position is fed to the Light Handle program every 20 milliseconds and, provided this position lies within the border, the change ΔV in the displayed value is determined from the following expression:

$$\Delta V = \Delta y|a\Delta y|^{k}2^{b-z}$$

where

a, b are constants

Δy is the change in y

z is the largest integer $< \frac{x}{32}$

$k = 0$ if (x, y) lies within the right-hand column, 1 otherwise

x and y are measured in raster units.

The program to carry out this computation, together with its display file, occupies about 120 words of memory.

The reader will notice that this expression creates the effect of a number of vertical scales or *potentiometers* arranged parallel to one another within the square border. The scale of each potentiometer is double that of its left-hand neighbour, and the "square-effect" is applied to all but the right-hand one. The use of pen coordinates to achieve a potentiometer effect has been described by Rose (1965).

Thus the basic movement recognized by the program is linear vertical movement; horizontal movement on its own has no effect on the displayed value. Rotation of the pen position is detected as movement up one potentiometer and down another, with the cumulative effect of either increasing or decreasing the value. This is illustrated by the sequence of **Fig. 4.** Other patterns of movement can be used to achieve the same effect as rotation. For example, a quick flick upwards followed by a slow return to the original position will leave the value increased, and repetition of this manoeuvre has the same effect as clockwise rotation.

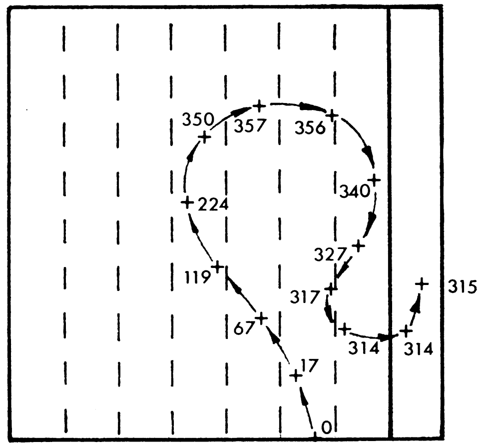

Fig. 4. Variation in displayed value during a typical sweep of the pen. The boundaries of the 'potentiometers' are shown in broken lines

Performance

Once the basic principle of the Light Handle has been mastered, it becomes a very simple and natural method of numerical input. As mentioned above, it can be used in two modes, depending on whether the value is sampled continuously or only when setting-up is complete. In the first mode it simulates the action of a shaft encoder, and appears to be quite capable of matching the performance of such a device. In the second mode it is capable of setting up a number in about five seconds, and can be used instead of typing the number. Its relative performance in this context depends on many factors, such as the user's proficiency at typing, the siting of the typewriter keyboard and the pattern of use. Experience so far has shown that the Light Handle can be operated at about half the speed of a typewriter.

The principal asset of the Light Handle is that it provides the programmer with a shaft encoder without the expense of extra hardware. It also offers him a number of advantages over the typewriter which compensate for its relative slowness. For example, it avoids the need to check each character for validity; limits can easily be set on the displayed value; and the value may be incremented by any desired step size. It has the added advantage to the user of not diverting his attention from the display screen. For these reasons it appears to be a valuable tool for the display programmer.

References

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