INSTRUMENTATION

& TECHNIQUES

A method of producing a three-dimensional cathode ray tube display¹

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A method of producing a true three-dimensional cathode ray tube display has been developed. It has been used to plot three-dimensional vectorcardiograms, bar graphs, and would probably be useful to research in visual perception.

A true three-dimensional display can be produced by reflecting the face of a cathode ray tube in a rotating mirror. As shown in Fig. 1, the reflected image of the tube face sweeps out a volume of space. By correctly locating and timing the spot display on the tube, an image point may be produced anywhere in the swept volume.

The geometry involved in producing a point at an arbitrary x, y point is shown in Fig. 2. The oscilloscope point is brightened at the time at which the mirror is at an angle θ given by

$$\theta = \frac{1}{2} \left[\tan^{-1} \frac{y}{x} - \alpha \right]$$

Fig. 1. Method of sweeping the image of the face of a cathode ray tube through a volume of space by reflecting in a rotating mirror.

Fig. 2. Geometrical construction used for finding spot timing and positioning to produce an image point at an arbitrary point in space.

where α is found from

$$\alpha = \tan^{-1} \sqrt{1 - \frac{x^2}{L^2} - \frac{y^2}{L^2}}$$

The third dimension is vertical (perpendicular to the plane of the drawing). For each required point the display must occur at a particular angle of the mirror. Points at different locations in space may require simultaneous display. The problem may be avoided by displaying conflicting points on alternate rotations of the mirror. Flicker rate may be reduced for a given mirror speed and computer speed by the use of a two-sided or multi-sided mirror.

Figure 3 shows a two-sided brass mirror. In this case the mirror was rotated by a synchronous motor; computer synchronization (PDP-8) was achieved by photosensing a light reflected from the mirror and entering the display subroutine when light was detected.

It must be realized that the image produced by this method is truly three-dimensional. Thus it cannot be photographed in the usual sense without losing its three-dimensional quality. An illustrative stereo-pair can be photographed as in Fig. 4. This picture of a single display has been photographed as a stereo-pair by reflecting it in a mirror. It is viewed by standing a mirror on edge over the central line and placing one's nose approximately over the mirror. The image reflected in the mirror and the direct

Fig. 3. Two-sided rotating brass mirror placed in front of cathode ray tube.

Fig. 4. Stereoscopic pair produced by photographing a single display. See text for viewing instructions.

image are fused and the combination appears as a three-dimensional display.

The technique has been used to generate three-dimensional graphical displays, and, in particular, vector electrocardiograms, and it has obvious applications to research on visual perception.

NOTE

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What does the ultrasonic activity recording device measure?¹

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Rats were observed while their behavior was being monitored by an ultrasonic activity recording device. It was found that the device yielded more counts when Ss were being more active. But very active behavior is relatively rare, so that most of the counts over a period of time are likely to result from the more frequent but less active kinds of behavior, such as grooming.

Peacock and Hodge (1962) have described a device for recording bodily movement that consists of a very high-frequency (40 kHz) sound source and receiver. The basic principle is that as long as S does not move, the receiver will pick up a reflected signal of constant intensity, but if S moves around in the sound field, then the field will be distorted and the intensity of sound reflected back to the receiver will vary accordingly. The received signal is detected, i.e., rectified and integrated, and put through a pulse amplifier, so that the rate at which output pulses are generated is proportional to the rate of modulation of the reflected sound signal. This modulation rate is presumed to be proportional to the rate of movement of S within the sound field.

Although different kinds of movements by different kinds of Ss are potentially measurable with Peacock and Hodge's device, it has been used primarily to measure the general activity of the rat. The present paper is concerned just with this application. We pose the question: what do the rat's different activities contribute to its general activity score as measured by the ultrasonic device? What is the rat likely to be doing when the device reports that it is being active?

METHOD

A single test cage was used. It was a standard 7 x 7 x 10 in. hardware cloth living cage, with the front wall replaced by Plexiglas to facilitate observation of S. The cage was suspended in a 2-ft cubicle that was lined with acoustic tile on all sides except the front. The ultrasonic transducers were located about 4 in. apart, to one side of the cage, and approximately 7 in. from the nearest wall of the cage. The cubicle was located in a sound-attenuating isolation room and S could be observed through a one-way window without being disturbed. Light in the isolation room was on (approximately 10 ft-c) for 9 h a day, and during the remaining 15 h of darkness, illumination sufficient to see S was provided by a single 24-W red light bulb.