Light scanning photomacrography with electronic memory unit

While presenting a short seminar on photoinstrumentation basics at the NASA Langley Research Center, I was myself educated when I came across a Model 593 electronic memory unit by Colorado Video. Normally used for applications in motion analysis, surveillance, detection of random events, etc., it begged to be used for applications beyond its demonstrated uses.

This instrument sits between a video camera and a monitor. In "live" mode the device simply allows the live video picture to be displayed on screen. However, when switched to its active function the device "keys in" the values of the pixels displayed on the screen. As long as the image viewed by the camera does not change, the image on the monitor appears very much the same as if one were viewing a live scene.

Now the fun begins. When activated, the 593 will compare the value of each pixel to its previous value with each frame or field. If the new value is higher or lower than some preset value, that pixel's value is changed to the new level. When, for example, a ping-pong ball is dropped across the camera's field of view, it will record the position of the ball over time at 1/30- or 1/60-second intervals—assuming the device is set to detect a rise in value, and the background is dark. The image displayed on the monitor can then be "frozen" such that any further changes will not alter the image displayed on the monitor. In this instance, the image shown on screen will very closely resemble what a stroboscope might reveal when used with a conventional still camera—except that the pictures can be made in room light and the system has all the advantages of electronic imaging media. The images can, of course, be recorded by attaching a VCR to the monitor.

Although I first explored the potential of the 593 as a tool for teaching basic motion analysis applications, I later realized the device could be used to demonstrate many other "photographic" techniques. Although it is not a photon-accumulating memory such as film is, the 593 electronic memory actually mimics photographic film in the manner in which it stores image information. One of these later applications was the use of the 593 in the technique described below.

In high magnification imaging, it is painfully obvious that as magnification increases, depth of field decreases dramatically. Typically photographers over-

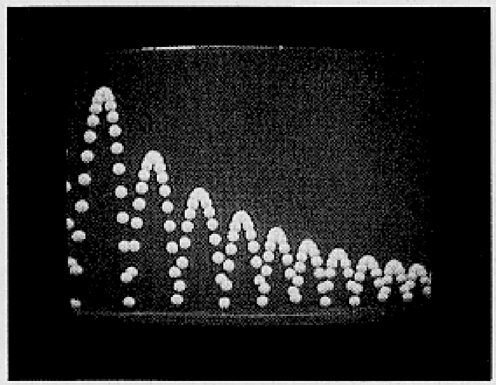

Figure 1. Video stroboscopic sequence of ping pong ball seen at 1/30-second intervals and a duration of 1/1000 second each time set by camera's electronic shutter.

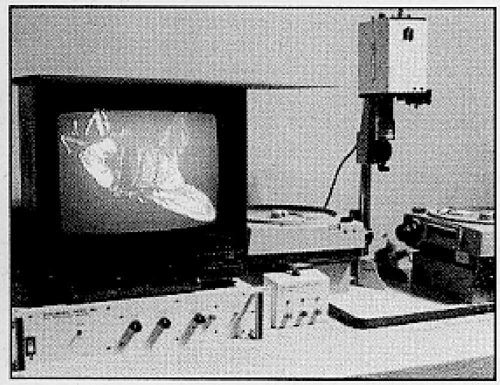

Figure 2. Overall layout of electronic light scanning macrography set-up. (Colorado Video 593 located under video monitor, Xybion camera on copy stand, standard Kodak slide projectors set up to project thin beams of light onto subject located between them on a motorized elevating mechanism.)

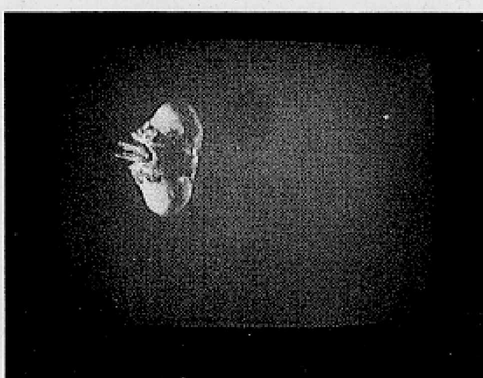

Figure 5. Appearance of stored image information after head of fly passed light beam.

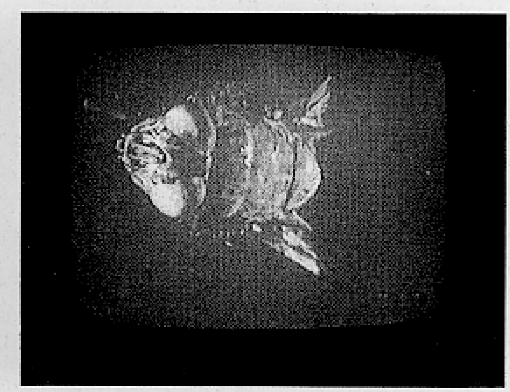

Figure 6. Appearance of stored image after fly's thorax had passed through beam.

come this difficulty by stopping the lens down. This raises problems associated with imaging with small apertures, and under extreme circumstances, may not yield sufficient sharpness in depth by itself.

One solution is to employ a technique that enables great depth to be recorded at the expense of conventional perspective and instantaneous exposure. It is called "light scanning photomacrography." The imaging camera is focused on a relatively wide but very thin beam of light, often generated by two or three common slide projectors projecting fine slits. Sometimes the lenses are stopped down to increase the distance over which the beams have roughly the same thickness. The individual beams are carefully aligned and superimposed so they appear to be a single thin beam.

The lens, typically located above the beam, is focused on it at the desired magnification. The beam of light is generally made to be narrower than the depth of field of the lens at the chosen aperture. Finally the subject, placed on a string, is moved towards the beam of light, and towards the lens.

I set up a Xybion S9 video camera for photomacrography with an extension tube and a 75 mm "C" mount lens and fed the video output of the camera to the 593, set in turn to detect increases in light level. Once I activated the 593, an image could not be seen on the monitor because the beam only illuminated the air below the lens. As the subject broke into the beam, that part of it which was detected by the 593 was displayed on the screen. As the subject continued to move upwards, successively lower portions of it were illuminated, memorized by the 593, and simultaneously displayed on the screen. Since the subject is only detected when its various parts were in the beam of light, the final "composite" reproduction of the image appears uniformly sharp over an extended distance. This effectively appears to increase depth of field.

The 593, in effect, acted as film would in a conventional camera, but, it had the added benefit that the process of image acquisition and storage could be perceived in real time. This is invaluable for teaching purposes. The experiment worked perfectly as can be seen from the figures. Light scanning photomacrography, whether accomplished with conventional film or electronic cameras, is a useful technique which yields extended depth at high magnifications.

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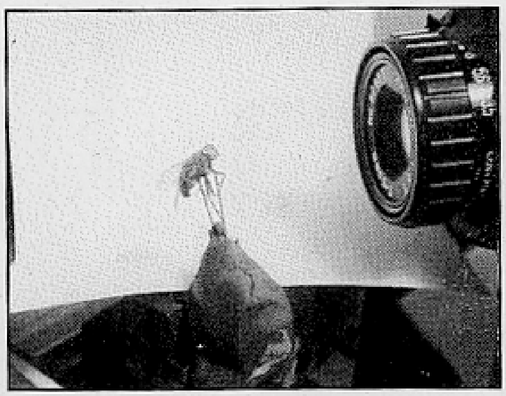

Figure 3. Fly on string attached to motorized elevating mechanism.

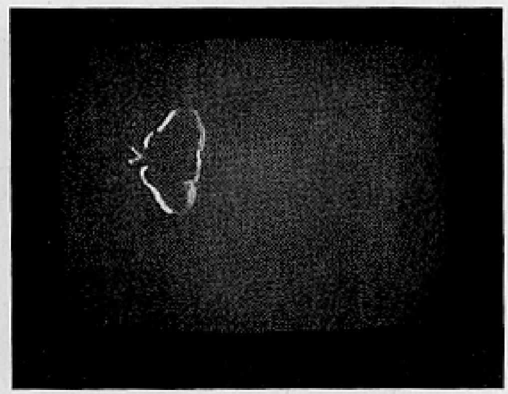

Figure 4. Instantaneous view of appearance of light beams projected onto fly's head. Lens is focused on the light beam plane.

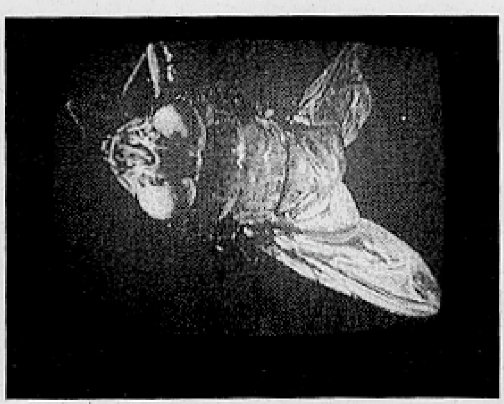

Figure 7. Final image after all of fly had moved up through light beam. Sharp overall.

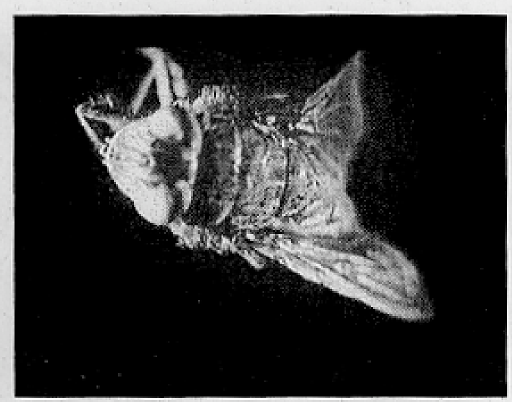

Figure 8. Unscanned image of fly at same aperture as that used during the light scanning process. Note that head and wingtips are out of focus.

References

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