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Peripheral Imaging with Electronic Memory Unit

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While presenting a short seminar on photoinstrumentation basics at the NASA Langley Research Center I was myself educated when I came across a piece of imaging gear that begged for applications beyond the ones for which it was being used. The device is a Model 593 electronic memory unit made by Colorado Video. It is designed for applications in surveillance, detection of random events, etc.

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 the screen. However, when switched to its active function the device "keys" in the values of the pixels displayed on the screen and with each frame or field, compares the value of each pixel to its previous value. If the new value is higher (or lower) than some preset value that pixel's value is changed to the new value.

Early on after becoming acquainted with the device I realized that this feature or capability of the device makes it possible to demonstrate many principles associated with traditional film-based imaging without incurring the expense of actually using expendable materials, the delay associated with processing or viewing a small print. Essentially the 593 electronic memory mimics photographic film in the manner in which it stores image information although it is not a photon-accumulating memory such as film is.

The first application where I successfully used the device was in a demonstration of its application for light-scanning photomacrography, a technique whereby extreme depth of field is achieved even at optimum (relatively large) apertures in a close-up imaging situation. This was described in the January 1994 issue of this newsletter.

In the application described below, the Peak Store device is applied to the making of peripheral images of cylindrical objects.

Peripheral Imaging

Peripheral imaging refers to making a reproduction of a 3-dimensional subject in such a manner that the record contains information about the subject from all surrounding points of view, thus displaying its "periphery" to an observer.

Normally we can not see all sides of an object at once and we resort to the process of turning it in our hands or moving ourselves around it to perceive the subject's peripheral

details and then we use our memory to build up an impression of what the subject actually looks like from all sides. We "scan" it.

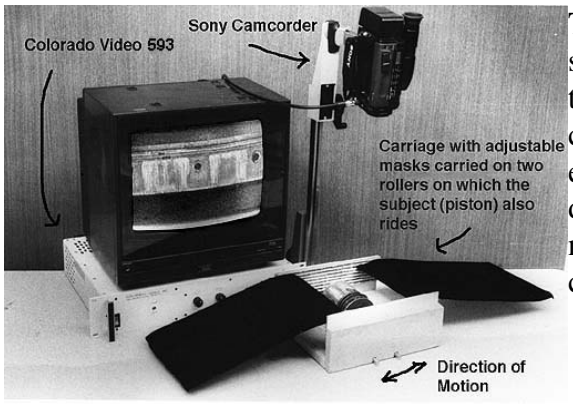
Photographically speaking, we deal with the problem of making a record of such a subject by making a series of photographs and then placing them side by side, with each image making up a portion of the subject's surface. Then we mentally bring the series together to compile information in our minds about the peripheral details of the subject.

An alternative, if we assume a simple case, such as recording the surface of a soft drink can, one could make a peripheral record by slitting the can along a vertical seam and after flattening out the metal one makes a "snapshot" of the metal sheet. Assuming one can not physically damage the original the only recourse is a photographic approach and these have been described in the literature since the late 1800's. Traditional photographic methods tend to be cumbersome and difficult to set up. A peripheral imaging system based on the use of Peak Store 593 unit, however, provides a simple, direct, efficient and relatively low cost method for making peripheral records of cylindrical subjects.

A fundamental concept is that to make a peripheral record that bears as undistorted a relationship to the original subject's proportions as possible, the subject needs to be turned in front of the video camera at the same time it is translated across its field of view. If the subject is the can referred to above, or a piston showing signs of wear around its periphery, one could simply roll these on a flat surface and inevitably the proper relationship will be achieved. The principle is the same as that used in a printing press where the ink on an impression cylinder is transferred to a sheet of paper by rolling the cylinder over the paper. There is a 1:1 relationship between the information on the cylinder and the reproduction on the paper.

However, simply rolling a can or a piston in front of the camera is not enough to make a peripheral record. One must first limit the instantaneous view of the can to a small longitudinal section so that the various parts of the subject are recorded by the 593 sequentially and there is no subsequent interference of "exposed" image areas by subject parts double-exposing a previously recorded area.

This is achieved by rotating the can under a slot that the motion of the can as it is rolled across the field of view of the camera. The "slot" essentially mimics the "nip" in a printing press; the nip being line where the impression cylinder meets the paper receptor and where information transfer takes place.



The general layout of the peripheral imaging system discussed in this article is shown in this illustration to the left. A standard video camera is aimed at a wooden carriage equipped with adjustable black masks which during imaging are set up so that only a narrow slot is left between them. The carriage rides on two rollers on which the

cylindrical subject is placed. The camera is connected to the Colorado Video 593 device and it provides a video signal which is displayed on the monitor and recorded on a VCR if needed.

When regular cameras are used in this process, and film provides a response which is a byproduct of the cumulative exposure that a given piece of film receives, one must take extreme measures to insure that the mask material on either side of the traveling, open, slot under which the subject moves and rotates, be as light absorbing as possible. The reason for this is that since the surface of the subject (a piston in the case illustrated here) as seen through the slot exposes its information onto the film in a brief time, the surrounding material is seen or recorded by the film over the whole time that the piston is rolled across the camera's field of view. Even if the mask material only has a reflectance of a few %, over a long time this typically results in excessive "background" density or "noise", and thus low contrast, in photographic records.

The 593 overcomes this problem associated with film cameras due to the fact that if the signal level does not increase above a particular point the 593 simply maintains that spot's value. This means that increasing the exposure _time_ does not result in increased signal and thus a reasonably dark mask is sufficient to prevent interference with the surface information recorded by the camera's sensor as the subject passes sequentially under the exposing slot.

Finally, an examination of the of the rotating piston's surface as it rolls across the field of view reveals that while the part of the piston in contact with the surface on which it rolls is always stationary with respect to the surface, the upper, free, surface of the piston, opposite the contact point, is moving at a rate twice that of the forward motion of the piston. The consequence of this is that if one simply rolls the piston in front of the camera the image that is recorded will be reversed in orientation. Further, since during exposure the piston's surface features are moving with respect to the slot, the record will be blurred.

To overcome this problem a set of rollers is installed below the piston and the piston is placed on them. Then, as these rollers are moved across the camera's field of view they not only roll the piston "backwards" but they also carry along with them the exposing slot under which the piston rotates. In this manner the counter-rotating piston displays its surface to the recording camera sequentially and these features appear stationary with respect to the moving slot. The Colorado Video Peak Store 593 senses the change in value from black to some higher value and provides the memory necessary to store the surface image information.

The 593 in effect acts as film would in a conventional camera but it has the added benefit that the process of image acquisition and storage can be perceived in real time. This is invaluable for teaching purposes. The application of the device to peripheral imaging is illustrated in the attached illustration. Peripheral photography whether accomplished with conventional film or electronic cameras is a useful technique which yields an additional perspective on many subjects.