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Use of Vidicons in On-Line Measuring Machines at BNL*

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The idea of a micro-scan in conjunction with a digitized stage first occurred to me in 1962 as an alternative to the SMP, but pressure from film transports and the like put the idea into the back of my mind. In 1963, Bob Glasser, then at CERN, showed me a proposal written by Hertz at ONR and Univ. of Maryland for a variation of SMP using a vidicon as a scanning element. This again made me give a few moments thought to the micro-H.P.D. and in somewhat more definite form the idea was again put in the inactive file.

About a year ago Ed Salant, on the eve of his retirement from Brookhaven, came forth with an eruption of all those ideas which he was perhaps storing within himself over the many fruitful but perhaps, he felt, too conservative years he spent in the human processing of bubble chamber photographs at BNL. A number of ideas were discussed in a somewhat smaller number of stimulating meetings, one of which is the device I'm going to describe today.

First, a word about the physical environment into which this device will be incorporated. The group, presently under the direction of Nick Samios, has an SDS 920 computer which will

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have within the next six months, 12 K of memory, a cycle-stealing data channel, 2 mag tapes, a rapid access (33 ms av.) disc, and 32 interrupt channels. At present the computer is connected to two digitized stage projection measuring machines (Gaertner's) and one mangiaspago, with Model 33 teletypes used for communication with the operators. The goal of the system is to handle 5 stage type machines and 7 mangiaspagos. The computer is used to insure correct sequence of operations, correct number of tracks in all views consistent with event type, smoothness of digitization of the tracks, correct fiducial separation, a 3-dimensional reconstruction of end points of tracks where possible to check track identification in the 3 views, and automatic view advance and identification. One might think of our micro-H.P.D. as a small rotatable slot replacing the crosshairs on a projection table. It is in this slot that the micro-scan takes place.

Next we come to the question of why do this at all. I think everyone will agree that it makes economic sense to have a number of human operated measuring machines, whatever production facilities exist. Also the idea of combining human pattern recognition abilities with the accuracy and repeatability of hardware digitizing which underlies the SMP philosophy is very attractive, especially to the physicist who wants to contemplate a roll of film rather than simply put it through the mill. The advantage the vidicon scan brings to the SMP idea is the known

and piece-wise constant scan angle with consequences of better statistics on a slice of track and simple and obvious gap counting ability.

The pertinent parameters on our first go-around with this device are:

- 1) 4:1 aspect ratio in the slot.
- 2) 1-2 μ least count.
- 3) 1-2 mm scan length.
- 4) 5-10 μ scan line separation.
- 5) 256 scan lines at 4 kc.
- 6) 16 frames/sec with 4 fold interlace.

The first problem that appeared in the design of this device was the rotation of the scan. One could rotate the whole vidicon assembly with the nasty consequence of limited rotation and tangled wires. One could rotate the raster electronically, but this is almost impossible to achieve without great expense, considering linearity requirements. This problem turned out to have an interesting and economical solution. A schematic view of the system which evolved is given in Fig. 1. The image of the area to be scanned is focussed on the vidicon through a Dove prism which rotates the image on the vidicon twice the angle of rotation of the prism. To make the operator's control more realistic, the prism rotation is geared down 2:1 so that the angle of image rotation equals that of the knob.

We, of course, wish to display on a monitor CRT for the operator that portion of the picture which she has chosen to digitize. To eliminate the rotation of this image we use sine-cosine potentiometers to rotate the display in the opposite direction, producing the desired illusion of a fixed image and a rotating raster.

Figure 2 shows a block diagram of the electronics involved in the system. There are two modes of operation, "display" and "read".

In the display mode, the scan proceeds in a T.V. fashion except that the scan lines are orthogonal to the edge. This is achieved by generating the horizontal scan from a digital-analogue converter attached to a scan line counter. The last two bits of the counter are connected to the first two bits of D-A converter to produce the fourfold interlace. The start of each scan line starts a clock whose output is counted by the vertical counter which will be used to digitize the video signal. In the display mode, however, this is used only to delineate the active or "window" area on the CRT..

On command from the computer at the end of the current horizontal scan, we are put into the read mode. The track center is determined by differentiation and discrimination set to reject noise and terminate on the zero crossing of the differentiated wave form. If such a signal is produced in the window area, a computer interrupt is generated and the clock turned off, leaving the coordinates of the point in the two counters. If no video is encountered, the end of window simulates the video and freezes

the counter at that value, similar to the full grating count in the H.P.D. The scan continues on the same line until the computer reads the coordinates and releases the wait flip-flop. At the end of the entire read operation the mode is reset to display.

The operator will be instructed to set the "aperture" so that the track segment to be digitized is roughly parallel to the edge of the scan, and so that the desired track is the first one to appear in the window.

The remainder of the slides show various steps in the process, and are self-explanatory. The scan on the display photographs is from bottom to top in a NNE direction.

Since the operator works with such a small area of the picture, she should be able to perform the HPD "gating" operation with comparative ease. The filter problem on the small amount of data presented by each scan should be trivial as long as the operator can avoid extremely messy segments of track. The angle of the image will, of course, also be digitized and sent to the computer for use in calculating a master point.

Future developments will probably include automating the procedure as far as possible so that track following with minimum guidance can be achieved. This would require a minimum hardware addition to the apparatus, but a non-negligible amount of software to the program.

The programming of the bookkeeping and curve fitting on this project is being done by Dave Hill, the bubble density software

by Mark Sacket, and the system and interface software by myself.
I would also like to thank Ed Salant and Nick Samios for supply-
ing support for this work.

BLOCK DIAGRAM VIDICON SYSTEM

Fig. 1

FIG. 2 INTERFACE ELECTRONICS

FIGURE 3

**ENLARGED VIEW
SHOWING DIGITIZED AREA**

FIGURE 4

FIGURE 5

DIFFERENTIATED VIDEO

FIGURE 6

DISCRIMINATOR

FIGURE 7

FIGURE 8