FUTURE PLANS FOR CERN HAZE

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(presented by W.G. Moorhead)

The main flow of HAZE has been described by D. Hall. He has also mentioned some of the differences in the program at the three centres - LRL, BNL and CERN.

CERN HAZE now occupies half the 709 store. It is hoped to keep it about that size so as to "share time" with THRESH. The program now works and includes the 90^{o} scan for those tracks which require it.

Unfortunately it gives a high rejection rate due to FILTER. FILTER is discussed later. Some changes thought desirable in the main program, (sometimes called the "DISPATCHER") are :

1) Procedures when error signals are received from the HPD are incomplete. In particular, a roll of film cannot be restarted in the middle after a breakdown.

2) If there is a very large number of tracks so that more than one 0^{o} sweep is required, the tracks to be analysed in each sweep, should be judiciously chosen so as to avoid gating and filtering too many in one scan-line (not merely to take the first eight).

3) Finding the "road" fiducials requires much more program work-space than finding the "glass" fiducials because of the greater uncertainty of their positions. But tracks are not being gated at the beginning of the picture; therefore the track gating work-space should be used.

4) More of the program could be transferred into MIST if there is difficulty in fitting THRESH into store at the same time.

We have processed only about ten events using HAZE. However, we have encountered all (except one) of the cases of failure by FILTER described in other papers. We are particularly worried about "average points" being found which are in some cases a considerable distance from

the track.

The GATE and FILTER routines of HAZE need considerable modification. In fact we feel that FILTER can never work properly unless it is modified so as to converge towards a track-following system which makes use of points already found on the track.

There are two basic reasons why FILTER II does not work :

1) The road edge is always computed from the circle fitted through the scan-table points. This means that a coarse histogram (about a track width per bin) has to be used throughout due to possible misalignments of the road and the track. This gives very poor resolution of the interesting track from the background.

2) FILTER is called each time when twenty points in the road have been accumulated by GATE. These twenty points can represent a very widely varying length of track. When there are nearby or crossing tracks the twenty points are shared by several tracks, thus further making resolution difficult. (This problem may be partly solved by adding successive histograms together but this is at best a palliative).

At CERN we have decided to rewrite the GATE and FILTER part of HAZE. For this an earlier collaboration with NIRNS has been renewed. The basic method has been described by J. Burren. Gating is over a fixed number of scan-lines (called a slice) at a time. At first the scan-table road slope is used, then the slope, road width and histogram bin width are changed on the basis of extrapolation from previously found average points.

It may be noted in connection with the question of histograms that if the track can be accurately extrapolated, then a very narrow road (say 20μ wide) can be used. This means that histograms are unnecessary because nearly all the digitizings found in the road must belong to the track. However, it may be better to keep a slightly wider road in order to see, in advance, tracks intersecting at a small angle.

It has been shown (in CERN 61-31) that the RMS deviation of digitizings from a good track is about 3 or 4μ. If the noise can be rejected completely the average points should ultimately be accurate to $3\mu/\sqrt{N}$ where N is the number of digitizings used in the averaging. However, the least count of the output is the same as the least count of the digitizers viz. 1.6 μ and this is certainly good enough.

The GATE and FILTER being programmed for CERN HAZE (figure 1) differs in some respects from the NIRNS experimental program. (The NIRNS final program will differ from this also, of course !)

1) The number of scan-lines per slice is a program variable. It is hoped to find the best value by experiment.

2) Scan-lines are counted separately for each track from its beginning. This avoids having only a short piece of track in the first slice. Gating will also cease immediately at the end of a track so as to avoid picking up digitizings further along which do not belong to it.

3) There is a subroutine in HAZE to compute the road edge and tangent from the circle through the scan-table points. FILTER will use this to help to predict ahead with decreasing weight as the track becomes "established". It will also be used to check if the track leaves the road.

4) There are also many differences in detail of FILTER operation such as that no intermediate histogram block size is used - only 16 least counts and 4 least counts.

5) Parabolic road edges will be used over the slice for all tracks.

6) The main difficulty with any track-following scheme lies in getting started. The digitizings in the wide road in the first two slices will be kept and dealt with afterwards (or concurrently in a second priority time-shared program). There are several reasons for this :

   a) To clean up the first two average points of the track which have come from a coarse histogram.

   b) To find the very first digitizing of the track using a narrower road extrapolated back.

   c) To treat short tracks (less than two slices long) by a special procedure.

   d) If a track does not get started, to examine the digitizings of the first two slices more carefully to see if anything can be picked up.

7) In any case, if no track has been started in a road it is proposed to return the stage to the beginning of that track and deal with it separately in a special routine.

Figure caption

Fig. 1 Provisional flow chart for the new GATE routine.

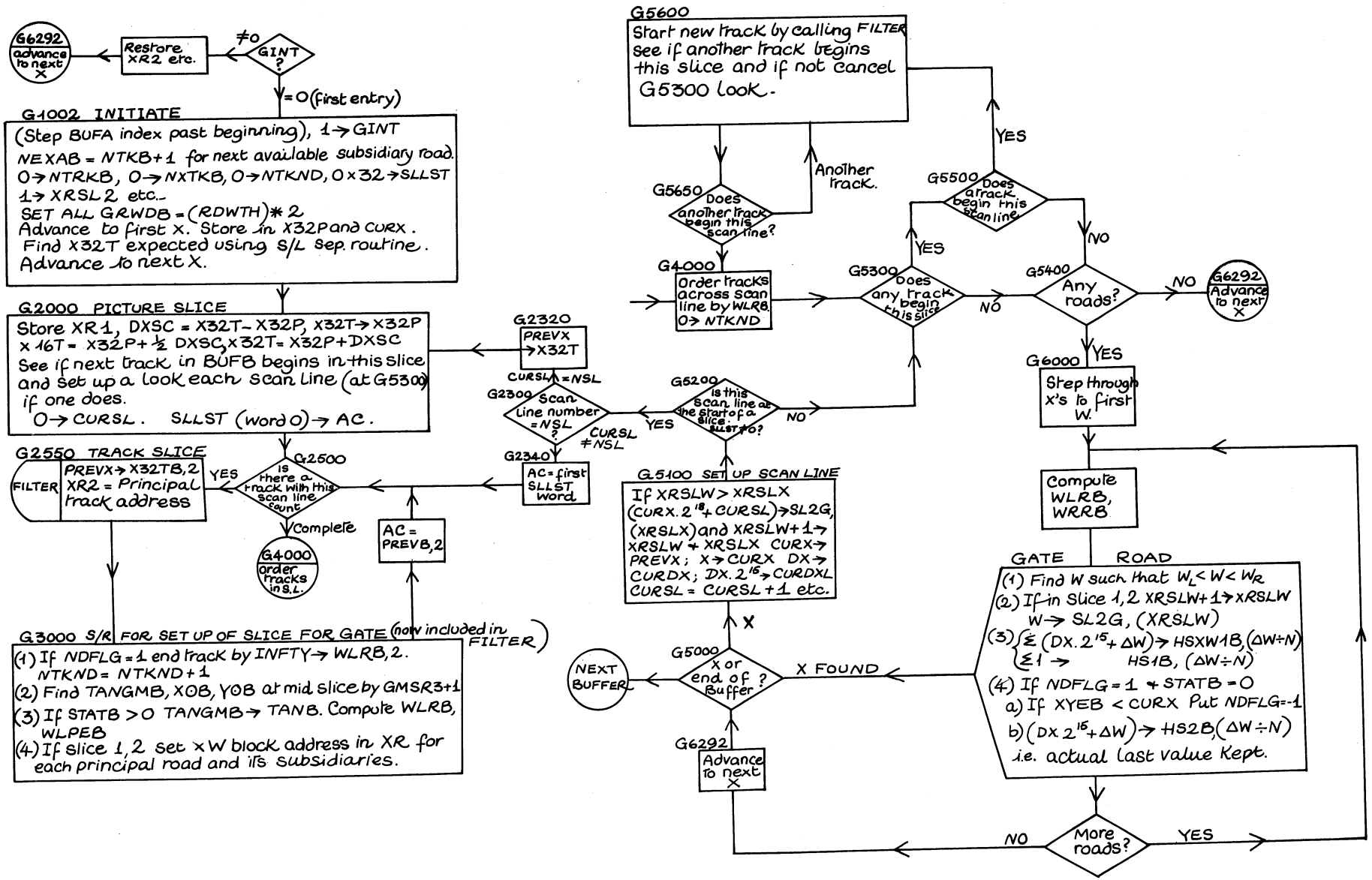
G6292 advance to next X
Restore XR2 etc.
≠0
GINT ?
=0 (first entry)
G1002 INITIATE
(Step BUFA index past beginning), 1→GINT
NEXAB = NTKB+1 for next available subsidiary road.
0→NTRKB, 0→NXTKB, 0→NTKND, 0×32→SLLST
1→XRSL2 etc.
SET ALL GRWDB = (RDWTH)*2
Advance to first X. Store in X32P and CURX.
Find X32T expected using S/L sep. routine.
Advance to next X.
G2000 PICTURE SLICE
Store XR1, DXSC = X32T−X32P, X32T→X32P
X 16T = X32P+½ DXSC, X32T = X32P+DXSC
See if next track in BUFB begins in this slice and set up a look each scan line (at G5300) if one does.
0→CURSL. SLLST (word 0)→AC.
G2320 PREVX →X32T
CURSL = NSL
G2309 Scan Line number = NSL ?
CURSL ≠NSL
G5200 Is this scan line at the start of a slice - SLLST ≠0?
NO
YES
G2340 AC = first SLLST word
G2550 TRACK SLICE
FILTER
PREVX→X32TB,2
XR2 = Principal track address
G2500 Is there a track with this scan line count
YES
Complete
G4000 Order tracks in S.L.
AC = PREVB,2
G5100 SET UP SCAN LINE
If XRSLW > XRSLX
(CURX.2^18 + CURSL)→SL2G,
(XRSLX) and XRSLW+1→
XRSLW + XRSLX CURX→
PREVX; X→CURX DX→
CURDX; DX.2^15→CURDXL
CURSL = CURSL+1 etc.
G3000 S/R FOR SET UP OF SLICE FOR GATE (now included in FILTER)
(1) If NDFLG=1 end track by INFTY→WLRB,2.
NTKND = NTKND+1
(2) Find TANGMB, XOB, YOB at mid slice by GMSR3+1
(3) If STATB >0 TANGMB→TANB. Compute WLRB, WLPEB
(4) If slice 1,2 set xW block address in XR for each principal road and it's subsidiaries.
G5600
Start new track by calling FILTER see if another track begins this slice and if not cancel G5300 look.
Another track.
G5650 Does another track begin this scan line?
G4000 Order tracks across scan line by WLRB, 0→NTKND
G5300 Does any track begin this slice
YES
NO
G5500 Does a track begin this scan line
YES
NO
G5400 Any roads?
NO
G6292 Advance to next X
YES
G6000 Step through X's to first W.
Compute WLRB, WRRB
GATE ROAD
(1) Find W such that W_L < W < W_R
(2) If in Slice 1,2 XRSLW+1→XRSLW
W→SL2G, (XRSLW)
(3) Σ (DX.2^15 + ΔW)→HSXW1B, (ΔW÷N)
Σ 1→ HS1B, (ΔW÷N)
(4) If NDFLG=1 + STATB=0
a) If XYEB < CURX Put NDFLG=-1
b) (DX.2^15 + ΔW)→HS2B, (ΔW÷N)
i.e. actual last value Kept.
More roads?
NO
YES
X
G5000 X or end of Buffer ?
X FOUND
NEXT BUFFER
G6292 Advance to next X

Figure 1

DISCUSSION

HOUGH: If you develop 2 or more pulses in the first slice, will you follow each of them ?

MOORHEAD: Yes, we do. I would be grateful if anyone could tell us of a better way of initiating than a coarse histogram.

HALL: We don't really believe the filtering problem is solved at Berkeley. However, we do believe it can be solved in some sense within the existing framework. I mean that finally less than 50% of the errors will be due to Filter. So in effect this is what the future plans of a FILTER at LRL will be.

BLOCH: Would you care to make an estimate of the time needed to carry through that program ?

MOORHEAD: This GATE, of which I've shown you the flow chart, I am in the middle of writing. The only part which is missing really is the GATE ROAD block in the bottom right hand corner of the flow chart. It is not writing the thing which counts but getting it to work. I hope that the writing will be complete in a couple of months. I feel sure we can get this working in a far shorter time than we can clear up even one of the troubles in the other version.

EDMONDS: Could you tell us what programming language you are writing this in, and also how far these various techniques you are using are IBM oriented and special to that type of computer ?

MOORHEAD: For the first question, we are using FAP. For the second, I don't think they are very much IBM oriented. There are IBM features which I have never been able to make use of, like the indicators; but I think these techniques of linked addresses and using erasable blocks should be available on any machine.

TYCKO: Have you had any experience so far that has made you take what seems to be a much more difficult or at least a more extreme approach than Brookhaven or Berkeley ?

MOORHEAD: We have not had much experience, based on about 10 events, but that was enough to show us that there were things which would never be satisfactory for production, e.g. a track getting lost

in a not very difficult region, just because of the 20 points and a coarse histogram. We had a vested interest in trying to make this work because it is much easier to use someone else's program. But we had enough experience to see all the difficulties already mentioned except possibly the sinusoidal curve inside the road. To my mind the most disturbing one is that of getting average points which are wrong. The smoothing should be done when you have the HPD points; it is a very powerful device with all the accuracy you can want. One should do the smoothing when you have got the full accuracy of the machine.

HALL: Could you explain why the 3x1000 word blocks are better than 2x2000 word blocks ?

BURREN: The actual size of the buffer that you require is the size necessary to even out the flow of the data because your program has to filter every now and again. You could perhaps get away with a buffer of only 50 words but FILTER takes rather a long time, so you have to have a big enough buffer to smooth out while doing filtering. That gives the smallest size of buffer that you could get away with. But you don't want to keep on trapping, so you spread a few traps down a bigger buffer. We actually use 4 buffers of 250 words.

HALL: It is essentially a space saving device.

BURREN: Yes, you work with the smallest buffer you can, so that you don't waste space on a buffer.