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LUMINARY Memo #150

To: Distribution
From: Dana Densmore
Date: 15 May 1970
Subject: LUMINARY Revisions 152-154

Note: corrections to LUMINARY Memo #145:

C1. Description of change to implement ACB L-18.

The exit from landing guidance was cleaned up. (The old logic, which had been known to not work right for a long time, was fixed in the 1C re-release along with the Auto P66 changes.)

The attitude hold check was removed so that a rate stop would be done in attitude hold as well as in auto. Formerly on attitude hold it branched all the way down to DISPEXIT, skipping both the rate stop action in RATESTOP and that in FINDCDUW. Now there is no difference between attitude hold and auto; they both follow the same path.

The first check made is now the overflow check (it used to be the STEERSW check). In the case that there is an overflow, an overflow routine is performed (that routine, OVFDESC, does a rate stop) and then the program branches to DISPEXIT. If there is no overflow, it checks STEERSW. If STEERSW is on it calls THROTTLE and FINDCDUW, branching around RATESTOP. If STEERSW is down it does RATESTOP and then branches to DISPEXIT.

C2. Part of ACB L-17 now PCN 1043.

ACB L-17 included the removal of the zeroing of bit 4 of channel 14 in STARTSB2. This should have been a PCN since it affects Section 2 of the GSOP. That change is now covered by PCN 1043.

The following changes were incorporated into Revisions 152 thru 154.

1) (PCR 1021)

(a) The antenna beam transformation matrices were put into the controlled constants section.

(b) The erasable LR Velocities beam vectors were deleted.

(c) The routines SETPOS1, SETPOS2, used to transform the beam vectors depending on position, were deleted. P63 needed the core function of SETPOS1 so coding was added at P63SPOT4 to initialize STILBADH and STILBADV to two; LRLCTR, LRMCTR, LRRCTR, and LRSCTR to zero; and VSELECT to zero.

(d) Routines POSUPDAT and VELUPDAT were rewritten to transform the altitude and velocity beam into stable member coordinates depending on the radar positions. Both routines call POSINDEX as a subroutine to set X1 to -24D for position 2 and 0 for position 1, X2 to zero, and pushlist to zero. VELUPDAT gets the proper VBEAM, converts it from Nav base to stable member coordinates, and scales it. POSUPDAT does a phase change, converts the HBEAM vector from Nav base to stable member, scales it, scales HMEAS (the slant range) and multiplies that times the HBEAM unit vector to get the slant range vector.

2) (PCR 996) (PCR 991.2)

The flag to be used as a "lift-off indicator" by V92 and the uplink summing routine was renamed "NODOP07" to comply with a specification of PCR 996. It had originally been named "SYSTFLAG."

3) (PCR 991.2)

UPSUM was redefined as being three locations long. The system test people want to use the third location.

4) (PCR 996)

The update program lead-in was changed to do a POSTJUMP to "UPPART2" in bank 4, the P27 bank, from bank 43, the extended verb bank,

immediately after the return from TESTXACT. The remaining lead-in checks and housekeeping are now done at UPPART2 in the same bank as the rest of P27. A savings of 10 words resulted in bank 43, where more words were needed for the implementation of the uplink summing. Only 9 words were added to bank 4 because a branch to the P27 error exit could be done directly rather than with a POSTJUMP.

5) (PCR 1027)

Coding for the a priori terrain model was implemented.

(a) W-matrix overlay erasables, the braking and approach phase target parameters for landing guidance, were rearranged so that slope and abscissa padloads for the terrain model could fit in. The middle components of each vector happen to be zero and are expected to remain zero for all future flights. By interleaving the nonzero components of the position, velocity, and acceleration vectors for the braking and approach phases (and letting the other parameters follow, also in interleaved format) twelve more locations were obtained (six double precision vector components).

	<u>The old order was</u>	<u>new</u>
(braking)	BPX	BPX
	BPY	APX
	BPZ	BPZ
	BVX	APZ
	BVY	BVX
	BVZ	AVX
	BAX	BVZ
	BAY	AVZ
	BAZ	BAX
	other braking parameters	AAX
		BAZ
		AAZ
(approach)	APX	other parameters (interleaved)
	APY	
	APZ	
	AVX	
	AVY	
	AVZ	
	AAX	
	AAZ	
	AAZ	
	other approach parameters	

where first column B = braking
" " A = approach
second column P = position
" " V = velocity
" " A = acceleration
third column shows component.

(b) A routine (ZEROMID) was written in lunar landing guidance equations to zero the zero middle component of a vector in MPAC. This is now used to replace the now-garbage middle component of each vector with zero before it is used.

(c) The program will pick up BPX, APX, BPZ first, substitute zero for the middle component, resulting in the proper braking phase target position vector. In the approach phase (indexing now by 2 rather than 34) it picks up APX, BPZ, APZ and (again calling ZEROMID to get a zero middle component) has the Approach target position vector. As the vectors are picked up by name (position velocity or acceleration) it doesn't matter that the Velocity vectors are now 8 registers down from the position instead of 6.

(d) Ten padloaded erasables were defined sharing with W-matrix and system test erasables in the landing padload overlay. Room for them had been made by the rearrangement of the target parameters (See 5. a above). These consisted of five abscissas and five slopes.

(e) Coding for implementation of the terrain model itself was put into Servicer at the landing radar position update computations just before "post highgate" check to see whether to do the data reasonability test. For a detailed explanation of the terrain model, see LUMINARY Memo #147 by Klumpp, McCoy and Eyles.

6) (PCR 1022)

(a) FUNCTIONAL DESCRIPTION:

The landing radar position alarm logic was changed to simplify astronaut procedures and permit landing radar data incorporation any time the data good signal is present.

(1) The program will accept landing radar data in either position as long as the data good discrete is present.

(2) If neither position discrete is present or if both are present, program alarm 511 is issued.

(3) Alarm 511 will not be repeated until after the program finds one position discrete present.

(4) An unexpected LR position change will not produce a 523 alarm but the data will not be used the first time.

(b) CODING CHANGES:

(1) ERASABLE CHANGES: Erasable LRADRET is no longer used in the new coding. The same erasable (E7, 1650) will now be used to store the last radar position discrete for the check whether the position has changed since the last pass. If it is different from the present discrete updating is bypassed. It is called LRPOS and contains either bit 1 or 2 depending on whether it was position 2 or 1.

(2) R12 was changed to test the position discrettes and then if one or the other is present it clears the NO511 flag and if it is the same as the previous it branches to UPDATCHK; if different from previous it falls into CONTSERV. If neither or both discrettes are present and the NO511 flag is set the program branches to CONTSERV; if it was not set it issues the 511 alarm, sets the flag, and then branches to CONTSERV.

(3) The reposition logic in HIGATJOB was cleaned up and LPOS2FLG and the 523 alarm removed. (The 523 alarm is still given by V59.) After repositioning a bit 1, signifying position 2, is placed in LRPOS to indicate to R12 that position 2 is expected. The same logic is followed whether the repositioning was successful or unsuccessful.

7) (PCR 1025)

The call to MUNGRAV to recompute the gravity vector after the landing radar altitude update is done was removed to reduce execution time during R12. The possible change in the gravity vector since it was last calculated (in RVBOTH) was considered insignificant.

8) (ACB L-20)

(a) NEGORKP, a quantity defined in erasable but unreferenced and unused except as the low order half of a downlist word (POSTORKP), was misspelled where it was defined in erasable (mispunched as NEGOTKTP). These registers are part of DOWNTORK which is incremented by the Kalman Filter routine in the DAP coding.

(b) As a result of another keypunch error, a number in the pinball noun scaling (FORVEL scaling) was 5.517 instead of 5.571. It was corrected to the latter.

9) (PCR 1028)

To implement the 2 segmented landing radar weighting function, LRWH1 was defined (=RODSCAL1) as the second segment (LRWH is still the first segment) and LRWH1 is picked up for P64 and put into LRWH so that the LR updates will be weighted more after the start of the approach phase. During the braking phase the roughness of the terrain does not affect the vehicle and it is not desirable to follow it too closely. Lower, however, terrain variations are more important and it is desirable to keep the altitude estimation errors small near the site.

In the theoretically possible case that P66 is entered directly from P63 by going into attitude hold in P63 and exercising the ROD switch, LRWH would not be initialized for the second segment since P64 is bypassed. A correction to initialize it properly in P66 may be advisable since the PCR specifies that a separate load be provided "in the programs following P63."

10) (PCR 296)

The coding to implement this PCR was rewritten, saving 5 words. The new procedure is to convert vector RN from reference coordinates to stable member, unitize, convert from stable member to nav base, then store in GSAV.

11) (ACB L-19)

A new routine, QTPROLOG was written as a lead-in to QUICTRIG. P66ROD was then changed to call QTPROLOG and *NBSM* instead of CDU*NBSM, thus saving some time. This did not sacrifice any significant accuracy. QTPROLOG stored CDUX, Y, and Z in the CDUSPOTS.

12) (PCR 307)

CURSOR and SPIRAL were set in consecutive locations (CURSOR = GDT/2, SPIRAL = GDT/2 +1) for downlinking in the same telemetry word.

13) (ACB L-22)

The setting and resetting of R04FLAG which was intended solely to prevent the issuing of the 521 alarm (which no longer exists as a result of PCR 979) was deleted. R04FLAG now again has its original meaning of "R04 running."

14) (PCR 1209)

(a) Erasables SERVDURN and DUMLOOPS were defined at E3, 1776 and 1777, where there were two spare erasables. They should be moved to unswitched when two contiguous unused erasables can be found (or created by moving something else out), because time is important where they are used, in DUMMYJOB loop and SERVICER, and it would be better not to have to set the EBANK.

(b) In the ADVAN section of DUMMYJOB the EBANK is switched to E3 and DUMLOOPS is incremented. (It is not necessary to restore the EBANK.) To get room for these three words: (1) In the executive at EJ1 an "INDEX Q, TC 2" was changed to "TCF Q+2", (2) At EJ2 an "EXTEND, QXCH BUF, INDEX BUF, TC 2" was changed to "CA Q, TS BUF, TCF Q+2", (3) A waitlist call in WAITLIST at LASTTIME was changed to a TWIDDLE.

(c) Coding was put into SERVICER at SERVOUT just before going to AVGEXIT to set the EBANK and calculate SERVDURN (TIME1 - PIPTIME +1).

15) (PCR 896)

(a) Downlink parameters that were no longer needed with the new radar read request logic were deleted. These were LRXCDUDL, LRYCDUDL, LRZCDUDL, and LRUTIMDL.

(b) Some quantities on the downlist which were removed from the program in the implementation of this PCR were removed from the downlist.

The quantities eliminated were LRZCDUDL, VSELECT, LRVTIMDL, VMEAS (d. p.), HMEAS (d. p.) (replaced by HMEASDL (d. p.), RM (d. p.) AIG, AMG, AOG, and TRKMKCNT.) Words 2, 3, 4, 5, 6 and 13 were made spare; word 7 was made MKTIME, 8 HMEASDL, and 9 VMEAS.

16) (PCR 942)

(a) A correction was made to the original implementation of this PCR in Rev 132. A "DAD" was changed to a "DLOAD."

(b) The altitude cutoff erasable was made a single-precision number. HLROFF was defined in fixed memory as a single precision constant. It is loaded in interpretive as a d. p. constant into the erasable HLROFF (two locations, E5, 1772, 1773). HLROFF is used as a single precision word in basic coding in MUNRETRN (see 16, c below). HLROFF +1 (garbage) goes into HLROFF +1, which is not picked up. HLROFF replaced 50FIXED, a d. p. number, thus saving a fixed word.

(c) Coding for the implementation of this PCR was rewritten in a better way with a prolog to R12 called LROFF? which tests whether the vehicle is below the cutoff using HLROFF. HLROFF is added single precision to the complement of the altitude (HCALC +1); if the altitude is below the cutoff the landing radar permit flag is turned off.

LUMINARY GSOP

GSOP sections to be checked with respect to the changes described:

Section 2 (Items C2*, 2, 12, 13, 14, 15)

Section 4 (Items C1*, 1, 5, 6, 7, 9, 16)

Section 5 (Items C1*, 1, 5, 9, 11)

*Correction note.