山人科技集

LEE'S TECHNIQUE BOOKS
ENGLISH EDITION 1

（英文版）

（文集之三）

李世富 博士

(五行山人)

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（五行山人）

INTRODUCTION

NATIVE : MANCHU (yellow flag) ,CHINA.
BORN IN : MACAU, CHINA, 1925.

RELIGIONS:
BUDDHA : FAMILY.
CHRISTIAN: EDUCATION & SCHOOLS.
TAO : EDUCATION, WORK & HOBBY.

EDUCATIONS:
CHINA : LINGMAN UNIVERSITY .H.K.
CHAO TONG UNIVERSTY, SHANGHAI.
U.S.A. : COLUMBIA U.MICHIGAN.
BRITISH : ST. OLIVA UNIVERSITY.
TAIWAN : CHINESE MEDICAL COLLAGE.

HONOR DEGREES:
PHD, MSc, BSc, MB .
PRINCIPAL ENGINER .
ENGINEERCONSULTAN .
MY NAME WAS ON FRIST COVER OF
(NRA - NATION RIFEMAN AMERICAN).
MAGAZINE.

JOBS:
C.I. T. (CALTECH).
JPL (JET PROPULSION LABORATORY) .
BECHTEL CORP.

McDONNELL AIRCRAFT CO.
TRW CO.

SIDE JOBS: JEWELLY & WATCH MAKER.

STUDY OBJECTS:
AERO, SPACES PROGRAMS;

ELECTRICAL; POWER;
(SPACE; STATION; SUB-STSTION & NUCLEAR) ;

ELECTRONIC; MICRO CIRCUITS , TECHNOLOGY,
CONTROL SYSTEMS:
SERVO; AUTOMATIC CONTROL SYSTEM ,
FLIGHT CONTROL SYSTEMS;
AIRCRAFT AUTO LANDING,
MISSILES (TOW, ROCKETS) .
ENVIROMENT: FAIL-SAFE CONTROL SYSTEM, REILABILITY CONTROL SYSTEMS.

FIBIC OPICS...

PUBLISHS :
1. TO STUDYOF CHINESE MEDICINE (OVERSEA CHINESE EDITION) .
2. THE MOMORY. (CHINESE EDITION).
3 .THE HIGH TECHNIQUE(ENGLISH EDITION).

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CHAPTER 1

第一章

THE STUDY OF AIRPORT TERRAIN EFFECTS ON AUTOLAND FOR ANY AIRPLANE

机场地形对飞机自动着陆影响之研究

THE STUDY OF AIRPORT TERRAIN EFFECTS ON AUTOLAND FOR ANY AIRPLANE

The terrain profile at several airports has caused some difficulty with autolands on the DC-10 and MD-80.Some operators have reported that the pilot had to disconnect the flight guidance system during flare and land manually.

At present, the autoland guidance system is not uniquely designed to handle the variations of terrain. Since there is no accurate substitute for radio altitude (h_{rad}) the only variable left to improve is radio altitude rate (h_{rad}).

During this simulation and analysis, barometric altitude rate （ $\dot{h}_{Baro}$ ） is used in the radio altitude complementary filter for smoothing the terrain effects for the flare initiation. Also, we cannot use $\dot{h}_{Baro}$ through the flare because of ground effects so it is switched out below 50 feet. The aircraft flight condition used in this simulation was for the DC-10-30, case#2193(aircraft weight 350 000 perdition, C.G.=20%,Mach=0.213,Flap=50.0deg.). The autoland control laws are from the MD-80 DFGC.

The sensor locations were with respect to the MD-11 aircraft configuration and 7 airports (9 runways) with and without terrain (see 2 Figure 1) were simulated in this study.

The seven (7) airports and nine (9) runways simulated are:

Seattle airport (runway 16R & 34R)

San Francisco airport (runway 28L & 28R)

Pittsburgh airport (runway 28L);

Minneapolis airport (runway 29L);

Boston Logan (runway33L);

Oakland airport (runway29);

Kennedy airport (runway4R).

This study also consists of a self of final approach "Time Histories"and includes terrain profiles of 2 types:

(1) With a fictitious level ground profile (G=0)

(2) With simulated actual terrain profile (G≠0)

w/wo/fix for the 7 airports listed above.

1. The Systems

1.1 Description

Autoland system control laws depend on the inertial measurement of the wheel height above the runway which is obtained from the radio altimeter. The flare control law also needs altitude rate which is obtained by taking the derivative of the radio altitude, then filtering with it, and then comparing it with altitude rate derived from the integration of verticals acceleration. This is used to provide a high frequency altitude rate, so that the noise resulting from differentiating radio altitude can be improved. Because the aircraft (A/C) main gear wheels are not over the runway threshold at the flare height, ground terrain sensed by the radio altitude can seriously affect the flare performance at some airports.

This is not a new problem and has been reported by airline operators. This problem could be improved by relocating the glide slope antennas closer to the main gear. This is being done on the MD-11 aircraft by using the nose gear location already installed on some DC-10 aircraft.

Another potential solution is to initialize flare at a fixed altitude like 35 to 40 feet to assure that the terrain has been passed over. This flare altitude would be a function of the aircraft glide slope to main gear geometry and the worst terrain profile expected. The desired vertical speed filter must also recover quickly once the terrain effects are over but this is contrary to the desire to smooth the signal. The terrain can affect the flare performance in two dramatically different ways. If the terrain is sloping up at the flare initiate point, the sensed vertical speed is low causing the control law to demand a nosedive (which is usually inhibited) resulting in a very late flare. If the terrain is sloping down at flare, a very high vertical speed is detected calling for excess pitch up resulting in over-rotation.

To avoid making significant changes to the existing flare control law, a proposed solution to the problem would be to modify the radio altitude complementary filter, so that, prior to some altitude such as 50 feet, the desired altitude rate filter uses barometric vertical speed instead of radio altitude rate.

No change to the flare law would be required and if a failure of the barometric rate is detected the filter would revert to its present configuration. The comparator threshold level of this monitor will have to be evaluated.

1.2 The Radio Altitude Complement Filter

The filter which generates estimated radio altitude ($\hat{h}_{rad}$) complements inertial normal acceleration with radio altitude and its rate to produce filtered radio altitude (HRADIO or h_{rad}) and altitude rate (HDTRAD $\hat{h}_{rad}$) state estimate terms.

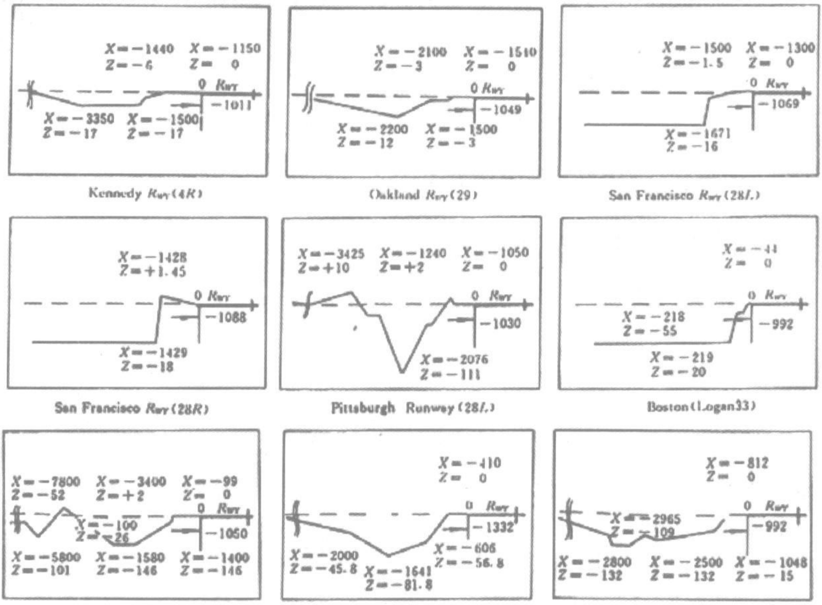
In the presence of terrain anomalies in the approach area, the altitude rate can contribute to non-optimum flare initial altitudes which adversely affect autoland performance.

$\dot{h}_{Baro}$ (HDOTF) is smooth at high altitude.

$\dot{h}_{rad}$ (HDTRAD) is smoother and more accurate over the runway.

Therefore, $\dot{h}_{Baro}$ was used at high altitude (above 50 feet) and h_{rad} was used at over the runway (touchdown) during this study.

2. The System Problems



2.1 The airport runway terrain profile characteristics

2.2 The flare and landing problems

Automatic landing problems occur when terrain in case (A)in the approach landing area rises steeply(i.e. Boston and San Francisco airports),in case (B)when irregularities in surface terrain precedes the runway threshold(i.e. Kennedy, Oakland, Minneapolis and Seattle(34R)airports),and in case (C)of steep and irregular surface terrain conditions (i.e. Pittsburgh and

Seattle(16R)airports).

The 3 cases above are caused by the following problems during the landing:

Case (A): The terrain profile in front of the runway has a long flat trench and a vertical step up(steep)to zero or positive(+)elevation in front of the runway threshold. This will cause early flare and early touchdown.

Case(B):The terrain profile in front of the runway has an irregular surface in front of the runway threshold (except 2 000 feet or more in front of the runway threshold).That will cause late flare, high sink rate and hard landing.

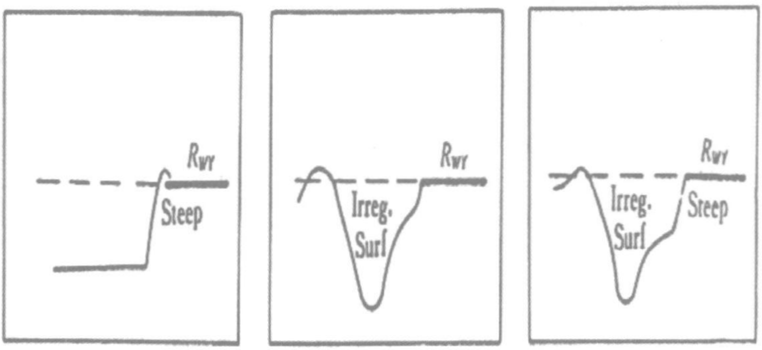
Case(C): The terrain profile in front of the runway has an irregular surface and a steep step up combination terrain in front of the runway threshold, which will create high sink rate, late flare, and over-flare, pitch oscillation and delay throttle retard and can cause a hard landing, float and unstable touchdown rate conditions.

The overall effect is to destabilize the flare due to:

(1) A late flare and firm touchdown sooner than normal.

(2) An extended flare with an extended float, a slight gain in altitude during flare and a long touchdown.

(3) A firm touchdown following the float and speed is bled off during the extended flare.



Case (A) Steep Terrain Case (B) Irregularities Surface Terrain Case

(C)Steep + irregularities Surface Terrain

3. Flight Data Analysis

Four runways from three airports: Pittsburgh (Rwy 28L), Minneapolis (Rwy 29L), and Seattle (Rwy 16R and 34R) have caused airline pilots discomfort during auto landing because of terrain. The following data shows 4 runways which were analyzed.

3.1 The Initial and Touchdown Flight Data

3.1.1 Airport runway without terrain (G=0) (reference only)

Table 1 G/S=3° wo/terrain (G=0)wo/noise

AIRPORT	GLIDE-SLOPE ANTENNA LOCATION	DISTANCE (PAST XMITTER)		ALT (FT.)		SINK RATE (FT./SEC.)		PITCH ATT. (DEG.)		FLARE (FT.)	
		INIT	T.D.	INIT	T.D.	INIT	T.D.	INIT	T.D.	DIST (XI)	ALT
ANY	Nose	-5855	343	280	-3	-11.4	-2.3	4.0	6.5	-1511	56
	Nose gear	-5607	591	280	-3	-11.4	-2.3	4.0	6.5	-1264	55

Table 1 :(Reference Only)

This Table shows the touchdown parameters with no terrain and the glide slope antenna located on the nose (DC-10) and nose gear (MD-11).The latter results can be used as a baseline for the rest of the tests in this report.

3.1.2 Airport runway with terrain (G=0)

Table 2 G/S=nose gear (3°) w/terrain (G≠) no/noise