QUANTITATIVE ASSESSMENTS OF RUNWAY EXCURSION PRECURSORS using Mode S data

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26–29 June 2018 @ Castelldefels
Future Sky Safety project: prototyping a Risk Observatory that will assist in the safety assessment of the aviation transport system

Compute the probabilities of occurrences of various incident and accident categories using risk models

Evaluation of the risk of runway excursion

Modelling and quantitative assessments: limits reached when more information than available was necessary

Use of ADSB/Mode S data
MODELLING THE RISK OF RUNWAY EXCURSION
PC8622, TRABZON, 14 JAN. 2018
BACKBONE MODEL – RUNWAY EXCURSION

Longitudinal Runway Excursion

- Non-decelerated incorrect touchdown
  - Non-rejected incorrect touchdown
    - Incorrect touchdown
      - Non-corrected Unstable Approach
        - Unstable Approach
          - 4 - Failure to manage stabilization in final approach
          - 1 - Failure to prepare and manage approach by A/C system
          - 2 - Failure to prepare approach by Flight Crew
          - 5 - Failure to manage short final, flare and touch-down
            - 5.1 - Absence of rejected landing
            - 7a - Total Loss of A/C deceleration on ground
              - 7b - Partial Loss of A/C deceleration on ground

- 4.6 - No go around
FAULT TREE FOR CONTRIBUTING FACTOR 4.

4 - Failure to manage stabilization in final approach

A/C Unstable Approach Contributor

4.1 – Excessive or unstable speed

4.x – ...

4.7 – Late destabilization

Combined Unstable Approach Contributor

3.8 – ATC does not reject change request

4.8 – Crew request late change
## Contributing Factors for Unstabilized Approach

<table>
<thead>
<tr>
<th>Contributing factors</th>
<th>( p )</th>
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<tbody>
<tr>
<td>4.1 excessive or unstable speed</td>
<td>( 10^{-2} )</td>
</tr>
<tr>
<td>4.2 excessive or unstable lateral and vertical path</td>
<td>( 3 \cdot 10^{-2} )</td>
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<tr>
<td>4.3 excessive or unstable thrust</td>
<td>( 10^{-2} )</td>
</tr>
<tr>
<td>4.4 late or inappropriate flaps/gear configuration</td>
<td>( 10^{-3} )</td>
</tr>
<tr>
<td>4.5 inappropriate use of automation during approach</td>
<td>( 10^{-1} )</td>
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<tr>
<td>4.6 absence of go around when unstable approach</td>
<td>( 10^{-1} )</td>
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<tr>
<td>4.7 late destabilization of the approach</td>
<td>( 10^{-2} )</td>
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<tr>
<td>4.8 crew requests late change</td>
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CREW REQUESTS LATE CHANGE
CONTEXT FOR THE STUDY

- TLS/LFBO airport
- 6 months of data
- QFU 32 final approach
FUNCTIONAL PCA ON THE TRACK ANGLE SIGNAL
FUNCTIONAL PCA ON THE TRACK ANGLE SIGNAL

Variance ratio

Index of the component in the decomposition
First component depicts the average trend;
Second and third components depict **low frequency variations** with the most variance on the dataset.
FUNCTIONAL PCA ON THE HEADING SIGNAL

EZY74ZU, Feb 07 11:23

AF146FZ, Feb 02 22:05
AF522VH, Feb 09 16:28
EZY1728, Feb 23 18:11
EZY1729, Feb 23 18:11
EZY690A, Feb 23 10:19
AF100GN, Feb 28 07:36
Ryr3011, Feb 25 07:50

Distance to runway threshold (in nm)
Track angle (in degrees)
PLACING IN CONTEXT
Among 1398 flights (Feb. 2017) landing on QFU 32:

- 51 flights (~ 3.6%) found to follow this pattern;
- 6 flights (~ 11.8%) present a poorly kept glide path → failure to manage stabilization in final approach

Same model on 6 months:

- 387 trajectories with late runway change;
- among them, 64 show signs of unstable approach (~ 16.54%)
LOOKUP ON ONE FLIGHT

AF106GX, Feb 21 09:43

Distance to runway threshold (in nm)

Altitude profile (in ft)
FIRST CONCLUSIONS

- Figures can be fed to our model
- Exploratory analytics may give hints to refine the model
- Reproducible results (open data)
- Code available (soon)
LIMITS OF MODE S DATA
TOO HIGH, TOO FAST: SHOULD WE USE GROUND SPEED?
EHS MESSAGES IN TOULOUSE TMA

Number of BDS 6.0 messages per flight during final approach
TOUCHDOWN ZONE ESTIMATION

Extracted from the first positional surface message

Extracted from vertical speed information

Coordinates received upon landing of flight DLH83K on Feb. 25
UNUSUAL FLIGHTS – AIB93CB, 28 FEB. 2017
UNUSUAL FLIGHTS – ILS CALIBRATION, 16 JUN. 2017
UNUSUAL FLIGHTS – N56821, 17 SEP. 2017