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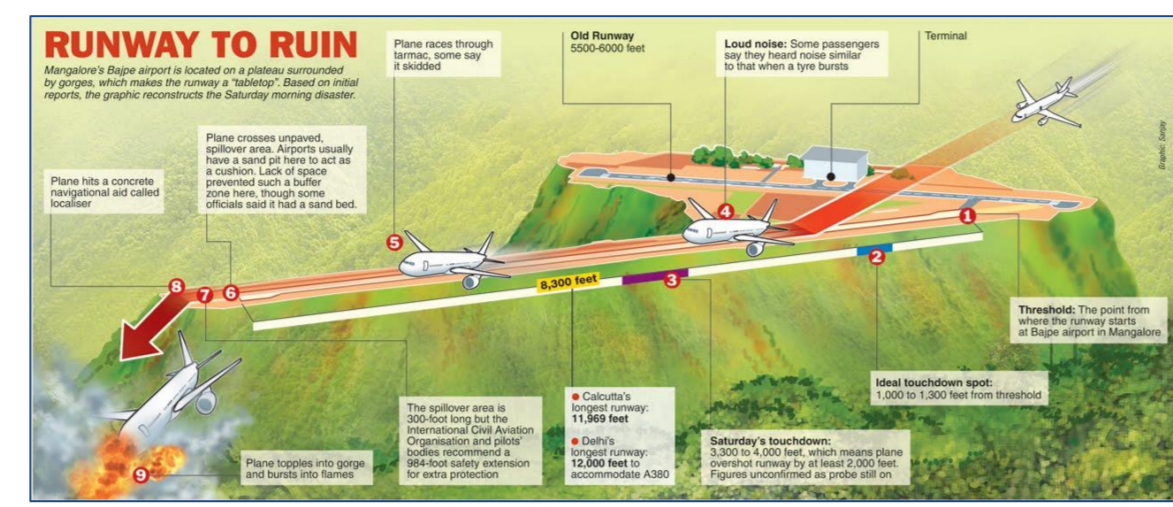
Pant, Vatsal and Demmou, Hamid and Chaudemar, Jean-Charles Safety Analysis of Pilot-System Interaction. (2018)
In: 12th International Conference on MOdeling, Optimization and SIMulation (MOSIM18), 27 June 2018 - 29 June 2018 (Toulouse, France).

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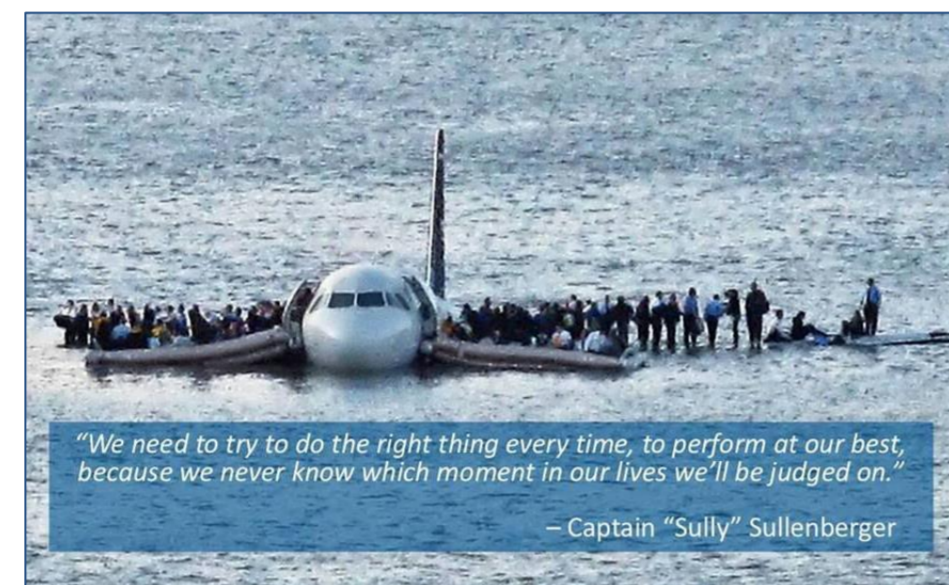
Motivation

Could this be possibly avoided if the pilot is informed about his actions?



Crash of Air India 812 in 2010 in Mangalore

Can the pilot be informed of the “wrong” thing he might do in order to help him always do the “right” thing?



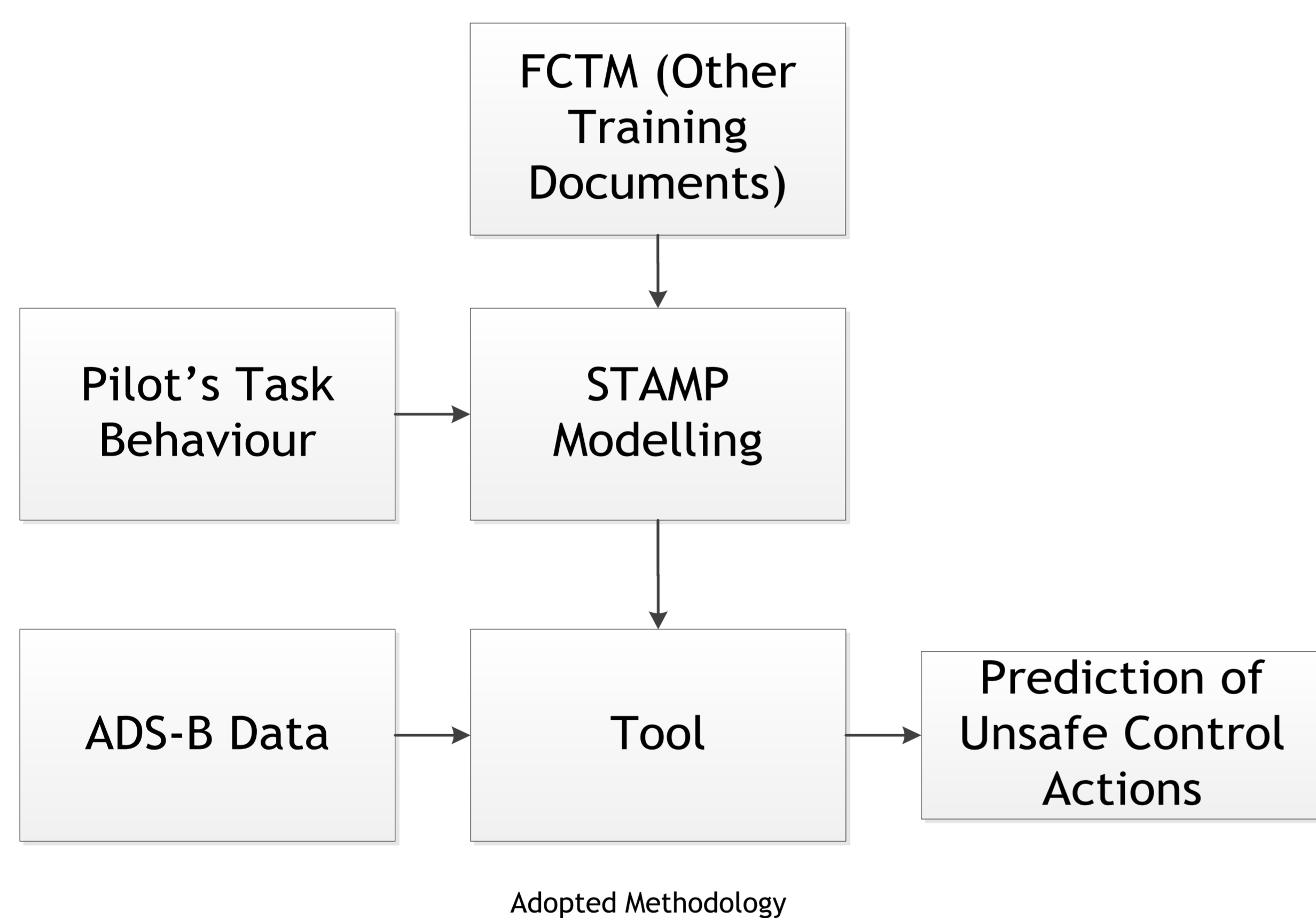
US Airways 1549 after successful ditch on Hudson

Introduction

The objective of this research is to understand how the pilots perform their tasks in the cockpit and how to identify any error (unsafe control action) that they might make (perform). And finally to model it in a way that can be used to formalize for validation.

The methodology is referred to as non-intrusive or non-invasive as it doesn't require additional monitoring tools in the cockpit (eye tracker, video recording etc..) and doesn't interfere with pilot's task performance. In the initial phase it can be used to learn/identify the UCAs but later on (once validated) can be implemented in the cockpit to warn the pilots of any imminent hazard that might arise because of their actions.

Methodology



A sample FCTM (Flight Crew Training Manual) is used in this research that does not exactly represent the one provided to the pilots but it is fairly representative.

The information given in the FCTM is translated to a process-controller model that can be used to perform STPA analysis in order to obtain:

- Unsafe Control Actions (based on the four types prescribed in STPA)
- Improved Safety Constraints

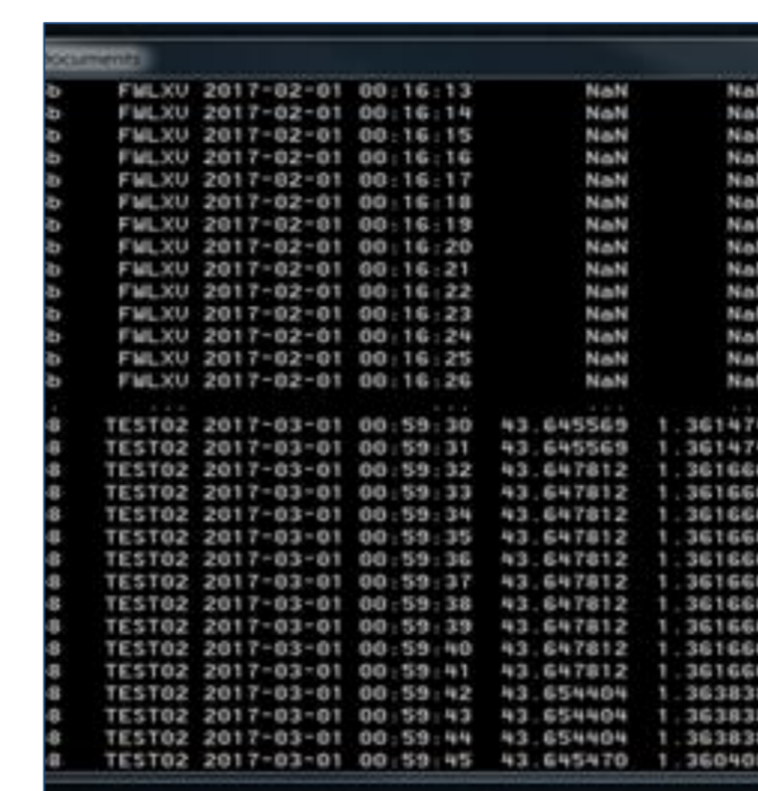
Once the Unsafe Control Actions have been obtained they are stored in excel database as “Control Action+Context+Hazard”

The next step is to use ADS-B data to know the position of the aircraft and compare it with the safety margin as generated from the normal approaches.

Use of ADS-B data

Data transmitted by many aircraft (but similar type, e.g. Airbus 320) over a period of time is gathered from an ADS-B (Automatic Dependent Surveillance - broadcast) receiving source and studied to obtain a nominal approach pattern (called the approach curve). Some assumptions are made about certain parameters like autopilot disengage, landing gear down, etc.. These parameters are used to define safe operating zones.

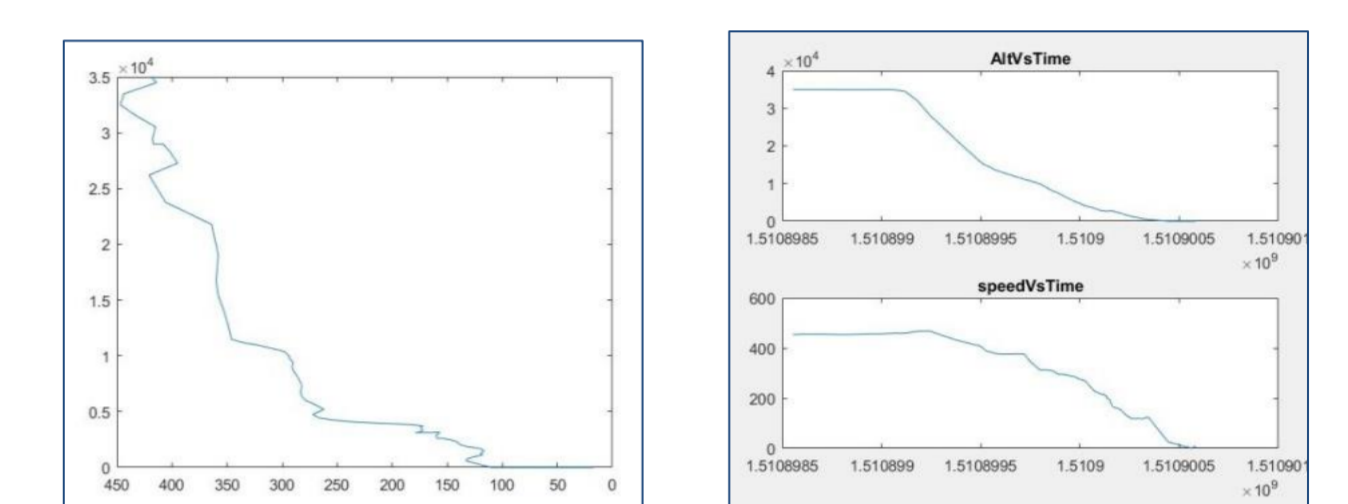
The approach curve together with safety zones help in making of a safety margin.



ADS-B data processing in Python



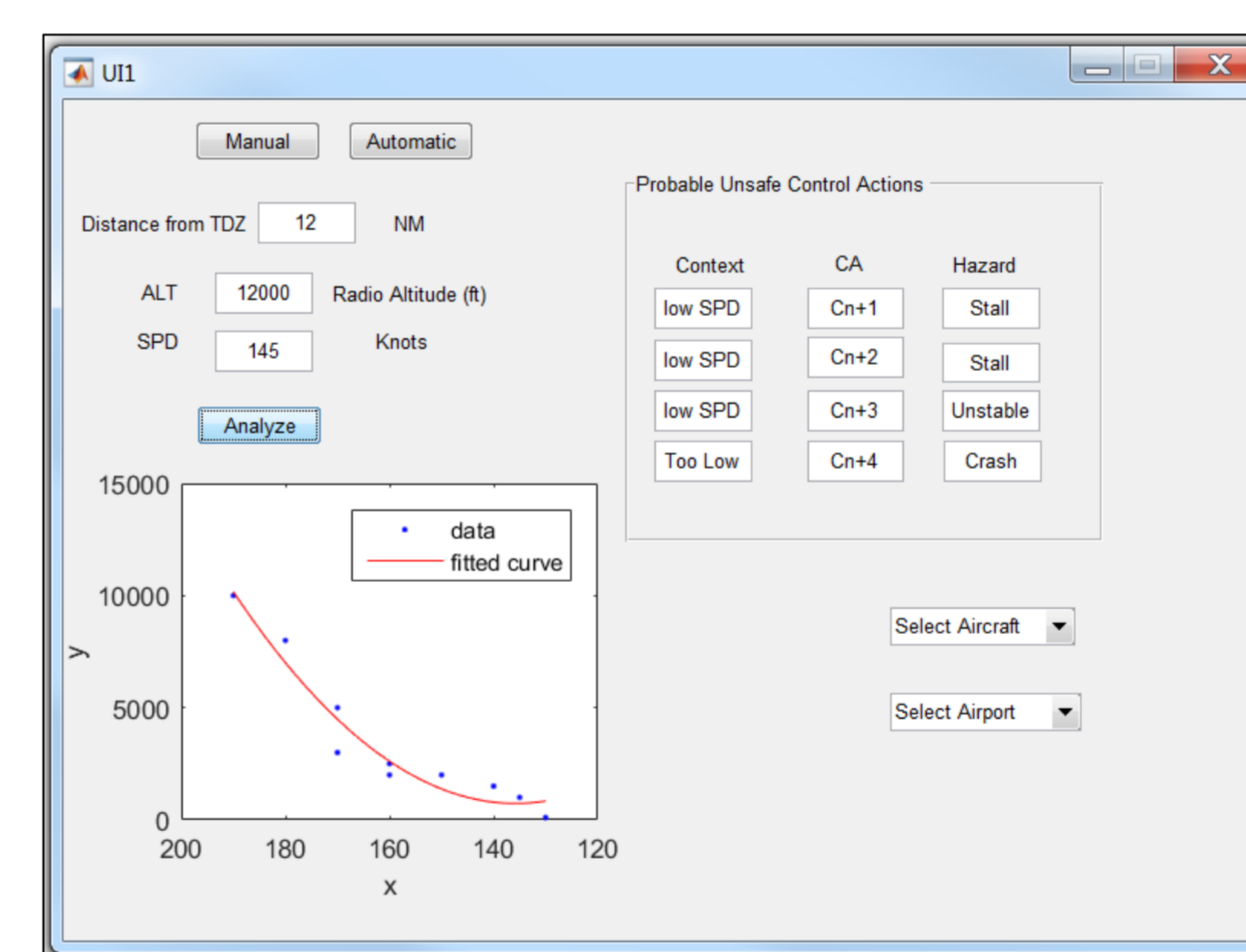
Screenshot of flightradar.com that uses ADS-B data to identify aircraft on maps



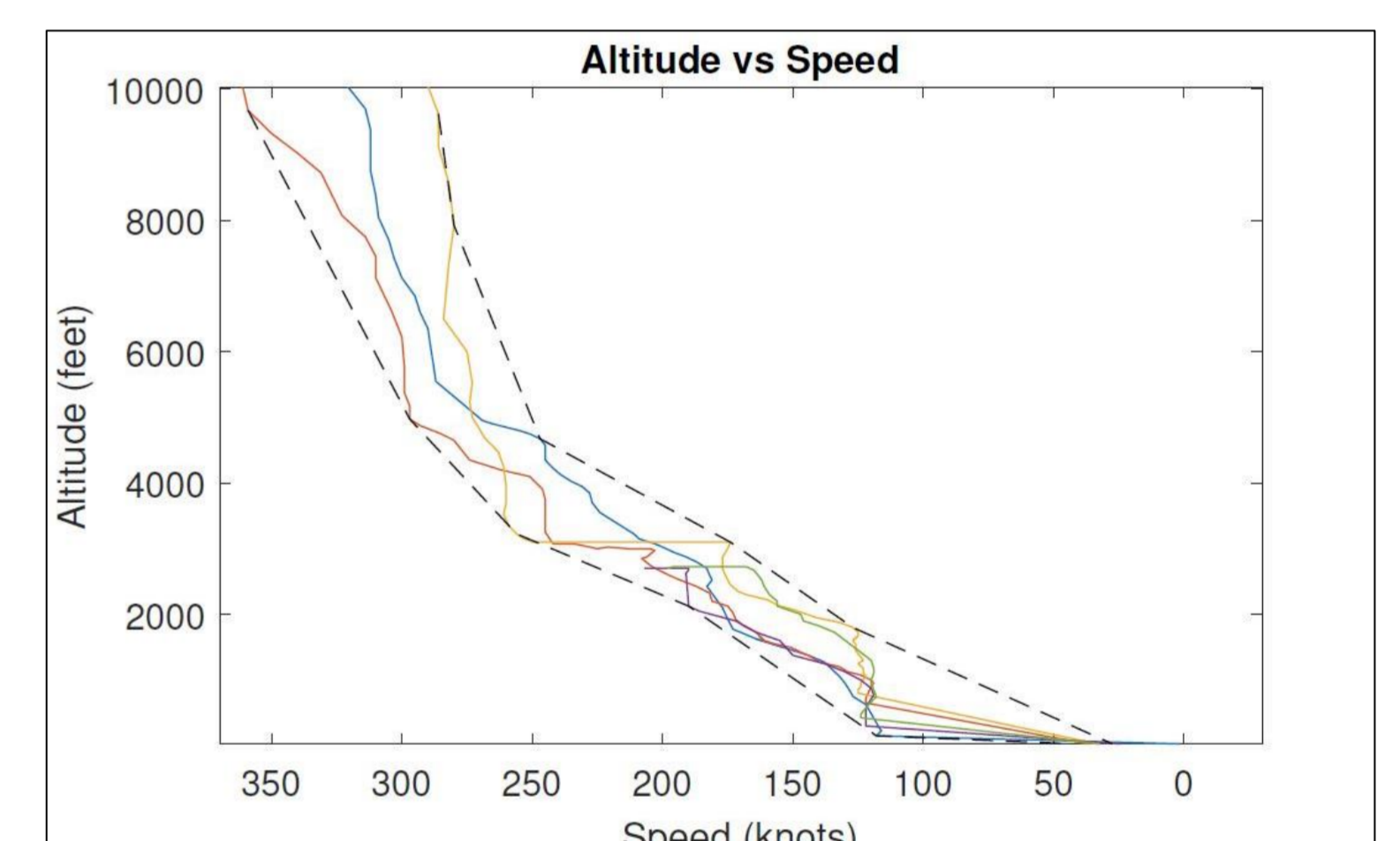
A few curves obtained after data processing

Tool

MATLAB based GUIDE (Graphical User Interface Development Environment) is used to build this tool. The tool takes ADS-B data as the input and predicts unsafe control actions. It also plots an altitude vs speed diagram of the approach in order to compare it to safe approach patterns.



A screenshot of the tool



A few approach curves within the safe margin

The tool predicts unsafe control actions and makes a log that can later be evaluated.

Recursive Unsafe Control Actions can be assumed to be a design/requirement issue and can be discussed with an expert.

Next Steps

For the moment the values of some parameters have been assumed. This is planned to be improved once actual aircraft data is (if possible) acquired.

- Use of Machine Learning for automated generation of safety margins (by training the model with a lot of real cases).
- Discussion with pilots about detection of false alarms and validation of the tool.
- Request Aircraft Manufacturer for FCTM/SOPs/FCOM in order to validate the methodology.

Acknowledgements

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