Final Report

Analysis of Aircraft Touchdown Point and the Associated Uncertainty

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I. Introduction

Adequate determination of aircraft landing distance is critical to the safety of terminal area operations. In general, the aircraft landing process consists of the touchdown and rollout/turnoff. Although the current aviation system tracks a number of landing parameters for commercial operations, the operational touchdown performance is not readily measured and recorded.

This research project consisted of two phases. In Phase I, we collected landing traces from a flight simulator, analyzed the traces, and developed and validated computational methods that can back-calculate the touchdown points. The accuracy of the calculation was verified against high precision Global Positioning System information. These computational methods are implemented in the Matlab script language, and they are very efficient. Matlab provides interfaces to all commonly used database systems, including Microsoft Access. Thus these methods can be readily incorporated in an integral system to process large amounts of operational landing data. We submitted the Phase I report in October 2006, and that interim report is attached to this final report.

In Phase II of the project, we performed the preparation for the analysis of operational landing data. The operational data would be provided to us by anonymous sources. Additionally, we have been downloading meteorological data from a web server at the National Oceanic and Atmospheric Administration (NOAA) since November 2006. The weather conditions at the landing airports would be incorporated in the analysis of the operational touchdown performance.

II. Operational In-Flight Data

The in-flight recorded data will be provided to us by anonymous sources. We have received data of eight sample flights. These data are encoded in a specific binary coding scheme, and we have developed methods and computer scripts that decode the data. Specifically, the data are collected during the course of a flight in chunks of time-blocks. The data collecting rate can be ¼ Hz, ½ Hz, 1 Hz, 2 Hz, 4 Hz, 8 Hz, 16 Hz, 32 Hz, or 64 Hz. For each flight, we are given the following:

- A set of general information of a flight.
- The start date and time and the end date and time of each time-block.
- Detailed descriptions pertinent to each piece of data being collected. This includes, to name a few, the data name, data description, ATA code, data type, sign, minimum value, maximum value, table look-up information for numeral data, and data collecting rate.
- Sets of raw data for each of the data collecting rate.

We have created a set of tools to decode the raw data and generate different reports for a given flight. The tool is capable of the following:

- Present all data for the given flight. Multiplex through data sets of all collecting rates. Recreate the time stamp for all recorded data and align them accordingly. For each piece of data, presents its detailed descriptions and collected values. All numeral data are replaced with the values from the look-up tables. All numerical data are checked for validity against their minimum and maximum values. Out-of-bound data are flagged.
- Given a data collecting rate, present the detailed descriptions for each piece of data and its collected values. All numeral data are replaced with the values from the look-up tables. All numerical data are checked for validity against their minimum and maximum values. Out-of-bound data are flagged.
- Given a data name, present its detailed descriptions and collected values. All numeral data are replaced with the values from the look-up tables. All numerical data are checked for validity against their minimum and maximum values. Out-of-bound data are flagged.
- Given a data name and a data type, decode the raw data according to the specified data type. This is useful if the given data detailed information might not be accurate.
- Generate report according to a specified data delimiter so the report can be imported into Excel, database, or other tools.

III. Meteorological Data

The National Oceanic and Atmospheric Administration (NOAA) maintains an internet-accessible hourly-updated repository of aviation weather reports from around the world. Specifically, the weather reports are called METAR reports. The word METAR is a contraction from MÉTéorologique Aviation Régulière, and FAA and NOAA define a METAR as an "aviation routine weather report," an approximate translation of the French. The URL of the web site is http://weather.noaa.gov/weather/metar.shtml.

All METAR reports received for the hour (Greenwich Mean Time, GMT) are placed in a file hhZ.TXT where hh is between 00 and 23. The files are updated approximately every five minutes as data become available. Reports may be duplicated within the files and multiple reports received from a station may appear in a file. SPECI reports are also included in the file. A report cycle has 60 minutes and starts from 45 minutes past the hour. Cycle files are deleted ten minutes before the start of the cycle; for example, the file 15Z.TXT will be deleted at 1435Z in preparation for receipt of new data. This means that data up to 23 hours old are available.

During our preliminary studies, we found that the NOAA METAR repository would continue to update a cycle file several hours past the corresponding cycle time. Thus, we constructed a tool based on Unix Shell scripts that downloads all 24 METAR cycle files every hour and save them before they are overwritten. The tool has the error

recovery capability to remedy any incomplete file download either due to network problems or due to the delay of receiving reports for prior hours. We started data downloading and processing in November 2006, and the activity continues to this day. There are approximately 1 Giga-bytes of raw data every month.

IV. Conclusion and Future Work

The current project has established a pipeline of in-flight data analysis, with an emphasis on the reconstruction of the touchdown events. Furthermore, we have developed the capabilities to store and process large amounts of operational data and meteorological data. The analysis pipeline and the data are essential to future studies of touchdown performance.

V. Acknowledgment

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