JAVA FRAMEWORK FOR PARAMETRIC AIRCRAFT DESIGN PERFORMANCE ANALYSIS MODULE

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Abstract

The aim of this work is to provide a comprehensive overview about the development in Java of a library, named JPAD, dedicated to the preliminary design of an aircraft, focusing on the take-off and landing performance analysis modules. To validate the results of each module, two parametric aircraft models have been taken into account; one related to a regional turboprop similar to the ATR-72 and another related to a transport jet similar to a B747-100B. Tests upon each of these models have been performed in order to compare the obtained output with the performance data from the related flight manuals or public brochures.

The choice of the Java language derived from the following key points. This language is widely supported by Oracle and a huge community of developers so that the problem of having an obsolete library due to aging is avoided; the java language promotes the use of open source libraries which provide a very simple management of input and output tasks as well as complex mathematical operations; furthermore, the language and the companion IDE provide a widely supported GUI framework and a GUI visual builder. Finally, the language promotes modularity so that is easier to work with an ever changing team.

The calculation of the take-off and landing distances have been implemented using a simulation-based approach. This expects to solve an appropriate set of ordinary differential equations (ODE), which describes the aircraft motion during all these phases, giving as input a specific time history of the angle of attack. In this case Java has proven to be very performing as it allowed to use dedicated external libraries from the Internet which provided a fast and accurate tool to solve a complex mathematical problem. The results obtained for the FAR-25 take-off and landing field length have been compared with the flight manual data of the two analysed aircrafts to validate the performed calculations; furthermore, a sensibility analysis has been carried out with the aim of comparing the JPAD output with the statistical field length at different values of two main design parameters: the wing loading W/S, for both take-off and landing, and the thrust ratio T/W, only for the take-off. The results obtained shown a difference with the flight manual data less than the 10% and less than the 5% if compared with the statistical trend.

ISA CONDITION / SEA LEVEL	FLIGHT MANUAL	JPAD	DIFFERENCE (%)
ATR-72 TO FAR-25 FL	1300 m	1404 m	≈ 7%
B747-100B TO FAR-25 FL	3080 m	2761 m	≈ 10 %

ISA CONDITION / SEA LEVEL	FLIGHT MANUAL	JPAD	DIFFERENCE (%)
ATR-72 LND FAR-25 FL	1067 m	1146 m	≈ 7%
B747-100B LND FAR-25 FL	1930 m	2015 m	≈ 4%

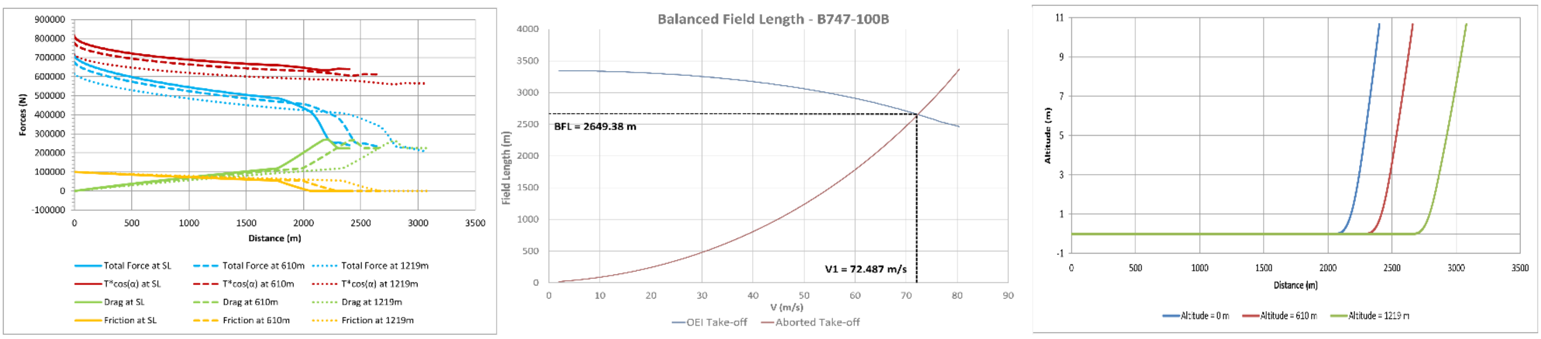

Figure 1 –Evolution of forces acting on the aircraft in take-off (left), balanced field length evaluation (right) and take-off trajectory at different field altitudes (down) for the B747-100B.

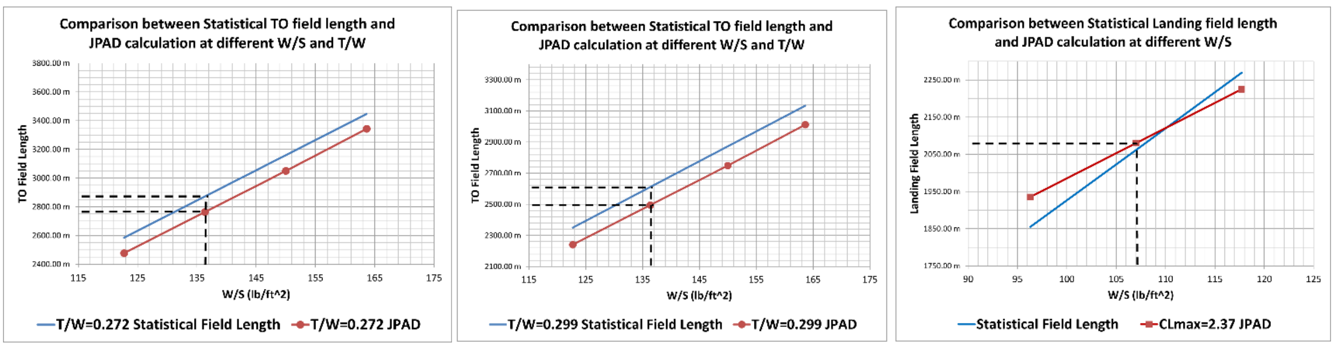

Figure 3 –Comparison between JPAD take-off and landing field lengths and the statistical trend at different W/S and T/W (only for take-off).

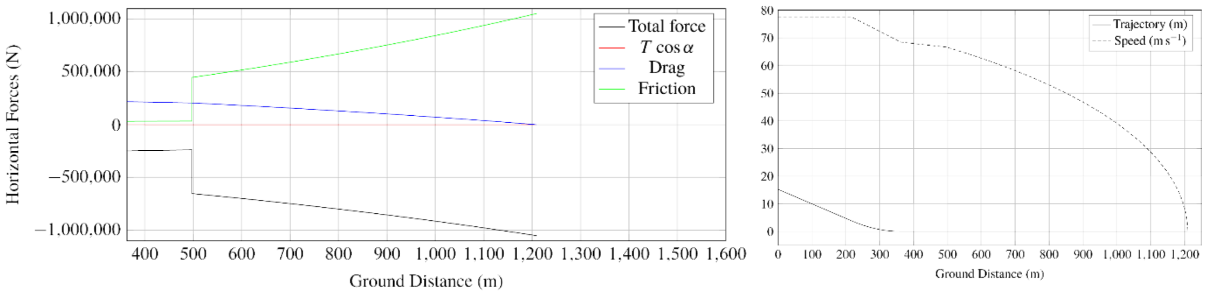

Figure 4 – Evolution of forces acting on the aircraft during the landing phase (left), landing trajectory and speed evolution (right).