

Simulation of a passenger aircraft flight with the wing tip cut using aerodynamics with full separation

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Abstract:

Purpose – The aim of this paper is to present the result of simulations using high angles of attack including total flow separation that were performed to assess the uncontrolled motion of the passenger aircraft following its wing tip was suddenly cut. Such the simulation can help to understand the tendencies of aircraft behaviour after wing tip cut, assess how fast this phenomenon is going on and estimate the values of angles of attack, sideslip and pitch angle basing on given aerodynamic characteristics. Also, answer the question if pilot is able to counteract high deviations from flightpath initially planned during the final phase of approach to landing.

Design/methodology/approach – Simulation is based on the full nonlinear equations of motion at high angles of attack including total flow separation derived from generalized equations of change of momentum and moment of momentum of rigid body. Dynamic Equations of Motion in the so-called normal mode are solved in the so-called stability frame of reference.

Findings – It was found that asymmetric rolling moment must be compensated by essential increase of pitching moment. Moreover it appeared that aircraft goes into high angles of attack and high pitch angle and therefore for reliable simulation the available aerodynamic characteristics must include angles of attack till 90 degrees when total flow separation occurs.

Practical implications – For accurate simulation it is strongly recommended to perform first the wind tunnel testing in the range of $+20^\circ \div 120^\circ$ and use it in flight simulation.

Originality/value – The presented methodology is an original for numerical simulation of flight trajectory during the final phase of approach to landing in a hazardous state of flight. For reliable simulation the available aerodynamic characteristics must include angles of attack till 90 degrees when total flow separation occurs, whereas usually maximum angles of attack used in wind tunnel experiments for passenger aircraft are not higher than 25 degrees. The influence of limited range of experimental data on results of simulation is another value which can be adopted in the future investigations of hazardous states of flight.

Keywords hazardous states of flight, nonlinear equations of motion, flight simulation, FEA

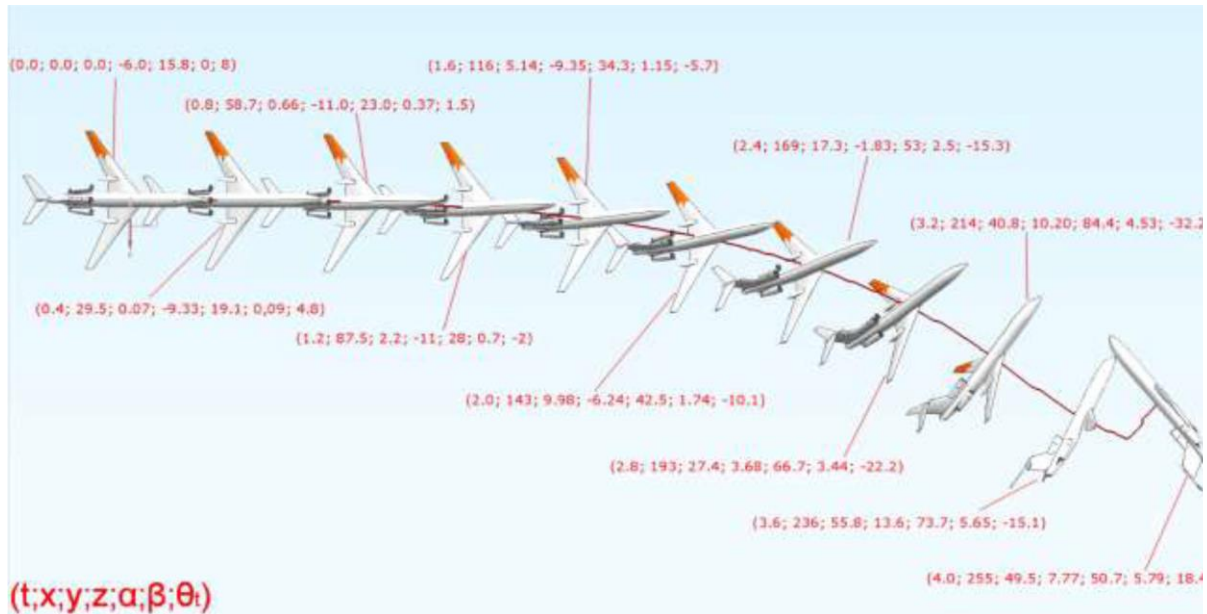


Figure 1 Flight trajectory – top view (DOI [10.1108/AEAT-12-2020-0294](https://doi.org/10.1108/AEAT-12-2020-0294))

Selected references:

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