Control in curvilinear approach to landing

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Abstract:

Increasing use of transport and various air services, including the inclusion of unmanned aircraft in controlled traffic, poses new challenges in the organisation of air traffic, especially around airports, and airport network. At the same time, modern navigation systems and automatic control systems provide opportunities for the development of new flight and take-off and landing procedures. The use of curvilinear rather than straight line trajectories in certain situations can increase an airspace capacity and create new opportunities of an airport localization. The presented paper addresses the use of non-linear trajectory in the process of approach and landing of an aircraft. A non-linear part of the trajectory of the approach, during which the altitude decrease, reduces the range of air traffic influence, e.g. by noise, in the airport environment.

Effective implementation of such kind of control method depends on the proper development of a trajectory enabling the aircraft to safely be brought to a touchdown point and the design of control algorithms taking into account the possibility of go around in the case of the event of adverse conditions preventing its safe continuation. Achieving a repeatable trajectory of a non-linear approach, as is obtained in the standard straight line approach procedure, is a more difficult task. The proposed solution is an automatic control system that controls the flight along the approach trajectory segments by position and attitude stabilisation and it also maintains the assumed flight speed. Automation ensures predictability of the behaviour of the landing aircraft.

The developed control system implements the control process in a multi-layer structure. The outer layer is the master decision-making system, which defines the parameters of the subsequent segments of the approach trajectory and assesses the correctness of the implementation of the flight. The inner layers consist of controllers that stabilize the flight speed, position on the trajectory and aircraft attitude. The master system defines the structure in which the controllers work and their characteristics according to the requirements of the control in each phase of the flight. Verification of the operation of the developed algorithms is carried out in simulation studies where the control system controls the simulation model of the aircraft. The simulation results in the interception of approach trajectory, approach control, final landing procedure and runway movement show the effectiveness of the designed procedure. In addition, the introduction of selected disturbances shows the extent of the possibility of suppressing interference and the implementation of approach abort and go around procedures in situations where safety thresholds are exceeded. The attitude and components of the aircraft's speed during touchdown and the response forces of the landing gear are used in landing correctness analysis.