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Landing Performance Improvement Using Genetic Algorithm for Electric Vertical Take Off and Landing Aircrafts

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Abstract : In order to improve commute time for small distance trips and relieve large cities traffic, a new transport category has been the subject of research and new designs worldwide. The air taxi travel market promises to change the way people live and commute by using the concept of vehicles with the ability to take-off and land vertically and to provide passenger's transport equivalent to a car, with mobility within large cities and between cities. Today's civil air transport remains costly and accounts for 2% of the man-made CO_2 emissions. Taking advantage of this scenario, many companies have developed their own Vertical Take Off and Landing (VTOL) design, seeking to meet comfort, safety, low cost and flight time requirements in a sustainable way. Thus, the use of green power supplies, especially batteries, and fully electric power plants is the most common choice for these arising aircrafts. However, it is still a challenge finding a feasible way to handle with the use of batteries rather than conventional petroleum-based fuels. The batteries are heavy and have an energy density still below from those of gasoline, diesel or kerosene. Therefore, despite all the clear advantages, all electric aircrafts (AEA) still have low flight autonomy and high operational cost, since the batteries must be recharged or replaced. In this sense, this paper addresses a way to optimize the energy consumption in a typical mission of an aerial taxi aircraft. The approach and landing procedure was chosen to be the subject of an optimization genetic algorithm, while final programming can be adapted for take-off and flight level changes as well. A real tilt rotor aircraft with fully electric power plant data was used to fit the derived dynamic equations of motion. Although a tilt rotor design is used as a proof of concept, it is possible to change the optimization to be applied for other design concepts, even those with independent motors for hover and cruise flight phases. For a given trajectory, the best set of control variables are calculated to provide the time history response for aircraft´s attitude, rotors RPM and thrust direction (or vertical and horizontal thrust, for independent motors designs) that, if followed, results in the minimum electric power consumption through that landing path. Safety, comfort and design constraints are assumed to give representativeness to the solution. Results are highly dependent on these constraints. For the tested cases, performance improvement ranged from 5 to 10% changing initial airspeed, altitude, flight path angle, and attitude.

Keywords : air taxi travel, all electric aircraft, batteries, energy consumption, genetic algorithm, landing performance, optimization, performance improvement, tilt rotor, VTOL design
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