Student Research Project / Master Thesis

Payload Forecast for Responsive Satellite Launches via Air Launch Systems

GAIA Aerospace is currently investigating the launch procedure for air launch systems in more detail. Air launch systems have the advantage over vertical take-off launch systems that they can utilize high-altitude winds during launch. With a tailwind, the rocket can gain a few percent in maximum payload capacity due to the higher initial speed of the carrier aircraft. Similarly, headwinds can reduce the payload capacity and possibly prevent launches with fixed high payload masses. However, since high-altitude winds can vary greatly in terms of time and location, it is essential to include a reliable high-altitude wind forecast in mission planning.

Another advantage of air launch systems is that the launch site can be relocated at short notice. This means that if unfavorable wind conditions prevail in the launch corridor on the originally planned launch day, the departure airport and launch area can be relocated at short notice with a precise high-altitude wind forecast. This capability is particularly important in the areas of responsive space and space-on-demand. For this reason, a tool for the forecast of maximum payload capacity as a function of high-altitude winds is to be developed as part of this work for various launch corridors in Europe.

For this purpose, the work is divided into the following steps:

1. Literature research on air launch systems, high-altitude winds, jet streams, wind forecast, artificial neural networks, particle filters and flight control of rockets
2. Definition of launch corridors in Europe as well as mathematical wind models, time- and location-varying wind fields and an approach for generating target trajectories
3. Implementation of current high-altitude wind forecasts, the wind model and the target trajectories in a predefined flight simulation in a Matlab/Simulink environment
4. Implementation of particle filters to identify the ideal trajectory and subsequent training of an artificial neural network to maximize payload capacity
5. Comparison of the time-varying payloads in the different launch corridors and critical analysis of the wind effects on the trajectories
6. Summary of the results and presentation of recommendations for action for a successful launch and further optimization potential for the tool

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Execution only after consultation of supervising university Institute