Design and Computational Analysis of a Wing-in-Ground Effect UAV

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Abstract
Wing-in-Ground (WIG) Effect Unmanned Aerial Vehicles (UAVs) utilize aerodynamic benefits that occur during low-altitude flight, significantly increasing lift and reducing induced drag. This preprint summarizes the design, CFD modeling, and aerodynamic analysis of a WIG UAV optimized for energy-efficient operation near ground level. CFD simulations demonstrate strong ground-effect lift augmentation and favorable flow characteristics near the surface.

1. Introduction

WIG UAVs operate close to the ground, where aerodynamic behavior changes significantly. This project investigates the aerodynamic performance of a fixed-wing UAV designed specifically to take advantage of ground effect. Visual analysis and preliminary CFD simulations were conducted to evaluate flow acceleration, lift behavior, and stability implications.

2. Methodology

The UAV was modeled using CAD tools and analyzed using CFD simulations. Boundary conditions included an inlet velocity of 30 m/s, an atmospheric outlet, and a no-slip ground plane. Multiple visualization angles were considered to understand near-ground flow behavior.

3. CFD Setup

A structured ground-effect CFD environment was used. Key considerations included:
- Inlet velocity: 30 m/s
- Ground plane: no-slip boundary
- Remaining surfaces: symmetry or slip

CFD results show strong flow acceleration and lift enhancement near the surface.

4. Results

The CFD simulations indicate:
- Increased lift due to ground proximity
- Stabilizing high-pressure regions forming near the wing root
- Clear visualization of flow acceleration in the ground-effect zone

5. Conclusion

The analysis demonstrates that the proposed WIG UAV design effectively leverages ground-effect aerodynamics for improved performance. Future work includes higher-fidelity OpenFOAM modeling, stability analysis, and autonomous navigation development.

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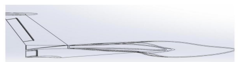
Abstract

Wing-in-Ground (WIG) Effect Unmanned Aerial Vehicles (UAVs) utilize the aerodynamic advantages that arise when an aircraft operates close to a surface, significantly increasing lift and reducing induced drag. This project presents the design, development, and performance assessment of a WIG UAV optimized for low-altitude, energy-efficient flight. This model provides a strong and energy-efficient aerodynamic platform, placed in dynamic low-altitude environments.

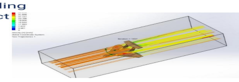
METHODOLOGY

Design anameturicel fluid dynamics UAV talleered for ground-effect analysis



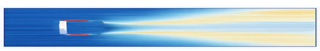
CFD SETUP

Use CFD mothodelling with a ground-effect analysis for 1
Remaining surfaces
No-stip wells
Inlet at 30m/s
outlet at atmosphere
Ground plane



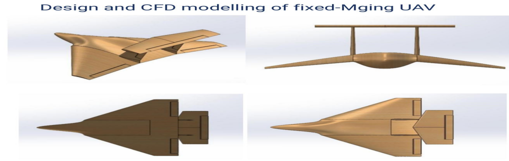
Results.

Provided: CFD simulations provclog flow accercelation near the ground n+ above the ground



Introduction

Design and CFD modelling of fixed-Mging UAV



Ground-Effect Aerodynamics

- High-pressure region forming into sitbillity and control analysis on high-pressure region.
- Positive lift augmentation in near-ground plane in protes near-ground renidor lifts.
- Develop control strategies for safe safe autonomous operations in SAR mission controls

Future Work

- Use OperOAM solvers for further CFUxation
- Develop stability and control strategies
- Px+ based autonomous navigation near theg ground
- Integrating SAR mission capabilities

CONCLUSION

CFD analysis conducted with optimall wing and flight configurations demonstrate

- Effective grounal effect utilization, an Px4 based solution
- Px4 based autonomous navigation near ground
- Integrating SAR mission capabilities