PURDUE UNIVERSITY | The Data Mine

STRATOLAUNCH

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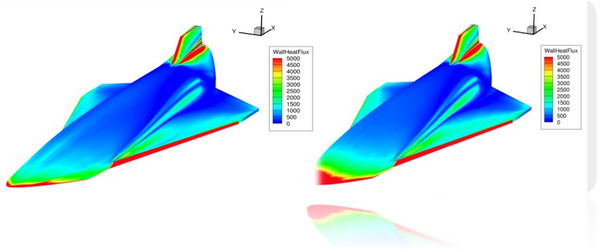
INTRODUCTION

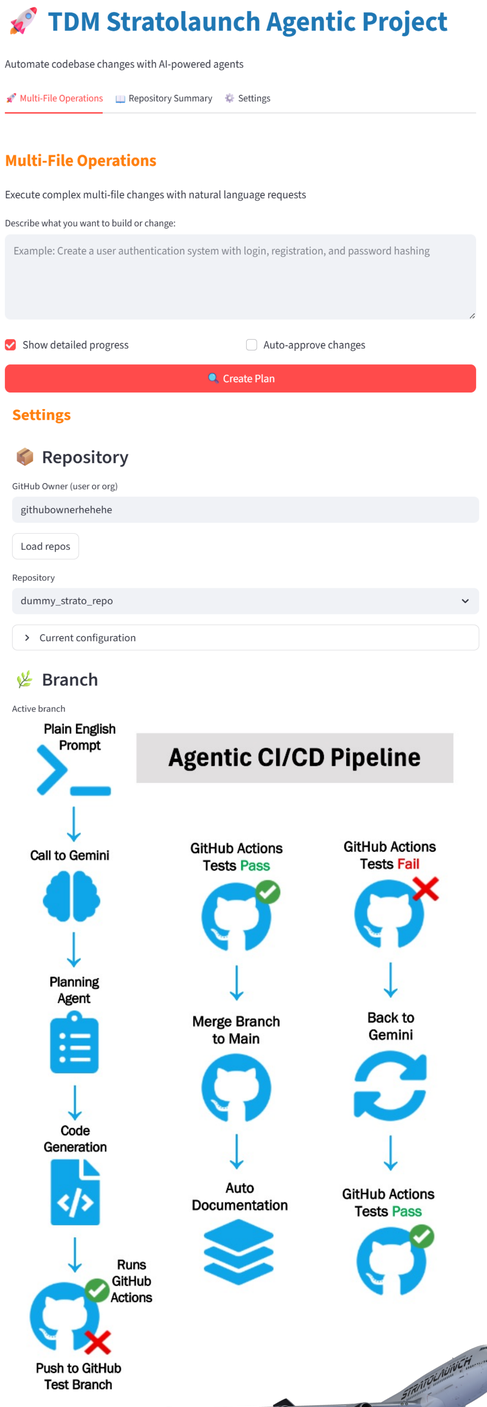
Stratolaunch is looking to modernize workflows and accelerate onboarding and other processes.
This year, we had four main tasks:

1) Develop an agentic framework to accelerate software development process.
2) Write three papers of different levels to help with new member onboarding.
3) Develop a neural network to help quickly and accurately determine the behavior of different airfoils.
4) Summarize research findings that Stratolaunch sponsored Purdue facilities to conduct

AEROSPACE RESEARCH

Experimental Investigation of the Talon-P Geometry in Mach 6 Quiet Flow
Researchers captured heat flux across the aircraft for three nosecone compression angles and three angles of attack. The 5.5-degree compression angle triggers distinct thermal effects, generating heat streaks that vary by angle of attack.
Talon-P: Multidisciplinary Design Analysis and Optimization Framework Using Low-Fidelity Models
Researchers developed an MDAO code loop with NASA OpenMDAO as a low-fidelity CFD model to reduce hypersonic design cycle time from weeks to minutes. This approach identified a superior nosecone geometry that increases Talon-A cruise time by 148.7 seconds, while also providing a graph of nosecone volume versus optimized cruise time.
Talon-P: CFD Simulations
By measuring heat flux using CFD simulations and wind tunnel data, researchers confirmed that the nose experiences the greatest heating during flight. Furthermore, changing the nose shape directly alters aerodynamic heating patterns.





AGENTIC PIPELINE

The team focused on creating an AI-powered CI/CD pipeline to resolve:

1) Manual code management
2) Scattered documentation in large repositories

The pipeline interacts with the user through an interactive interface.
Other components within the pipeline include:

1) A multi-agent framework built using LangChain
2) Agents for planning, coding, reviewing, testing, and integration - improving context management and stabilizing workflows with GitHub Actions
3) Automatic repository updates and README documentation

Built-in functionality allows the system to stage, commit, test, and push generated code changes. Pushed code is isolated in a separate branch, where the user can decide whether to merge it into the main branch.

CONCLUSION

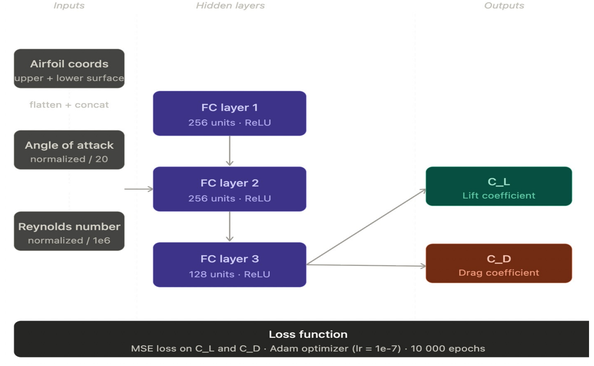
Agentic Pipeline:
The following pipeline has been created, this includes a working UI for the user to have the features to change their branches, documentation, repository, and to prompt for the following AI to change the following code.
Aerospace Engineering Research:
This work synthesized key finding from multiple Purdue x Stratolaunch papers to clearly communicate the capabilities of combining experimental data, CFD simulations, and low fidelity modeling as an effective approach to preliminary hypersonic design and predicting aerodynamic behavior
Neural Network:
This neural network is able to predict the lift and drag coefficients for a given airfoil and angle of attack using gradient descent and back propagation to update the weights in the neural network to produce more accurate results.

NEURAL NETWORK

This project implements a neural network designed to predict the lift and drag coefficients of an airfoil. A neural network trained to predict lift and drag coefficients from three key inputs:

1) Angle of attack
2) Reynolds number
3) Airfoil geometry — loaded from coordinate files, flattened into a vector, and normalized

All inputs are normalized to improve learning efficiency. The network is trained purely on data, using a standard loss function to compare predictions against known values and an optimizer then adjusts the weights over many epochs to reduce error. Over time, the model learns the relationship between geometry, flow conditions, and aerodynamic performance. Once trained, it can predict lift and drag coefficients for new inputs, enabling significantly faster aerodynamic analysis than traditional methods.



FUTURE GOALS

1) The Agentic team would like to add model flexibility, in addition to Gemini, so code can be generated with more than one model.
2) The aerospace engineering research group's future work will focus on deeper analysis of hypersonic methods and the testing of the Talon-P architecture within CBAero, a software tool for the prediction of aero-thermodynamic environments.
3) The Neural Network team would like to experiment with multiple airfoils and have it provide comparisons on performance between the two airfoil sets.

REFERENCES & ACKNOWLEDGEMENTS

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