Final Year Project Proposal

TU857

AeroCast: Machine Learning-Based Turbulence Forecasting for Passenger Comfort

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10 October 2025

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Declaration

I hereby declare that the work described in this dissertation is, except where otherwise stated, entirely my own work and has not been submitted as an exercise for a degree at this or any other university.

Signed:

*Casey Edwards Lawrence*_____

Casey Edwards Lawrence

10/10/2025

Summary

This project proposes to develop a passenger-oriented turbulence/comfortability prediction application designed to forecast the likelihood and intensity of turbulence for commercial flights. The system will allow users to input a flight number or route to obtain a turbulence forecast presented through clear visualisations and descriptive summaries.

While airlines and pilots have access to turbulence data, passengers do not. Many people experience anxiety about flying, especially during turbulence. This app aims to make aviation data accessible and understandable to the public, using predictive analytics and visual tools to present forecast in a clear non-technical way (Navigating Turbulent Skies with Certainty, 2025).

A few existing platforms, such as Turbli, have demonstrated that it is possible to present turbulence forecasts to the public, however these are primarily data dissemination rather than ux. This project aims to bridge that gap by combining predictive modelling with an intuitive and informative UI tailored to non-technical people.

The proposed system will collect meteorological and flight related data vis open- source APIs and use machine learning techniques trained on historical datasets to generate turbulence predictions (Zhuang, Hui, Pak-Wai, Hongda, & Zheng, 2023) (Lee, Soo-Hyun, Yoo-Jeong, & Kim, 2023).

Background (and References)

Air turbulence happens when air moves in irregular and unpredictable ways because of things like jet streams, convection, mountains, buildings, or thunderstorms. Although turbulence is rarely dangerous, it is the main reason for in-flight injuries and makes many passengers feel anxious.

New technology and better access to data have made it possible to create systems that forecast turbulence. For instance, Turbli uses open data from the National Oceanic and Atmospheric Administration (NOAA) to offer turbulence forecasts to the public. Research shows that machine learning models like Random Forests and LSTM networks can predict turbulence more accurately than older, physics-based methods (Zhuang, Hui, Pak-Wai, Hongda, & Zheng, 2023).

Studies in human-computer interaction and aviation psychology show that clear visuals and helpful explanations can lower flight anxiety. This project aims to combine machine learning turbulence predictions with user-focused design to make forecasts more reliable and improve the passenger experience. The system will give passengers easy-to-understand and trustworthy information about turbulence on their flight, helping them feel more confident and comfortable before they travel (Yildiz, 2024).

A calendar-based turbulence model could help anxious passengers choose the best times to travel by using past turbulence data for their destinations.

Proposed Approach

1. Research

The initial phase will focus on building a comprehensive understanding of turbulence prediction methodologies, aviation meteorology, and relevant machine learning techniques. I will review academic literature to evaluate existing forecasting models and the use of machine learning approaches such as Random Forests (Williams, 2014) and Long Short-Term Memory. Further research will include existing platforms as mentioned before Turbli to understand how they present turbulence data to the public. As well as revising my Human Computer Interaction module, and some studies on UX design for anxiety-reducing applications. This research will guide both the technical and psychological design aspects of the project ensuring the solution is feasible, ethical, accessible and user focused.

2. Requirements Gathering

This phase will involve identifying functional and non-functional requirements for the system and the end user. The target group will be the passengers, particularly nervous or anxious fliers. Feedback will be collected through online surveys and interviews to determine user preferences for information presentation, visualisations, and comfort features. From a technical point of view requirements will include data sources (open meteorological APIs such as NOAA and Open Weather), data processing and infrastructure considerations for model training and prediction delivery.

3. Analysis and Design

Based on requirements, I will develop system architecture and uml/ data flow diagrams to illustrate how the application will process data to produce turbulence forecasts. The design will emphasize simplicity and clarity using clean/clear visualisations and colour coded comfort indicators. I will design the backend to collect weather and flight route data; process it using a predictive model and display the results on the frontend. The UI and UX design will follow principals based on HCI research to promote reassurance and ease of understanding.

4. Implementation

Following the design stage, we will progress to implementation. Before development begins research will be conducted into suitable frameworks and technologies to determine the most appropriate tools for the system. The selection of technologies will be based off the findings of the research stage ensuring that the chosen approach is feasible and effective. The implementation stage will be devised into two stages, the first will focus on developing a prototype to demonstrate the systems main functionality and design concept, the prototype will allow for early feedback and refinement. The second stage will focus on building the application to the best of my ability and within the given time. Development will follow an iterative process, allowing for continuous integration, continuous development, ongoing testing, and improvement throughout.

5. **Testing and Evaluation**

   The final stage will involve testing and evaluation. Functional testing will ensure the system operates as expected with reliable data handling and accurate forecasts. Unit tests will be carried out iteratively throughout development to ensure all parts are compatible with each other. Usability testing will be carried out with a sample of users to gather feedback on clarity, design and user experience. Evaluation will assess how effectively the application achieved its purpose.

Deliverables

My project deliverables consist of a combination of research outputs, design documentation, and a functional software application, all combined into a single dissertation.

- **Research**

  A research section in my dissertation will outline the findings from the initial literature review and market analysis. This will include background information on turbulence prediction, existing aviation data systems, and user-centred design principles relevant to communicating flight comfort information.

- **Requirements Specifications**

  Documentation of functional and non-functional requirements for the system will be included in my dissertation and be the basis of development.

- **System Design**

  Conceptual designs including data flow diagrams, system architecture layouts and user interface prototypes will be developed, illustrating how turbulence data is processed and presented to users.

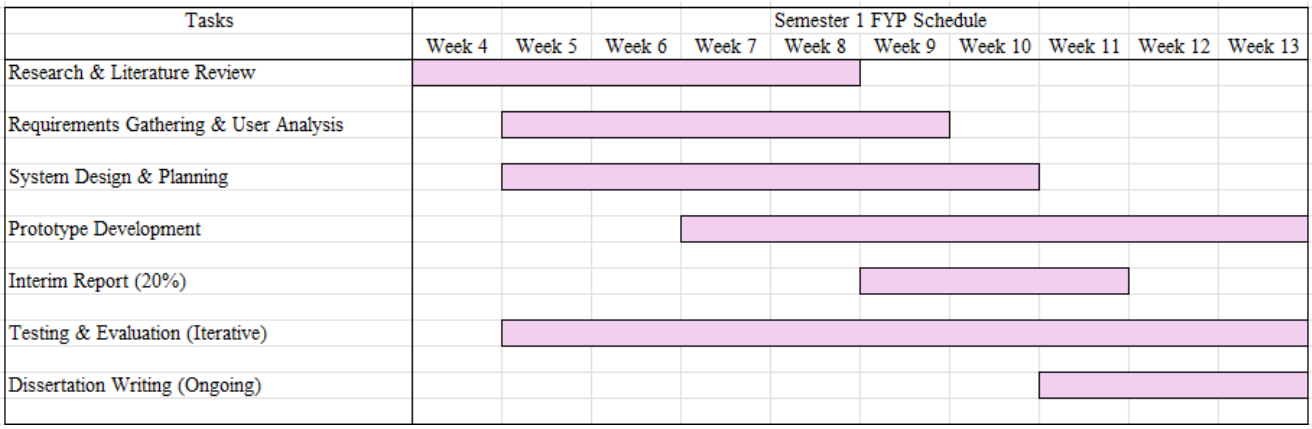
- **Prototype**

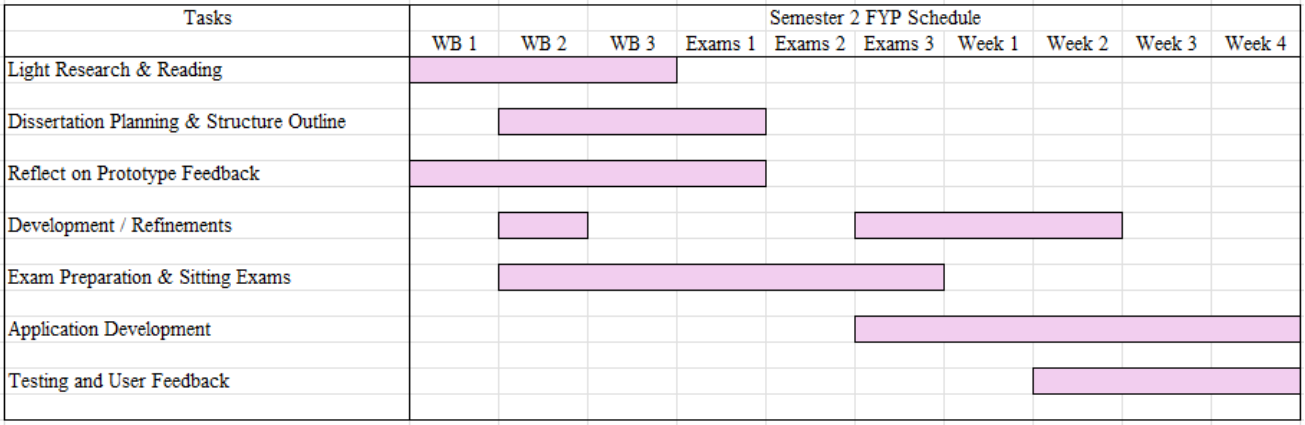
  An initial prototype demonstrating the core functionality and interface design enabling early testing and validation of concepts, will be ready for end of semester one submission.

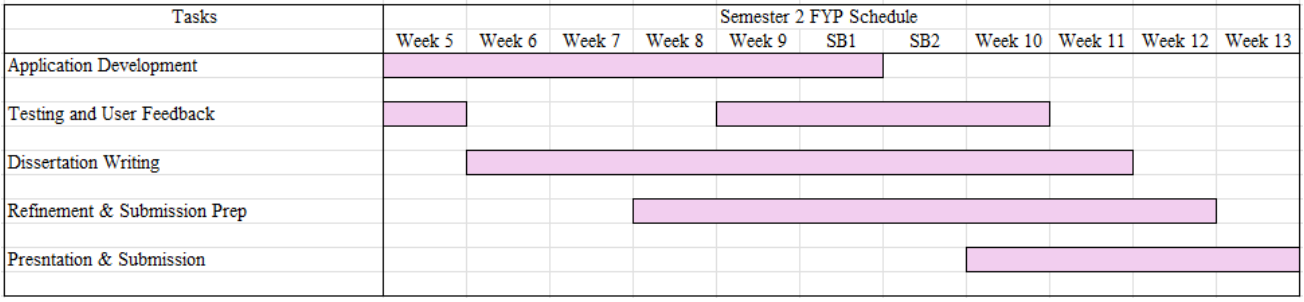
- **Functional Application**

  My goal is to have a complete version of the turbulence prediction application, developed to the best of my ability and within the timeframe of the final year, allowing users to input a flight number or route and receive turbulence forecasts through clear visualisations and summaries.

Project Schedule







Technical Requirements

Hardware:

Development and testing will be conducted on my personal computer to support local data processing, model training and visualisation tasks. Access to a stable internet connection is also essential for obtaining live and historical flight and weather data.

Software:

Initially standard tools such as Microsoft word and excel will be used for documentation and data management. Software for design, such as LucidChart will be used to model the system architecture and data flow.

Once research on suitable technologies is completed, implementation will proceed using whichever development environment, programming languages and framework best align with the project's goals. Version control will be maintained through GitHub.

Infrastructure:

The system will initially be developed and tested in a local environment; however, cloud resources may be considered if time permits. Publicly available aviation and meteorological APIs or open datasets will be integrated.

Conclusion

This project aims to create an app that helps passengers predict turbulence and feel more comfortable when flying. Unlike airlines and pilots, passengers do not have a tool to check turbulence before their trips. With this app, users can enter a flight number or route and get easy-to-understand forecasts using clear visuals and simple summaries.

The project will start with research and gathering requirements, then move on to building a working prototype. This prototype will show the main features and design. After that, the app will be fully developed using the best technologies found during research. Testing and feedback from users will help make sure the app is easy to use and reliable.

The final results will be a working app, built-in visuals showing turbulence predictions, and a detailed report covering the research, design, development, and testing. This project stands out because it gives passengers information they do not have now, making travel planning easier and more comfortable.

References

Gallego-Marcos, I. (n.d.). Retrieved from https://turbli.com/about/

Lee, Y., Soo-Hyun, K., Yoo-Jeong, N., & Kim, Y.-H. (2023). Deep Learning–Based Summertime Turbulence Intensity Estimation Using Satellite Observations.

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Williams, J. K. (2014). Using random forests to diagnose aviation turbulence. *Machine Learning*, 51-70.

Yildiz, E. (2024). Advancing Aviation Through Human-Computer Interaction: A Focus on Safety, Efficiency, and Performance. *Journal of Aerospace Science and Management*, 81-95.

Zhuang, Z., Hui, Z., Pak-Wai, C., Hongda, T., & Zheng, D. (2023). A Machine Learning-Based Model for Flight Turbulence Identification Using LiDAR Data.

Appendix A: First Project Review

Title: Predicting YouTube Category Growth Using Machine Learning – Final Project Report

Student: Sanat Thukral

Description: This project developed a web application designed to predict the growth of YouTube categories based on viewing trends. Using regression-based machine learning models, the system analyses data and tests predictions against data obtained from YouTube services. It is designed as an analytical tool for creators to track and compare category performance over time.

What is complex in this project: The Complexity of this project is in combining multiple technologies and methodologies across different areas such as web development, machine learning and cloud computing. The student had to build and train a regression model, process large data sets, ensure smooth integration between python-based ML component and a java script web stack and manage the deployment of a cloud hosted web application.

What technical architecture was used:
The project adopts a full stack web architecture integrating machine learning capabilities.

Frontend: NextJS with TypeScript
Backend: Python and MongoDB
Machine Learning Algorithm: Random Forest
Hosting: Heroku and FastAPI
Data Sources: Kaggle and DeepNote to automate getting YouTube current data.

Explain key strengths and weaknesses of this project, as you see it.

Strengths:

- The project delivered a comprehensive full-stack solution that integrated machine learning and web technologies,
- The project combined static data from Kaggle and live data for model evaluation.
- A well-structured approach was implemented for data visualisation, deployment and visualisation.

Weaknesses:

- The reliance on third party APIs introduces potential instability in APIs if they change.
- Scalability and long-term deployment considerations are not explored in detail, which limits the projects potential real-world robustness

Appendix B: Second Project Review

Title: Disease-Prediction Mobile App

Student: Diogo Cardoso Lessa Carmo Reis

Description (brief): An Android mobile app that predicts a patient's disease based on symptoms entered by the user. The app uses an AI-powered chatbot with NLP to interact with users, ask follow-up questions if needed, and match symptoms to diseases from a dataset. The goal is to provide patients with guidance on potential health issues.

What is complex in this project:

- Integrating NLP chatbot functionality to interact naturally with users.
- Designing an accurate prediction model that can handle incomplete or vague symptom input.
- Combining AI/machine learning with a mobile UI (Flutter + Python) in a seamless way.
- Handling multiple datasets for symptoms, precautions, and disease severity ratings.

What technical architecture was used:

Frontend: Flutter
Backend: Python
Machine Learning: Random Forest

Explain key strengths and weaknesses of this project, as you see it.

Strengths:

- Combines user-friendly mobile interface with AI chatbot.
- Integration of Python and Flutter allows powerful AI logic while maintaining good UI.
- Practical, real-world application.

Weaknesses:

- Accuracy depends on completeness of the dataset.
- Might struggle with rare symptoms that aren't well represented in the data set.
- Potential ethical concerns with providing medical predictions.

Appendix C: Prompts Used with ChatGPT

“Is this a good idea for my final year project for computer science infrastructure? This project proposes to develop a passenger-oriented turbulence/comfortability prediction application designed to forecast the likelihood and intensity of turbulence for commercial flights. The system will allow users to input a flight number or route to obtain a turbulence forecast presented through clear visualisations and descriptive summaries.

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The proposed system will collect meteorological and flight related data vis open- source APIs and utilise machine learning techniques trained on historical datasets to generate turbulence predictions. “

” Based on that summary I gave you, could you help me name the project/application.”

“Do these deliverables seam realistic.
Deliverables

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Appendix D: