Automated Turbulence Detection, Analysis and Remote Viewing

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I. Motivation

Flight planning is a routine task done by all pilots to map out their flights. In the flight planning process, pilots must taken into account the comfort and safety of crew and passengers which can be largely impacted by in-flight turbulence. Between 2002 and 2016, the Federal Aviation Administration reported 563 accounts of injury to passengers or crew on air carriers due to turbulence (Duquette 2017). To relay information about turbulence, pilots must verbally submit a pilot weather report, or PIREP, over radio to the nearest ground station. Then, turbulence information may solicited from air traffic control upon a pilot's request. The result is an inefficient and unreliable flight planning process that produces uncomfortable and potentially dangerous flights due to turbulence. While some flight planning applications like ForeFlight can display PIREPs geographically with weather-condition-specific icons, currently, no technology gathers real-time sensor data from aircraft to produce a flight map showing turbulence-affected zones. Due to the unpredictability of turbulence, applications cannot supply reliable turbulence information, resulting in the reliance on in-flight plane reports. The client wishes to solve this problem by offering pilots and air traffic control an automated display of turbulence data based on real-time information which allows pilots and air traffic control to develop new flight paths in order to avoid turbulence. Table 1 summarizes the problem statement that our product will address.

Table 1. The Problem Statement

The problem of	An inefficient and error-prone system which requires pilots to report turbulence over radio frequencies to air traffic control who bears the responsibility of recording reports and disseminating turbulence information to aircrafts.
affects	General aviation and commercial pilots, passengers, air traffic control, and actors in the aviation industry.
the impact of which is	Accidents and sub-optimal flight comfort due to turbulence and inefficient flight paths, both financially and in terms of time.
A successful solution would be	A system which collects turbulence information from sensors of in-flight aircrafts and continuously uses the real-time turbulence data to provide pilots with a visual display of turbulence-affected flight zones through an interactive application.

There is a multitude of flight planning applications currently available, including ForeFlight, FlightAware, and iFly FPS, that are available on different platforms including iOS, Android, Windows and the web. As mentioned above, these applications only allow users to enter a desired flight path and show weather conditions and other charts based on the present time data. However, none display turbulence-affected flight zones on a map from real-time data

collected from aircraft sensors. To reach a wide user base, we plan on making our product a general-purpose cross platform web application, so both general aviation and commercial pilots and air traffic control can utilize it. Table 2 further summarizes our product position.

Table 2. Product Position

For	General aviation and commercial pilots and air traffic control
Who	Plan, advise, and execute flight paths
Our System	Cross platform web application using a framework
That	Allows pilots to avoid turbulence-affected flight zones
Unlike	ForeFlight, FlightAware, iFly GPS, AOPA GPS, Garmin GPS Avionics, ATC radar systems
Our Product	Provides real-time turbulence information and displays turbulence-affected flight zones

II. Users

The target end users of our application are general aviation and commercial pilots. Currently, there are only a few resources available to a pilot for dealing with turbulence. Before taking off, they can obtain a standard briefing which contains forecasted turbulence data. During the flight, pilots can obtain turbulence reports from air traffic control. These reports come from other pilots who have encountered turbulence along their flight routes and chosen to report this information to a local ground station. While the practice of reporting potentially dangerous weather conditions is recommended, it is not required. According to the National Transportation Safety Board, few PIREPS are submitted in comparison to overall aircraft traffic volume (“Improving Pilot Weather Report” 2017).Thus, these intermediaries prohibit pilots from receiving the most current information regarding turbulence. While the current means of relaying turbulence information does assist pilots in making educated decisions in regards to their flight safety, more consistent information can help pilots more quickly and effectively.

We are assuming our users will have different degrees of flight and technological experience, so user-friendliness, ease of use and accessibility will be of utmost importance to us. Our users would foremost expect for the application to clearly display flight turbulence for the pilot to avoid as the primary concern of a pilot is always safety. They would also expect for the application to update regularly so they can view real-time data on turbulence to makes flight decisions in case of dangerous conditions. Finally, they would expect for the application to be stable and responsive in the case of a loss of data or other unpredictable conditions in a consistent manner without issues.

III. Constraints

When developing a solution to this problem, we must take into account a number of constraints. The functionality of the application depends on collecting turbulence-related data. If connectivity is slow or lost, the data may not be consistently updated. Thus, a lack of up-to-date data may reveal itself to be a constraint.

While our product will initially use simulated turbulence data for testing, some important factors to consider for real-flight scenarios are the consistency of the product's behavior and its ability to handle a loss of connection. If the application acts inconsistently, it may be prone to make decisions that pilots will not trust. Additionally, the application must handle the case where data is unavailable. It must still provide turbulence data but alert the pilot that poor connectivity may result in an inaccurate or delayed information. Although pilots are trained not to rely on electronic devices for navigation or turbulence information, the product should be consistent with their standard procedure when suggesting actions to take.

Since we will be building a cross platform web application, we have no hardware dependencies. Additionally, there are no costs to consider for our product at this time.

IV. Works Cited

Duquette, Alison, and Les Dorr. “Fact Sheet – Turbulence.” *Federal Aviation Administration*, Federal Aviation Administration, 19 Apr. 2017, www.faa.gov/news/fact_sheets/news_story.cfm?newsid=20074.

Improving Pilot Weather Report Submission and Dissemination to Benefit Safety in the National Airspace System. Washington, D.C.: National Transportation and Safety Board, 29 March 2017. https://www.ntsb.gov/safety/safety-studies/Documents/SIR1702.pdf.