ENHANCING FLIGHT NAVIGATION MECHANISM FOR OPTIMAL ROUTE PLANNING AND RISK MITIGATION

CREATIVE MINDS

May 25, 2024

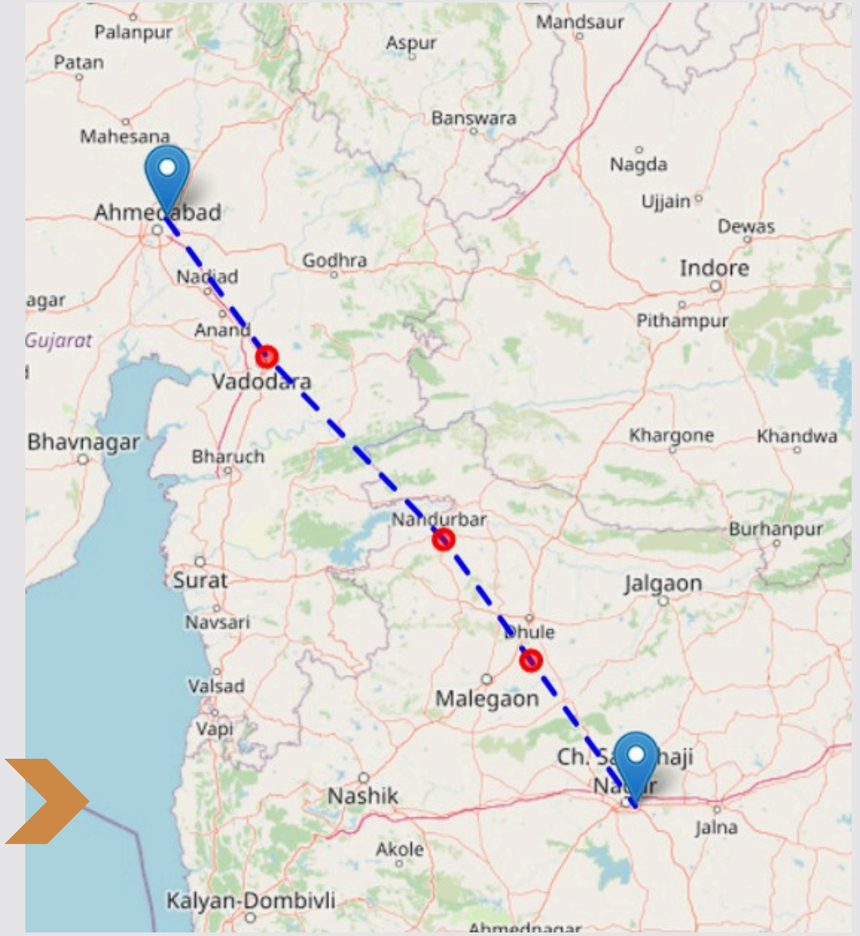
Problem Statement

Goal

- Design, develop, and implement a robust software solution for identifying optimal flight paths.
- Provide real-time risk assessment and alternative route suggestions.
- Integrate real-time health metrics tracking from flight sensor data.

Factors Taken into account

- Shortest Path
- Weather code
- Precipitation (Turbulence)
- Wind Speed (Stability)
- Relative Humidity (Static electricity)
- Temperature (Engine Efficiency)
- Rain
- Snowfall
- Cloud Cover (Visibility)



Tech Stack

Frontend

Languages
HTML ,CSS, JS,Tailwind

Frameworks
React, Node,Apache Kafka

Tools
Vs code, Github

Backend

Languages
Java , SQL

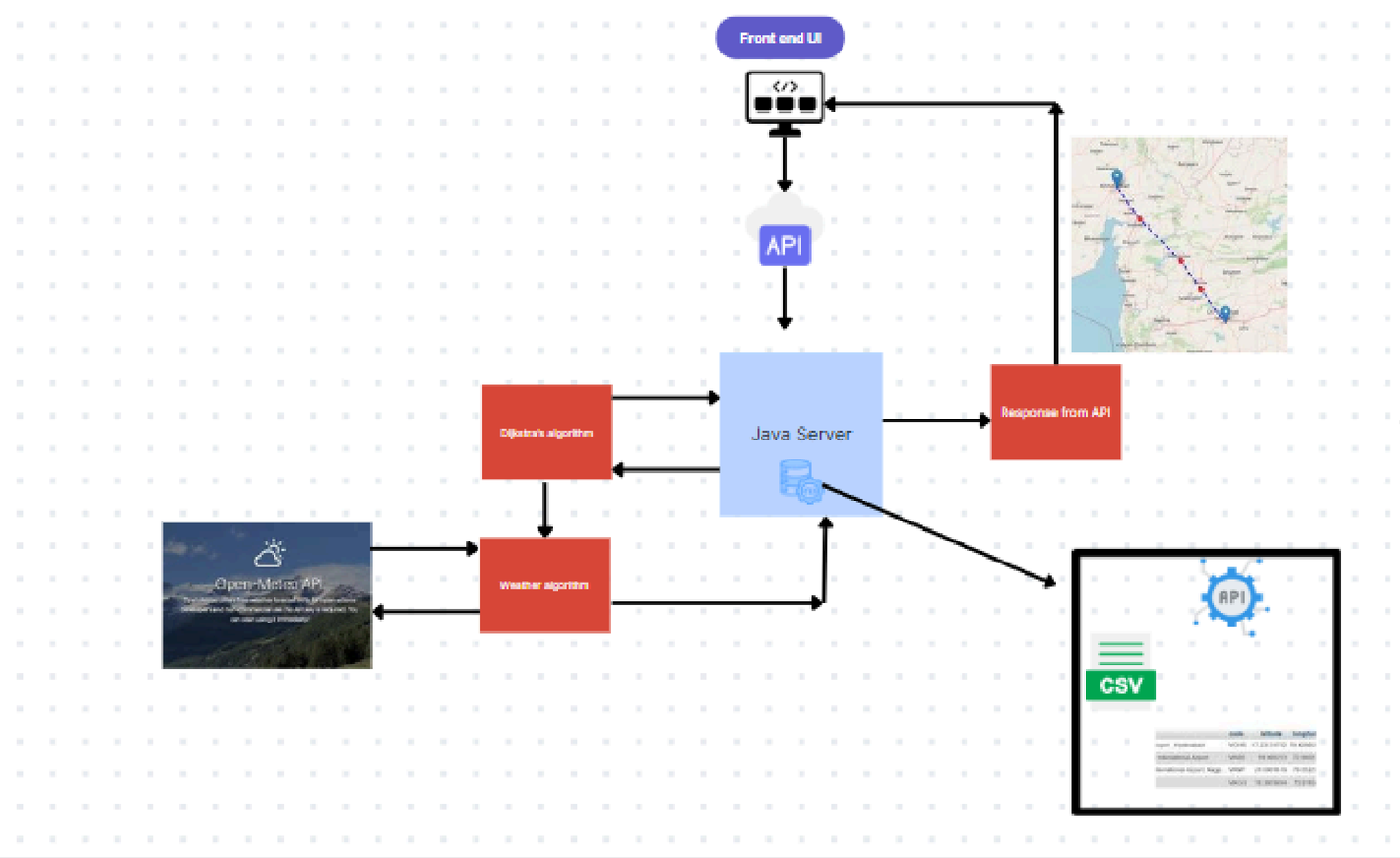
Frameworks
Spring Boot, Spring Data JPA, Junit

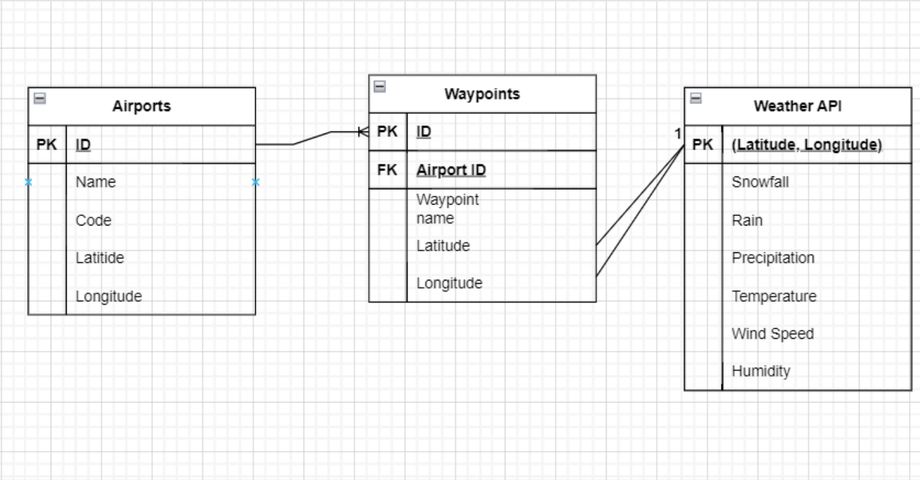
Database
MySQL

Tools
Postman, Eclipse, XAMPP

Other
REST API

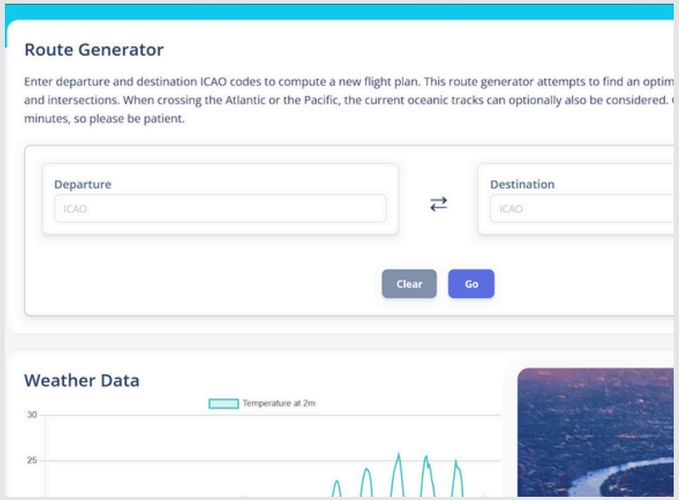
Architecture and ERD

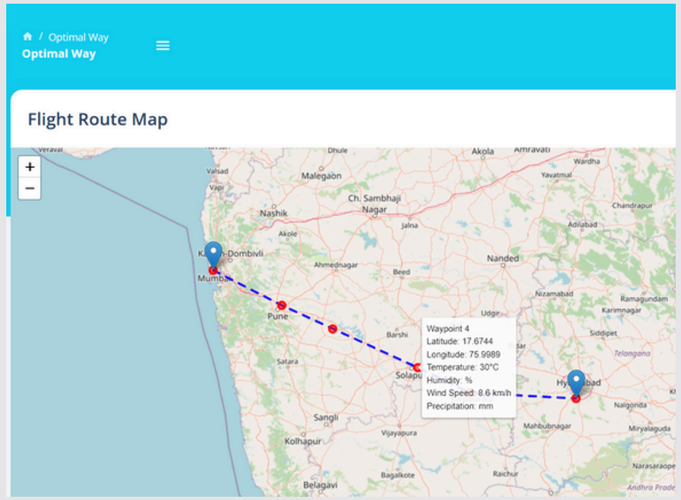


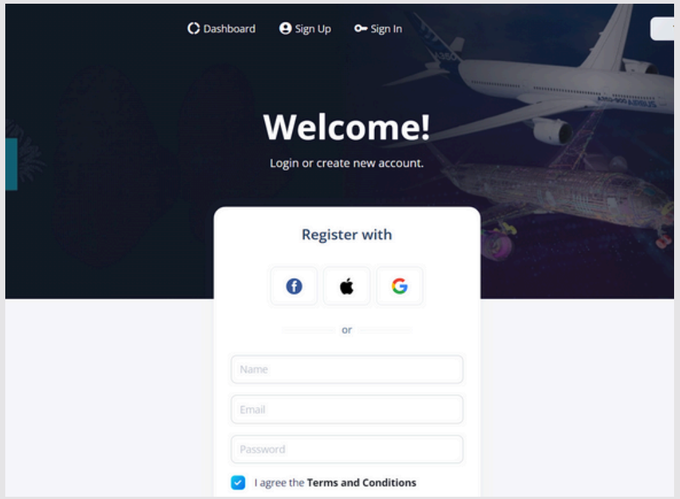


Features

- Real Time Route Planner based on weather and three different popular algorithms and logic which includes Dijkstra's algorthm, Haversine algorithm and waypoint logic created by us.2018 : Expansion into new markets, establishing a global presence in Arrowwai.
- Real time weather data from open meteo api

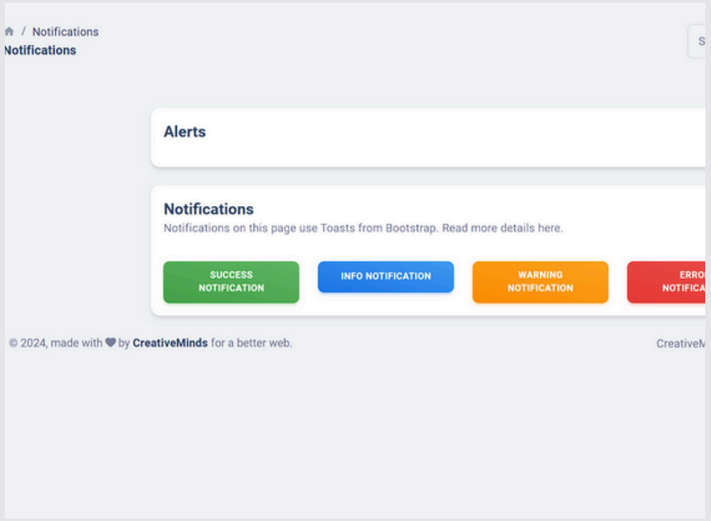






Features

- Flight Maintenance Dashbaord with notifcations to track information about flights .
- Real time data from flight sensor which include fuel consumption, Pressure, ETG readings.
- Information about flight map curent flight and summary of flights over a month.



Use Case

There are multiple use case for our project out of which five key use cases that are essential for modern aviation management: real-time weather data, flight optimal route through waypoints, flight optimal route based on weather, flight maintenance dashboard, and flight metrics dashboard

- **Real time weather data**
- **Flight Optimal Route through waypoints**
- **Fight Optimal Route based on weather**
- **Flight Maintence Dashbaord**
- **Flight Metrics Dashbaord**

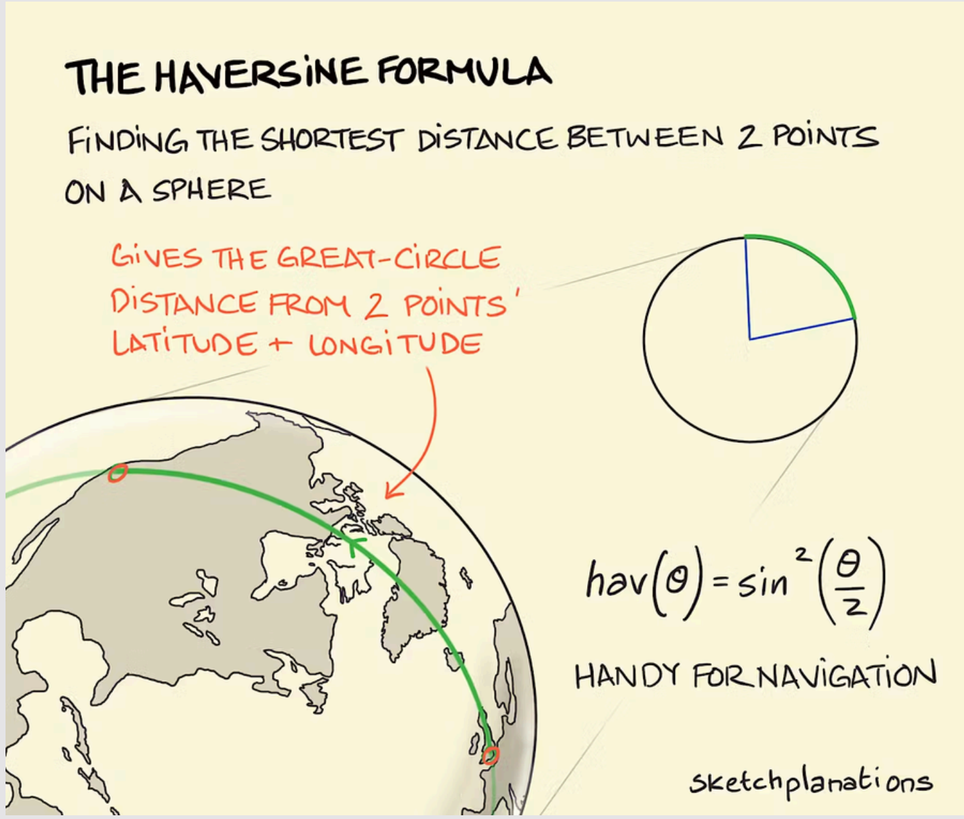
Algorithms

I - Haversine Algorithm

Haversine is an algorithm that can determine the distance between two objects on the surface of a sphere. Haversine has now been developed by using a simple formula, which with computer calculations, can provide a very accurate level of precision between two points.

The Haversine formula is perhaps the first equation to consider when understanding how to calculate distances on a sphere. The word "Haversine" comes from the function:
haversine(θ) = $\sin^2(\theta/2)$

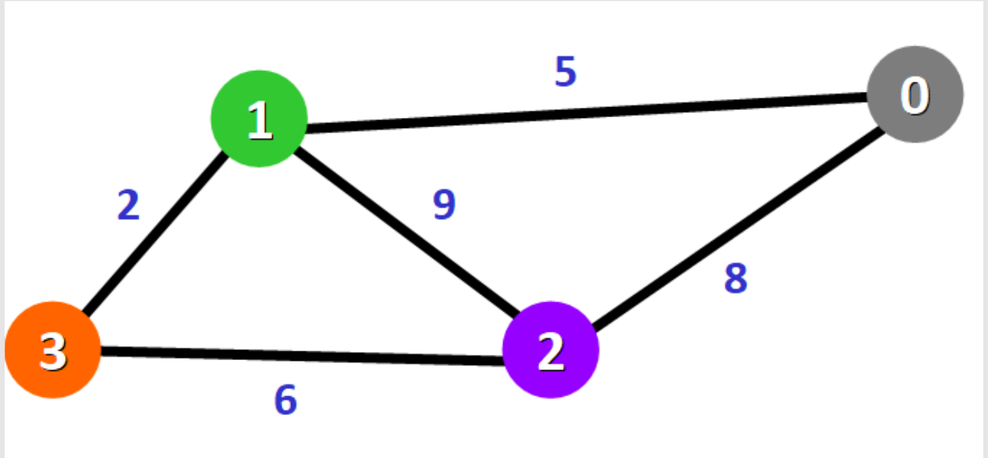
The following equation where φ is latitude, λ is longitude, R is earth's radius (mean radius = 6,371km) is how we translate the above formula to include latitude and longitude coordinates. Note that angles need to be in radians to pass to trig functions:
$a = \sin^2(\varphi B - \varphi A/2) + \cos \varphi A * \cos \varphi B * \sin^2(\lambda B - \lambda A/2)$
$c = 2 * \text{atan2}(\sqrt{a}, \sqrt{(1-a)})$
$d = R \cdot c$



Algorithms

II- Dijkstra's Algorithm

Dijkstra's algorithm is a popular algorithms for solving many single-source shortest path problems having non-negative edge weight in the graphs i.e., it is to find the shortest distance between two vertices on a graph. It was conceived by Dutch computer scientist Edsger W. Dijkstra in 1956.

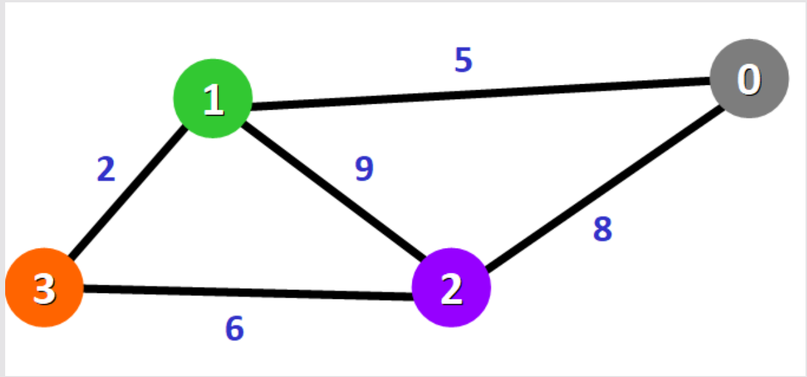


Algorithm for Dijkstra's Algorithm:

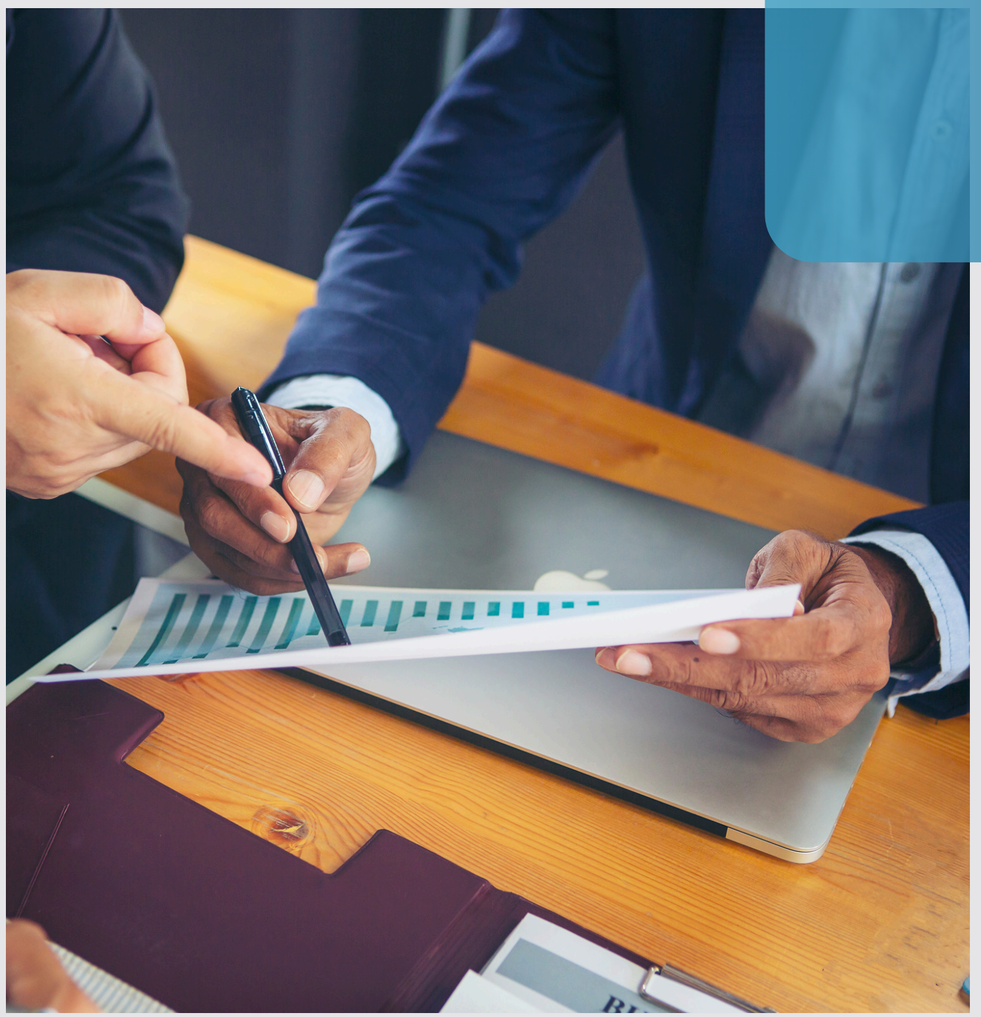
1. Mark the source node with a current distance of 0 and the rest with infinity.
2. Set the non-visited node with the smallest current distance as the current node.
3. For each neighbor, N of the current node adds the current distance of the adjacent node with the weight of the edge connecting 0->1. If it is smaller than the current distance of Node, set it as the new current distance of N.
4. Mark the current node 1 as visited.
5. Go to step 2 if there are any nodes are unvisited.

Implementation Using Mentioned Algorithms and Weather Factors By Waypoint Based Approach

For finding the optimal path we are considering Waypoint based path. We can calculate the shortest straight direct path using Havesine formula but in real-time its not possible as straight path may come under unauthorised flight area or any other issue.
So we choose multiple waypoints between source and destination that are authorised and choose the shortest path connecting them .We use Haversine formula to find shortest distance between them and connect them using Dijkstra's shortest path algorithm.
In this way we get result as shortest optimum path(fuel-optimised) of waypoints connected with each other from source to destination.



Considering Weather factor-
We fetch the real-time weather data using API(open-meteo) for waypoints based on their coordinates.We consider factors -temperature(Engine efficiency), cloud cover(visibility), wind speed (flight Stability),Precipitation(turbulence)Snowfall,Humidity(Static Electricity), Rain,Weather Code and disable the waypoints that are not falling under desired range for above factors and feed it to Djikstra-Haversine algorithm.
In this way we get result as shortest optimum path of waypoints connected with each other from source to destination considering weather/external factors.



Future Scope

There are many chaneg that we can include in fufture scope which inludes

1. **Integrating real time APIs for flight maintaince records**
2. **Implementing Object Detection algorithm like Yolo to idenity defects.**
3. **Increasing number of waypoints for each airports.**
4. **Adding more info about flights and adding more factors for optimizaing route.**

THANK YOU

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