Avia: AI Copilot for Enhanced Pilot Training & Safety

Rana Taki [1] Xiaoyue Wang [1] Zoey Zheng [1]

[1]Stanford University, Department of Computer Science

Introduction

Aviation training and safety face significant challenges: 53% of plane crashes are caused by pilot error. Despite standardized testing, training quality varies widely and pilots remain unprepared for real emergencies.

Avia is an AI-driven voice assistant designed to enhance flight training and improve pilot proficiency. By leveraging large language models (LLMs) and real-time voice interactions, Avia provides in-flight guidance, personalized performance analysis, and streamlined learning tools for student pilots and experienced aviators alike.

Background: Aviation Training Challenges

Traditional pilot training suffers from several limitations that Avia addresses:

- **Training Inconsistency:** Pilot training hours vary from 60-100+ hours with significant quality differences across regions and instructors
- **Emergency Preparedness Gap:** No amount of traditional training can predict how a pilot will react in a real emergency situation
- **Reliance on Static Materials:** Current training relies on memory and static checklists rather than adaptive, dynamic assistance
- **Limited Real-time Support:** Pilots lack contextual guidance during critical flight moments when cognitive load is highest

These challenges contribute to the high rate of aviation incidents caused by human error, creating an urgent need for smarter pilot training solutions that can adapt to individual learning needs and provide real-time support.

System Architecture

Avia integrates several technological components to create a comprehensive AI copilot system:

- **Speech Processing:** Advanced speech-to-text and text-to-speech systems enable natural, hands-free interaction during flight operations
- **Fine-tuned Aviation LLM:** Specialized OpenAI model trained on aviation protocols, emergency procedures, FAA regulations, and flight training materials
- **Audio Integration:** Compatible with Bose aviation headsets for clear communication in noisy cockpit environments
- **Mobile Application:** Intuitive iOS interface for pre-flight planning, in-flight assistance, and detailed post-flight analysis

The system is designed to function both online and offline to ensure reliability in various flight conditions and remote locations without consistent connectivity.

Model Training

Latency Reduction for Real-Time Response

- Model compression and on-device inference for faster processing
- Adaptive response system ensuring under **200ms delay** in high-priority tasks

Data Collection

- Simulated flight data for emergency scenarios
- Crowdsourced pilot interactions to improve natural language understanding
- Future plan: Real-world flight logs from Garmin SD cards

Broken or Incomplete Language Inputs

- Multi-turn dialogue system for progressive clarification
- Aviation-specific error correction for non-native English speakers

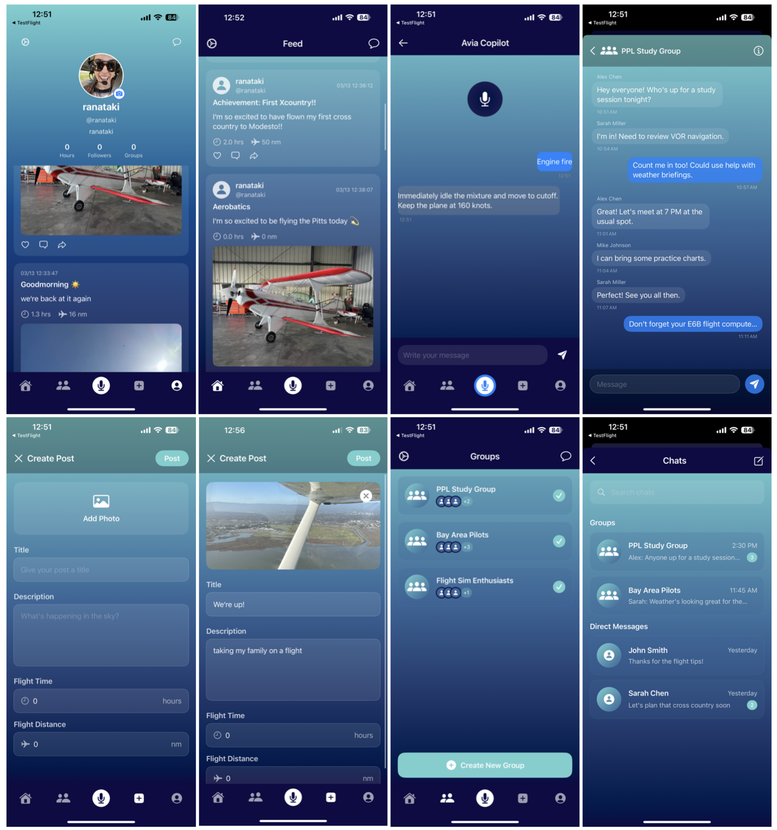
Presummarized Response

- Start with a brief statement
- If it's relevant, users can follow up like "please expand..."
- User can also mention answer length in their prompt

Key Features

1. **In-flight Guidance:**
   - Offers real-time procedural support for training and emergencies
   - Monitors aircraft systems for anomalies and safety concerns
2. **Post-flight Analysis:**
   - Provides personalized feedback and improvement suggestions
   - Identifies recurring patterns and areas for focused training

UI Flowchart



Emergency Response Capabilities

- Immediately recognizes critical situations through aircraft data anomalies or pilot voice commands
- Calmly provides step-by-step guidance through appropriate emergency procedures with timing cues
- Cross-checks aircraft health data to verify effectiveness of interventions in real-time
- Provides clear, concise instructions that reduce panic and cognitive overload

Market Opportunity

Avia targets a substantial market with significant growth potential:

$$\text{Total Addressable Market} = \text{Flight Schools} + \text{Private Pilots} + \text{Commercial Aviation} + \text{Defense}$$

- **Flight Training Industry:** Valued at $30B+ globally with 5% annual growth
- **Private Pilots:** 664,000+ active pilots in the US alone spending $10,000-$15,000 each on training
- **Commercial Aviation:** $5B+ spent annually on pilot training and simulation
- **Military Aviation:** $5B+ spent on test flights and advanced training programs

Business Model

Avia's monetization strategy includes:

- **B2B Licensing:** $2,000-$5,000 per month partnerships with flight schools, commercial airlines, and defense contractors
- **Subscription Model:** $49-$99 monthly fees for private pilots and flight instructors
- **Enterprise Solutions:** $100,000+ custom implementations for large aviation organizations with integrated simulation environments
- **Data Analytics:** Aggregate anonymized flight training data to improve aviation safety protocols and identify industry-wide trends

Go-to-Market Strategy

Initial focus on California flight schools and student pilots, with planned expansion to commercial and defense sectors as the technology matures and gains regulatory acceptance. Partnerships with Garmin and Bose create additional distribution channels.

Future Directions

Avia's roadmap includes several key developments:

- **Enhanced Aircraft Integration (2025):** Expanding compatibility with various aircraft systems beyond Garmin to include Avidyne, Dynon, and legacy analog systems
- **Advanced Simulation Training (2025-2026):** Creating virtual training scenarios powered by Avia to improve ground-based training before expensive airborne instruction
- **Commercial Aviation Applications (2026):** Adapting the system for use in commercial cockpits to assist professional pilots with complex procedures and rare emergency scenarios
- **Defense Applications (2026-2027):** Specialized versions for military aircraft and mission-specific protocols, including fighter jet training and military transport operations
- **Regulatory Certification (2027+):** Working with the FAA and international aviation authorities to certify AI assistance for broader adoption and integration with certified flight systems

The long-term vision is to make Avia the gold standard for AI copilots, ensuring that every pilot has the smartest, most reliable support system possible—saving lives and revolutionizing aviation safety worldwide while reducing the barriers to becoming a proficient pilot.

Team

- **Rana Taki:** Private pilot with firsthand experience of aviation training challenges. Completed pilot training in 2024 and identified critical gaps in emergency preparedness.
- **Xiaoyue Wang:** AI and systems integration specialist with expertise in LLM fine-tuning and real-time speech systems. Previously worked on LLM research.
- **Zoey Zheng:** Business development with connections to flight schools and aviation industry partners.