PA - Real-time Onboard Characterization of Sea State

Context and Objectives

The operation of seaplanes, particularly high-performance scooper aircraft like the FF72 (derived from the ATR 72), is fundamentally dependent on the conditions of the water surface. The sea state—characterized by parameters such as wave height (Significant Wave Height, H_s), wavelength, wave period, and swell direction—critically impacts safety, operational envelope limits (e.g., maximum permissible wave height for scooping and landing/take-off), structural loads (e.g., water impact fatigue), and overall hydrodynamic performance.

Current methods for assessing sea state in real-time for onboard flight crew decisions often rely on external meteorological forecasts or subjective visual estimations. To maximize the operational safety and availability of the FF72 demonstrator (FF72-X1 project), there is a crucial need to develop a robust, real-time, onboard system for accurately characterizing the sea state immediately ahead of the aircraft during critical phases like landing, take-off, and water scooping.

This project aims to leverage existing or proposed onboard sensing technologies (e.g., optical sensors, altimeters, accelerometers) to develop and validate a methodology for real-time estimation of key sea state parameters.

Key Objectives

During the 6-month internship period, the candidate will address the following objectives:

1. **Literature Review and Sensor State-of-the-Art:** Conduct a comprehensive review of non-intrusive, onboard sensing technologies and methodologies used for real-time sea state characterization on ships or aircraft, focusing on techniques applicable to a fast-moving seaplane. This includes analysis of optical methods, radar altimetry, and inertial measurement unit (IMU) data processing.
2. **Algorithm Development for Sea State Estimation:** Develop and implement algorithms to derive critical sea state parameters (H_s, dominant period, direction) from selected sensor data sources (e.g., processing radar altimeter measurements, optical imagery, or aircraft motion data).
3. **Data Integration and Modeling:** Investigate how the real-time sea state estimation can be integrated into existing operational models, specifically focusing on:
    - **Operational Envelope Determination:** Mapping estimated sea state to the maximum permissible conditions for various flight maneuvers (landing, take-off, scooping).
    - **Structural Load Estimation:** Developing a conceptual link between characterized wave patterns and anticipated water impact loads on the floats/hull.
4. **Proof-of-Concept and Validation Plan:** Propose a methodology (including a software prototype using test/simulated data) to demonstrate the feasibility of the real-time estimation process. Outline a clear validation plan for testing the system against known sea state data sources (e.g., buoys, satellite data) or simulation results.

Required Skills

- Major in Aerospace Engineering, Electrical Engineering, Applied Mathematics, or Remote Sensing.
- Proficiency in data processing, signal analysis, and scientific programming (e.g., Python, MATLAB, or C++).
- Familiarity with ocean wave mechanics, hydrodynamics, or signal processing techniques (e.g., spectral analysis, Kalman filtering) is a strong plus.
- Ability to work autonomously and strong analytical skills are essential.

Expected Outcome

The successful completion of this internship will result in:

1. A detailed literature review and technological roadmap for onboard sea state sensing.
2. A functional, documented software prototype (e.g., Python scripts) demonstrating the real-time calculation of key sea state parameters from simulated or available test data.
3. A conceptual framework and recommendations for integrating the sea state characterization into the FF72 operational decision-making tools and structural monitoring strategy.
4. A final report summarizing the methodology, results, and future steps for full system development and flight test integration.

Contact

Interested candidates are encouraged to submit their CV and a brief cover letter to jonathan.beck@positive-aviation.com for consideration.
