Phase 2 Project Summary

Firm: Ophir Corporation
Contract Number: NNX12CA69C
Project Title: Multifunction Laser Radar for Kinetic Air Hazard Detection and Air Data Measurement

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Identification and Significance of Innovation: (Limit 200 words or 2,000 characters whichever is less)

The innovation of this project is the capability to provide a single sensor that has multiple use functionality – air data measurement, turbulence and wind hazard detection and ride comfort enhancement – in a lightweight, low cost laser radar (lidar). Conventional air data systems provide critical information to the aircraft for safe flight. However, there are vulnerabilities to the conventional Pitot-static systems, as evidenced by the recent Air France catastrophe. A more robust air data system for flight controls on aircraft is needed – particularly to measure airspeed in icing and hazardous weather conditions. In addition to introducing this more robust air data capability, the proposed lidar system also measures airspeed ahead of the aircraft in order to measure kinetic wind hazards such as turbulence and wind shear. Finally, range-resolved wind measurements provided by the identical lidar hardware can be used to enhance aircraft ride stability, improving passenger comfort and reducing stresses on the airframe.

Technical Objectives and Work Plan: (Limit 200 words or 2,000 characters whichever is less)

The overarching goal of this SBIR research is to develop and demonstrate a multifunction, low-cost, Rayleigh/Mie lidar capable of accurately measuring kinetic air hazards at long range, as well as airspeed, temperature and pressure, at short range, over operational aircraft altitudes. The technical objectives include:

- Design, assemble and test a multifunction lidar capable of providing atmospheric measurement of temperature, pressure and velocity;
- Complete Proof-of-Capability testing to demonstrate lidar air data measurement capabilities in a controlled environment;
- Perform Proof-of-Functionality testing of a multifunction lidar from a flight test platform.

The Phase II Work Plan includes the following tasks:

- Task 1: Finalize the Phase II prototype multifunction lidar design.
- Task 2: Assemble, laboratory test and calibrate the prototype lidar.
- Task 3: Proof –of-capability lab testing.
- Task 4: Algorithm development for velocity retrievals.
- Task 5: Phase II prototype flight packaging.
- Task 6: TRL 5 multifunction lidar prototype flight demonstration.
- Task 7: Final report and data analysis.

Technical Accomplishments: (Limit 200 words or 2,000 characters whichever is less)

Ophir has successfully assembled a flight-worthy prototype and validated the measurement capability of the lidar in a flight environment (TRL 5). This effort included completion of prototype multifunction lidar design, assembly and laboratory testing to calibrate the lidar. Also, algorithms were developed for velocity retrievals. The prototype was successfully packaged for the flight test demonstration.

The flight test demonstration measured air velocity on a 3D surface. Velocity on this surface was measured both inside and outside the propeller wash of the aircraft with significantly varying velocities from inner range bins to outer range bins, thereby demonstrating the ability of the instrument to measure turbulence on an operating airplane.

Using the optical head from this system and four channels of angular data, true airspeed, angle of attack and sideslip were measured up to 40 Kft in altitude.

The calculation of temperature and pressure have been started and successfully calculated in theory. The proper method of implementing these theoretical methods has not yet been determined and will resume in the next phase.

This phase II has successfully shown the ability of the system to function as a multi-function lidar system on an aircraft and is ready for the next phase.

NASA Application(s): (Limit 100 words or 1,000 characters whichever is less)

Airspace transformation to NextGen may be significantly safer by providing additional information for kinetic air hazard detection. NASA has pioneered many innovations and improvements for wind hazard detection, warning and forecasting. This innovation enables this airspace transformation by providing wind hazard measurement and resulting real-time information for air traffic operations. This innovation will not only increase in-flight safety, but also may impact the volume of air traffic due to the provision of resultant weather warnings. Also, safety of the air traffic system will be improved with a dually redundant air data system on commercial aircraft. NASA has shown the utility of lidar wind and air data measurements over the years, however, the systems have been quite cumbersome. Ophir solves this challenge by providing a redundant air data system and a dual-use kinetic air hazard monitoring system in a small size, weight and power consumption package at a low cost.

Non-NASA Commercial Application(s): (Limit 200 words or 2,000 characters whichever is less)

The commercial markets have been reticent to adopt an optical air data sensor due the size, weight and power consumption factors, as well as, the single function nature of the sensor. But, the ability to condense the sensor and the offer multimode operation enables the market acceptance and ultimate sensor commercialization. The markets addressed by this multifunction sensor development are the unmanned and manned military and commercial aircraft markets. The proposed innovation may also be used in the regional jet market for new aircraft flight testing and calibration. The commercial aircraft markets include the scheduled air carrier operations and the business jet market, as well as the airport safety market.

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