PHASE I PROJECT SUMMARY

Firm: Michigan Aerospace Corporation

Contract Number: NNX12CF44P

Project Title: Planetary-WhiGS: Optical MEMS-Based Seismometer

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Identification and Significance of Innovation:

Michigan Aerospace Corporation, in collaboration with Professor Volkan Ötügen and his group at Southern Methodist University, has completed a Phase I SBIR effort for NASA Marshall Space Flight Center to develop a compact seismometer suitable for planetary exploration. The seismometer in development is optical-MEMS based, and the sensing element exploits the high-Q of optical whispering gallery mode (WGM) resonances. This whispering gallery mode seismometer designed in this Phase I is an all optical seismometer.

This final report describes the seismometer concept and preliminary results obtained with a simple prototype tested in parallel with a CMG-3T seismometer at the Southern Methodist University. The test results were highly valuable to improve the seismometer design. Significant improvements were made to the preliminary prototype and models indicate that this new design will be able to perform in the nano-g range. The end-to-end design of the seismometer, along with the impact and mitigation of environmental effects, is presented in this report.

Technical Objectives and Work Plan:

The proposed work plan for this Phase I effort included four tasks: Task 1: Requirements definition; Task 2: Microsphere selection and design; Task 3: Environmental effects; Task 4: Seismometer design. All tasks have been completed.

Technical Accomplishments:

During this Phase I effort, a prototype seismometer was tested in parallel with a CMG-3T, and a new design was developed for the seismometer. The following results and conclusions were drawn from this effort: 1. WGM technology was proven to be an excellent sensing technique for this application; 2. A preliminary mechanical prototype demonstrated micro-g sensitivity; 3. A mechanical assembly providing mechanical amplification to nano-g sensitivity was designed; 4. The path for the development of a FPGA based processing and control was defined; and 5. Environmental protection of the instrument was defined.

NASA Application(s):

This work is designed to lead to a practical seismometer for use off-Earth (on the Moon and other planetary bodies and also for acceleration measurement of free-flying spacecraft).

Non-NASA Commercial Application(s):

Applications for such an accelerometer encompass a broad range of activities. They include: Geological research: mining and oil prospecting; Earth sciences; Space exploration: satellite drag measurements, docking, navigation; Homeland security: footstep detection, tampering, entry and illicit activities; Building safety; Academic research; and Vehicle safety research.

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