

# Innovation

**SBIR Topic Number:**  
AF073-075

**SBIR Title:**  
Agile Optics and Optical Systems For Autonomous Aerial Cameras

**Contract Number:**  
FA8650-09-C-1610

**SBIR Company Name:**  
Technest, Inc.,  
Bethesda, MD

**Technical Project Office:**  
AFRL Sensors Directorate,  
Wright-Patterson AFB, OH

This Air Force SBIR/STTR Innovation Story is an example of Air Force supported SBIR/STTR technology that met topic requirements and has outstanding potential for Air Force and DoD.

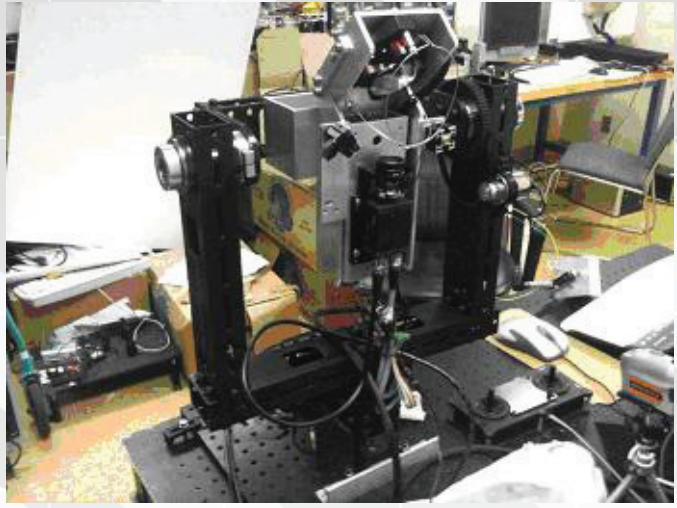
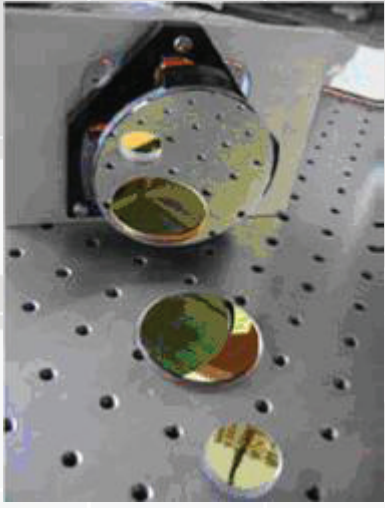


Figure 1 (left): Two-inch diameter fast-steering mirror. Figure 2 (right): Fast-steering mirror prototype on motion table.

## SpectralBird: Electronically Tunable Active Optics Sensor

- Small unmanned aerial systems may require non-mechanical camera stabilization systems to provide high stability while being lightweight
- Technest, Inc., developed a sensor prototype called SpectralBird using a new sensor concept and novel components such as dual-zoom-stage camera, dual solid-state gyroscopes, and a lightweight fast-steering mirror (FSM)
- Technest successfully demonstrated the compact zoom optic of approximately 1.3 inches in diameter and only 4 inches in length; additionally, the contractor worked to develop a line-of-sight stabilization algorithm based on the FSM
- The prototype developed in this SBIR project will help demonstrate the potential for non-mechanical (i.e., optical) line-of-sight stabilization in a compact package

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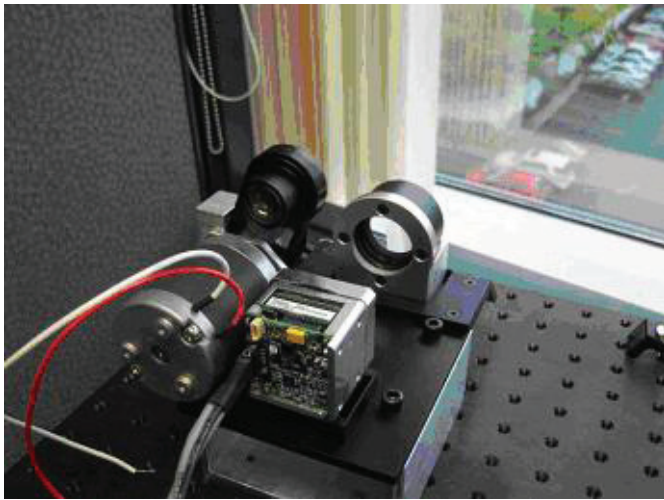
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## Air Force Requirement

Small unmanned aerial systems may require non-mechanical camera stabilization systems to provide high stability while being lightweight. Large turret systems, such as those on manned aircraft, achieve stability due to their high weight and thus inherent resistance to motion due to the high inertia.

## SBIR Technology

Technest, Inc., developed a sensor prototype called SpectralBird using a new sensor concept and novel components such as dual-zoom-stage camera, dual solid-state gyroscopes, and a lightweight fast-steering mirror (FSM). Strategic use of these novel components, resulting from recent advances in miniature-sensor and active-optics technology, is the key to the development of the SpectralBird sensor. Extensive engineering efforts were made to design the dual-field-of-view camera lens. By the end of the SBIR program, Technest successfully demonstrated the compact zoom optics of approximately 1.3 inches in diameter but only 4 inches in length. Additionally, the contractor worked to develop a line-of-sight stabilization algorithm based on the FSM.



**Figure 3: Imaging test with dual-field-of-view lens.**

Although FSMs have been proposed and demonstrated for imaging applications because of their high-frequency response, one issue regarding their use is that one of the two rotation axes of the FSM is not parallel with the rotation axis of the unmanned vehicle. In addition, although the FSM

has extremely high resolution and precision, it suffers from two issues: (1) absolute position accuracy can be low, and (2) it can be difficult to specify with current technologies. This is especially true for low-end FSMs. Technest successfully tackled these issues by developing new control algorithms. Figure 1 shows the FSM in its mount prior to integration, and Figure 2 depicts the laboratory prototype undergoing line-of-sight motion compensation testing. Figure 3 shows the prototype undergoing bench testing.

## Potential Application

The prototype developed in this SBIR project will help demonstrate the potential for non-mechanical (i.e., optical) line-of-sight stabilization in a compact package.

## Company Impact

“This challenging control system design effort helped our learning curve in being able to take an idea from the concept phase to realization in hardware,” states Dr. James Z. Wen of Technest. “The residual hardware will be used to further Technest’s future development efforts. Further, these SBIR results will improve the SpectralBird system to provide versatile imaging capabilities, such as electronic zoom, tracking, and line-of-sight stabilization for UAVs and other military applications.”

“In the past few years, SBIR programs have helped Technest to translate new concepts and discoveries into valuable products and jobs. The programs have been instrumental in our development of a number of commercial products, such as Rainbow 3D Cameras, WellCam, and other innovative 2D/3D and 360-degree imaging technologies for various defense, biomedical, and consumer applications.”



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