Department of the Navy SBIR/STTR Transition Program

NAVAIR 2018-652

Topic # N152-106

Metrology of Visibly Transparent Large Aspheric Optics

Optimax Systems, Inc.

WHO

SYSCOM: NSMA

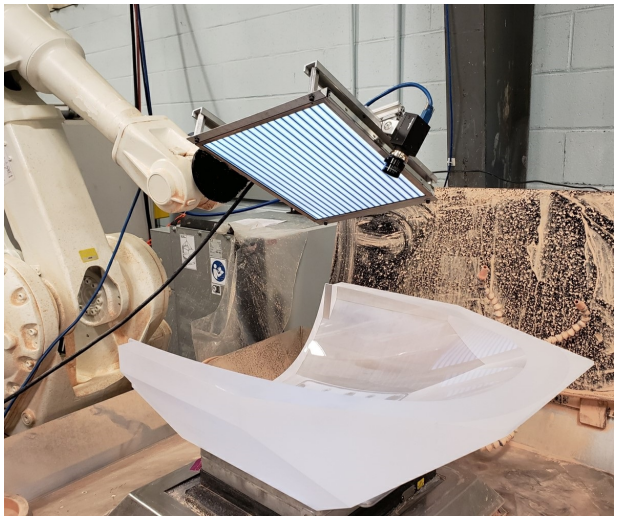
Sponsoring Program: Unmanned Carrier Aviation Program Office PMA-268

Transition Target: MQ-25 Stingray

TPOC:
(760)939-1649

Other transition opportunities: The applications of this technology include: conformal sensor windows, augmented/virtual reality optics, and large aspheric or freeform optics.

Notes: Optimax has commercialized several SBIR developed technologies since the completion of our first Phase II in 2009. $8 million in SBIR funding has created over $23 million in revenue and created 55 jobs through 2017. It is estimated that an additional $9 million in revenue and 10 additional jobs will be created by the end of 2018.



Robotic platform taking mid-spatial frequency error measurements using deflectometry in-situ on a 580 mm freeform optic (Copyright, 2018, Optimax)

WHAT

Operational Need and Improvement: A need for freeform conformal sensor windows on military aircraft is increasing as more, and higher performing, sensors are incorporated into each aircraft. Conformal windows follow the curvature of an airframe to increase aerodynamic performance over traditional flat or spherical windows. Large aperture (<500 mm (<19.7 in)) transparent ballistic materials can be used to provide a large angle of regard for the sensor, as well as protection from impact for the warfighter inside the aircraft.

Specifications Required: There is a need for faster measurement of large diameter freeform optical components with strong curvature, specifically up to 610 mm x 610 mm (24 x 24 inches) with 203 mm (8 inches) of sag. Currently these components are prohibitively expensive and have lead times that often exceed 8 months, in part due to the extremely long measurement process, which consumes 30-50% of the manufacturing time. An improvement on cost and lead time is needed to advance the state of the art from an optical design perspective. Mid-spatial frequency errors are of special concern, as they cannot be easily corrected for within an optical system and are extremely detrimental to the warfighter's vision.

Technology Developed: Optimax Systems has developed a metrology tool which can be used in-situ on our custom polishing platform capable of measuring mid-spatial frequency errors on large diameter (~700 mm (27.6 in)) optical components. This tool is highly sensitive and can resolve features 50 nm (0.08 waves) in height. Deflectometry is also much faster than the current state of the art, taking only a few minutes to gather data on the part surface, improving the state of the art by 2 orders of magnitude.

Warfighter Value: Freeform optical components have the potential to drastically reduce the number of elements in an optical system, reducing weight and increasing output power through less transmission loss. The metrology tool (deflectometry) designed in this project eases the manufacturing process for freeform optics; resulting in shorter lead times, better optical surfaces, and lower cost than the current state of the art.

WHEN

Contract Number: N68936-17-C-0028 **Ending on:** January 24, 2019

Milestone	Risk Level	Measure of Success	Ending TRL	Date
Develop initial deflectometry algorithms and implement into software	N/A	Initial test of software were in good agreement mathematical models	3	April 2016
Measured mid-spatial frequency of actual freeform optic using deflectometry	N/A	Deflectometry measurements of actual freeform optic were in good agreement with standard contact metrology equipment to within 1 micron	4	December 2016
Automated deflectometry software on robotic platform	N/A	Performed 'hands-off' deflectometry measurements of conformal window on robotic platform	5	April 2018
Measurement of large conformal window on large robotic platform	Low	Acquire several sub-aperture deflectometry measurements and stitch together	6	January 2019
If Option exercised: Full automated deflectometry measurement of large conformal window	Low	Full aperture stitched images on large conformal window (<500 mm) showing < 1 micron agreement with standard metrology	7	July 2019

HOW

Projected Business Model: Since Optimax was founded in 1991, optics have been behind enormous progress in technologies as diverse as fiber optic telecommunications, solid-state lighting, digital photography, displays, and diagnostic medicine. We have worked key programs in aerospace, government research, and defense, and our customers' successes have fueled our growth. Optimax reliability has allowed us to become America's largest prototype optics manufacturer. Optimax specializes in Asphere, Cylinder, Sphere, Freeform, and Plano/Flat optics in sizes up to 400 mm. All parts are manufactured to customer-supplied specifications and include final inspection data.

Optimax is a service business providing custom precision optical components made to customer specifications. A core tenet of the business is short lead times while maintaining high quality and customer satisfaction. Optimax is an early adopter of novel technology and utilizes SBIR and internal R&D projects to fill in technological gaps in existing manufacturing processes. These projects focus on processes to enable higher precision, more complex geometries, and the ability to work with novel materials. Optimax is set up to manufacture, test and deliver with the speed and performance your programs require -- prototype optics in one week.

Company Objectives: The technology developed under this project is applicable to manufacturing optical geometries from 10 mm to 700 mm (0.4 in - 27.6 in) in diameter; including both simple rotationally symmetric and extreme freeform shapes. Optimax seeks to build partnerships with prime contractors and system integrators that require high precision optics, large optics, and optics with low mid-spatial frequency error.

Potential Commercial Applications: Commercial service already in place to manufacture conformal sensor windows, large (<500 mm) telescope mirrors, freeform corrector optics, other freeform optics, laser grade optics, high energy laser optics, large (<500 mm) aspheric optics, and a variety of other optical products such as AR/VR headsets.

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