

**SBIR Topic Number:**  
AF05-218

**SBIR Title:**  
Compact Multispectral  
Measurement System

**Contract Number:**  
FA8650-06-C-1013

**SBIR Company Name:**  
Surface Optics  
Corporation  
San Diego, CA

**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.



## Compact Multispectral Measurement System (CMMS)

- The Air Force needs a cost-effective, man-portable, high-quality, zero-range, ground-truthing data collection tool for capturing three-dimensional (3-D) shape, hyperspectral, and bidirectional reflectance distribution function (BRDF) data
- Surface Optics Corporation developed the CMMS for measuring the 3-D shape and contours of measured objects, and for simultaneously characterizing the hyperspectral reflectance properties of the component surfaces
- The CMMS will be used by the Department of Defense as a tool for generating realistic models of automobile-sized objects
- Sales of the hyperspectral image (HSI) camera component of the CMMS occurred while the SBIR Phase II project was in process

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## Air Force Requirement

The Air Force is investigating various methods by which multi-signature target data are collected against military targets, vehicles and objects of interest to support research and development of sensor fusion (SF) algorithms. The Air Force needs a cost-effective, man-portable, high-quality, zero-range automated measurement system and supporting process capable of rapidly capturing three-dimensional (3-D) shape, hyperspectral, and bidirectional reflectance distribution function (BRDF) data for algorithm development.

## SBIR Technology

Surface Optics Corporation (SOC) developed, built, and tested the Compact Multispectral Measurement System (CMMS) for measuring the 3-D shape and contours of measured objects, and for simultaneously characterizing the hyperspectral reflectance properties of the component surfaces. The CMMS images a scanned laser dot with four high speed cameras. The cameras contain field programmable gate array (FPGA) processors that automate the dot location process on the focal plane, allowing the cameras to operate at frame rates up to 500Hz.

The imagery is processed with photogrammetry to produce point cloud, polygon mesh, or non-uniform rational B-splines (NURBS) surface formats. The output data is a 3-D model of the object surfaces, with a sampled BRDF representation of the spectral reflectance of the component surfaces. The root mean square (RMS) 3-D measurement accuracy is typically 1 millimeter or less.

The photogrammetric cameras have spatial resolution of 1240x1024 pixels, and the hyperspectral (HSI) imagery has spatial resolution of up to 1024x1024 spatial pixels, with up to 240 wavebands. The HSI sensor is incorporated as a fifth camera in the photogrammetry system, and the spectral reflectance for each polygon cell in the model is extracted from the hyperspectral cubes by inverse processing. The HSI sensor was specially designed for this program to provide precise and reproducible scans, which is required for photogrammetric processing. The CMMS is designed for ease of use, portability, and rapid measurement.

## Potential Air Force Application

The CMMS will be used by the Department of Defense as a tool for generating realistic models of automobile-sized objects for use in sensor algorithm development. The CMMS also has high commercial potential as a metrology tool in

manufacturing, for characterizing the shape and exact color of manufactured products. Further, the CMMS is being marketed to the entertainment industry for applications in highly realistic animation. Other applications include data collection for use in phenomology studies, hyperspectral assistance in vehicle identification and tracking, and hyperspectral ground truthing for data collections.

The cost of the components in the CMMS is lower than in competitive systems. The SOC-730 HSI imager was developed specifically under the CMMS program, and has become a standard SOC product. Seven SOC-730 systems have been delivered to date. Two other custom systems have also been derived from the basic SOC-730 design.

## Company Impact

SOC benefitted from an early commercialization opportunity when it was able to sell HSI cameras (a CMMS component) while the SBIR Phase II project was still in process. SOC has worked with the Air Force Research Laboratory and other Department of Defense customers to improve the performance, capabilities, and versatility of this instrument.

Founded in 1970, SOC designs, builds and sells hyperspectral imaging systems that cover the UV through the LWIR wavebands. These systems provide state-of-the-art performance in terms of spatial and spectral resolution, sensitivity, and versatility of use. SOC designs and manufactures cameras and FPGA processors for hyperspectral systems. SOC also operates a measurement facility for characterizing the reflective and emissive properties of surfaces.

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