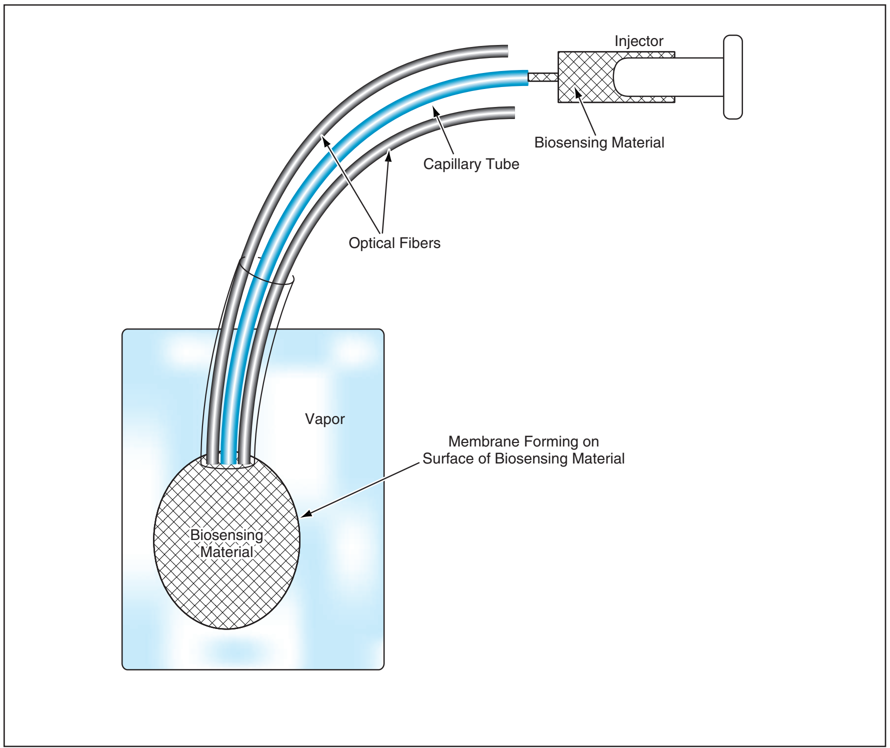

Figure 2. A **Fiber-Optic Sensor Could Be Fabricated** in a process that would include placement of a droplet containing biosensing material on the tip and vapor deposition of a polymer on the droplet and the optical fibers.

any of several alternative techniques. In one well-known technique, the biosensing material would be illuminated with light having the proper wavelength to excite fluorescence. The intensity and/or wavelength of the fluorescence would depend on the presence or absence of the bound analyte. In some cases, it may be desirable to use the same optical fiber to transmit the exciting light to the sensor and to transmit the fluorescence back to the photonic analyzer. The use of a single fiber would be appropriate if, for example, a brief excitation pulse of light could be expected to produce a longer-lived fluorescence that could be detected after the excitation pulse had been extinguished. In other cases, it may be necessary to use one optical fiber to transmit the excitation light to the biosensing material and another fiber to transmit the fluorescence back to the photonic analyzer. Alternatively or in addition to using fluorescence, it could be possible to measure the concentration of an analyte in terms of the amount of absorption of light of a particular wavelength from a broadband or spectrally modulated illumination.

Figure 2 illustrates a process that might be used to fabricate a two-fiber sensor according to the proposal. The two optical fibers would be bundled with a capillary tube at the end destined to become the sensory tip. The bundled end would be placed in a chamber, which would be partly evacuated and then back-filled with the vapor of a vapor-depositable material. As the vapor condensed and polymerized on the surface of the bundle, a droplet of biosensing material would be injected through the capillary tube. The droplet would become cooled rapidly by rapid evaporation in the partial vacuum. The cooling of the droplet would increase the rate of condensation of vapor and polymerization on the surface of the droplet, thereby causing the formation of the aforementioned membrane, which would be continuous with a tightly adherent coat over the contiguous optical fibers and capillary tube.

A suitable vapor-depositable material could be Parylene — a thermoplastic polymer made from poly-para-xylylene. Parylene is a highly biocompatible material that tends to discourage the adhesion and tracking of epithelial cells. Because Parylene exhibits little or no permeability by typical analytes that one might seek to detect, it would be necessary to create pores in the membrane. This could be done by, for example, burning holes by use of a tightly focused laser beam.

This work was done by Thomas George of Caltech and Gerald Loeb of the University of Southern California for **NASA's Jet Propulsion Laboratory**. *Further information is contained in a TSP (see page 1).*

In accordance with Public Law 96-517, the contractor has elected to retain title to this invention. Inquiries concerning rights for its commercial use should be addressed to:

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Refer to NPO-30651, volume and number of this NASA Tech Briefs *issue, and the page number.*

Video Guidance Sensors Using Remotely Activated Targets

These systems would not rely on wire connections or GPS signals for synchronization.

Marshall Space Flight Center, Alabama

Four updated video guidance sensor (VGS) systems have been proposed. As described in a previous *NASA Tech Briefs* article, a VGS system is an optoelectronic system that provides guidance for automated docking of two vehicles. The VGS provides relative position and attitude (6-DOF) information between the VGS and its target. In the original intended application, the two vehicles would be spacecraft, but the basic principles of design and operation of the system are applicable to aircraft, robots, objects maneuvered by cranes, or other objects that may be required to be aligned and brought together automatically or under remote control.

In the first two of the four VGS systems as now proposed, the tracked vehicle would include active targets that would light up on command from the tracking vehicle, and a video camera on the tracking vehicle would be synchronized with, and would acquire images of, the active targets. The video camera would also acquire background images during the periods between target illuminations. The images would be digitized and the background images would be subtracted from the illuminated-target images. Then the position and orientation of the tracked vehicle relative to the tracking vehicle would be computed from the known geometric relationships among the positions of the targets in the image, the positions of the targets relative to each other and to the rest of the tracked vehicle, and the position and orientation of the video camera relative to the rest of the tracking vehicle.

The major difference between the first two proposed systems and prior active-target VGS systems lies in the techniques for synchronizing the flashing of the active targets with the digitization and processing of image data. In the prior active-target VGS systems, synchronization was effected, variously, by use of either a wire connection or the Global Positioning System (GPS). In three of the proposed VGS systems, the synchronizing signal would be generated on, and transmitted from, the tracking vehicle.

In the first proposed VGS system, the tracking vehicle would transmit a pulse of light. Upon reception of the pulse, circuitry on the tracked vehicle would activate the target lights. During the pulse, the target image acquired by the camera would be digitized. When the pulse was turned off, the target lights would be turned off and the background video image would be digitized.

The second proposed system would function similarly to the first proposed system, except that the transmitted synchronizing signal would be a radio pulse instead of a light pulse. In this system, the signal receptor would be a rectifying antenna. If the signal contained sufficient power, the output of the rectifying antenna could be used to activate the target lights, making it unnecessary to include a battery or other power supply for the targets on the tracked vehicle.

The third proposed VGS system could include either passive or active targets. This system would include two or more video cameras and associated digitizing and digital image-processing circuitry on the tracking vehicle for acquiring stereoscopic pairs of images of the targets on the tracked vehicle. At distances beyond the normal VGS operating range (that is, at distances so great that the target images would merge into a single spot of light on each camera focal plane), a VGS system operating in its normal short-range mode could determine the direction to the tracked vehicle but could not determine the distance to, or the orientation of, the tracked vehicle. However, in such a situation, this proposed system would determine the distance to the tracked vehicle by use of the known geometric relationships of stereoscopy — provided, of course, that the distance were not so great as to bring the stereoscopic disparity below the minimum useful level.

The fourth proposed system would be an active-target VGS system in which synchronization would not involve the transmission of pulses from the tracking vehicle. Instead, the target lights would be flashed at a repetition rate of 5 Hz governed by a free-running oscillator on the tracked vehicle. Each flash period would include a lights-on interval of 3/60 of a second (corresponding to three video fields at standard video frame rate of 30 Hz at two fields per frame) and a lights-off interval of 9/60 of second. The system would digitize two pictures in a row, subtract them, and look for the expected target pattern in each synthetic image generated by the subtraction. If the target pattern were thus found, then the flash timing would be known to within one field. If the target pattern were not found, then the time of each picture would be advanced one frame (two fields – 1/30 of a second) relative to the beginning of a 5-Hz processing cycle and the aforementioned actions repeated. This process would quickly bring the digitizing and data-processing circuitry into synchronism with the flashing of the targets.

This work was done by Thomas C. Bryan, Richard T. Howard, and Michael L. Book of **Marshall Space Flight Center**. *Further information is contained in a TSP (see page 1).*

This invention has been patented by NASA (U.S. Patent No. 6,254,035). Inquiries concerning nonexclusive or exclusive license for its commercial development should be addressed to Sammy Nabors, MSFC Commercialization Assistance Lead, at (256) 544-5226 or sammy.nabors@msfc.nasa.gov. Refer to MFS-31278/79/80/81.

Simulating Remote Sensing Systems

Stennis Space Center, Mississippi

The Application Research Toolbox (ART) is a collection of computer programs that implement algorithms and mathematical models for simulating remote sensing systems. The ART is intended to be especially useful for performing design-tradeoff studies and statistical analyses to support the rational development of design requirements for multispectral imaging systems. Among other things, the ART affords a capability to synthesize coarser-spatial-resolution image-data products. The ART also provides for simulations of image-degradation effects, including point-spread functions, misregistration of spectral images, and noise. The ART can utilize real or synthetic data sets, along with sensor specifications, to create simulated data sets. In one example of a particular application, simulated imagery of a coarse resolution system was created using high-resolution imagery from another system in order to perform a radiometric cross-comparison. In the case of a proposed sensor system, the simulated data can be used to conduct trade studies and statistical analyses to ensure that the sensor system will satisfy the requirements of potential scientific, academic, and commercial user communities.

This collection of programs was written by Vicki Zanoni of **Stennis Space Center** *and Robert Ryan, Slawomir Blonski, Jeffrey Russell, Gerald Gasser, and Randall Greer of Lockheed Martin Corp.*

Inquiries concerning rights for the commercial use of this invention should be addressed to the Intellectual Property Manager, Stennis Space Center, (228) 688-1929. Refer to SSC-00181.