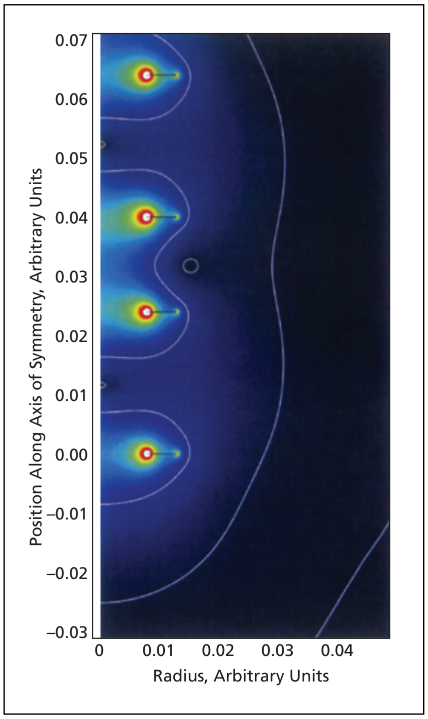

This **False-Color Plot** represents half-meridional-plane contours of the magnetic field that would be generated by driving current through the four washerlike turns of an optimized second-order gradiometer sensing coil of the type described in the text.

distance from the sample arise from the fact that the sample is at room temperature but the coil and the SQUID sensor must be enclosed within a cryogenic shield to maintain superconductivity.

One element of an approach to increasing sensitivity without appreciably increasing size is to increase the number of turns, subject to the requirement to maintain an impedance match with the SQUID sensor. On the other hand, simply increasing the number of turns also increases the self-inductance. One way to effect a substantial reduction in inductance without reducing the number of turns is to make the coil of a thicker wire and/or to shape the wire to other than a commonly available circular or square cross section, as described in "Improved Sensing Coils for SQUIDs" (NPO-44397), NASA Tech Briefs, Vol. 31, No. 10 (October, 2007), page 26. On the other hand, the allowable increase in size and change in shape of the wire is limited by the above-mentioned geometric constraints pertaining to enclosure in the cryogenic shield and distance from the sample.

Taking all of the aforementioned considerations into account, it was found that for both SQUID MRI and SQUID MEG, the optimum or nearly optimum coil geometry would be realized by constructing each turn of the coil in the form of a thin washer. Moreover, in the case of a four-turn coil in a second-order gradiometer arrangement (see figure), it would be beneficial to axially separate the two middle turns in order to further reduce the self-inductance. It has been estimated that for an MRI coil designed according to the present optimized geometry, the increase in sensitivity over that of the corresponding conventional wire-wound coil would make it possible to reduce measurement time by a half.

This work was done by Byeong Ho Eom, Konstantin Penanen, and Inseob Hahn of Caltech 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-44629, volume and number of this NASA Tech Briefs *issue, and the page number.*

Sensing a Changing Chemical Mixture Using an Electronic Nose

ASIC may enable continuous, high-speed monitoring.

NASA's Jet Propulsion Laboratory, Pasadena, California

A method of using an electronic nose to detect an airborne mixture of known chemical compounds and measure the temporally varying concentrations of the individual compounds is undergoing development. In a typical intended application, the method would be used to monitor the air in an inhabited space (e.g., the interior of a building) for the release of solvents, toxic fumes, and other compounds that are regarded as contaminants. At the present state of development, the method affords a capability for identifying and quantitating one or two compounds that are members of a set of some number (typically of the order of a dozen) known compounds. In principle, the method could be extended to enable monitoring of more than two compounds.

An electronic nose consists of an array of sensors, typically made from polymer-carbon composites, the electrical resistances of which change upon exposure to a variety of chemicals. By design, each sensor is unique in its responses to these chemicals: some or all of the sensitivities of a given sensor to the various vapors differ from the corresponding sensitivities of other sensors. In general, the responses of the sensors are nonlinear functions of the concentrations of the chemicals. Hence, mathematically, the monitoring problem is to solve the set of time-dependent nonlinear equations for the sensor responses to obtain the time-dependent concentrations of individual compounds.

In the present developmental method, successive approximations of the solution are generated by a learning algorithm based on independent-component analysis (ICA) — an established information-theoretic approach for transforming a vector of observed interdependent signals into a set of signals that are as nearly statistically independent as possible. The algorithm can be characterized as being equivalent to a computational architecture known in the art as a space-invariant ICA architecture. In principle, this architecture is amenable to implementation in an application-specific integrated circuit (ASIC). The anticipated future development of such an ASIC would make it possible to construct a miniature, high-speed, low-power electronic-nose sensor system for continuous monitoring.

This work was done by Tuan Duong and Margaret Ryan of Caltech for NASA's Jet Propulsion Laboratory.

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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