ticipate possible sequences of events and learns strategies for the solving of problems that it has not encountered but that could occur.

The architecture is still undergoing development. An SES has been implemented in the NASA Robonaut (a developmental anthropomorphic robot intended to serve as an astronaut's assistant). Production-quality software to implement the architecture has not yet been written. A major problem in writing this software is that of efficient representation of sensory data in vector spaces.

This work was done by Alan Peters of Vanderbilt University for Johnson Space Center.

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 MSC-23489, volume and number of this NASA Tech Briefs *issue, and the page number.*

Hypothetical Scenario Generator for Fault-Tolerant Diagnosis

This is a means of performing diagnostic reasoning when data are missing.

NASA's Jet Propulsion Laboratory, Pasadena, California

The Hypothetical Scenario Generator for Fault-tolerant Diagnostics (HSG) is an algorithm being developed in conjunction with other components of artificial-intelligence systems for automated diagnosis and prognosis of faults in spacecraft, aircraft, and other complex engineering systems. By incorporating prognostic capabilities along with advanced diagnostic capabilities, these developments hold promise to increase the safety and affordability of the affected engineering systems by making it possible to obtain timely and accurate information on the statuses of the systems and predicting impending failures well in advance.

Prognosis is tightly coupled with diagnosis. The simplest approach to prognosis by an artificial-intelligence system involves the use of a diagnostic engine in a controlled feedback loop to project from the current state of the affected engineering system to future states that are elements of scenarios that are discovered hypothetically. A hypothetical-scenario generator is a key element of this approach. A hypothetical-scenario generator accepts, as its input, information on the current state of the engineering system. Then, by means of model-based reasoning techniques, it returns a disjunctive list of fault scenarios that could be reached from the current state.

The HSG is a specific instance of a hypothetical-scenario generator that implements an innovative approach for performing diagnostic reasoning when data are missing. The special purpose served by the HSG is to (1) look for all possible ways in which the present state of the engineering system can be mapped with respect to a given model and (2) generate a prioritized set of future possible states and the scenarios of which they are parts. The HSG models a potential fault scenario as an ordered disjunctive tree of conjunctive consequences, wherein the ordering is based upon the likelihood that a particular conjunctive path will be taken for the given set of inputs. The computation of likelihood is based partly on a numerical ranking of the degree of completeness of data with respect to satisfaction of the antecedent conditions of prognostic rules. The results from the HSG are then used by a model-based artificial-intelligence subsystem to predict realistic scenarios and states.

To avoid the need to create special models to generate hypothetical scenarios, the HSG uses the same model that is used to perform fault-detection and other diagnostic functions but interprets the results generated by the model in a manner unique to the generation of hypothetical scenarios. An important additional advantage of this approach is that a future state can be diagnosed by the same model as that used to diagnose the current state.

This work was done by Mark James of Caltech for NASA's Jet Propulsion Laboratory. Further information is contained in a TSP (see page 1).

The software used in this innovation is available for commercial licensing. Please contact Karina Edmonds of the California Institute of Technology at (626) 395-2322. Refer to NPO-42516.