NASA-JSC Technology Opportunity

MSC-21465 Discrete Event Simulation Tool for Analysis of Qualitative Models of Continuous Processing Systems (CONFIG)

The CONFIG tool supports modeling of system configurations that include combinations of continuous and batch processes and discrete events. CONFIG provides a flexible object-oriented capability to model reconfigurable equipment with operating and failure modes, and to model procedures executed by automation equipment and plant operators.

With CONFIG, you may:

- Analyze, design and experiment with operation of a "virtual plant" with a model that includes details of process control and operations.
- Analyze, modify and refine processes that are too complex to analyze with spreadsheets or flowcharts.
- Simulate and analyze cascades of failure effects in a hybrid system, to support failure modes and effects analysis and diagnosability analysis.
- Perform what-if analysis during operations to support validation of modifications of procedures to handle faults and degradations.
- Demonstrate the effectiveness of a design or solution.
- Validate advanced software for control and management of the plant by having it control the virtual plant simulation in test scenarios.
- Reuse this capability for training.

Applications

CONFIG is a general-purpose simulation tool that can support simulations in several domains, including process-oriented industries (chemicals, foods, pharmaceuticals), water and waste processing, manufacturing, power systems, and computer/telecommunication networks.

At NASA Johnson Space Center, CONFIG is currently being used for design analysis and for control software validation for advanced life support systems and propellant production systems. These include biological and physico-chemical systems for processing gases and water. CONFIG was used to test intelligent control and monitoring software for oxygen and carbon dioxide transfer between chambers in the Phase III Lunar-Mars advanced life support test. The simulation uses models of the crew, plants in the growth chamber, gas processing systems, flow configurations, operating modes, schedules, procedures, and controllers.

Features
CONFIG object-oriented models describe how the components of a system behave in operational and failure modes and how they transition between these modes. Components are connected together to define flow. The simulation identifies global changes in the configuration of flow paths that result from local state changes, and keeps track of related changes in pressure and flow. CONFIG activity models can be used to describe control, procedures and schedules and the behavior of human operators. Simulations can use deterministic scenarios or operate with random events. CONFIG supports graphical model building and model building via programming (using a process definition language or underlying Lisp). System models are built by drag and drop from libraries. The model can be animated to support visual model validation and demonstration, and can be instrumented to support interactive data input and control during the simulation. Independent models of portions of the plant can be combined in distributed simulations. Distributed simulation can also be used to increase the scale of simulations. Currently, CONFIG runs on Unix systems.

The Technology
CONFIG is an enhancement of discrete event simulation to handle hybrid systems that include fluids. Discrete event simulation is dynamic simulation, modeling the time-based behavior of systems, where the intervals between time steps are usually dependent on when events occur. Typical discrete event simulations abstract events so that they can be run much faster than real time. To support early analysis, CONFIG models can be both quantitative and qualitative. Capabilities for continuous modeling include continuous integration algorithms and qualitative simulation, based on fuzzy sets. CONFIG uses a unique graph-analysis-based capability for reconfiguring global flow and pressure during simulations.

Development Status
CONFIG is currently being used in-house at Johnson Space Center, and by university and defense researchers in a NASA machine learning project and as such is being continually extended and improved.

Options for Commercialization
This technology opportunity is part of the NASA Technology Transfer Program, the goal of which is to stimulate development of commercial applications of NASA developed technology. NASA is seeking industrial partners to license the technology for commercialization.
The CONFIG technology is protected by two NASA patents. The Discrete Event Simulation Tool for Analysis of Qualitative Models (MSC 21465-1) is protected under U. S. patent number 4,965,743 issued on October 23, 1990. The Global Qualitative Flow-Path Modeling for Local State Determination in Simulation and Analysis (MSC 22618-1), which is part of the CONFIG technology, is protected under U. S. patent number

5,732,192 issued on March 24, 1998. Both patents are owned by the United States of America and were developed by the National Aeronautics and Space Administration.

Contacts for Technical Information

National Technology Transfer Center
Marketing Department
316 Washington Ave.
Wheeling, WV 26003
800-678-6882
hottechnologies@nttc.edu