A Plug-and-Play Module for Assessing Real-Time Mission Readiness Using Subsystem Health and Interactions

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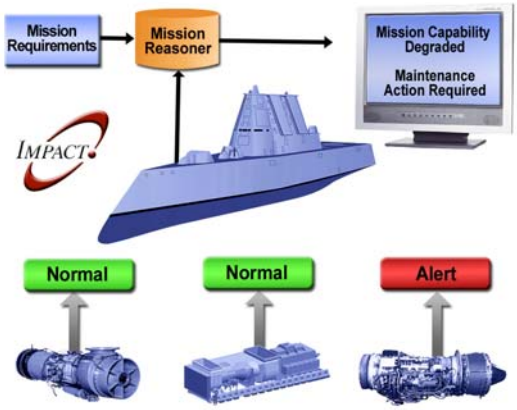
Need

Current ship equipment health and information management systems are focused on fault detection and problem isolation at the equipment component level of individual ship systems. Development of an information and decision support tool that fuses multiple independent system health indicators with repair and maintenance decision support systems will provide the Navy a readily deployable, cost effective solution to enable comprehensive, global assessment of a ship's overall health and mission readiness. This technology leverages existing open source data systems and on-board diagnostic and prognostic modules to efficiently and seamlessly employ advanced reasoning and self-learning techniques to assess and predict high level system health and readiness using multiple forms of component level inputs.

Technology Development

Impact Technologies advanced Mission Readiness Assessment Tool incorporates several novel approaches including use of a uniform gray-scale method for identifying system health and readiness; fusion of multiple independent low-level indicators to predict overall system health and readiness; methodologies to account for the interactive effects of interconnected subsystems on overall system health and readiness; and use of reinforcement learning techniques to provide automated improvement in future system health and readiness predictions.

The computer software application includes a robust modeling environment to define the overall ship using any hierarchical format or standardized system categories such as the Navy's Expanded Ship Work Breakdown Structure (ESWBS). This open, structured format provides the user flexibility to choose the appropriate level of complexity to represent any given on-board ship system. System models can be configured to accept a number of health state indicators including time based failure distributions, real-time sensor inputs, and diagnostic and prognostic system inputs.



Block diagrams constructed within the model building environment define system dependencies and subsystem interconnections for each mode of operation. Share and logic functions are used to capture these relationships which in turn, are used in combination with unique, evolutionary algorithms to correlate low level independent subsystem health indicators to overall system and ship readiness values.

A gray-scale index is used to visually represent system health and readiness. This method normalizes disparate health and readiness indicators to a common uniform scale that captures usage, criticality, and damage level effects on operational capability.

To improve future health state and system readiness predictions, the Mission Readiness Assessment Tool employs reinforcement learning techniques, utilizing historical data and current predictions to continually adjust and refine future health and readiness predictions.

The computer software application interface provides the user a comprehensive view of a ship's overall mission capability. Visibility to the health and readiness state of each system, subsystem, and component within the ship can be readily obtained by navigating through the system hierarchy; thereby, enabling improved mission capability planning and execution of shipboard maintenance actions.

Technology Transition

The primary targeted customers of the Mission Readiness Assessment Tool are all branches of the US military. Given the robust, flexible nature of the core technology, this computer software application can easily be adapted to a variety of commercial applications including commercial airlines, land and marine propulsion systems, and large utilities and processing industries.