2008 Summary of Research Reports

Associate Professor Edwin L. Zivi
Weapons and Systems Engineering Department
zivi@usna.edu

Project: Metric Based Design of Integrated Engineering Plants (final increment)
Sponsor: ONR

Statement of Work:

The Integrated Engineering Plant (IEP) integrates a ship's propulsion, electrical, auxiliary and damage control system architectures including resource management for rapid reconfiguration of dynamically interdependent mission critical services under disruptive scenarios, while simultaneously reducing the need for human intervention. A highly robust and autonomous IEP is a core problem in the design of future naval combatants. Because of the high degree of complexity in such a system, this issue is yet unresolved. In this effort, a metric based approach to the design of the IEP control is taken. Toward this end, wrap up efforts in the development of a metric based approach to component controls so that the system has the best possible time-domain performance will be conducted.

Project: Dependability Based Design of Electric Warship Integrated Engineering Plants
Sponsor: ONR

Statement of Work:

Under a previous effort [1,2,3], the groundwork was laid for a unique early design tool for electric warship engineering plants. This methodology was based around the idea of establishing well-defined metrics for the performance of the integrated engineering plant during battle damage. Using a layered simulation approach of the integrated engineering plant in which the AC power distribution system, DC power distribution system, thermal behavior, seawater cooling system, and component control were all represented in a partitioned but completely coupled fashion combined with evolutionary computing based optimization method, a means quantifying the performance of an integrated engineering plant during hostile, correlated disruptions (i.e. battle damage) was achieved. The proposed tasks are threefold.
(1) To socialize the methodology developed to the Naval engineering community. This work has already begun through collaboration with Northrop Grumman Newport News.
(2) To expand the representation of the integrated engineering plant to make the approach more comprehensive. In particular, the automation and communications layers will be expanded.
(3) To take the tool to the next level. In particular, to take the tool form primarily an analysis method for quantifying the performance of the integrated engineering plant to one which automatically designs aspects of the integrated engineering plant so as to achieve the best possible performance under the worst case conditions in a mathematically quantifiable sense.

References

[1] E. Zivi, "Design of Robust Shipboard Power Automation Systems," Annual Reviews in Control, Volume 29, Issue 2, 2005, Pages 261-272.

[2] S. Sudhoff, E. Zivi, S. Zak and T. McCoy, "Survivability Performance Formulation, Metrics and Modeling for an Integrated Engineering Plant," ONR Integrated Reconfigurable Intelligent Systems (IRIS) Progress Report, Contract N00014-05-WX-2-0362, August 2005.

[3] Y. Lee, R. Chan, S.D. Sudhoff, E.L. Zivi, "Optimization of the Ship Service Converter Module and System Capacitances in the Naval Combat Survivability DC Distribution System," IEEE Electric Ship Technologies Symposium, 25-27 July, 2005