Experiences of an ONR YIA Awardee

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Outline

Numerous researchers from our community have been supported by ONR.

My support dates from 1995, and includes the ONR Young Investigator Award (YIA), 1997-2000.

ONR brings tradition and a focus on fundamental issues - very rare today!

Modern naval power systems are in many ways prototypes of likely future utility systems - a great opportunity for synergy.

Background

Basic info - “A Frequency-Selective Approach to Modeling and Control in Switched Power Processing”, ONR Award N00014-97-1-0704, ONR Program Officer – Terry Ericsen.

Original research objective - development of frequency-selective models for power electronic converters, electric drives and power systems.

Basic aim was to study “the class of models captures system behavior around close-to-periodic (or cyclical) trajectories by emphasizing frequency bands that contain dominant portions of signals of interest...The main thrust in the theoretical domain is the exploration of connections between the generalized averaging procedures that yield models describing dynamics of switching harmonics (“dynamic phasors”), and control architectures suitable for stabilization and tracking in nonlinear power networks.”.

Looking back - a bit ambitious (still working on it!), but a great challenge and a great fun.

Outcomes

Supported (in part) two PhD students (T. Aydin, V. Petrovic) and a post-doctoral fellow (G. Escobar).

Developed (and widened) a number of collaborations - at my school (H. Lev-Ari), nearby (MIT - B. Lesieutre, G. Verghese) and at distant places (P. Mattavelli - Italy, R. Ortega - France, J.M. Carrasco - Spain)

A number of papers, book chapters and two patent applications.

Lessons Learned

Emerging naval power systems have a number of features that makes them a possible prototype of future utilities:

- A very high concentration of power electronic loads,
- Dynamic couplings over a number of time scales,
- Harmonics may play a crucial role in stabilization and control.

Naval power systems are sufficiently different from utility systems that all modeling assumptions (and our favorite analysis tools) have to be carefully re-examined.

A comparative analysis of the two classes of systems points out towards two-way (or feedback) interconnections between various problem domains.

An Example

Some characteristics of naval power systems:

- Very little rotational inertia of power sources compared to loads.
- Need to use dynamical models for all components, especially loads.
- Fast prime movers.
- Tight coupling between electrical and mechanical systems.
- Large, dynamic loads.
- Need for detailed fault modeling.

Some analytical expediences used in standard power systems are not applicable ("infinite" generator bus, constant power-current-impedance loads).

Related tools will also be needed in utility systems with distributed generation - interesting synergies may emerge.

Why ONR YIA Program Matters?

Allows young researchers to focus on fundamental issues.

Support for PhD students and postdocs - hard to find and crucial for new programs that have to achieve both depth and breadth.

Gives visibility and independence when they are most needed.

Demands that we constantly redefine our fields within the ever-changing electrical engineering.

Can YIA and CAREER Programs be Improved?

The two programs are critical, especially for faculty at universities where power programs are not well established.

Some ways to make YIA and CAREER even better:

- Increase $s, as costs of education are rising.
- Demand reduced overhead from host institutions.
- Encourage networking among awardees.
- NSF and ONR should continue to work together, and possibly bring attention of others (DARPA, ARO, AFOSR) to the energy field.