Barron Associates, Inc.
Current Research

SAE International
Aerospace Control & Guidance Systems Committee

Hilton Head, SC
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David G. Ward
(434) 973-1215
ward@barron-associates.com

Reusable Launch Vehicles
(AFRL, NASA, Marshall)

Aid in recovery to control failures / vehicle damage, larger than expected dispersions

- Reconfigurable control / adaptive guidance, and …

Primary focus on trajectory command reshaping

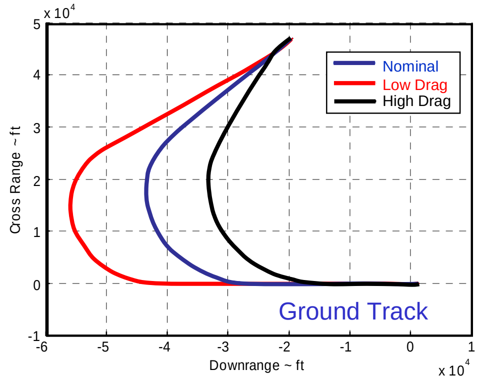
- Entry – TAEM – Approach/landing
- Adaptive energy management
- In-flight retargeting to alternative landing sites

Feasible solutions obtained in real-time

- Traditional approach: extensive pre-planning prior to launch

Currently partnered with Boeing, Huntington Beach

- Involved in high-fidelity, real-time hardware in the loop studies



Promising results obtained, tests to be completed in near future

Trade Studies for Abort Re-entry (NGC/Boeing/Draper)

Initial trades studies involving ballistic re-entry trajectories for Crew Exploration Vehicle

Other reconfiguration studies

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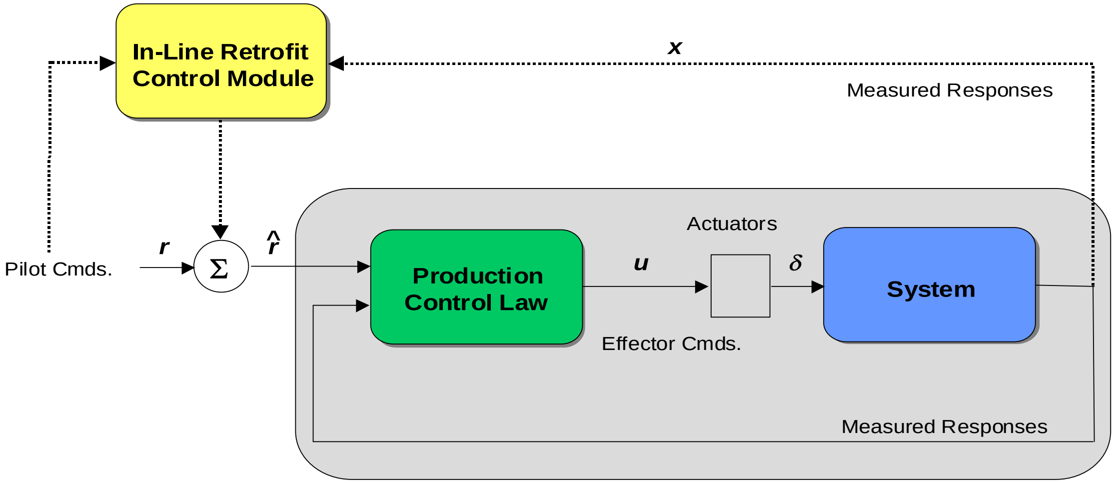
Recent Adaptive Flight Control: Retrofit Reconfigurable Control System

Goal

- Push TRL of reconfigurable control systems

Progress

- Developed retrofit algorithms
  - Real-time *lumped* system identification
  - Receding-Horizon Optimal Control
- Validated algorithms in batch and piloted simulation
  - Reconfiguration improves HQR of failed aircraft
- Ported to flight hardware and performed HIL checkout
- **Successful First Flight !**
  - July 6, 2005



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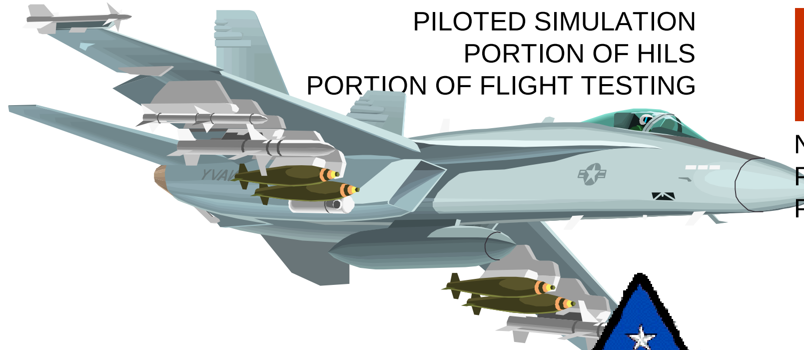
Φ II SBIR

NRT SIMULATION
PILOTED SIMULATION
PORTION OF HILS
PORTION OF FLIGHT TESTING



BOEING

NAVAIR/BOEING RESEARCH

NRT SIMULATION
PILOTED SIMULATION
PORTION OF HILS

NAWC NAVAL AIR WARFARE CENTER

FLIGHT TESTING
NAVAIR ASSETS

Retrofit | Production CAS

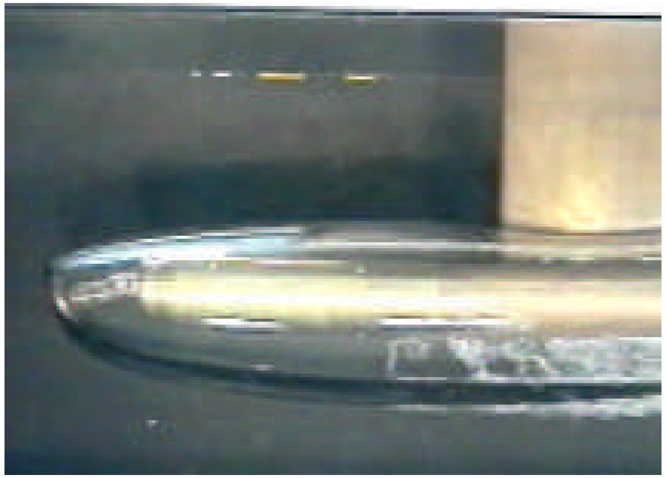
Cooper-Harper Handling Qualities Ratings
1 2 3 4 5 6 7 8 9 10

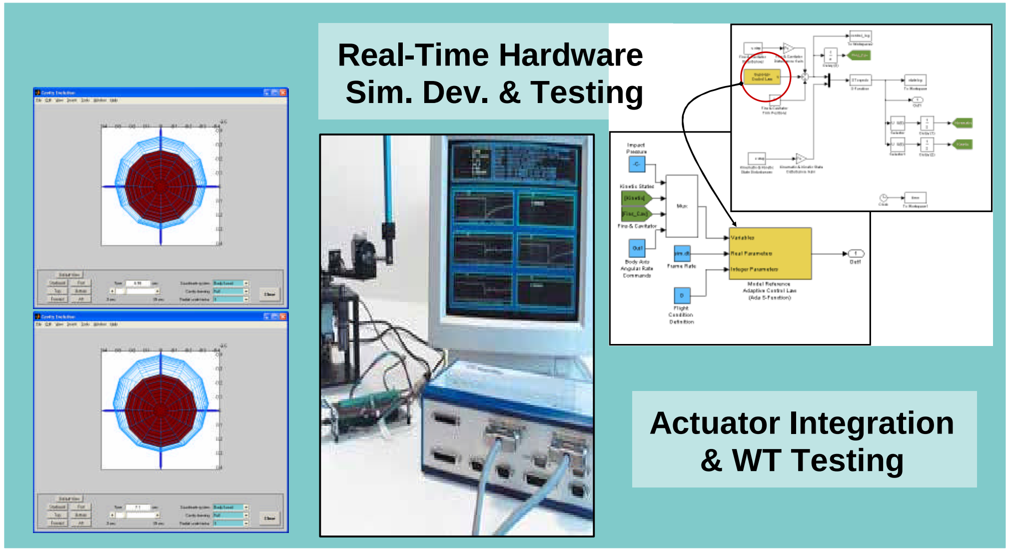
Tony Page, CoTR (PageAB@navair.navy.mil)

High-Speed Supercavitating Torpedo
ONR SBIR Phase II (with Musyn and Anteon Corp.)

Challenges

- **Abrupt Changes:** fully enveloped to partially wetted body during maneuvering manifested as slope discontinuity in applied force
- **Memory Effects:** cavity shape and flow evolve as functions of current and prior motions
- **Other Important Considerations:** center of gravity aft of center of pressure, absence of lift, etc.

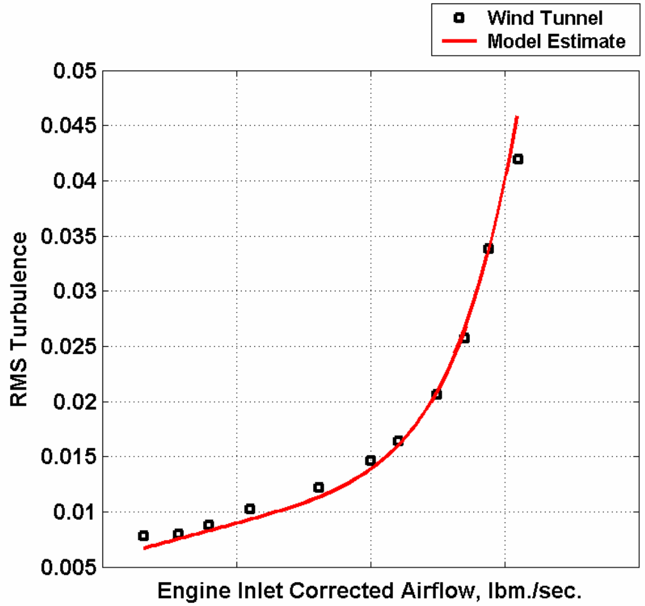


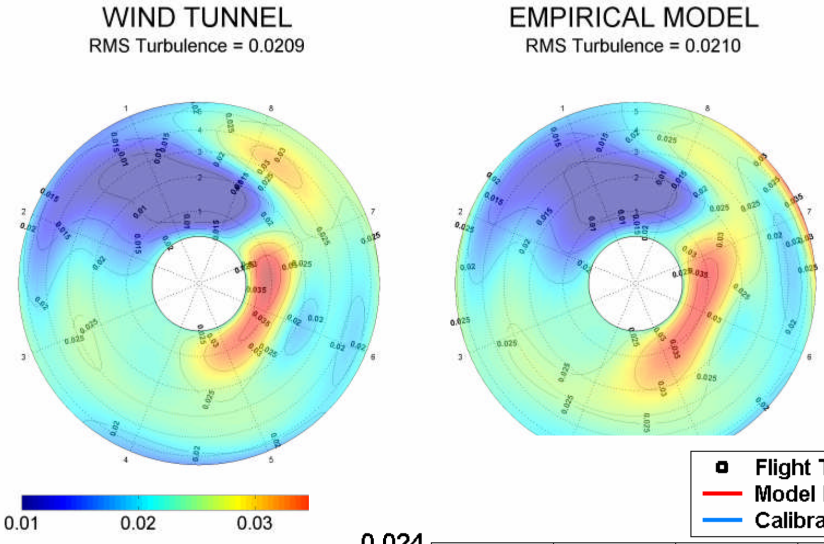


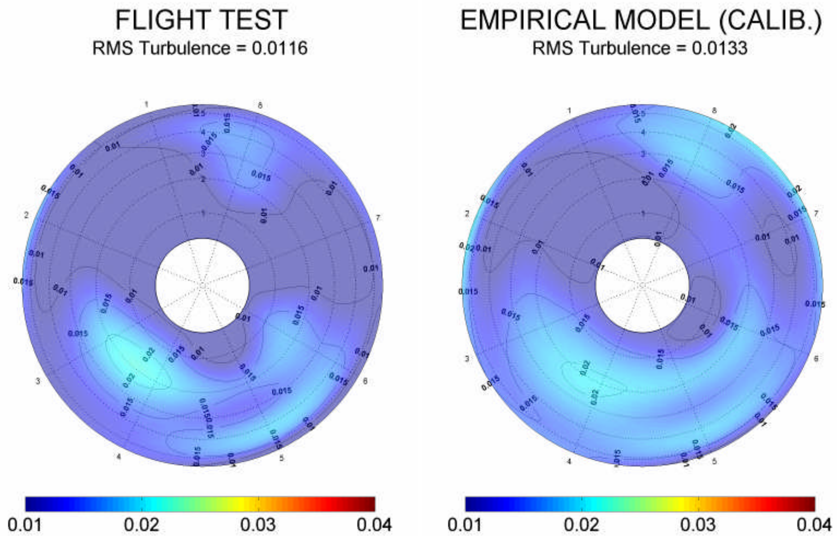
Phase I & II SBIR

- Nonlinear Model-Based Control
- Adaptation
  - Backstepping / Receding Horizon
  - Joint Parameter/State Estimation
- High-Fidelity Sim Evaluation
- Real-Time Water-Tunnel Testing

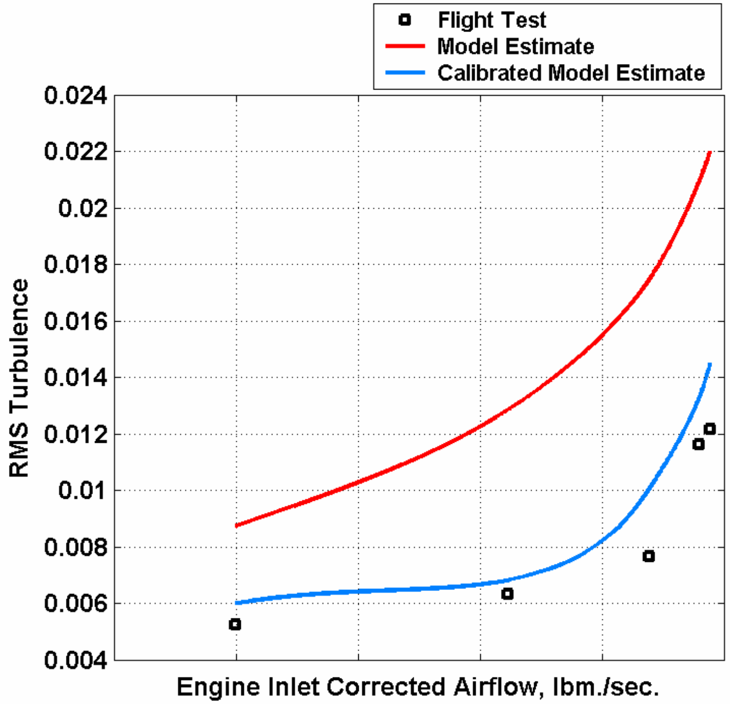
M&S
Automated Simulation Updating







RMS Turbulence Contours



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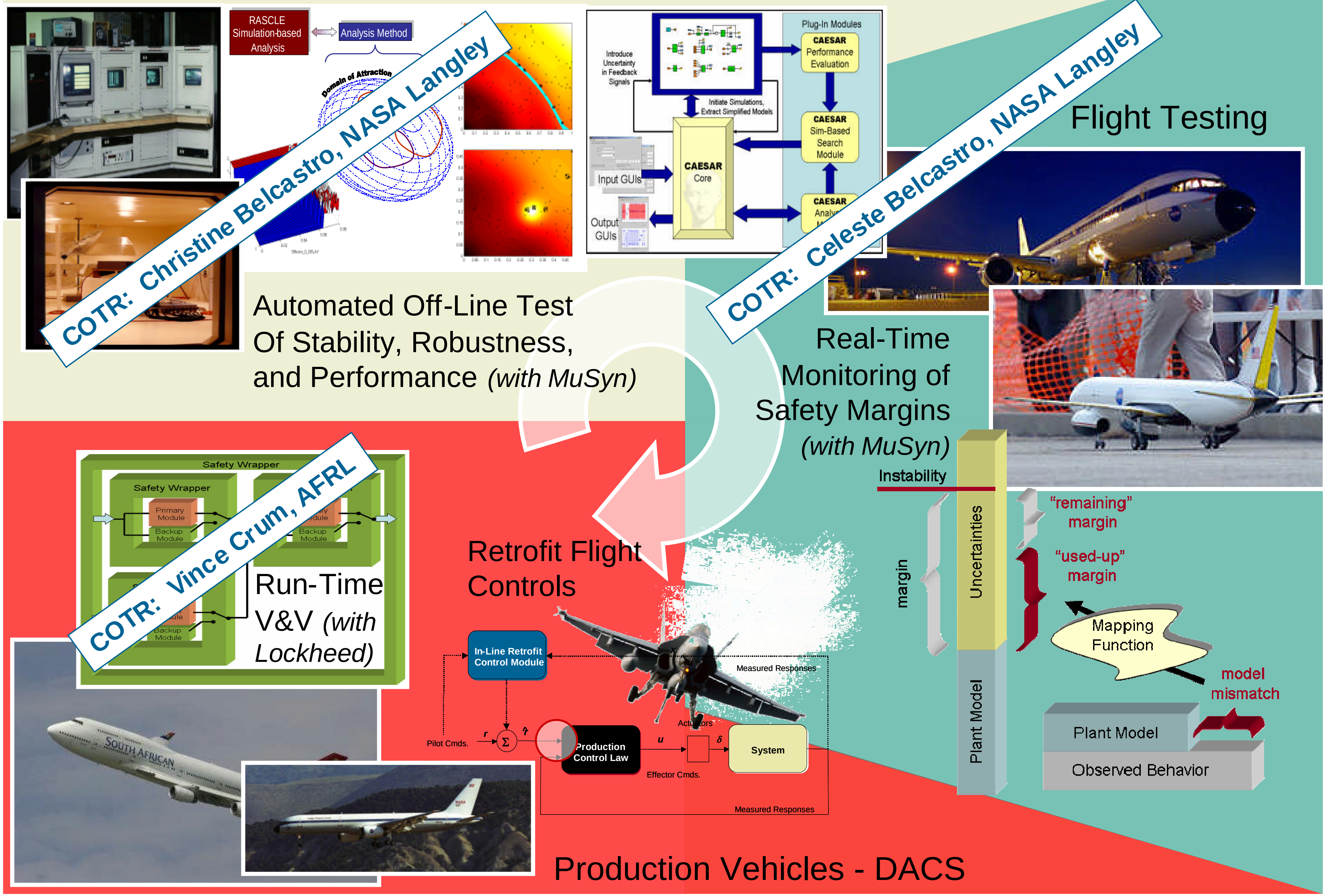
Analysis Methods, Software Tools, and Novel System Designs

V&V Through the Control Law Life Cycle



An Integrated Control and Diagnostic System for Marine Diesel Engines

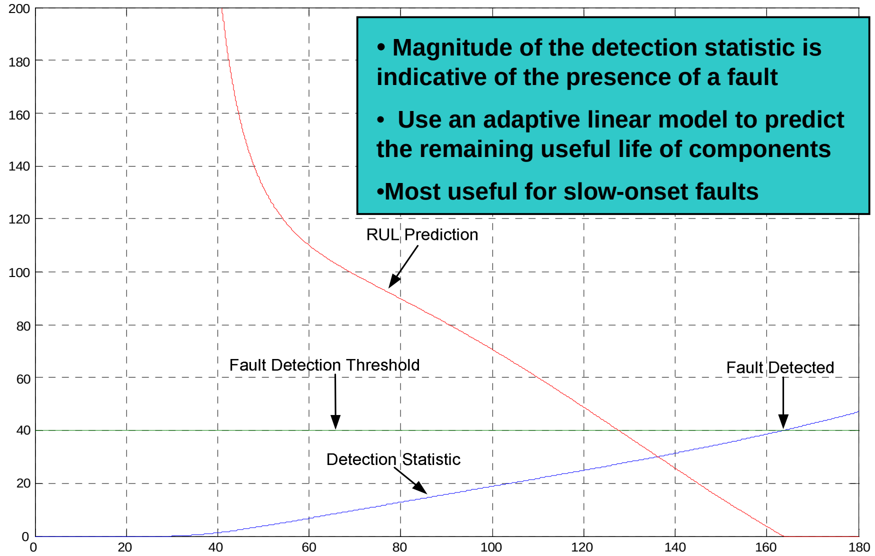
Topic: N04-079, Firm: Barron Associates, Charlottesville, VA,
PI: Jason Burkholder, burkholder@bainet.com, (434)-973-1215
ONR Phase II SBIR Sept. 7, 2005 – Sept. 6, 2007

Phase I Results

- Constructed a marine diesel engine model in Matlab/Simulink that includes a diverse set of failure modes
- Applied generic algorithms that use statistical change detection to detect and isolate failures
- Achieved perfect fault detection and isolation performance for a variety of sensor and actuator failures

Phase II Plan

- Install a diesel engine in SwRI's engine test facility and instrument the engine with additional sensors, including accelerometers
- Operate the engine in a series of faulted and unfaulted conditions and record the data using a ruggedized ECU and data logger
- Optimize diagnostic and prognostic algorithms and demonstrate the algorithms in real-time
- Instrument a diesel engine aboard a research vessel and conduct a sea trial



- Magnitude of the detection statistic is indicative of the presence of a fault
- Use an adaptive linear model to predict the remaining useful life of components
- Most useful for slow-onset faults

Collaborator:

Southwest Research Institute

Dept. of Engine & Emissions Research

Investigators:
Jayant Sarlashkar, Ph.D.
Ryan Roecker

Sponsor:

Robert Brizzolara, Ph.D.
Ship Science & Technology Division
Office of Naval Research
Tel: (703) 696-2597

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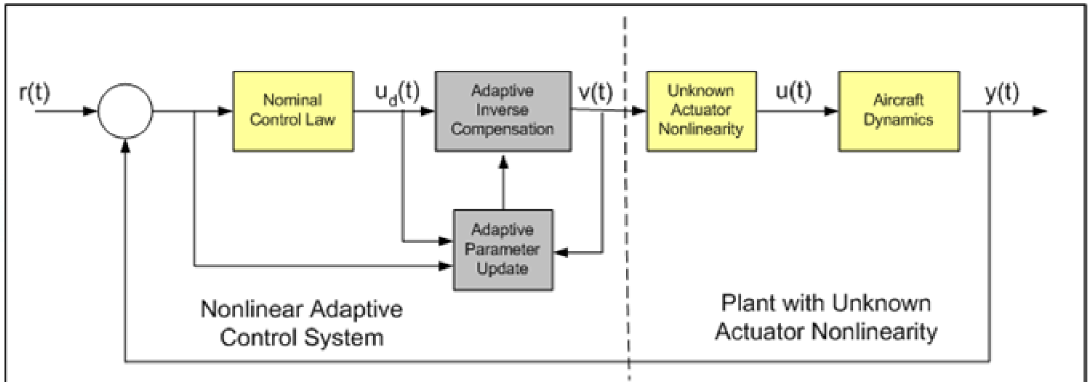
Adaptive Control of Synthetic Jet Arrays with Unknown Nonlinearities

Topic: AF04-T027, Firm: Barron Associates, Charlottesville, VA,
PI: Jason Burkholder, burkholder@bainet.com, (434)-973-1215

AFOSR STTR Phase II Sept. 30, 2005 – Sept. 29, 2007

Phase I Results

- Design for the arrangement of synthetic jet arrays that facilitates virtual shaping of an airfoil at low angles of attack
- Parametric model of synthetic jet actuators
- Practical, implementable adaptive control algorithm based on an adaptive nonlinearity inverse technique
- Successful simulation results using synthetic jets for virtual shaping of a tailless aircraft



$u_d(t)$: Commanded Control Surface Deflection
$v(t)$: Synthetic Jet Array Input Signal
$u(t)$: Effective Virtual Surface Deflection
Adaptive Compensation Objective:
$u(t) \rightarrow u_d(t)$ which implies $y(t) \rightarrow r(t)$

Phase II Plan

- Design and fabricate an innovative wind tunnel model with integrated synthetic jet actuators
- Demonstrate adaptive control of synthetic jet arrays for separation control at high angles of attack
- Demonstrate adaptive control of synthetic jet arrays for virtual shaping of airfoils at low angles of attack

Collaborators:

University of Virginia
PI: Dr. Gang Tao
Adaptive Control Development

University of Wyoming
PI: Dr. Douglas R. Smith
Modeling and Experiment Design

Sponsor:

Lt Col Sharon Heise, PhD
Program Manager, Dynamics & Control
AFOSR/NM
Tel: (703) 696-7796

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