



INNOVATIVE TECHNOLOGY
APPLICATIONS COMPANY



UNIVERSITY OF
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Facility Control Software

An advanced Facility Control Software (FCS) has been developed to improve the performance, management, and productivity of large-scale wind tunnel facilities over a wide range of operating conditions.

Under Air Force Office of Scientific Research (AFOSR) sponsorship, Innovative Technology Applications Company (ITAC), LLC and University of Notre Dame jointly developed the NNFMCS software using physics-based mathematical modeling and neural network technologies to improve facility control, enhance data extraction and management, and reduce the various costs associated with large-scale facility operations. The software can also function as a reliable and robust model-based feedforward controller for control of large wind tunnels.

The FCS begins with a physics-based mathematical model in which heat and mass flows in the modeled facility are computed using fluid-mechanic conservation equations. Robust accuracy is achieved by efficiently calibrating the model's parameters using operations data recorded from standard instrumentation. Measured or model-generated facility data are organized using neural networks, which have been shown to improve facility control, usage, data management and operations over a wide range of conditions. The resulting improvement in facility usage can lead to significant energy savings, reduction in maintenance and operational costs, and enhanced test productivity.

The FCS software can be uniquely adapted to any wind tunnel or test facility. The process involves the following main steps:

- Formulation of a physics-based mathematical model of the facility
- Training of neural networks to organize and manipulate facility data
- Development of applications and interfaces
- Development of model-based feedforward controller

KEY BENEFITS

- Reduced energy costs
- Operator training
- More efficient test scheduling
- Real-time monitoring for tunnel safety
- Plant model for feed-forward control
- Improved data management
- Facility health and performance tracking
- Error identification via complex signal comparisons

REFERENCES

- Rennie, R.M., Sutcliffe, P., Vorobiev, A., and Cain, A.B., "Mathematical Modeling of Wind-Tunnel Thermal Behavior," *J. Heat Transfer & Thermophysics*, V. 29, No. 3, pp. 524-532, 2015.
- Rennie, R. M., Sutcliffe, P., Vorobiev, A., and Cain, A. B., "Mathematical Modeling of Wind-Speed Transients in Wind Tunnels," AIAA 2013-1024.
- Sutcliffe, P., Vorobiev, A., Rennie, R. M., and Cain, A. B., "Control of Wind Tunnel Test Temperature Using a Mathematical Model," AIAA-2013-2491.
- Rennie, R. M. and Cain, A. B., "Management of Wind Tunnel Performance Data Using Neural Networks," AIAA-2012-0321.
- Rennie, R. M., Kane, T., and Cain, A. B., "Mathematical model for the Thermal Behavior of a Wind Tunnel," AIAA-2011-3782.

ITAC, LLC is a high-technology, small business company providing contract research and development, and consulting services for the aerospace, defense, and energy sectors. Combining fundamental research capabilities and leading-edge expertise, ITAC collaborates with academic and industry experts to provide its customers high-performance solutions and products in areas of aerodynamics, aero-optics, aero-acoustics, and computational flow physics.

Contact us for tech-transition & research opportunities!

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