

AVT-ET-204 – Data Fusion and Assimilation For Scientific Sensing and Computing

NASA Langley Upstart

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Advanced Measurement and Data Systems Branch

**NATO/NASA Interchange Meeting
February 6, 2020**

General Information

- Activity Number: ***AVT-ET-204***
- Classification: ***NATO Unclassified + EOP***
- Output: ***RTG Proposal***
- Planned Start: ***10/2019***
- Expected End: ***09/2020***
- Nations: ***USA, ITA, FRA, CAN, GER, TUR, GRC, NOR***
- Lead Nation: ***USA***
- Expected Technology Readiness Level: ***2-4***
- Co-Chairs: **Philippe Bardet (USA), Matteo Diez (ITA)**
- ***New Panel Member: William Humphreys (NASA LaRC)***

Background / Motivation

- With the advancement of low-cost sensors and multi-sensor data fusion algorithms developed over the years by the military and consumer industry, we are on the verge of a paradigm shift in scientific instrumentation and computations
- Networks of multiple inexpensive sensors with advanced algorithms will enable the closing of gaps in traditional scientific instrumentation while enabling data mining
- Recent machine learning, surrogate modelling, and optimization methods (including fusion of multi-fidelity models, solvers, data) offer a unique opportunity for advancing the effective use of low-cost instrumentation and multi-sensor data

Mission / Scope of ET

- Provide the NATO community with information on the state of the art for data fusion and assimilation methodologies
- Translate SOA into applications to scientific experiments and computations
- Build communities through the review of methods that are typically studied in specialized fields and the conduction of demonstrations
- Propose demonstrations including experiments, computations, and design of experiments with optimized deployment of sensors and assimilation of data into computational models

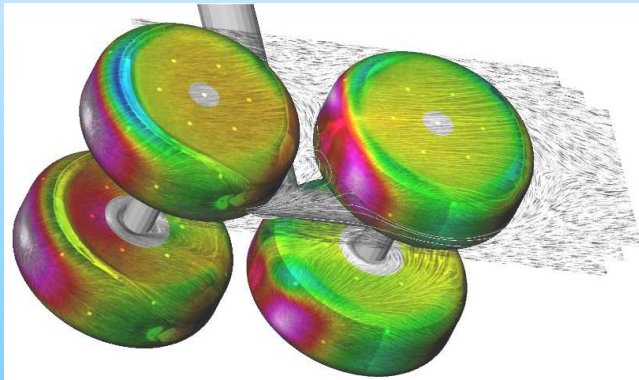
Status: First meeting of ET was held in Trondheim, Norway in Oct., 2019

Next Meeting of ET: Quebec, Canada in April, 2020

Deliverable: Final report and possible RTG proposal in Oct, 2020

NASA LaRC Activities in Data Fusion

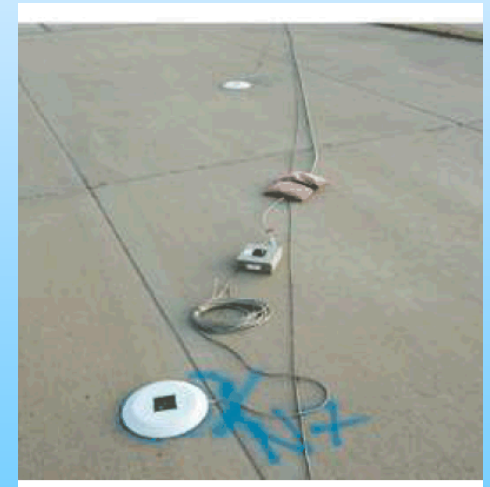
- D301 (CAB) – Developing data fusion technologies to revolutionize use of wind tunnel and computational capabilities
- D304 (AMDSB) – Investigating methods for use of sensor fusion methodologies for flow control state estimation
- D304 (AMDSB) – Investigating use of edge computing to reduce bandwidth while maximizing information return from sensor arrays



Fusion of Oil Flow, Surface Pressure
And Velocity Measurements (Severance, 2004)



State Estimation Fusion Processor
For Flow Control (Humphreys, 2008)

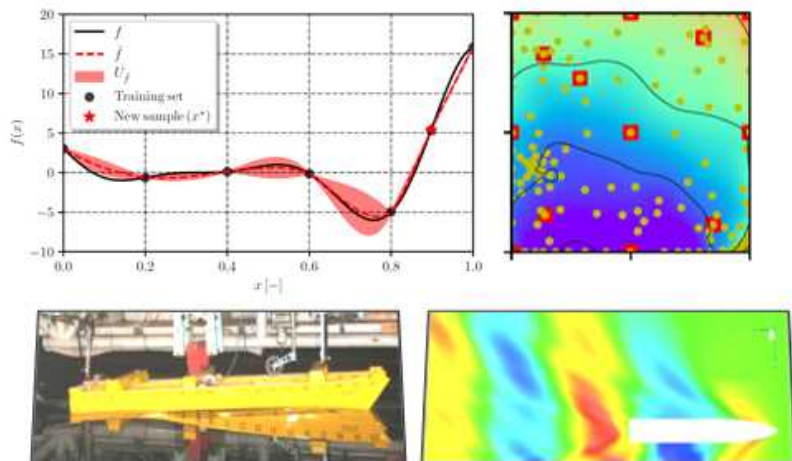


Microphone Array Edge Computing
Demonstration (Humphreys, 2019)

Summary

- ET reviewing state-of-the-art methods for data fusion and assimilation particularly suited for integration of data and simulations in the scientific context
- Reviewing state-of-the-art methodologies for networks of sensors and extension to scientific sensing
- Proposing routes for demonstrations for computing, sensing, and validation methodologies
- Preparing RTG proposal (tentative) on data fusion and assimilation methods

AVT-ET-204: Data fusion and assimilation for scientific sensing and computing



Team leader(s): Philippe Bardet (USA)
Matteo Diez (ITA)

Panel Mentor: Thomas Fu (USA)

Members: USA, ITA, FRA, CAN, GER, TUR,
GRC, NOR

Partners: TBD

Duration: OCT 2019 – SEP 2020

Coordination: TBD

Related activities: AVT-252, AVT-253, AVT-280, AVT-331

Objectives:

Evaluate state of the art of data fusion and assimilation methods and translate them to scientific sensing and computing for applications of interest to NATO.

Topics/Themes:

- Inexpensive distributed multi-physics sensor network
- Fusing with traditional scientific instruments
- Reduction of data imperfection and sensor-fault detection
- Data assimilation for computational models' development
- Optimization of sensors deployment
- Deployment in real-world platform
- Distributed data processing, storage, and replication
- Simulation, machine learning, and optimization

Impact and Exploitation (DOTMLPFI)

- Assessment of ability to deploy inexpensive sensing network to rival traditional scientific instruments.
- ET to develop follow-on activities:
 - ✓ Evaluation of various data fusion and assimilation methodologies for new sensing and computing paradigms for military sea, ground, and air vehicles.
 - ✓ Demonstrate methodologies in experiments, computations, and design of experiments.
 - ✓ Establish validation datasets based on those principles

