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Dynamic data driven methods for structural assessment and self-aware air-vehicles

ABSTRACT

Next generation of aerospace vehicles will be able to autonomously operate accounting for the evolution of their health (self-awareness) and the dynamic change of the surrounding environment (situational awareness). This form of autonomous reasoning can be formalized as instance of the general Sense-Infer-Plan-Act flow that processes data into information, information into knowledge, and knowledge into intelligent decisions. We discuss the specific problem of supporting self-awareness and associate the Sense-Infer-Plan-Act flow with measurements (physical quantities that can be monitored with sensors), and capabilities (quantities that evolve with the state of the system and limit the operational space). In this framework, we wish to obtain real-time estimates of capabilities from sensor measurements. To achieve this goal, we develop an offline-online methodology that combines data and physics-based models through a Multi-Step Reduced Order Modeling (MultiStep-ROM) procedure. In addition, we propose a novel approach for the identification of the most informative sensor locations. We apply our methodologies to the practical case of autonomous aerospace vehicles that dynamically adapt their mission to the evolution of their structural state.

BIOGRAPHY

Laura Mainini is Visiting Professor at Politecnico di Torino and Research Affiliate at MIT. Laura is currently on sabbatical leave from United Technologies Research Centre (Ireland) where she has been serving as Principal Investigator of a major Clean Sky 2 project. Before joining UTRC, Dr. Mainini was postdoctoral associate at MIT and served as Principal Instructor at Singapore University of Technology and Design for the MIT-SUTD Collaboration Program. Laura earned her BSc, MSc. and PhD in Aerospace Engineering from Politecnico di Torino; she received a Fulbright grant to conduct research at MIT during her doctoral studies. In addition, she obtained a MSc. in Aeronautical Engineering from Politecnico di Milano and a Diploma for multidisciplinary graduate studies from Alta Scuola Politecnica. Dr. Mainini's scientific research career brings together international academic, industrial, and government projects in Europe, the United States, and Singapore. Her research interests include multidisciplinary design optimization, multi-fidelity analysis, reduced-order modeling, data-to-decision, and physics-based machine learning.



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