

PROGRESS IN THE APPLICATION OF MACHINE LEARNING AND ARTIFICIAL INTELLIGENCE TO ENHANCE EFIT EQUILIBRIUM RECONSTRUCTION FOR FUSION DATA ANALYSIS AND REAL-TIME APPLICATIONS

L.L. Lao, C. Akcay, T.A. Bechtel, Y.Q. Liu, J. T. McClenaghan, D. Orozco, D. Schissel
General Atomics
San Diego, USA
Email: Lao@Fusion.gat.com

S. Kruger, E. Howell, J. Leddy,
TechX
Boulder, USA

S. Madireddy, P. Balaprakash, J. Koo
Argon National Laboratory
Lemont, USA

S. Williams
Lawrence Berkeley National Laboratory
Berkeley, USA

M. Leinhauser
University of Delaware
Newark, USA

A. Pankin
Princeton Plasma Physics Laboratory
Princeton, USA

Abstract

Recent progress in harnessing novel machine learning (ML) / artificial intelligence (AI) algorithms to enhance EFIT equilibrium reconstruction for fusion data analysis and real-time applications is presented. This includes development of a ML-enhanced Bayesian framework to automate and maximize information from measurements and Model-Order-Reduction (MOR)-based ML models to efficiently guide the search of solution vector. A device-independent portable core equilibrium solver has been created to ease adaptation of ML enhanced reconstruction algorithms. An EFIT database comprising of DIII-D magnetic, motional Stark effect (MSE), and kinetic reconstruction data is being generated for developments of EFIT-MOR surrogate models to speed up the search of solution vector. A parallel Python framework is used to construct input and output vectors for communication with the equilibrium database and training of EFIT-MOR surrogate models. Approaches to improve portability between the OpenMP and GPU EFIT versions are being explored on Linux GPU clusters and the new NERSC Perlmutter to create a performance-portable GPU implementation for further optimization of ML/AI based reconstruction algorithms. Other progress includes development of a Gaussian-Process Bayesian framework to improve processing of input data, and construction of a 3D perturbed equilibrium database from toroidal full MHD linear response modeling with the MARS-F MHD code for developments of 3D-MOR surrogate models.

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