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Learning-based methods applied to real-time control using the integrated MARTe2/MDSplus framework.

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In this paper, an application of real-time control with integrated learning-based models is presented. In development, the MARTe2/MDSplus framework was used for rapid prototyping of control system components, including the training of learning-based models. MARTe2, a networked, real-time control framework, and MDSplus, a data management framework, are widely used in fusion experiments to increase efficiency in research. The two frameworks have been interfaced to provide flexibility in component modularization and robust data management of experiment results for real-time control systems. To demonstrate deep learning system development within the MARTe2/MDSplus framework, a vision-based observer was trained from and implemented in a real-time control system for a levitated magnet. The levitated magnet control system was designed to be analogous to plasma control systems and includes key characteristics such as distributed modular deployment, multi-timescale operation, scalability, and usability. The development process of this simplified model can be effectively abstracted thereafter to be applied to more complex problems. The controller was initially designed through linear optimal control methods. The training data for the vision-based observer was then acquired from test results, and the model was developed in parallel with controller improvement. The performance of the vision-based observer show that the proposed framework provides a robust and efficient pipeline for training deep learning models. Furthermore, the observer was implemented in real-time to analyze the system requirements for inference speed and accuracy imposed by the MARTe2/MDSplus framework. The application of this framework can be naturally extended to apply to different learning-based methods such as data-driven control, system dynamics modelling, etc.

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