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Development of a digital twin towards enhanced monitoring of the SF6 subsystem on the Z Machine

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In this work, we develop a digital twin of the Sulfur Hexafluoride (SF6) subsystem on the Z Machine at Sandia National Laboratories. The Z Machine is a premier pulsed power research facility for studying high energy density science. Z's SF6 subsystem provides centralized SF6 distribution to high voltage components which use it as an insulating gas to enable nanosecond time frame switching operations. Due to varying experimental requirements, the SF6 system is highly dynamic, heavily automated, and equipped with numerous monitoring systems. Partially motivating this automation is a desire for online leak detection, as SF6 emissions are regulated and reportable. Refinements to the leak detection system improve response times and minimize gas losses. A digital twin can dynamically update alongside the physical system using real-time data, providing a precise estimate of the SF6 subsystem's internal state which can augment monitoring processes. The digital twin described in this work was developed in Simulink and calibrated using historical data from the Z Machine. It supports real-time, online IO and interaction with the SF6 control system. Future work will include incorporating the digital twin as the plant model in a state observer using online telemetry to synchronize the digital twin's state with that of the full system. We discuss potential future functionality which could further reduce SF6 loss, including leak localization, system optimization, and predictive maintenance.

Footnotes

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