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Real-time disruption prediction in the PCS of EAST tokamak using a random forest model

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A real-time data-driven disruption prediction algorithm has been implemented in the Plasma Control System (PCS) of the EAST superconducting tokamak. Disruptions are dangerous, unforeseen events and they can cause extreme damage to the plasma facing components via rapid (on the order of milliseconds) release of the magnetic stored energy and plasma current. Therefore, a real-time warning system that predicts disruptions ahead of time to initiate avoidance actions or trigger the mitigation system is necessary in current experiments and for future fusion reactors. To this aim, we developed a data-driven algorithm based on random forests that uses zero-dimensional plasma parameters including diagnostic measurements and modelling data that reconstructs the plasma state. This system is able to calculate the disruption probability in real time, by using signals to transferred to the PCS every 500 microseconds and taking approximately 150-300 microseconds for inference. The random forest is a machine learning algorithm used in many other fields outside plasma physics, but also already exploited on another tokamak (DIII-D). The model is trained using around 1000 plasma discharges including disruptive and non-disruptive discharges. The estimated disruption probability can serve as the trigger to the disruption control systems, such as MGI and fast ramp down of the plasma current to safely shut down the experiment with no damage. The algorithm can also provide indications of the causes of the disruptivity by analyzing the feature contributions in real-time. This can be used to detect which action should be taken by the PCS to avoid the disruption safely.

Minioral

Yes

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No

Are you a student?

No

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