An interpretable, transferable and real-time disruption predictor in HL-2A based on deep learning

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A disruption predictor based on deep learning is developed in HL-2A. It has an accuracy of 96.1% on Shot Nos. 32000-36000. Novel 1.5-D CNN + LSTM structure is used to get such a high accuracy. [1] In recent years, further investigations and updates are carried out on the basis of the original algorithm, which bring it interpretability, transferability and real-time capacity.

For the interpretability, HL-2A's algorithm give saliency maps indicating the correlation between the algorithm's input and output. The distribution of correlations shows good coherence with the disruption causes. A disruption recognizer can be realized by using Bayes theorem to inference disruption reasons by correlations distributions. [2]

For the transferability, a preliminary disruption predictor is successfully developed in HL-2M, a newly built tokamak in China. Although only 44 shots are used as the training set of this algorithm, it still gives reasonable outputs with the help of data from HL-2A and J-TEXT.

For the real-time capacity, the algorithm is accelerated to deal with an input slice within 0.3ms with the help of some adjustments on it and TFLite framework. It is implemented into the plasma control system and get an accuracy of 89.0% during online test. Figure 2 shows a demo shot where the algorithm predicted a disruption and triggered the SMBI to mitigate it. [3]

These three characteristics along with the high accuracy make the deep learning-based disruption predictor in HL-2A a new promising method for the disruption prediction in ITER.

References

[1] Zongyu Yang et al, Nuclear Fusion 60, 016017

[2] Zongyu Yang et al, Nuclear Fusion 61, 126042

[3] Zongyu Yang et al, 4th IAEA FDPVA, short talk

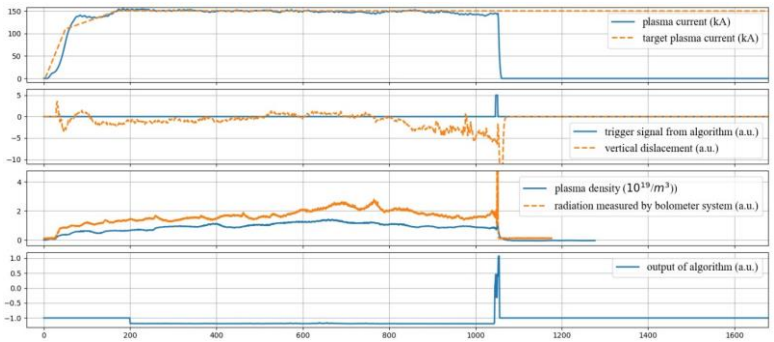

Figure 1. Demo shot for real-time disruption prediction and mitigation in HL-2A