AI applications on EAST for plasma control

Bingjia Xiao, Wenhui Hu, Yao huang, Yuehang Wang, Yanci Zhang, Binnuo Liu, Dalong Chen, Bihao Guo, Qiping Yuan, Wangyi Rui, Huihui Song, Sun Wang, Kai Wu, and Biao Shen

Institute of Plasma Physics, Chinese Academy of Sciences,
Hefei, China
Email: bjxiao@ipp.ac.cn

Robust control of tokamak plasma requires deep understandings of complicated plasma dynamics together with its response with complicated structures and actuators. However, these understanding are not well done because of the complexities. In recent years, artificial intelligence has shown its great success in many fields. In controlled fusion fields, AI also received more and more attentions in predication of plasma states based on the existing data and in control of plasma equilibrium based simplified model and reinforcement learning. On EAST, we used Bayesian inference-based identification of plasma equilibrium parameters and profiles, aiming at a consistent and accurate reconstruction of the plasma equilibrium. We collected all the disputed shots to establish disruption database. We trained AI models by CNN, LSTM, Random Forest and XGboost to predict disruptions by impurity burst, MARFEE and other unknown reasons. Cross machine disprution prediction has been done with Alcator C-mod and DIII-D in collaboration with MIT team. In order to get more accurate and quicker real-time estimation of the plasma position and vertical growth rate, we trained a neural network by using off-line EFIT equilibrium data. Real-time performance and accuracy haven been verified in the experiments. By using METIS modeling of plasma response with Low Hybrid Wave and experimental data, we demonstrated the control of plasma beta and li by using the reinforce learning (RL). Such RL method is also applied to the vertical control by using a rigid RZIP model and experimental data and the control of the vertical stability has been demonstrated. In order to predict a discharge, we reconstructed an EAST database in HDF5 from the original MDS+ PCS control database. Good prediction of the discharge parameters including plasma pressure and even the plasma boundary has been achieved.