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Plasma optical boundary detection based on instance segmentation

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During long pulse steady-state discharge, the position and shape of plasma reconstructed by the EFIT code may produce significant errors due to factors such as integrator drift and local magnetic field changes, which in turn affect discharge stability. However, optical based boundary reconstruction signals are not affected by the complex electromagnetic environment within the Tokamak. The use of high-speed cameras can capture real-time visible spectral images of plasma discharge, and it is of great significance to stably identify plasma optical boundaries in real-time under various illumination conditions for long pulse steady-state discharge.
In this study, a plasma boundary detection algorithm based on Yolov8 algorithm is developed and a dataset for plasma optical boundaries has been established, containing image data under various illumination conditions, labeled through Retinex image enhancement algorithm. After training, the MPA (mean pixel accuracy) of the Yolov8 detection algorithm is 0.872 and the mIoU is 0.74 on the test set. However, the detection of the overall contour and detailed texture of the plasma optical boundary is still insufficient. Consequently, the model initially introduces P6 feature layer to augment the receptive field, enabling more effective capture of the comprehensive structural information of the plasma optical boundary. The MPA on the test set is 0.877 and mIoU is 0.75. Subsequently, CBAM attention mechanism is introduced in this model. The channel attention module is capable of discerning significant features within the multi-scale feature map, such as the internal texture information of the plasma optical boundary, to improve model segmentation accuracy. The spatial attention module concentrates on the main regions of the plasma optical boundary in the image and reduce the attention to the noise and occlusion parts, thereby enhance the model's ability to deal with noise and occlusion. Through subsequent testing on the same test set, Yolov8n-seg-p6-CBAM recognizer demonstrates improved performance, the MPA is improved to 0.901, mloU is improved to 0.79, and single detection time of the recognizer is 4.3ms on single NVIDIA 3090 GPU. Plasma optical boundaries can be accurately detected under different illumination conditions of plasma discharge image. This research offers a novel approach for long pulse steady-state control in future Tokamaks.
References:
[1] Yan, H. et al. Optical plasma boundary detection and its reconstruction on EAST tokamak. Plasma Phys. Control. Fusion 65, 055010 (2023).
[2] HAN, X. et al. Development of multi-band and high-speed visible endoscope diagnostic on EAST with catadioptric optics. Plasma Sci. Technol. 25, 055602 (2023).
[3] Woo, S., Park, J., Lee, J.-Y. & Kweon, I. S. Cbam: Convolutional block attention module. in Proceedings of the European conference on computer vision (ECCV) 3–19 (2018).

Speaker's Affiliation

Unviersity of Science and Technology of China, Hefei

Member State or IGO

China, People's Republic of

Primary author: ZHANG, Qirui

Co-authors: CHEN, ming; GUO, bihao; Prof. SHEN, biao (Institute of plasma physics, Chinese Academy of Sciences); CHEN, Dalong; YANG, Jianhua; HUANG, YAO (ASIPP); XIAO, Bingjia (Institute of Plasma Physics, Chinese Academy of Sciences)

Presenter: ZHANG, Qirui

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