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NEURAL NETWORKS APPLICATION FOR MAGNETIC PLASMA CONTROL ON THE T-15MD TOKAMAK *)

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When solving the problem of equilibrium reconstruction for the purposes of magnetic control at the initial stage of discharge, the control system uses the reconstructed data of the position of the plasma column, the coordinates R and Z. Further, after intial ramp-up and at the current flat-top, the shape of the plasma column if controlled.

The modern concept of controlling the shape of a plasma column is reduced to ensuring the maintenance of programmable values for the distances (gaps) between the last closed magnetic surface of the plasma and a number of control points located outside the plasma region [1].

In our case, a neural network is used to reconstruct divertor plasma configurations, which expands the possibilities of the methodology described in [2].

As a result of simulation of a various divertor's configurations of the plasma colunmn, the signal data from Rogowski loops for measurement of coil currents and plasma current, from axisymmetric poloidal flux loops, from tangential magnetic probes for the measurement of local magnetic field, were used in training the neural network for reconstruction tasks.

The creation of training and testing samples for neural networks was carried out using the DINA code [3].

The development of a neural network approach for the reconstruction of plasma parameters is widely used in a number of experiments [4, 5].

As part of the problem of reconstruction, the following tasks were solved:

Selection of the neural networks architecture and algorithm for the reconstruction of plasma parameters used in the magnetic control system;

Investigation of the possibility of direct restoration of controlled parameters by means of neural networks;

The neural networks was trained on the calculated values of the gaps between the plasma boundary and four to five specified points, as well as the distance from the selected points to the coordinates of the intersection of the surface of the divertor plates by the separatrix;

Testing of the neural networks operation was carried out by modeling the divertor stage of the discharge scenario in the tokamak T-15MD.

References

[1]. Скопинцев Д.А., Докука В.Н., Хайрутдинов Р.Р., Андрианова Р.Р., Хайрутдинов Э.Н. Применение нейронных сетей для задач восстановления равновесия плазмы в токамаке, будет опубликовано в ВАНТ, ТС в 2025 г.

[2]. Докука В.Н., Хайрутдинов Р.Р., Кавин А.А. Синтез и моделирование системы магнитного управления плазмой в токамаке КТМ // ВАНТ. Сер. Термоядерный синтез, 2008, Вып. 1, С. 12 – 20.

[3]. Khayrutdinov R.R., Lukash V.E. Studies of Plasma Equilibrium and Transport in a Tokamak Fusion Device with the Inverse-Variable Technique. // J. Comput. Physics, V. 109 (1993), P. 193–201.

[4]. F. Long, X. Xia, J. Liu, et al., Reconstruction of Poloidal Magnetic Fluxes on EAST based on Neural Networks with Measured Signals, 2024 //https://doi.org/10.48550/arXiv.2403.10114

[5]. H.H. Song, B. Shen, Q.P. Yuan1, et al., Research on plasma vertical displacement calculation based on neural network // *J. Plasma Phys.* (2023), *vol.* 89, 895890104

*) abstracts of this report in Russian