Disruption Prediction with Sparse Modeling by Exhaustive Search

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Plasma disruption is one of crucial phenomena in a tokamak fusion reactor. To realize nuclear fusion reactor, it is necessary to elucidate and control it. However, its physical mechanism is not clearly identified yet, so there are some studies trying to predict occurrence of disruptions based on experimental data.

In this research, we constructed disruption predictor using a support vector machine(SVM) based on the large experimental data in JT-60U and feature extraction by sparse modeling was carried out. The concept of sparse modeling exploits the inherent sparseness that is common to all high-dimensional data and enables us to efficiently extract the maximum amount of information from data. For the sparse modeling, we used exhaustive search with SVM, assuming that the optimal combination of explanatory variables is K-sparse [1].

We have obtained some results showing that feature extraction can contribute to improvement of disruption prediction performance and understanding of the physical background of disruption. As a variable before narrowing down, we chose 17 parameters from physical knowledge. We selected normalized beta and plasma internal inductance because we use results of high-beta experiment. We also selected safety factor 95% of minor radius, and these parameters are obtained from MHD equilibrium calculation. We use not only those parameters' value, but also time derivative value. In our results, 6 parameters including mode lock amplitude and its time derivative are extracted as the optimal combination of parameters.

We will try to specify dangerous parameter area where disruption is likely to occur using sparse modeling.

References

[1] Y. Igarashi, H. Takenaka, Y. Nakanishi-Ohno, M. Uemura, S. Ikeda, and M. Okada. Exhaustive search for sparse variable selection in linear regression, 2017.