§38. Long-Time Real-Time Measurement of Plasma Parameters with Neural Networks

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In a long time discharge, real time measurement of plasma parameters and the real time control are indispensable. Accordingly fast data acquisition, high-speed data processing, and rapid control output are necessary. As a method of high-speed data processing, neural network is a best selection, since it may induce the results in a speed higher than the normal nonlinear processing.

The neural network is trained with teacher data of output raw signal (A) from a plasma parameter diagnostics and the processed output data (B). The neural network may output (B) in real time during discharge from input of (A). And we can bring up the neural network by adding teacher data pairs and training it again shot by shot. The training may be possible during dishcharges. By adding (A) various data from other diagnostics, we can make clear the correlations with the data (B). Namely scaling law of plasma parameters may be deduced.

First we apply the neural network system to magnetic measurement in a long time discharge of single null divertor configuration by 2.45 GHz LHCD on TRIAM-1M. In Fig. 1 is shown a long-time real-time measurement system of plasma parameters with neural networks. The operating system of the data acquisition and signal output device is Windows NT and that of neural network training device is UNIX. AD and DA convertors can manipulate data at one point in time to take a real time system into consideration.

A real time measuring program is coded with visual basic, since the AD and DA convetors can be driven by the language and the language is good at drawing the results on the display. The real time measurement system may be applied not only to the magnetic data processing but also to Langmuir probe data analysis, plasma cross-section image processing, etc.

Finally this system is applied to long-time real-time measurement of plasma parameters on LHD. In the case of HIBP[1], the system is designed so as to measure spatial potential with good spatial resolution even without neural network. By taking spatial resolution profile (slit function) into consideration and solving inverse problem of convolution integral, we can correct the spatial potential profile (not the simple correction of the measured profile width reduced by spatial resolution). Plasma density and electron temperature profile may be deduced from attenuation of HIBP[2] by solving inverse problem of integral equation with neural network. In order to apply to fluctuation and correlation measurement, we need AD convertor, which can input not one point but plural points in time.

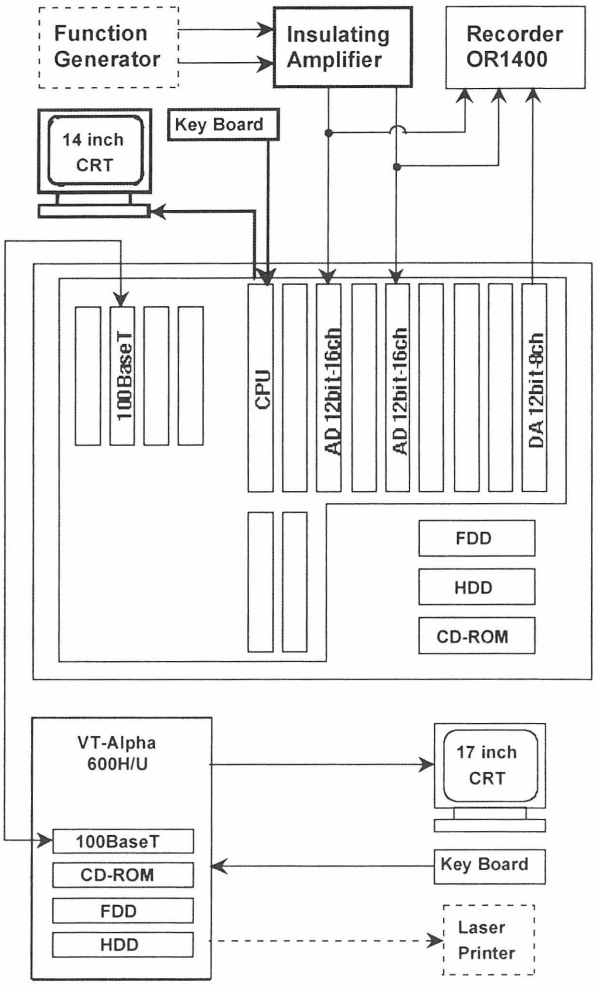

Fig. 1. A long-time real-time measurement system of plasma parameters with neural networks.

Reference

1) Ido, T., Hamada, Y., Nishizawa, A., Kawasumi, Y., Miura, Y., Kamiya, K.: Heavy Ion Beam Probe Diagnostic System on JFT-2M, Rev. Sci. Instr., Vol.70, No.1 (1999) 955-958.

2) Malaquias, A., Nedzelskii, I. S., Varandas, C. A. F., Cabral, J. A. C.: Evolution of the Tokamak ISTTOK Plasma Density and Electron Temperature Radial Profiles Determined by Heavy Ion Beam Probing, Rev. Sci. Instr., Vol.70, No.1 (1999) 947-950.