

1.9 HL-2A Shot Program Editor

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A tokamak plasma discharge involves a series of complex and concerted actions conducted by its control system. The HL-2A control system can be divided into two parts^[1], the machine control system and the discharge control system. The machine control system, which consists of industrial PC (IPC), configures and operates the tokamak's various technical subsystems. Timing system is integrated into machine control system giving absolute time for all subsystems. The discharge control system, which is a real time control system, will control plasma position and plasma current. The discharge control system consists of IPC. Local area networks, Profibus DP and cables are used to link together the workstations, programmable logical controllers, IPC and control center.

1 Task

1.1 Background and environment

In order to study the plasma discharge, and fulfill the physicists' s experiment purpose, the editor should provide functions for physicists to preset the discharge parameters and to display the collected results as well. In order to store the presetting parameters and download them to the corresponding subsystem to control the plasma discharge, well-structure data files is needed so as to meet the growing demands on safety and control task^[2~6].

Time sequence and feedback control will operate down to millisecond range. That is very fast, we can not use Microsoft Windows NT or 9X as our real time operating system because their maximum interrupt latencies are too long to meet our special need, we have no real time operating system such as VxWorks or QNX, the only operating system we could use is Microsoft DOS. Our editor is developed within Microsoft Excel under Microsoft Windows. Information should exchange between Microsoft DOS and Microsoft Windows. There are two ways to exchange information between the editor and other part of control system. The first is to

exploit file sharing, and the second is to use standard socket and winsock for process-to-process communication. The first method is rather slow but simple and reliable. Slow is not the problem because the presetting parameter information's exchanging process occurs during the interval between plasma discharges, and the interval is more than 20 minutes long. The process-to-process communication programs under Microsoft DOS are difficult to develop because of lacking knowledge and heavy workload, that is the problem we encounter. According to the above discussion, we use the first way to exchange information between the editor and other part of control system.

1.2 Switch and condition definition

The control information, such as operation mode, switch setting, and subsystem on and off, and constants that define the operation technical limit, should be preset in the editor. Because the data types of these parameters are strongly heterogeneous, a hierarchical data structure is needed to store these parameters. The time segment and its transition conditions will be added in later editor's version^[3, 5].

1.3 Waveform

Time variant signals such as the plasma current or the current in vertical field coil should be stored specifically and send to discharge control system for feed-forward and feedback control. In order to be compliant with HL-2A data acquisition system (DAS), which saves diagnostic signals by files with extension and data file with data extension, the same data format should be used to store signals and send them to discharge control system.

2 Software implementation

This shot program editor was developed within Microsoft Excel by HL-2A control group with less signal or switches being changed from one shot to the next. The details for the editor will be given as follow.

2.1 Switch and condition definition

The switch and condition definition parameters can be preset in the editor's worksheets by clicking the radio button, checkbox, combo box or modifying the cells' values. The switch and condition definition information is stored in a data file with HL-2A extension. The data file is well-structured so that it is easily extended to meet the growing demands on safety and control task. Online input checks are realized by using the Microsoft Excel built-in worksheet change event with a range

parameter.

2.2 Waveform

The editor uses Microsoft Excel built-in Chart to edit the waveform graphically. This is the kernel part of the editor. A new command-bar and command-buttons within it are added to the Microsoft Excel workbook as the interface for physicist to edit the waveform, save the time variant data and display the waveform.

We use Microsoft Excel built-in msoFree-form shape as a tool to get the ideal waveform. You can easily edit the curve as the msoFree-form shape provides to any shape you want by adding nodes and move the nodes to the right position. The smoothness of curves is good enough to the requirement, so curve fitting is not needed when the curve is converted to its corresponding data. Because freehand drawing may result in curves with time flowing backwards, counteracting measures haven taken to avoid it. You can draw a default curve just by clicking the draw command-button. Before you edit the curve. You should click the edit command-bar. If you think the curve is too chaotic to work further, you can delete the curve by clicking the delete curve (del) command-button in the command-bar. If you think the curve you are editing becomes the one you want it to be, you can convert it to its data filled in the worksheet and display it again in the Chart by clicking the curve-to-sheet (C2S) command-button in the command-bar. You can display the data that is edited and saved by this editor in advance or experiment data of HL-2A DAS format by clicking the File-to-Sheet (F2S) command-button in the command-bar. You can save all sheet data into the sharing folder as control parameters by clicking the sheet-to-file (S2F) command-button. This action will lead to a password dialogue, when correct username and password is provided, and all sheet data are saved. You can save the favorite curve to a file as a template curve for later use by clicking the template (tmp) command-button in the command-bar if you think it is necessary. In order to give more details for command-button in the command-bar to users, Tooltip Text properties are used.

3 Discussion

3.1 Speed bottleneck

In order to display the curves in Microsoft Excel by chart, time variant data should be filled into Excel cells. The larger the number of data is, the slower the filling process is. This is the bottleneck of the whole editor. From the Ref. [7], we

find a solution for this problem. Here is solution: (1) set the cells we will fill the data into to a range, (2) define a special function and assign it to the formula array property of the range, (3) use copy method of the range to fill it with data.

3.2 Security

As security is the most important aspect of this editor, ordinary precautions such as virus checking and avoiding hacker attack should be provided in the environment later. When saving and publishing the setup parameters in our editor, a special account and password is needed.

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