Web-based Logbook System for EAST Experiments*

YANG Fei (杨飞)[1,2], XIAO Bingjia (肖炳甲)[1]

[1]Institute of Plasma Physics, Chinese Academy of Sciences, Hefei 230031, China
[2]Computer Center of Anhui Medical University, Hefei 230032, China

Abstract Implementation of a web-based logbook system on EAST is introduced, which can store the comments for the experiments into a database and access the documents via various web browsers. The three-tier software architecture and asynchronous access technology are adopted to improve the system effectively. Authorized users can view the information of real-time discharge, comments from others and signal plots; add, delete, or revise their own comments; search signal data or comments under complicated search conditions; and collect relevant information and output it to an excel file. The web pages can be automatically updated after a new discharge is completed and without refreshment.

Keywords: EAST, MDSplus, logbook, database, ajax

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1 Introduction

EAST is a fully superconducting tokamak with a non-circular cross-section with a goal of a 1000 s. discharge duration [1]. There is an increasing need for cooperation and information exchange among fusion labs worldwide [2]. During the discharge, specialists need to view the status of both the engineering operation and the plasma. They may also need to share information simultaneously, through which the device can be operated with more reasonable parameters.

After each experiment of the EAST discharge, a large amount of documents is generated. Due to the lack of unity, these documents are stored in different file formats, such as excel, text, draft and PDF, and distributed in different locations and computers. So it is tedious or difficult to search related information for a given shot.

Logbook software system provides a shared lab notebook abstraction for all of the scientists in experiments [3]. An electronic logbook has been used for TEXTOR [4], and other fusion devices [5]. We established a logbook system for EAST, which enables experts to share comments on EAST shots and to provide GUI (graphics user interface) to view the real-time discharge information.

Through unified planning and deployment, all the information can be collected and stored in a relative database. By adopting the three-tier architecture and asynchronous access technology, authorized users all over the world can easily access the logbook system via various web browsers without installing any client software. The logbook system was designed and implemented with the following features.

a. Real-time interactive comment,

b. Real-time viewing of discharge information,

c. Real-time viewing of signal plots,

d. Complicated retrieval according to the interested fields.

2 System architecture

The logbook system includes three principal modules, namely a presentation layer, a middle layer and a data storage layer. Fig. 1 shows the system architecture adopted in the present work.

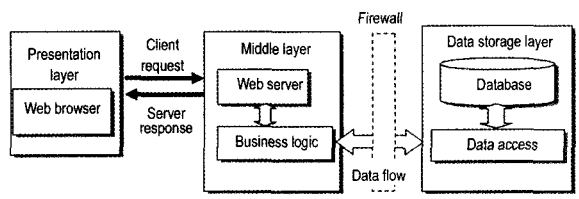

Fig.1 Scheme of three-tier architecture system

The presentation layer is a client application, which can easily access the logbook system through the browser. The web browser is capable of retrieving hyper-text documents. In response to various "input" user requests to search the requested information for a shot, various "output" web pages are generated by the web server via the HTTP protocol. The requests are sent to the web server through web links. After data processing, the web server generates HTML pages and delivers them back to the client browser for display. The browser performs the input and output activities with the web service. The function of the presentation layer is realized by PHP script language [6]. A rich user interface is achieved by using the ActiveX controls and JavaScript technologies.

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The middle layer is the core part of the system, which implements the business logic to process all data requests. An HTTP web server is running at the server-side to receive the request from the client-side, activates the business logic application, and responds to clients with related HTML pages. The main business logic is encapsulated at the server-side, which processes data requests and provides different modules of the application. The modular design is conducive to expand the system functions for future improvement requests from physicists.

The data storage layer is the base of the web database application. The raw data and analysis data from experiments are stored and managed on the data storage layer which provides the data access interface for middle layer application. The data management includes storage and retrieval of data, concurrent access by middle layer process, security mechanism, and data integrity. The logbook system includes two databases. One is the relative database (RDB) which contains several tables that hold the commentary information, running plans, analyzed data, user information, etc. The RDB has advantages such as reliability, auditing capabilities, efficient search, and recovery options. The other is the database for the experimental signals. Designed especially for pulse data, MDSplus [7~9] is used by many fusion labs in the world. It is a data acquisition, storage and analysis system [10]. EAST also uses MDSplus to store pulse data.

The three-tier architecture is a versatile and modular component intended to improve system performance, flexibility, scalability and security. When there are system requirements or technology changes, this architecture allows any of the three tiers to be upgraded or modified without affecting the other tiers, and reduces the system development's life cycle.

3 Implementation

During a discharge, part of the diagnostic data, and all PCS (plasma control system) data, as well as engineering data are directly stored in MDSplus. Because MDSplus does not directly support data search [11], so it is necessary to reprocess part of the most important MDSplus data and store them into the relative database in the middle layer for data search. Fig. 2 shows the flow chart of data conversion thread. Taking into account the amount of data from each shot, the mean value, maximum and minimum for each important data signal are calculated and stored into a MySQL database. The conversion thread keeps sleeping until a new shot occurs. When the new shot is completed, it wakes up and reads data from MDSplus according to the signal tag. Experimental data, such as the density and current of plasma, discharge duration etc, are converted into MySQL.

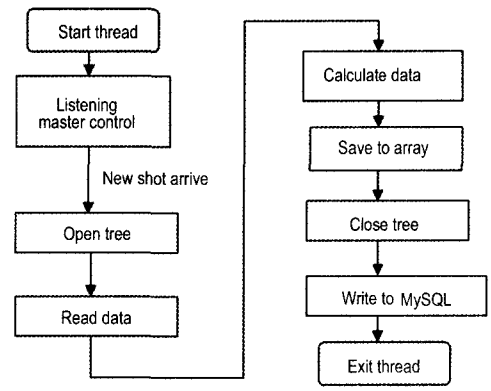

Fig.2 Flow chart of data conversion thread

The logbook system automatically updates a web page when new comments are entered or experimental data of a new shot comes. In the middle layer, an Apache HTTP server is installed as the web server. MySQL resides on the data storage layer. Ajax (Asynchronous JavaScript and XML [12]) engine, programmed in JavaScript and XML, acts as the bridge between client browser and web application. An ActiveX object named XMLHTTP is created, it regularly communicates with the server application which receives the latest comment, and discharges information from the MySQL relative database once new information arrives. The related data are sent back via XMLHTTP object, and the relevant fields of the web page are parsed and updated by DOM (document object model). By using the asynchronous access mechanism, all requests and data are placed in the background to refresh the web page automatically. Users can continue entering data, scrolling around, and viewing the plot of the discharge information. In this way, the system can not only display discharge information without manually refreshing the web page, but also reduce the burden on the server and bandwidth requirement of the network.

The logbook system contains dynamical generation of data plots for specified signals. In the business logic, the monitor thread keeps running. The new shot number is received from the EAST master control system as soon as the DAS (data acquisition system) finishes data acquisition [13~15]. According to the shot number, the signal data are retrieved from an MDSplus tree using the MDSplus PHP module, drawn with plots generated by the phplot class. This process is quite slow due to receiving excessive amount of data. In order to solve this problem, signals are re-sampled to reduce the total amount of data transfer. The re-sampling is effective to greatly reduce the network workload and improve the graphical display speed, helping experts rapidly understand the real status of discharge. The key problem of data plotting is to handle the relation between screen coordinates and raw data, as raw data need to be mapped onto screen coordinates (time T as x-axis, signal value V as y-axis). Assuming the sampling frequency f, coordinates of the origin ($x0$, $y0$),

the screen coordinates (X, Y) and following mapping relations,

$$T = t_{\text{start}} + (X - x0)(t_{\text{end}} - t_{\text{start}})/x_{\text{len}}$$

$$V = d_{\min} + (Y - y0)(d_{\max} - d_{\min})/y_{\text{len}}$$

t_{start}, t_{end} are the starting time and terminating time of the discharge; x_{len}, y_{len} are the length of the x-axis and y-axis.

Security is also a concern in such a widely accessible Internet-related web application. In order to ensure security of the background database, a firewall is installed on the server-side. By configuring the firewall, a limit is made for unauthorized users to access the database server. In addition, the system also provides various security means in the web server, including password encryption, login classification, user authentication, and secure sockets layer (SSL) for data transfers.

4 Application

The main application of the logbook system is to share comments in real-time, display important parameters and plots for selected signals, as shown in Fig. 3. This application allows experts to make comments on engineering plant operation and physical operations. According to the current discharge status, the data on web pages can be changed automatically.

In the retrieval page, the authorized users can customize the retrieval criteria according to the shot number, discharge duration, and signal value so that they can view the most interesting information (Fig. 4). The query result can be added to their collection column and this will help experts to view the relevant information in time. All comments and parts of discharge parameters are stored into the relative database. For the database, the indexes are created according to the shot number and query optimization, which can significantly improve the access speed. For example, to retrieve the comments from all records containing the string 'coil' takes about 0.03 s. This query returns 624 out of 14400 records. Selection of all records from a given criteria takes less than 0.2 s.

The logbook system also provides other management functions, such as discharge plans, discharge statistics and database management.

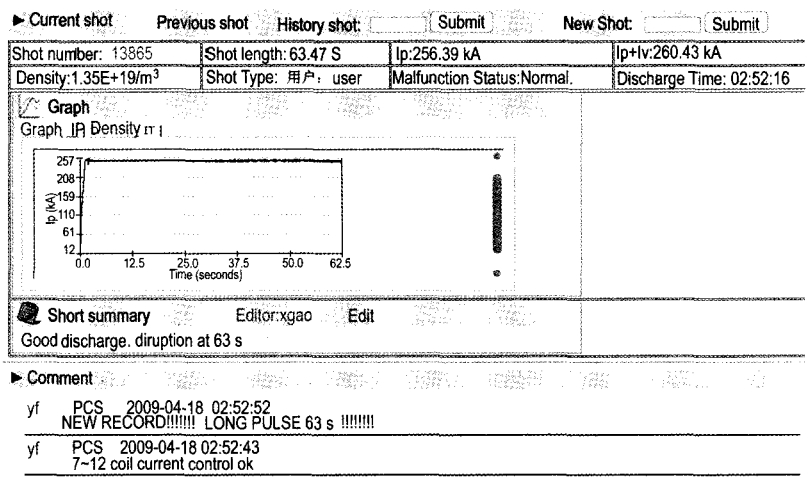

Fig.3 Main page of logbook system

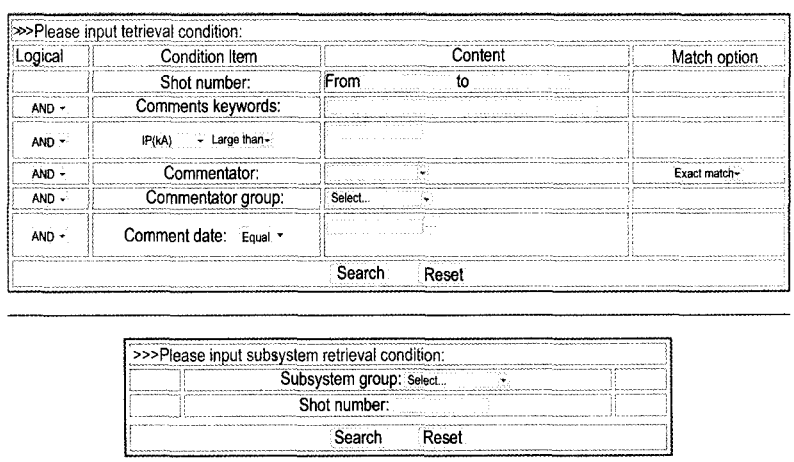

Fig.4 Retrieval page

5 Conclusion

The logbook system based on the three-tier architecture was designed and implemented, and successfully applied for EAST experiments. By accessing the logbook web pages, people can view the status of the discharge and engineering operation in real-time wherever they are. In addition, they can share comments and communicate on any problem during the experiment. Application shows that the logbook system is reliable, stable, timely delivery of experimental information and is a convenient for EAST experiments.

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E-mail address of YANG Fei: fyang@ipp.ac.cn