Component design of word report generation based on LabWindows/CVI

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Abstract: In order to realize the automation and diversification of word report generation business in the field of test and measurement, this paper first proposes a report generation collaborative processing mechanism based on a series of functional components through the demand analysis of report generation business and the design of software function allocation. Then, based on the development resources provided by LabWindows/CVI, this paper discusses the realization ways of the bookmark management and the automatic report generation based on word template. Finally, the practical effect of the word report generation business is given.

1. Introduction
With the continuous promotion and application of all kinds of testing equipment or testing system in the field of manufacturing, the demand for automation and diversification of report generation business is becoming more and more common[1-2]. At the same time, modularization and componentization software development model shows many advantages, such as reusability, easy reconfiguration, maintainability, scalability, and gradually becomes one of the mainstream software development models. LabWindows/CVI is an integrated development environment of test application software based on C language, which was launched by NI company in 1989[3]. LabWindows/CVI not only provides comprehensive and professional graphic control and virtual instrument software development support, but also has built-in powerful test, communication, control and numerical analysis function library, which has many advantages, such as easy to use, high efficiency and portability. Based on the development resources provided by LabWindows/CVI and adopting the modularization and componentization development mode[4], it has become the first choice to realize the automation and diversification of the word report generation business in the field of test and measurement.

2. LabWindows/CVI supports for ActiveX technology
ActiveX technology is a set of technology which is based on COM (Component Object Model) and enables software components to interact in the network environment[5-7]. ActiveX is powerful and programming language independent. It is widely used in all kinds of web server and client applications, and can be used to create all kinds of desktop applications. As the foundation of ActiveX, COM completes the communication between the server object and the client in the form of the middle layer. The transparent mechanism can make the two ends not care about the location or implementation method of the other end. As a result, all kinds of applications and software components interact according to the unified standards and specifications, showing good reusability. As an important part
of ActiveX technology, ActiveX control interacts between the application programs and the interfaces such as properties, events and methods. In essence, it is also a reusable COM component object.

In LabWindows/CVI environment, ActiveX related resources available to developers mainly include ActiveX function library and supporting development tools[8]. Among them, the ActiveX function library includes a series of functions to create and control the ActiveX server, which are used to access the objects, properties and methods of the specified ActiveX server. The supporting development tools mainly include ActiveX Controller Wizard and ActiveX Server Wizard. The ActiveX Controller Wizard is used to assist in the generation of ActiveX server drivers. The ActiveX Server Wizard is used to edit and set parameters for ActiveX server objects, interfaces, methods and properties. In general, developers can use LabWindows/CVI to implement three kinds of ActiveX technology applications, namely ActiveX automation, ActiveX controls and ActiveX documents.

ActiveX server provides function services in the form of ActiveX object set, and each ActiveX object provides methods and properties that allow other applications to access. ActiveX client can interact with ActiveX server by accessing ActiveX server's object properties and calling object methods. ActiveX automation allows one CVI application to automatically operate another. ActiveX controls allow independent interactive objects to be used in external applications. For example, embed and use a date control (such as Microsoft Calendar) or a graphic control (such as Measurement Studio 3D Graph) in a container (such as CVI panel). ActiveX documents allow to view documents (such as word format documents) in containers (such as CVI panel).

3. Requirement analysis of report generation

Through the research on the report application requirements of typical business scenarios, it is found that the report generation function has become an important part of all kinds of detection equipment or systems, and its output results are all kinds of word document reports. Through further understanding of these word document reports, it is found that although these reports have various formats and are difficult to describe uniformly, most of them deal with test data information through text, table, chart and other elements, including fixed content part and changed part. The report structure is generally composed of header, table body and tail. Among them, the header is at the beginning of the report, which mainly includes data items such as title, company, location and date. The table body, as the main data content of the report, is generally in the middle of the report, which is mainly composed of text, data, table or picture. The tail is at the end of the report, which mainly includes data items such as signature column or summary description. Comparatively, the format of header and tail is relatively fixed, and the data content is often deterministic and easy to handle. Due to various formats and dynamic data changes in the table body, some of the data contents are unknown and uncertain items, which need to be obtained from the specified data source.

In addition, in the process of report generation, it is required to reduce the links of manual confirmation and manual compilation, and adopt efficient and accurate semi-automatic or full-automatic methods for simple and fast man-machine collaborative processing. The main functional requirements include:

1) Report model processing provides report template library and management tools to facilitate the rapid generation of specific types of report documents. It can assist users in unified management and design modification of report template, and allow users to set page layout, style format, bookmark content mapping and design effect preview for the selected report template file.

2) Provide automatic report generation based on template file. Automatically load the specified template file, extract the data item content from the specified data source according to the preset control options, automatically format and fill, and generate the business report matching the report template.

3) Provides "what you see is what you get" report preview, storage and printing. Among them, the report preview interface should support multi page display, scaling, printing and export storage functions. Report printing should allow users to set the number of printed copies, printer properties and page properties.
4. Top level design of report generation

According to the principle of "modularization, componentization and standardization", combined with the analysis of the functional requirements of report generation, and considering the ability requirements of easy combination and reusability, we decouple the function and encapsulate the interface of the whole report generation process, forming three parts: report template management, report generation control and report preview printing. The function allocation is shown in Figure 1.

Furthermore, we need to abstract and simplify the main function logic of the module, define the function calling interface of the module, and realize three functional components: report manager component, report generation component and report browsing component. The collaborative processing mechanism of the three functional components is shown in Figure 2. Through the functional assembly and action collaboration of the three components, the functional requirements of report template management, report generation control and report preview printing can be realized. Among them, the report manager component is mainly used to assist users to model report information, and use ActiveX automation to call word software to complete the page layout setting, style format setting and bookmark content mapping of word template file. In addition, the report manager component can also realize the generation verification and effect preview of word document files by calling the function services of the report generation component and report browsing component. The report generation component mainly assists users to automatically generate reports based on template files and bookmark mapping files, and uses ActiveX automation to call word software according to the bookmark mapping relationship, extract data content from the test result file in turn, and automatically fill in the data content, so as to generate the word document file corresponding to the word template file. The report browsing component mainly assists the user to preview and print the "what you see is what you get" report of the specified word document file, and uses ActiveX automation to call word software to preview and print the report. Test application or third-party software can flexibly call report manager component, report generation component and report browsing component through component function call, so as to realize seamless collaborative processing of report template library management, report automatic generation and report browsing and printing.

5. Bookmark management and report auto generation based on word template

Word report generation and processing under LabWindows/CVI environment generally adopt two methods: direct generation or pre-processing. Among them, the direct generation method first creates a blank word document, and then fills it by classification according to the data content, writes the text, table, image and other element objects in turn, and finally outputs and stores the word document. The pre-processing method needs to first configure the word report style (that is, template), mainly
including page layout setting, style format setting, bookmark management, and preview the effect. Then, when the report is automatically generated, the data content is automatically extracted according to the set conditions and written to the specified location (that is, the bookmark location of the word document), and finally the word document is output and stored. In comparison, pre-processing method not only has the advantages of definable, preview, simple control and efficient execution, but also has the advantages of changeable style, strong universality, reusability and reusability, so it becomes the preferred report generation strategy. Considering the two function points of the bookmark management and automatic report generation belong to the key implementation point of the pre-processing method. Next, we will explain the implementation of the bookmark management and automatic report generation.

5.1 Bookmark management design based on word template

In word software, the document bookmarks can be used to quickly locate a specific location in a document. The bookmark management functions provided by word software mainly include adding, deleting and locating bookmarks. These bookmark management functions can be realized through the microsoft word ActiveX automation server library wordreport.fp provided by LabWindows/CVI to control the interaction and call. As shown in Figure 3, for the bookmark management function, developers can use WordRpt_Add Bookmark, WordRpt_Delete Bookmark, WordRpt_Go To Bookmark for function call and collaborative control. Of course, you firstly need to use to manipulate the specified WordRpt_Bookmark Exists function to determine whether a bookmark exists. If it exists, it will be processed. If it does not exist, it will be prompted for exception or special processing.

In this way, developers can control word software to set page layout, style format, bookmark management, report style preview and report template storage by using the series of functions in Word Report library. Then, the data set mapping is carried out by combining the bookmarks in the report template file to establish the mapping relationship between the bookmarks and the data content of the data items to be filled in the data source. The established bookmark mapping relationship is saved to form a label mapping file that matches the report template file. Of course, you can also call the existing report template file and bookmark mapping file to configure and edit the report style and mapping relationship.

Figure 3 The Word Report function library

Figure 4 Flow chart of the automatic report generation
5.2 Automatic report generation design based on word template

Automatic report generation based on word template can be realized by using related functions in Word Report function library. These functions mainly include WordRpt_ApplicationNew, WordRpt_ApplicationQuit, WordRpt_DocumentOpen, WordRpt_DocumentSaveAs, WordRpt_AppendText and WordRpt_InsertScaledImage, etc. As shown in Figure 4, the main processing steps are designed as follows:

1. Through the WordRpt_ApplicationNew function creates a new word application and obtains the control handle of the application.
2. Reads the specified bookmark mapping file and obtains all the bookmark lists in the file and the mapping relationship of each bookmark.
3. Through the WordRpt_DocumentOpen function opens the word template file and obtains the control handle of the document.
4. Through the WordRpt_BookmarkExists function determines whether the current specified bookmark exists in the word template file? If it exists, go to step 5; if it does not exist, prompt that the current specified bookmark does not exist, go to step 10.
5. According to the mapping relationship of the current bookmark, gets the matching dataset content from the specified data source.
6. Through the WordRpt_GoToBookmark function to locate the current bookmark.
7. According to the content of the data set obtained, classifies and fills the content data.
8. Determines whether the next bookmark exists in the bookmark list? If yes, go to step 4; if no, go to step 9.
9. Through the WordRpt_DocumentSaveAs function saves the word document to the specified media file.
10. Through the WordRpt_ApplicationQuit function releases all kinds of objects, documents, applications and other related resources.

6. Application verification and interface effect

With the help of the component design method of the report generation function described in this paper, we have developed a series of functional components, mainly including report generation component, report browsing component and report manager component. After passing the self-test evaluation, these functional components have been applied and verified in many engineering projects, such as semiconductor test, antenna RCS test, and achieved good practical results. Among them, the report manager component not only provides the page layout setting, style and format setting, bookmark content mapping and effect verification preview of the report template, but also can complete the management operations of adding, deleting and browsing the report template. The main interface screenshot is shown in Figure 5. The report browsing component customized according to the requirements of a project is used to parse, preview, store and print the word document generated by the report generation component.

7. Concluding remarks

In short, the component design method of word report generation based on CVI can realize the automation and diversification of word business report generation. The developed series of functional components have the advantages of reusability, easy reconstruction, simple and practical, and low development cost. They have been applied in many engineering projects and achieved good feedback effect. It is hoped that this method can provide valuable reference for similar report generation business applications.
Figure 5 Screenshot of the report manager main interface

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