Research of VB Programming Automatic Scoring Method Based on the Windows API

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Abstract—**First of all, this paper analyzes various VB Programming Automatic Scoring Methods; and then, based on a deep analysis and study of the techniques of Window API and API Hook, this paper stimulates a method of whole process in artificial scoring by applying a method of combining dynamic scoring with static scoring-making both dynamic evaluations of the function of event codes of students' programs and static measurements of interfaces' designs respectively. The solutions and design ideas of the scoring system described in this paper focus on the following points: The scoring processes consist of mainly two types-a dynamic one and a static one. In a dynamic scoring, API Hook is applied to record the messages which are triggered by any human operators while the standard answer programs are being run; meanwhile, the system uses *VB 6.0* to compile and run students' programs, and it will send the recorded messages to the running students' programs to drive them to run automatically, then sends out the results of students' programs, which is at running, to the specified file with the output code, and to match the results with the standard answers; in a static scoring, it will match the program files of students in aspects of form information, controller information in the form, keyword and score points, based on the different weights to calculate students' scores. Finally, programmers apply the Scoring System to "Basic Computer Programming (VB) Test System" and test the feasibility of it.**

Index Terms—**Windows API; VB programming; Windows message mechanism; Hook; automatic scoring**

I. INTRODUCTION

THE realization of programs scoring automatically , can not only saves teachers' time, just as scoring objective questions do and reduces their labor intensity, but also evaluates students' understanding level of this programming language fairly[1].This paper involves the artificial intelligence, the pattern recognition, the natural language understanding and many other fields [2], so the realization has a strong boost to developments of fields above-mentioned. The realization of this method needs to solve technical problems such as lexical analysis, syntax analysis, interactive features, multi-threaded parallel processing features, message

processing, system robustness and some others, so it has a high value on both of research and practice.

The method can be divided into three categories [3]: dynamic test method, source code analysis method and software measure parameters analysis method. The basic idea of dynamic test method is: at first, the system executes the source programs of students, and then it compares the executed results with the standard answer after running is over, finally, gives the scores. Source analysis method generally refers to the use of program understanding, semantic analysis and other methods to analyze the students' source code, which transfers the source code into an intermediate forms of expression that can be understood by the scoring system at first, then standardizes the intermediate forms and eliminates varieties of codes, then matches the students' procedure with the template procedure of the standard answer. The basic idea of software metrics analysis is that it is based on the complexity and the program' features of the students' program, such as the module length, the identifier length, the number of code lines, and the number of variables, which the system is using in to evaluate the quality of students' programs, and then gives out the score.

II. RELATED TECHNOLOGIES INTRODUCTION

A. Windows API

Windows API [4] (Application Programming Interface, API), which is also known as WIN32 API, includes a series of complex functions, messages and data structures. Windows API is the cornerstone of the whole Windows framework, under which there is the Windows operating core, and above it, there is the Windows application.

Applications (clicking the mouse, inputting text, etc.) in the applications will lead to one or more API function calls, and then the API functions accomplish functions what the application wants to. In essence, Windows API is a set of predefined functions which control the appearance and behavior of Windows controllers, and it is stored in the dynamic link libraries (Dynamic Link Library, DLL). According to different functions, WIN32 API functions can be divided into the following categories [5]: Window management class, common controller window class, SHELL feature class, system service class, international character class, network service class.

B. API HOOK

API Hook is not the proprietary technology of computer viruses, but viruses often use this technique to hide them. The Hook related to this paper is not to monitor the process of students' answers, but recording messages and message sequences triggered by manual operations when the standard answer runs. In a dynamic scoring, the system will send the

message recorded to the corresponding form or controls in the students' procedure, and then plays messages back according to the corresponding order, finally, students' programs can run automatically.

(1) Basic concepts

Hook is one of the main features in Windows Message Mechanism, which allows users to monitor this process and other processes triggered by an event or messages sent [6].In fact, Hook is a block of segments which processes messages, the Hook procedure can capture the message on the first before it arrives to objective forms whenever a particular message is sent, in other words, the hook always acquires the control of messages' procedures the first [7].The Hook program can process the message captured, while it also can do nothing, and then continues delivering the message.

(2)Operation mechanism

①Hook list and procedure

Hook has a chain (pointer list); the pointer of this list specified by Hook points to the callback function which is called by the sub Hook procedure, the callback function is also the sub-procedure of the Hook. The Hook sub-procedure is an application-defined callback function used to monitor the system or a particular type of the event. When the associated message specified by Hook type occurs, the system takes this message to the Hook's sub-procedure. Hook's sub-procedure syntax:

```
LRESULT CALLBACK HookProc(
  Int node,
  WPARAM wParam,
  LRARAM lParam
  )
```

Among the program, HookPro is an application-defined name; parameter nCode is the code number used to determine the hook sub-procesdure's tasks, its value depends on the type of Hook; parameter wParam and lParam depend on the Hook' code number; their value typically contains information about sending or receiving messages.

②Hook' installation

Function SetWindowsHookEx is the role of installing an application-defined Hook sub-procedure to the beginning of the Hook list. When the monitored event related to Hook type occurs, the system calls the sub-procedure of the Hook list. Function SetWindowsHookEx statements are as follows:

```
Public Declare Function SetWindowsHookEx Lib
"user32" Alias
"SetWindowsHookExA" (
ByVal idHook As Long,
ByVal lpfn As Long,
ByVal hmod As Long,
ByVal dwThreadId As Long
) As Long
```

Among them, parameter idHook determines the type of the Hook, and more than that the type also is the message type handled by the Hook; Parameter lpfn is an address pointer of the child procedure, if it is 0 or a thread ID created by another procedure, it must point to the Hook sub-process in the DLL; parameter hmod is a handle of an application instance; parameter dwThreadId is specified by tracked thread.

③The Hook sub-procedure's transfer

When the Hook sub-procedure passes event messages to the next Hook sub-procedure function what is needed to call the function CallNextHookEx. CallNextHookEx statements are as follows:

```
Public Declare Function CallNextHookEx Lib "user32"
Alias
"CallNextHookEx"
(
ByVal hHook As Long,
ByVal ncode As Long,
ByVal wParam As Long,
lParam As Any
) As Long
```

Among them, the parameter hHook is a handle of the current hook, returned by the function SetWindowsHookEx, ncode is the event code passed to the hook procedure, parameter wParam and parameter lParam are wParam value that passed to the Hook sub-procedure respectively, and its specific meaning relates to the Hook type.

④Uninstall the Hook

Hook must be uninstalled when it has completed its work, otherwise the system performance will be reduced because of consumptions of time when the Hook processes message. Release function is UnHookWindowsHookEx(),its prototypes are:

```
Public Declare Function UnhookWindowsHookEx Lib
"user32" Alias "UnhookWindowsHookEx" (
ByVal hHook As Long
) As Long
```

If Hook is successfully uninstalled, returns true, otherwise returns False.
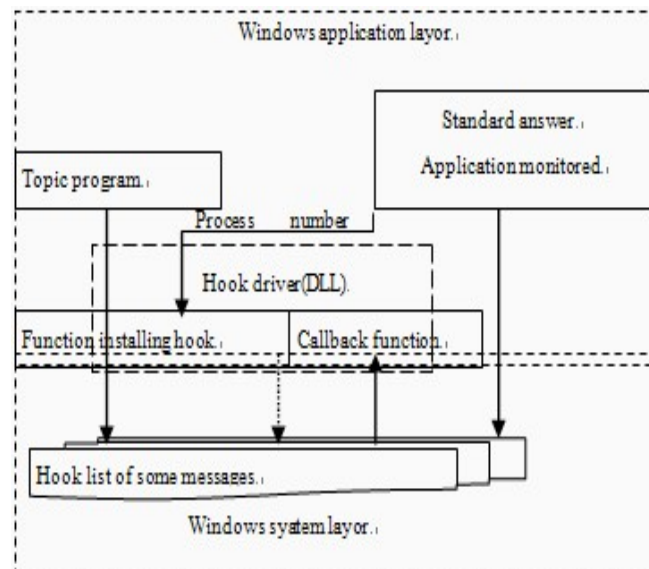

Figure1. Schematic diagram of API Hook

In summary, the Hook has priority on the specific type of messages, can intercept the message before they achieve the target form, and can process messages intercepted, or do nothing to continue passing on. How API Hook works is shown in Figure1.

III. SOLUTIONS OF WINDOWS API-BASED VB PROGRAMMING AUTOMATIC SCORING

Before introducing the overall solution, VB language's features can be introduced, because of which, it makes the VB Automatic Scoring more difficult.

(1) Feathers of VB language

①Event-driven

In process-oriented programs, they be consist of one or more functions, and there must be a main function. All the running process of the entire program is starting from the main function, and is executed according to the order designed or calls another function, when the main function finished its running, the program ends.

Event-driven programming mechanism and the approach of process-oriented programming have notable differences; event-driven programming mechanism is driven by the generated event. Because the event is generated disorderly, so each function' execution flow of the event-driven program is disordered. When programming with VB, the program does not have to build an explicit start or an end code, what the user should do is just to write some procedures. These processes are for different objects, and then accomplish the specific function with event-driven.

②Object-oriented and Visualization

VB encapsulates programs and data, which are also code entities that can be loaded and executed in the computer, in the way of object-oriented programming. In VB, objects were divided into two categories: one is designed by the system, known as pre-defined objects, such as standard controls in the toolbox, users can directly use or manipulate; the other is defined by the user themselves. With the standard controls in the toolbox users can draw out various objects they want on the screen, and then complete the visual design.

(2) It is more difficult to achieve the VB class programming language through the source analysis method

Through the above introductions of characteristics of VB syntax, it is difficult to achieve the idea of scoring with source code analysis methods, for the following reasons:

①The order of the procedure call is uncertain because of event-driven programming method, and the stored order of the event code is only representing for the order in compiling, which has nothing to do with procedure calls. The processed information by adopting compiler theory technology can only describe the internal structure of each process, but it does not have shown the process of inter-dependence.

②The grammars within the processes are not regular. VB syntax is not as regular as pure compiled languages, there are many ambiguous phenomena. For example, there are many different ways of writing the If statement:

(3) The merits and demerits of the dynamic test method

Source analysis method used in the short term cannot finish the task of VB programming automatic scoring accurately, and then users turn around to consider the dynamic test methods. Although the dynamic test analysis method does not have taken the process of students' programming into account, the results of the dynamic running can reflect the level of the students improving the function of programming from the view of functional testing, which is reasonable for giving the score on this ground.

VB programmers' assessment automatic scoring system based on technology dynamic test methods has merits and demerits:

① Merits: Achieve students' program running automatically by sending simulation messages, controlling the program of students and good inter-process communication forms.

② Demerits: Extra control information and event information influence the policy file's (the file that drives students' procedure running automatically) generation; Do not handle the event code which do not achieve the desired function.

In VB-programmers automatic assessment scoring system, the driver of students' procedures running automatically is generated based on the control information and event information, which are analyzed out in the static analysis of the reviewers. The extra control and event information in students' program will affect the driver file's generation, and in a static review there will appear that it only exists control information, but no control events information, messages the type of control sends cannot be determined.

(4) Formation of the overall solution of automatic scoring

The paper takes advantages of VB programmers' Assessment Automatic Review System, at the same time it improves the shortcomings, and then forms a methodology of the Windows API-based VB Programming Automatic Scoring System, scoring steps are as follows:

①The system records message sequences triggered by manual operation with API Hook when the standard answer is at run-time, and then takes the processed procedure as a driver that the students' program runs automatically in dynamic scoring. Output the results of related control properties and event codes which are changed after the manual operations to the specified file, and then as the running results of standard answer.

②In the dynamic scoring, the system compiles students' programs and controls its running in the method of combining the CreateProcess functions with the VB compiler.

③The system is using function SendMessage and function PostMessage to send recorded appropriate messages in step ①to the running students' program, to achieve students' program running automatically.

④The system in using output codes (consistent with the output code in the first step ①)sends results after running or control properties to news which have changed to the specified file, and then matches the results with that after the standard answer ran . If the match is accurately perfect, full score is given out, if it is not so exact, the system gives the threshold (that is, the percentage of total score), then enters into the static scoring.

⑤In a static scoring, using strings matching algorithms to carry on form information matching, control information in a form matching, event keyword matching in the event code and score points matching in the event.

⑥According to the different weights of each part of the program, the system gives students their scores.

IV. EXPERIMENTS AND RESULTS ANALYSIS

This paper will be applying VB programming automatic scoring solution based on the Windows API to "Computer Program Design Basis (VB) Exam System". In order to verify the accuracy of the score results, the programmers have chosen as a test case scoring of some questions of Simple

Applications with Visual Basic in Rank II from the National Computer Rank Examinations. Test objects are 162 students who are learning the VB program design in a grade.

Then programmer select student1' programming questions to be automatically scored, among this, the standard answer program event codes of the question are as follows:

```
Private Sub Command1_Click ()
If Option1.Value = True Then
  Text1.FontName = "Song typeface"
Else
  Option2.Value = True
  Text1.FontName = "blackbody"
End If
If Check1.Value = 1 Then
  Text1.FontUnderline = True
Else
  Text1.FontUnderline = False
End If
If Check2.Value = 1 Then
  Text1.FontItalic = True
Else
  Text1.FontItalic = False
End If
End Sub
```

Student' interface design is as shown in Figure 2, student1' event code in the program looks like this:

```
Private Sub Cmd1_Click ()
Text1.FontName = IIf(Opt1, " blackbody ", " blackbody ")
Text1.FontUnderline = IIf(Chk1, True, False)
Text1.FontItalic = IIf(Chk2, True, False)
End Sub
```
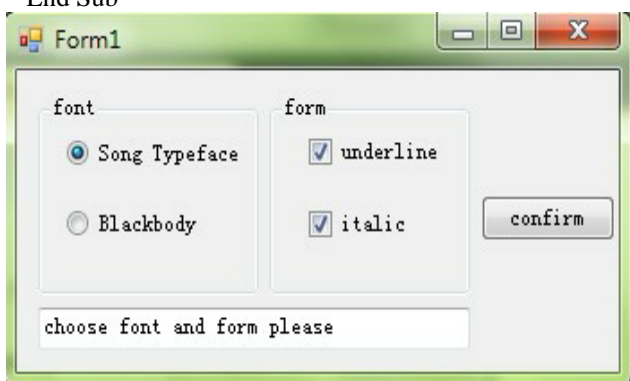

Figure2. Program Interface of Student 1

① Extract and compile program files

The system calls "UNRAR" software to extract compressed files submitted0 by students, after the extract is completed, views that if student1' folder is empty, and then inserts the output code into the tail of student1's form file. Compile students' program files with VB6.0, student1' programs are compiled successfully. It generates "bianyi.txt" under the student1' folder, the content of this file is "project1.exe is compiled successfully", it generates "project1.exe" executable files under the sudent1's folder at the same time.

② Run student program's executable file

Assign the path and the file' name of "project1. vbp" in Student1 to the parameter "projectname" of the *vb6.0* "/run projectname" command line. Set the parameter "path" in the run-time error output command "/out path" to "run. txt " under the folder for students (the txt file does not exist at this time, only when there is a run-time error generated). After the setup is completed, it calls the CreateProcess function to run the students' program.

③ Send a message - driven student programs

Use the API function "FindWindowEx" to find the window "Form1".after running the student's programs. If the function "findwindowex"'s return value is not 0, gets the message sequences of the problem from "message" tables in the database, uses the function "findwindowex" looking for "parent form title" recorded by "parent form heading" field from "message" tables in the database. When the "parent form" is discovered, assigns values of the parent form handle to function findwindowex, so that it can continue to look down the form control recorded by "form title ". When users find their forms, verify the type of the form, users can also depend on the type number recorded in the "message type", sending a message. Program Messages sent to students' program are:

Send the message selected by "Blackbody" radio button, " SendMessage temp, BM_SETCHECK, ByVal CLng(1), ByVal CLng(0) ", where temp is the handle of "blackbody" radio buttons.

Send the message selected by the"italic" check box, " SendMessage temp,BM_SETCHECK, ByVal CLng(1), ByVal CLng(0)", where temp is the handle of the "italic " check box.

Send the message selected by "underline" check box," SendMessage temp, BM_SETCHECK, ByVal CLng(1), ByVal CLng(0) ", where temp is the handle of " underline " check box.

Send the message selected by "confirm"command button," SendMessagetemp,WM_LBUTTONDOWN,0,ByVal&H10 001"and"SendMessagetemp,WM_LBUTTONUP,0,ByVal& H10001" , where temp is the handle of "confirm"command button, WM_LBUTTONDOWN is the message when users are pressing the mouse left button, and WM_LBUTTONUP is the message when the left mouse button is up.

④ Get students' running results

Find the "dat" file corresponding question number under Student1' folder, and match the result file with the standard answer after running. If Student1 the content of "p013. dat" under Student1' folder is "False, True, 1, 1, blackbody, True, True " exactly matched with the actual answers, and then it gives out full marks.

⑤ Static scoring

Static scoring carries read operations on students' program, and then separate out the form information, the form control information, version number, variable declarations and event code and so on. Interface design results is 5*80*50=2 points, and then match with the code event in students' program respectably in two ways: the keyword matching method and the scoring points matching method, among it, there are 12 keywords (which is the reserved word commonly used in VB program hunting scoring system, and at the same time, there are 19 in the standard answer). Use string matching algorithms to give out the findings of the static scoring.

According to the scoring criteria, to test the accuracy of automated scoring, each student' program is carried out in manual scoring and automatic scoring respectively, and with the procedures for each test, average scores are calculated in manual scoring and automatic scoring separately. Figure3, the line graph, shows the comparisons between the artificial scoring and automatic scoring and automatic scoring results for the each student program in an exam; and Figure4,

another line graph, shows the comparisons between the two average scores for each of the five examinations respectively.
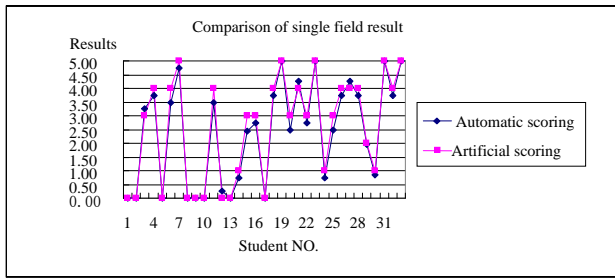

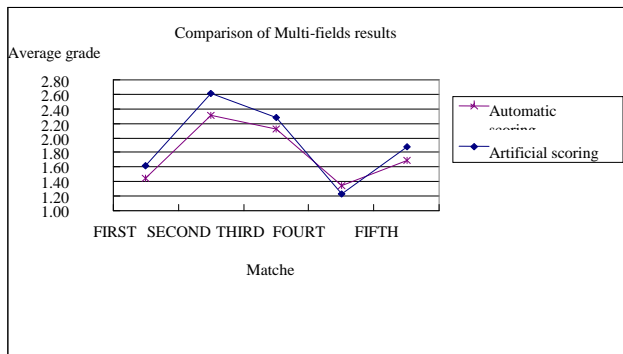Figure3. Test results of the automatic scoring compared with artificial Score in the single field

Figure4. Test results of the automatic scoring compared with artificial score in more fields

Through the above comparison, it can be seen, in this article, "the Windows API-based Automatic Scoring Solution" is very effective.

V. CONCLUSION

After this system design has completed, it will be for the programming automatic scoring in "Computer Program Design Basis (VB) Exam System" of Dalian Maritime University through testing in the multi-channel VB programming. During the programmer test the scoring system, it is stable, and the score results are consistent with the results of manual reviewers.

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