Design and Implementation of a Student Experiment Behavior Analyzing System

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Abstract
Along with the development of modern society, graduates who have a strong practical ability are in need. To improve university’s education quality and cultivate students’ practical ability, in this paper, we present the design and implementation of a Student Experiment Behavior Analyzing System (SEBAS) and a simple example in operating system experiment class. This system can help teachers to know how the students complete their experiment projects, to analyze the students’ experiment behavior and to control the process of experiment class. This paper also presents the architecture of SEBAS, which mainly includes the data collecting component, data storage component and data analyzing component. And then this paper presents the implementation of SEBAS in detail. SEBAS can monitor, collect and store students’ behavior data for teachers to do further analysis to improve the quality of experiment class.

Keywords
Project Experiment; Behavior Analyze; Operating System

Introduction
With the progress of computer science and technology, our society needs more and more graduates with strong practical ability. To meet this requirement, universities offer more and more experiment classes for students to train their practical ability. So, how to let students learn what teachers have taught in the class sufficiently becomes the key of the education of computer science and technology. But teacher doesn’t have enough energy to guide every student in experiment class. This will cause a problem that teacher doesn’t exactly know what students are doing during the class and what students need to be tutored. In order to solve this problem and improve the quality of experiment teaching, we design and implement a Student Experiment Behavior Analyzing System (SEBAS) to help teachers to get a better understand about their students and control the process of class.

The SEBAS will not only can help teachers to monitor what the students are doing in experiment class, but also can store the students’ behavior data so that teachers can even do further analysis in the future. Researching students’ behavior directly with an objective and experimental method can improve the quality of experiment class teaching effectively. The SEBAS will not only be useful for traditional classroom education, but also open a viable way for online experiment class and opening laboratory.

In this paper, we firstly present the SEBAS’s architecture, and then we will demonstrate a SEBAS example which is preliminarily used in our operating system experiment teaching; at last we will prospect our future work.

Related Work
There are some studies put forward methods to analyze students’ experiment behavior. Lei Shi and Lei Fan bring into behavior analysis (Lei Shi, 2009), and they mainly focused on how to use ontology in data analysis, rather than building an integral system. Martin Cápay etc (Martin Cápay, 2011) proposed a method of analyzing students’ behavior by keeping on asking students questions, this may be a solution to know whether students have mastered the knowledge on theory class, but this method is not suitable for experiment class.

Many studies also put forward some systems for e-learning. Hsiu-Mei Huang etc (Hsiu-Mei Huang, 2012) developed a Collaborative Virtual Reality Learning System (CVRLS) which was very useful for medical students and teachers, and it can trigger a revolution of medical classroom education. For medical students, however, this system can not take the place of the real experiments. Kwang B. Lee and Raied Salman (Kwang B. Lee, 2012) proposed the architecture of Mobile Collaborative Learning (MCL) system; it can make
students engage in studying anytime and anywhere. Baodan Chen etc (Baodan Chen, 2011) proposed an integral system to analyze student e-learning behavior (ELB) and they proved that the students' digital records can reflect their real individual learning style/preference.

The above systems mainly focus on recording and analyzing students’ course learning and browsing habits, and they are the traditional theory class oriented systems. The SEBAS is an experiment class oriented system; the function of SEBAS is to record students’ behavior during their experiment class and analyze their operations to help teachers to get a better understand about their students and control the class.

**Architecture of SEBAS**

The system is based on client-server model and it can support multi-user to use simultaneously. Both teachers and students can login or logout through a client application, and then complete their tasks on the remote experiment platform which the server has already provided. The system manages users including both teachers and students by giving them different account permissions. So, the SEBAS is divided into 2 parts: Clients and Server. On the server side, there are Data Collecting Component, Data Storage Component and Data Analyzing Component. On the client side, a Client Application should be installed. The architecture of SEBAS is shown in FIG. 1.

**Client**

Any PC (Personal Computer) installed a client application with network function can be a client. Student users just use client application to login the server and do something on the server by sending commands, and the server completes the commands and returns the output to the client application.

**Server**

The server in SEBAS mainly works as a remote experiment platform. To collect and store students’ behavior data, there are data collecting component, data storage component and data analyzing component on the server.

1) **Data Collecting Component**

The function of this component is to monitor every user on the system and write users’ behavior data into the data storage component. This component works as a daemon process running in the system background, recording every user’s operations. Just letting only the supreme authority user can terminate or start the process is important, because this part involves in system configuration.

2) **Data Storage Component**

The function of this component is to store the data which the data collecting component has already got. Generally speaking, the data can be divided into three parts: user login or logout data, user operation data and the usage of system resource data. The data should contain useful information as much as possible, such as login or logout time, user’s name, user’s commands and user’s login IP address and so on.

3) **Data Analyzing Component**

The function of data analyzing component is to monitor and analyze the data stored in the database. The design of this component is very flexible; programmers need to design the data analyzing component according to different requirements. The design of data analyzing component is crucial to realize the system requirements.

With this architecture we can deploy a similar system in our traditional classroom experiment education to help teachers to know more about how to tutor their students and control the process of class. This will not only be a brilliant way to improve the quality of experiment education, but also open a way for online experiment class teaching and opening laboratory.

**The Implementation of SEBAS**

According to the architecture of SEBAS we present, we implement a SEBAS example which is used in our operating system experiment teaching to improve the quality of operating system course teaching.
We use RedHat Enterprise Linux 6.5 as our remote experiment platform. Both teachers and students can login the system using SSH secure shell client. The system distinguishes the identity of users by giving them different account permissions. To fully introduce our system, we will introduce the components of the system in detail.

Data Collecting Component
We develop a program to collect users’ behavior data called watcher, it works as a daemon process running in the system background. It can monitor any users’ login or logout operations by listening to the wtmp file in the Linux system. If a user logsins the system, the watcher will start a systemfilewatcher thread. When a user exits, watcher will terminate this user’s systemfilewatcher thread by sending a signal to the running thread. The systemfilewatcher thread can monitor commands the user has issued by monitoring the change of user’s bash shell history file and send the operation data to the Data Storage Component by a SQL statement which mainly contains user’s name, user’s operation, timestamp and IP address etc. This program can not only collect the commands issued by the user but also collect the parameter of each command.

Data Storage Component
In our system we use MySQL database as our Data Storage Component. To collect users’ behavior data in detail, we create three different tables: login or logout data table, user commands data table and users table. The login or logout data table is used to store every user’s login and logout operations, each entry of the table contains the user’s ID, timestamp, and IP address and login or logout operation. The commands table is used to store every user’s commands they have issued, and each entry of the table contains the user’s ID, timestamp and a command they have issued. The user table is used to store the information of every user registered in the system. The design of login or logout data table and commands table are shown in TABLE 1 and TABLE 2.

Data Analyzing Component
We develop our Data Analyzing Component using QT Creator 4.7.2. This program has two main functions: user’s logging analysis and user’s operation analysis.

In the user’s logging analysis module, we take three steps to complete our task. Firstly, we query the Data Storage Component using a SQL statement to gain a data set which we will analyze later. Secondly, by traversing the data set and matching each user’s login and logout operation we can count the online time of each login. Thirdly, by analyzing the user’s online time of each login we can calculate the user’s total online time, user’s longest online time, the user’s shortest online time, average online time, the login frequency of each time period and the time distribution of the student doing experiment in a specific period of time.

In the user’s operation analysis module, we create two lists to store commands the user has issued and the command’s frequency respectively. The index of a command’s frequency in the command’s frequency list is equal to the index of this command in the command list. To complete our task, we take three steps.

Firstly, we query the Data Storage Component by a SQL statement to gain a data set we will analyze. Secondly, we traverse each entries of the data set to get one command issued by user, and check whether the commands list contains this command. If it contains this command, we will increase the frequency of the command by one; otherwise we append this command into the command list and initialize the command’s frequency to one.

Thirdly, by analyzing the user’s commands and the frequency of each command we can count the number of every command, and total number of the command the user has issued in a specific period of time.

TABLE 1 LOGIN OR LOGOUT DATA TABLE

<table>
<thead>
<tr>
<th>Field</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Id</td>
<td>The number of the line</td>
</tr>
<tr>
<td>UserID</td>
<td>The ID of the user</td>
</tr>
<tr>
<td>Time</td>
<td>The time of user’s operation</td>
</tr>
<tr>
<td>Action</td>
<td>Login or logout</td>
</tr>
<tr>
<td>Address</td>
<td>User’s login or logout IP address</td>
</tr>
</tbody>
</table>

TABLE 2 USER’S COMMANDS DATA TABLE

<table>
<thead>
<tr>
<th>Field</th>
<th>Meaning</th>
</tr>
</thead>
<tbody>
<tr>
<td>Id</td>
<td>The number of the entry</td>
</tr>
<tr>
<td>UserID</td>
<td>The ID of the user</td>
</tr>
<tr>
<td>Action</td>
<td>The commands the user issued</td>
</tr>
<tr>
<td>Time</td>
<td>The time of user’s operation</td>
</tr>
</tbody>
</table>

SEBAS is preliminarily applied to the student experiment behavior analysis in our operating system experiment class. A part of the students’ login or logout data our system collected is shown in FIG. 2. The analysis result of a user in our system is shown in TABLE 3. The operation analysis result of that user is shown in TABLE 4. The overview of our data analyzing component application is shown in FIG. 3.
Future Work and Conclusion

In this paper we present the SEBAS’s architecture and demonstrate a SEBAS example which is used in our operating system experiment class teaching. SEBAS can effectively help teachers to handle the class and know more about how to tutor students. SEBAS can also be an available way of online experiment class, and let experiment class become a part of online learning and opening laboratory.

We look forward to continuing our research and developing a new software based on our proposed SEBAS architecture which has a stronger operation analysis function. The biggest contribution of this paper is to provide an effective way to improve experiment education and a novel method to record students’ operations during the experiment class.

REFERENCES


