Design of Teaching Platform for Visual Programming of Industrial Robot Based on PBL and Multimedia

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Abstract. Aiming at the problem of poor load capacity in the traditional teaching platform of industrial robot visual programming, the teaching platform of industrial robot visual course based on PBL and multimedia is designed. This paper designs the teaching mode based on PBL mixed multimedia, realizes the communication of teaching data by using MVC framework, designs the authority management function of teaching platform according to the idea of unified authority management, considers the burden of multiple people on the platform at the same time, allocates reasonable transmission bandwidth for users, and completes the overall design of teaching platform. The experimental results show that: compared with the traditional teaching platform, the design of industrial robot visual teaching platform based on PBL and multimedia has stronger load capacity, and the platform is suitable for practical projects.

Keywords: Multimedia · Industrial robot · Visual programming · Teaching platform

1 Introduction

Industrial robot is a multi joint manipulator or multi degree of freedom machine device facing the industrial field. It can automatically perform work, and it is a kind of machine that realizes various functions by its own power and control ability [1]. It can accept the command of human beings or run according to the pre arranged program. Modern industrial robots can also act according to the principle program formulated by artificial intelligence technology [2]. With the development of information technology, industrial robots have been able to learn from the environment. Many problems in human life can be solved by industrial robots. Therefore, industrial robots have been widely used. Most of the development platforms for industrial robot applications are based on the text programming language to write the code, so as to achieve a variety of robot control [3]. Therefore, the study of visual programming for industrial robots is a trend that can not be ignored.

Modern educational technology plays an extremely important role in education. In recent years, the development of user learning puts forward higher requirements for the

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design of teaching platform. With the rapid development of society, national education is becoming more and more popular and informative, and visual programming teaching platform plays an important role in the national education system [4]. In particular, the large-scale application of mobile Internet and mobile media technology provides support for the teaching environment that can be applied to mobile devices.

With the rapid development of network technology in the direction of cross belt, high-speed and multimedia, people pay more and more attention to the construction of corresponding curriculum resources, and the advantages of education resources are more and more important [5–7]. The authenticity of PBL design task, emphasizing and practicing learning with complex background and meaningful problem situation, solving problems through learners' independent exploration and cooperative learning, which is the hidden problem behind the formation of scientific knowledge, and improving students' ability of problem-solving and independent learning [8].

At the same time of using PBL teaching mode to change teaching, for the problem of poor platform load capacity in traditional visual programming teaching platform, in the design of industrial robot visual programming teaching platform based on PBL and multimedia, the remote transmission bandwidth is allocated to improve the load capacity of teaching platform.

2 Design of Visual Programming Teaching Platform for Industrial Robot

2.1 Design a Teaching Model Based on PBL and Multimedia

PBL teaching method is more advanced. It is a teaching mode based on problems, with students as the main body and in the form of group discussion. Combining PBL teaching mode with multimedia technology, the teaching platform of industrial robot visual programming based on PBL and multimedia is designed.

PBL teaching mode emphasizes problem-solving as the center. Compared with "experimental" learning methods and discovery learning methods, PBL believes that the integration of a wide range of subjects or topics should be the direction and focus of learning, more emphasis on the role of social team interaction and collective cooperation, and more emphasis on the support and guidance of teachers' strength.

Design multimedia courseware. Multimedia courseware is composed of text, pictures, tables, sound, video and other factors. The biggest feature of PBL teaching is that there is no need to present the teaching knowledge one by one. So PBL multimedia courseware should be streamlined. According to the case script prepared by the teacher, the content involved in each scene is made into a multimedia courseware with a unified template, making full use of the sound, image, animation, video and other functions brought by the multimedia technology. Difficult-to-understand materials such as examinations and treatment methods are made into easy-to-understand multimedia materials [9]. This process is by no means a list of text and auxiliary examinations. From a psychological perspective, students do not like a large amount of text accumulation. At this time, we will match the text with sound effects or animation effects to improve student attention and avoid students. Visual fatigue. Avoid lengthy video content, extract key content as much as possible, and control the time for about a minute. The multimedia courseware will be supplemented after the course feedback.

Combining multimedia courseware with PBL teaching mode, the basic teaching framework is as follows (Fig. 1).

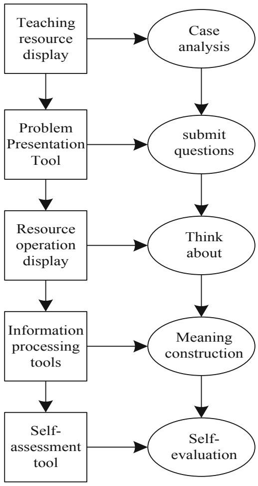

Fig. 1. Teaching framework of multimedia combined with PBL

The above teaching design is a process of optimizing teaching resources and teaching framework. It is a systematic planning process that uses systematic methods to analyze teaching problems, determine teaching objectives, establish problem-solving strategic plans, try out teaching applications, evaluate trial results and revise design plans. Because the main learners of network teaching are personalized learners, the significance of network teaching is mainly reflected in the design and development of network teaching resources.

The design of network teaching is based on a systematic approach and based on the relevant theories of learning and teaching. Through the analysis of teaching content and teaching objectives, it determines the teaching resource development model, the control method of teaching information, and the interaction between certain teaching situations And feedback methods, so as to provide learners with network resources for distance learning and provide some effective learning strategy selection methods [10].

The teaching design of the visual programming teaching platform for industrial robots is mainly to create and guarantee a good environment and learning conditions for network learning, which is conducive to the optimization of the network learning process. Teaching goals, teaching resources, teaching strategies, and teaching evaluation are the four basic elements of teaching design. Therefore, the teaching design of visual programming teaching platform must solve three main problems: clear "What do students want to learn?" Goal orientation; what kind of teaching resources and strategies should be provided to achieve certain learning objectives, that is, to solve the problems of resources and strategies; how to evaluate the learning effect of students?

2.2 Realization of Teaching Data Communication

The teaching platform interacts with the data according to the MVC framework and the specified communication format. The view organization submits the parameters in the specified format to the controller. After receiving the request, the controller parses the request and passes the parameters to the model. The model receives the parameters for data processing, The processing result is returned to the controller, which organizes the result into the specified data format and transmits it to the view to complete the data interaction.

The specific implementation of each module interaction of the platform is shown in Fig. 2. When users access code classification page or online integrated development environment through web browser, the request will be submitted to httpserver controller, which will directly return the corresponding web page file after receiving the request.

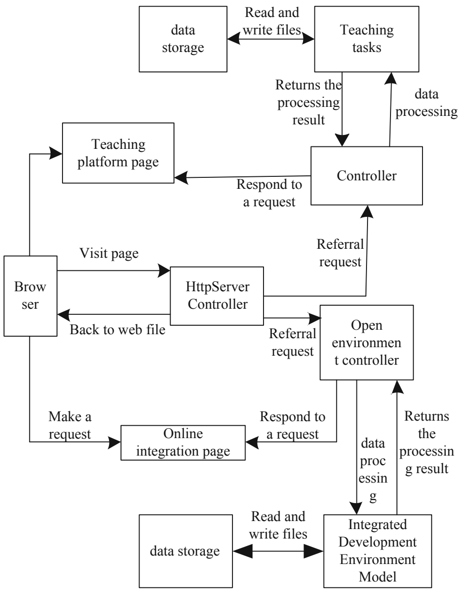

Fig. 2. Data interaction diagram

When the user submits the request in the teaching task page, the front-end script first organizes the request data into JSON format and submits the request to the httpserver controller through Ajax. After receiving the request, the controller parses the specific path and parameters of the request. It is found that the request is from the teaching task page, so the parsed parameters are transferred to the controller, After receiving the request information, the controller specifies a specific function for processing according to the specific request path, and passes parameters to the function. This function calls the corresponding model, here is the integrated development environment model. After the model receives the specific data, it calls the corresponding function. The module performs data processing and returns the processing result to the controller. The controller organizes the model's processing result into a specific json data format and returns it directly to the page. After the page script receives the returned result, the result is parsed and the corresponding fields are parsed. Display to the corresponding area.

When users submit code compilation, code running and other requests in the online integrated development environment page, the script organizes the data required by the request into the specified JSON data format, and submits the request to the httpserver controller through Ajax. After receiving the request, the httpserver controller parses the specific path and parameters of the request, and finds that it is the request of the integrated development environment controller. Therefore, after receiving the request data, the integrated development environment controller transfers the request. The integrated development environment controller calls the specified function according to the request path, and passes the request parameters to the function. The function calls the corresponding model. Here is the integrated development Development environment model. After the model receives the specific data, it calls the corresponding module for processing, and reads the processing result and returns it to the online integrated development environment controller. The controller receives the returned result of the model. The results are organized into a specified json data format and fed back to the online integrated development environment page. After receiving the results, the script parses the results in json format and reads the corresponding fields to the corresponding area for visual display.

2.3 Design of Authority Management Based on Unified Authority Management

It can be seen from the overall requirements of the platform that there is an intersection of users among different modules in the platform. At the same time, considering the future expansion of the platform, the authority management of user identity should at least meet the principle of global allocation. Therefore, in the authority management of the platform, the authority management is designed based on the idea of unified authority management.

The authority management design of the platform refers to role-based access control (Role Based Access Control, RBAC) programme, Design according to the actual situation. In the design of rights management, the relationship between users, user groups, roles, and permissions is shown in the following figure (Fig. 3).

In practical application platform, roles and user groups are usually one-to-one relationship. In this case, user groups can be regarded as roles.

The authority management of the teaching platform is relatively fixed, as long as the maintenance of the teaching platform and users with access rights can. However, the definition of the authority of functions and resources is quite variable, depending on the different business logic of the teaching platform, and the implementation method may also be different depending on the design of the teaching platform. If the authority of functions and resources is also entrusted to the unified user management, the unified user management must be modified with the addition of each new user, which will inevitably affect the stability of the unified user management. At the same time, the design of teaching platform is difficult to adapt to the authority of unified user management and maintenance functions and resources.

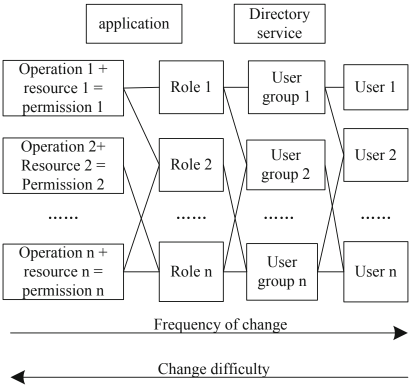

Fig. 3. Permission relationship

Therefore, functions and resource permissions and assignments between roles, roles and user groups are maintained by the application itself, while application access permissions and user group assignments are maintained by directory service management. The role permissions in the platform are divided into student roles, teacher roles, and administrator roles. The comparison of roles and permissions is shown in the following table (Table 1).

Table 1. Role permission cross reference table.

Authority	Root	Resource library				
		A1	A2	A3	A4	A5
Library	√	√	√	√	√	√
browsing	√	√	√	√	√	√
Upload	√		√			√
Download	√	√				√
Review	√			√		√
Maintain	√				√	√
Classification	√					√

In the table, A1 indicates the user, A2 indicates the uploader, A3 indicates the reviewer, A4 indicates the maintainer, and A5 indicates the administrator.

The authority management design based on unified authority management idea is shown in Fig. 4.

Through the above content to complete the design of authority management in the teaching platform of industrial robot visual programming. According to the above content, there are many users with different permissions, so the transmission bandwidth is allocated reasonably to ensure the normal operation of the platform.

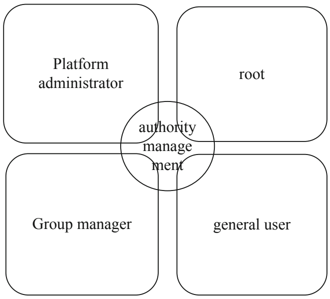

Fig. 4. Authority management design based on unified authority management idea

2.4 Allocate Remote Transmission Bandwidth

In order to ensure the quality of teaching, determine the priority of transmission rate, allocate the network bandwidth resources to the appropriate users.

Set Z_{ic} represents the n-th local user group in network s, The users of the local user group are registered users. For the terminals that users access the system, the transmission priority is determined by the decision factors of different teaching tasks. A matrix of $u \times u$ is formed by comparing the priority decision factors

$$U = \begin{bmatrix} a_{11} & a_{12} & \cdots & a_{1u} \\ a_{21} & a_{22} & \cdots & a_{2u} \\ \cdots & \cdots & \cdots & \cdots \\ a_{u1} & a_{u} & \cdots & a_{uu} \end{bmatrix} \tag{1}$$

Formula: a if Represents different decision factors. The weight vector of each decision factor is $\lambda = [\lambda_1, \lambda_2, \cdots, \lambda_m]$, Is the eigenvector corresponding to the maximum eigenvalue of matrix U, According to this vector, the weighted value of decision factors can be obtained。Each decision-making factor in the platform is compared with each other according to the degree of influence on the teaching task, and the weighted value of the decision-making factor is obtained. According to the weighted value, the transmission rate priority is judged, and the priority decision rules are formed. Based on this, the network bandwidth resources are allocated to different user terminals.

The optimal bandwidth allocation matrix is:

$$X = \frac{Z_{ic}(r, v)}{s(r, v)} \tag{2}$$

In the formula: r represents the user terminal, v represents the network transmission rate, and $s(r, v)$ represents the spectral efficiency of the c th bandwidth resource in the network s to the user terminal z of the teaching service.

Due to the limited bandwidth resources and platform resource capacity constraints, the optimal broadband allocation matrix is constrained by certain conditions. The constraints of the bandwidth allocation matrix are:

$$X_{\min} \leq \sum_{c=1}^{C} \sum_{i=1}^{I} X \leq X_{\max} \tag{3}$$

In the formula: $X_{\min}$ and $X_{\max}$ represent the actual maximum and minimum bandwidth resources of the user terminal supporting the teaching task. The requirements of the actual teaching task are met by the above constraints. So far, the design of visual programming teaching platform for industrial robots based on PBL and multimedia has been completed.

3 Research on the Teaching Platform of Industrial Robot Visual Programming

In the process of experimental research of visual programming teaching platform for industrial robots, the traditional teaching platform is used to measure the load capacity of the platform. A comparative experiment is designed and the actual load capacity of the teaching platform is analyzed according to the experimental results.

3.1 Experimental Environment Configuration

The visual teaching platform of industrial robot based on PBL and multimedia is studied to ensure the smooth and reliable operation of the platform. First, configure java web framework. Java web configuration uses XML file to publish information and generate web.xml file, which is saved under directory inf. The web.xml file configures the necessary information for the program to run, including the initialization of servlet parameters, the corresponding mapping of JSP files, the configuration of security domain parameters, environment variables, etc. Complete the deployment of the descriptor XML file, declare the XML version used, and make new rules for the character encoding of the file.

In addition to configuring the struts development framework, the core function of the struts.xml file is to manage the business controller. Under normal circumstances, the system has a default state. In the Inf directory, the specified struts.xml file is automatically loaded and executed by the Struts2 framework. In this way, the Struts2 framework provides a modular way to manage and configure the above files. Using an open source framework to operate the database, JDBC is lightweightly packaged, making it easier to operate on different platforms in the platform. The relevant content of its configuration file is shown below (Fig. 5).

The figure shows the mapping and connection of the database in the xml file. Through the above configuration, the database and other functions of the industrial robot visual programming teaching platform can be operated.

```
<GlobalNamingResources>
  <Resource name="UserDatabase" auth="Container"
            type="org.apache.catalina.UserDatabase"
            description="User database that can be updated and saved"
            factory="org.apache.catalina.users.MemoryUserDatabaseFactory"
            pathname="conf/tomcat-users.xml" />
</GlobalNamingResources>

<Service name="Catalina">
  <Connector port="8080" protocol="HTTP/1.1"
             connectionTimeout="20000"
             redirectPort="8443" />
  <Connector port="8009" protocol="AJP/1.3" redirectPort="8443" />
  <Engine name="Catalina" defaultHost="localhost">
    <Realm className="org.apache.catalina.realm.LockOutRealm">
      <Realm className="org.apache.catalina.realm.UserDatabaseRealm"
             resourceName="UserDatabase"/>
    </Realm>

    <Host name="localhost"  appBase="webapps"
          unpackWARs="true" autoDeploy="true">
      <Valve className="org.apache.catalina.valves.AccessLogValve" directory="logs"
             prefix="localhost_access_log." suffix=".txt"
             pattern="%h %l %u %t &quot;%r&quot; %s %b" />
    </Host>
  </Engine>
</Service>
</Server>
```

Fig. 5. Configuration file content

3.2 Platform Load Capacity Test

Based on the above configuration, verify the load capacity of different industrial robot visual programming teaching platforms. Record the experimental results of the traditional Spark-based programming teaching platform as experimental result 1, the experimental results of the teaching mode-based programming teaching platform as the experimental result 2, and the experimental results of the industrial robot visual programming teaching platform based on PBL and multimedia as the experimental results 3. The results of experiments using third-party software statistics are shown below (Fig. 6).

Observe the results in the figure, from the whole of the three experimental results, when the number of virtual online people is the most, the network delay belongs to the normal range, but the highest network speed and the lowest network speed, the experimental results of the three groups are the best. According to the results of Experiment 1, the highest network delay is 209 ms, the highest network speed is 6.37 mb/s and the lowest network speed is 0.63 mb/s when the number of virtual online users is the same; the highest network delay is 424 ms, the highest network speed is 9.04 mb/s and the lowest network speed is 2.97 mb/s in Experiment 2; the highest network delay is 49 mb/s in Experiment 3 ms, the maximum network speed is 10.43 mb/s, and the minimum network speed is 5.11 mb/s.

In conclusion, compared with the other two teaching platforms, the designed teaching platform based on PBL and multimedia for visual programming of industrial robots has the lowest network delay and high network speed, which shows that the load capacity of the designed teaching platform is significantly better than the traditional teaching platform.

Number	Number of virtual online	Network delay	Internet speed (H)	Internet speed (L)
1	25	23	5.36MB/s	2.54MB/s
2	36	34	6.37MB/s	3.07MB/s
3	494	45	6.36MB/s	3.47MB/s
4	57	78	4.24MB/s	1.55MB/s
5	74	79	3.24MB/s	1.69MB/s
6	83	84	4.69MB/s	2.22MB/s
7	92	67	4.41MB/s	2.13MB/s
8	117	105	4.24MB/s	2.47MB/s
9	146	140	4.50MB/s	2.04MB/s
10	153	117	3.21MB/s	1.52MB/s
11	168	136	3.26MB/s	1.44MB/s
12	177	147	4.01MB/s	2.07MB/s
13	189	125	4.22MB/s	2.06MB/s
14	206	157	3.17MB/s	1.04MB/s
15	224	169	3.06MB/s	1.59MB/s
16	256	201	2.54MB/s	0.97MB/s
17	271	204	2.56MB/s	0.63MB/s
18	289	183	2.59MB/s	0.88MB/s
19	304	179	1.98MB/s	0.74MB/s
20	322	208	2.68MB/s	0.96MB/s
21	358	209	2.93MB/s	1.05MB/s
22	390	186	1.74MB/s	0.86MB/s

（a）Experimental results 1

Number	Number of virtual online	Network delay	Internet speed (H)	Internet speed (L)
1	25	45	8.45MB/s	5.24MB/s
2	36	64	6.21MB/s	4.32MB/s
3	494	54	7.45MB/s	3.64MB/s
4	57	156	6.00MB/s	4.69MB/s
5	74	424	5.44MB/s	3.04MB/s
6	83	87	8.21MB/s	6.22MB/s
7	92	123	7.24MB/s	5.69MB/s
8	117	79	5.45MB/s	2.98MB/s
9	146	45	6.33MB/s	3.54MB/s
10	153	55	7.21MB/s	3.87MB/s
11	168	98	9.04MB/s	6.13MB/s
12	177	64	6.44MB/s	4.25MB/s
13	189	23	7.11MB/s	4.63MB/s
14	206	78	8.00MB/s	5.74MB/s
15	224	166	7.25MB/s	5.41MB/s
16	256	165	6.39MB/s	4.01MB/s
17	271	87	7.45MB/s	3.74MB/s
18	289	31	7.62MB/s	4.65MB/s
19	304	48	7.33MB/s	3.55MB/s
20	322	78	6.57MB/s	3.74MB/s
21	358	154	5.87MB/s	4.21MB/s
22	390	167	6.09MB/s	2.97MB/s

（b）Experimental results 2

Fig. 6. Load capacity test results of different platforms

Number	Number of virtual online	Network delay	Internet speed (H)	Internet speed (L)
1	25	11	9.45MB/s	6.93MB/s
2	36	15	9.50MB/s	5.56MB/s
3	494	9	9.47MB/s	5.79MB/s
4	57	13	8.66MB/s	6.54MB/s
5	74	21	10.43MB/s	7.01MB/s
6	83	7	7.54MB/s	5.32MB/s
7	92	19	9.51MB/s	6.44MB/s
8	117	16	7.21MB/s	5.21MB/s
9	146	21	8.65MB/s	5.32MB/s
10	153	18	8.34MB/s	5,88MB/s
11	168	22	9.55MB/s	6.13MB/s
12	177	24	8.99MB/s	6.10MB/s
13	189	25	7.57MB/s	6.51MB/s
14	206	19	7.43MB/s	5.06MB/s
15	224	31	8.59MB/s	6.07MB/s
16	256	27	7.61MB/s	5.08MB/s
17	271	44	8.61MB/s	6.19MB/s
18	289	49	7.62MB/s	5.11MB/s
19	304	37	8.66MB/s	6.01MB/s
20	322	39	9.64MB/s	6.26MB/s
21	358	28	8.11MB/s	6.13MB/s
22	390	47	7.23MB/s	5.14MB/s

(c) Experimental result 3

Fig. 6. (*continued*)

4 Concluding Remarks

Visual programming teaching platform, as a form of modern teaching technology, has changed traditional teaching concepts, combined with modern technology, promoted the development of teaching to information technology, and implemented standardized and efficient teaching tasks. Design a visual programming teaching platform for industrial robots based on PBL and multimedia, and design a comparative experiment for the problems existing in traditional teaching platforms. The experimental results prove that the visual teaching platform for industrial robots based on PBL and multimedia can effectively solve the traditional teaching platform In the existing problems, its load capacity has been significantly improved.

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