Design of Higher Education Aided Teaching System Based on Analysis of Economic Coupling Coordination Degree

Shan Wang(✉)
School of Engineering and Management, Pingxiang University, Pingxiang 337000, China
wangshan5754@163.com

Abstract. Aiming at the problem of the unsatisfactory feedback effect of the traditional auxiliary teaching system, a higher education auxiliary teaching system based on the analysis of economic coupling coordination degree was designed. The auxiliary teaching tasks are assigned based on the degree of economic coupling and coordination, and the interactive feedback of the teaching system is realized by setting the distributed filtering method of the auxiliary system to the teaching content. Experimental results show that compared with the two traditionally designed auxiliary teaching systems, the higher education auxiliary teaching system designed this time has better feedback effect and stronger system stability. The system can be applied to higher education auxiliary teaching tasks.

Keywords: Economic coupling consistency · Higher education · Auxiliary teaching system

1 Introduction

According to the characteristics of network teaching, the auxiliary teaching system strives to break through the limitations of traditional auxiliary teaching systems, and designs and implements a network teaching system based on the analysis of economic coupling and coordination. Analysis of economic coupling coordination degree, setting up educational resource allocation tasks according to the rule mode, and realizing a more targeted and interactive system design. Connect the system to the course resource website, and set up teaching courses, add course-related teaching content, students learn online by browsing the course website, or download course-related materials for self-study, submit assignments online, communicate with teachers and classmates online, online Exam and check your results. Teachers can post related teaching content online, view and correct student assignments, reply to student messages, and more. The higher education auxiliary teaching system designed this time provides a platform for communication between students and teachers, students and students, breaks the constraints of time and space, autonomously studies anytime, anywhere, and provides interactive data feedback through strong technical support [1].

© ICST Institute for Computer Sciences, Social Informatics and Telecommunications Engineering 2020
Published by Springer Nature Switzerland AG 2020. All Rights Reserved
S. Liu et al. (Eds.): eLEOT 2020, LNICST 340, pp. 176–188, 2020.
https://doi.org/10.1007/978-3-030-63955-6_16
2 Hardware Design of Higher Education Auxiliary Teaching System

In order to ensure the reliability of the aided teaching system, the hardware of the aided teaching database cluster system is redesigned. In order to ensure fast instruction execution and high execution efficiency, to ensure that data operations are completed in registers, the ARM processor is replaced. The new ARM processor model is ARM-A33. This processor is shown in Fig. 1.

![Processor physical diagram](image)

Fig. 1. Processor physical diagram

The processor is connected with the central control module of the system, and the communication mode between the main control equipment and the analysis hardware is established to form a complete system hardware architecture to control the receiving of the access data by the auxiliary teaching system. At the same time, the DSP processor in the original system should be replaced, the processor should be connected to the sensor, and the digital information with the characteristic of volume should be converted into electric signal to find, identify, process and feedback the massive data in the database quickly [2].

By redesigning the hardware of these two systems, the cluster system can complete the effective operation of the hardware under the economic coupling coordination analysis in one instruction cycle, and ensure that there is a gap between the program and the data space, and the query and search data can be accessed simultaneously to realize the distributed general sharing management of the system. The type of DSP processor is J380, the applicable working temperature range is between $-30 \, ^\circ\text{C}$ and $60 \, ^\circ\text{C}$, the signal-to-noise ratio is more than 92 dB with static noise, and it is more than 85 dB without static noise, which conforms to the design and use requirements of the teaching database cluster system.
3 Design of Higher Education Auxiliary Teaching System Based on Economic Coupling Coordination Analysis

3.1 Allocation of Auxiliary Teaching Tasks Based on Economic Coupling Coordination

In order to ensure that the task assignment of the auxiliary teaching system conforms to the actual work requirements, the database cluster access node is set up to ensure the real-time, synchronization and modifiability of the assigned tasks. The rules for setting the access node are shown in Fig. 2 below [3].

From Fig. 2, it can be seen that the large square indicates the central node; the small square indicates the secondary central node; the straight line with the arrow indicates the connection path between the nodes; and the dotted line indicates the degree of association between the data in each node. Assume that the central node is \( c_0 \) and the secondary central node is \( c_n = \{ c_1, c_2, \ldots, c_n \} \), where \( n \) represents the total number of secondary nodes and is a non-zero natural number. Set the processing request parameters of each node. The parameters are shown in Table 1 below [4].

![Fig. 2. Node setting rules](image)

| Node number | Weight | Processing request parameters |
|-------------|--------|------------------------------|
| \( c_1 \)   | \( w_1 \) | \( F * \frac{w_1}{w_1 + w_2 + w_3 + \ldots + w_n} \) |
| \( c_2 \)   | \( w_2 \) | \( F * \frac{w_2}{w_1 + w_2 + w_3 + \ldots + w_n} \) |
| \( c_3 \)   | \( w_3 \) | \( F * \frac{w_3}{w_1 + w_2 + w_3 + \ldots + w_n} \) |
| \( \ldots \) | \( \ldots \) | \( \ldots \) |
| \( c_n \)   | \( w_i \) | \( F * \frac{w_i}{w_1 + w_2 + w_3 + \ldots + w_n} \) |

\( F \) in the table indicates a rule parameter. According to the request processing parameters obtained in the above table, the CRITIC weighting method and the Mahalanobis...
distance calculation method are combined to set the relative distance between the nodes. The calculation expression of the distance is:

\[
\begin{align*}
\mathcal{d}(X_i, \gamma) &= \sqrt{\Sigma(x_i - \gamma^+) \Sigma^{-1}(x_i - \gamma^-)^T} \\
\mathcal{d}(Y_j, \gamma) &= \sqrt{\Sigma(y_j - \gamma^+) \Sigma^{-1}(y_j - \gamma^-)^T}
\end{align*}
\]  

(1)

In the formula: \(d\) represents the distance between any two adjacent points; \(X_i\) represents the node to be calculated at position \(i\); \(Y_j\) represents the node to be calculated at \(j\) closest to \(i\); \(\gamma^+\) represents a positive ideal solution; \(\gamma^-\) represents negative ideal solution; \(\Sigma\) represents the covariance matrix; \(\Sigma^{-1}\) represents the inverse matrix; \(T\) represents the matrix transpose sign. Determine the effective control distance between nodes according to the above formula, and make sure that all information can pass smoothly without affecting the balance of the load [5].

Based on the node position set above, a threshold \(\sigma\) is introduced to divide all the data to be processed in the database into light load nodes and heavy load nodes according to the processing nodes. When the load value is \(\mu > \sigma\), the node is a heavy load node. When \(\mu < \sigma\), the node at this time is a light load node. When performing a teaching query task, all nodes begin to execute query search instructions. Assume that the light and heavy nodes are evenly distributed in the data space, so that the load value of the heavy load node is \(\mu_1\), the load value of the light load node is \(\mu_2\), and the total number of nodes in the relevant domain is \(a\). The function expression of the average load is:

\[
\bar{\mu} = \frac{\sigma_a + \eta \sum_{i=1}^{n} w_i}{a + 1}
\]

(2)

In the formula: \(\sigma_a\) represents the load value when the total number of nodes is \(a\); \(w_i\) represents the data load corresponding to the node at the \(i\) node; \(\eta\) represents the standard index of the degree of coordination of economic coupling. In order to ensure that the data selected by the selected nodes to the visiting users are reliable, introduce a control coefficient \(A\) that can avoid load migration. Based on this coefficient, calculate the load amount. The calculation expression is:

\[
\mu' = \frac{f_a(\sigma_a - \bar{\mu})}{\Delta \eta \sum_{i=1}^{n} f_i}
\]

(3)

In the formula: \(\mu'\) represents the calculation result after the load changes; \(f_i\) represents the control coefficient of \(i\) related nodes; \(\Delta \eta\) represents the economic coupling coordination degree, and the control result under the control of the control coefficient \(f_a\) [6].

The degree of coupling refers to the degree of influence between the two. Here, the degree of coupling between higher education and the regional economic system can be obtained by calculation. Let us denote it as \(\Delta \eta\) and \(\Delta \eta \in [0, 1]\). The larger the value, the higher the coupling level, and the smaller the value, the more uncoordinated. The coupling level is lowest when the \(\Delta \eta\) value is zero and highest when the value is one. Set the sequence parameter of the higher education subsystem as \(V_1\) and the sequence
parameter of the regional economic subsystem as \( V_2 \), the specific formula is as follows:
\[
\Delta \eta = \frac{2\sqrt{V_1 \cdot V_2}}{V_1 + V_2}.
\]

The degree of coupling can determine the degree of synergy between the two subsystems, but it is difficult to analyze the overall effect and comprehensive synergy of the two subsystems based on the degree of coupling. Therefore, a new variable \( T \) needs to be introduced, and its calculation formula is \( T = 0.5V_1 + 0.5V_2 \). In this way, the coupling coordination degree function is constructed, thereby eliminating the disadvantages of the coupling function. Let \( B \) be the coupling coordination degree, and its calculation formula is as follows: \( B = \sqrt{\Delta \eta \times T} \). For the coupling coordination degree, it can be divided into ten different grades in turn, as detailed in Table 2.

**Table 2.** Evaluation criteria for coupled coordinated scheduling rating

| Coupling coordination B | 0.00–0.09 | 0.10–0.19 | 0.20–0.29 | 0.30–0.39 | 0.40–0.49 |
|-------------------------|-----------|-----------|-----------|-----------|-----------|
| Coupling level          | Extreme disorders | Severe disorders | Moderate disorder | Mild disorder | No disorders |
| Coupling coordination B | 0.50–0.59 | 0.60–0.69 | 0.70–0.79 | 0.80–0.89 | 0.90–1.00 |
| Coupling level          | No coordination | Primary coordination | Intermediate level coordination | Good coordination | Senior coordination |

After the construction of the index system, the collection and processing of the index data, the data for empirical analysis are obtained, including the order parameters of the higher education subsystem, the order parameters of the regional economic system, the coupling degree and the coupling coordination degree between the higher education and the regional economy, as shown in Table 3.
### Table 3. Data calculation results

| Years | Coupling degree A | Coupling coordination degree B | Coupling level  |
|-------|-------------------|-------------------------------|-----------------|
| 2005  | 0.960             | 0.203                         | Moderate disorder |
| 2006  | 0.989             | 0.275                         | Moderate disorder |
| 2007  | 0.999             | 0.288                         | Moderate disorder |
| 2008  | 0.989             | 0.331                         | Mild disorder    |
| 2009  | 0.995             | 0.350                         | Mild disorder    |
| 2010  | 0.999             | 0.388                         | Mild disorder    |
| 2011  | 0.999             | 0.427                         | Endangered       |
| 2012  | 0.998             | 0.464                         | Endangered       |
| 2013  | 0.995             | 0.531                         | Barely coordinate|
| 2014  | 0.999             | 0.548                         | Barely coordinate|
| 2015  | 0.997             | 0.598                         | Barely coordinate|
| 2016  | 0.992             | 0.630                         | Primary coordination|
| 2017  | 0.992             | 0.657                         | Primary coordination|

Set the index system of coupling system and coordinate the allocation of auxiliary teaching tasks, and the specific index system is shown in Table 4.

### Table 4. Index System of Coupled Systems

| Coupling Systems                        | Indicator level I                          |
|-----------------------------------------|-------------------------------------------|
| Regional Higher Education Development   | Higher education                          |
| System                                 | Talent Training in Colleges and Universities |
|                                         | Scientific research in higher education    |
|                                         | Educational benefits                       |
| Regional economic development system    | Economic aggregate                        |
|                                         | Domestic and foreign trade volume          |
|                                         | Economic benefit level                     |

Under the control of the load, the auxiliary system adjusts the operating parameters of the server according to regular or irregular time conditions, and issues corresponding query requests to the database control unit according to the choice of students and teachers, thereby achieving balanced distribution of queries. The purpose of the task.
3.2 Setting up the Distributed Filtering Method for Teaching Content by Auxiliary System

On the basis of achieving a balanced distribution of auxiliary teaching tasks, the distributed processing method of the auxiliary system is used to process massive amounts of higher education teaching data, and the original program is converted into numerous sub-processing programs in the same processing time to speed up the frequency of data processing. This technique presets the Euclidean distance between subroutines:

\[ d_{\mu'} = \sqrt{\sum_{s=1}^{n} (P_{\mu'r} - P_{\mu's})^2} \]  

(4)

In the formula: \( d_{\mu'} \) represents the Euclidean distance between any two adjacent subroutines whose load is \( \mu' \); \( P_{\mu'r} \) and \( P_{\mu's} \) represent the load variables of program \( r \), \( s \) and \( \mu' \). Set the distance matrix at this time to \( W \) and determine the minimum distance element \( d_{\text{min}} \). When the corresponding position of the data in the subroutine is \( i, j \) and its value is less than the threshold \( Z \), then the distance matrix is merged to reduce the dimension [7]. In the setting program, the two nearest data class clusters are \( K_i^{(W)}, K_j^{(W)} \), and the merged new class cluster is \( K_{ij}^{(W)} = \{ K_i^{(W)}, K_j^{(W)} \} \), so the new classification is \( K_1^{(W)}, K_2^{(W)}, \ldots, K_m^{(W)} \), and the system sets a distributed data processing subroutine according to the new class cluster.

Based on the completion of the distributed processing program, the massive teaching data is classified linearly, so that the data in each processing unit is of the same type, or has the same purpose, or has similar value. Randomly select two sample data and divide them into two categories. The \( n \)-dimensional vector \( x \) represents the corresponding data features, and \( y \) represents the corresponding classification mark. The calculation expression of the linear classification hyperplane and classification function is:

\[
\begin{align*}
\{ & w^T x + e = 0 \\
& f(x) = w^T x + e 
\} 
\]  

(5)

In the formula: \( w^T \) represents the transposed matrix established for the data type; \( e \) represents a fixed constant; \( f(x) \) represents the classification function. When \( f(x) > 0 \), the corresponding classification flag \( y = 1 \); when \( f(x) < 0 \), \( y = -1 \); when \( f(x) = 0 \), the support vector of the data is above the hyperplane. According to the classification of the above formula, it can be known that the linear classification is shown in Fig. 3 as follows.

The triangles and circles in the graph represent vectors in two randomly selected samples [8]. Set constraints and establish a fast processing function to achieve instant processing of massive teaching data. The calculation expression of this function is as follows:

\[
\lambda = \frac{\beta \Delta h \sum_{i=1}^{n} v_i f(x)}{\varphi \ln t_{(n-1)}} 
\]  

(6)
In the formula: \( \lambda \) represents the instantaneous processing function established; \( \beta \) represents the total amount of data; \( \Delta h \) represents the error correction coefficient; \( f(x) \) represents the processing constraint; \( v_i \) represents the limit of the processing frequency in the \( i \) data segment; \( \varphi \) represents the control harmonic coefficient; \( t \) represents the instantaneous response time; \( n \) represents the processing path. According to the above formula, a mass data processing program is set to control the processing process of the subroutines, and distributed filtering processing of mass higher education data is realized.

### 3.3 Implementing Interactive Feedback in Teaching Systems

The core of the designed higher education auxiliary teaching system lies in the design of interactive functions. The behavior interaction module is assigned to the computer control center, and the operation processing order of the interaction module is distinguished in the form of a flowchart. According to the preset teaching system framework, arrange the operating mechanism of the teaching system, and use the response function to complete the triggering of complex teaching procedures, data transfer, and layout conversion. The calculation expression for this response function is:

\[
f(w) = k \cdot s - \lambda \cdot w_i
\]

In the formula: \( f(w) \) represents the response function under the \( w \) teaching program; \( k \) represents the conventional coefficient of the software response; \( s \) represents the level of the teaching materials inquired; \( w_i \) indicates the comprehensive response coefficient of the \( w \) software teaching page under the selected \( i \) th operation target. This function is used to trigger the operation procedure when the user inquires the teaching content, so as to quickly enter the teaching content storage database according to a series of chain reactions. After the user enters the teaching database, by switching keywords, he sends instructions to the control center and obtains teaching information fed back from the system control center [9].
A new layered implicit algorithm is introduced, and the interaction data obtained is divided into three layers using this algorithm: weak feedback, strong feedback, and extremely weak feedback. It can be seen that there is $U \cap V$, $U \cap W = \emptyset$ between them, where $W$ means very weak feedback; $V$ means strong feedback; $U$ means weak feedback. The comprehensive calculation formula of the implicit algorithm is:

$$
\tau = - \sum_{i=1, j=1}^{h} \ln q \left[ (s_{hi} - s_{hj}) \times \varepsilon_{ij} \right] + f(w)^{\delta \| \Psi \|^2} / \omega_{c}(V_{ij})
$$

(8)

In the formula: $q$ represents the total amount of specific information in the feedback layer; $h$ represents the trust of the same type of information source; $i, j$ represents any two layers of feedback; $s_{hi}$ represents the amount of interaction behavior at the layer; $s_{hj}$ represents the amount of interaction behavior data at the $j$ layer; $\varepsilon_{ij}$ represents the differentiation coefficient between the two layers; $\delta$ represents the maximum likelihood parameter of $f(w)$; $\Psi$ represents the feedback decomposition estimated value. Use the feedback code to feedback the analysis results, some of which are shown in Fig. 4 below [10].

```python
def upload_file_to_hdfs(filepath):
    client = InsecureClient(config.HDFS_URL)
    now = datetime.now()
    today_dir = now.year / 100 / now.month / now.day
    data_exist = client.status(today_dir, strict=False)
    if not data_exist:
        client.makedirs(today_dir)
    client.upload(today_dir, filepath)
```

Fig. 4. Key feedback code

By relying on the above code, the obtained feedback data is uploaded to the feedback page through the data transfer unit, and the higher education assistant teaching system based on the economic coupling coordination analysis is designed.

4 Testing Experiment

In order to verify the function of the designed higher education auxiliary system, a comparative experiment is proposed to compare the functional differences between the designed auxiliary system and the two traditional designs. This test work, according to the differences between the two, improve the original system of educational assistance function, the traditional design of the problems in the auxiliary system, make adjustments and modifications.
4.1 Experiment Preparation

Before the experiment starts, it is necessary to arrange the test environment in an orderly manner, according to the response time, system function, select the appropriate experimental object, so as to make a detailed experimental plan, and put forward more targeted contrast content. In the experimental test environment built this time, the server has 512 GB of memory, 2 TB of hard disk size and Windows Server 2018b of operating system; the server of the test machine contains 32 GB of running memory, 2 TB of hard disk, the operating system version is Windows 10, and the browser is IE11.0. Set the number of network nodes in this test experiment to 2000, and the node IP is the 16A class subnet mask in the same network; the data is stored in a decentralized form. Figure 5 below shows the basic environment for this experiment.

![Experimental test basic environment](image_url)

The VRML browser is loaded into the computer of the selected three teaching systems. In order to ensure that the system can play the teaching content normally, download the Cycore series plug-ins to ensure that the dynamic teaching files can be opened normally. After the software of the three computers is installed, the teaching system is run and the experimental environment is tested. If the system can run normally after 1 h, there is no phenomenon of unstable operation and wrong screen casting, which indicates that the setting of the experimental environment meets the requirements of the experiment.

The test was carried out in three groups at the same time, and in order to ensure the reliability of the output results, feedback analysis of the interactive results of the query search data of a certain subject in a certain grade is carried out, and the test results are shown in Fig. 6 below.
Fig. 6. Comparison of experimental results

(a) Feedback results of the designed system

(b) Feedback from the traditional teaching aids system (I)

(c) Feedback from the Traditional Auxiliary Teaching System (II)
Analysis of the above three groups of experimental results shows that the educational aid system based on the economic coupling coordination analysis has feedback degree similar to the interactive result feedback for the 10 groups of teaching test data. Under the traditional design, the feedback results of the auxiliary teaching system (1) are high and low, and the feedback of the same set of interactive data will fluctuate violently, which shows that the feedback stability of the system is poor. The interactive data feedback curve has more stable data feedback in the first five groups of data, and the following five groups of data feedback results are extremely close to 0. According to the above analysis, the interactive feedback effect of the designed higher education assistant teaching system is better and the system is more stable.

5 Conclusion

Based on the design of the traditional teaching system, the higher education auxiliary teaching system designed this time enhances the feedback of interactive results through the analysis of economic coupling coordination degree, and improves the stability of the auxiliary teaching system. However, the design of the higher education auxiliary education system proposed this time is carried out under idealized conditions. In the actual application process, the compatibility between other hardware equipment and system software must also be considered. In future research, Focus on research and optimization in this regard.

6 Fund Projects

The 13th Five Year Plan of Jiangxi Education Science “Research on the Coordinated Development of Regional Higher Education and Economy” (17ZD065).

References

1. Devlin, M., McKay, J.: Teaching inclusively online in a massified university system. Widening Part. Lifelong Learn. 20(1), 146–166 (2018)
2. Pokhodnya, K., Anderson, K.J., Kilina, S.V., et al.: The mechanism of charged, neutral, mono- and polyatomic donor ligand coordination to perchlorinated cyclohexasilane (Si 6 Cl 12). J. Phys. Chem. A 122(16), 4067 (2018)
3. Auerbach, J.E., Concordel, A., Kornatowski, P.M., et al.: Inquiry-based learning with Robo-Gen: an open-source software and hardware platform for robotics and artificial intelligence. IEEE Trans. Learn. Technol. 12(3), 356–369 (2018). PP(99): 1–1
4. Gao, M., Xu, G., Liu, T.Y., et al.: Development of teaching training and assessment system for warming acupuncture. Zhongguo Zhen Jiu = Chin. Acupunct. Moxibustion 39(9), 1021–1023 (2019)
5. Minati, L., Frasca, M., Yoshimura, N., et al.: Versatile locomotion control of a hexapod robot using a hierarchical network of nonlinear oscillator circuits. IEEE Access 6(99), 8042–8065 (2018)
6. Zhang, X., Wang, H.: Optimal dispatch method of transmission and distribution coordination for power systems with high proportion of renewable energy. Dianli Xitong Zidonghua/Autom. Electr. Power Syst. 43(3), 67–75 and 115 (2019)
7. Lai, C.M., Cheng, Y.H., Hsieh, M.-H., et al.: Development of a bidirectional DC/DC converter with dual-battery energy storage for hybrid electric vehicle system. IEEE Trans. Veh. Technol. 67(2), 1036–1052 (2018)

8. Wang, R., Xiao, F., Zhao, Z., et al.: Investigation on measurement method of transformer winding AC resistance by using auxiliary winding. Diangong Jishu Xuebao/Trans. Chin. Electrotech. Soc. 34(2), 245–254 (2019)

9. Li, M.: Example-based learning using heuristic orthogonal matching pursuit teaching mechanism with auxiliary coefficient representation for the problem of de-fencing and its affiliated applications. Appl. Intell. 48(9), 2884–2893 (2018)

10. Ratzinger, D., Amess, K., Greenman, A., et al.: The impact of digital start-up founders’ higher education on reaching equity investment milestones. J. Technol. Trans. 43(3), 1–19 (2018)