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Ideological and Political Teaching Information Management based on Artificial Intelligence and Data Security Model

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Abstract. In order to improve the efficiency of ideological and political teaching information management, this paper combines artificial intelligence technology and data-complete technology to construct an ideological and political teaching information management model to improve the quality of modern ideological and political teaching. Aiming at the multi-input multi-output discrete-time system with disturbance, a two-degree-of-freedom controller based on virtual reference feedback tuning VRFT method is designed in this paper. In addition, this paper designs the transfer function from the reference model to the output and the transfer function from the disturbance to the output two-degree-of-freedom controller. The experimental results show the effectiveness of the method. From the statistics of the experimental data, the ideological and political teaching information management system based on artificial intelligence and data security model proposed in this paper has good effects.

Keywords: artificial intelligence; data security; ideology and politics; teaching information
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1 INTRODUCTION

System theory believes that the most basic factors affecting the state of a system are the structure and function of the system. System structure refers to the way or order in which the elements within the system are interconnected and interact with each other. System function refers to the ability of the system to interact with the external environment, which expresses the nature and behavior of the system. In order to realize the system function, the components of the system must be complete, which is called the basic structure of the system. Moreover, the elements of the system can be coordinated and ordered, which is called a complete structure. At the same time, the overall system is further able to actively adapt to the structure of the external environment changes, which is called the optimized structure.

The literature [1] believes that the evaluation of the information ecosystem should start from the basic components of the system, and construct the system structure index that reflects the completeness of the elements and the relationship between the elements. Secondly, it is necessary to construct assessment indicators from the functions of the network teaching information ecosystem, which is also the most intuitive choice for understanding the system. Thirdly, in the Internet era, the online teaching information ecosystem is in an open and constantly evolving educational environment. Whether it is the active demand of the main body of the system ecology or the stimulus change of the external environment, the system should have the ability of sustainable development. Therefore, a systematic review should include indicators that can reflect the development of the system. The literature [2] constructs a set of hierarchical evaluation index system. The highest level is the target level, and the index is the college network teaching information ecosystem (G), and the specific calculation results are synthesized from the second level index. The second layer is the criterion layer. According to the above analysis, this paper defines the criterion layer as system structure (A), system function (B), and system development (C). The third and fourth layers start from three criteria, discuss the factors affecting the online teaching information ecosystem, and form the first-level index layer and the second-level index layer under each criterion layer.

The network teaching information ecosystem in colleges and universities includes three major elements: information people, information resources and information environment. Among them, the information people mainly include teachers, students, teaching management personnel, and network teaching technical support personnel who participate in online teaching; the online teaching information environment mainly includes the online teaching platform that integrates information technology and infrastructure, and is related to the maintenance and management of online teaching. The network teaching information system, the network teaching information culture that reflects the explicit and implicit influence of network teaching [3]. The structural factors affecting the system can be divided into five parts: network teaching information people, network teaching information resources, network teaching platform, network teaching information system, network teaching information culture. The human factor of online teaching information [4]. As the main body of the information ecology, the quality and ability of the information people have a very significant impact on the online teaching information ecosystem. In the era of network teaching, teachers not only need to have a solid professional foundation, but also have a high level of information technology application and network guidance. Teachers' teaching design, curriculum organization, and learning evaluation should be able to fully reflect the characteristics of network teaching, and be able to use information technology to strengthen interaction with students, and guide students to learn independently and communicate with each other. As information consumers, in addition to conventional learning ability, students' information literacy plays an important role in the system [5]. Information literacy reflects students' awareness and ability to use information and their mental state when faced with information. Therefore, when measuring students' state, indicators should be scored from the perspectives of students' online learning awareness, autonomous learning ability, and information analysis and processing ability. For network teaching administrators, the most important thing is to use information technology to improve the efficiency of teaching management services, such as timely issuing various announcements, responding to the needs of teachers and students in real time and feedback processing information [6]. The technical support personnel must do a good job in the maintenance of the system and the development of corresponding functions, so the inspection can be based on the number of times they have upgraded and maintained the system, the average time to complete the iteration of the system version, and the time to respond to the needs of users of the online teaching platform. Factors of online teaching information resources. There are three resource factors: information quantity, information quality and information organization. The amount of information is the richness of network teaching resources, which is more reflected in the amount of learning subject resources, and directly affects the information activities of the information person [7]. Information quality is the key to network teaching resources, including the usefulness and ease of use of information. Usefulness means that the content of online teaching resources is highly specialized, covers a wide range of subject knowledge, and has strong learning pertinence. Ease of use includes the update speed of teaching resources, the degree of openness, and the difficulty of obtaining them. Information organization mainly refers to the organization of teaching resources on the online teaching platform. For example, the online teaching platform has the functions of displaying excellent courses and recommending courses. These functions are used to reorganize and display teaching resources in different ways. Students are more convenient and efficient in using online teaching resources. Factors of online teaching platform [8]. The network teaching platform is the prerequisite for the development of network teaching activities. A healthy network teaching information ecosystem requires that the network teaching platform infrastructure is complete, the teaching system is stable, the platform design is reasonable, and the platform functions are complete. The improvement of infrastructure can be considered from two aspects. On the one hand, the server is stable and secure, which can ensure uninterrupted operation and can resist malicious attacks by hackers; The terminal accesses the network teaching platform. The stability of the teaching system requires that the platform can support a large number of students to study online at the same time, and the response time of logging into the teaching platform is short enough, otherwise students' learning will be disturbed [9]. Reasonable platform design is about the function presentation of the platform, which requires the platform to have scientific navigation design, good retrieval function, reasonable plate layout, and beautiful color matching. In addition, the functions of the platform must be perfected to meet the needs of various information people when they work in the system. The factors of network teaching information system. The information system is the code of conduct and norms that all kinds of information people must abide by when they carry out information activities. This factor includes two aspects; one is whether the network teaching system is complete; the other is whether the information system can play its due role. Therefore, whether the teaching authority has formulated a series of rules, systems and policies to promote the development of online teaching is the basic condition [10]. At the same time, the existing network teaching information system should effectively promote teachers' online teaching practice, effectively promote the improvement of students' interest and effect of online learning, and effectively promote the development of teaching management personnel. Information culture factors in online teaching. Cultural factors are similar to institutional factors. On the one hand, there must be the promotion and recognition of online teaching culture. That is to say, information culture should affect the behavior of information people and be integrated into teachers' teaching concepts, so that teachers can make better use of network technology for online teaching; integrating into students' study habits can enable students to improve their own independent learning ability and promote their thirst for knowledge. It integrates into the thinking of teaching management personnel and technical support personnel, and urges them to make full use of the powerful advantages of information technology to communicate with teachers and students in a timely manner to meet their needs. On the other hand, the network teaching information culture should play its due role, promote the improvement of the network teaching information system, and promote the construction of teaching resources [11].

Review relevant domestic and foreign literature and materials such as teaching information statistical analysis, teaching error analysis, teaching information feedback, effective application and comparative analysis of teaching process data, and sort out the current typical cases of teaching information error feedback mechanism, in order to build a statistical-based system suitable for colleges and universities in the western region. The teaching information error feedback model of learning method provides a scientific theoretical basis [12].

Sort out the feedback and suggestions made by teachers during the exchange process, and conduct sampling interviews with students and teachers on course knowledge points in stages and periods in the course teaching process, and extract the value information of the teaching process from the sampling data. The proposed teaching information error feedback model is further improved through value information [13].

The course team designs questionnaires and final exam papers according to the teaching situation of the courses. The difficulty level of the papers and the coverage of knowledge points should be consistent with the questionnaires. The knowledge point questionnaires were designed according to the degree of difficulty and mastery. Before the final exam, a questionnaire survey will be carried out for the entire grade, and the class and teachers will conduct a questionnaire survey on the course. According to the score of knowledge points, the students' test situation is counted, and the teacher's teaching error is analyzed based on the data of the students' questionnaire and the teacher's questionnaire data of the course group [14]. College supervisors, college leaders, and teacher groups conduct objective evaluations based on the teaching situation of each teacher and the explanation of teaching knowledge points [15].

This paper combines artificial intelligence technology and data integrity technology to build an information management model for ideological and political teaching, improve the quality of modern ideological and political teaching, and improve the effect of ideological and political teaching information management.

2 DESIGN OF IDEOLOGICAL AND POLITICAL TEACHING INFORMATION MANAGEMENT SYSTEM

2.1 Design of Two-degree-of-freedom Controller based on VRFT Method

Although there are some achievements on the design of two-degree-of-freedom controllers, most of them are for single-input single-output systems, and there are few results on the design of two-degree-of-freedom controllers for multi-input and multiple-output systems. Unlike single-input single-output linear systems, multiple-input multiple-output systems are more complex and difficult to demonstrate their effectiveness when designing a two-DOF controller. In this chapter, we consider the controller design using the two-degree-of-freedom VRFT method for a multiple-input multiple-output linear system.

This paper considers a class of multiple-input multiple-output discrete systems.

$$y(t+1)=p\Big(u(t),\cdots,u(t-n_u),y(t),\cdots,y(t-n_y)+d(t)\Big) \tag{1}$$

Among them, $u(t)\in R^m$ and $y(t)\in R^n$ represent the input and output of the system, respectively, nu and ny are the orders of u(t) and y(t), and d(t) represents a bounded additive interference signal. The reference system is shown in Figure 1(a).

For convenience, system (1) is simplified to:

$$y(t+1)=p\big(u(t),y(t)+d(t)\big) \tag{2}$$

The two-degree-of-freedom controller is designed as:

$$u(t)=C_r(z;\theta_r)r(t)+C_t(z;\theta_y)y(t) \tag{3}$$

Among them, r(t) is the reference signal. Because the controller is linearly parameterized, Cr and Cy can be written as:

$$C_r\left(z;\theta_r\right)=\beta_r^{\ T}\left(z\right)\theta_r, C_r\left(z;\theta_y\right)=\beta_y^{\ T}\left(z\right)\theta_r \tag{4}$$

Among them, β_r and β_y are vectors of discrete-time transfer functions, and θ_r and θ_y are parameter vectors. Then, there is:

$$\begin{cases} y\left(t+1\right)=p\left(u\left(t\right),y\left(t\right)+d\left(t\right)\right) \\ u\left(t\right)=C_r\left(z;\theta_r\right)r\left(t\right)+C_t\left(z;\theta_y\right)y\left(t\right) \end{cases} \tag{5}$$

For the closed-loop function and sensitivity function, it can be expressed by $M\left(r\left(t\right),y\left(t\right)\right)\in R^{n\times n}$ and $S\left(d\left(t\right),y\left(t\right)\right)\in R^{n\times n}$ (the closed-loop function represents the transfer function between r(t) and y(t) in the system). We are given a set of parameterized controllers $\left\{\left(C_r,C_y\right)\right\}$ that are linearly related to the parameter vector, and the control objective is to find the parameter vector $\left(\theta_r^*,\theta_y^*\right)$ such that:

$$\min_{\left(\theta_r,\theta_y\right)}=\left\|\frac{p\left(z\right)C_r\left(z,\theta_r\right)}{\left(1+P\left(z\right)C_y\left(z,\theta_y\right)\right)}-M\left(z\right)\omega_M\right\|_2^2+\left\|\frac{1}{\left(1+P\left(z\right)C_y\left(z,\theta_y\right)\right)}-S\left(z\right)\omega_S\right\|_2^2 \tag{6}$$

Among them, ω_M and ω_S are weighting functions chosen by the designer.

Since p(·) is unknown, the optimal control problem in this chapter is not a standard optimal control problem. To overcome this challenge, the VRFT method is introduced, that is, the method of directly designing the controller from the input and output measurement data collected from the system p (·)

2.2 Design of a Two-degree-of-freedom Controller

The VRFT method approximately solves the model reference problem, where the control rules are determined by a reference model that describes the desired behavior of the closed-loop system. The structure of the two-DOF controller is shown in Figure 1(b).

The data $y(t)$ can be regarded as the output of the feedback control system under the transfer function M (z), at the same time, as the output signal $y(t)$, there is y) = P(z)u(t). If the controller class is f and the control signal is u(t), the control signal is close to $C_r\left(r'\left(t\right)-y\left(t\right)\right)$ to some extent.

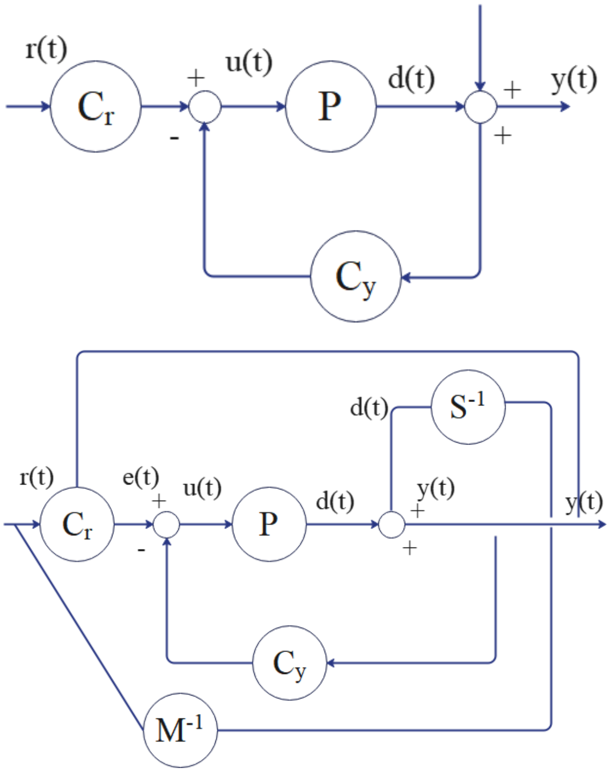

Figure 1: Controller design structure (a) Control system (b) Structure diagram of controller design.

Therefore, it can be clearly seen that the closed-loop system under the action of the controller class $\{C_r\}$ is close enough to the reference model M (z). For a given output $y(t)$, the reference signal $r'(t)$ is chosen such that $r'(t)=M^{-1}(z)y(t)$. For the sensitivity function, we assume that the reference signal r(1) is zero, and for the measured data sn), consider a perturbation $d'(t)$ such that $d'(t)+y(t)$ is the desired output, that is, $d'(t)=S^{-1}(d'(t)+y(t))$. The next task is to find a class of controllers {C} such that the closed-loop system with disturbance signal d(n) is infinitely close to the reference disturbance model S(z). After that, a set of input and output data $\{\tilde{u}(t),\tilde{y}(t)\}_{t=1,2,...,N},\tilde{y}(t)_{t=1,2,...,N}=p\left(\tilde{u}(t)_{t=1,2,...,N}\right)$ is collected. Next, the VRFT algorithm is given.

1. The virtual reference signal $r'(t)$ and the disturbance signal $d'(t)$ given by the algorithm make:

$$y(t)=M(z)r'(t) \tag{7}$$

$$y'(t)=S(z)d'(t) \tag{8}$$

2. The algorithm selects appropriate filters LM (z) and Ls(z), and under the action of the filters, we obtain:

$$u_M(t)=L_M(z)u(t) \tag{9}$$

$$y_M(t)=L_M(z)y(t) \tag{10}$$

$$y_M(t)=L_M(z)y(t) \tag{11}$$

$$u_S(t)=L_S(z)u(t) \tag{12}$$

$$y'_S(t)=L_S(z)y'(t) \tag{13}$$

3. The algorithm selects the parameter vector $\left(\theta_r^N,\theta_y^N\right)$ to minimize the following control rules:

$$J_{VR}^N\left(\theta_r,\theta_y\right)=\frac{1}{N}\sum_{t=1}^{N}\left[u_M(t)-C_r(z;\theta_r)r'_M(t)+C_y\left(z;\theta_y\right)y_M(t)\right]^2 +\frac{1}{N}\sum_{t=1}^{N}\left[u_M(t)+C_y(z;\theta_r)y'_S(t)\right]^2 \tag{14}$$

It should be noted that when $C_r(z;\theta_r)=\beta_r^T(z)\theta_r$ and $C_y\left(z;\theta_y\right)=\beta_y^T(z)\theta_y$, formula (13) can be written as:

$$J_{VR}^N\left(\theta_r,\theta_y\right)=\frac{1}{N}\sum_{t=1}^{N}\left[u_M(t)-\varphi_M^{r'}(t)^T+\varphi_M^{y}(t)\right]^2+\frac{1}{N}\sum_{t=1}^{N}\left[u_S(t)-\varphi_S^{y'}(t)\right]^2 \tag{15}$$

Among them, $\varphi_M^{r'}(t)=\beta_r(z)r'_M(t)\theta_r$, $\varphi_M^{y}(t)=\beta_y(z)y_M(t)\theta_y$, and $\varphi_S^{y'}(t)=\beta_y(z)y_S(t)\theta_y$.

The controller parameter vector is $\left(\theta_r^N,\theta_y^N\right)$, where N represents the number of datasets, and then we have:

$$\begin{pmatrix}\theta_r^N\\ \theta_y^N\end{pmatrix}=\left(\sum_{t=1}^{N}\left(\begin{pmatrix}\varphi_M^{r'}(t)\\ -\varphi_M^{y}(t)\end{pmatrix}\begin{pmatrix}\varphi_M^{r'}(t)\\ -\varphi_M^{y}(t)\end{pmatrix}^T+\begin{pmatrix}0\\ -\varphi_S^{y'}(t)\end{pmatrix}\begin{pmatrix}0\\ -\varphi_S^{y'}(t)\end{pmatrix}^T\right)\right)^{-1} \cdot\left(\sum_{t=1}^{N}\left(\begin{pmatrix}\varphi_M^{r'}(t)\\ -\varphi_M^{y}(t)\end{pmatrix}u_M(t)+\begin{pmatrix}0\\ \varphi_S^{y'}(t)\end{pmatrix}u_S(t)\right)\right) \tag{16}$$

When P is a linear discrete system, the transfer function is P (z). Since the analysis of the controller design criteria will be done through the concept of an ideal controller, the ideal controller $\left(C_r^*(z),C_y^*(z)\right)$ can be given by solving the following model matching problem.

$$C_r^*(z)=\frac{M(z)}{P(z)\cdot S(z)} \tag{17}$$

$$C_y^*(z)=\frac{1-S(z)}{P(z)\cdot S(z)} \tag{18}$$

It can be seen that the ideal controller does not belong to the control class $\left\{\left(C_r,C_y\right)\right\}$, nor is the transfer function and rational function; this ideal controller is only used for the analysis of the following problems. When N → oo, using the Parse-val theorem, formula (14) can be written in the frequency domain form:

$$J_{VR}^N\left(\theta_r,\theta_y\right)=\frac{1}{2\pi}\int_{-\pi}^{\pi}|P|^2\left|C_r^*-C_r+M\left(C_y-C_y^*\right)\right|^2\frac{|L_M|^2}{|M|^2}\Delta_u d\omega$$
$$+\frac{1}{2\pi}\int_{-\pi}^{\pi}|P|^2\left|C_y-C_y^*\right|^2\frac{|S|^2|L_S|^2}{|1-S|^2}\Delta_u d\omega \tag{19}$$

Among them, Δ_u is the spectral density of the input u. Meanwhile, equation J_{MR} can be written as:

$$J_{MR}\left(\theta_r,\theta_y\right)=\frac{1}{2\pi}\int_{-\pi}^{\pi}|P|^2\frac{\left|C_r^*-C_r+M\left(C_y-C_y^*\right)\right|^2}{\left|1+PC_y\right|^2}|W_M|^2 d\omega+\frac{1}{2\pi}\int_{-\pi}^{\pi}|P|^2\frac{\left|C_y-C_y^*\right|^2}{\left|1+PC_y\right|^2}|S|^2|W_S|^2 d\omega \tag{20}$$

If $\left(C_r^*,C_y^*\right)\in\left(C_r,C_y\right)$, then $J_{MR}\left(\theta_r,\theta_y\right)$ and $J_{VR}\left(\theta_r,\theta_y\right)$ have the same minimum value. However, if $\left(C_r^*,C_y^*\right)\notin\left(C_r,C_y\right)$, then it is necessary to find suitable filters $L_M(z)$ and $L_s(z)$ to match the virtual reference rules. The filters $L_M(z)$ and $L_s(z)$ are selected to satisfy:

$$|L_M|^2=|M|^2|S|^2|W_M|^2\frac{1}{\Delta_u} \tag{21}$$

$$\left|L_S\right|^2=\left|1-S\right|^2\left|S\right|^2\left|W_S\right|^2\frac{1}{\Delta_u} \tag{22}$$

Among them, $\forall\omega\in[-\pi,\pi]$. Note that all parameters on the right-hand side of equations (20) and (21) are known, and then the filter can be actually calculated. Only when the designer chooses the input signal characteristics, Δ_u can be considered known, otherwise, Δ_u needs to be estimated.

Before stating the theorem, we introduce some notations:

$$\Delta C_r=C_r^*-\beta_r^T(z)\theta_r^{'} \tag{23}$$

$$\Delta C_y=C_y^*-\beta_y^T(z)\theta_y^{'} \tag{24}$$

Among them, $\left(C_r^*,C_y^*\right)$ is the ideal controller, $\left(\theta'_r,\theta'_y\right)$ is the parameter that minimizes $J_{MR}\left(\theta_r,\theta_y\right)$, and ΔC is part of C*.

Next, this paper introduces the controller expansion vector:

$$\hat{C}_r\left(z;\hat{\theta}_r\right)=\left[\beta_{r1}(z),\beta_{r2}(z),\cdots,\beta_{rn}(z),\Delta C_r\right]^T\hat{\theta}_r \tag{25}$$

$$\hat{C}_y\left(z;\hat{\theta}_y\right)=\left[\beta_{y1}(z),\beta_{y2}(z),\cdots,\beta_{yn}(z),\Delta C_y\right]^T\hat{\theta}_y \tag{26}$$

Among them, $\hat{\theta}_r=\left[v_{r1},v_{r2},\ldots,v_{rn},v_{rn_{r+1}}\right]$ and $\hat{\theta}_y=\left[v_{y1},v_{y2},\ldots,v_{yn},v_{yn_{y+1}}\right]$, then, the following extended performance index function can be obtained:

$$\hat{J}_{MR}=\left\|\left(\frac{P(z)\hat{C}_r\left(z;\hat{\theta}_r\right)}{1+P(z)\hat{C}_r\left(z;\hat{\theta}_r\right)}-M(z)\right)W_M(z)\right\|_2^2+\left\|\left(\frac{1}{1+P(z)\hat{C}_y\left(z;\hat{\theta}_y\right)}-S(z)\right)W_S(z)\right\|_2^2 \tag{27}$$

Note that the difference between formula (19) and formula (26) is that $\hat{J}_{MR}$ is obtained by the parameterization of the controller, and there is a global minimum value $\left(\hat{\theta}_r^*,\hat{\theta}_y^*\right)$ of $\hat{J}_{MR}$, so that:

$$\hat{J}_{MR}\left(\hat{\theta}_r^*,\hat{\theta}_y^*\right)=0$$

Finally, the Taylor expansion of $\hat{J}_{MR}$ at $\left(\hat{\theta}_r^*,\hat{\theta}_y^*\right)$ is:

$$\hat{J}_{MR}\left(\hat{\theta}_r^*,\hat{\theta}_y^*\right)=\hat{J}_{MR}^*\left(\hat{\theta}_r,\hat{\theta}_y\right)+o\left\|\hat{\theta}_r-\hat{\theta}_r^*\right\|_2^2+o\left\|\hat{\theta}_y-\hat{\theta}_y^*\right\|_2^2 \quad (28)$$

Among them, $\hat{J}_{MR}^*$ is the second-order Taylor expansion of $\hat{J}_{MR}$. Then, the following theorem is obtained.

Theorem 1.1 a vector $\left(\theta_r,\theta_y\right)$ can minimize J_{MR}, and a vector $\left(\tilde{\theta}_r,\tilde{\theta}_y\right)$ can minimize J_{VR}. If filters $L_M\left(z\right)$ and $L_s\left(z\right)$ are chosen according to formulas (20) and (21) such that:

$$\left(\tilde{\theta}_r,\tilde{\theta}_y\right)=\underset{\left(\theta_r,\theta_y\right)}{arg\,min}\,\hat{J}_{MR}^*\left(\begin{bmatrix}\theta_r^T & 0\end{bmatrix}^T,\begin{bmatrix}\theta_y^T & 0\end{bmatrix}^T\right) \quad (29)$$

Prove: Since the second-order expansion of the function contains only second-order terms, $\hat{J}_{MR}^*$ can be computed by the following expression

$$\hat{J}_{MR}\left(\hat{\theta}_r,\hat{\theta}_y\right)=\frac{1}{2\pi}\int_{-\pi}^{\pi}\left|P\right|^2\left|C_r^*-C_r\left(\hat{\theta}_r\right)+M\left(C_y\left(\hat{\theta}_y\right)-C_y^*\right)\right|^2\cdot\frac{\left|W_M\right|^2}{\left|1+PC_y\left(\hat{\theta}_y\right)\right|^2}d\omega$$
$$+\frac{1}{2\pi}\int_{-\pi}^{\pi}\left|P\right|^2\left|C_y\left(\hat{\theta}_y\right)-C_y^*\right|^2\frac{\left|S\right|^2\left|W_S\right|^2}{\left|1+PC_yC_y\left(\hat{\theta}_y\right)\right|^2}d\omega \quad (30)$$

Filters $L_M\left(z\right)$ and $L_s\left(z\right)$ are chosen according to formulas (20) and (21), and J_{VR} is given by the following equations.

$$J_{VR}\left(\theta_r,\theta_y\right)=\frac{1}{2\pi}\int_{-\pi}^{\pi}\left|P\right|^2\left|C_r^*-C_r\left(\theta_r\right)-C_y^*\right|^2\cdot\frac{\left|W_M\right|^2}{\left|1+PC_y\left(\theta_y\right)\right|^2}\Delta_u d\omega$$
$$+\frac{1}{2\pi}\int_{-\pi}^{\pi}\left|P\right|^2\left|C_y\left(\theta_y\right)-C_y^*\right|^2\frac{\left|S\right|^2\left|W_S\right|^2}{\left|1+PC_yC_y\left(\hat{\theta}_y\right)\right|^2}\Delta_u d\omega \quad (31)$$

Comparing formula (29) and formula (30), it can be seen that:

$$J_{VR}\left(\theta_r,\theta_y\right)=\hat{J}^{*}_{MR}\left(\left[\theta^{*}_r \quad 0\right]^T,\left[\theta^{T}_y \quad 0\right]^T\right) \tag{32}$$

The proof is over.

Next, we consider a noisy environment, that is, the collected output data y(t) is affected by a disturbance d(t).

$$\begin{cases} y'(t)=P(z)u(t)+d_t \\ y'(t+1)=p\left(u(t),y(t)+d(t)\right) \end{cases} \tag{33}$$

$\left\{u(t),y'(t)\right\}_{t=1,2,\ldots,N}$ is collected from the experiment when the system runs open-loop, that is, the controller process and the perturbation process are uncorrelated. If the VRFT algorithm is applied to $\left\{u(t),y'(t)\right\}_{t=1,2,\ldots,N}$, the estimation of $\left(\theta^N_r,\theta^N_y\right)$ will be different due to the presence of noise. If $\left\{u(t),\bar{y}'(t)\right\}_{t=1,2,\ldots,N}$ from the noise experiment is assumed to have the same input signal $\left\{u(t)\right\}_{t=1,2,\ldots,N}$, then the parameters can be estimated by the following equations:

$$\begin{pmatrix}\theta^N_r\\ \theta^N_y\end{pmatrix}=\left(\sum_{t=1}^{N}\left(\begin{pmatrix}\varphi^{r'}_M(t)\\ -\varphi^{y}_M(t)\end{pmatrix}\begin{pmatrix}\varphi^{r'}_M(t)\\ -\varphi^{y}_M(t)\end{pmatrix}^T+\begin{pmatrix}0\\ -\varphi^{y'}_S(t)\end{pmatrix}\begin{pmatrix}0\\ -\varphi^{y'}_S(t)\end{pmatrix}^T\right)\right)^{-1}$$
$$\cdot\left(\sum_{t=1}^{N}\left(\begin{pmatrix}\varphi^{r'}_M(t)\\ -\varphi^{y}_M(t)\end{pmatrix}u_M(t)+\begin{pmatrix}0\\ \varphi^{y'}_S(t)\end{pmatrix}u_S(t)\right)\right) \tag{34}$$

Among them, $\varphi^{r'}_M(t)$, $\varphi^{y}_M(t)$ and $\varphi^{y'}_S(t)$ are constructed from $\left\{y'(t)\right\}_{t=1,2,\ldots,N}$ in formula (32). Using the output data $\left\{\tilde{y}'(t)\right\}_{t=1,2,\ldots,N}$ and $\varphi^{r'}_M(t)$, $\varphi^{y}_M(t)$ and $\varphi^{y'}_S(t)$ can be constructed in the same way.

Note that the two sequences from the two experiments are affected by two different noise implementations, so $\left\{\tilde{y}'(t)\right\}_{t=1,2,\ldots,N}$ will be different from $\left\{y'(t)\right\}_{t=1,2,\ldots,N}$. In this case, we assume that the two noise signals are uncorrelated. In addition, the actual representation of the estimated system is not directly used to design the controller, but its sole purpose is to generate useful variable signals.

2.3 Simulation Study

We consider the system as:

$$P(z)=\begin{bmatrix} \frac{2.6z^{-1}}{1+3.7z^{-1}} & 0 \\ 0 & \frac{1.3z^{-1}}{1+6.7z^{-1}} \end{bmatrix} \tag{35}$$

We choose the disturbance signal d(t) as:

$$d(t)=\frac{0.1}{1-0.2z^{-1}}\gamma(t) \tag{36}$$

Among them, $\gamma(t)$ is white noise, the variance is $\sigma_\gamma^2=0.01$, and the reference signals r' and d' are shown in Figure 2.

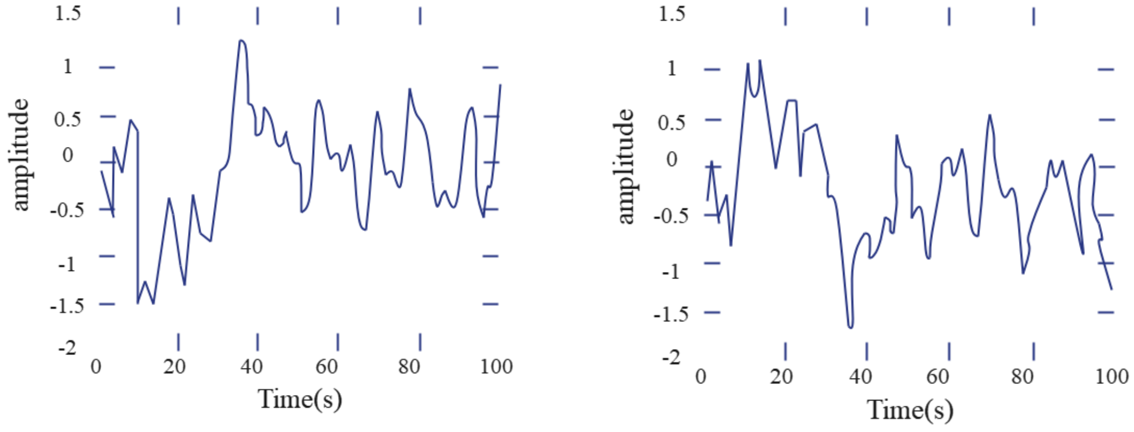

Figure 2: (a) Virtual signal Virtual reference input signal r', (b) Virtual reference disturbance signal d'.

The reference model required for the VRFT controller is designed as:

$$M(z)=\begin{bmatrix} \frac{0.5z^{-1}}{1-0.5z^{-1}} & 0 \\ 0 & \frac{0.6z^{-1}}{1-0.3z^{-1}} \end{bmatrix} \tag{37}$$

$$S(z)=\begin{bmatrix} 1-\frac{0.2z^{-1}}{1-0.8z^{-1}} & 0 \\ 0 & 1-\frac{0.7z^{-1}}{1-0.3z^{-1}} \end{bmatrix} \tag{38}$$

Among them, the selection of M(z) needs to be designed according to the specific application object, according to the time domain or frequency domain requirements of the system, and meet the performance index transfer function. Figure 3 depicts Bode plots of P(z), M(z) and S(z).

The selected weighting function is as follows:

$$W_M(z)=W_S(z)=\frac{1}{1-z^{-1}} \tag{39}$$

The transfer function of the offline time controller can be expressed as:

$$C(z)=\begin{bmatrix} \frac{\theta_1+\theta_2 z^{-1}+\theta_2 z^{-2}}{1-z^{-1}} & 0.07 \\ 0.86 & \frac{\theta_4+\theta_5 z^{-1}+\theta_6 z^{-2}}{1-z^{-1}} \end{bmatrix} \tag{40}$$

Since the VRFT algorithm only relies on a set of input and output data of the system (the sample data needs to be a ergodic stationary random process of various states), an appropriate controller can be selected. It is characterized by specifying the reference model, parameterized controller set, weight function and filter in advance, and then tuning the controller parameters. Next, this paper collects a set of open-loop system noise input and output data $\{u(t),y'(t)\}_{t=1,2,...,512}$.

Formulas (20) and (21) estimate the controller parameter $\theta_i\left(i=1,\cdots,6\right)$.

$$\hat{\theta}_r^{512}=\left[\hat{\theta}_1 \quad \hat{\theta}_2 \quad \hat{\theta}_3\right]=\left[0.2250 \quad 0.0299 \quad 0.7773\right]^T \tag{41}$$

$$\hat{\theta}_y^{512}=\left[\hat{\theta}_4 \quad \hat{\theta}_5 \quad \hat{\theta}_6\right]=\left[0.2288 \quad 0.0315 \quad 0.7874\right]^T \tag{42}$$

From the point of view of the design process of the controller, the dependence on the model has been completely eliminated (without any explicit expression for P(z)). Therefore, the method in this chapter is based on a data-driven controller parameter tuning method. Figure 4 depicts Bode plots of closed loop transfer functions M(z) and S(z). Figure 5 shows the step response of the closed-loop transfer function.

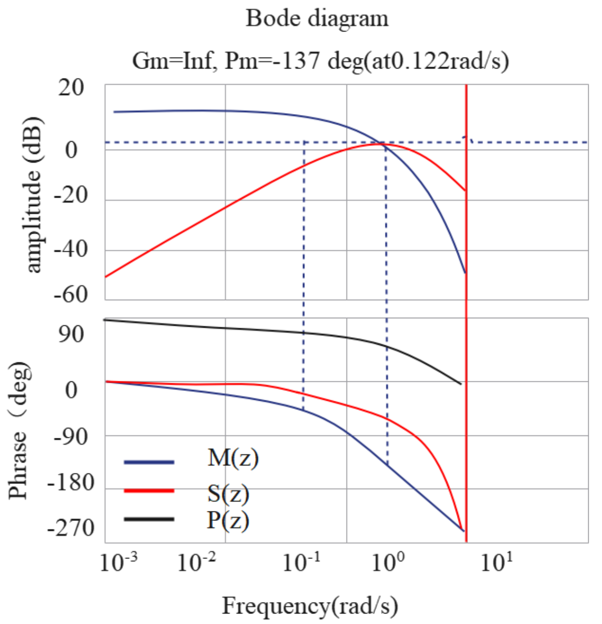

Figure 3: Amplitude-frequency curves: P(z), M(z) and S(z).

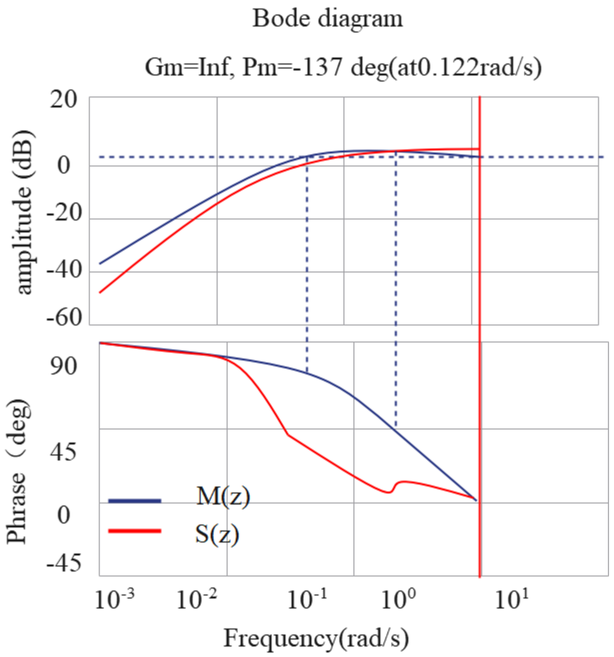

Figure 4: Amplitude-frequency curve: M(z) and S(z).

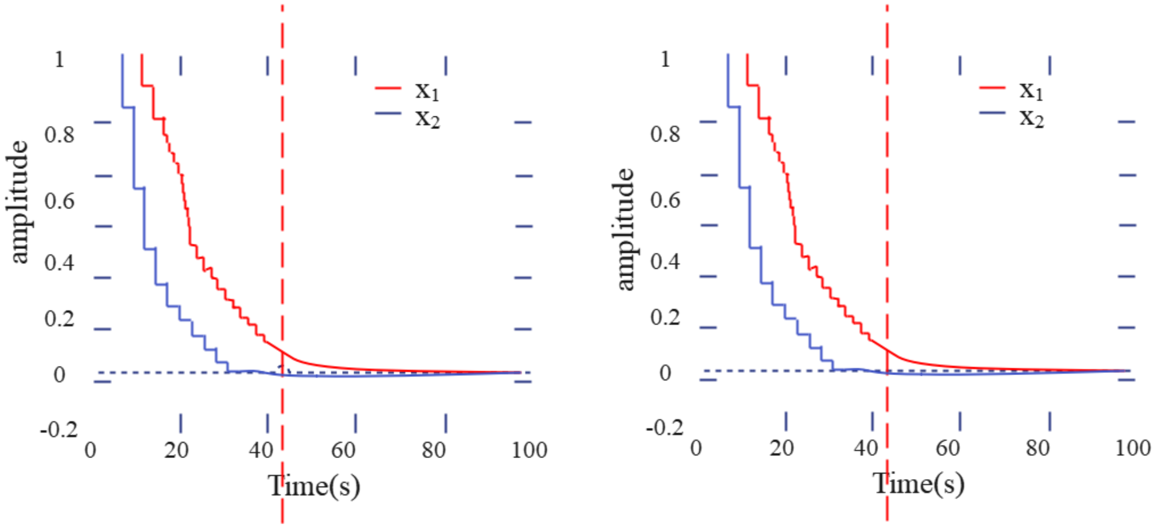

Figure 5: Step Response of (a) Closed-loop transfer function, (b) Sensitive transfer function.

The state space expression considering the Twin Rotor Aerodynamic System (TRAS) is as follows.

$$\begin{aligned}
&\dot{\Omega}_h = \left[l_t F_h\left(\omega_h\right) \cos\alpha_v + \Omega_h f_h + u_2 k_{vh} \right] / J_h \\
&\dot{\Omega}_v = \left\{ l_m F_v\left(\omega_y\right) - \Omega_v f_v + g\left[\left(A-B\right)\cos\alpha_v - C\sin\alpha_v\right] \right\} / J_h \\
&-\left\{ \left(\Omega_h^2 / 2\right)\left(A+B+C\right)\sin 2\alpha_v \right\} / J_v \\
&\dot{\alpha}_h = \Omega_h \\
&\dot{\alpha}_v = \Omega_v \\
&\dot{\omega}_h = \left(u_1 - k_{Hh}^{-1}\left(\omega_h\right)\right) / I_h \\
&\dot{\omega}_v = \left(u_2 - k_{Hv}^{-1}\left(\omega_v\right)\right) / I_v \\
&y_1 = \alpha_h \\
&y_2 = \alpha_v
\end{aligned} \tag{43}$$

Among them, u1 is the first control signal, representing the horizontal (main) DC motor pulse width modulation (PWM) duty cycle. uz is the second control signal representing the PWM duty cycle of the vertical (tail) DC motor. The position control of the pneumatic system means that y and yz in the control process are used as outputs, and the physical meanings and values of other variables and parameters \. The typical control objective of TRAS is to ensure regulation and tracking of vertical and horizontal motion, that is, control of azimuth and pitch. The multiple-input multiple-output control system is decomposed into two single-input single-output control systems, the azimuth control loop and the pitch control loop. In all experimental scenarios, the time range is set to t = 200s, the sampling time is Ts = 0.1s, and the number of sampling points is N = 2000. The reference trajectory is defined as:

$$y_1' = \begin{cases} 0.2, 0 \le k \le 200 \\ -0.2, 200 \le k \le 400 \\ 0.2\sin(0.14k), 400 \le k \le 1200 \\ -0.2, 1200 \le k \le 1600 \\ 0.2, 1600 \le k \le 2000 \end{cases} \tag{44}$$

$$y_1' = \begin{cases} 0.3, 0 \le k \le 300 \\ -0.3, 300 \le k \le 600 \\ 0.3\sin(0.15k), 600 \le k \le 1200 \\ -0.3, 1200 \le k \le 1600 \\ 0.3, 1600 \le k \le 2000 \end{cases} \tag{45}$$

The disturbance signal d(t) is selected as in formula (35), and the reference models are $M(z) \in R^{2\times 2}$ and $S(z) \in R^{2\times 2}$.

$$M(z) = \begin{bmatrix} \dfrac{0.041z^{-1}}{1-1.571z^{-1}+0.647z^{-2}} & 0 \\ 0 & \dfrac{0.048z^{-1}+0.038z^{-2}}{1-1.409z^{-1}+0.496z^{-2}} \end{bmatrix} \tag{46}$$

S(z) is defined as formula (37). The weighting function is chosen as follows:

$$W_M(z) = W_S(z) = \frac{1}{1-z^{-1}} \tag{47}$$

The controller parameters can be estimated from the optimal filter equations (20) and (21). Finally, the transfer function of the discrete-time controller (including the horizontal control input u1 and the vertical control input u2) can be written as:

$$C(z) = \begin{bmatrix} \dfrac{1.23+0.5z^{-1}+0.21z^{-2}-1.7z^{-3}}{1-1.571z^{-1}+0.647z^{-2}} & 0.02 \\ 1.1 & \dfrac{5.3-2.5z^{-1}-1.8z^{-2}+3.4z^{-3}}{1-z^{-1}} \end{bmatrix} \tag{48}$$

Among them, the two elements of the main diagonal of the controller above are linear-integral controllers with four parameters, and to improve performance, two other elements are added to address the cross-coupling between the SISO control loops. The diagonal reference model is also chosen to achieve partial decoupling between the control loops.

The goal of the second simulation study is to determine which data-driven algorithm is more suitable for tuning and tracking. In the literature, the MFAC algorithm behaves as an integral controller, so it cannot cancel the poles responsible for the oscillatory transient behavior specific to pitch motion. The MFAC integral characteristic, derived from the azimuthal motion integral characteristic, leads to an oscillatory response of the system due to improper zero-pole cancellation.

In the VRFT algorithm, the controller structure is fully parameterized to ensure the zero-pole elimination of the azimuth and pitch control channels, respectively. The reason for this is that the reference model is already heavily damped. Therefore, the pitch angle follows the reference model, and its output oscillation is significantly damped. In addition, the complex conjugate zero point of the azimuth controller tries to cancel the controller integrator and the process integrator at the same time, which improves the performance of the VRFT azimuth controller.

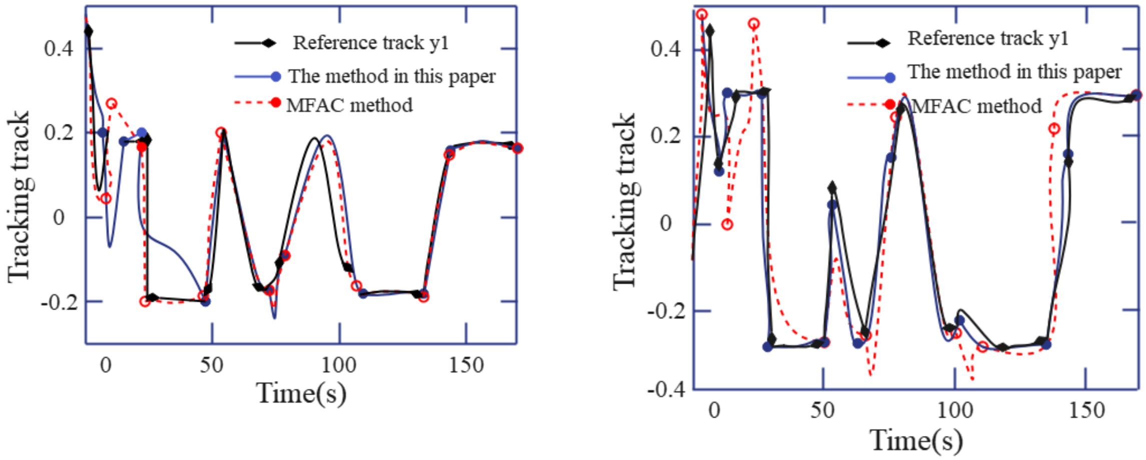

Figure 6: The first algorithm (a) Experimental result 1,(b) Experimental result 2.

Figure 6 presents the experimental results. The experimental results are shown in Figure 7.

$$y_1' = \begin{cases} 0.2, 0 \le k \le 400 \\ -0.2, 400 \le k \le 700 \\ 0.2, 700 \le k \le 1000 \\ 0.2\sin(0.14k), 1000 \le k \le 1800 \end{cases} \quad (49)$$

$$y_1' = \begin{cases} 0.2, 0 \le k \le 250 \\ -0.2, 250 \le k \le 550 \\ 0.2, 550 \le k \le 850 \\ 0.2\sin(0.15k), 850 \le k \le 1800 \end{cases} \quad (50)$$

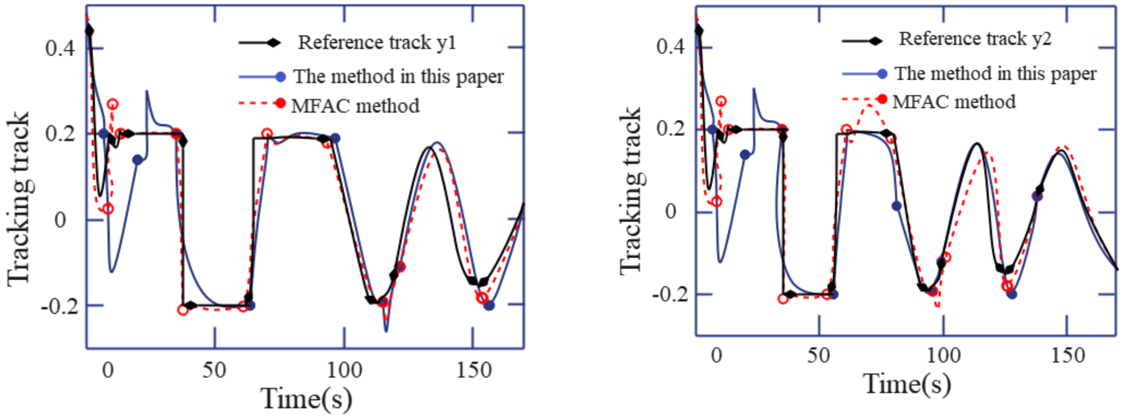

Figure 7: The second algorithm (a) Experimental result 1,(b) Experimental result 2.

Figures 6(a) and 7(b) show that the tracking performance of the two-degree-of-freedom VRFT is better than the model-free adaptive control method mentioned in the literature, and it can better suppress interference. In addition, the two-degree-of-freedom VRFT method uses the initial experimental data to solve the controller offline, which improves the robustness of the closed-loop system without changing the command input response.

3 IDEOLOGICAL AND POLITICAL TEACHING INFORMATION MANAGEMENT BASED ON ARTIFICIAL INTELLIGENCE AND DATA SECURITY MODEL

In order to effectively meet the informatization, automation and intelligent development needs of modern ideological and political teaching, the powerful advantages of modern mobile Internet technology are used in the design of the ideological and political teaching information management system, so that the ideological and political teaching information and ideological and political teaching management level are effectively improved. Moreover, it provides convenient services for teachers and students to upload, download, and manage various ideological and political teaching information, thereby providing good support for ideological and political teaching. The function module is shown in Figure 8.

The data security system is mainly composed of three modules: identity verification module, digital signature module and D RM management module. The essence of the data security system is an interface between an ideological and political teaching management system and a PKI-based CA center. By using the digital certificate of CA for identity identification, the authenticity of the user's identity can be ensured, and the submitted form data can be digitally signed by using the digital certificate to ensure the authenticity of the user's identity, the integrity of the form data and the non-repudiation of its behavior. Moreover, the use of digital certificate-based data encryption technology to encrypt confidential files transmitted in the network can ensure the safe transmission of sensitive information and prevent sensitive data from being maliciously tampered with or leaked. In addition, the use of digital certificates for digital copyright management of ideological and political teaching courseware can dynamically manage user licenses, which enhances the security and convenience of the DRM system.

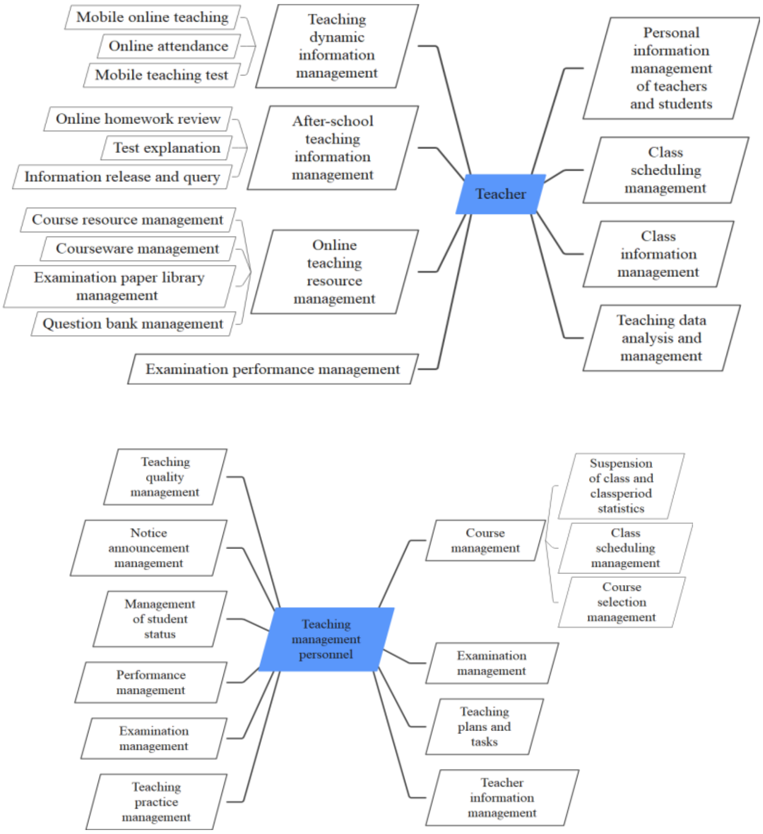

Figure 8: Function module (a) Teacher user module function (b) Function of ideological and political teaching administrator module.

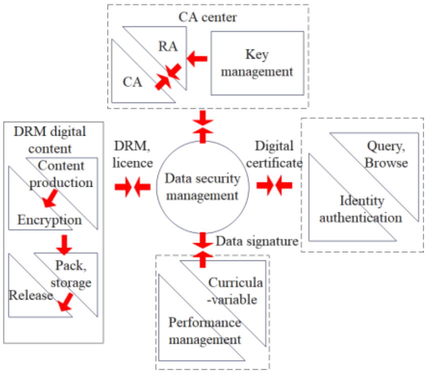

Figure 9: Structure of the data security system.

In this paper, experiments are used to determine the effect of the proposed system of ideological and political teaching data security and teaching information management, and Table 1 and Table 2 are obtained.

From the statistics of the experimental data, the ideological and political teaching information management system based on artificial intelligence and data security model proposed in this paper has good effects and can effectively improve the management efficiency of ideological and political teaching.

Number	*Information security*	*Number*	*Information security*
1	*83.69*	*15*	*86.37*
2	*87.23*	*16*	*88.88*
3	*88.57*	*17*	*84.49*
4	*88.62*	*18*	*88.99*
5	*87.55*	*19*	*84.66*
6	*86.94*	*20*	*88.50*
7	*88.64*	*21*	*87.61*
8	*87.68*	*22*	*85.25*
9	*83.54*	*23*	*84.87*
10	*82.39*	*24*	*83.21*
11	*82.92*	*25*	*84.51*
12	*82.54*	*26*	*88.99*
13	*88.60*	*27*	*82.15*
14	*82.12*	*28*	*82.36*

Table 1: Data security evaluation of ideological and political teaching.

Number	*Information management*	*Number*	*Information management*
1	*91.07*	*15*	*86.85*
2	*89.82*	*16*	*86.36*
3	*86.99*	*17*	*87.34*
4	*89.61*	*18*	*88.13*
5	*92.69*	*19*	*92.01*
6	*92.69*	*20*	*92.96*
7	*89.63*	*21*	*86.82*
8	*91.76*	*22*	*91.01*
9	*87.98*	*23*	*88.32*
10	*86.32*	*24*	*88.60*
11	*91.33*	*25*	*87.44*
12	*91.41*	*26*	*90.08*
13	*87.13*	*27*	*90.94*
14	*91.41*	*28*	*89.95*

Table 2: Ideological and political teaching information management.

4 CONCLUSIONS

In order to design a teaching information error feedback model in line with the improvement of teachers' teaching ability, an exploratory experiment is conducted using statistical and visual analysis methods, and interviews are conducted with teachers and students for Nationalities, school-level teaching supervisors and teaching administrators. Moreover, in-depth exchanges and discussions are carried out in terms of the current teachers' emphasis on the teaching process, the application of teaching evaluation information feedback, teachers' understanding of teaching ability improvement, and their understanding of error correction of teaching process information. In addition, this paper combines artificial intelligence technology and data integrity technology to build an information management model for ideological and political teaching, improve the quality of modern ideological and political teaching, and improve the effect of ideological and political teaching information management. From the statistics of the experimental data, it can be seen that the ideological and political teaching information management system based on artificial intelligence and data security model proposed in this paper has good effects.

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