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ORIGINAL ARTICLE

Design of interactive digital media course teaching information query system

Shaofei Wu[1,2]

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Abstract

In the current university teaching environment, digital media technology has been widely used in the teaching platform to better serve the course teaching. In this paper, the connotation of digital media technology is briefly introduced, the advantages of applying digital media technology in network teaching resources system are analyzed in detail, and the design and implementation method of network teaching resources system based on digital media technology are given. System design through the introduction of a variety of digital media technology teaching, which can enrich the teaching form and promote the improvement and development of more course teaching platforms. Research shows that the B/S structure is the browser structure of the browser to improve the structure. STRUTS is a popular front-end development framework. The DaVinci series processors are embedded system-on-chip and have been designed as a whole. The key technologies used in this system are described. The research shows that the system provides a convenient operation platform for the information construction of colleges and universities, which greatly improves the work and management efficiency of colleges and universities.

Keywords Digital media · Teaching information · System design

1 Introduction

The rapid development of contemporary computer technology, network technology and digital communication technology has brought broad space for the development of digital media art. Many universities have opened digital media art specialty (Dębiec 2018). With the emergence of network teaching platforms, introducing

✉ Shaofei Wu
04005047@wit.edu.cn

[1] Hubei Province Key Laboratory of Intelligent Robots, Wuhan Institute of Technology, Wuhan, People's Republic of China

[2] School of Computer Science and Engineering, Wuhan Institute of Technology, Wuhan, People's Republic of China

digital media technology into the network teaching resources system can provide more abundant educational resources and achieve more flexible and effective interactive teaching. Apply the digital media technology to the teaching platform reasonably, fully express the educational ideas, objectives and contents, and improve the modernization of teaching means (Ouimette et al. 2013). The simplification of the complex problems in the current teaching, the difficult to understand content is easy to accept, and the boring learning becomes wonderful. It is convenient to visually display abstract concepts and images, enriching the educational and teaching methods of educational researchers. Enriched the teaching information transmitted, greatly improving the teaching effect (Wong et al. 2015). Changing the educational model and the role of teachers is conducive to achieving teaching and learning. Optimize configuration and make the most of educational resources. Nowadays, colleges and universities have accumulated a large number of digital media resources, and digital media resources have become an indispensable part of university informationization (Chang et al. 2014).

Digital media is a digital content work. It is the whole process of distribution to terminals and users for consumption through a perfect service system, with modern network as the main carrier of communication (Graziotin et al. 2014). The structure is improved by using B/S structure, that is, the server structure of browser. STRUTS is a popular foreground development framework. DaVinci series processors belong to embedded on-chip system, and the overall design is carried out. Analog teaching courseware is to simulate and simulate the experimental operation and skill training which are not easy to achieve under general conditions through computer software and hardware combined with digital technology. Ultimately achieve the purpose of learning and understanding (Tseng et al. 2016). Digital technology is different from industrial technology and is a brand new thing. It is closely related to electronic technology, programming technology, storage technology, etc. (Brown 2015). System design begins with the management of the media resource library in the process of system development. Second is the contribution of resources, resource contribution can facilitate teaching management (Romerotroncoso et al. 2014). Finally, with the rapid development of digital compression technology, digital storage technology and digital media technology, the combination of these technologies and computer network technology directly impacts the management of traditional media data (Garcia et al. 2015).

The design of teaching information inquiry system of digital media is a management platform for the integration of digital media resources in Colleges and universities, which provides a favorable tool for the full utilization and management of resources and enables the reuse and sharing of digital media resources (Duncan 2013). It makes full use of the existing resource management platform to reduce development costs. At the same time, the original resource bank of campus and the resource bank of teaching courses are established (Shepherd 2013). According to the actual situation of the system, the requirements are analyzed, and reasonable functional division and specific design are carried out, including: static structure, dynamic structure analysis, and database analysis. The model diagram is used to design and design, to clarify the functions of each module, to realize the overall planning and design of the system, and to describe the corresponding requirements

(Garfinkel 2013). The network technology platform brings great convenience for teachers to exchange lecture experience and share multimedia courseware. With the development of network technology, the scope of teachers' communication learning is getting bigger and bigger, and even global information can be queried, making education globalization a reality (Marturana and Tacconi 2013). The first section of this chapter introduces the background and meaning of digital media. The second paragraph introduces the digital media system designed in conjunction with digital technology. The third section introduces the advantages of digital media systems (Nulman and Özkula 2016).

2 Related work

From the perspective of development, the emergence of China's digital media resource management system is the inevitable outcome of the development of digital media resources to the expansion stage. With the increasing number of digital media resources, how to manage these digital media resources has become a top priority (Ranard and Merchant 2018). S. LPressey of the United States began researching program teaching and teaching machines in 1925. He designed an automatic teaching instrument that can simultaneously perform both test and scoring functions, which is the condition for CBE to be born. Teaching machine and program teaching started around 1950. B.F Skinner, a psychologist at Harvard University in the United States, published many research papers based on continuous research and experimentation (Chen and Chen 2014). And these results have been successfully applied in the teaching of the military and have been recognized by the society (Güler et al. 2014).

Zhang Wenjun presented an introduction to digital new media in 2014. Integrate distance education and excellent curriculum resources, such as video, etc. Guo Xiangyong proposed to build a resource base for teaching resources such as material base, courseware base, case base, exercise base, curriculum system and video system. And use the digital media resources to build a feature retrieval table to integrate the various digital resource databases from the retrieval level (Mullins 2014). Relying on the campus network, Li Taifeng emphasized the integration of campus digital resources for sharing, and proposed to design an easy-to-use and copyright-supporting resource management system. The system input digital resources such as text, pictures, courseware, videos, e-books, and provide users with the publishing function of text and pictures (Joksimović et al. 2015). From the perspective of users, Wang Zhihua and Yan Yazhen proposed to ensure the participation of users in the use of the system, and to allow users to interact with the system. Huang Chen analyzes digital resource management from the perspective of resource integration, and proposes navigation integration, platform integration and other sources. Resource integration approach to integration and data integration (Petko et al. 2015).

3 Overview of software development technology

Digital media is closely related to communication. Today we mainly use storage technology and network technology to disseminate information (digital, text, image, graphics, voice, music, sound effect, animation, film and television). As a new product, software is similar to the development of new products in software design and product design, but it has different carriers and technologies, but it also presents information to users. What they have in common is that users interact when they receive information or use software. B/S structure, browser server structure, is a structure that changes or improves with the rise of technology. In this structure, the user interface is completely implemented by the browser, and part of the transaction logic is implemented at the front end, but the main transaction logic is implemented on the server side. The design of online teaching resource system based on digital media technology requires teachers and students to conduct online interactive teaching activities through the system. Teachers can use this system to conduct effective online teaching. Students can use network-assisted learning to improve learning efficiency and achieve good teaching results. System users are mainly divided into students, teachers, and administrators. On the one hand, this software has a simple human–computer interaction interface, which is convenient for users to quickly learn and create this software. On the other hand, this software also has a good programming language creation. The design of the digital media teaching information system word and line spacing is shown in Table 1 and Fig. 1. The input items of the digital media teaching information system teaching research resource management module are shown in Table 2 and Fig. 2.

STRUTS, as a popular foreground development framework, mainly applies MVC design pattern, which is supported by many developers. The user initiates the request through the front end and requests to use the distributor to distribute the request initiated by the user. The system responds to the system request by calling the front-end controller, and then the system processes the related information by calling the Delegate class. When the processing is finished, the system's processing results will be returned to the front page, so that users can view the corresponding system call results through the front desk. The system should satisfy the teaching of format design course for art design specialty, and realize the interactive control of each knowledge point. At the same time, the design of the teaching platform reflects its rich expressiveness, good interaction, easy teaching and learning, strong interest in classroom teaching, and the avant-garde guiding role of current knowledge. The data platform meets the current data explosion trend and the needs of next-generation data-driven applications, supporting the data platform vision: mission-critical data platforms, dynamic development, relational data, and business intelligence. It also provides a rich set of services to interact with data: search, query, data analysis, reporting, data integration, and powerful

Table 1 Comparisons of word data and line spacing design in information system

	Representation number	Data layer
Written evidence	21.69	24.84
Row spacing	18.72	17.61

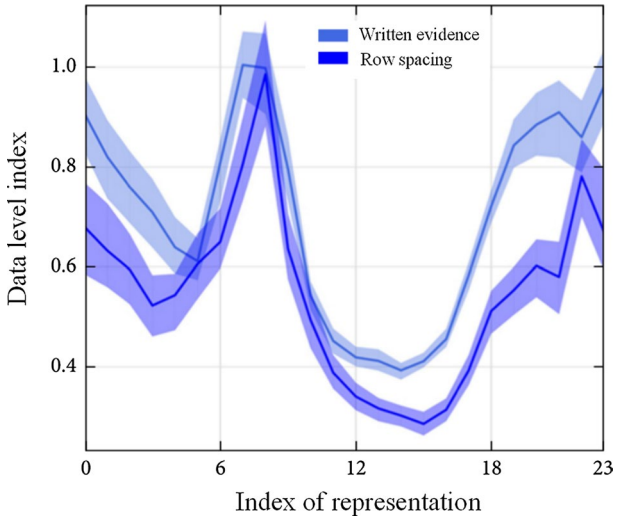

Fig. 1 Comparisons of word data and line spacing design in information system

Table 2 Input item of teaching and research resource management module

	Storage number	Main characteristics
Type label	12.67	14.61
Classified labels	15.92	17.83
Original label	15.91	17.84

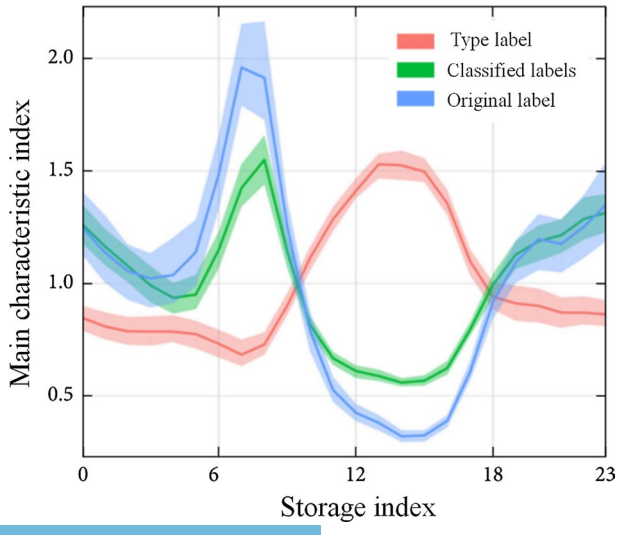

Fig. 2 Input item of teaching and research resource management module

synchronization. The resource fixed label table is shown in Table 3 and Fig. 3. The digital media broadcast control subsystem operation scores are shown in Table 4 and Fig. 4.

DaVinci series processors are embedded on-chip systems. The system integrates high-performance core, core processor, video front-end processor and video back-end processor. In addition, the system also has a wealth of peripheral devices, which can analyze the running status of each node in the cluster through the management node, and also can analyze the disk residual situation among the nodes. DaVinc is characterized by simple, fast, stable performance, and can be used as a proxy server. With the gradual expansion of demand, software functions will continue to expand. Therefore, the system must adopt a general DaVinc, open architecture, easy to expand. The teacher can quickly enter the DaVinc multimedia courseware production, and the PPT can insert various images, sounds, images and texts. And the system loads the classification attribute table to query the corresponding document or video material. After the retrieval is completed, the corresponding storage information and classification attribute can be displayed on the foreground page. DaVinc's system architecture is B/S structure, and the development framework is J2EE level framework, thus ensuring the system's technical advancement. The correspondence between the length interval of the interactive digital media course teaching system and the fixed length unit length is shown in Table 5 and Fig. 5.

4 Experimental design and analysis

The digital media technology is applied to the embedded system, and an embedded digital media experimental system is developed. It can make students have a deeper understanding of embedded systems, and a clearer understanding of digital media applications based on systems. It has a good practical application value. With the help of the system, users can easily and quickly combine text, pictures, audio, video and animation to form a continuous picture, and transmit it to the designated terminals at different locations through the network. When designing the system architecture, considering the actual business requirements, combining with previous project development experience, and based on the principles of flexibility and security, the standardized hierarchical architecture mode is chosen. Although the implementation of digital media processing algorithm on the platform can be realized clearly by using the framework, it is necessary to complete the algorithm creation and integration in the execution process. Teachers have their own teaching resource database in the teaching resource database, which can upload the resources audited by the management system to the

Table 3 Resource fixed label

Data type	Field length	Index count
A1	21	17
A2	32	31
A3	33	31

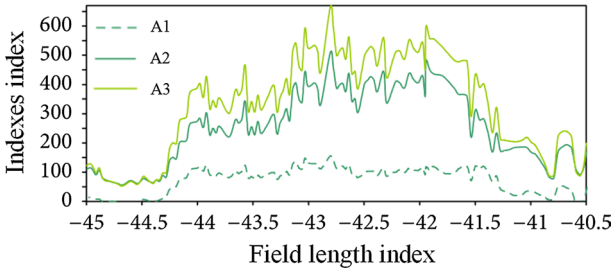

Fig. 3 Resource fixed label

Table 4 Operational scoring number of digital media broadcast control subsystem

	Player operation	Media audit
User login	8.91	9.12
User management	6.57	6.81

public resource database. Auditing is to ensure the security of resources, and you can also download data from the public resource database to the personal resource library. However, students can only use the specified resources to browse the learning materials, but they cannot modify them. The server layer of the experimental system designed in this paper, in general, consists of two parts, the digital media processing algorithm experiment, and the other part is the graphics processing algorithm experiment. Digital media processing algorithms and graphics processing algorithm pairs are shown in Table 6 and Fig. 6.

Digital media processing algorithm can be embedded in the amplitude of the media signal or hidden in its phase. Are defined as.

$$Q = 2 \times \frac{\Delta w}{M} \times N \times e \tag{1}$$

$$T = \frac{Q}{I} = 2 \times \frac{\Delta w}{MI} \times N \times e \tag{2}$$

If there are digital sampling data, there are.

$$D_k(x, y) = \begin{cases} 255 & \left|P_k(x, y) - B_k(x, y)\right| > T_h \\ 0 & else \end{cases} \tag{3}$$

In order to ensure that the inverse discrete Fourier transform of the modified results is real, the modified amplitude should satisfy the positive symmetry condition:

$$I_k(x, y) = \left|P_k(x, y) - P_{k-1}(x, y)\right| \tag{4}$$

The formula is quantified by the unipolar parameter quantization method discussed above. The quantization results can be expressed as follows:

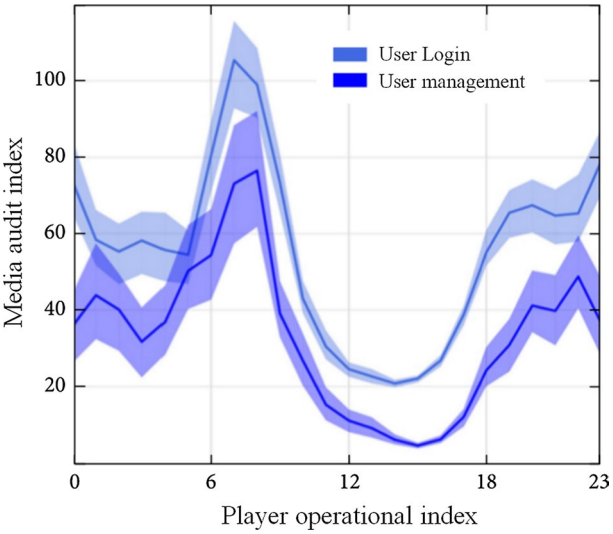

Fig. 4 Operational scoring number of digital media broadcast control subsystem

Table 5 The corresponding relation between the length range of digital media course teaching system and the length of fixed length unit

	Fixed length unit length	Length interval
Digital media course teaching system	72	689

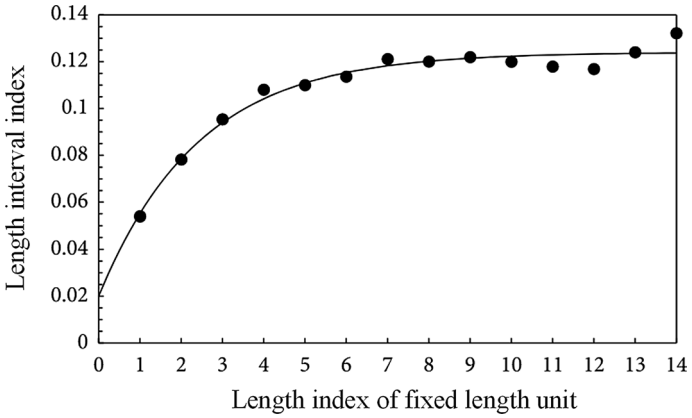

Fig. 5 The corresponding relation between the length range of digital media course teaching system and the length of fixed length unit

Table 6 Comparisons of digital media processing algorithms and graphics processing algorithms in server layer

	Video processing	Video streaming
Digital media processing algorithms	21.33 ± 2.34	16.67 ± 5.12
Graph processing algorithm	12.31 ± 0.31	11.03 ± 0.07

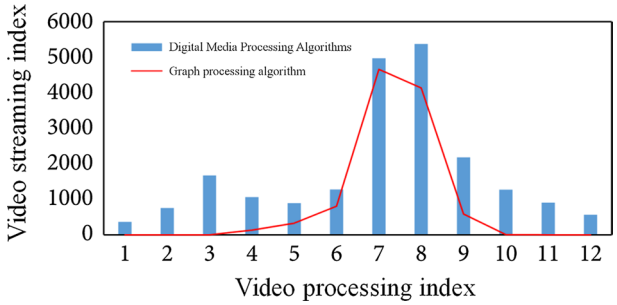

Fig. 6 Comparisons of digital media processing algorithms and graphics processing algorithms in server layer

$$D_k(x,y) = \begin{cases} 255 & I_k(x,y) > T_h \\ 0, & else \end{cases} \tag{5}$$

Negative symmetry modification is needed to ensure that the inverse transformation is real:

$$D_k(x,y) = \left| f_{k-1}(x,y) - f_k(x,y) \right| \tag{6}$$

Multiplicative amplitude modulation can be expressed as follows:

$$B_k(x,y) = \left| f_k(x,y) - B(x,y) \right| \tag{7}$$

Its two-dimensional discrete cosine transform:

$$T_k(x,y) = D_k(x,y) + B_k(x,y) \tag{8}$$

The corresponding inverse transformation is defined as:

$$R_k(x,y) = \begin{cases} 1, & \text{target, } if\ T_k(x,y) > Th \\ 0, & \text{background, } if\ T_k(x,y) \le Th \end{cases} \tag{9}$$

The image processing algorithm translates the initial coordinates. The relationship between these two points is the relationship between the formally expressed pixels after translation, such as the formula:

$$l^2 = \frac{4\varepsilon_0 U_0}{9eZN_i}\left[\sqrt{\left(1 + \frac{u(t)}{U_0}\right)^3} + \frac{3u(t)}{U_0} - 1 \right] \tag{10}$$

$$N_i = N_{i0} \exp\left(-\frac{t - t_0}{\tau}\right)\left(\frac{D_{amp} l^2}{D_{gap}^2} + 1\right) \tag{11}$$

For the original image with height and width, the coordinates of the pixels are changed by horizontal image transformation:

$$U_0 = \frac{M_i}{2e}\left(v_i + \frac{dl}{dt}\right)^2 \tag{12}$$

The image zoom transformation makes the zoom ratio of the original image axis direction equal, the zoom ratio of the axis direction equal, and the initial coordinates equal. After the zoom transformation, the coordinates of the pixels become equal:

$$i(t) = \frac{\pi D^2 Z N_i e}{4}\left(v_i + \frac{dl}{dt}\right) \tag{13}$$

Pixel points of initial coordinates are transformed by image rotation. After clockwise rotation, the coordinates are changed to:

$$i(t_0) = \frac{\pi D^2 Z\left[N_{i0} \exp\left(-\frac{t_0 - t_0}{\tau}\right)\left(\frac{D_{amp} l^2}{D_{gap}^2} + 1\right)\right] e}{4}(v_i + 0) \tag{14}$$

The image processing algorithm on the platform of digital media system needs to build a test system first. The whole test system consists of four main parts: development board, camera, display screen and terminal computer. First, the camera collects image data. The backup of database, the addition of database administrator, the change of database server and other operation-oriented items. The entity relationship model is transformed into logical model as follows: administrator information, user basic information, user operation log permission information, permission, user-defined label of resource ownership, system description information log and so on. The entire framework of database design is basically complete. Next, the corresponding fields of each table are more precisely defined. We carry out detailed visual analysis and display from the system design theme, pre-planning, final works and so on. Synchronize the basic principles and methods of layout design contained in the works in the works and show them in comparison, so that students can more easily understand the works and grasp the knowledge of the teaching content, master how to use the knowledge points, and how to use them. The system provides comprehensive data backup, data export, data recovery and data download functions, and provides the function of completing storage backup according to the customized data backup task. Since all data storage management is implemented by software and based on the B/S structure, users can save a lot of investment in data security storage and use it conveniently. Users in the database are shown in Table 7 and Fig. 7. The server layer in the database stores the corresponding data as shown in Table 8 and Fig. 8.

Create personalized digital media processing algorithms, and type them into standard algorithmic packages. The algorithm has the characteristics of short response time, fast processing speed and good stability. On the basis of maintaining the independence of each module, it improves the overall collaboration efficiency between modules. It is used to check the data input by users from keyboard and other input devices, and display the data output by the application. Graphic user interface is commonly used, which is easy to operate. The users of this system are for teachers and students. These users have certain computer knowledge and experience, but some users can not operate computers skillfully. Since the data stored in the system includes structured data, document data, image data, etc., the system is designed to store data through different hosts. The database server stores the data structure, the document data server stores the corresponding document data, and the image server stores the image data, so the system needs to interact with different hosts. With the help of the system, users can quickly and easily combine text, pictures, audio, video, and animation to form a continuous segment of the image, and transmit it to designated terminals in different locations through the network to establish digital media teaching information system. The network transmission change rule is shown in Fig. 9.

The purpose of system testing is to find as many defects as possible and eliminate them by correcting them, so as to improve the quality of software. Simulate the real environment and test the concurrent submission request of the Web system through the identity of the actual user. The scope of the test focuses on the system's response to concurrent requests. Through concurrent requests, the response time and results of the system to concurrent requests are checked to determine whether the system meets the needs of users. To test the network transmission of video streams, first run the sender application program on the platform, and then run the multimedia player on the terminal computer. When the display resolution is 710X480, the number of transmitted frames in 100 s is calculated. The average transmission rate is 3300, which is very close to the coding rate, and the data transmission has good real-time performance. When the test script is executed, the browser automatically clicks, enters, opens, verifies, etc. according to the script code, and tests the application from the perspective of the end user, just like the real user does. Automating browser compatibility testing is possible, although there are subtle differences in different browsers. Through comprehensive functional testing of the system, the system can conclude that the system implementation function is basically consistent with the system design goal, so the system meets the actual needs of the user and achieves the expected goals of the system. And each function of the system can be controlled according to the authority, thus achieving data security. The test trend

Table 7 User table

Field	Length value	Default value
ID	7.32	14.12
Username	5.58	13.70
Passwd	10.11	9.41

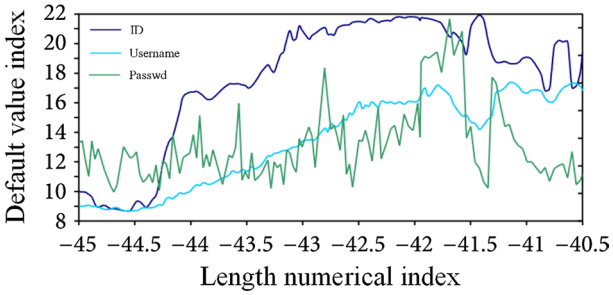

Fig. 7 User diagram

Table 8 The server layer stores the corresponding data

	View	Controller
Notification selection	3.64 ± 0.12	2.94 ± 0.08
User request	1.81 ± 0.06	1.70 ± 0.05

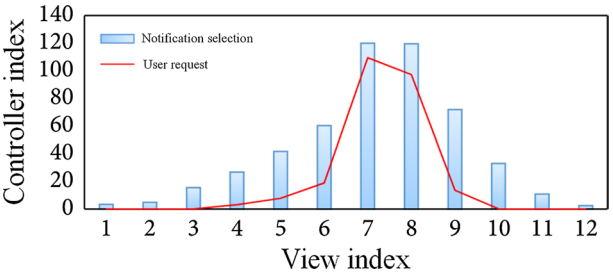

Fig. 8 The server layer stores the corresponding data

diagram of the system function and performance of the media course teaching information system implementation stage is shown in Fig. 10.

5 Conclusions

In this paper, a new experimental system of digital media processing is developed by researching digital media processing algorithms such as platform, image and video, and the technical basis of related network transmission protocols. Implement image, video processing algorithm and real-time video network transmission technology on embedded platform. It also adjusts and tests the arrangement of characters in the platform system and the part of the assistant teaching system. Firstly, the requirements of the digital media publishing system are analyzed, and the software and hardware requirements of the whole system are determined. Secondly, the overall design of the system is carried out, and the overall structure of the system and the

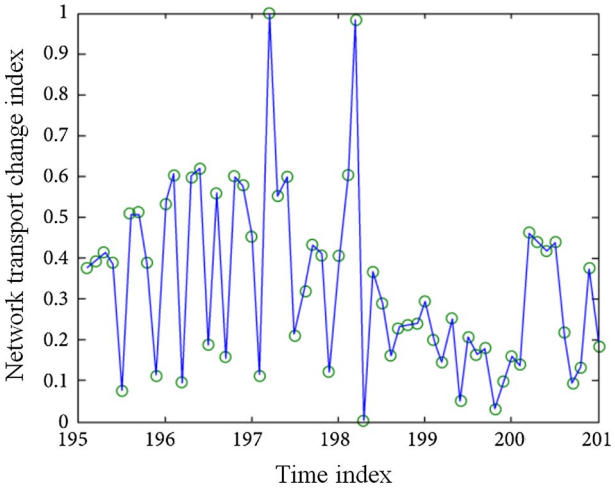

Fig. 9 Change law of network transmission

basic functions of each subsystem are given. Through detailed analysis of requirements and functional modules, independent business processes are designed. The business process of the system is carried out strictly according to the actual process, and the logical relationship in the process is judged, which is more practical. The system design is divided into functional modules such as unified retrieval module, user management module, paid resource management module, teaching research resource management module, campus original resource management module, intellectual property management module, platform management module and database

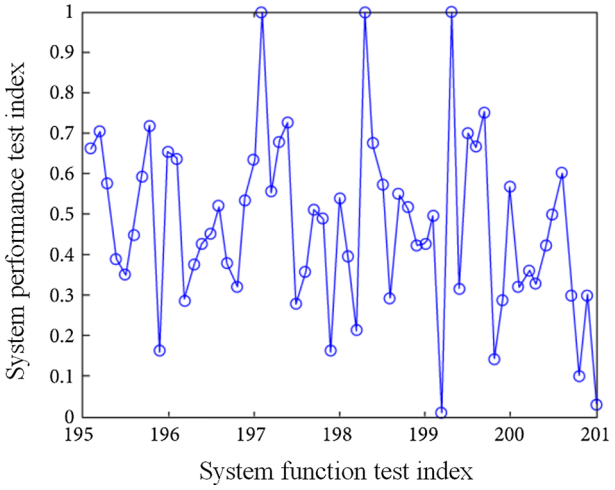

Fig. 10 Test trend chart of system function and performance in system implementation phase

management module. For the management of digital media resources in colleges and universities, this teaching information system can bring them a lot of convenience. It not only simplifies the process of digital media resource storage management, but also effectively improves the efficiency of managers and facilitates the use of teachers and students. It can also make the management of digital media resources in colleges and universities more intelligent and informative.

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References

Brown JP (2015) Complexities of digital technology use and the teaching and learning of function. Comput Educ 87(C):112–122

Chang KE, Chang CT, Hou HT et al (2014) Development and behavioral pattern analysis of a mobile guide system with augmented reality for painting appreciation instruction in an art museum. Comput Educ 71:185–197

Chen CM, Chen FY (2014) Enhancing digital reading performance with a collaborative reading annotation system. Comput Educ 77:67–81

Dębiec P (2018) Effective learner-centered approach for teaching an introductory digital systems course. IEEE Trans Educ 61(1):38–45

Duncan S (2013) Instructional design for librarians and information professionals. Libr Q 83(1):76–78

Garfinkel SL (2013) Digital media triage with bulk data analysis and bulk extractor. Comput Secur 32(C):56–72

Graziotin D, Wang X, Abrahamsson PK (2014) A framework for systematic analysis of open access journals and its application in software engineering and information systems. Scientometrics 101(3):1627–1656

Güler Ç, Kılıç E, Çavuş H (2014) A comparison of difficulties in instructional design processes: mobile vs. desktop. Comput Hum Behav 39:128–135

Garcia I, Guzmán Ramírez E, Pacheco C (2015) CoLFDImaP: a web-based tool for teaching of FPGA-based digital image processing in undergraduate courses. Comput Appl Eng Educ 23(1):92–108

Joksimović S, Gašević D, Loughin TM et al (2015) Learning at distance: effects of interaction traces on academic achievement. Comput Educ 87:204–217

Marturana F, Tacconi S (2013) A machine learning-based triage methodology for automated categorization of digital media. Digit Investig 10(2):193–204

Mullins K (2014) Good IDEA: instructional design model for integrating information literacy. J Acad Librariansh 40(3–4):339–349

Nulman E, Özkula SM (2016) Environmental nongovernmental organizations' digital media practices toward environmental sustainability and implications for informational governance. Curr Opin Environ Sustain 18:10–16

Ouimette J, Surry DW, Grubb A et al (2013) Essential books in the field of instructional design and technology. Australas J Educ Technol 25(5):731–747

Petko D, Egger N, Cantieni A et al (2015) Digital media adoption in schools: bottom-up, top-down, complementary or optional? Comput Educ 84:49–61

Ranard BL, Merchant RM (2018) Harnessing digital media to promote health and research. Circulation 137(21):2197–2199

Romerotroncoso RJ, Garciaperez A, Cabalyepez E et al (2014) Experimental system for teaching induction motor faults during the startup transient and steady state. Comput Appl Eng Educ 22(1):33–38

Shepherd M (2013) Introduction to the digital media: content and communication track. J Lipid Res 41(8):1603–1603

Tseng HW, Tang Y, Morris B (2016) Evaluation of iTunes University Courses through instructional design strategies and m-learning framework. Educ Technol Soc 19(1):199–210

Wong LH, Chai CS, Zhang X et al (2015) Employing the TPACK framework for researcher-teacher co-design of a mobile-assisted seamless language learning environment. IEEE Trans Learn Technol 8(1):31–42