International Journal of Web-Based Learning and Teaching Technologies
Volume 19 • Issue 1

The Application of Multimedia Information Fusion Technology in the Construction of University Intelligent Libraries

Nan Pang, North China University of Science and Technology, China*

ABSTRACT

Multimedia information fusion technology is currently a popular technology for data processing. The advanced productivity it brings is dozens of times that of traditional data information processing. The collected and processed information is not only efficient and accurate, but also has strong scalability. With the continuous development of college education in China, the problem of the construction of intelligent library in colleges and universities has gradually surfaced. The establishment of a university intelligent library is a process of integration and common progress between disciplines. This article starts from the current situation of university libraries, studies and analyzes intelligent libraries at home and abroad, and finally combines the existing multimedia information fusion technology to analyze the theoretical level of information flow as an important idea of the current university intelligent library construction.

KEYWORDS

Information Fusion, Multimedia, University Intelligent Library

1. INTRODUCTION

With the continuous development of mobile internet technology, traditional media and emerging media have begun to integrate in an all-round way. This has become a major trend in the development of the digital era. Over the years, China's university libraries have been committed to building an intelligent service system and promoting its convergence with various media (Tang et al., 2012). However, the smart service system of university libraries has not fully applied the new concepts and technologies under the media convergence environment (Qian et al., 2021). In the current daily service work of university libraries, a large number of service work still relies on a single media to achieve. This has led to the current inability of university libraries to meet the personalized knowledge service needs of students (Zhao et al., 2019). It can be seen that university libraries should coordinate the construction of intelligent service system with media convergence and fully apply new concepts and technologies under the media convergence environment in future reader services (Jie, 2019).

Domestic scholars have carried out research on library intelligent services and made some theoretical achievements. Zhang and Mei (2022) believe that the connotation of library intelligent

DOI: 10.4018/IJWLTT.336850 *Corresponding Author

service covers intelligence, knowledge, and ideality. Song Yu first proposed the concept of context-aware service, then elaborated the characteristics, difficulties, and construction strategies of the library to carry out this service, and finally elaborated the architecture of the library context-aware service (Quan & Lei, 2019). Yin (2021) first explained the meaning of maker space, then analyzed the necessity of introducing the concept of mass innovation into the intelligent service of library, and finally elaborated the intelligent service architecture of university library based on mass innovation from multiple perspectives. Wang and Zhao (2015) proposed the ubiquitous intelligent service system of smart library based on multiple collaborations and designed corresponding guarantee mechanism to improve the service level of smart library.

With the development of information technology and the diversity of information needs of teachers and students, the service mode of university libraries is also undergoing new changes. At present, most university libraries have the function of book information retrieval. Information retrieval makes it easier for students and teachers to find the books they need more conveniently by scientifically and orderly classifying the books in university libraries (Jing, 2019; Tang et al., 2014). With the continuous expansion of college students' enrollment, great changes have taken place in the way college libraries borrow books, greatly changing the original library borrowing and returning models (Zhang et al., 2020). With the upgrading of information and intelligent services, more intelligent consulting equipment and related software systems are applied to the consulting services in university libraries (Li, 2021). When readers encounter problems that need to be consulted in the library, they can ask questions to the library management system through online consultation, which greatly improves the efficiency of information retrieval (Zavaadskas et al., 2011).

In recent years, China's university libraries have been committed to building intelligent service systems, but they have not fully adopted new concepts and new technologies in the context of media convergence, which has led to their inability to meet the diverse knowledge service needs of readers. This paper discusses the construction of intelligent service system of university library based on multimedia information convergence, aiming to provide theoretical support for the construction of intelligent service system of university library. Firstly, it introduces the connotation of multimedia information convergence technology and smart library. Secondly, it analyzes the impact of media convergence on the intelligent service system of university libraries. Thirdly, it expounds the level of the construction of the intelligent service system of university library under the background of media convergence. Finally, the paper puts forward some countermeasures for the construction of university library's intelligent service system under the background of media convergence.

2. RELATED WORKS

2.1 Development Status of University Libraries in China

First of all, the infrastructure is outdated. As we all know, traditional media are good at simple content organization and production, while in the new media era, due to the lack of support from technical tools, the content is not accurate enough after release; it is difficult for traditional media to form a good interaction with users and it lacks insight into user needs. In the multimedia information age, the way we acquire knowledge will no longer be limited to paper books, newspapers, and magazines (Wang et al., 2019). Reading habits have also changed to a certain extent. Many colleges and universities are unwilling to invest in the construction of collections of books, which will inevitably lead to a series of chain reactions: books in the library are outdated, the update time of books is prolonged, and the category of books is single (Ma et al., 2021).

Secondly, due to the lack of follow-up funds, the construction of university libraries is purely a cultural activity of "public welfare nature," and it is not possible to ask for fees from all walks of life (Ying, 2018; He et al., 2011).

Thirdly, the overall quality of staff in university libraries is relatively low, and the proportion of in-service personnel in university libraries presents a cliff-like distribution (as shown in Table 1), resulting in the overall lower quality of the department compared with other departments; the aging age structure and lack of self-awareness lead to the lack of service awareness of department staff and the lack of awareness of book maintenance, which will bring adverse effects to the majority of students as "retirement posts" (Chen et al., 2021).

2.2 Introduction to Smart Library

European and American countries put forward the concept of smart library many years ago, that is, through the application of intelligent technology in library construction and follow-up maintenance, to create an intelligent and automated digital library (Owusu-Ansah, 2001). As an important part of the "smart campus," it has always been favored by the majority of scientific researchers. For example, the Chicago Mansueto Library (Figure 1), which is a model of smart library construction, is covered by a huge oval high-tech glass, and the building is constructed of high-performance low-e sintered glass.

As one of the six major libraries of the University of Chicago, the library has a storage capacity of 3.5 million books. The basement of the reading room of the library is composed of a high-density automatic book transfer device with a height of 15 meters (Fang et al., 2019). Through the ASRS system, readers can find and get books from 3.5 million books in less than five minutes. Hunt Library (Figure 2), which is called the technology kingdom of libraries, is located at North Carolina State University in the United States. The intuitive feeling of the library is that of a large "technology factory." There are various learning places, laboratories, and 3D printing workshops in the library, and technological sound insulation technology has been applied between the areas (Tang, 2020).

Table 1. The proportion of educational background and age of in-service staff in university libraries

Educational level	Proportion (%)	Age range
High school	34.25	Above 50
College	57.33	35-50
Undergraduate	8.12	26-28
Graduate and above	0.3	28-35

Figure 1. Chicago Mansueto Library

This operation will not affect the normal learning of students in the reading area. In terms of data retrieval, the automatic retrieval robot (bookBot) adopted by Hunt Library can find qualified books among two million books within three minutes through customized retrieval conditions. In addition, Hunt Library supports virtual browsing, and readers create their own virtual library. The system automatically classifies and strengthens the books that readers have browsed, and records the time and progress of readers in the current part, which brings great convenience to readers.

2.3 Optimization Plan for the Problem of University Library in China

First, colleges and universities should adopt an inclusive learning attitude, actively study and learn from the excellent experience in the construction of intelligent libraries in colleges and universities at home and abroad, pay attention to the parallel development of software and hardware in the construction of college libraries, pay attention to the construction of spiritual culture, and achieve green, sustainable development (Fu & Yang, 2017; Li et al., 2020).

Second, in response to funding issues, colleges and universities should "open source and reduce expenditure." In addition to hardware issues, they should also strengthen the bond between students and libraries and increase the atmosphere of a "scholarly campus." On the one hand, this can increase the cultural heritage of the library itself and spread its charm on the campus. On the other hand, it can spread the latest information about the library through the campus network and the student union so that students can know which books have been updated, which books are currently returned or in the library, etc.

Third, in terms of the quality of university library staff, major universities should appropriately invest in human resources to improve the average cognition and educational level of university library staff. In order to motivate the library staff, give the department staff the courses of university teachers and motivate the staff to improve their own cognition, service ability, and service level from the root. Let them have a strong sense of identity and professional mission to the profession of library staff.

3. UNIVERSITY LIBRARY CONSTRUCTION BASED ON MULTIMEDIA INFORMATION CONVERGENCE

3.1 Multimedia Information Convergence Technology

Information convergence technology is an emerging discipline proposed in the late 1970s. It aims to output the required effective information technology by efficiently and accurately filtering and

Figure 2. Hunt Library

integrating information from different information sources (Yang, 2018). This research focuses on the application of multimedia information convergence technology in the context of the rapid development of digital technology and mobile internet technology. The emergence of media convergence technology has been made possible through the collaborative development of these two technologies, which have significantly reduced the cost of data transmission. Digital technology has greatly improved the transmission and carrying capacity of traditional media content, while mobile internet technology has improved the efficiency of data transmission and satisfies users' needs to receive digital information at all times. Media convergence involves the deep integration of traditional media and emerging media in terms of transmission path, content, and mode, resulting in the sharing of information resources between providers of traditional and emerging media. Media convergence has also resulted in the development of new forms of digital products that are delivered to users through the internet. By leveraging these technologies, university libraries in China can create smart libraries that provide seamless access to a wide range of multimedia resources, including digitized books and journals, audiovisual materials, and other digital content. These smart libraries can also support a variety of teaching and learning activities, enabling students and faculty to access information and collaborate with each other more effectively.

The existing information convergence models are roughly divided into information convergence models and mathematical statistical models, such as the commonly used JDL model proposed by the Ministry of Information of the Ministry of Defense (Figure 3). The model divides the results of information convergence into five levels. The first level is to optimize the sub information object and preprocess the sub information data to correct the information deviation and perform spatial and temporal correction. The second level is object optimization, where information data are associated to obtain the location or corresponding attributes of target information. The results that can be obtained at this level include target classification and target status and direction. The third level is refinement and optimization. This level is mainly used to analyze the correlation of information objects or events and estimate their correlation in the overall model environment, that is, target information in a specific environment. The fourth level is risk assessment, which forecasts the current information, so as to predict relevant events, estimate threat intentions, analyze their own weaknesses, and report on feasibility. The fifth level is the improvement opinion report, which evaluates the information fusion process and provides users with optimization and improvement suggestions, such as the priority of their own transactions and the allocation of occupied resources.

There are many methods of multimedia information convergence, such as estimation theory method, uncertainty reasoning method, artificial intelligence, and pattern recognition method. Because the composition of source information is very complex and the amount of information is large, uncertainty reasoning is used to process this uncertain source information for the first time, and through basic filtering, it can realize the "body method recognition" and attribute judgment of the information.

3.2 The Levels of University Library Construction Under the Multimedia Information Convergence

The proposed intelligent service system for university libraries is based on media integration and divided into three levels: online service, professional service, and collaborative service. By leveraging

Figure 3. JDL Model Hierarchy Diagram

digital technology and mobile internet technology, university libraries can provide more efficient and personalized services to readers, thus improving the overall user experience and facilitating knowledge innovation.

3.2.1 Online Service

With the rapid development of mobile internet technology, smart phones are increasingly popular on university campuses. University libraries can use this online software to count readers' reading interests and literature needs. Subsequently, university libraries can use these statistical results for data mining, thus laying a solid foundation for the future development of literature push with reader differentiation.

With the continuous expansion of the intelligent construction of university libraries under the background of media integration, the functions of personal digital libraries are also increasingly deepening. In the personal digital library, readers can search professional literature and collate and edit the literature of interest. At the same time, readers can forward and comment on the downloaded literature at will, so as to fully meet their own needs for literature resources.

3.2.2 Professional Service

The effective collection of digital resources has laid a solid foundation for university libraries to carry out knowledge innovation. Some university libraries have carried out corresponding services for readers' digital resource integration needs, which include personalized multimedia resource sorting, tacit knowledge mining, and bibliometric analysis.

From the perspective of the actual service situation of university libraries, embedding in the learning and scientific research activities of teachers and students is the main means for them to carry out subject services. Under the background of media integration, the subject service construction of university library mainly includes the organization of specialized subject service teams, the construction of subject navigation system, and the formation of subject service assessment system.

3.2.3 Collaborative Service

Under the environment of media integration, the needs of readers in university libraries are diversified and differentiated. The construction of university smart library objectively requires the libraries of sister universities to build a university inter-library collaborative service alliance with the goal of resource sharing. Within the inter-library collaborative service alliance of universities, intelligent reference consultation and document push services can be carried out more efficiently. In addition, the inter-library collaborative service alliance of universities can also provide intelligent document procurement, collaborative cataloging, and cooperation and exchange services for the vast number of readers.

3.3 Countermeasures for the Construction of University Library Based on Multimedia Information Convergence

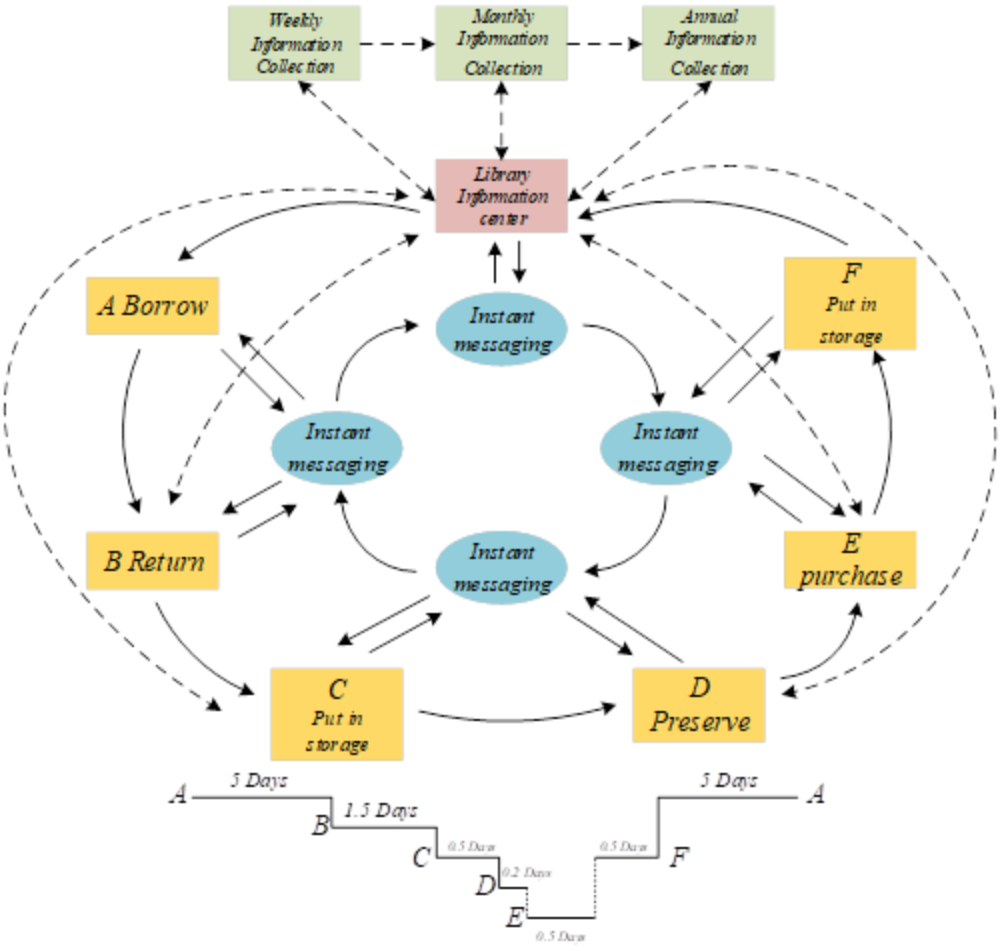
Under the blessing of network communication technology, public service places such as university libraries should use information technology to arm themselves, increase the intensity of information-based data processing, and build a system that operates independently and is not affected by upstream systems, so as to improve the quality of library books. It is conducive to the improvement of the comprehensive quality of the library personnel. In the era of smart libraries, libraries must adopt advanced technology to achieve think tank services and apply various management and document processing software to all aspects of the work, and these need to be mastered and operated to play a role. The main idea of applying multimedia information convergence technology in the design of university library is to carry out information flow.

Firstly, the information flow of the university library is classified in detail. The so-called information flow refers to the collection of data information transmitted from one information

source to another information source in a broad sense. The main function of the category of information flow is for information collection. Different categories of information flow show different information storage capabilities. By exerting the connection function, control function, and decision-making function of information flow, it directly strengthens the university library for information collection and filing capabilities, such as adding, borrowing, and returning popular publications (Figure 4).

The communication system is mainly used for communication between students, teachers and students, and library managers. Passing through the firewall through P2P technology can greatly reduce the pressure on the server to transfer audio, and it will not cause network congestion in the server room of the university library due to too many students who consult online. And it supports UPNP protocol; colleges and universities can take the initiative to open the port mapping according to their own situation and improve the efficiency of P2P communication. Combined with the characteristics of information flow diversification, information sharing, and information independence, multimedia information convergence technology has been well applied in the design of university libraries, improving the query rate and utilization rate of resources and bringing excellent scientific and technological experiences to the audience.

Figure 4. Construction diagram of information flow design ideas in university libraries



Second, in the context of the rapid development of mobile internet technology, university libraries can promote mobile library APP software to all teachers and students through independent research and development or cooperative research and development. At present, most university mobile library APP software can only provide knowledge search, consultation, and transmission, and cannot realize knowledge innovation and value mining. University libraries can add knowledge and social functions to mobile library APP software. In this way, the university library has created an exchange platform for readers, experts, and librarians to carry out knowledge innovation.

Third, it is necessary to establish a regional alliance of university smart libraries. By sharing the resources and services of each member library, we will build a modern intelligent service system of university libraries in the region. First of all, each member library in the alliance should realize the sharing of electronic resources, especially the characteristic electronic resources of each university library. Secondly, the regional alliance of university smart libraries can build a network service platform of integrated media to realize the synergy of data transmission. Finally, each member library in the alliance should promote the cooperation and exchange of professional librarians to fully meet the urgent needs of readers for knowledge innovation services. In addition, each member library in the alliance can also carry out strategic cooperation with some online live broadcasting platforms, online learning platforms, and mobile operators to realize the market-oriented operation of some smart services, thus expanding the social influence of the regional alliance of university library smart services.

4. CONCLUSION

This paper proposes a plan for constructing university smart libraries in China using multimedia information convergence technology. The plan involves three levels of implementation: establishing an information flow system for university libraries, developing mobile terminal applications, and forming regional alliances of university smart libraries. The potential applications of multimedia information convergence technology in college teaching are immense. By exploring these possibilities, this paper aims to provide new ideas and insights for optimizing and innovating higher education in China. With the rapid development of technology, it is essential for universities to adapt to the changing needs of their students and stakeholders in order to remain competitive and effective in the digital age.

DATA AVAILABILITY

The figures and tables used to support the findings of this study are included in the article.

CONFLICTS OF INTEREST

The authors declare that they have no conflicts of interest.

FUNDING STATEMENT

This work was not supported by any funds.

ACKNOWLEDGMENT

The authors would like to show sincere thanks to those techniques which have contributed to this research.

REFERENCES

Chen, Z., Zhou, M., & Feng, L. (2021, June). Analysis of the smart library construction in colleges based big data and artificial intelligence. []. IOP Publishing.]. *Journal of Physics: Conference Series*, *1955*(1), 012017. doi:10.1088/1742-6596/1955/1/012017

Fang, J., Xu, Y., & Liu, J. (2019, July). Information service of the intelligent library based on the internet of things. In *International Conference on Frontier Computing* (pp. 1332-1336). Springer, Singapore.

Fu, X., & Yang, H. (2017, December). Research and design of intelligent library based on virtual reality. In *2017 International Conference on Computer Technology, Electronics and Communication (ICCTEC)* (pp. 706-711). IEEE. doi:10.1109/ICCTEC.2017.00157

He, R., Xiong, N., Yang, L. T., & Park, J. H. (2011). Using multi-modal semantic association rules to fuse keywords and visual features automatically for web image retrieval. *Information Fusion*, *12*(3), 223–230. doi:10.1016/j.inffus.2010.02.001

Jie, S. (2019, June). On the reader service of the intelligent library in universities. In *International Conference on Applications and Techniques in Cyber Security and Intelligence* (pp. 95-103). Springer, Cham.

Jing, Z. (2019, August). Logical construction and realization of intelligent service in AI library. In *2019 International Conference on Smart Grid and Electrical Automation (ICSGEA)* (pp. 270-275). IEEE. doi:10.1109/ICSGEA.2019.00069

Li, C. (2021, May). Construction of intelligent service system of university library based on internet of things in artificial intelligence environment. In *2021 5th International Conference on Intelligent Computing and Control Systems (ICICCS)* (pp. 471-474). IEEE. doi:10.1109/ICICCS51141.2021.9432378

Li, Q., Liu, Y., Meng, S., Zhang, H., Shen, H., & Long, H. (2020). A dynamic taint tracking optimized fuzz testing method based on multi-modal sensor data convergence. *EURASIP Journal on Wireless Communications and Networking*, *2020*(1), 1–21. doi:10.1186/s13638-020-01734-0

Ma, Q., Zhang, C., Zhang, M., Han, D., & Tan, W. (2021). DNA computing: Principle, construction, and applications in intelligent diagnostics. *Small Structures*, *2*(11), 2100051. doi:10.1002/sstr.202100051

Owusu-Ansah, E. K. (2001). The academic library in the enterprise of colleges and universities: Toward a new paradigm. *Journal of Academic Librarianship*, *27*(4), 282–294. doi:10.1016/S0099-1333(01)00215-4

Qian, Y., Xing, Z., & Shi, X. (2021). From collection resources to intelligent data: Construction of intelligent digital humanities platform for local historical documents of Shanghai Jiao Tong University. *Digital Scholarship in the Humanities*, *36*(2), 439–448. doi:10.1093/llc/fqaa027

Quan, Y., & Lei, C. (2019, February). Use of the internet technology in the intelligent library services of colleges and universities in the big data era. In *International Conference on Application of Intelligent Systems in Multi-modal Information Analytics* (pp. 118-123). Springer, Cham. doi:10.1007/978-3-030-15740-1_19

Tang, L., Gao, H., Zhu, X., Wang, X., Zhou, M., & Jiang, R. (2012). Construction of "small-intelligent" focused mutagenesis libraries using well-designed combinatorial degenerate primers. *BioTechniques*, *52*(3), 149–158. doi:10.2144/000113820 PMID:22401547

Tang, L., Wang, X., Ru, B., Sun, H., Huang, J., & Gao, H. (2014). MDC-analyzer: A novel degenerate primer design tool for the construction of intelligent mutagenesis libraries with contiguous sites. *BioTechniques*, *56*(6), 301–310. doi:10.2144/000114177 PMID:24924390

Tang, M. (2020, October). The construction of intelligent professional discipline service platforms of libraries. In Proceedings of the *2020 International Conference on Computers, Information Processing and Advanced Education* (pp. 292-295). ACM. doi:10.1145/3419635.3419737

Wang, T., & Zhao, P. (2015, July). Research and application of internet of things in intelligent library. In *First International Conference on Information Sciences, Machinery, Materials and Energy* (pp. 683-686). Atlantis Press. doi:10.2991/icismme-15.2015.141

Wang, Y., He, H., & Liu, T. (2019, June). Intelligent library information service terminal based on BDS and wireless communication. In *2019 14th IEEE Conference on Industrial Electronics and Applications (ICIEA)* (pp. 955-959). IEEE. doi:10.1109/ICIEA.2019.8834239

Yang, Y. (2018, June). Research on development paradigm of the university library. In *2018 2nd International Conference on Management, Education and Social Science (ICMESS 2018)* (pp. 1819-1822). Atlantis Press. doi:10.2991/icmess-18.2018.406

Yin, X. (2021). Construction of service mode of intelligent library. *Frontiers in Economics and Management*, *2*(7), 53–57.

Ying, N. (2018, March). The way to construct the intelligent library. In *2nd International Conference on Economics and Management, Education, Humanities and Social Sciences (EMEHSS 2018)* (pp. 69-73). Atlantis Press. doi:10.2991/emehss-18.2018.15

Zavadskas, E. K., Kaklauskas, A., & Banaitis, A. (2011). The use of the intelligent library and tutoring system at all stages of a building life cycle. *The Engineering Economist*, *22*(1), 14–23.

Zhang, B., Zhang, Y., Zhang, S., & Yu, B. (2020, May). Design and implementation of university intelligent library based on cloud computing. []. IOP Publishing.]. *Journal of Physics: Conference Series*, *1550*(3), 032031. doi:10.1088/1742-6596/1550/3/032031

Zhang, M. (2022). Analysis on the current situation of intelligent informatization construction in university library. In *International Conference on Cognitive based Information Processing and Applications (CIPA 2021)* (pp. 669-677). Springer, Singapore. doi:10.1007/978-981-16-5857-0_85

Zhao, L., Xing, L., & Liu, J. (2019, July). Strategies of information service based on intelligent library. In *International Conference on Frontier Computing* (pp. 1382-1386). Springer, Singapore.

Nan Pang was born in Tangshan Hebei Province, China, in 1981, Male, Han nationality, Master, Associate professor at North China University of Science and Technology, Research direction: library information management, education management.