The Application of Artificial Intelligence in Smart Library

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Abstract—Artificial intelligence has become one of the main driving forces for the development of modern society, and it has also injected new vitality into the development of smart libraries. This paper expounds the basic situation of smart library and artificial intelligence, analyses the application of artificial intelligence in the field of smart library, and demonstrates the application value of artificial intelligence in library service. Artificial intelligence will be widely used in the development of smart libraries.

Keywords—Artificial Intelligence, Smart Library, Big Data, Internet of Things

I. INTRODUCTION

In the past ten years, under the influence of the new technology revolution, smart library has realized the physical space intelligence, information resource (knowledge) organization intelligence, service mode intelligence and management method intelligence of library with the help of the Internet of things, big data, cloud computing, RFID technology, artificial intelligence, virtual reality and other new technologies. Smart library strives to provide users with more efficient and high-quality services, build a more attractive information interconnection environment, and create a more diversified information sharing space. The mature application scenarios of smart library include 24-hour self-borrowing and returning system, mobile phone/network self-renewal system, intelligent inventory/positioning system, intelligent seat reservation system, 3D/AR/VR navigation system, etc[1]. However, as a high-level development stage of digital libraries, smart libraries need to introduce modern scientific and technological means to increase readers' experience and enhance readers' services. Only relying on the Internet of things, RFID and other technologies has been unable to fully meet the technical requirements of smart library, artificial intelligence will be a new driving force for the development of smart library[2]. This paper will analyze the application of artificial intelligence technology in the smart library, summarize the application status of library artificial intelligence, put forward the existing problems, and look forward to the application of artificial intelligence in the smart library.

II. THE SMART LIBRARY AND ARTIFICIAL INTELLIGENCE

A. The smart library

In 2003, Finnish library scholar Markus Aittola first proposed the concept of "smart library", which considered smart library to be a space-limited, perceptible mobile library service[3]. Its basic characteristics are: (1) All-round perception. The smart library uses RFID, Internet of Things, "Internet +", image recognition, speech recognition, PDA and other artificial intelligence technologies to achieve the organic integration of readers and libraries. (2) People-oriented. The smart library allows readers to interact on the same platform, tracking and acquiring the personalized needs and information of users, providing users with real, all-round, humanized services. (3) Low cost. The smart library can reduce the cost of manpower and material resources, and rationally develop and utilize resources in the library. (4) Adhering to the concept of green development. The smart library can achieve energy conservation and environmental protection, rational use of various natural resources, and promote coordinated development of cultural and ecological construction[4].

B. The artificial intelligence

At present, the booming artificial intelligence (AI) technology is called the fourth industrial revolution by the industry[5]. In 1956, at the academic conference held in Dartmouth, USA, the concept of artificial intelligence was formally proposed. This conference was also recognized as a symbol of the birth of global artificial intelligence[6]. Artificial intelligence is a comprehensive discipline developed by computer science, control science, information science, cognitive science, neuroscience, neurophysiology, psychology, linguistics, brain science and other disciplines. Its essence is to study the production of intelligent machines or intelligent systems, simulate human intelligence activities, and extend the science of human intelligence. Artificial intelligence can be divided into three types: symbolism, connectionism, and

behaviorism. Symbolism is an intelligent simulation method based on logical reasoning to simulate human intelligent behavior. The main principle of connectionism is the connection mechanism and learning algorithm between neural network and neural network. The theory of behaviorism is cybernetic and perceptual-action control system. At present, the popular technical fields involved in artificial intelligence research are: problem solving, natural language processing, artificial neural networks, genetic algorithms, expert systems, knowledge engineering, artificial life, deep learning, intelligent control, etc[7]. From 1956 to the present, the development of artificial intelligence can be divided into four stages[8]. The field of artificial intelligence research mainly includes expert systems such as flight tracking systems and medical diagnostic systems, natural language processing such as speech recognition, automatic speech output, neural networks such as pattern recognition systems, face recognition, character recognition, handwriting recognition, robots such as industrial robots, consulting robots. Some scholars also divide artificial intelligence into the disciplines covered: computer vision, natural language processing, cognition and reasoning, robotics, game ethics, machine learning[9].

The concept of artificial intelligence is very broad and there are multiple classification methods. According to the overall level of artificial intelligence, artificial intelligence can be divided into three levels: weak artificial intelligence (only good in some aspects), strong artificial intelligence (equivalent to human intelligence) and super artificial intelligence (overall beyond human intelligence). From the overall level of artificial intelligence development, humans have mastered weak artificial intelligence, but strong artificial intelligence has not yet been realized[10].

The application of artificial intelligence technology laid the technical foundation for the establishment of a smart library. Applying more applicable artificial intelligence technology to the transformation and upgrading of smart library can make smart library truly develop into smart library and realize the precision, personalization and initiative of smart library services.

III. THE APPLICATION STATUS OF ARTIFICIAL INTELLIGENCE IN SMART LIBRARY

Artificial intelligence covers almost all of the business activities of the Smart Library. Through the case analysis and systematic review of a large number of domestic and foreign literature and practical applications, the three application areas are summarized: Intelligent resource system, intelligent management (smart warehouse management and intelligent security management), intelligent services

(smart application services, intelligent consulting services, intelligent knowledge services).

A. Intelligent resource system

With the development of big data and artificial intelligence technology, the intelligent resource procurement system can automatically collect and integrate all users' personalized demand information and various types of document resource information through deep learning mechanism. Therefore, it is possible to construct an intelligent document resource procurement decision system. Intelligent procurement system construction needs to pay attention to two key points. (1) It is necessary to scientifically and reasonably determine the influencing factors. The library can establish a scientific and objective decision-making model by combining the comprehensive factors such as user group characteristics (such as gender, age, educational background, occupation, etc.), user personalized information (such as in colleges and universities, the number of teachers and students of various majors, subject setting, subject status ranking, school key construction disciplines, teachers and students hobbies, school opening Course name), recommendation and purchase of books (related to professional degree, popularity or utilization of books, book prices, etc.), expert advice (discipline construction, book utilization rate, book reproduction rate, etc.) and annual budget, so as to complete the book ordering plan and optimize the allocation of book purchasing funds[11]. (2) To comprehensively collect and analyze open resources. Through intelligent collection and analysis of open resources, the intelligent procurement system can provide reference for procurement librarians to make decision.

B. Intelligent management

1) Intelligent warehouse management

Intelligent warehousing management has several distinct characteristics: (1) realize the self-service management of the book library with the goal of automatic book circulation and paper document management; (2) the books can be stored randomly on the bookshelf, no need for the book number, reducing the multifarious bookshelf arrangement; (3) Introduce a robot system to realize the management of automatic and unmanned counting, checking and sorting of book storage.

There are many successful cases in the library intelligent warehouse management system. The ultra-high-frequency RFID technology intelligent book inventory robot of Nanjing University Library in China mainly uses the automatic identification technology and RF phase technology in RFID technology, as well as machine automation technology to realize the automatic library book counting function. And the library book

inventory can be realized accurately and quickly, so that the library administrator can find and manage the book conveniently and quickly, which greatly reduces the reader's time to find books[12, 13].

BookBot, the Hunter Library of North Carolina State University, is a robotic book delivery system that uses high-density automated shelf technology to store up to 2 million items and deliver any item within five minutes of clicking on the online catalog. BookBot only accounts for one-ninth of the space of traditional traditional bookshelves, transforming the library from a storage facility into a rich learning and collaborative space environment. Books and other items are bar coded, sorted by size, and stored in more than 18,000 boxes, and each book and item is scanned as it is borrowed or returned from the system, allowing the library's online catalog to track all data at any time[14].

The unique Work Robotics Project (CAPM) at the Johns Hopkins University Library in the United States automatically retrieves books on the shelves and carries them to a scanning station outside the bookshelf. CAPM has real-time enhanced browsing and search capabilities, using a combination of robotics, automated systems, and software technologies to find books on shelves through the web. The user enters the requirements into the CAPM system, which starts a robot to find the appropriate book. The user can view or print the required page and choose to return or borrow the book. Once the text is scanned, the user can also use CAPM to perform automatic text analysis options[15].

In addition, LIB-100B, the book loss prevention intelligent terminal of the Library of Southwest University of China, the Automatic Access Center (ARC) of the Villard Merlot Library, and the AVG of the Humboldt University Library in Germany, are bold innovations of intelligent warehouse management of libraries, and also the future development direction of intelligent warehouse management of libraries.

2) Intelligent Security Management

The library's daily services include seat management, lending management and identity management and other security management, while face recognition, fingerprint recognition and other artificial intelligence technology can further solve the library's security management[16]. For example, face recognition technology specially designed by artificial intelligence technology is used to collect students' face information and bind it with students' information. After binding, students no longer need to carry student identification information, but can directly enter and exit the library through face brushing. The smart library identity authentication flow chart is shown in Figure 1 below.
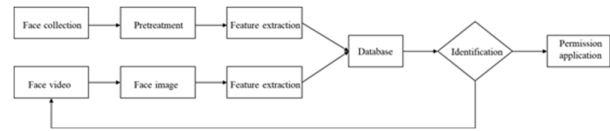

Fig. 1 smart library identity authentication flow chart

The identity authentication module uses face recognition technology as a technical support. Previous face recognition technologies are mostly traditional statistical methods such as Adaboost and PCA (Principal Component Analysis). After the deep development of artificial intelligence, deep learning algorithms such as CNN (Convolutional Neural Networks) and RCNN (Region CNN) have emerged. Such algorithms have been qualitatively improved in recognition accuracy and speed. With the improvement of these core algorithms, the application of face recognition technology has algorithm support in the construction of smart libraries. Face recognition technology is mainly composed of four parts: face image acquisition and detection, face image preprocessing, face image feature extraction, matching and recognition[17].

C. Intelligent services

1) Intelligent application service

At present, the technology of library self-service application service is relatively mature, and the forms and contents of services are also rich and diverse. The main representatives are: Self-service seat management system, self-service library ATM, self-service print copy management, lecture training appointment management system, etc. Self-service applications have the following advantages over traditional application services: (1) Break through the space-time boundary with artificial intelligence to realize instant service in no-show; (2) Extend the service form of library services and expand the scope of service targets, thereby reducing the logistics and labor costs of library services; (3) Enhance the user's willingness to participate and protect the service application privacy of reader users; (4) Promote the rational allocation of service resources and reduce the probability of service errors caused by manual services. The above intelligent application services are visible in the general smart library.

2) Intelligent consulting service

Consulting services are an important part of library services. Traditional consulting services are inevitably insufficient, such as the limited number of consulting librarians, the low efficiency of manual consultation, and the time limit for consulting work, etc. The emergence of intelligent consulting services can effectively meet the needs of users' consulting services, make up for the above shortcomings, and realize the

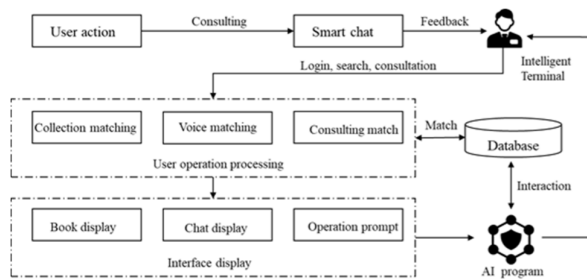library's independent, instant, convenient and all-weather intelligent consulting services.

Fig. 2 The working mode and process of intelligent consulting service

At present, intelligent consulting service plays an important role of "consulting librarian" in many libraries, such as "Xiao Tu" of Tsinghua University library, "Xiao Jiao" of Shanghai Jiaotong University library, and WeChat automatic answering robot of Harbin Institute of Technology[18]. hese are also the library intelligent service application bright spot and one big characteristic.

3)   Intelligent knowledge service

Knowledge service is the core of library service, and intelligent knowledge service is the new positioning of library service innovation, with strong vitality and broad prospects. The rapid development of artificial intelligence technologies such as cross-media awareness, big data management, deep autonomous learning, virtual bionic functions and simulation language interaction provides convenient conditions for the intelligentization and specialization of knowledge services. The patterns and deep knowledge mining processes of intelligent knowledge service are mainly embodied in intelligent analysis of user behavior, intelligent management of information data and intelligent operation of service business, etc., which are realized through knowledge analysis tools, knowledge presentation methods, research conceptual models and analytical research methods[19]. Specific as follows:

a)   Intelligent analysis of user behavior. From the perspective of the user, the user's application behavior is analyzed through artificial intelligence, and the required knowledge is actively recommended to meet the individualized needs of the user and improve the utilization of knowledge resources；

b)   Intelligent management of information data. Use literature, patents, science, and personal data to conduct intelligent analysis and forecasting, establish knowledge-related networks, and provide reference for knowledge services；

c)   The intelligent operation of the service business. From the service business and management

process, to enhance the core competitiveness of knowledge services, On the one hand, optimizing knowledge service process can improve service efficiency. On the other hand, it can also provide decision-making and strategic planning for knowledge service. The SoLoMo-based smart service of Huazhong Normal University and the knowledge search engine of Wuhan University have begun to boldly try different forms of intelligent knowledge services[20].

IV.   THE APPLICATION PROSPECTS OF ARTIFICIAL INTELLIGENCE IN SMART LIBRARIES

According to the 2016 IFLA Trend Report, AI now has the ability to both enhance and replace existing library functions. Libraries need to develop innovative thinking. In the literature review of the IFLA Trend Report, artificial intelligence is listed as one of the four technological trends, and it is proposed that the influence of artificial intelligence on libraries in the future mainly includes three aspects: (1) The next generation of browsers beyond keyword search and semantic analysis of web content; (2) Integrated speech recognition, machine translation, speech synthesis to support real-time multi-language translation; (3) Cloud services for the translation and identification of diverse and complex web content[21].

Although artificial intelligence has been applied in various aspects in the intelligent library, most of its applications are still in the theoretical stage, which is more or less limited and cannot be really implemented. The reasons for this situation are as follows: Library AI hardware equipment research investment is insufficient, big data collection and data mining are facing difficulties, library artificial intelligence talent team is in short supply, and artificial intelligence thinking in library business is lacking.

Looking forward to the future application of artificial intelligence technology in the construction of smart libraries, it is mainly reflected in the following three aspects:

(1) Intelligent guidance service for space in the hall. On the basis of the intelligent sensing space construction, users can use mobile phones, touch screens in the museum, wearable devices and other mobile terminals to enjoy intelligent voice service, intelligent seat reservation, accurate positioning of books, intelligent navigation in the museum, intelligent machine consultation (which can be combined with virtual reality technology) and other intelligent guidance services.

(2) Deep learning and neural network models are used in the library's new generation information retrieval system. In contrast to the traditional learning ranking model, which uses machine learning techniques on manually annotated information retrieval features, the neural network model can learn language representations from original text materials that can bridge the gap between query and document vocabulary.

(3) Carry out accurate information intelligence services. Through information collection and behavior analysis based on big data, Internet of Things, and artificial intelligence technology, users can obtain effective information such as reading habits, research interests, teaching content, professional fields, research directions, research teams, educational backgrounds, and related groups. According to specific scenarios, the smart library provide users with accurate, personalized, high-quality information resources and knowledge push, such as recommended borrowing books, special literature information in a certain field, the latest cutting-edge research hotspots, teaching reference courseware and materials, etc.

V. CONCLUSION

The New Media Alliance Horizon Report (2017 Library Edition) states that AI has become one of the most important technologies for libraries in the next five years. The development and application of library robots will promote the transformation of library service methods[22].

Under the impact of artificial intelligence, the education system will change. The status of the library as a social education, learning center, knowledge center and communication center will be more important, and the library can obtain a broader development space. The introduction of artificial intelligence technology in libraries is not intended to replace librarians, but to enrich and enhance knowledge exchange and interpersonal interactions. Therefore, libraries should also change their minds in the application of artificial intelligence. They should embrace artificial intelligence in a more positive attitude and contribute to the activation of library communication functions and service efficiency.

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