Exploration on Smart Library Construction in 5G Era

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Abstract. With the rapid development of information technology and network, we have ushered in a new round of communication technology called fifth generation communication technology (5G). The arrival of 5G has brought new opportunities and challenges to all walks of life. As a document information center, the library is the carrier of collecting, sorting and collecting document resources. As a librarian, we should keep up with the pace of the times, take practical and effective management methods to combine 5G with the construction of smart library, and establish efficient, intelligent, interconnected and convenient smart library services.

Keywords: 5G; smart library construction; Artificial intelligence.

1. Introduction
In June 2019, the Ministry of Industry and Information Technology issued 5G commercial licenses to China Telecom, China Mobile, China Unicom and China Radio and Television, marking the first year of 5G commercial development in China. This also means that China’s communication industry is about to start a new round of boom cycle [1]. The application of 5G technology accelerates the process of the interconnection of everything and data for many years, stimulates the rapid development of artificial intelligence and machine learning, and further influences people's life, learning and consumption [2-3]. An intelligent society is emerging.

Reviewing the development course of the library in the past several decades, the evolution of each period has injected new connotation and vitality into the library from the traditional library to digital library, then moving library, compound library, and now intelligent library. "Smart library" was first put forward by Finnish scholar Aittola in 2003. He believed that smart library should be a mobile library service mode that was not limited by space and time and could be perceived, which could help users find the literature materials they need. 5G era has also brought a new opportunity to libraries -- the construction of smart libraries [4-6].

1.1. Definition and characteristics of 5G
5G is the abbreviation of the fifth-generation mobile communication technology. It is a new generation of cellular mobile communication technology with ultra-high transmission rate, low latency, support for large-scale high-density and high-speed device connection and high reliability. It is also an extension after 4G (LTE-A, WiMAX), 3G (UMTS, LTE) and 2G (GSM) systems (see Table 1). 5G is no longer just an air interface technology with higher speed, greater bandwidth and stronger capabilities, but an...
intelligent network oriented to service applications and user experience. It is a multi-service and multi-technology integration network. Through technological evolution and innovation, it can meet the needs of the rapid development of various services including a wide range of data and connectivity in the future and improve user experience [7]. 5G will become an important infrastructure and key user for the whole network to connect the world and the future information society.

### Table 1. 5G technology development

| Communication technology | Development time | Application scenarios          |
|--------------------------|------------------|--------------------------------|
| The first generation (1G)| 1980s            | Voice service                  |
| The second generation (2G)| 1992-2000 | Voice service, Text communication |
| The third generation (3G)| 2000-2009 | Music, picture, video          |
| The fourth-generation (4G)| 2009--            | Broadband business             |
| The fifth generation (5G)| coming soon | eMBB+mMTC+uRLLC                |

5G, through a series of key new technologies, will provide 10Gbps super-capacity, end-to-end 1ms ultra-low latency, and 100 billion massive connections. Full duplex technology, Massive MIMO multi-open (128*128), high-order band (30G-100GHz) provides up to 10Gbps capacity; The time delay is reduced to 1ms by using 0.1ms TTI, and the variable bandwidth sub-carriers support more than 100 billion connections. In response to the huge changes in the ICT industry in the next 10 years, the internet of everything will realize. Base station peak rate increased from 1 GBPS of 4G to 5G 20 GBPS, user experience rate several times higher than that of the 4G era to more than a dozen times, mobile performance also support equipment of access 500 km per hour, at the same time can satisfy the urban autopilot control and provide wisdom million per square kilometer in the city level of high density sensor online connection (see Table 2). The application of 5G is used for communication, it is not on the 4G technology upgrade, is a new technology, it is not only an enhanced mobile broadband, as well as synonymous with low power consumption, low-latency connections, can satisfy the use of a wide range of high density crowd demand at the same time, it will will be an important key to open the library. From the point of view of the current development of 5G, it is not just as simple meet the mobile communication, also promote the development of artificial intelligence. To a certain extent, achieved a number of technology integration, a number of technology development, to enhance the intelligence, science and technology will gather in the human wisdom and make the continued development of human society, continuing evolution, lead the people into a new era [8-9].

### Table 2. Comparison of 8 key capabilities between 4G and 5G

| Indices            | 4G                  | 5G                  |
|--------------------|---------------------|---------------------|
| Density measurement| 0.1 Tbps/Km2        | 10 Tbps/Km2         |
| Connection density | 10w/km2             | 100w/Km2            |
| Delay              | 10ms                | 1ms                 |
| Mobility           | 350Km/h             | 500Km/h             |
| Energy efficiency  | 1 multiple          | 100 multiples       |
| User experience rate| 10 Mbps            | 0.1-1Gbos           |
| Spectrum effectiveness| 1 multiple       | 3 multiples         |
| Peak rat           | 1Gbps               | 20Gbos              |

#### 1.2. The definition of intelligent library

A library that can provide "intelligent" services which is defined as an intelligent library. The intelligent services contained in it have two meanings: one is to provide a large number of "unmanned" or "self-service" services, just like Alibaba's unmanned supermarket or library's self-service book borrowing and returning services; The second is to provide accurate and high-quality services through automatic
perception of user needs. For example, when a user enters a specific subject word, big data will perceive the literature resources that the user need according to this specific subject word. With the advancing of science and technology, the library is no longer a single literature information service, but go deep into the knowledge level, through the analysis of the large data to provide information service knowledge and communication, including the traditional reading provided by the library floor space, circulation, conferences, exhibitions, lectures, promote and autonomous learning exchange activities such as reading, as well as the library provided by collecting, sorting, preservation, transfer literature service, and even into the information analysis, users access trends and the release of the information resources, these services are greatly improved informatization of the library and intelligent space construction, This is also the connotation of the service platform of "the third generation library".

In the future, the intelligent library can realize that the library thinks like people and has the sum of human knowledge. The intelligent library can provide the required knowledge services at the time and meet people's need. This goal will be gradually realized, the modern library has gradually developed from semi-self-service to full-self-service, intelligent navigation, self-service retrieval, self-service card handling, self-service borrowing, self-service electronic resources use and other self-service equipment, so that readers can experience one-stop service under the condition of complete autonomy [10].

2. The characteristics and development status of intelligent library

2.1. The characteristics of intelligent library
As early as 2003, Etuola from the University of Oulu Library in Finland put forward the concept of "intelligent library". He believed that the intelligent library was a mobile library that was not limited by space and time but could be perceived. With the continuous improvement of science and technology in China, the concept of "Internet +", Internet of Things, AI intelligence and so on have promoted the development of library from digital library to intelligent library. The intelligent library is based on digitized, networked and intelligent information technology, with interconnection, efficiency and convenience as the main characteristics, and with green development and digital benefit for the people as the essential pursuit, which is the concept and practice of modern library scientific development.

The main characteristics of smart library are interconnection, efficiency and convenience. Interconnection is the foundation of smart library, efficiency is the core of smart library, and convenience is the purpose of smart library. They are interrelated. In the smart library, through the Internet of Things technology, mobile phones, computers, intelligent AI systems, global positioning system, laser scanners, infrared sensors and other intelligent devices are used to deeply understand, analyze and transmit information such as literature, digital resource usage and user needs. The interconnection of time, space and information carrier is realized by connecting with the acquisition equipment. Through cloud computing and big data analysis, we can screen out the knowledge readers need from the system, master the reading habits of readers, and provide efficient, intelligent and convenient service quality to meet the personalized needs of readers.

2.2. The development status of intelligent library
Today, what we call "intelligent library" is different from the traditional library, which serves only as knowledge intermediary, document transmission or modern management service platform. And smart library can provide services for users more accurately. Users are no longer limited by time and space. They can access the information resources of the library anytime and anywhere and accept the intelligent services provided by the library, which is also the advantage of smart library instead of traditional library.

The theoretical research and practical application of intelligent library are still in the exploration stage. At the present stage, the library application, with RFID technology as the leading technology, utilizes the Internet of Things, cloud computing and AI intelligent technology to initially realize intelligent shelf management, intelligent book positioning, intelligent navigation, intelligent retrieval and other intelligent services.
However, due to the high cost of equipment, new technology needs to spend a lot of manpower, material resources and financial resources to maintain and update, in order to ensure its normal operation. So the present construction of library of wisdom of all the difficulties, but with the continuous development of science and technology, especially the application of 5G technology, high transmission rate, low latency, support large-scale high density high speed equipment connection and high reliability of a new generation of cellular mobile communication technology to the development of the intelligence library provides full technical support, wisdom library will usher in a new stage of rapid development, bring readers more fluid, more convenient and high quality service.

3. Application scenarios of 5G technology in smart libraries

In intelligence library, the arrival of the 5G technology on the Internet of things technology, big data technology, a new era of cloud computing, AI intelligent development, as storage, organization, and dissemination of information and knowledge in the library, 5G technology will be promoted in the library management, service, 5G technology will play its role in library of wisdom.

3.1. Non-inductive borrowing

Inducing borrowing refers to fast face recognition through the ultra-high transmission rate of 5G. Readers no longer need to show various credentials to prove their identity. Readers’ information can be verified through fast face recognition, thus reducing the waiting time for readers to enter the library. To connect to the Internet at the same time also with the library in the library entrance guard system, self-service library system, intelligent bookshelf positioning system, intelligent seat succession and distribution system that allows the reader to clear within the library, the library of independent reading books, newspapers and other data, and the independent complete book lending operations, such as intelligent system is done automatically in the background related proof and circulation borrowing formalities, the reader is through the terminal automatically receive borrowing information and related information.

3.2. Intelligent navigation

In our real life, people use navigation when driving cars, and the same navigation can also be used in the library. When the reader into the library, if floor distribution in the library are not familiar with or does not understand the book shelf order bearing, can all through the library provide intelligent navigation devices or smart phones terminal APP for navigation positioning. To find the library introduction, floor layout, the collection of information, all kinds of notice and service. When readers want to go to a certain place or to find a certain book, they can search the content through the system, and then use the 5G ultra-high speed mobile bandwidth to find the floor, library and price of the book according to the navigation system, which greatly reduces the time of readers.

3.3. Wisdom study

The library is an important department to realize the functions of document preservation and knowledge dissemination, as well as an important window to serve the readers. The advantages and disadvantages of book storehouse setup directly affect whether the library collection utilization is optimized, whether the readers are convenient to use, and whether the information service has characteristics. According to the needs of users, the themed library can provide corresponding intelligent services and equipment, and use 5G high transmission rate technology to carry out network coverage, so as to facilitate readers to find literature resources, literature reading and extraction functions, and improve users’ reading experience.

3.4. Wisdom venues

With 5G technology support, the internal space of library all electronic equipment can realize the online intelligent control, through the system can real-time monitor to the library of temperature, humidity, brightness, personnel density monitoring, again through the AI technology is analyzed, according to the
real-time monitoring data to adjust the light in the library, the temperature, the readers to create a reading environment is comfortable and energy saving.

3.5. Cloud classroom
The university library should not only do the basic work well, but also integrate education and teaching comprehensively and deeply, so as to better promote the innovation of teaching and research. The library does a good job of docking with the college, integrating teaching and opening micro-classes, recording the important knowledge points of relevant courses, especially the school's characteristic subjects and popular content reported by students. The college produces refined video courses, which will be released by the library on the cloud platform. Compared with courses on online course MOOC platform, these videos are short in length and each micro-lesson only focuses on one knowledge point, which is convenient for users to grasp and absorb. Besides, there are no time and regional restrictions, which can become a powerful auxiliary teaching method. The library can add question plug-in in the micro course, allowing barrage, interaction and communication to understand users' doubts and difficulties. Through the video insert questions, while learning and practice; By following WeChat, users can also upload questions and have special discussions with teachers and classmates to drive their learning enthusiasm. Library to develop information literacy education, the freshmen education of reading guidance, can also use the classroom as auxiliary, the library situation, resources and tutorials, video retrieval skills into micro class, implementation of online learning, online examination, allow users to flexible time autonomous learning, familiar with and use of library resources more efficiently, also facilitate users to view.

3.6. Accurate delivery
Wisdom precision push is through to the readers of library, trajectory for collecting and statistics, we analyzed the library reading and book circulation situation, using big data + algorithm for sorting, huge data information analysis, according to the reader is always demand, potential demand and behavior habit and accurate information. Precision push library and we want to be a big data of deep development, along with data acquisition channel is more and more, involving dimension is becoming more and more high, the data quantity will grow exponentially, traditional network has been unable to support such a large data regulated, the high transmission capacity of 5 g just solved the big data flow. 5G opens a new era of person-to-person, the Internet of Things and the Internet of Everything, bringing a new way for the collection of big data. Meanwhile, 5G will also improve the speed of data processing and guarantee the application boundary of data, thus promoting the development of big data analysis technology. The library will use the 5 g technology, intelligent Internet of things and big data technology, collection, sorting, storage and analysis of the library, circulation borrowing situation, academic reading and downloads, e-book downloads, etc., let us more clear readers use the library resources, through the data analysis for the library to understand the reader's reading habits and preferences, so as to realize the precise delivery of resources, services and activities. The precise push service based on 5G will provide readers with more targeted resources, more personalized services and better reading experience for their study and research.

3.7. Robotic Services
With the continuous development of 5G technology and AI technology, intelligent robots are appearing in libraries and venues. High-frequency and multi-antenna 5G technology is used for accurate positioning and high-bandwidth communication of the library, so as to realize the technical interaction and coordination between robots and robots, and between robots and other intelligent devices at millisecond level with low delay, which enhances the service efficiency of robots and improves the characteristic services of the library.

At present, there are two types of intelligent library robot services: one is intelligent question-and-answer robot, which can provide auxiliary reference services and annual "freshman entry education". It can conduct "librarian" mode entry education for freshmen, and provide one-to-one voice retrieval
and location guidance services for readers. Another kind is automatic inventory robot, it can be in the middle of the night tirelessly to find books put disorderly, provide function of intelligent warehousing, logistics, inventory, with functions of automatic information acquisition and predict, and upload data collected to a central database, the future will be more robots appear in all kinds of the positions of the librarians, and even have a universal robot librarians.

3.8. Intelligent security monitoring
A complete intelligent security system including access control, alarm and monitoring three parts, and the video monitoring is one of the most important part of intelligent security, 5 g technology of high-speed transmission rate and low delay millisecond will effectively improve the existing monitoring video transmission speed and speed of feedback processing, face recognition technology, AI temperature monitoring and other technical introduction, makes the intelligent security remote real-time control and early warning, make more effective safety precautions, let security monitoring scope to further expand, access to a multidimensional monitoring data. During the COVID-19 epidemic this year, AI face recognition technology and AI temperature monitoring were applied in places with large staff flow, such as hospitals, stations and libraries, which greatly reduced the congestion caused by queuing up to measure the body temperature, reduced the mutual contact between people and reduced cross-infection.

4. Considerations on the development of smart library brought by 5G technology
5G technology not only brings opportunities to the development of smart libraries, but also brings new challenges. 5G technology still has some technical defects until now, and its application in smart library may bring certain security risks, such as disclosure of user data and privacy. This also requires the library to strengthen the management of its own data and emphasize the awareness of information security.

4.1. Strengthen the service transformation mode of knowledge intermediary
Libraries exist to ensure fair access to knowledge for all, and to act as intermediaries between publishers and readers. The popularity of 5 g technology make interpersonal communication more direct and efficient, readers and publishers may skip the library intermediary contact, when the reader through the phone can easily from publishers, database, access to the literature information they want, it will reduce the demand of the readers to the library to find literature information, no longer even went to the library. This also requires the library to transform from offline service to online service, and at the same time, the library should carry on the extended analysis to the needs of readers and carry out the deep resource service.

4.2. Strengthen the construction of the contingent of intelligent librarians
In the 5G era, the service work of intelligent librarians should be informationized and intelligent. However, traditional library services still focus on borrowing, returning and simple reference consulting, and lack of attention on the construction of informationized talents, and the professional ability and accomplishment of library staff are relatively weak. Therefore, in the construction of talent team, combined with the application of 5G technology, it is necessary to continuously strengthen the construction of talent team, optimize the talent recruitment system and improve the talent training system. Moreover, intelligent librarians should have the ability of cognition and adaptation, service and action, cooperation and communication, and development and innovation. Only with the comprehensive improvement of librarians’ knowledge and accomplishment can we provide users with more humanized and diversified services.

4.3. Strengthen the construction of data resources
In the era of big data, strengthening data management strategies and improving data security and stability are indispensable core elements for data service organizations. In the 4G era, digital resources in libraries mainly exist in the form of text, while multimedia resources can only be broadcast online on demand
due to the influence of network transmission rate. 5G's ultra-high transmission rate and ultra-low latency solve this problem. Relying on 5G high-tech, the acquisition, collection and application of data resources will be comprehensively improved to promote the development of library modernization.

5. Conclusion
With the arrival of 5G technology, cloud platforms, big data, artificial intelligence and the rapid development of "Internet +". Promote the intelligent development of library. 5G technology will bring changes to library information organization and user service. We should actively respond, reform, innovation and precise implementation to make smart library develop rapidly, establish a reader-centered, efficient, convenient, accurate, personalized and intelligent service system, and provide readers with a more appropriate reading experience.

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