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Towards a multilingual, multimedia and multimodal digital library platform

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Abstract: The China-US Million Book Digital Library Project (Million Book Project) is an international cooperation program between China and the US. However, one million digitized books are considered not to be the ultimate goal of the project, but a first step towards universal access to human knowledge. In particular, there are four challenges about the new way to analyze, process, operate, visualize and interact with digital media resource in this library. To tackle these challenges, North China Centre of Million Book Project (in Chinese Academy of Sciences) has initiated several innovative research projects in areas such as multimedia content analysis and retrieval, bilingual services, multimodal information presentation, and knowledge-based organization and services. In this keynote speech, we simply review our work in these areas, and argue that by technological cooperation with these innovation research topics, the project will develop a top-level digital library platform for the million book library.

Key words: Digital library, Million Book Project, Multimedia content analysis, Multilingual services, Multimodal information presentation, Knowledge organization
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PROGRESSION REVIEW ON CHINA-US MILLION BOOK PROJECT

Digital library with huge mass of structured text and media resource will benefit people's access to all human knowledge anytime and anywhere. A preview of the potential of digital library can be found in the explosively popular Internet. The World Wide Web has spawned an enormous amount of information on the Internet that can be considered a rudimentary digital library (PITAC, 2001). Digital library promises new societal benefits and enables modern sciences and traditional wisdom to be utilized in depth, enhancing the communication and comprehension between different cultures and expediting human knowledge innovation and civilization progress.

It is estimated that throughout recorded history worldwide, there are about one hundred million books. Building a Universal Digital Library (UDL) to contain all books step by step will realize the dream of sharing all human knowledge. The first challenge for UDL is to organize one million books with text and images online and thus globally make them accessible.

To meet the challenge, China and US parties initiated the China-US Million Book Digital Library Project (Million Book Project). Dr. Raj Reddy, Herbert A. Simon, University Professor of Computer Science and Robotics of Carnegie Mellon University, as Co-Principal Investigators of the US side, Dr. Ching-chih Chen, Professor and Former Associate Dean at the Graduate School of Library and Infor-

mation at Simmons College, Co-Principal Investigators of the US side, Prof. Qin-Ping Zhao, Chief Executive Officer of 211 Office of the Ministry of Education of China, Professor of the Computer Science of Beijing University of Aeronautics & Astronautics and Dr. Wen Gao, Deputy President and Professor of the Computer Science, the Graduate School of the Chinese Academy of Sciences, as Principal Investigators of the China side, signed "Memorandum of Understanding on the China-US Million Book Digital Library Project" in Dec. 2000.

In Aug., 2001, a Chinese eight members delegation led by Professor Yunhe Pan, president of Zhejiang University, visited the US to promote the Million Book Project. The delegation visited CMU (Carnegie Mellon University), National Science Foundation and MIT (Massachusettes Institute of Technology). During this visit, a steering committee was set up for the Million Book Project. The steering committee is responsible for establishing project planning and policy, providing resource and environmental guidelines. Four committee members from the China side are President Yunhe Pan, Dr. Gao Wen (PI), Prof. Chi Huisheng (Vice President of Peking University), Prof. Hu Dongcheng (Vice President of Tsinghua University). Four committee members from the US side are Dr. Raj Reddy (Co-PI), Dr. Ching-chih Chen (Co-PI), Dr. Victor Zue (Professor of MIT) and Dr. Gloriana St. Clair (Director of CMU Library).

During the 2nd steering committee meeting hosted by China in Mar., 2002, the US 12 members delegation visited the Chinese university libraries involved in the project and the two technical centers in the Graduate School of the Chinese Academy of Sciences and Zhejiang University. India became the 3rd partners of UDL in May, 2002. The 3rd steering committee meeting was hosted by India in Jan., 2003. The Chinese 12 members delegation led by Dr. Wen Gao and the US delegation led by Dr. Raj Reddy visited the India partners and the President of India. On Nov. 04, 2003, Raj Reddy visited the Graduate School of the Chinese Academy of Sciences again. The 2004 annual workshop of the Million Book Project was held in CMU and the 2005 annual workshop will be held in China.

The State Development and Reform Commission, Ministry of Education and the Finance Ministry of China had agreed to support the China-US Million Book Digital Library Project with a project "Chinese American Digital Academy Library (CADAL)" as a part of the Project 211 in the tenth Five-year Plan. CADAL is led by Zhejiang University and the Graduate School of the Chinese Academy of Sciences. Peking Univ., Tsinghua Univ., Fudan Univ., Nanjing Univ., Shanghai Jiaotong Univ., Xi'an Jiaotong Univ., Wuhan Univ., Huazhong Univ. of Science and Technology, Zhongshan Univ., Jilin Univ., Sichun Univ. and Beijing Normal Univ. agreed to take tasks to jointly the building of CADAL. Eighty million RMB was allotted to support the organizing, scanning and processing of million books. Half of the fund was provided by the China side of the Million Book Project.

The first batch of Chinese and English digital books were uploaded and shown on http://www.ulib.org.cn. The number of books in Million Book Project will exceed that of any university library. Digitalization of one percent of all human race books by the Million Book Project jump-started the "Human Genome Project" in the knowledge domain (Huang and Gao, 2004).

The Million Book library will become a culture and technology bridge between China and the US. Along with the involvement of China, the US, India, and more and more countries, the shared resources in UDL will contain several millions digital books. By combining Chinese, English and other languages books into a digital library, people from different cultures can communicate more deeply with each other. It will impact human civilization by accelerating different culture communication.

FURTHER CHALLENGES

One million digitized books are deemed not to be the ultimate goal of the project, but a first step towards universal access to human knowledge. Nevertheless, researchers can explore the new way to analyze, process, operate, visualize and interact with digital media resource in this library. Specifically, some innovation researches should be conducted to tackle with the following challenges.

Cross-lingual access

Million Book Project integrates Chinese, Eng-

lish and other languages books into a universal digital library. To facilitate inter-communication of people from different cultures, the digital library platform must support multi-lingual access. For example, if metadata can be automatically transformed from Chinese to English and vice versa, people can directly conduct multi-linguistics retrieval for required information.

Multimedia

Certainly, the human knowledge is not explicitly saved in the digital library, but is implicitly expressed in different media such as text, image, audio and video. Thus how to effectively extract the required knowledge and information from multimedia resources is indeed a key issue that needs to be tackled in the next step.

Multimodal HCI

The multimodal presentation techniques will enable people, especially children, elders, deaf-mutes and blind persons, to easily access the digital library in a more intelligible way. For example, deaf-mutes can easily "hear" books through sign language presentation and virtual reality navigation interface. As a result, multimodal HCI will further extend the service ranges, and consequently increase the power of digital libraries to a wider extent.

Efficient knowledge organization and services

When the full potential of digital libraries is realized, any citizen will for the first time be able to access all human knowledge immediately from any location. However, every one can only read a very small portion of books (averagely less than ten thousand books) in a digital library throughout his life. Thus the digital library needs effective and efficient knowledge organization and retrieval tools to realize the mapping from one million and even more books in a library to ten thousand books for each reader.

To tackle these challenges, North China Center of Million Book Project (in the Chinese Academy of Sciences) has initiated several innovative research projects in areas such as multimedia content analysis and retrieval, bilingual services, multimodal information presentation, and knowledge-based organization and services. In the following, we will simply review our work in these areas.

MULTIMEDIA CONTENT ANALYSIS AND RETRIEVAL

Multimedia is a very important form of contents in the future digital library. Over the past decade, we have seen the explosive growth in the amount of available multimedia information in our daily lives. These multimedia data can be stored in a digital library for further access. This trend necessitates the development of content-based multimedia indexing and retrieval techniques. Since humans tend to use high-level semantic concepts when querying and browsing multimedia databases, it is critical to develop techniques for semantic image retrieval and semantic video analysis.

In semantic image retrieval, our research topics include visual feature extraction, object segmentation, relevance feedback, sequential moving image analysis, image filter and semantic retrieval, etc. (Wang *et al.*, 2004). In semantic video analysis, we are now seeking to novel methods for automatic semantic organization of the content of multiple digital media in news and sports (Ye *et al.*, 2005). Technologies and prototypes have been developed to automatically or semi-automatically categorize images, analyze video content, extract semantic events or highlights, intelligently adapt, enhance, retrieve and personalize the content to meet users' preferences and network/device capabilities.

The achievements can be easily extended to the multimedia organization and retrieval applications in other contexts, such as movies and commercials, as well as be expected to find their wide applications in 2008 Beijing Olympics Games.

BILINGUAL SERVICES

Most current popular digital libraries such as Library of Congress, Chinese National Digital Library and ACM Library, do not provide multi-lingual access interfaces and automatic translation services. As there are both English and Chinese books in Million Book Project, bilingual services are required for users to access resources in any language.

With the cooperation of Xiamen University, we are doing some research works on how to carry out the multi-layered bilingual machine translation in

English and Chinese books. Our research focuses mainly on the following topics: the metadata translation between English and Chinese, the accurate translation of proper nouns such as names for unique individuals, events, or places, the selective translation in a full-text context, the translation of Old Chinese text, and the distributed translation service technique. Technologies and prototypes have been developed to accurately translate proper nouns, and selectively translate the metadata and descriptions of e-books in a full-text context. An online translation service will then be integrated into the portal of the Million Book Project. Consequently, people can be directly conduct semantic-based multi-linguistics retrieval of required information in our digital library.

MULTIMODAL PRESENTATION

Traditionally, digital libraries use a single presentation modal, i.e., text, to deliver the information to users. To make it easy for all kinds of people, including children, elders, deaf-mutes and blind persons, to freely access the human knowledge stored in the digital library, the multimodal presentation technique is used. For example, deaf-mutes can easily "hear" books through sign language presentation, and blind persons can also easily "read" books by means of text-to-speech engines. Towards this end, we are working on how to naturally translate the given text to sign language and spoken language. Our research focuses mainly on the following topics (e.g., Gao *et al.*, 2003): a new text-to-speech engine based on rhythm analysis, text driven facial animation, text driven sign language animation, synchronization and association of learning derived from speech and facial animation, cooperative rhythm learning for multimodal behaviors, and multimodal sign language synthesis, etc. We have realized a suite of Chinese sign language synthesis tools, which can be directly used to provide multimodal information presentation for users of Million Book Project.

KNOWLEDGE ORGANIZATION AND SERVICES

Million Book Project will provide innovative resources and services. One example is the ability to interact with information: rather than presenting a reader with a list of books, it should allow users to choose from a variety of ways to view and work with the books, including graphical representations that they can explore. Towards this end, we are developing a visual e-book navigation and retrieval system based on topic map, KnowMap. Based on statistical relational learning and dependency network (Tian *et al.*, 2005), the KnowMap system uses three layer knowledge networks for users to conduct effectively access. At the top level, the taxonomy such as Dewey classification is utilized for users to rapidly locate the subjects of interest. At the middle level, a topical term network, called TopicNet, can be used for further exploration of knowledge organization in the library. And at the bottom BookNet, each book is related to other books through different relationships such as topical-relatedness, co-authoring. Information visualization techniques are also used in the system to visualize the knowledge networks. Consequently, KnowMap can provide powerful new technological capabilities that enable users to refine their inquiries, analyze the results, and change the form of the information to interact with it.

Another ongoing research work is semantic-based illustration retrieval. Pictorial data in the forms of synthetic illustrations, diagrams, charts, or graphics can appear in e-books and consequently it is important to develop methods for navigating, searching, and browsing illustrations as effectively as one can now do with text. We are developing a semantic-based illustration retrieval system, Illustrator, where an elaborate semantic model is used to extract the semantics of illustrations from the surrounding text information and visual features. The system shows good retrieval performance in a collection containing about 200 000 illustrations.

CONCLUSION

In conclusion, by technological cooperation with knowledge management, multilingual service, multimedia retrieval, multimodal information presentation and other innovative research topics, the project will develop a top-level digital library platform for the China-US Million Book Digital Library.

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