DESIGNING MULTIMEDIA DIGITAL LIBRARIES WITH CONTENT DEVELOPMENT AND MANAGEMENT:
TECHNOLOGY POTENTIAL AND CHALLENGES

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Abstract:

This short paper will stress the importance of content building for developing multimedia digital libraries in making them functional and operational. It will discuss both the problems and issues related to content development and management and will emphasize the potential and challenges for global interdisciplinary collaborative research. Experiences gained from both the author's PROJECT EMPEROR-I and Chinese Memory Net will be referenced.

1. INTRODUCTION

In the US, digital library development has gone through several significant stages. The Digital Library Initiative-1 (DLI-1) phase was supported by the Joint NSF/DARPA/NASA Program from 1995-1999 with a four-year $24 Million dollars to six major US academic institutions. The DLI-2 phase is a multi-agency initiative with a yearly funding of $8 to $10 Millions beginning 1998 for 5 years. Most DLI-2 funds came from the NSF budget. In addition, since 2000, digital library related research has also received substantial support from the NSF's Information Technology Research (ITR) program as well as the National Science Digital Library (NSDL) Program. Similarly, digital library R&D activities have received progressively substantial support in other parts of the world, specifically in Europe and Asia. As a result, we have witnessed considerable progress in area-specific research related to digital libraries – several of which are presented at this meeting. Yet, it is safe to say that there are still few fully functional and operational digital libraries because most of them are limited in scope and contents. Without broad-based, large-scale and multimedia contents, digital libraries are poor comparisons with their analogue counterparts.

Therefore, in contemplating the future directions of digital library development, there is a cry for integrated functional libraries with large volume of digital contents in multimedia formats. This is because, in the current networked digital environment, digital libraries must have enough contents in order to be able to provide universal access to human knowledge to any one, any where and any time. This is a vision clearly articulated in the *Report of the Panel of Digital Libraries of the US President's Information Technology Advisory Committee* [US PITAC, 2001]. At the present, we are clearly still a long way from achieving this vision.

In designing and developing functional multimedia digital libraries, one faces many barriers. While there are technological and logistical challenges, the major difficulties lie in the serious lack of sufficient large-scale multi-formatted digital contents, and the complex issues related to intellectual property (IP) and copyright. Without a solution to IP and copyright, there will continue to be issues related to the "quality" of contents. This is because of the reluctance of people putting up "quality," "valued," or "treasured" content resources on the web for public access. Thus, even the technology

is ready; there are inadequate amount of multimedia digital resources to support the current digital library development.   In addition, there is also a serious lack of quality descriptive and annotated information on the available digital resources because of the labor-intensive nature of the work as well as the difficulty in having the involvement of subject specialists.

In working toward the PITAC's vision, this paper will discuss the effort of *Chinese Memory Net (CMNet)* in multimedia content development and management, and present some of the potentials for collaborative technology research.

2. MULTIMEDIA CONTENT DEVELOPMENT AND *CHINESE MEMORY NET*

In 1983, the US National Endowment for the Humanities awarded its first major technology grant to

Figure 1. The First Emperor of China's terracotta warriors in Xian

PROJECT EMPEOR-I (PI: Ching-chih Chen) at Simmons College in Boston. This was a cutting-edge interactive videodisc technology project showing how technology was insensitive of time and geography, and could bring world's archaeological wonders in China - the First Emperor of China's 7000 terracotta warriors and horses (Figure 1) - to interested researchers and general public all over the world.   It was a perfect example on the use of multimedia technology, and was the beginning of my concept of a "virtual library." Twenty years ago, it was incredible that we could have 108,000 images on a double-sided videodisc, and it was amazing how the interactive videodisc could provide information seekers an incredible array of needed multimedia information for research, education, and entertainment purposes. *PROJECT EMPEOR-I*'s by-products were the popular interactive videodisc (1989) and multimedia CD (1991) published by the Voyager Company. These products demonstrated that the multimedia technology indeed have changed the way we seek, demand and use information. Despite of the usefulness and popularity of these products, they have been used in workstation environment, and information could not be used and shared in the networked environment dynamically.

Realizing the coming of the powerful global information network, in early 1990s, experience and knowledge gained from *PROJECT EMPEROR-I* prompted Chen to advocate digital knowledge base [Multi-media…, 1994] as well as global digital library concepts (Figure 2) [Chen, 1993]. As shown in the over-simplified conceptual diagram, she advocates essentially that each country should develop its own large-scale multimedia contents digitally and properly organized them in interoperable ways. By doing so, then in the current distributed networked environment, these digital collections will be able to be linked together via the broad-
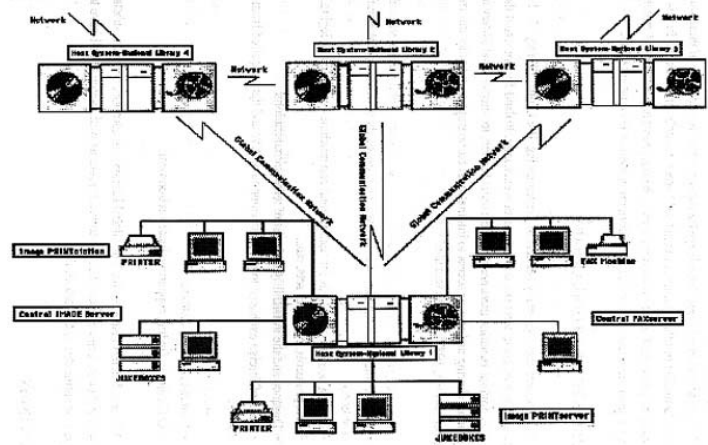

Figure 2. The Global Library - Conceptual Diagram

band high-speed network from one country to the other to form a global digital library.   It was in this same direction, her recent *NIT (New Information Technology)* international conferences as well as book publications advocated similar ideas, as shown clearly from the title of her latest book (see Figure 3), *Global Digital Library Development in the New Millennium: Fertile Ground for Distributed Cross-Disciplinary Collaboration* [Chen, 2001].   Here she also stressed the importance of cross-disciplinary collaboration.   In other words, in order to have successful global digital library development, single subject disciplinary approach will not work.   Technology alone is not sufficient, so is not the subject content. A successful digital library will need to see the conver-

Figure 3, Book cover of the GDLD book

gence of technology, content, domain expertise, organization and management. Thus, it will require the involvement of content and subject specialists, computer scientist, library and information scientists, librarians, etc.
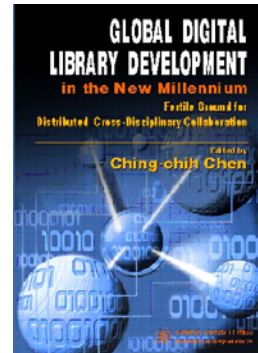
2.1. Chinese Memory Net

Chinese Memory Net (CMNet): US-Sino Collaborative Research Toward A Global Digital Library in Chinese Studies is intended to be a model project which demonstrate such kind of convergence [Chen, 2001a]. It was was proposed in response to a new International Digital Library Program (IDLP) (Program No. 99-6) initiated by NSF in 1999, and fortunately was one of the very first projects funded by this NSF/IDLP Program in the first half of 2000.

The NSF/IDLP Program has intended to contribute to the fundamental knowledge required to create information systems in international settings that can operate in multiple languages, formats, media, and social and organizational contexts. It has hoped that the "cooperative research can help avoid duplication of effort, prevent the development of fragmented digital systems, and encourage productive interchange of knowledge and data around the world."

Following this guiding principle, *Chinese Memory Net,* as shown in Figure 4, "is intended to bring selective academic educational and research partners in different subject disciplines in the U.S., China, and Taiwan together working toward an effective and sustainable global digital library in Chinese Studies. Each collaborator of this complimentary and synergetic group possesses experience, knowledge, expertise, and capability in different but related research area(s). Each participating institution contribute either part of its superb Chinese culture and heritage collection, which form the core of Chinese Memory, or cutting-edge techniques to facilitate the creation of a multimedia digital library. The unique collections are essential to

Figure 4. Preliminary Home Page of *Chinese Memory Net*

education and research, but most of them are not accessible due to distance, form, and technical barriers. This project is to find new ways to enable academic users to access and exploit these significant research collections via global network. *CMNet* is directed by Ching-chih Chen of Simmons College, and her part of the contribution is on multimedia content development and management related to The First Emperor of China's 7000+ terracotta warriors and horses. In this regard, she has capitalized on the interactive videodisc and multimedia CD-ROM products of her earlier *PROJECT EMPEROR-I*, supported by the US National Endowment for the Humanities (1983-1986); as well as the project's large amount of raw resources. These consist of multiple hours of movies, 60 hours of audio tapes, thousands of images of significant research value, and numerous reference textual resources.

In additional to technology-related research, her Chinese collaborators have been working on digital library content development in other subject areas related to Chinese studies, such as Chinese architecture for Tsinghua University in Beijing, rubbing for Peking University in Beijing, and musical instruments for the Shanghai Jiao-tong University.

2.2. CMNet and Content Management

In 1984, in order to create interactive videodisc applications, descriptive and annotative information on each significant image of the Emperor project has to be prepared as shown in Figure 5. This labor-intensive but essential work has proven to be invaluable for *CMNet*'s content development and management. Much of these descriptive and annotative data could be directly converted to be part of the essential metadata information of the Emperor image database, and in turn, they could be used for both traditional image retrieval, such as by title, subject, keyword, etc. or for more cutting-edge image retrieval, such as content-based image retrieval (CBIR).
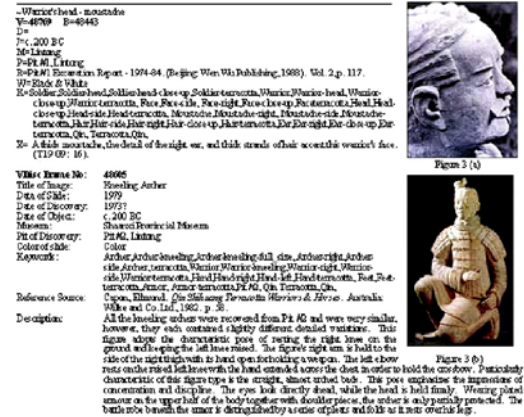
Figure 5. Emperor images's early descriptive data

CMNet has devoted considerable effort in developing a high-resolution image database with some of the most significant images scanned in resolutions larger than 1200dpi from the original source slides (the resolutions of the images on the videodiscs are of the TV quality and therefore could not be used). Over 4000 images of great scholarly value to research and education have been rescanned, and commercially available image management software of Luna Imaging, Inc. has been used to develop an online web-based demonstration as shown in Figure 6, where desired images can be retrieved by more conventional methods, with zoom and other capabilities. Here, the harvested metadata information can also be cross-mapped to other standard

Figure 6. Multiple tiles can be retrieved and shown on the screen with any part of it enlarged, as well as other views and metadata information.

formats, such as Dublin Core, MARC, VRA, CIMI, etc. as well as used for metadata related

research essential for content management. In addition to this demonstration, detailed metadata information for these images has been used to developing both traditional image retrieval tools as well as for productive collaborative research using cutting-edge CBIR techniques. It is expected that ccess to this type of CBIR image searches will be available on the Web soon as a part of the developed web site as shown on Figure 4, and Figure 7.

Figure 7. The Home Page of the Searchable Emperor Image Collection

3. CMNET'S POTENTIAL FOR CROSS-DISCIPLINARY RESEARCH & DEVELOPMENT

In addition to the collaborative effort in expanding the subject contents of Chinese memory, some of the most exciting activities have been related to *CMNet*'s productive cross-disciplinary collaborative research. For example, several leading computer science research groups have found the Emperor's attractive images together with the large amount of comprehensive metadata information of these images, as well as the Emperor's multilingual digital videos to be either invaluable or challenging for their research. Thus, several productive synergistic cross-disciplinary research activities have taken place since 2000. They have produced substantial mutually beneficial research results. A few exciting examples are briefly listed in the following:

3.1. Intelligent Agent and Image Retrieval

Since 2000, the collaborative research with Prof. V. W. Soo of the Computer Science Department of the National Tsinghua University has yielded interesting results in developing similarity matching algorithm for retrieving relevant Emperor images (Figure 8). The preliminary Emperor's metadata information as shown in Figure 5 have been used to develop extensive ontological terms [Soo, 2002; Soo, 2003].
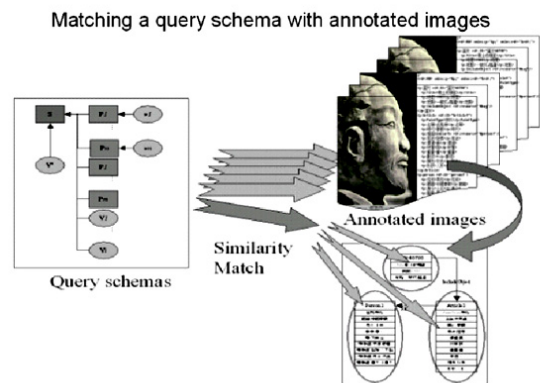

Figure 8. Collaborative research on intelligent agent and image retrieval

3.2. Semantic Sensitive Content-based Image Retrieval

Since 2000, close collaboration with Prof. James Z. Wang of the School of Information Sciences and Technology and Prof. Jia Li of the Department of Statistics of the Pennsylvania State University has yielded exciting results in semantic sensitive content-based image retrieval of Emperor images using the SIMPLIcity technology developed by Wang [Chen, 2002; Wang, 2002] as shown in Figure 9. These retrieval techniques will be incorporated to the web-based retrieval of *CMNet* images. Currently, we are also extending the use of the extensive metadata information for machine annotation using Automatic Linguistic Indexing of Pictures [Wang, 2003] hoping to eliminate some of the labor-intensive work related to image indexing.

3.3. Emperor's Digital Video and Informedia Technologies

Carnegie Mellon University's well-known Informedia Project is one of the six original DLI-1 projects. It has continued its further development in digital video related technologies ever since 1995. Collaboration between Informedia and

Figure 10. Using Infor-media technologies in retrieving Emperor digital videos.

Figure 9. Using SIMPLIcity to retrieve images by color and shape

CMNet has enhanced perspectives from cultural and historical video documentaries (Figure 10). Its multi-lingual (English and Chinese) has also posed challenges in its speech recognition research [Wactlar, 2002].

3.4. Nanoparticle Technology in Restoration and Multimedia Digital Library Development

Prof. Piero Baglioni and his research group at the Center for Colloid and Interface Science (CSGI) of the University of Florence have developed an effective and sophisticated nanoparticle technology for restoring damaged or degraded cultural relics. Currently, Baglioni and Chen has collaborated in developing a multimedia digital library, Project Restore, [Baglioni, 2003] as an extension of the *CMNet*'s scope and activities toward the *Global Memory Net*.

In addition to these, there are many other research potentials, such as using Emperor's images for object-based image retrieval research [Shi, 2003], etc.

4. TOWARD GLOBAL DIGITAL LIBRARY

Chinese Memory Net has accomplished one of its goals in being a model for more global distributed collaboration in creating a multimedia digital library for global cultural and heritage resources. Recent effort has moved beyond the subject domain coverage in Chinese studies to include any other types of areas studies. It has also moved from geographical coverage of China to covering any other parts of the world. Structurally, the *Global Memory Net* has been formed and with more collaborative consortium arrangement and contribution, we can begin to see the realization of a small-scale global digital library with much richer and diversified multimedia contents to meet the needs of a much larger audience. Project Restore is one of such extended efforts.

Chinese Memory Net also shows how it has benefited from various cross-disciplinary collaborative research activities. This is very much in line with recommendations of the *Report of the DELOS-NSF Working Group on Digital Imagery for Significant Cultural and Historical Materials*.

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