A New Hybrid Data Model for Malaysian Cultural Heritage Artifacts Management Database and Application

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Abstract— This paper presents an investigation into the use of data model in the domain of cultural heritage both for collection management and digital multimedia content. Vast amount of multimedia content needed a special data model to cater the need of both database and application in cultural heritage. Research in database and application for cultural heritage application are currently active. However, limited research has been done in the local context. The paper presents a new hybrid data model which employ a combination of CIDOC Conceptual Reference Model standard (ISO 21127:2006) and MPEG-7 standard. The methodology of this research is by conducting multiple case studies to local museum organizations in order to gather information and requirements of cultural heritage database and application. Information regarding the relevant guidelines, standards and reference models are also been studied. The new hybrid data model designed in this paper shows that both of the standards can be combined together to cater the need of local requirements of database and applications.

Keywords: Cultural Heritage, Data Model.

I. INTRODUCTION

THE fact that the ever increasing multimedia data which has been driven by the cheaper cost and yet more powerful computing technology as well as media capture devices is inevitable. As consequences, multimedia database systems have emerged as an important research area for the storage, handling and retrieval of these vast multimedia data.

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Recent trend and activities in the cultural heritage sector is creating digital collections of cultural heritage artifacts. Digital artifacts collection is known to be a new method and alternative to preserve cultural heritage artifacts. The idea of using digital artifacts collections for the cultural heritage artifacts is promoted by the fragility nature and space consuming characteristics of the physical artifacts. Digital artifacts collections may stores the artifacts permanently in the digital form (2D/3D images, graphics, audio, video or animation) for the purpose of preservation and archiving.

Another advantage of digital cultural heritage artifacts collections is the dissemination for the purpose of research, education or tourism through portal and of course supported by multimedia database system for storage, retrieval and manipulation.

The leverage of multimedia data, advantages of having cultural heritage artifacts in digital form (i.e. multimedia) and the need of multimedia database system for digital cultural heritage artifacts collection storage, management and dissemination motivate this research. Therefore, the aim of this research is to design a new hybrid data model for Malaysian cultural heritage artifacts management database and application.

II. RELATED WORK

There are many research has been done in the field of cultural heritage especially in Europe where proposes a better handling of cultural heritage artefact data such as 3D MURALE [1], eCHASE [2], BRICKS [3] and many more. However, limited research and development is being done in Malaysia. Multimedia database system is necessary to support the ever increasing number of digital cultural heritage artifacts collections. The problem is, even though cultural heritage artifacts are currently being actively digitized by museum organization in Malaysia, to date no multimedia database system has been implemented for the storage, management and preservation of these collections in Malaysia. Based on the stated problem, this research is done to study and design a data model for multimedia database of cultural heritage management.

The most prevalence and highly discussed metadata in the cultural heritage particularly museum community is CIDOC CRM [6]. Though CIDOC CRM has already accepted as an ISO standard, there are still limitations. One of the limitations is unable to properly describe multimedia data.

Therefore, research has been done by Hunter [8] to harmonize CIDOC CRM with other multimedia standard for example MPEG-7 to overcome these kinds of problems. From the analysis, the CIDOC CRM which is an ISO standard (ISO 21127:2006) is the major metadata standard and reference model developed specifically for and widely used in museums community [6], thus the implementation of CIDOC CRM and MPEG-7 in this research is significance.

III. APPROACH

The approach of this research can be divided into three stages; data collections, analysis and results (refer to figure 1). We also use Unified Modeling Language (UML) notation as a tool to develop the data model because we find that UML is most suitable tool to develop a data model for any databases that required any multimedia object to be stored.

A. Data Collections

In the first stage, the study is started from literature review as the preliminary study and secondary data collection. As a result, design pattern, reference model and the architecture of database system is extracted in the form of data attributes and operations. This attributes will be used to formulate user requirement checklist in a form of functional and non-functional requirement and considered as secondary data. Interviews and document reviews has been done to gather and localized user requirements.

Prior to the requirement gathering activities, the requirement checklist is formulated as a reference for the interviews using the Canadian Heritage Information Network (CHIN) [4] and the *mda* SPECTRUM standard [5] as a guideline. Selected representative from museums governing body in Malaysia (national museum, states museum and private museum) has been interviewed. The output from the interviews is the localized user requirements and considered as the primary data of the research (refer to Table 1).

B. Analysis

There are two part of work in analysis stage; analysis of user requirement and formulation of DBMS selection criteria. In the user requirement analysis, the localized requirements are analyzed by comparing it to the prior requirement checklist. The localized user requirement is then used to design the logical data model. Any new requirement which is differs from the secondary data, is translated first into use case diagram before designing the class diagram. The class diagram is developed using the secondary and primary data. The other part of analysis stage is the process of DBMS selection. The DBMS selection criteria are formulated using the database system architecture from the literature reviews for the purpose of designing the physical design of the multimedia database model.
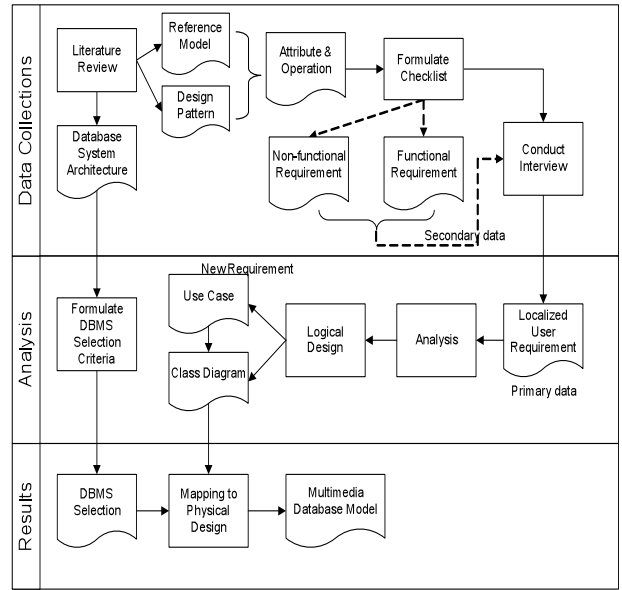

Figure 1: Research Design

IV. RESULT AND DISCUSSION

The data model is generally developed based on the localized user requirements. The current reference model and metadata model used by cultural heritage community throughout the world was also being analyzed. By gathering the localized user requirement and using suitable model or standard, we come out with the result which is the hybrid data model that is meet with the local museum requirement and using international standards.

A. Localized Requirements

The localized user requirements were gathered from a number of selected cultural heritage institutions in Malaysia. Interviews have been made to the responsible person of the institution who is in charge on dealing with cultural heritage data to identify localized requirements. Table 1 shows the functional requirements of each case study. Case Study 1 represents Jabatan Muzium Malaysia, Case Study 2 represents Perbadanan Muzium Melaka, Case Study 3 represents Lembaga Muzium Selangor and Case Study 4 represents Islamic Arts Museum Malaysia. These requirements are currently needed for current and future needs. The requirements from different museums are generally consistent with the formulated requirement checklist. Therefore, the requirements of museums in Malaysia are more or less is the same with museums in other part of the world.

Table 1: Localized Requirements

Requirements	Object Entry	Acquisition	Loans In & Out	Inventory Control	Location & Movement Control	Cataloguing	Conservation Management	Right & Reproduction	Risk Management	Use of Collection & Exhibition Management	De-accession & Disposal
Case Study 1	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓
Case Study 2	✓	✓	✓	✓	✓	✓	✓	✓	✓	✓	✗
Case Study 3	✓	✓	✓	✓	✓	✓	✓	✗	✓	✓	✗
Case Study 4	✓	✓	✓	✓	✓	✓	✓	✗	✓	✓	✗

B. Cultural Heritage Reference Model

The interoperability capabilities of CIDOC CRM are suitable for information sharing between cultural heritage institutions particularly in Malaysia. Information sharing between cultural heritage institutions means collaboration and networking of database system to all cultural heritage artifact information where all cultural heritage institution shared information of their cultural heritage artifacts. This means one cultural heritage institution may access and retrieve another cultural heritage institution artifacts database and vice versa. This information sharing is needed for better information dissemination and enables wider access to cultural heritage artifacts information. Therefore, this data model may develop to become a framework of electronic cultural heritage information system for Malaysia context.

C. Final Result

Figure 2 shows the simplified version of the model where the attribute are hidden. In the proposed data model, the CIDOC CRM [6] and MPEG-7 [7] standards are applied together with the classes formulated from the user requirement analysis in accordance to [8]. The classes derived from the CRM are named with the E prefix and a number after it, (i.e. E39_Actor) while classes derived from MPEG-7 is named with the MPEG7 initial (i.e. MPEG7_Image).

There are two subsystems in the model: cultural heritage artifacts management and multimedia database. Both of the subsystem is proposed to be implemented separately using different DBMS technology. The artifacts management subsystem may use any DBMS technology while the multimedia database subsystem may be deployed in either ORDBMS or OODBMS technology which supports multimedia storage. The main reason of hybrid implementation is because of most organizations currently implemented RDBMS technology where it is insufficient for multimedia data storage and handling. Therefore, a hybrid approach is needed in order to use current RDBMS for cultural heritage artifacts management subsystem while deploying the multimedia database subsystem using specialized DBMS technology.
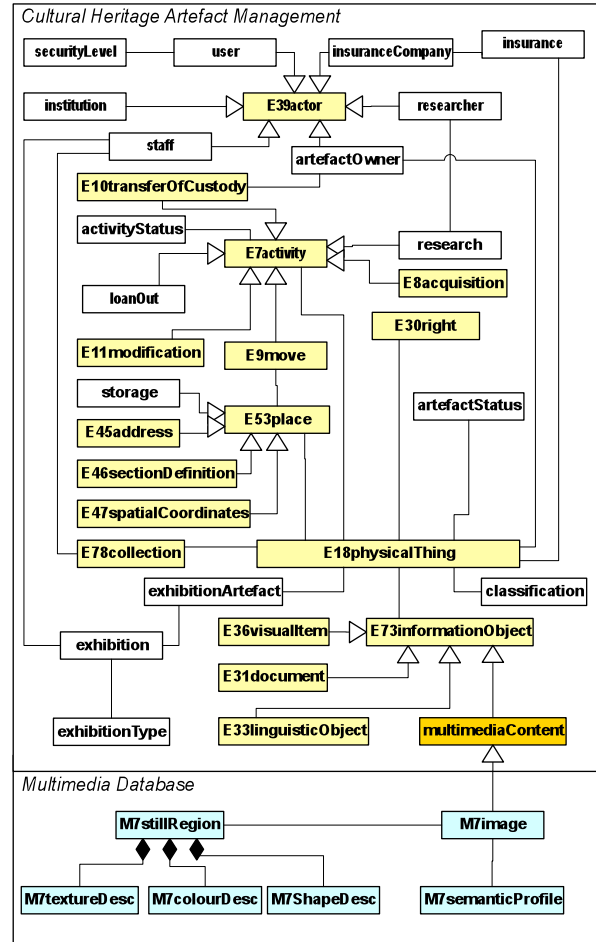

Figure 2: Data Model for Cultural Heritage Artifacts Management

Generally, the data model was design in accordance to the localized requirements. Several CRM classes were identified as matching with the localized requirements were used in the data model while others are excluded. The MPEG-7 standard was adapted in the multimedia database subsystem especially to describe image descriptions. Hunter [8] model was used mainly for interconnecting cultural heritage artifacts management subsystem (CRM) with multimedia database subsystem (MPEG-7).

V. FUTURE WORKS

There are several potential future works of this research. First of all, the full experiment of implementation in the real cultural heritage institution environment and using real data would be done. A prototype of an application that makes a full use of the designed data model would be created. Full experiments should be done to give clearer result of the successful rate of this model in term of performance, reliability, adaptability and so on.

A thorough study and implementation of CIDOC CRM especially in information retrieval could also be executed. Furthermore, a thorough study of a multimedia retrieval system and the usage of CIDOC CRM where experiments can be conducted to all kind of multimedia retrieval systems to compare each technique.

It could also be interesting and productive to locate and study an implementation of multimedia database system based on different DBMS such as OODBMS and perhaps the XML data definition language. Furthermore, different system approach such as open source could be explored. Open source is interesting features for non-profit organizations like museums. The low total cost of ownership of open source software should be considered in the first place.

Lastly, this model should be expanded to support intangible cultural heritage and other media such as audio, video and animation. This model could develop to become a framework of integrated cultural heritage information system where cultural heritage preservation and dissemination would mostly gain benefit.

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REFERENCES

[1] E. Grabczewski, J. Cosmas, P. Van Santen, D. Green, T. Itagaki, and F. Weimer, "3D MURALE: Multimedia Database System Architecture", In *Proceedings of the 2001 Conference on Virtual Reality, Archeology, and Cultural Heritage, November 28 - 30, 2001, Glyfada, Greece,* ACM Press, New York, NY, 2001, pp. 315-322

[2] P. Sinclair, P. Lewis, K. Martinez, M. Addis, D. Prideaux, D. Fina, and G. Da Bormida, "eCHASE: Sustainable Exploitation of Electronic Cultural Heritage", In *Proceedings of 2nd European Workshop on the Integration of Knowledge, Semantic and Digital Media Technologies*, IEEE Savoy Place, 2005.

[3] T. Risse, P. Knezevic, C. Meghini, R. Hecht, and F. Basile, "The BRICKS Infrastructure - an Overview", In *Proceedings of 75th Conference on Electronic Imaging, the Visual Arts & Beyond,* 2005.

[4] Canadian Heritage Information Network (2007, February 13). *Collections Management Software Review Criteria Checklist.* [Online]. Available: http://www.chin.gc.ca/English/Collections_Management/Criteria_Checklist/index.html.

[5] G. McKenna, and E. Patsatzi, (eds.) *SPECTRUM: The UK Museum Documentation Standard Version 3.1.* Museum Documentation Association, 2007.

[6] M. Doerr, "The CIDOC Conceptual Reference Model: An Ontological Approach to Semantic Interoperability of Metadata", *AI Magazine*, 24(3), pp. 75–92, 2003.

[7] J. Martinez (Ed.), *MPEG-7 Overview. Technical Report ISO/IECJTC1/SC29/WG11 N6828, International Organisation for Standardisation. Version 10.* 2004. Available: http://www.chiariglione.org/mpeg/standards/mpeg-7/mpeg-7.htm

[8] J. Hunter, "Combining the CRM and MPEG-7 to Describe Multimedia in Museums", *Museum and the Web 2002.* Available: http://www.archimuse.com/mw2002/papers/hunter/hunter.html