UNIVERSITI TEKNOLOGI MARA

A DATA MODEL FOR MULTIMEDIA DATABASE OF MALAYSIAN CULTURAL HERITAGE ARTEFACTS MANAGEMENT

MOHD NORASRI BIN ISMAIL

MSc IT

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for the degree of
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ABSTRACT

Multimedia is one of the much talked fenomena in the field of information technology. Currently, vast amount of multimedia content are created for multiple purposes particularly to convey information effectively. Cultural heritage domain is also benefited from multimedia technology where multimedia content is used for depicting tangible and intangible artefacts and for information dissemination. However, the vast amount of multimedia especially in the cultural heritage domain needed a special data model to cater the need of both collection management and digital multimedia content. There are finished and currently active research activities regarding multimedia database for cultural heritage application throughout the world especially in Europe. The problem is there is no research has been done in the local context especially in the field of multimedia database application in the cultural heritage domain. There are also no data model that support both information of cultural heritage and multimedia data in the local context. The intention of this research is to design a data model for multimedia database of cultural heritage artefact management as well as tries to fill the gap of cultural heritage dan multimedia database research in the context of Malaysia. A multiple case studies is conducted to gather information and requirements from the local museums governing organizations. Literature study also conducted to gain information regarding the guidelines, standards and reference models which is relevant to this research. From the requirements gathering as well as literature reviews, the logical and physical data for multimedia database of Malaysia cultural heritage artefacts management was designed and modelled. The data model employ a hybrid of museum metadata standard known as ISO 21127:2006 or CIDOC Conceptual Reference Model (CRM) and multimedia database standards known as MPEG-7. This research also employ a model developed by Jane Hunter (2002) where combination between CRM and MPEG-7 for describing multimedia in museums is made possible.

Candidate's Declaration

I declare that the work in this thesis was carried out in accordance with the regulations of Universiti Teknologi MARA. It is original and is the result of my own work, unless otherwise indicated or acknowledged as referenced work. This topic has not been submitted to any other academic institution or non-academic institution for any other degree or qualification.

In the event that my thesis be found to violate the conditions mentioned above, I voluntarily waive the right of conferment of my degree and agree be subjected to the disciplinary rules and regulations of Universiti Teknologi MARA.

Name of Candidate	Mohd Norasri Bin Ismail
Candidate's ID No.	760723-01-7351 / 2005102390
Programme	Master of Science in Information Technology
Faculty	Faculty of Information Technology & Quantitative Sciences
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Signature of Candidate ....

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CHAPTER 1

INTRODUCTION

The aim of this research is to design a data model for multimedia database of cultural heritage artefacts management in Malaysia. The outcome of this study is the design of the database where it would be useful for the Government of Malaysia through the Ministry of Culture, Arts and Heritage in their effort and intention to manage and preserve our invaluable cultural heritage artefacts.

1.1 Background

Since the introduction of multimedia in personal computers, it has become more common every day to digitize part of the multimedia data around us. A major advantage of digitized data over traditional method is that digitized data can be shared easily with others. People now create their own homepages on the World Wide Web (WWW), partially as a tool to manage the information they collect. But, browsing the web makes clear that a computer with a web server is not the best tool to share your multimedia data. It is not easy for others to find your data, and, the information pointed at by search engines is often incorrect, or has been moved to another location.

The fact that the ever increasingly multimedia data which has been driven by the cheaper cost of computing technology as well as media capture devices is inevitable. As a consequence, multimedia database systems have emerged as an important research area for the storage, handling and retrieval of these vast multimedia data. A multimedia database system must provide the support for managing text, video, audio and image data, and it must also manage the retrieval of these data types.

Recent trend in the cultural heritage sector is creating digital collections of cultural heritage artefacts. Digital artefacts collection is known to be a new method of preserving cultural heritage. The idea of using digital artefacts collections for the cultural heritage artefacts is promoted by the fragility nature and space consuming characteristics of the physical artefacts. Digital artefacts collections may stores the artefacts 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 artefacts 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 artefacts in digital form (i.e. multimedia) and the need of multimedia database system for digital cultural heritage artefacts collection storage, management and dissemination as discussed above motivate this research.

1.2 Problem Statement

There are finished and current active researches in cultural heritage information system especially in Europe where proposes a better handling of cultural heritage artefact data such as 3D MURALE (Grabczewski et. al., 2001), eCHASE (Sinclair et. al., 2005), BRICKS (Risse et. al., 2005), ACIS (Klamma et. al., 2005) and many more. On the other hand, very limited research and development are being done in Malaysia. Multimedia database system is necessary to support the ever increasing number of digital cultural heritage artefacts collections. The problem is, even though cultural heritage artefacts are currently being actively digitized, 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.

1.3 Research Questions

The research questions of this thesis are as follows:

i. What are the models and standards for cultural heritage artefacts management system?

ii. What are the localized requirements of cultural heritage artefact management system as well as multimedia database implementation?

iii. How to design the multimedia database for cultural heritage artefacts management system?

1.4 Research Objectives

The objectives of this thesis are as follows:

i. To identify reference model and standards for cultural heritage information system.

ii. To identify requirements of cultural heritage artefacts management system and the database management system technology for museums in Malaysia.

iii. To design the logical and physical data model for multimedia database of cultural heritage artefacts management.

1.5 Contribution of the Study

The ever increasing of digital cultural heritage artefacts in various media types needs a suitable database system for data handling, manipulation and dissemination. This is needed to effectively manage Malaysia invaluable cultural heritage treasures. This research contributes in the data handling, management and dissemination of cultural heritage artefacts by designing a data model for multimedia database in the perspective of Malaysia's cultural heritage artefact management. This research will also support the Ministry of Culture, Arts and Heritage in achieving their missions "to highlight and popularize the arts and culture" and "to preserve national heritages in its tangible and intangible form to cultivate patriotism" (Ministry of Culture, Arts and Heritage, 2004) as one of major electronic government application. Moreover, this research will also might be a base for the implementation of nationwide electronic cultural heritage online application for supporting cultural heritage management, education, cultural tourism and so on.

1.6 Research Scope

This study investigates the implementation of multimedia database in the cultural heritage artefacts management in Malaysia. The setting of the study is museum institutions in Malaysia. The requirements from the cultural heritage institutions will be collected for designing logical data model of multimedia database. In this study, only tangible cultural heritage artefact in the form of images will be taken into consideration.

1.7 Thesis Organization

The content of this thesis is presented in 7 chapters. The remainder of this thesis is organized as follows:

- **Chapter 2: Multimedia Database System**

  This chapter gives an overview of database technology and particularly discussed the multimedia database system.

- **Chapter 3: Cultural Heritage Information System**

  This chapter give background information of the cultural heritage domain especially in cultural heritage information system and standards.

- **Chapter 4: Research Methodology**

  To answer the research questions, this chapter outlines the research design.

- **Chapter 5: Analysis and Findings**

  This chapter presents findings from data analysis.

- **Chapter 6: Discussion**

  This chapter discuss the achievement, contribution, significance and limitations of this research. The future related work is also suggested.

- **Chapter 7: Conclusion And Recommendations**

  This chapter present overall conclusion of this thesis.

CHAPTER 2

MULTIMEDIA DATABASE SYSTEM

The proliferation of multimedia data in this era causes the critical need of effective handling and management of these kinds of data. Database management system (DBMS) has proven to be efficient and effective in data handling and management. However, traditional DBMS is not capable of handling and managing multimedia data efficiently because of the nature of multimedia data which is different compared to the traditional textual data. Therefore, multimedia database system is needed for handling and managing multimedia data.

To design a multimedia database system, an understanding of database technology as well as multimedia database system is necessary. Initially, brief overview of database includes database definition, database management system, database system, and data model will be given. Later, multimedia database system will be discussed. Included in the discussion of multimedia database system are; definition, multimedia data types, characteristics, storage, indexing, retrieval, querying, issues and current research in multimedia database system.

2.1 Overview of Database Technology

Since the birth of computers, data handling, manipulating and storing received great notice. Database technology is one of the major field in computing which concentrate on issues in data handling, manipulating and storing. There are numerous explanations and definitions of what a database actually is. The definition of database is a collection of related data (Elmasri & Navathe 2000; Connolly & Begg, 2005) and a description of this data, designed to meet the information needs of an organization

(Connolly & Begg, 2005). Elmasri and Navathe (2000) list three implicit properties for a database:

- A database represents some aspect of the real world, i.e. some aspect that is of interest for users.
- A database consists of a collection of data which is logically coherent and has some inherent meaning
- A database is designed, built, and populated for a specific purpose.

Usually, when "database" is used, it is mean something that is stored electronically (on disk, on tape, on in a computer's main memory) for handling, manipulation and retrieval, and is managed by a specialized software, a database management system (DBMS). The importance of database system is the information gathered from the data which can be used in analysis and decision making. Databases are structured to facilitate the storage, retrieval, modification, and deletion of data for various data-processing operations.

2.1.1 Database Management System (DBMS)

A DBMS is a generalized set of software package for accessing, implementing and maintaining one or more computerized databases (Elmasri & Navathe, 2000; Beynon-Davies, 2004). Connolly and Begg (2005) give clearer definition by defining DBMS as a software system that enables users to define, create, maintain, and control access to the database. The DBMS defines data types, structure and constraints before constructing a database by handling incoming data for storage and organizes it. The DBMS should also capable of manipulating data by providing users or applications ways to extract and modify the stored data. Another DBMS capability is allowing database sharing and concurrent access to multiple users or applications. Last but not least, the DBMS protects and maintains a database.

2.1.2 Database System

A database system can be defined as the combination of a database, a DBMS, and application programs (Elmasri & Navathe, 2000; Connolly & Begg, 2005). In a database system, database is functioning as data repositories where all data and data definition are stored. Database management system (DBMS) basically functioning as a mediator between application programs or queries and database. Users may retrieve the desired data or information using application programs or queries.

An important aspect of a database system is that a description of the structure of the database is stored in the database itself. Such information is called metadata ("data about data") and is used by the DBMS in its work to access the data files. In a relational database the names of tables and columns are examples of such metadata.

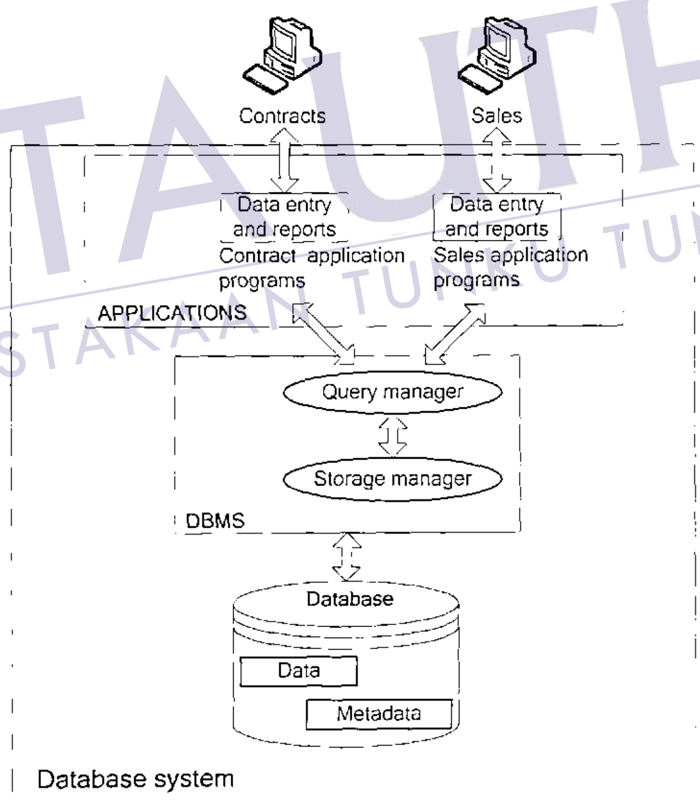

Figure 2.1: Database System Environment

2.2 Data Model

A data model can be loosely used to describe an organized and ordered set of data stored on a computer (Powell, 2005). Data model provide a solution for structuring these ordered set of data in order to more efficiently retrieve and manipulate that data. The purpose of data model is to represent data and to make the data understandable in order to be easily used for database design (Connolly & Begg, 2005). Several data model was introduced since the advent of database technology including network model, hierarchical model, relational model, object-oriented model, object-relational model and etc.

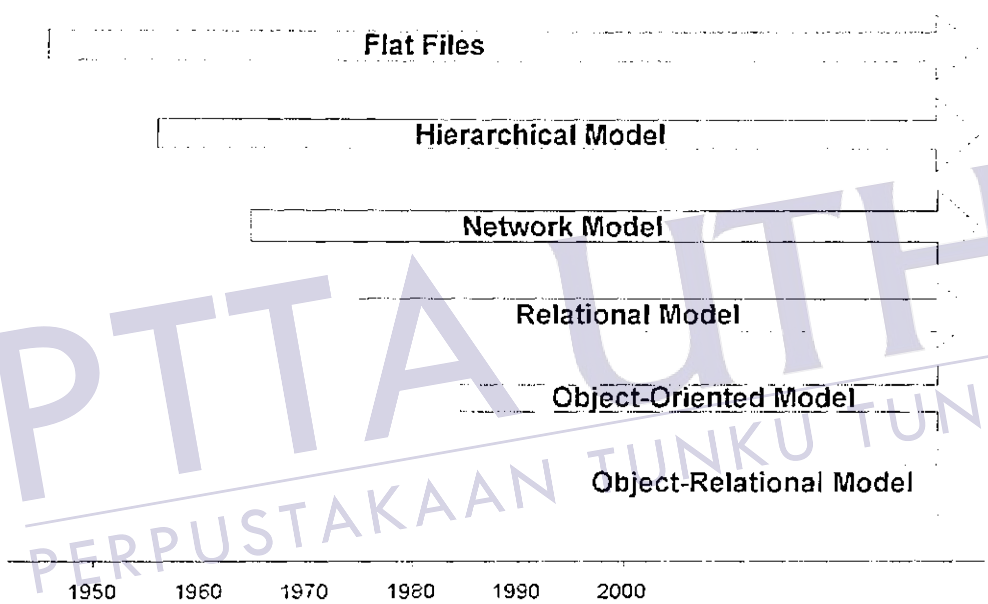

Figure 2.2: The Evolution of Data Modelling (Powell, 2005)

2.2.1 Flat Files

Before the advent of database technology, the approach for data storing and manipulation was file-based system. File-based system is a collection of application programs that perform services for the end-users such as the production of reports where each program defines and manages its own data (Connolly & Begg, 2005). This means only certain programs can access certain data files because of the specifications and parameters were only defined in that particular program. As for example, the payroll department could only access files used by the payroll department programs, the accounts department could only access files used by the accounts department programs and the sales department could only access files used by the sales department. Using a file-based method mean that no modelling techniques are applied and that the data is stored in flat files in a file system, utilizing the structure of the operating system alone (Powell, 2005). The term flat file means a simple text file where data is simply dumped without any structure.

The file-based system had several limitations including separation and isolation of data, duplication of data, data-application dependence, incompatible file formats and fixed queries/proliferation of application programs (Connolly & Begg, 2005).

- **Separation and isolation of data**

  File-based systems have the tendency to separate and isolate logically-related data. With important data being spread out across different application, the retrieval of crucial data can be time consuming.

- **Duplication of data**

  Redundant data in different files may occur especially when different application uses the same data but in decentralized manner. Any modifications of data in one application is not affect the same data on the other application, thus create inconsistencies.

- **Data-application dependence**

  Since the data definition and structure was controlled and may only be defined within a particular application, a change in these parameters required a change in the application making it difficult and time consuming to change or add in new data.

- **Incompatible file formats**

  Applications may be incompatible with each other, preventing data from easily being transferred from one application to the next.

- **Fixed queries/proliferation of application programs**
  File-based systems are very dependent to the fixed query where required during the development of the application programs. However, from time to time new or unplanned queries may be required where it is not supported by the application programs. Other limitations of file-based systems were including no provision for security and integrity; limited or non-existent of recovery process; and access to the application programs was restricted to only one user at one time.

All of above limitations may increase program maintenance and application development time, hence labour intensive and cost consuming. Therefore, the database management system was introduced to address these shortcomings.

2.2.2 Hierarchical Model

The development of Information Management System (IMS) by a joint venture of IBM and North American Aviation (NAA, now Rockwell International) is one of the important milestones in database technology. The IMS was developed based on Generalized Update Access Method (GUAM) developed by NAA for NASA's Apollo moon-landing project in the 1960s where huge amount of data needed to be handled. GUAM was based on hierarchical structure which conforms to an upside-down tree. The hierarchical model is derived from the IMS and was adopted by many banks and insurance companies as well as inventory and accounting systems used by government departments and hospitals.

The Hierarchical Model stores data in a series of records where it is equivalent of tables in the relational model. The structure of this model is much like an inverted tree where the relations of tables are using parent-child relationship. Each parent table can have multiple child tables while each child table can only have one parent table. Therefore, child tables are completely dependent on parent tables where a child table can only exist when corresponding parent table exist.

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The advantage of this model is it offers a very efficient access along the links of the tree. However, this model is only able to cope with a single tree, and is not able to cope with linking between branches or over multiple layers.

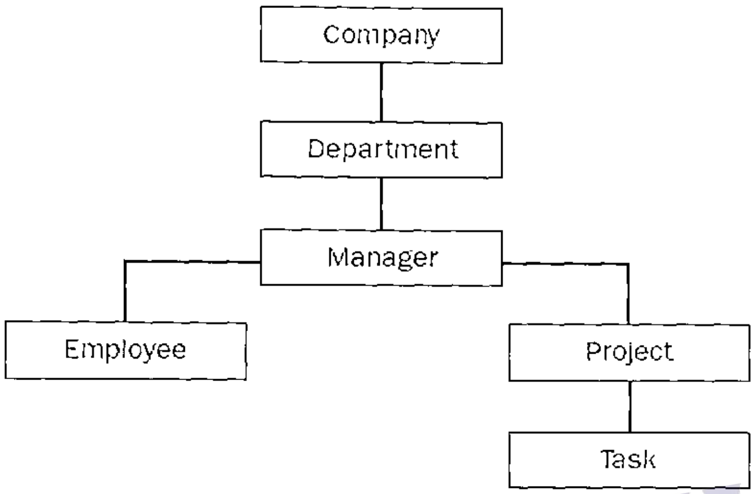

Figure 2.3: Hierarchical Model (Powell, 2005)

2.2.3 Network Model

One of the first generation of DBMS was the Integrated Data Store (IDS). IDS was designed by General Electric team headed by Charles Bachman in the early 1960s and was the first general-purpose DBMS where it featured data schemas and logging (Ramakrishnan & Gehrke, 2000). For his work in the database area, Bachman was awarded the first ACM's Turing Award (Nobel Prize equivalence) in 1973. The Network Model was derived from the IDS and was standardized by the Conference on Data System Languages (CODASYL).

The Network Model is basically a refinement of the Hierarchical Model where it allows child tables to have more than one parent. It is called the Network Model because the data represented in the form of a network of records and sets which are related to each other, forming a network of links. In addition to one-to-many relationship, many-to-many relationship is allowed in this model because of each child tables are allowed to have multiple parent tables. In other words, an employee can be assigned many tasks, and a task can be assigned to many different employees. Thus, many employees have many tasks, and visa versa.

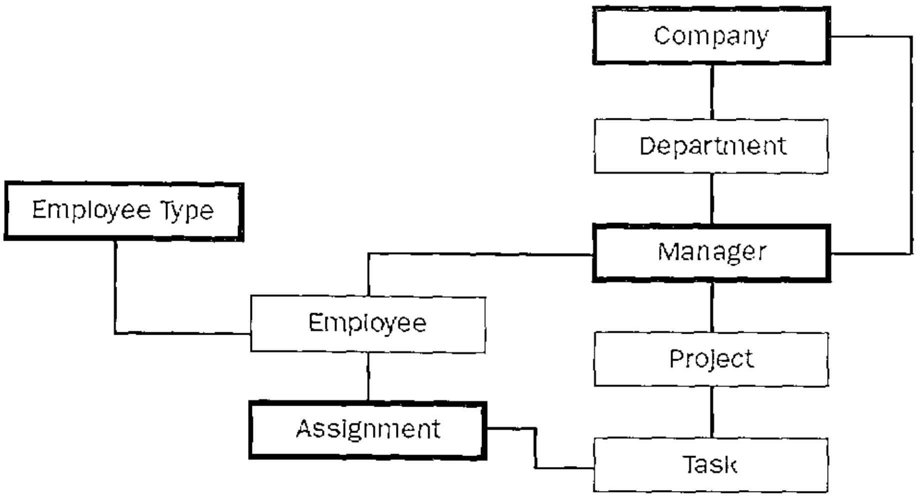

Figure 2.4: Network Model (Powell, 2005)

2.2.4 Relational Model

The Relational Model was introduced by Edgar F. Codd in his influential paper titled "A Relational Model of Data for Large Shared Data Banks" in 1970 (Codd, 1970). Codd was looking for a better way to organize databases and address the disadvantages of previous approach, came up with the idea of a relational database. In his paper, Codd disconnects the logical organization of a database from the physical storage methods.

The Relational Model provided a simple yet powerful means for structuring information and improves the restriction of a hierarchical and network model where any table can be accessed directly without the need to access parent tables. Another advantage of this model is the ability to link any table regardless of hierarchical structure. With the development of clear and understandable relational languages, such as QUEL and SQL (Stonebraker, 1988), the popularity of the relational model was assured and gained a strong basis of support with the development of many commercial applications based on it.

The Relational Model is one of the oldest models used for creating a database and was a breaking point event in the development of DBMS. Relational Database Management System (RDBMS) which is based on this Relational Model is the major approach and used by the majority of businesses today. Today's major RDBMS are Microsoft Access, Microsoft SQL Server, MySQL, Oracle, IBM DB2 and PostgreSQL. Later versions of Oracle and DB2 have been extended with object-oriented features, and may now be called object-relational DBMS.

Although the relational model provides a concise model and was tremendously successful in handling applications with relatively simple primitive data types, it is inadequate to handle complex data such as medical, multimedia and engineering data (Elmasri & Navathe 2000; Connolly & Begg 2005).

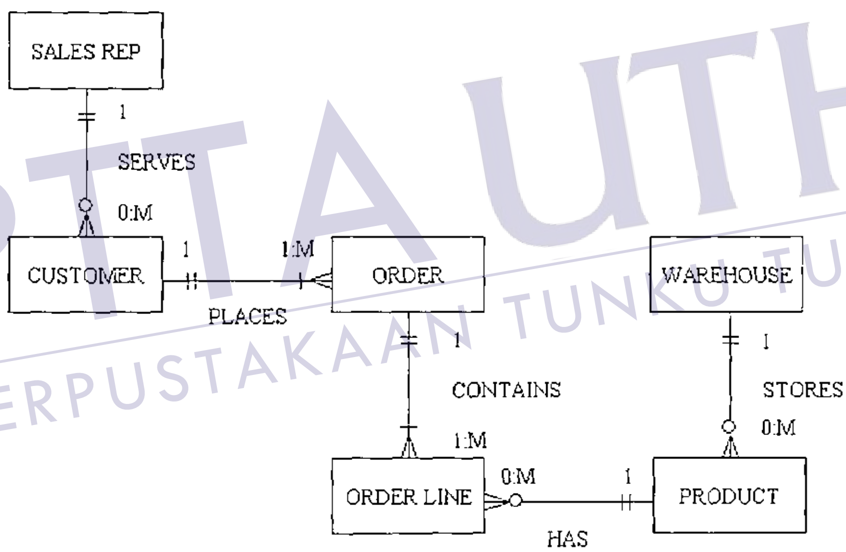

Figure 2.5: Relational Model

2.2.5 Object-Oriented Model

The emergence of object oriented system in the late 1970s and early 1980s gain interests of researchers. The idea of Object-Oriented Model was to provide a database the capabilities to transparently store objects of application programs written in object-oriented programming language such as JAVA, C++ and Smalltalk to facilitate object persistence. The result of this action is the Object-Oriented DBMS

(OODBMS). The research in this model was done to address restrictions of Relational Model especially in storing and handling large amounts and complex data.

Unlike earlier models which stores data as a row in a table, in an object data model, data are seen as objects with properties, or state, and behaviour. In an object-oriented (OO) environment the "real world" is modelled by a collection of objects that communicate with each other by exchanging messages. This model also does not have a high level language like SQL in the Relational Model. This is both an advantage and a disadvantage. The advantage is it gives low level control of how the data is to be store and manipulated to the programmer. This can be more efficient than using a general language like SQL, as storage techniques can be optimized for the data being stored.

In object-oriented model, each object has a system-unique object identifier thus eliminates data redundancy. Another important difference from the modelling perspective is that the implemented database schema often is easier to understand. Its main advantage is the unification of the application and database development into a seamless data model and language environment resulting less code in applications, more natural data modelling and easier to maintain code bases. By using an object-oriented approach both in application program and database the so-called "impedance mismatch problem" could be avoided. Impedance mismatch means a problem of the way programmers structure their data is not the same as the way the database structures it where programmers needed to write additional code to convert data for insertion process into a compatible format of the database, and likewise, change the information from the database into the format required for the applications. Without the impedance mismatch problem, object-oriented database system development can be completed with a slight amount of additional effort (i.e. less programming code).

A more important argument, is that OODBMSs supposedly are more suited than RDBMSs for handling "modern applications", such as computer-aided design (CAD), computer-aided software engineering (CASE), geographical information systems (GIS), and multimedia systems (Elmasri & Navathe 2000; Connolly & Begg 2005). Some factors in favour of OODBMSs are that they have a user-extensible type system, and that they more easily than RDBMSs in handling complex object, long transactions, object versioning, and schema evolution. Some of the major commercial OODBMSs are Objectivity/DB, Versant, ObjectStore, Caché, ObjectDB and FastObject.

2.2.6 Object-Relational Model

The Object-Relational Model is not a new technology in its own, but a blend of the Relational Model and the Object-Oriented Model. This new model was created because that the Relational Model was not designed for, and is not able to cope efficiently with the new types of data includes audio, video and image files as well as user defined types. The development of this model was also triggered by the increasing use of object oriented programming languages and the realization that there is a large degree of impedance mismatch between these and the RDBMS software

This kind of problem does not occur in Object-Oriented Model as the information stores as objects into the database. However, it is unlikely to stop using an established database system and change to another database system overnight. This is where the Object-Relational Model comes into a valuable approach as it allows organizations to continue their existing database structure and start implementing Object-Relational Model for the benefits of object-orientation without having major changes.

Most of the major relational DBMSs have lately been converted to object-relational database management system (ORDBMS), which means that desired object-oriented features have been incorporated into the relational products. For example, Oracle8i and IBM's DB2 UDB (universal database server) may all be termed object-relational (Stonebraker & Brown, 1999). Stonebraker and Brown (1999) list four main features of an ORDBMS:

- support base type extensions
- support complex objects
- support for inheritance
- support for a production rule system.

The first three features must be available in an SQL context. An important aspect of commercial ORDBMSs is their abilities to use "plug-ins" to extend the functionality for a particular information domain. For example, there are spatial extensions available for all ORDBMS products mentioned above, which is suitable for efficient storage, access and analysis of GIS application data. These kinds of extensions are called DataBlades (Informix), Cartridges (Oracle), and Extenders (DB2 UDB).

2.2.7 Semi-structured Data

Semi-structured data is data that has some structure, but the structure may not be rigid, regular, or complete and generally the data does not conform to a fixed schema (Connolly & Begg, 2005). The information that is normally associated with a schema is contained within the data, which is sometimes called "self-describing", and the amount of structure used depends on the purpose. Semi-structured data is often represented as a graph, with a set of data elements connected by labelled relationships, and this self-describing relationship structure takes the place of a schema in traditional, structured database systems (Cooper et al., 2001)

According to Ramakrishnan and Gehrke (2002) there are three reasons why data might be semi-structured:

- The structure of data might be implicit, hidden, unknown, or the user might choose to ignore it.
- Consider the problem of integrating data from several heterogeneous sources where data exchange and transformation are important problems. Highly flexible data model is needed to integrate data from all type of data sources including flat files and legacy systems.

- A structured cannot be queried without knowing the schema, but sometimes there is need to query the data without full knowledge of the schema.

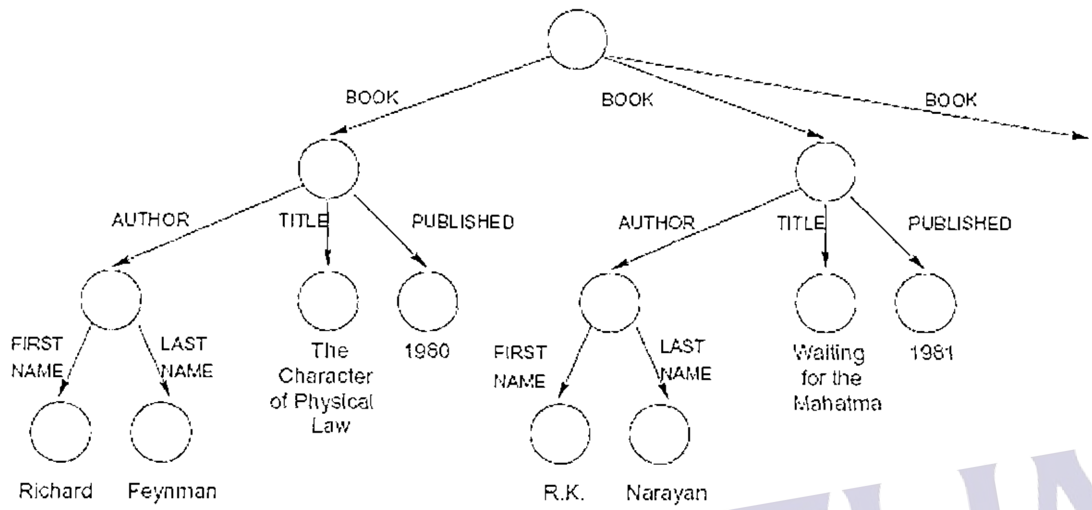

Figure 2.6: Semi-structured Data Model (Ramakrishnan & Gehrke, 2002)

There are several advantages of this model. One of them is it can represent the information of some data sources that cannot be constraint by schema, thus providing a flexible format for data exchange between various types of databases. This model also can be helpful in viewing structured data as semi-structured for the purpose of data browsing. Another advantage is the schema of semi-structured model can easily be changed. Last but not least, the data transfer format may be portable.

XML, the eXtensible Markup Language is one example of a language for representing semi-structured data. It is an open standard meta-language developed by the World Wide Web Consortium (W3C) to store data in a self describing, human readable and internet aware manner. XML document is one of the important sources of semi-structured data. XML's main function in Internet technology is in transmitting data between computers, applications, and users. In particular, since XML is based on plain text, and therefore, XML based documents can be received and processed by many different computing platforms, such as by a platformindependent browser or other networked application programs. Because of its extensive use in the Internet applications which also use databases in storing and transmitting information, database management systems and applications must also work with XML documents.

As XML gain popularity, more and more XML documents are created thus need a better management and handling. There are two way of managing XML data: use XML extension of traditional DBMS and use native XML DBMS (Salmien & Tompa, 2001; Vakali, Catania & Maddalena, 2005). Realizing the growing usage and importance of XML data, all current commercial database systems provide some XML support. Examples of commercial systems are Oracle's XML Database (Baum, 2007) and IBM's DB2 pureXML (IBM, 2007). Another option for managing and handling XML data is use native XML DBMS. Another approach is using native XML DBMS. There are three characteristic of native XML DBMS (Bourret, 2007):

- Defines a (logical) model for an XML document - as opposed to the data in that document - and stores and retrieves documents according to that model.
- Has an XML document as its fundamental unit of (logical) storage, just as a relational database has a row in a table as its fundamental unit of (logical) storage.
- Is not required to have any particular underlying physical storage model. For example, it can be built on a relational, hierarchical, or object-oriented database, or use a proprietary storage format such as indexed, compressed files.

There are current a lot of native XML DBMS available either commercial or open source such as eXist, Tamino, Lore, GoXML DB, and many more.

2.3 Metadata

Metadata is a term originating from the Greek word "meta" denoting words such as "along with, after, among, between". Within information technology, the term usually refers to any information associated with the organization of the data, the various data domains and the relationship between them (Baeza-Yates & Ribeiro-Neto, 1999). It represents "data about data" (Sundgren, 1973) and in the context of a database management system, it usually refers to information specified in the database schemas such as entity- and relation- names, the attributes associated with the entities and relations, and also possible attribute domains. The term "attribute" is a widely used term within DBMS referring to a characteristic or quality of a person or thing. Describing data objects within a DBMS (as done through data modeling) inherently implies assigning and/or associating some sort of metadata to the data objects.

When querying digital repositories, one is compelled to use some kind of descriptive terms as part of a query indicating required or desired characteristics or aspects of the intended retrieval result (the data objects). These terms are metadata reflecting some characteristics of the data objects in the repository. Due to the vast increase of large digital repositories and the continuous growth and development of the Internet, the search and retrieval of specific data objects (documents, images, etc.) is often both a time consuming and cumbersome process. Lacking information and awareness regarding the existing metadata associated to the data objects in such repositories is frequently hindering users from locating and retrieving relevant data objects effectively. A wide scale adoption of descriptive standards and practices for digital resources is likely to improve the retrieval of relevant resources (data objects) from large, digital repositories (Hillmann, 2001).

Metadata is created for and associated with the resource (media object) to support its discovery, use, storage, and migration. Or, in the case of a purely bibliographic (citation) database, metadata is created to describe the resource and there is no media object. According to the National Information Standards Organization (NISO), metadata is most often divided into three types (NISO, 2004):

- **Descriptive metadata:** used for the indexing, discovery, and identification of a Resource. Examples of descriptive metadata include title, author, publisher, and physical format. This is the type of metadata described in this document.
- **Structural Metadata:** information used to display and navigate through Resources (records/media objects); also includes information about the internal organization of the Resource. Structural metadata indicates structural divisions of a Resource (i.e., chapters in a book) or sub-relationships (such as distinct parts of a letter; e.g., salutation, body, closing).
- **Administrative metadata:** represents the management information for the object, and includes information the user needs to access and display the Resource, as well as rights management and long-term preservation and archiving information. Administrative metadata includes the resolution at which an image was scanned, the hardware and software used in producing an image, compression information, pixel dimensions, etc. There are several subsets of administrative metadata; two that are sometimes listed as separate metadata types are:
    - **Rights Management metadata**, which deals with intellectual property rights, and
    - **Preservation metadata**, which contains information needed to archive and preserve a resource.

Besides metadata describes by NISO (2004), there are also other type of metadata especially for the purpose of cultural heritage domain. According to Baca (2000) and Gilliland-Swetlund (2000), there are another two type of metadata besides metadata describles by NISO (2004):

- **Technical metadata**, which related to how a system functions or metadata behave.
- **Use metadata**, which related to the level and type of use of information resources.

Further explanation of metadata for cultural heritage will be discussed in section 3.6.

2.4 Overview of Multimedia Database System

The rapid technological advancement in digital media captures devices and computing is responsible for the tremendously increased in production and acquisition of digital multimedia content in recent years. Current situation is where digital devices are already taken over the analog world. As for example, now everyone may own their digital still or video camera at a relatively low price compared to five years back. Almost every new mobile device in the market such as Personal Digital Assistant (PDA) and mobile phone are equipped with digital image and video capture capability. When talk about audio, the same situation with image and video is happen where the usage of magnetic tape is decreases compared to digital audio devices such as MP3 audio player and recorder. With support and advancements in computing such as powerful processing capability, storage and high-bandwidth network, which are increased dramatically makes multimedia more significant in our daily life. Furthermore, the cost of these advanced technology of multimedia and computing are relatively low where everyone may own it personally. The explosion of multimedia data which are complex and rich-content leads to a strong need in efficient and effective systems for organizing, managing and retrieval of these multimedia data.

Ideas of managing multimedia data came up in as early as 1990s. Campbell and Chung (1995) have presented their idea where they feel that database systems can be a strong tool for managing multimedia data. A multimedia database is a controlled collection of multimedia data comprises of text, graphics and images, audio and video while a multimedia database management system (MMDBMS) provides support for the creation, storage, access, query and control of multimedia database (Adjeroh & Nwosu, 1997).

Early application of multimedia database system is merely for presentational purposes only (Dunckley, 2003). For example, a student database may include the student's picture; an online catalogue where seller put picture of the products. These systems could be easily implemented by simply storing the image file in the external file system. The database will only store the location of the images. However, current need of multimedia database is to manipulate multimedia data as it is an alphanumeric in the traditional database with the ability to store, indexing, querying and retrieval.

DBMS is well known to have been very successful in managing formatted data which they offer data independence, centralized control, easy access to the data through high-level query languages and system enforced integrity. The task of designing and building a multimedia database system is to apply the same principles of DBMS to the management of multimedia data. Until recently this was very difficult to do, because of the size of the files, and because of the complexity of the data. The advent of several new approach of database management system (DBMS) such as Object-Oriented DBMS and Object-Relational DBMS which can handle much more complex data compared to traditional DBMS makes multimedia database system can be realized. However, there are very few products and systems that are exclusively MMDBMS, instead, multimedia database (MMDB) application are typically within existing DBMS that already include some features and capability for multimedia data types (Khoshafian & Baker, 1996). However, these DBMS are mostly exploited as storage mechanism where a multimedia layer is built on its top for handling multimedia data while special purpose DBMS (i.e. multimedia DBMS) for managing and manipulating multimedia data is still in concern (Heimrich, 2004). In this case, some extensions of commercial databases (e.g. IBM DB2, ORACLE) offer these capabilities.

2.4.1 Purpose of Multimedia DBMS

The first task of multimedia DBMS is providing basic DBMS functionalities such as database definition and creation, data retrieval, data access and data organization, data independence, privacy, integration, integrity conrol, version control, and concurrency control (Adjeroh & Nwosu, 1997):

- **Integration**. Ensures that data items need not be duplicated during different program invocations requiring the data.

- **Data independence**. Separation of the database and the management functions from the application programs.
- **Concurrency control**. Ensures multimedia database consistency through rules, which usually impose some form of execution order on concurrent transactions.
- **Persistence**. The ability of data objects to persist (survive) through different transactions and program invocations.
- **Privacy**. Restricts unauthorized access and modification of stored data.
- **Integrity control**. Ensures consistency of the database state from one transaction to another through constraints imposed on transactions.
- **Recovery**. Methods needed to ensure that results of transactions that fail do not affect the persistent data storage.
- **Query support**. Ensures that the query mechanisms are suited for multimedia data.
- **Version control**. Organization and management of different versions of persistent objects, which might be required by applications.

2.4.2 General Multimedia Database Model

Multimedia database architecture should be flexible and extensible to support various applications, inquiry types and contents. To satisfy these requirements, common multimedia database should have a number of functional modules. New modules can be added to expand the functionality and existing modules can be deleted or replaced by new ones to improve the functionality.

According to Lu (1999), the major functional blocks are the user interface, feature extractor, communication module, indexing and search engine and storage module. Figure 2.7 shows the basic architecture of a multimedia database. The main purposes of these modules can be explained through the operation scenario of multimedia database. Two major operations of a multimedia database are insertion of new items and retrieval. During the insertion process, the user gives a multimedia item through the user interface. Then the feature extractor creates the feature vector to insert the

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