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3D REGISTRATION FOR MALAYSIAN CADASTRE SYSTEM

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ABSTRACT

2D cadastre mapping is being practiced in Malaysia and at the moment it provides vital land and property information like ownerships of the parcels for most parts of the country. However in very near future this 2D information may not be able to serve more advanced situations for example in large city centers. The establishment of Malaysia cadastral system is to monitor matters of land especially the land ownership. The system is setup to ensure consistency in cadastral information that comes from cadastral survey and cadastral land registration. In general, the cadastral survey and cadastral land registration are managed by Department of Survey and Mapping Malaysia (DSMM) and Land Offices (LO) respectively. The cadastral object can be either a complete land parcel, parcel of storey houses (strata) e.g. apartments, flats residential or parcel below the surface (stratum). There is a need for 3D cadastre registration as real-estate property is actually in 3D. Therefore, the new cadastral system should reflect the existence of the real-world objects - 3D physical objects and have its own legal rights. Current 3D computing technology could be used to develop a registration system for 3D Cadastre and eventually a solution for 3D

Cadastre objects situations. One of the main challenges is to transform the proposed cadastre model into computer environment i.e. logical model. The validation of logical model will be then encoded in the spatial database. Spatial DBMS is the foundation for both GIS (presentation, analysis) and CAD (creating the 3D models). It offers spatial data type in its data model structure and also in the query language and it can interact with the spatial DBMS. The cadastre objects will be also link with the land registration attributes. This paper discusses a development of 3D registration system for cadastre objects in 3D. The paper elaborates on the integration of Oracle Spatial and Autodesk Map 3D towards developing a 3D Cadastre registration system.

Keywords: 3D cadastre, spatial objects, DBMS

1.0 INTRODUCTION

Traditionally, cadastral registration systems are parcel based systems and it is in 2D nature. 2D cadastre mapping is practiced in Malaysia and at the moment it provides vital land and property information like ownerships of the parcels for most parts of the country. Obviously current cadastral information serves most of the users need for decades. However in very near future these 2D information may not be able to serve more advanced situations for example in large city centers (see Figure 1) because one way to deal with this situation is by having a more advanced cadastral system like 3D cadastre. This means we need to extend the 2D system into a three-dimensional (3D)(Rahman, Stoter et al., 2005). The disadvantage of the solutions to register 3D property units in current cadastral registration is that the 3D information is not integrated in the spatial part of the cadastral database. Therefore it is not possible to view the 3D situation interactively. Major primarily relevant aspects have to be considered before the implementation stage of having 3D cadastre system for Malaysia is technical as well as institutional aspects

Malaysia is a well developing country with the plenty of big cities all over the country especially the city of Kuala Lumpur. The high rise buildings have been built in order to optimize the limited space. Hence, more complex buildings being built to cater the needs of the people who do business or stay in the big city. The complex buildings have different architecture design and latest technologies situated in the limited space like in Kuala Lumpur.

With the technologies nowadays, buildings have been design in a complex way to occupied and optimize the space. Some of the buildings been built on top of each others or with the cross boundary edge. The major problems that will be address in this research are about the cross boundaries buildings. How the buildings or the properties should be register? Is the current cadastre system sufficient enough to handle the registration of these complex buildings?

Cadastre system is being used in some government agencies such as Local Authority and *Lembaga Hasil Dalam Negeri Malaysia* (LHDNM) to support the valuation and taxes system. In Malaysia, there are two organizations responsible on managing and maintaining the cadastre system (Gengatharan, 2005). The Department of Survey and Mapping Malaysia (JUPEM) deal with the cadastral survey with high accuracy survey determine the location, dimension and size of the properties. JUPEM is responsible for preparing, producing and managing the spatial including the surveying and mapping of the cadastre parcels. The non-spatial data (i.e. the registration) is being the responsibility of the Land Office (i.e. the PTG). PTG deal with the ownership registration, whose owns what (3R; Right, Responsible, Restriction). In Malaysia, the cadastre system is being managed by two different organizations. Both organizations have their well developed system called CLRS (Computerised Land Registration System) in PTG and CDMS (Cadastre Data Management System) in JUPEM. Unfortunately the systems works separately in each organization and is still in 2D in nature (Chai, 2006). As far as Malaysia is concerned the needs for this research output is clearly

sought after by the National Mapping Agency (NMA), i.e. JUPEM and the Land Office (LO), i.e. The Land and Mines Office (PTG). With the rapid development of technologies and technique, both systems could be integrated to cater the needs of 3D properties registrations.

A complex system needs a clear and concise method to show the representation of data modeling. It is the same thing happen in cadastre data modeling. Unified modeling language (UML) is a design mechanism that not only involves data modeling but the entire of the system environment. It is now a trend to use UML rather than conventional entity relationship diagram (ERD) which has a decent relationship in GIS data modeling. They are several types or components of UML diagrams namely Class diagram (a data modeling diagramming language), object diagram (class diagram for only one set of objects), use case diagram (use to show the interaction among actors, e.g. customers, employees), sequence diagram (shows an interaction of objects arranged in time sequence), collaboration diagram (shows the object and messages that are passed between those objects in order to perform some functions, statechart diagram (a standard state transition diagrams that shows what states an object can be in and what causes the object to change states), activity diagram (type of a flowchart and represents operation and decision points) and implementation diagram (shows the system components and how they interact and can either show the software or hardware components of the system). In the proceeding section we use UML class diagram to show the 3D cadastre data model.

This paper discusses the development of 3D cadastre registation system i.e integration of 3D cadastre object with the current registration of the 2D cadastre parcel. Section 2 starts with the solutions towards 3D cadastre registration. Here, two common registration models have been discussed namely the Core Cadastral Domain Model (CCDM) and Hybrid Cadastre registration model. Section 3 continues with the elaboration on the development of 3D

cadastre registration system. The section covers on the logical design of the system, the association of the components in the DBMS and the visualization of the 3D cadastre objects in Map 3D via Oracle Spatial. Finally, section 4 remarks the conclusion of the paper.

2.0 SOLUTIONS TOWARDS 3D CADASTRE REGISTRATION

Solution towards 3D cadastre registration is to study possible solutions in adding 3D component in current registration. Two common registration models has been studied in this research. The models are:

- Core Cadastral Domain Model (CCDM), and
- Hybrid Cadastre Registration Model

These models have been used as a platform to suit with the Malaysian cadastre system.

2.1 Core Cadastral Domain Model (CCDM)

Core Cadastral Domain Model (CCDM), (van Oosterom et al., 2006) has been introduced as a model for land registration purposes. The development of this model is design as a base for various land registration practice in different countries. Two important goals of this model listed in (van Oosterom et al., 2006) are; (1) avoid reinventing and re-implementing the same functionality over and over again, but provide a extensible basis for efficient and effective cadastral system development based on a model driven architecture (MDA), and (2)

enable involved parties, both within one country and between different countries, to communicate based on the shared ontology implied by the model. The UML class diagram of the CCDM is shown in Figure 1.

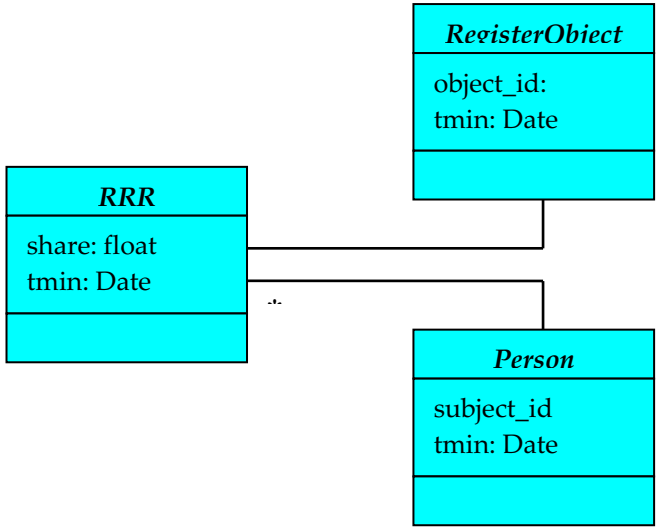

Figure 1: UML Class Diagram Concept of CCDM: Person, RRR (Right, Restriction, Responsibility) and RegisterObject, (van Oosterom et. al 2006)

2.1.1 Malaysian Cadastre Data Model

CCDM is designed as the base for various land registration system. Therefore, it can also used to describe Malaysia cadastre data model. The definition of these three core classes can be derived from (Chong, 2006). Table 1 shows the component of CCDM that follows with the Malaysia Cadastre System. These categories are base from the CCDM classes and reflected in the National Land Code 1965 and Strata Title Act 1985.

Table 1: Component of CCDM base on Malaysian Cadastre System

Persons (NLC: s.43)	• Natural persons (excluding minors less than 18 years old) • Corporations, sovereigns, governments or organisations • Persons authorised to hold land under the Diplomatic and Consular Privileges Ordinance 1957 • Bodies expressly empowered to hold land (e.g. Trade union Ordinance 1957)
RegisterObject	• Lot (land parcel) (NLC: s.516) • Parcel (building parcel) (STA: s.4) • Stratum (underground volume) (NLC: s.92A)
RRR (Right, Restriction and Responsibility)	• Rights (e.g. extent of general disposal under NLC: s.44 • Responsibilities (duty rent – e.g. survey fees, premium, annual quit rent etc.) • Restrictions (e.g. category of land, express and implied condition etc.)

2.2 Hybrid Cadastre Registration Model

Hybrid cadastre proposed by Stoter (2004) is a good start towards implementation of 3D cadastre in Malaysia. The concept of hybrid cadastre is to preserve the current 2D registration and add the 3D component in the registration system. There are two approaches to register 3D object namely registration of right-volume and registration of 3D physical object. The 3D representation of each approach is embedded in the CCDM base model.

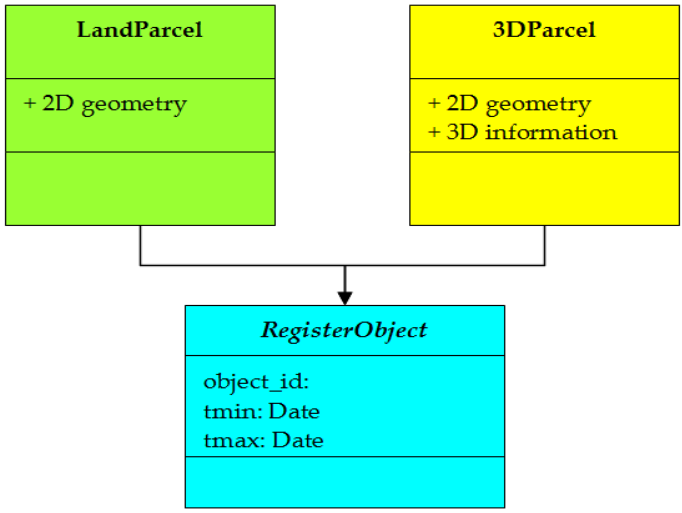

Figure 2: LandParcel and 3DParcel is part of RegisterObject

3.0 THE DEVELOPMENT OF 3D CADASTRE REGISTRATION SYSTEM

The development of 3D Cadastre Registration System is to looks on how to add 3D component in the current cadastre data model and

make information accessible between the two involved organizations. 3D cadastre object e.g. apartment buildings is a real property that being built on the 2D land parcel, which is the responsibility of DSMM. Adapting CCDM, the 3D spatial database being design to make it interoperable with the current land registration database developed by the LO, which is CLRS. In this model, both *LandParcel* and *3DParcel* are registered as an object in current registration system as shown in Figure 2.

The *LandParcel* is represented as a 2D geometry. This object is inherited from the current 2D registration system. Figure 3 shows the data model of land parcel as a registered object. *LandParcel* i.e. cadastral lot consists of boundary lines and boundary marks. The *3DParcel* is considered as 3D physical object based on the hybrid solution by (Stoter, 2004). *3DParcel* is formed with 2D geometry and 3D information. The *3DParcel* is projected with the 3D bounded space with list of coordinate that form flat faces and later form a 3D object which so called 3D cadastre object. The data model of *3DParcel* is illustrated in figure 4.

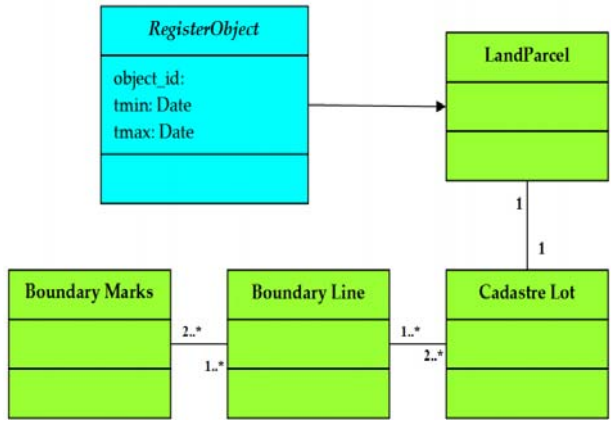

Figure 3: Data Model of *LandParcel* in Cadastral Registration

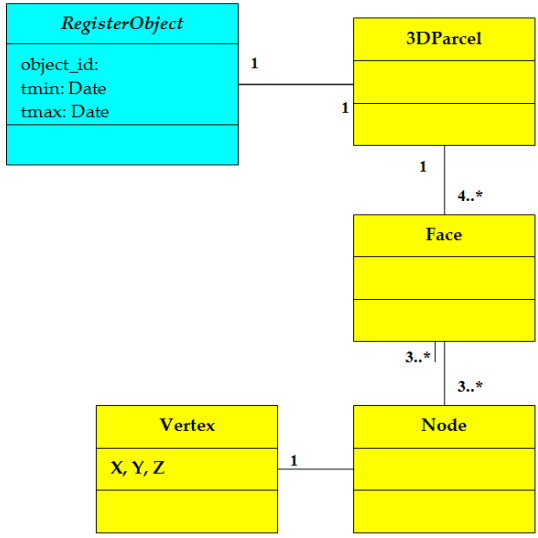

Figure 4: Data Model of *3DParcel* in Cadastral Registration

3.1 Logical Model for Registration OF 3D Cadastre OBJECT

3.1.1 Spatial Data Model

The spatial data model of 2D parcel and 3D parcel are stored in the Oracle DBMS.

The table recording 3D_Parcel include the following items:

- Owner_no: the ownership number of the particular building
- Area: the floor area of the building parcel
- Geometry: the list of coordinates which form the 3D spatial objects

The table recording the 2D_Parcel includes the following items:

- No_lot: Lot number of the mother parcel for buildings registered
- Area: the area of the main parcel for the buildings
- Geometry: List of coordinates that form the 2D Parcel

3.1.2 Administrative Data Model

The administrative component is created to show the attributes for registered 3D cadastre object. The attributes shows the information as follows:

The table recording table Owner include with the following items:

- Owner_No: the ownership number of particular registered object
- Name: the name of the person who hold rights on the registered parcel
- IC_No.: the identification number of the land owner
- State: description name of the state for the registered objects
- Mukim: the name of the mukim of the registered objects
- District: the name of district of the registered objects
- Type_owner: type of ownership referring to registered objects

Table 2: Physical Development of 3D Cadastre Registration System Database

Entity Name	Geometry Type	Field Name	Description	Data Type	Width	Key
Owner		Owner_No	Ownership no.	Varchar	25	PK
		Name	Name of land propriter	Varchar	25	
		IC_No	IC no	Varchar	15	
		State	Name of state	Varchar	10	
		Mukim	Name of mukim	Varchar	10	
		District	Name of district	Varchar	10	
		Type_owner	Type of ownership	Varchar	10	
3DParcel	Polygon	Owner_No	Ownership no.	Varchar	25	PK
		Area	Area of parcel	Number	10	
		Geometry	Column of geometry	Mdsys.sdo.geometry		
		Lot No.	Lot number	Varchar	10	FK
LandParcel	Polygon	Lot No.	Lot number	Varchar	10	PK
		Area	Area of parcel	Number	10	
		Geometry	Column of geometry	Mdsys.sdo.geometry		

3.2 Association of the Components in DBMS

Table 2 above shows the physical development of the registration for 3D cadastre object. There are three main entities that are owner, *3DParcel* and *LandParcel*.

The 3D cadastre registration system is developed to show registration of 3D spatial objects and combine with the land attributes. The linkage of these tables is base on owner_no (field name) that being set as primary key (PK). The 3D Parcel is located in the primary land of 2D parcel. Therefore, the linkage between these tables is based on the lot no.

3.3 The Visualization and Query via DBMS and CAD

In the experiment, we have chosen Autodesk Map 3D and Oracle database to visualize the spatial objects. The interoperability of Map 3D and Oracle is developed base on the schema that helps to connect the software. The specification of the schema need to be fulfilled before the connection can be done.

The visualization of 3D cadastre object is conducted via the Map 3D schema administration. Here, the Map 3D requires user to login the Oracle database login name, password and the service name. Later, the interested table in the Oracle database will be selected to visualize in the Map 3D. The visualization of the 3D cadastre objects are shown in Figure 5. The registered coordinates in the Oracle DBMS can be listed base on the primary key of the table. The query for the administrative purposes can be done via the interface develop by creating a linkage to Oracle database shown in figure 6. In the interface, several functions

have been setup to perform some operations such as add, save, delete and update data. The example of the query can be seen in figure 10 where the query is based on owner_no. Figure 7 shows result of the query together with the attributes of the registered 3D parcel object.

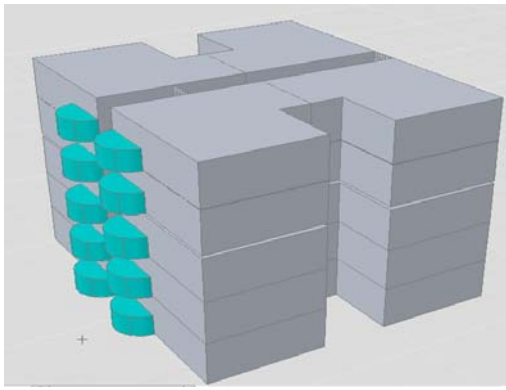

Figure 5: Visualization of 3DParcel in CAD

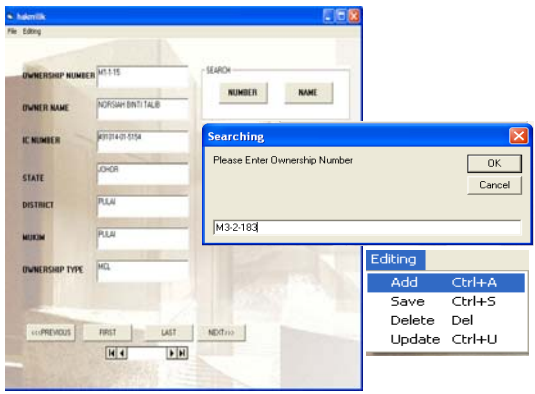

Figure 6: Interface for query the registered 3D Cadastre object

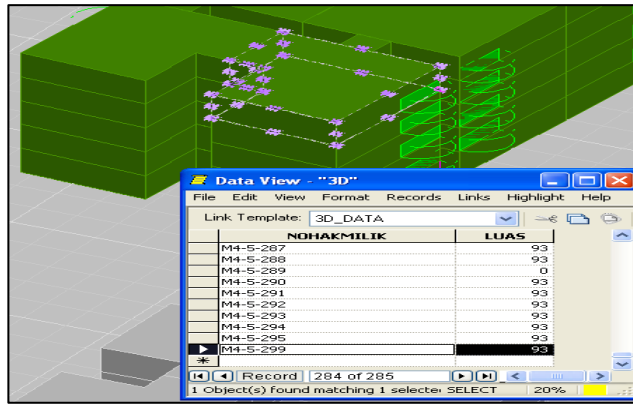

Figure 7: Result from the query with the attribute information

4.0 CONCLUDING REMARKS

From the foregoing discussions it can be realized that the Integrated 3D Cadastre Model introduce in this paper which is basically expanded from the CCDM model can be realize on the big scale of 3D cadastre object registration for Malaysia. Three main classes in CCDM namely RegisterObject, Person and RRR have been transformed to suit with Malaysian cadastre system. In the proposed registration model, new class namely 3D parcel has been derived from RegisterObject to hold 3D objects. The 3D parcel spatial is bound within 2D geometry and 3D information. The registration of 3D objects is validated in the geo-DBMS. Oracle Spatial was used to store the cadastre dataset. The 3D object registered in the Oracle Spatial DBMS then been queried using the simple interface and the both spatial and attribute information was displayed using Map 3D software. Beside, simple data updating function been developed on the query tool interface. This paper does not focus on the cross boundary object registration. The detail experiment on the mentioned problems will be carried out

in the very near future and certainly a prototype of 3D cadastre that works with existing Malaysia cadastre framework is our next task.

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