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VISUAL REPRESENTATION OF GEOGRAPHIC OBJECTS IN 3D SPACE AT LEVELS OF DIFFERENT DETAILS

Pham Van Dang[1], Tran Vinh Phuoc[2], Huynh Ngo Phuoc Tuyen[3]

[1]Faculty of Information Technology, Nguyen Tat Thanh University, Ho Chi Minh, Vietnam

[2]Thu Dau Mot University, Binh Duong, Vietnam

[3]FUNiX University, Hanoi, Vietnam

[1]pvdang@ntt.edu.vn, [1]pvdang.tps@gmail.com, [2]phuoc.gis@gmail.com, [3]hnptuyen@gmail.com

ABSTRACT: *Increasing of population very fast makes the urban architecture more and more become overload, which will lead to increase the positive and the negative sides in the residential community. Urban management stage is becoming increasingly urgent. We need to manage many aspects and especially to be timely at all times. Each of objects is a close relationship with one another making multiple levels of detail and users can observe at different angles. This paper focuses on researching and developing visual representation model of geographic objects (people (Ps), buildings (Bs) and geospatial space (GSs)) along with the relationships (blood relationships (BRs), social relationships (SRs), previous conviction relationships (PCRs), previous offence relationships (PORs), and vital relationships (VRs)) in 3D space (GS3D) at levels of different details (DLOD), which serves the protection of security and order of the social and safety in the area, it was called VRO-DLOD3D data model. This new model was installed on database management system of Oracle, used type of spatial data of Oracle and combined with the C# programming language to present data in the forms via some typical queries and finalized experimental results showing that it can be applied to the population data management system.*

Keywords: *Data model, Spatial Database, DLOD, GS3D, and VRO-DLOD3D.*

I. INTRODUCTION

Nowadays, the rapid population growth has made the urban architecture more and more become overload (Fig. 1) and bring about the strong development both in quality and quantify for society. This cause also leads to increase the positive and the negative sides in the residential community [2]. Be aware of this importance and the necessary of management of geographic objects (Ps, Bs, and GSs) along with the relationships (BRs, SRs, PCRs, PORs, and VRs) in GS3D to provide information to be timely for all levels of government make decision and especially to be timely to provide information, which serves the protection of security and order of the social and safety in the area. In which, geographic objects (GOs) are the objects in 3D space. Afterwards when developing temporal geography, GOs are space - time objects. Thus, GOs are generally called objects.

Fig. 1. An illustration of overload the urban architecture

There are the GOs such as Ps, Bs and GSs. In which, Ps who are living in a territory; Bs is the place where Ps live and work and is also the place where relationships happens and are located in GSs; GSs is the place where Bs and Ps reside, GSs is understood in two respects, one is human imposed, other is created by creator [2, 3].

There are the relationships including as BRs, SRs, PCRs, PORs, and VRs. In which, a person was born into a family (clan) must have ancestry, grandparents, parents, siblings, etc., called BRs; a D person and other members attend a meeting, a seminar, etc., called SRs; a person who called PORs when they are criminal violations of law in the warning, administrative penalties, the court was not guilty and are located in the area of law being followed; a person called PCRs when they are criminal violations of law and are convicted by a court. These mentions took place in space and time determined [2, 3].

Relationships management of objects in the residential community is most complex and is a major challenge for all levels of government. The paper presents to study the theory of national database of the population and existing 3D GIS data model and propose a new data model; it has the ability to representing visualization of detailed levels for objects along with the relationships in GS3D. The paper presents overview of the space – time – semantic – population data models that proposed in the last, tables are comparison both the data models over criteria and proposed a new data model. After, having comparison tables, we showed the limitations of a known data model, which is premise for the other data model was born that serves for the purposes particularly.

Structure of paper including: part I, it presents generalized and important in objects management along with the relationships. Part II, overviews of the space - time - semantics - population data models have been proposed in the last, tabulated tables comparison of the data models over specific criteria and proposed a new data model. Part III, it presents the concepts of data model, researching and developing visual representation model of geographic objects in GS3D at DLOD, which serves the protection of security and order of the social and safety in the area, it was called new VRO-DLOD3D data model. Part VI, this new model was installed on database management system of Oracle, used type of spatial data of Oracle and combined with the C# programming language to present data in the forms via some typical queries. Part V, presents of conclusion, evaluate experiments and proposed direction of development in the future.

II. THE DATA MODELS

A. OVERVIEW OF THE SPACE – TIME – SEMANTICS – POPULATION DATA MODELS

There are some models of space–time–semantics–population data proposed by the researchers in the past that are summarized in the following paper.

UDM (Urban Data Model) was a model of spatial data proposed by Coors in 2003 [1] based on four basic objects POINT, LINE, SURFACE, BODY. UDM uses two elemental objects NODE, FACE. ARC isn't proposed in this model. Each FACE is defined by 3 NODE, so the model reduces some NODE-ARC, ARC-FACE relationships. Some topology relationships such as NODE are on FACE, NODE in BODY is not described. The obvious advantage of the UDM is the efficient data storage, the object-oriented analysis which is used urban management applications and representation of faces and blocks based on triangulation.

ELUDM (Enhanced Levels of detail Urban Data Model) was a model proposed by Pham Van Dang and coworkers in 2011 [4]. These authors have proposed the addition of LOD (Levels of Detail) and complex links between Surface, Line, Point and LOD to the ELUDM to serve visual representation of 2.5D objects at multiple different levels. User defines the number of levels. The diversity of the visualizing will respond the requirements of different applications. This approach can extend for LOD of objects 3D that not depend on semantic.

TUDM was a model of 4D spatial - temporal data proposed by Nguyen Gia Tuan Anh and coworkers in 2012 [6]. These authors have focused on developing a time dimension to integrate into the known 3D GIS space model. The time dimension in TUDM can be a time or a time period. The birth and extinction time of an object in TUDM can either be in the real world or be recorded in the database. TUDM can represent and store not only the evolutionary history of 0D, 1D, 2D objects but also the life cycle of 3D objects.

TSUDM (Temporal and Semantic Urban Data Model) was a model proposed by Pham Van Dang and coworkers in 2015 [3]. TSUDM focuses on spatial, temporal and semantic data management in which spatial data record the shape, size and location of spatial objects. Time data records the time of formation and loss of space objects. TSUDM is capable of storing the history of spatial transformations of space objects (apartments, roads, fields, houses, grounds, light lamp, bridges) over time and semantics. In addition, TSUDM also has the ability to query over time, semantically; query space over time and semantics; has the ability to find ancestors and find descendants of space objects.

TPS (Time - Population - Space Data Model) was a model proposed by Pham Van Dang and coworkers in 2016 [2]. TPS focuses on the management of population data along with relationships (BRs, SRs, PCRs, PORs, and VRs) over space and time. TPS is also capable of managing people activities at the place of residence, place of work, location of relationships and other information that changes in space and time to support information for the protection of security and social order and safety in the area. In that, the spatial layer is used to manage the location, shape and size of the house, where people relationships take place at the place of residence, place of work and location of the termites relation; Time class has: time data records the beginning and end of relationships and information about people change. Time plays an important role in keeping track of people relationships. Based on the time factor, people can intervene in time to deal with urgent issues and to see things become clearer; the population class contains: resident data record of relationships, resident population, temporary residence, residence and other basic people information. Consequently, the population plays a very important role in the organization of data storage classes for the population. To answer what that relationships is? Who was involved in that relationship, along with the location of the relationships at that time? To answer the time – people – relationships - position. Also from this class can answer the blood relation (genealogy) of any person.

B. THE TABLE OF COMPARISON BETWEEN THE DATA MODELS

Through the integrated analysis of spatial-temporal-semantic-residential data models proposed by researchers in the past, the paper is reviewed in Section II.A. What characteristics are there in these models? And then extract the general criteria on the models and make three comparisons between these models.

Table 1. The table of comparison between the data models according to criterions: application, main entities, auxiliary entities, and basis of model

Name of Models	Application	Main Entities	Auxiliary Entities	Basis of Model
UDM	Urban management 3D	Point, Line, Surface, Body	Node, Triangle	Triangulation
ELUDM	Urban management 2.5D	Point, Line, Surface, LOD	Node, Triangle	Triangulation
TUDM	Urban management 3D	Point, Line, Surface, Time	Node, Triangle	Triangulation, showing good surface, data size is small
TSUDM	Historical evolution management of spatial objects over space, time and semantic	Point, Line, Surface, Body, Time, Semantic	Node, Triangle	Triangulation, showing good surface, data size is small
TPS	Population data management over space and time	Point, Line, Surface, Body, Time, Population, Relationships	Node, Triangle	Triangulation, showing good surface, data size is small

Table 2. The table of comparison between the data models according to criterions: representation of external face (REF), representation of internal face (RIF), and representation of detailed levels (RDL)

Name of Models	REF	RIF	RDL
UDM	Triangulation	No	No
ELUDM	Triangulation	Yes	Yes
TUDM	Triangulation	Yes	No
TSUDM	Triangulation	Yes	No
TPS	Triangulation	Yes	No

Table 3. The table of comparison between the data models according to criterions: storage of spatial data (SSD), storage of temporal data (STD), and storage of residential data (SRD)

Name of Models	SSD	STD	SRD
UDM	Triangulation	No	No
ELUDM	Yes	No	No
TUDM	Yes	Yes	No
TSUDM	Yes	Yes	No
TPS	Yes	Yes	Yes

C. TO PROPOSE A NEW DATA MODEL

Through the three tables (Tables 1, 2 and 3) in Section II.B, making a comparison between the data models according to the specific criteria, we find that the limitation of this model is the premise for tissue another model was born. In general, these models focus on the management and exploitation of spatial, temporal, semantic, residential and relationships objects. However, looking objectively, we find that with a society that is strong in both quality and quantify, the positive and negative aspects of the community are increasingly evident. For example, we look at an extortion incident (Fig. 2), the prey was robbed into a home in a real location in a GS3D, the extortioner has filmed and photographed to send the prey's family for ransom, but the extortioner doesn't think this photo revealing information that police can find where they hostages are. This example is an evidence showing the necessity of visual representation detailed levels for objects along with their relationships in a GS3D.

Fig. 2. (Picture on the left: There is one hostage; Picture on the right: There are two hostages) An illustration of the hostage who is kidnaped for a ransom (A picture excerpted from the film "Dangerous Instinct", movies of Vietnam)

From the extortion incident above (Fig. 2) tells us the importance of prevention and criminal hunting. Thus, the visual representation of the levels of detail of the objects together with the relationships is very necessary. The paper proposes to study and develop a visual representation model of geographic objects in GS3D together with relationships at DLOD and a new model called VRO-DLOD3D.

III. VRO-DLOD3D DATA MODEL

1. *THE CONCEPTIONS*

Each object has a close relationship with each other to create DLOD. At DLOD exist in the GS3D that is very important in practice used to observe and track down traces. The authorities, in particular the police, need to collect detailed information of the objects and relationships to serve the investigation, protection of security and social order and safety in their territory. In addition, users can view at DLOD and at different angles to respond specific purposes. They are shown in the following aspects:

- At DLOD shown clearly the objects along with: <BRs, SRs, PCRs, PORs, and VRs> how happened.

Within the scope of the paper, we propose the concept "At different detailed levels of every object along with relationships in GS3D" and develop into a class called CLOD: "Different detailed levels class of objects along with relationships in GS3D (CLOD)". CLOD is capable of detailed recording and describing changes of objects along with relationships in GS3D. Indeed, the CLOD will be applied in various occupational sectors for specific practical uses, particularly in terms of security in the territory.

2. *VRO-DLOD3D DATA MODEL*

VRO-DLOD3D data model is composed of four classes, including the spatial class, the population class, the relationships class, and the class of detail levels. Thus, VRO-DLOD3D is able to visually represent objects at DLOD along with relationships in GS3D. We see an example illustrating the visual representation for six DLOD (Fig. 3).

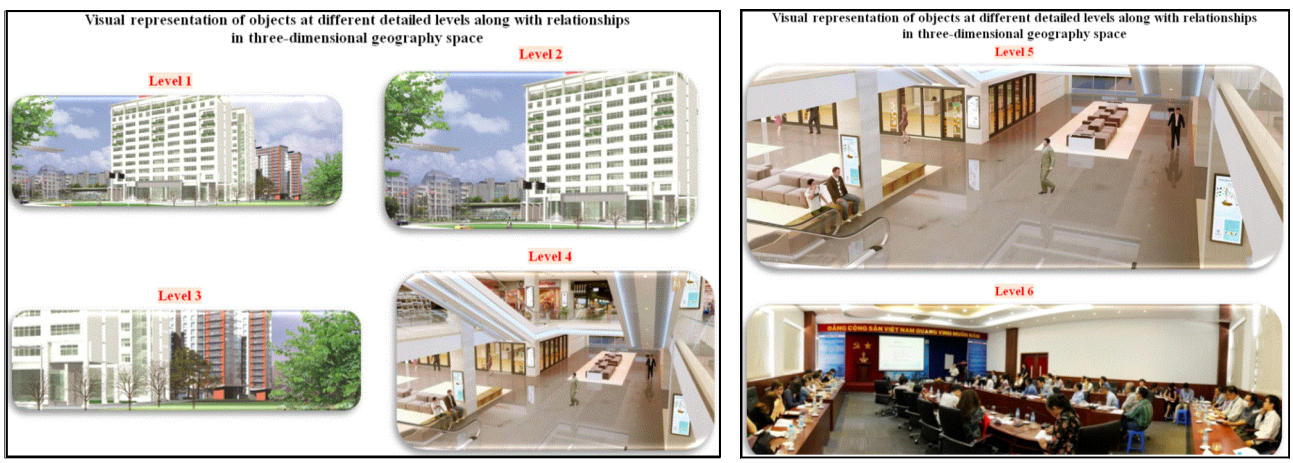


Fig. 3. Demonstration visual representation of objects at 6 DLOD along with "social relationships" in GS3D

The goal of VRO-DLOD3D is to satisfy the following criteria:

- Visual representation of spatial detailed levels (location + shape of the house) where people live and work (including living locations, working locations, and happening locations of the relationships at detailed levels) [2].
- Visual representation of spatial detailed levels (location + shape of the house) + people.
- Visual representation of spatial detailed levels (location + shape of the house) + people + relationships.
- Visual representation of spatial detailed levels (location + shape of outside the room) + people + relationships.
- Visual representation of spatial detailed levels (location + shape of inside the room) + people + relationships.

Spatial class (CSpace) records the shape, size, and location of spatial objects [3]. VRO-DLOD3D uses entities in UDM [1], TSUDM [3], and TPS [2] models, which include: line, point, node, face, surface, body, bodytype, surfacetype, house. The spatial objects need to solve the problem including: building and apartment building or blocks of flats are collectively called Building. The building is where people live and work, and also where the relationships take place. A building is a 3D block, defined as a set of constituent bodies, in which these blocks may contain more complex subforms such as: complex shape, prismatic form (Prism shape), etc. In addition to these blocks, the building can also contain special geometric objects such as line, point, surface, etc. A building has DLOD, because of this nature, we can represent them at DLOD, known as DCLOD in GS3D. The building consists of semantic properties such as house code, house number, street name, wards/commune/town/ hamlet/village, district and province, housing grade, number of floors, construction area, floor area, owner's code, ID card/personal identification number (ID), owner's name, date of birth, and gender.

Population class (CPopulation) records the population including: residence, temporary residence, staying and other basic people information (name, sex, date of birth, ID card, etc.) [2][3]. VRO-DLOD3D uses entities in the TPS model [2], entities include: people, full name, year of birth, place of birth, sex, hometown, nationality, ethnicity, image, identity card, residence, temporary residence, staying.

The relationships class (CRelationship) records relationships such as BRs, SRs, PCRs, PORs, and VRs. VRO-DLOD3D uses entities in the TPS model [2], which includes: BRs, SRs, PCRs, PORs, and VRs.

The levels of detail class (CLOD) records the DLOD for objects and relationships in GS3D. The CLOD class consists of attributes: IDCLOD is a detailed level of code description, NAME is a detailed level of name, and DESC is the descriptions needed for each IDCLOD. CLOD incorporates CSpace + CPopulation + CRelationship classes into the VRO-DLOD3D data model, which is capable of visually representing multiple objects at DLOD in a GS3D (Fig. 4).

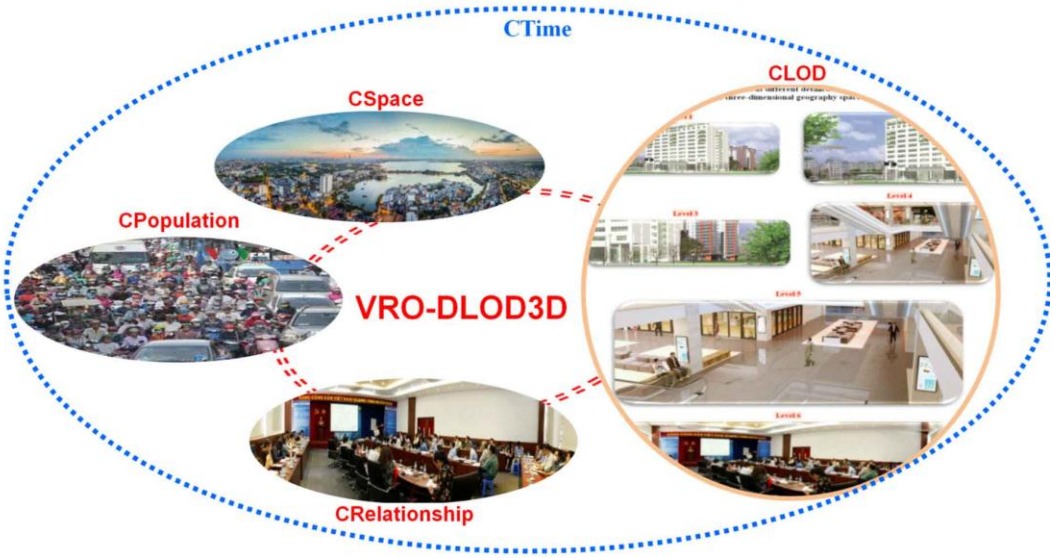


Fig. 4. Demonstration a 4-layer combination CSpace + CPopulation + CRelationship + CLOD for VRO-DLOD3D

As we have seen, today population growth will bring about the demand for urbanization becoming more urgent, the high-rise buildings and other types of buildings with a richly structured design and beautiful. Therefore, this is a big challenge for scientists, how they can perform it in the computer. This paper proposes a structural design approach to the building as follows: Use body blocks (including: Body Parents (BPs), Body Children (BCs)), Surface (Ss), Triangle (Ts), Line (Ls), points Point (Ps) to represent high-rise buildings and includes People (PPs) inside. The Objects (BPs, BCs, Ss, Ts, Ls, Ps, and PPs) of a BT1 mansion can be displayed at different DLOD detail levels. A DLOD level can have a lot of 3D, 2.5D, 2D, 1D, and 0D of Objects for a BT1 mansion, table 4 shows us such a representation and depends on the needs of the user. How these objects will display at what level. From here, the paper proposes a four-layer combination CSpace + CPopulation + CRelationship + CLOD to obtain a new data model, the new data model called VRO-DLOD3D (Fig.5). In which, VRO-DLOD3D is capable of representing spatial, populated, and relationships at DLOD in GS3D.

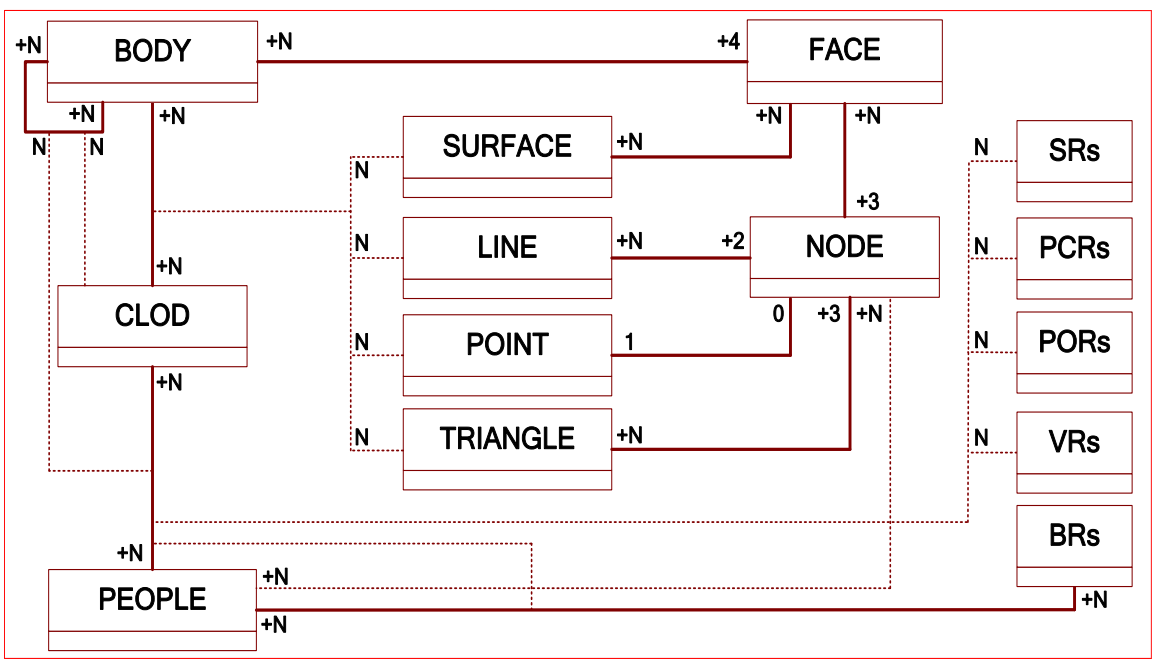
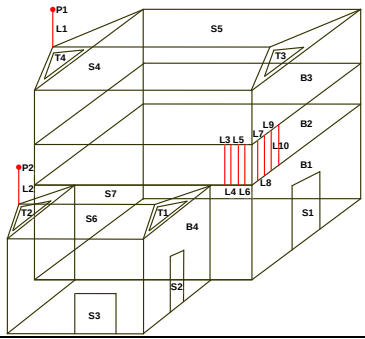
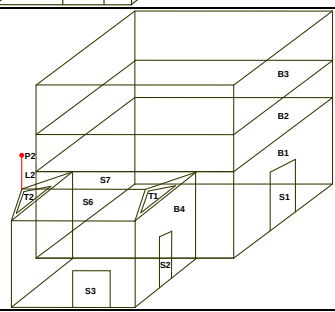
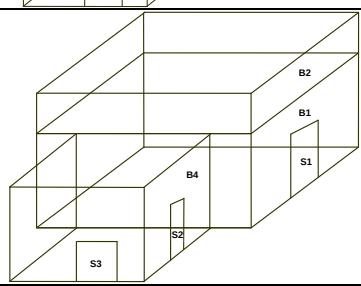
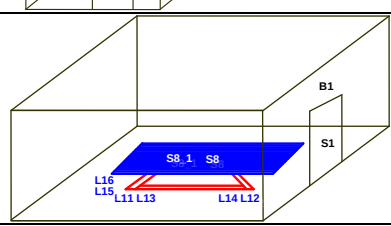
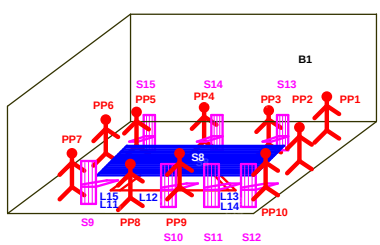
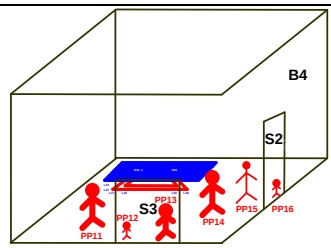


Fig. 5. VRO-DLOD3D data model

An illustration for VRO-DLOD3D on CLOD has showed the following (Table 4):

Table 4. A BT1 block (villa) is displayed at six levels of different details and accompanied the performance BT1 in the database

CLOD	PICTURES OF BT1	REPRESENTATION BT1 IN THE DATABASE						
		BPs	BCs	Ss	Ts	Ls	Ps	PPs
1		BT1	B1 B2 B3 B4	S1 S2 S3 S4 S5 S6 S7	T1 T2 T3 T4	L1 L2 L3 L3 L4 L5 L6 L7 L8 L9 L10	P1 P2	
2		BT1	B1 B2 B3 B4	S1 S2 S3 S6 S7	T1 T2	L2	P2	
3		BT1	B1 B2 B4	S1 S2 S3				
5		BT1	B1	S1 S8 S8_1		L11 L12 L13 L14 L15 L16		
6		BT1	B1	S8 S9 S10 S11 S12 S13 S14 S15		L11 L12 L13 L14 L15 L16		PP1 PP2 PP3 PP4 PP5 PP6 PP7 PP8 PP9 PP10
7		BT1	B4	S2 S3 S16		L17 L18 L19 L20 L21 L22		PP11 PP12 PP13 PP14 PP15 PP16

Decomposition of VRO-DLOD3D data model (Fig. 5) has given us the relations the following (Table 5):

Table 5. Detailed description table of the relations of VRO-DLOD3D data model

No.	Relations	Attributes	Meaning of Using
1	BODY	#Idb, Desc	Describes a body with a code and a description column on the Body.
2	CLOD	#Idclod, Name, Desc	Describes a CLOD with a code, a CLOD name, and a detailed description column for this CLOD.
3	BODYCLOD	#Idbp, #Idbc, #Idclod	Describes a body that can be used to display at DLOD for an object A. An object A has many bodies used like that.
4	SURFACECLOD	#Idbp, #Ids, #Idclod	Describes a surface that can be used to display at DLOD for an object A. An object with multiple surfaces is used.
5	LINECLOD	#Idbp, #Idl, #Idclod	Describes a line that can be used to display at DLOD for an object A. An object A has multiple lines used like that.
6	POINTCLOD	#Idbp, #Idp, #Idclod	Describes a point that can be used to display at DLOD for an object A. A Multiple Point Object is used as such.
7	PEOPLE	#Idpp, Firstname, Lastname, Birthday, Sex, Pob	Describes a people who has a code, Firstname, Lastname, Birthday, Sex, and POB (Place of Date).
8	PEOPLECLOD	#NoO, #Idbp, #Idbc, #Idpp, Idsrs, Idpcrs, Idpors, Idvrs, Idclod, Desc	Describes a people can appear at DLOD for an object A. An object with multiple people appears like that.
9	PEOPLECLODBRs	#NoO, #Idbp, #Idbc, #Idpppar, #Idppchil, Idbrs, Idclod, Desc	Describes a person having a blood relation that appears at DLOD for an object A. An object A has many People who have the same blood relation.
10	BRs	#Idbrs, Name, Desc	Describes a BRs with a code, column name, and a descriptive column for BRs.
11	SRs	#Idsrs, Name, Desc	Describes a SRs with a code, column name, and a descriptive column for SRs.
12	PCRs	#Idpcrs, Name, Desc	Describes a PCRs with a code, column name, and a descriptive column for PCRs.
13	PORs	#Idpors, Name, Desc	Describes a PORs with a code, column name, and a descriptive column for PORs.
14	VRs	#Idvrs, Name, Desc	Describes a VRs with a code, column name, and a descriptive column for VRs.
15	NODE	#Idn, x, y, z	Describes a NODE with a code and 3 coordinates X, Y, Z.
16	LINE	#Idl, Desc	Describes a Line with a code and a column describing the Line.
17	LINENODE	#Idl, #Idn, Seq	Describes a Line that has a code and is generated by Nodes, each with a Node in order SEQ.
18	POINT	#Idp, Desc, Idn	Describes a Point with a code and a descriptive column for Point.
19	SURFACE	#Ids, Desc	Describes a Surface with a code and a descriptive column for Surface.
20	FACE	#Idf, Desc	Describes a Face with a code and a descriptive column for Face.
21	FACENODE	#Idf, #Idn, Seq	Describes a Face that has a code and is generated by Nodes, each with a Node in order SEQ.
22	SUR_FACE	#Ids, #Idf, Desc	Describes each surface that is not a polygon represented by a set of faces.
23	BODYFACE	#Idb, #Idf, Desc	Describes non-cylindrical, pyramidal, conical, cylindrical, prismatic blocks representing the triangles of the surface.
24	TRIANGLE	#Idt, Idn1, Idn2, Idn3	Describes a triangle with a code and 3 nodes to form three vertices of the triangle.
25	TRIANGLELOD	#Idbp, #Idt, #Idlod	Describes a triangle that can be used to display at DLOD for an object A. An object with multiple triangles is used.
Notation: # is primary key			

Table 6. Representation the data of BT1 villas in BODYCLOD, SURFACECLOD, LINECLOD, POINTCLOD, TRIANGLECLOD, PEOPLECLOD, and PEOPLECLODBRs tables.

BODYCLOD		
#IDBP	**#IDBC**	**#IDCLOD**
BT1	B1	1
BT1	…	1
BT1	B4	1
BT1	B1	2
BT1	…	2
BT1	B4	2
BT1	B1	3
BT1	B2	3
BT1	B4	3
BT1	B1	4
BT1	B4	4
BT1	B1	5
BT1	B1	6
BT1	B4	7

SURFACECLOD		
#IDBP	**#IDS**	**#IDCLOD**
BT1	S1	3
BT1	S2	3
BT1	S3	3
BT1	S1	4
BT1	S3	4
BT1	S1	5
BT1	S8	5
BT1	S8	6
BT1	…	6
BT1	S14	6
BT1	S2	7
BT1	S3	7
BT1	S16	7

LINECLOD		
#IDBP	**#IDL**	**#IDCLOD**
BT1	L11	6
BT1	…	6
BT1	L15	6
BT1	L16	7
BT1	…	7
BT1	L20	7
BT1	L21	7

POINTCLOD		
#IDBP	**#IDP**	**#IDCLOD**
BT1	P1	1
BT1	P2	1
BT1	P2	2

TRIANGLECLOD		
#IDBP	**#IDT**	**#IDLOD**
BT1	T1	1
BT1	T2	1
BT1	T3	1
BT1	T4	1
BT1	T1	2
BT1	T2	2

LINECLOD		
#IDBP	**#IDL**	**#IDCLOD**
BT1	L1	1
BT1	…	1
BT1	L10	1
BT1	L2	2
BT1	L11	5
BT1	…	5
BT1	L15	5

PEOPLECLOD								
#NoO	**#IDBP**	**#IDBC**	**#IDPP**	**IDSRs**	**IDPCRs**	**IDPORs**	**IDVRs**	**IDCLOD**
1	BT1	B1	PP1	SRs	null	null	null	6
1	BT1	B1	…	SRs	null	null	null	6
1	BT1	B1	PP10	SRs	null	null	null	6

PEOPLECLODBRs						
#NoO	**#IDBP**	**#IDBC**	**#IDPPpar**	**#IDPPchil**	**IDBRs**	**IDCLOD**
1	BT1	B4	PP11	PP12	BRs	7
1	BT1	B4	…	…	BRs	7
1	BT1	B4	PP16	PP13	BRs	7

The VRO-DLOD3D data model is capable of querying Objects, Relationships, and CLOD represented by the following eight queries.

Query 1: Find and display the villa "BT1" at the given levels CLOD = x (x: 1, 2, 3, 4, 5, 6, and 7), the display information includes: the shape of mansion (The inside shape of room + the inside objects of room) + People + relationships at detailed levels CLOD = x (x: 1, 2, 3, 4, 5, 6, and 7).

Query 2: Find and display the villa "BT1" at the given levels CLOD = x (x: 1, 2, 3, 4, 5, 6, and 7), the display information includes: the shape of objects+relationships at detailed levels CLOD = x (x: 1, 2, 3, 4, 5, 6, or 7).

Query 3: Find and display Body Children and CLOD corresponding to IDBP = b, the display information includes: the shapes of Body Children + CLOD detailed levels at an IDBP (the code of Body parent) = b certain.

Query 4: Find and display blood relationships at detailed levels CLOD = 7, the display information includes: the inside shape of room + the inside objects of room + people + blood relationships.

Query 5: Find and display the villa "BT1" and social relationships at detailed levels CLOD = 6, the display information includes: the inside shape of room + the inside objects of room + people + social relationships.

Query 6: Find and display previous conviction relationships at detailed levels CLOD = x (x: 1, 2, 3, 4, 5, 6 or 7), the display information includes: the inside shape of room + the inside objects of room + people + previous conviction relationships.

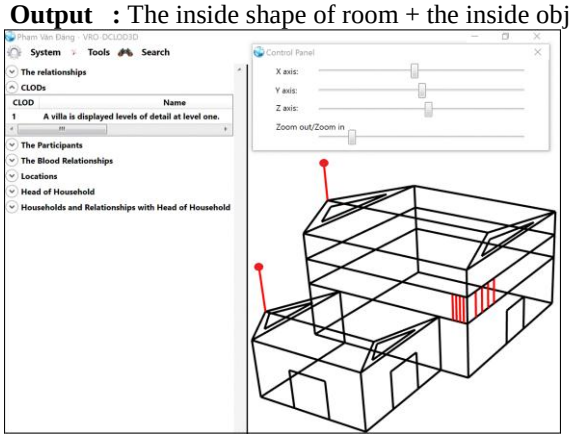
Query 7: Find and display previous offence relationships at detailed levels CLOD = x (x: 1, 2, 3, 4, 5, 6 or 7), the display information includes: the inside shape of room + the inside objects of room + people + previous offence relationships.

Query 8: Find and display vital relationships at detailed levels CLOD = x (x: 1, 2, 3, 4, 5, 6 or 7), the display information includes: the inside shape of room + the inside objects of room + people + vital relationships.

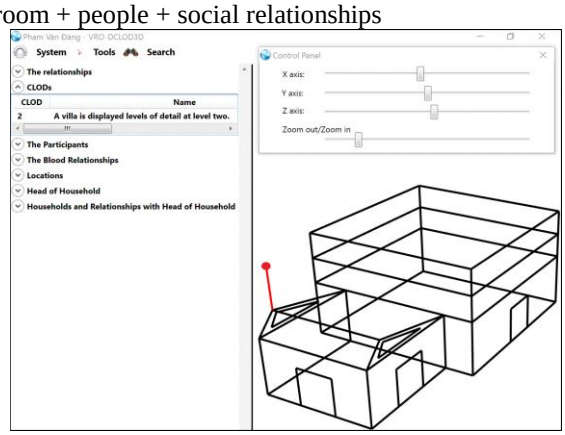
IV. EXPERIMENTS

Through analyzations and recommendations in Part III, the paper combined four layers of CSpace + CPopulation + CRelationship + CLOD to obtain a new data model, the new model called VRO-DLOD3D. In this section, we use the Oracle 11G database administration system [8, 9] to install the VRO-DLOD3D data model and use the Oracle 11G spatial data type to store spatial data, this spatial data type makes the display time of 3D buildings in GS3D faster and co-ordinate with the C# programming language [2, 3, 4, 5, 6, 7] developing visual representation applications for objects of 3D, 2.5D, 2D, 1D, 0D and People at DLOD along with the relationships in GS3D. In there, each form is described by two parameters: input parameters and output parameters.

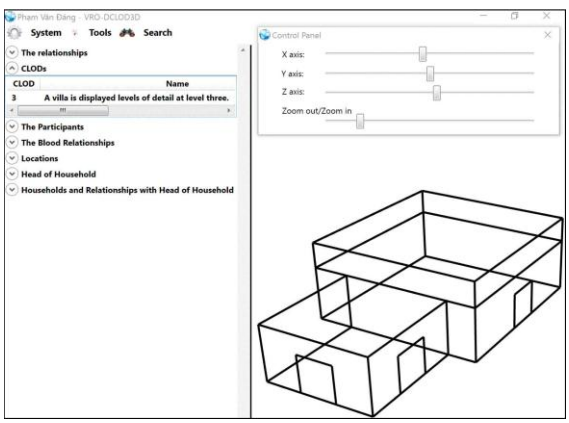
Form 1: Find and display the villa "BT1" at the given levels CLOD = x (1, 2, 3, 5, 6, and 7), using query 1 (Fig 6…11)
Input : ID of the villa "BT1" and ID of CLOD (x = 1, 2, 3, 5, 6, and 7)
Output : The shape of mansion (The inside shape of room + the inside objects of room) + People + relationships
Form 2: Find and display the villa "BT1" and blood relationships at the given levels CLOD = 7, using query 4 (Fig 11)
Input : ID of the villa "BT1" and ID of CLOD = 7
Output : The inside shape of room + the inside objects of room + people + blood relationships
Form 3: Find and display the villa "BT1" and social relationships at the given levels CLOD = 6, using query 5 (Fig 10)
Input : ID of the villa "BT1" and ID of CLOD = 6
Output : The inside shape of room + the inside objects of room + people + social relationships



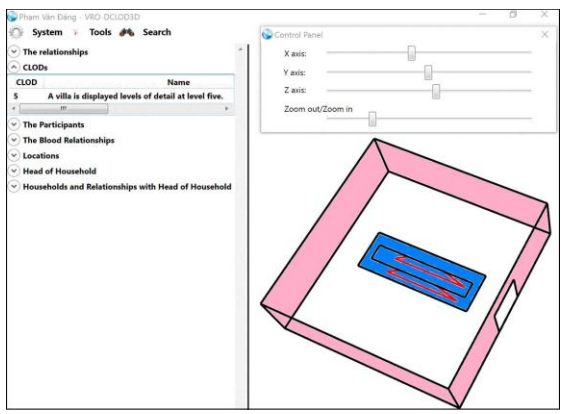
Expression of the villa "BT1" at CLOD = 1



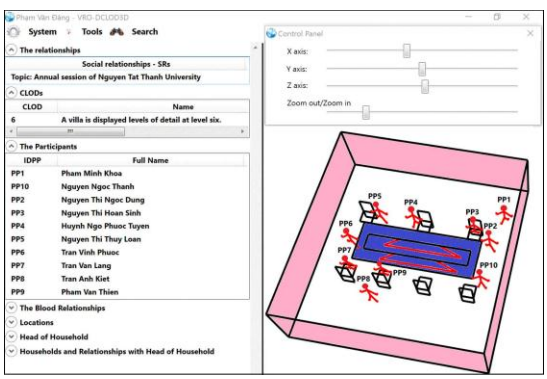
Expression of the villa "BT1" at CLOD = 2



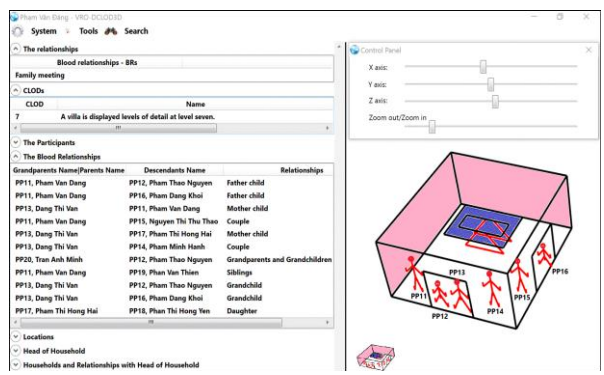
Expression of the villa "BT1" at CLOD = 3



Expression of the villa "BT1" at CLOD = 5



Expression of the villa "BT1" at CLOD = 6



Expression of the villa "BT1" at CLOD = 7

V. CONCLUSION

This paper presents an overview of the data models (space, time, semantics, and population) proposed by researchers in the past, and then compiles three comparisons of data models what characteristic there are, next, extracts the common criteria among these models as a premise for the proposed new data model. Through the above analyses, we focus on building the CSpace class, the CPopulation class, the CRelationship class, and the CLOD class, then combine the four CSpace + CPopulation + CRelationship + CLOD classes to obtain a new data model. This new data model called VRO-DLOD3D (Fig. 5). The VRO-DLOD3D has opened a new way of supporting the method of storing data space - population - relationships at DLOD. VRO-DLOD3D is not only capable of querying space, population, and relationships at DLOD but also the ability to find genealogies (including objects: space and people) at DLOD. Finally, the experimental results on the three typical queries on visual representation of objects at DLOD along with the relationships in GS3D are urgent and extremely important in assistance enforcement agencies in crime detection and planning for urban development policies in future. In addition, the VRO-DLOD3D data model needs to be developed to co-ordinate time into class clustering objects and relationships over time in GS3D to serve multiple contexts.

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BIỂU DIỄN TRỰC QUAN CÁC ĐỐI TƯỢNG ĐỊA LÝ TRONG KHÔNG GIAN 3 CHIỀU TẠI NHỮNG MỨC CHI TIẾT KHÁC NHAU

Phạm Văn Đăng, Trần Vĩnh Phước, Huỳnh Ngô Phước Tuyền

TÓM TẮT: *Dân số gia tăng nhanh chóng đã làm cho kiến trúc đô thị ngày càng trở nên quá tải, nguyên nhân này dẫn đến gia tăng những mặt tích cực và tiêu cực trong cộng đồng dân cư. Công tác quản lý đô thị ngày càng trở nên cấp bách. Chúng ta cần phải quản lý nhiều khía cạnh và nhất là phải kịp thời mọi lúc mọi nơi. Mỗi đối tượng đều có mối quan hệ khăng khít với nhau tạo thành nhiều mức chi tiết và sẽ giúp cho người dùng có thể quan sát ở các góc nhìn khác nhau. Bài báo này tập trung vào nghiên cứu và phát triển mô hình biểu diễn trực quan các đối tượng địa lý (con người, tòa nhà và không gian địa lý) cùng với các mối quan hệ (quan hệ huyết thống, quan hệ xã hội, quan hệ tiền án, quan hệ tiền sự và quan hệ sinh tử) trong không gian 3 chiều tại những mức chi tiết khác nhau, phục vụ cho công tác bảo vệ an ninh và trật tự an toàn xã hội trên địa bàn, mô hình mới có tên gọi là VRO-DLOD3D. Mô hình mới này được cài đặt trong hệ quản trị cơ sở dữ liệu Oracle, sử dụng kiểu dữ liệu không gian của Oracle và kết hợp với ngôn ngữ lập trình C# để trình bày dữ liệu bằng các biểu mẫu thông qua một số câu truy vấn điển hình và sau cùng các kết quả thực nghiệm cho thấy có thể áp dụng vào hệ thống quản lý dữ liệu dân cư.*