Development of Structure-based Topology of 3D Spatial Databases for Storing and Querying 3D Cadastre Cases

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Utilization of Space

- 2D representation for 3D objects registration:
  Appartment registration only, below and top of the land surface has not been regulated

Current Situation on 3D registration in Indonesia

3D registration needs effective 3D spatial databases

The Law on Apartment in 2011

Apartment

3D Cadastre
Visualization

3D Spatial Database

- Hypothesis
- To increase data quality and data consistency
- Execution time of spatial operation faster
Data

- Spatial Data of Rusun Plasa Simpanglima Semarang.
  - 3D coordinates \((X, Y, Z)\)
  - Format: CAD
  - Reference Coordinate System: Universal Transverse Mercator (UTM)
  - Survey Instrument: Total Station (TS) Leica reflectorless TCR805
  - Years of Measurement: 2011

- Attribute Data of Rusun Plasa Simpanglima Semarang
Phases of the Data Analysis

1. Spatial Data Editing
2. Spatial Data Storing into PostgreSQL
3. Creating Tables and Updating the Database Attribute
4. Development of the Topology-Based Structure
5. Analyses

1. Spatial Data Editing... (I)
1. Spatial Data Editing ... (II)

First Floor of the Rusun Plasa Simpanglima
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1. Boundary Parcel
2. Rooms

1. Spatial Data Editing ... (III)
I. Importing Spatial Data into KML Format

II. Conversion KML Format into PostgreSQL
2. Spatial Data Storing into PostgreSQL ... (III)

3. Creating Table and Updating Database Attribute
4. Development of the Topology-based Structure

Creating 2 topology schemas:
1. simpanglima_topo1
2. simpanglima_topo2

Creating topology table in public schema

Creating 2 topogeometry columns

Table in the topology schema:
1. Table of node
2. Table of edge_data
3. Table of face
4. Table of relation

Geometry data type: multilinestringz

each side of the room

Build the topology of:
- The top of the room
- The bottom of the room

Populating the topology schema

Populating the topogeometry column toTopoGeom function

Results
Topology-Based Structure Database ... (I)

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Topology-Based Structure Database ... (II)

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Topography-Based Structure Database ...

Table 1: Node Data

<table>
<thead>
<tr>
<th>node_id</th>
<th>containing_fe</th>
<th>geom</th>
<th>geometry(Po)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>01000000AE</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>2</td>
<td>01000000AE</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>3</td>
<td>01000000AE</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>01000000AE</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>5</td>
<td>01000000AE</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>6</td>
<td>01000000AE</td>
<td></td>
</tr>
</tbody>
</table>

Scratch pad

192 rows.

Topography-Based Structure Database ...

Table 2: Edge Data

<table>
<thead>
<tr>
<th>edge_id</th>
<th>start_node</th>
<th>end_node</th>
<th>next_left</th>
<th>abs_next_left</th>
<th>next_right</th>
<th>abs_next_right</th>
<th>left_face</th>
<th>right_face</th>
<th>geom</th>
<th>geometry(LineString)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>2</td>
<td>2</td>
<td>2</td>
<td>-9</td>
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<td>0</td>
<td>1</td>
<td>0102000000AE</td>
<td>77F00000020000</td>
</tr>
<tr>
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<td>2</td>
<td>3</td>
<td>3</td>
<td>9</td>
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<td>77F00000020000</td>
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<td>3</td>
<td>4</td>
<td>4</td>
<td>4</td>
<td>-2</td>
<td>01000000AE</td>
<td>2</td>
<td>1</td>
<td>0102000000AE</td>
<td>77F00000020000</td>
</tr>
<tr>
<td>4</td>
<td>4</td>
<td>5</td>
<td>5</td>
<td>-10</td>
<td>10</td>
<td>01000000AE</td>
<td>3</td>
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<td>77F00000020000</td>
</tr>
<tr>
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<td>5</td>
<td>6</td>
<td>6</td>
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<td>01000000AE</td>
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</tr>
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<td>8</td>
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<td>0</td>
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<td>0102000000AE</td>
<td>77F00000020000</td>
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<td>10</td>
<td>9</td>
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<td>2</td>
<td>0102000000AE</td>
<td>77F00000020000</td>
</tr>
<tr>
<td>10</td>
<td>10</td>
<td>1</td>
<td>5</td>
<td>5</td>
<td>-9</td>
<td>01000000AE</td>
<td>3</td>
<td>2</td>
<td>0102000000AE</td>
<td>77F00000020000</td>
</tr>
</tbody>
</table>
### Topology-Based Structure Database ...

#### (V)

<table>
<thead>
<tr>
<th>face_id</th>
<th>mbr</th>
<th>geometry</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>0</td>
<td>01030000020ED7F00000010000000050000000</td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>01030000020ED7F00000010000000050000000</td>
</tr>
<tr>
<td>3</td>
<td>2</td>
<td>01030000020ED7F00000010000000050000000</td>
</tr>
<tr>
<td>4</td>
<td>3</td>
<td>01030000020ED7F00000010000000050000000</td>
</tr>
<tr>
<td>5</td>
<td>4</td>
<td>01030000020ED7F00000010000000050000000</td>
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<td>5</td>
<td>01030000020ED7F00000010000000050000000</td>
</tr>
<tr>
<td>7</td>
<td>6</td>
<td>01030000020ED7F00000010000000050000000</td>
</tr>
</tbody>
</table>

65 rows.

---

### Topology-Based Structure Database ...

#### (VI)

<table>
<thead>
<tr>
<th>topgeo_id</th>
<th>layer_id</th>
<th>element_id</th>
<th>element_type_id</th>
<th>topology</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>5</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
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<td>1</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>7</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>8</td>
<td>1</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>9</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>10</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>11</td>
<td>2</td>
<td>1</td>
<td>2</td>
<td></td>
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<td>1</td>
<td>2</td>
<td></td>
</tr>
<tr>
<td>13</td>
<td>3</td>
<td>1</td>
<td>2</td>
<td></td>
</tr>
</tbody>
</table>

316 rows.
The relationship:

2.5 D Topological approach of PostGIS 2.0:
From 12 possible cases, 5 cases that can be resolved

**Case 1** : Shows the room which is directly adjacent to a specified room (in a horizontal direction).

**Case 3** : Indicate in which land parcel the room on the first floor was located.

**Case 5** : Inform rooms on the first floor that their entire room floor are above a certain land parcel.

**Case 7** : Mention rooms on the first floor which is above the two land parcels at once.

**Case 9** : Shows the line geometry that is the boundary of the wall directly adjacent to or shared with in a horizontal direction.
Case 1

Analyses of Real Cadastre Case ... (II) :: Resolving Case 1 ::

```
-- Menunjukkan ruang mana saja yang bersebelahan secara langsung di kiri, kanan, depan, -- maupun belakang ruang 001 (r_001) (arah horizontal)
select r_id as ruang
from (select st_asensh(st_topo) as p from topology where r_id = 'r_001') as a,
     (select r_id, st_asensh(st_topo) as q from topology where not r_id = 'r_001') as h
where st_overlaps(st_geo_fromensh(a,p), st_geo_fromensh(b,q))
```

Output pane

<table>
<thead>
<tr>
<th>ruang character varying(10)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1  r_002</td>
</tr>
<tr>
<td>2  r_003</td>
</tr>
<tr>
<td>3  r_004</td>
</tr>
</tbody>
</table>

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Case 3

Analyses of Real Cadastre Case ... (III) :: Resolving Case 3 ::

```
-- Menunjukkan di bidang sama tepatnya ruang 024 (r_024) pada lantai satu berada di atasnya
SELECT geom2.bt_id AS bidang_tanah
FROM (SELECT st_asewkb(s2_topo) AS topo WHERE r_id='r_024') AS geom1,
(SELECT bt_id, st_makepoly(st_addpoint(geom.g, st_startpoint(geom.g))) AS b
FROM (SELECT bt_id, bt_geoline AS g FROM bidang_tanah) AS geom2
WHERE st_contains(st_geomfromewkb(geom.b), st_geomfromewkb(geom.a))) AS geom3
```

Output pane

<table>
<thead>
<tr>
<th>bidang_tanah integer</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
</tr>
</tbody>
</table>

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Case 5

Analyses of Real Cadastre Case ... (IV) :: Resolving Case 5 ::

```
-- Menginformasikan ruang-ruang sama saja pada lantai satu yang keluar ruangan tersebut
-- berada di atas bidang tanah dengan bt_id adalah 2

select geom1.t_id as bidang_tanah
from (select t_id, st_asewkb(t2_topo) as a from topologi) as geom1,
     (select st_makepolygon(st_addpoint(geom, st_startpoint(geom, g))) as b
      from (select st_geoseline as g from bidang_tanah where bt_id = 2) as geom2)
where st_contains(st_geosfromewkb(geom2.a), st_geosfromewkb(geom2.a))
```
Case 7

Analyses of Real Cadastre Case ... (V) :: Resolving Case 7 ::
Analyses of Real Cadastre Case ... (VI) :: Resolving Case 9 ::
Analyses of Real Cadastre Case ... (VII) :: Resolving Case 9 ::

```
SELECT geom1 FROM tab1
```

Output pane:

```
geom1 text
1 LINESTRING Z (436434, 432879508 9227308.00282599 41.705, 436426, 549310549 922731.1)
2 LINESTRING Z (436426, 549310549 9227311.31197872 41.705, 436424, 948509122 9227307.1)
3 LINESTRING Z (436432, 832039771 9227304.17754396 41.705, 436424, 948509122 9227307.1)
```

OK. | Unix | Ln 1, Col 1, Ch 1 | 3 rows. | 297 ms ...

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Analyses of Real Cadastre Case ... (VIII) :: Resolving Case 9 ::

```
SELECT geom2 FROM tab2
```

Output pane:

```
geom2 text
1 LINESTRING Z (436434, 432879508 9227308.00282599 38.705, 436426, 549310549 9227311.3)
2 LINESTRING Z (436426, 549310549 9227311.31197872 38.705, 436424, 948509122 9227307.4)
3 LINESTRING Z (436432, 832039771 9227304.17754396 38.705, 436424, 948509122 9227307.4)
```

OK. | Unix | Ln 1, Col 1, Ch 1 | 3 rows. | 312 ms ...

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Analyses of Real Cadastre Case ... (IX) :: Resolving Case 9 ::

SQL Editor

```
SELECT geom3
FROM tab3;
```

Output pane

<table>
<thead>
<tr>
<th>geom3</th>
<th>text</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>LINESTRING (436432.832039771 9227304.17754396 41.705, 436432.832039771 9227304.177)</td>
</tr>
<tr>
<td>2</td>
<td>LINESTRING (436434.432879508 9227308.00282599 41.705, 436434.432879508 9227308.002)</td>
</tr>
<tr>
<td>3</td>
<td>LINESTRING (436426.549310549 9227311.31197872 41.705, 436426.549310549 9227311.311)</td>
</tr>
<tr>
<td>4</td>
<td>LINESTRING (436424.948509122 9227307.48678827 41.705, 436424.948509122 9227307.486)</td>
</tr>
<tr>
<td>5</td>
<td>LINESTRING (436424.948509122 9227307.48678827 41.705, 436424.948509122 9227307.486)</td>
</tr>
</tbody>
</table>

Analyses of Real Cadastre Case ... (X) :: Resolving Case 9 ::

3D Viewer

```
bapjan_bersama.x3d - Instant Player
```

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Conclusions

1. The topology-based data structure is not capable of describing the object as a whole space either as a solid or as a skeleton-shaped object.

2. 3D spatial database can provide information in relation to space (one space next to other space), indicate underlying land, inform the entire space above the ground plane, show a space located above two parcels, and exhibit adjacent spaces.

References ... (I)

- ______, 2011a, “Undang-Undang Nomor 20 Tahun 2011 tentang Rumah Susun”.
References ... (II)


References ... (III)

THANK YOU