IMPLEMENTATION OF A 3D GIS IN INTERNET ENVIRONMENT

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ABSTRACT:

With a growing availability of spatial data, a lot of detailed 3D city models are now accessible over Internet. Such models can include realistic 3D visualization, provide thematic information about city objects, supply users with some tools for data manipulation, i.e. routing, address search, etc. These models are more and more easy to access and manipulate due to the huge technological progress in terms of data storage, rendering and querying. However, there is no 3D GIS (Geographic Information System) analysis task available over Internet. Thus, the application of the 3rd dimension in Internet-based GIS, with rare exceptions, is restricted and limited to research work. With this intention, this work proposes a deployment of a 3D GIS platform over Internet allowing a dynamic creation of datasets through a set of superposed spatial layers. The creation of each layer is based on a query on spatial database and expresses how a common user needs to organize his datasets. The 3D GIS proposes, furthermore, a set of tools to carry out some topological and attribute queries on each layer. To facilitate data interrogation, such queries can be performed graphically through a set of graphical tools. The 3D GIS is implemented through a Java applet which allows 3D spatial data selection, query and presentation on a Web browser.

1. INTRODUCTION

In the era of ICT (Information and Communication Technology), information is more and more available for a growing number of users. Internet has revolutionized communication tools and has become an essential mean to exchange and share different kinds of information around the world. Reserved, in its early days, for local applications and particular users, spatial data are now generalized for worldwide shared set of complex geo-applications and for an extended number of users. Any more, a lot of concepts combining both GIS and Internet have occurred, i.e. WebGIS, Internet-Based GIS, GIS Web mapping, etc. Thus, a lot of detailed 2D/3D city models are now accessible over Internet allowing several kinds of spatial "services", i.e. routing, addresses search, simulation, etc. However, until now, the number of 3D WebGIS is very restricted and the majority of 3D GIS are implemented for commercial reasons. Therefore, this work proposes a deployment of a 3D GIS over Internet and a method to render and analyze spatial data on a web browser. The major ideas of this work consists in the dynamic creation of data sets through a set of 3D spatial layers by each user, carrying out Boolean operations to combine different layers, operating graphical and textual queries for topological and attribute analysis, etc.
This paper is organized as follows: It starts by an overview of some existing WebGIS and spatial data tools and discusses their advantages and limits. Then, our proposal of a 3D GIS deployment over Internet is described. Finally, a sum up is drawn and our future work is explained.

2. STATE OF THE ART OF INTERNET-BASED-GIS

More and more, local governments in charge of cities management look for services providers to share and distribute geospatial data to all their technical departments and users. GIS could be an appropriate tool to store, present and query such data. In the early days of GIS, its use was limited to a restricted number of users and to a few application areas. Nowadays, the use of spatial data has become more diversified and can be integrated into various application areas, i.e. urban planning, Business Intelligence, geo-marketing, data mining, etc. Spatial data tools take advantage of the prevalence of Internet users for data provision, administration and service delivery. On one hand, Internet allows a remote access, quick transfer and easy sharing of data between lots of web surfers around the world. On the other hand, Internet is a platform to run many kinds of application and programming languages. Therefore, GIS deployment over Internet has become an important research topic. Many Web sites were established to provide online services to manipulate spatial data. This section gives an overview of some existing tools using Internet to supply users with online "spatial" services.

2.1 Spatial data visualization and analysis over Internet

GIS can be defined as *"an organized collection of computer hardware and software, geographic data, and personnel designed to efficiently capture, store, update, manipulate, analyze, and display all forms of geographically referenced information"* (Foote, K,. Lynch, M., 1995). This definition distinguishes different functions of a GIS which can be summarized in three main parts: data storage, data management and data visualization. Due to the considerable technological progress of Internet in terms of data transfer and diffusion, standardization, high-speed Internet, etc., it is now possible to display many kinds of advanced applications over Internet including GIS applications.
There are a lot of web sites providing various spatial services, i.e. address search, routing and optimization, geo-portal, land occupation study, etc. Therefore, many kinds of spatial data could be distinguished over Internet, i.e. cartographic data, satellite data, virtual reality data, 3D data, etc. It is very important to distinguish between WebGIS and web sites providing spatial services. A WebGIS is the deployment of a GIS over Internet. However, a web site providing spatial

services is a set of online tools using and manipulating geo-referenced data.
Data visualization is a main task of either local or online GIS. It allows displaying graphically both spatial data and their querying results. Such spatial data could be visualized through a set of 2D, 2.5D or 3D models, satellite images, etc. In the last decade, many web sites, with commercial or non commercial purposes, have appeared to provide a set of spatial services.
Because of the complexity of spatial data and according to the type of service provided by a web site, the majority of online applications allow 2D representation of spatial data. *GoogleMaps* [15] is a free online tool representing geographic maps. It combines two basic types of visualization: 2D maps and satellites images. By zooming, it allows representing data from city scale to road scale. Many other Websites proposes similar services, i.e. *Michelin routing* [20], *yellow pages* [19], *National Geographic* [16], *French IGN* (French National Geographic Institute) [13], etc.
Nowadays, realistic views of cities are no longer limited to satellite images. Thus, many Web sites proposes 3D models of cities, i.e. IGN's *GeoPortail* [11], *Pages jaunes 3D* (3D yellow pages) [21], *3D Macau* [22], etc. 3D models provided by such web sites are generally presented as a set of 3D textured objects (buildings, DTM, etc.). Some web applications need particular installations on local machines, i.e. IGN's *GeoPortail* [11] and *3D Macau* [22] use Terra Explorer software as 3D viewer. Another type of 3D visualization was recently proposed by *GoogleMaps* called "Street view". It is not a 3D representation of buildings but a 360 degrees view of street at any given point in the street. It uses the technology of *Immersive Media Company* which films 360 degrees videos with high resolution. *GoogleMaps* "Street View" uses images instead of videos. This technique is not yet available in all cities around the world. Nowadays, even mobile phones, known as smart phones, and mobile devices, i.e. PDA (Personal Digital Assistant) are capable to show and provide some spatial services, i.e. GPS (Global Positioning System), routing, localization, etc. *Mobile 3D City* [17] is a mobile phone application providing some 3D city models and their corresponding attribute data, i.e. addresses, phones numbers of public buildings, buildings names, etc. It provides several services such as address search, thematic search (hotel, restaurant, etc.), routing, etc. It allows a very simple tactile zooming and navigation in the 3D model.
In the last decade, the concept of WebGIS has become omnipresent in the World Wide Web. The majority of web-based GIS provide 2D services. Depending on the purpose of a WebGIS, two main types of services could be distinguished: i) National or governmental services, i.e. wealth management, study of land occupation, study and control of natural resources, etc. ii) Private or commercial services, i.e. market study, competition study, routing optimization, etc. *DGO4* [10] is a 2D WebGIS consisting in a set of map layers and providing a variety of services, i.e. Atlas Streets, wealth study, communal development plans, urban renovation, urban revitalization, housing, energy, etc. Depending on the map layer, DGO4 associates to spatial data a set of thematic data, statistics, etc. *Pasco Internet GIS* [12] is an ESRI (Environmental Systems Research Institute) WebGIS application. It provides many GIS operations, i.e. Search features by selecting a layer and a field and specifying the attribute, view an attribute table for a specified feature and calculate values, create a pie chart or a bar graph for the selected features. *Main Street GIS* [14] is a WebGIS solution consisting in a set of map layers and a 2D viewer. It includes a variety of tools for zooming, navigation, spatial data interrogation, data print and export, etc.
There are a lot of other 2D WebGIS solutions around the world which provide various services. However, 3D WebGIS are not yet widespread. 3D WebGIS use different techniques to model and visualize 3D spatial objects, i.e. VRML (Virtual Reality Markup Language), X3D (eXtensible 3D), Web services, etc. *Apia Antica Project* [9] is a WebGIS for the Archaeological Park in Rome. It provides a 3D model for buildings projected on a DTM. *Mantova 3D terrain and buildings* [8] is a WebGIS which shows textured 3D buildings. It provides some tools of measurement of distance, area and volume and users can select different themes (buildings, monuments), etc. *O3DG* (Open3DGIS) [18] is an open source project which displays 3D objects from a Geodatabase (PostgreSQL/PostGIS) on the Web. This project was created by OpenGEO. The basic idea is to provide a simple way to integrate 2D GIS with 3D visualization and interactivity on the web.
This section gave a non exhaustive overview of some WebGIS and non-GIS tools which provide several services over Internet including 2D or 3D data. The advantages and limits of such tools are discussed in the next section.

2.2 Advantages and limits of current Internet-based GIS

Due to the large number of Internet users around the world, spatial data querying via Internet could be very useful in terms of data sharing and time saving. WebGIS are now common and provide several services to meet different needs. Such WebGIS can provide the same services on different Web browsers, i.e. Mozilla Firefox, Opera, Internet Explorer, etc. and on different platforms, i.e. Linux, Solaris, Macintosh, Windows, etc. Since GIS data are very diversified (geometric, topological and attribute data), on one hand, and GIS users are very various (from novice up to expert users), on the other hand, Internet could be an appropriate tool to share spatial data and to display, in real time, their querying results, users feedback, etc. Internet is also an important tool allowing multiple distant users to work on the same dataset.
However, some WebGIS need particular software installed on user computer, i.e. *IGN's GeoPortail* [11] and *3D Macau* [22] which need Terra Explorer, *O3DG* [18] which needs a specific plug-in to run X3D. Spatial data loading can be also time consuming when spatial data, especially 3D data, are visualized. And many security procedures have to be maintained to secure data access. The 3rd dimension is not yet prevalent in WebGIS. It is limited to some 3D virtual models with restricted functions.

3. PROPOSAL OF A WEBGIS

In this section, a proposal of a WebGIS is described. It explains data integration in the spatial database, data representation through a set of significant layers and analysis tools.

3.1 Spatial data storage

Because of the heterogeneity of spatial data sources, an integration process is necessary to obtain coherent spatial databases (SDB). Source data are materialized by a set of vector files like ESRI's shapefiles, Autodesk's dxf, dwg, etc. These files have usual format in the GIS and modeling world, including CAD (Computer Aided Design). Such kinds of files describe 2D geometries (3D points, lines and polygons) with little attention to 2D topology and absence of 3D geometry (solids) and 3D topology. The integration of these files in a SDB is realized by using some spatial tools distributed by the open source community. Among these tools, PostGIS is a set of spatial functions allowing the management and the manipulation of spatial objects in PostgreSQL DBMS (DataBase Management System). Some converters/integrators

such as the application *shp2pgsql* allow the integration of *shapefiles* and their linked files containing spatial indexes and thematic attributes in a PostgreSQL/PostGIS database.
Generally, these files provide only geometric data. Thus, to be integrated in a GIS, such files have to be transformed and enriched by topological and attribute data. The process of spatial data integration is described in Figure 1.

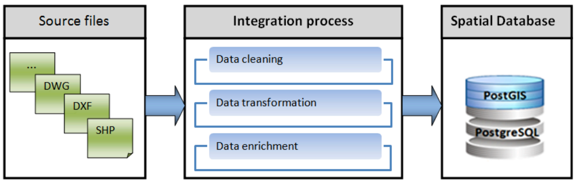

Figure 1. Spatial data integration in the database

The integration process consists in three main steps: data cleaning, data transformation and data enrichment. Data cleaning consists in the deletion of all useless data, i.e. noise data, invalid geometries, irrelevant data, etc. Data cleaning is carried out using some GIS software, i.e. ArcGIS, and CAD tools, i.e. AutoCAD, Microstation, etc. This step needs an important manual work because source data contain generally a significant number of irrelevant data set. Data transformation consists in the conversion of the format defined by source files, i.e. shp, dxf, etc. to a database format. Therefore, some open source tools are used to transform such files, i.e. *shp2pgsql*, *dxf2postgis*, etc. The last step consists in the enrichment of source data by topology and attributes. Since source files mentioned above are generally not designed to support 3D topology neither attribute data, this step could be very important to supply users with a GIS providing useful data.

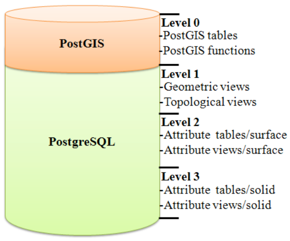

Figure 2. Multilevel Spatial Database

To facilitate data interrogation, the SDB is organized through a set of levels as shown in Figure 2. Each level contains a particular kind of data. Level 0 contains PostGIS tables and functions. PostGIS tables are the result of the conversion process of source files using *shp2pgsql*, *dxf2postgis*, etc. Level 1 contains geometric and topological views. Geometric and topological views store information about geometric primitives and relationships between them. Level 2 contains all tables and views storing information about each surface, i.e. color, texture, material, etc. Level 3 contains all tables and views storing information about solids, i.e. building identifier, building usage, etc. Since views are fictive tables, their use to store geometric and topological data is a good way to secure source tables, hide sensitive or irrelevant parts of the database, etc.

To carry out data integration, a java applet was developed and can be accessed online via Internet. Only the database administrator or authorized users can execute this application. It provides the capability of spatial data import and transformation. It allows the indexation of spatial tables, the creation of views, the definition of topology, the definition of 3D solids using one or many attributes of source tables, etc. It is based on predefined functions defined in PostgreSQL/PostGIS and some new functions developed especially for the WebGIS.

3.2 Spatial data representation

The major aim of this work is the establishment of a "dynamic" Internet-Based 3D GIS. User can define his own dataset and analysis tools. A dynamic GIS provides flexible services to process the whole or only a part of data stored in the database. Therefore, data processing can be easier and faster. Data are organized through a set of 3D layers. In order to make his 3D map and according to his privileges, the user connects to a database and creates one or many layers through a set of SQL queries. Figure 3 shows the conceptual model of a layer.

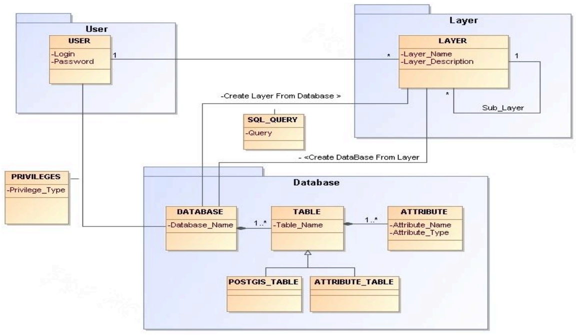

Figure 3. The conceptual model of a layer

The creation of a layer is based on a SQL query. Such query can include one or many linked views and can contain one or many predicates. A predicate can express a condition on geometric and/or attribute data. The user can so define a subset of spatial data for visualization and analysis. Since the interrogation of the SDB is carried out using SQL queries, it seems sometimes quite complicated for non-expert users especially when the query contains predicates, joins, etc. To simplify the interrogation process, for each SQL view chosen by the user, a separated predicate box is automatically created in which user expresses one or many conditions on the corresponding view. Thus, the query becomes clearer for users and relations between views are created automatically and invisibly to the user. The user defines also a significant name and a semantic description for each layer. Figure 4 shows an example of SQL query to create a 3D layer of buildings having gabled roofs.
Once data are imported and organized through a set of layers, the GIS platform proposes a set of tools to manipulate these data. 3D GIS users are supplied with the basic functionality of existing tools working on spatial data. Such functionality could be very interesting in terms of data visualization and interpretation. The basic tools are moving (forward, backward, right, left, up and down), rotation (roll, pitch and yaw), bird's eye view (viewing simultaneously a part of buildings facades and roofs), model zooming (zoom in and zoom out), orientation (north, south, east and west), etc. In order to combine two or many layers, a given user can also carry out different Boolean operations on such layers, i.e. union, intersection and difference. The operations are based on SQL queries (used in the beginning to create such layers) and result in the creation of new specific layers. For example, the union of two layers is materialized by the union of queries used to create such layers. Boolean operations on layers could be very important because users can create separately many layers, perform properly some analysis procedures on each layer and then make relationships between these layers through a set of Boolean operations. It is also possible to define a set of sub-layers within the same layer. These operations can be carried out graphically using a

graphical tool developed within the WebGIS. Figure 5 shows a simplified graphical union operation between two layers representing respectively buildings facades and buildings roofs to obtain a layer of complete buildings. The graphical query consists in a set of symbols corresponding to objects on which a Boolean operation is carried out, Boolean operators (union, intersection and difference) and links between them.

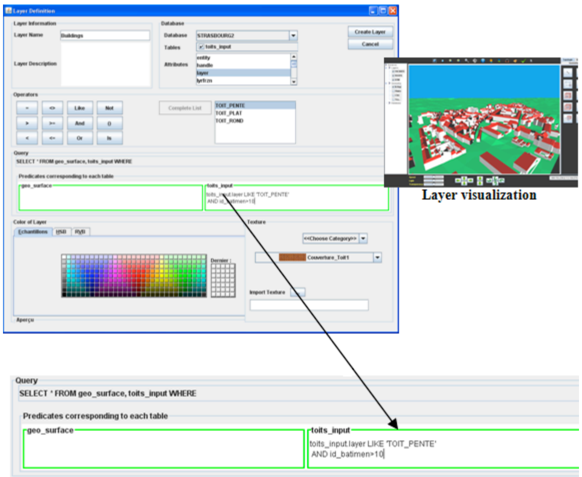

Figure 4. An example of SQL query to create a 3D layer

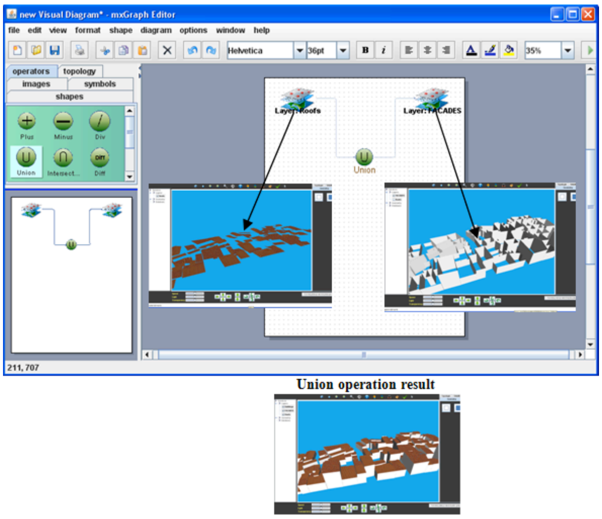

Figure 5. Union between two layers graphically carried out

The JGraph API was used to develop a set of useful graphical tools, i.e. Boolean operations between layers, topological operations between 3D objects, etc. The motivation of using a graphical tool to accomplish some analysis operations within the WebGIS is the ease and the swiftness of such operations. Graphical queries are generally more intuitive than textual queries.

Each layer is stored in a buffer memory during the visualization and analysis process. The user can store his layers in the database for a future use or to share it with other users. User feedback on each layer can be very valuable because other users working on the same layer can take advantage of it.

3.3 Spatial data analysis

Topological analysis is one of the most interesting services which can be provided by a GIS. In the WebGIS proposed in this work, a reflection on the topology applied to 3D buildings is carried out. The motivation to use the DBMS PostgreSQL/PostGIS in this work is its ability to store spatial data and to provide a set of spatial functions to manipulate such data. It proposes a lot of interesting topological function, i.e. *ST_INTERESECTS*, *ST_CONTAINS*, *ST_OVERLAPS*, etc. However, these functions are useful for 2D shapes and there is no function to process 3D shapes such as polyhedrons or solids. And since this work deals with 3D buildings, PostGIS spatial functions are used and completed by a set of particular 3D topological algorithms. These algorithms are materialized by a set of Java classes. In the field of 3D buildings, three main types of topological relationships can be distinguished: i) Polygon-Polygon relation, i.e. two facades. ii) Polygon-Solid relation, i.e. facade and building. iii) Solid-Solid relation, i.e. two buildings. Table 1 illustrates such relationships.

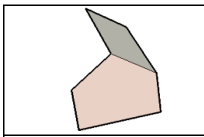	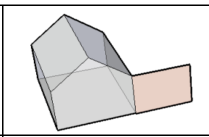	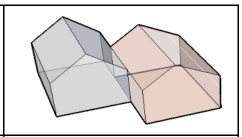
a - Polygon-Polygon	b - Polygon-Solid	c - Solid-Solid

Table 1. Different topological relationships between buildings

Since PostGIS is not able, until now, to store 3D solids such as polyhedrons, a particular organization of data is carried out in this work to store and handle 3D buildings. A solid corresponding to a building is represented by a set of boundary polygons and a set of non ambiguous vertices. Then, predefined functions of PostGIS are used to perform some topological operations, i.e. intersection, distance, etc. between polygons, i.e. facades of buildings. Such functions are completed by a set of issues developed within this project to execute topological operations on 3D buildings. A set of rules was defined to express topology of 3D buildings stored in PostgreSQL/PostGIS database. Since 1990, several topological models like in (De La Loza, A., 2000), (Molenaar, M., 1990), (Pfund, M., 2001) or (Pilouk, M., 1996) were proposed to define a formal structure of topological properties and spatial relationships of spatial objects. The 9-intersections matrix (9IM) is used in (Wei, G., Ping, Z., Jun, C., 1998) and (Ellul, C., Haklay, M., 2008) to express intersection relationships between n-simplex objects (n = 0 for vertices, 1 for edges, 2 for surfaces or 3 for bodies). Each object is defined by three main components: its interior, its boundaries and its exterior. Thus, 9IM consists in a 3*3 matrix representing all possible intersection results of each component of an Object A with each component of an object B. The 9IM is an interesting approach to identify intersection relationships between n-simplex objects, but it requires a formal description of the interior, boundaries and exterior of such objects. Intersection is one of main topological operations which can be classified into three main types: adjacency, containment and intersection relationships. The meta-model of a topological operation proposed in this work is explained in Figure 6.

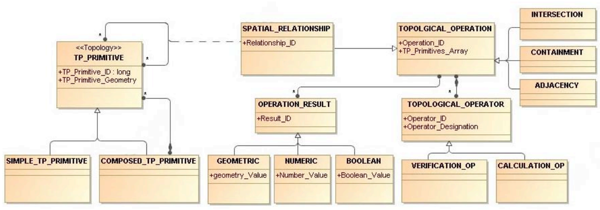

Figure 6. Meta-model of a topological operation

In this work, B-Rep (Boundary Representation) is used to model 3D buildings. Thus, bodies are described by their boundaries surfaces, surfaces are described by their boundaries edges and edges are defined by two extremity vertices. A small modification of B-Rep is carried out in this project to simplify data storage. Indeed, bodies are described by their boundaries surfaces and a set of vertices, and surfaces are represented by their vertices. Since surfaces vertices are ordered (counter-clockwise), edges are not stored because they can be easily obtained by combining surfaces vertices two by two. It is very important to distinguish two types of topological primitives: i) Simple primitives, i.e. points, edges, faces and solids. ii) Composed primitives i.e. composed surfaces, composed solids, etc. It is also important to know the dimension "*Dim(object)*" of each object (*Dim(object)* = 0 for vertices, 1 for edges, 2 for faces and 3 for solids).

Consider that we want to realize a topological operation on two objects A and B knowing their dimensions respectively *Dim(A)* and *Dim(B)*. Consider P_A the set of simple primitives composing A whose dimension is n knowing that ($0 \leq n \leq$ Dim(A)), *Bnd(A)* the boundaries of A composed of a subset of P_A whose dimension is Dim(A)-1 and *Vertices(A)* the set of vertices of A. And consider P_B the set of simple primitives composing B whose dimension is n' knowing that ($0 \leq n' \leq$ Dim(B)), *Bnd(B)* the boundaries of B composed of a subset of P_B whose dimension is Dim(B)-1 and *Vertices(B)* the set of vertices of B. Two algorithms were developed in this work to check respectively whether a point (with x, y and z coordinates) is inside a polygon and whether is inside a polyhedron. Thus, a particular relation called "*In*" was developed to check the containment of a 3D point in a polygon or in a polyhedron. Then, each kind of topological operation is expressed taking in account the constraints mentioned above. Since, this work deals with 3D buildings, topological operations are carried out on surfaces (facades) and solids (buildings).

. A « *Disjoint* » B

(1) distance (A, B) ≠ 0,

and

(2) ∀ p ∈ Vertices(A) and ∀ k ∈ P_B knowing that Dim(k)≥2, p«¬*In*» k,

and

(3) ∀ p' ∈ Vertices(B) and ∀ k' ∈ P_A knowing that Dim(k')≥2, p'«¬*In*» k'.

. A « *Touches* » B

(1) distance (A, B) = 0,

and

(2a) ∃ p ∈ Vertices(A) and ∃ k ∈ Bnd(B) such that p«*In*» k,

or

(2b) ∃ p' ∈ Vertices(B) and ∃ k' ∈ Bnd(A), such that p'«*In*» k'.

. A « *Meets* » B

(1) distance (A, B) = 0,

and

(2a) ∃ p_1, p_2 ∈ Vertices(A) and ∃ k ∈ Bnd(B), such that p_1«*In*» k and p_2«*In*»B,

or

(2b) ∃ p'_1, p'_2 ∈ Vertices(B) and ∃ k' ∈ Bnd(A), such that p'_1«*In*» k' and p'_2«*In*»A.

. A « *Contains*» B or B « *Inside*» A

∀ p ∈ Vertices(B) and ∀ k ∈ Bnd(A), such that p«*In*»A and p«¬*In*» K.

. A « *Covers*» B or B « *Covered_By*» A

∀ p ∈ Vertices(B) and ∃ p'∈ Vertices(B) and ∃ k ∈ Bnd(A), such that p«*In*»A and p'«*In*» K.

. A « *Overlaps*» B

(1) ∃ p_1 ∈ Vertices(A) and ∃ p_2 ∈ Vertices(A), such that p_1«*In*» B and p_2«¬*In*» B,

or

(2) ∃ p_1' ∈ Vertices(B) and ∃ p_2' ∈ Vertices(B), such that p_1'«*In*» A and p_2'«¬*In*» A.

. A « *Equal*» B

∀ p ∈ Vertices(A) and ∃ k ∈ Vertices(B), p=k.

In the field of 3D buildings, some topological relationships, with rare exceptions, are not possible such as the overlap of two buildings. Figure 7 illustrates the result of a topological relationship between two buildings carried out using a graphical query. The operation consists in verifying whether the two buildings, having the identifiers 24 and 28 as shown in the Figure 7, are intersecting or not. If they are intersecting, the system returns the common shape (point, line, triangle, quad, polygon or solid) shared by these two buildings, its coordinates if it is a point, its length if it is a line, its perimeter and area if it is a surface). Figure 7 shows the graphical query and its result in the 3D model.

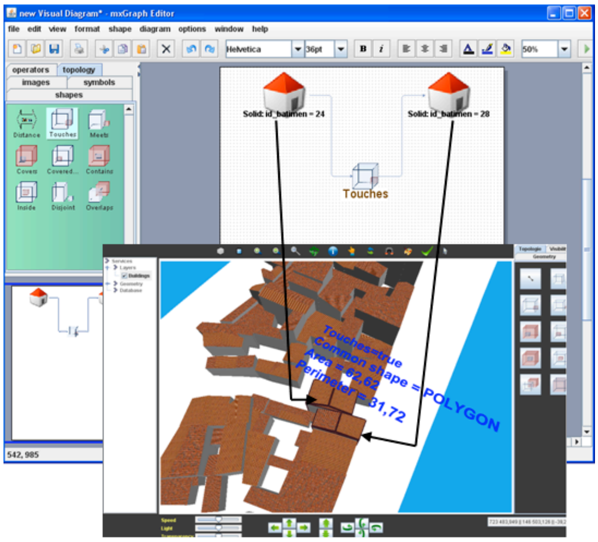

Figure 7. Topological operation between two buildings

In addition to topological queries, the WebGIS is able to perform geometric or attribute queries. Therefore, a dedicated graphical interface is implemented for this purpose. Such interface allows users to execute a query on one or many existing layers. The query may relate on geometric, topological, attribute properties of one or many objects and the combination of such properties. Such objects can be surfaces, i.e. building facades and roofs, or solids, i.e. buildings and buildings parts. The query interface contains two main parts. The first part consists in a stack of selected objects which can be used to search other objects, i.e. search all buildings which intersect a selected building. The second part consists in some tools to define the query. Figure 8 shows an example of a query which combines topological and attribute properties. It consists in the selection of a building, having the identifier 67, and searching all "administrative" building which do not intersect this building and located in a distance inferior than 1 km from it. Buildings verifying these conditions are selected in the 3D model.

The corresponding predicate shown to the user is:

SELECT All solids WHERE
Touches (id_batimen = 67) = false AND
Distance ((id_batimen = 67) < 1000
AND building_function_type.designation LIKE 'administration building'

The graphical result of the query is described in Figure 8.

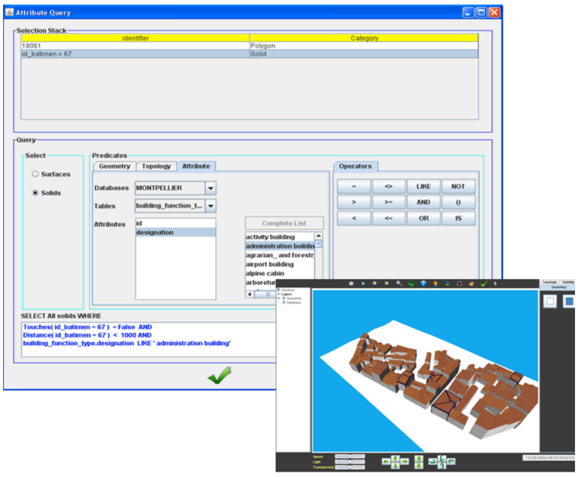

Figure 8. Query using topological and attribute properties

When selecting a particular attribute of a table, the user is able to show the list of different values of such attribute in the database. Therefore, predicates can be expressed easily.
In the query, the user is not obliged to indicate the relationships between tables because it is done automatically. Therefore, the creation of layers and their querying is a simple task for both novice and expert users. Layers, querying information, user feedbacks and other properties are stored in the database and can be shared between lots of users. User management and layers storage is not detailed in this paper.

4. CONCLUSION AND FUTURE WORK

Since Internet has become a basic tool for data communication around the world, a lot of geographic application can be now accessed online. However, there are not a lot of 3D GIS applications available over Internet. Therefore, this work proposes a contribution in the deployment of geographic data over Internet via a 3D WebGIS. It explains the required steps for data integration, data visualization and data querying. The major aim of this work is to supply users with some tools easy to use and allowing a dynamic creation of spatial datasets. Therefore, the future work will consist in the optimization of data visualization and querying, user management for spatial data sharing.

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