Road Data Analisys with FOSS GIS

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Abstract: This paper explains how the Local Government of Valencia has developed a gvSIG extension in order to analyze road data. This data is very important to know the state of the road network and to plan new interventions. Just with a good knowledge of the differents attributes and a good use of them, will be possible to optimize resources. We have found the solutions using Free and Open Source Software, gvSIG as GIS tool and PostGIS as database management system.

Key–Words: GIS, FOSS, road, data model, gvSIG, postGIS.

1 Introduction

The aim of this project is to facilitate the available geographic information to the Highways Agency of the Local government of the Generalitat Valenciana. That requires to have a definition of the road data model and a tool to visualize it and to how best to administrate different data related to the roads. This paper explains the development of a gvSIG extension, which helps to manage and analyze this data.

Thus, this tool should have:

- User, Profile and Permission Administration
- Database georeferenciation through linear referencing.
- Edition and maintenance tools for the specific roads cartography. Special mention should have the fact that the database stores historic information about the road network. So, the tools should be able to deal with historic data too.
- Analysis tools for road data.
- Tools for de automatic generation of print patterns and reports.
- Road schema generation.

1.1 Architecture

Then, the architecture for this gvSIG extension, will be as shown in Figure 1. The core is the road database, since it is the main source of the road data. This way, data should be load to it, in order to take them all available.

Some different profiles are defined as well. Each one will have some permissions, depending on the activity they will be working on. This way, a profile will be assigned to an user, which will determine the tools the user will have reachable.

To load the XML accidents to the database, we have developed a tool to make possible the importation. So, we are able to manage this information, make generic queries and to reference the accidents in the roads cartography.

For de traffic density data we followed a similar procedure. We have an importer, which is capable of load the data, making possible the administration and their representation.

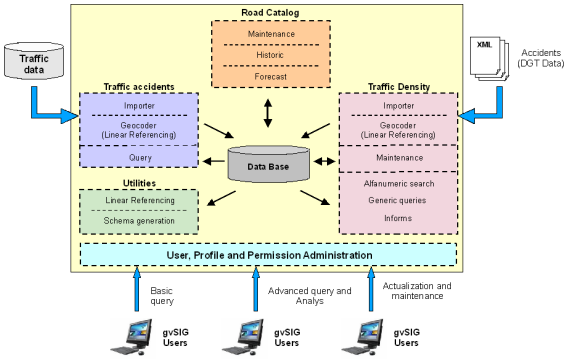

Figure 1: Architecture

2 User administration

The access to the application is limited to the users who are validated in the database. Each user will have associated a profile to determine the functions that are accessible for him.

The application security parameters are an extension from the database ones. This way, an user can only access to a resource if he has truly permissions for it. No matter if the access is from gvSIG-Carreteras or from any other place. The validation is always against the database.

It is possible the creation of unlimited profiles and users. But, there are two basics profiles that will be always present: basic and administration. The first one allows the user to query the data, but nothing else. On the other hand, the administration profile, allows the user to create, modify or delete data too.

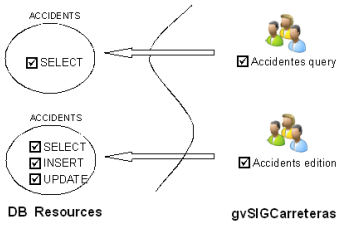

Figure 2: User administration

3 Linear Referencing

Linear Referencing is a technique where features (events or segments) are localized by a measure along a linear element. The advantage of linear referencing is its capability of locating attributes and events along a linear feature with only one parameter (measure (M) coordinate) instead of the two classical, such as latitude/longitude or x/y in Cartesian space. Sections of a linear feature can be referenced and created dynamically by indicating the start and end locations along the feature without explicitly storing them.

In this case, the linear element will be the roads, and the M coordinate will be provided by the network kilometer. That implies that the type of the roads in the database must be polylineM instead polyline, therefore we should convert them. So, this type will be supported by the client, and some tools had been developed to deal with it. It's important to be able to assign and change this M coordinate, because the road network is a dynamic net, and it can change.

Then, we will be able to locate accidents as events (Figure 3) and traffic density segments along the roads. And not only that, we will able to georeference any event along the network by the road and the kilometer it is located.

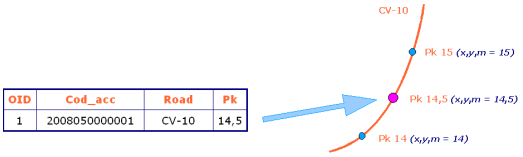

Figure 3: Example of an accident linear referencing

4 Edition

The main objective of this tools is the maintenance of the road network catalog. Thus, this tool can create, modify and delete road sections.

Therefore, the edit tools are divided into two parts:

- Road catalog
- Linear referencing

The first one is focused on the management of the catalog. We have tools for extract the road network for a specific day. That is important, because we store all road sections, and depending on the data, we can show one state or another. We have the possibility of searching an specific kilometer in a road, or to look for a specific stretch of the catalog, showing the associated alphanumeric data.

We can manage the m coordinate with the linear referencing, assigning or modifying it for each geometry or for the whole theme. When the m coordinate of an extreme of a segment is modified, the m coordinate of the contiguous segment is changed too, and both m values are recalculated. We can create a new theme from the linear referencing.

5 Traffic accidents

The tool aims to manage traffic accidents, not only the geographical point where the accident happened, but all information associated with that point.

Thus, with this tool, we will be able to:

- **Import data**: With this tool we retrieve the accidents information from the XML files provided

for the DGT. This XML is validated against a schema document (XSD). This XSD is stored in the database and can be replaced by another one when necessary.

The importation process is done into two parts. In the first one the XML files are selected to be imported and they will be validated against the XSD. In the second part the accident data are entered into the database.

During the loading process the database can find disagreements between the XML information and the one stored in the road catalog. The latter takes preference over the rest, but must be the user who specifies the right solution.

- **Accident georeferencing**: During the importation it is possible to georeference the accidents using linear referencing and the road catalog. This way, we obtain a new theme where the accidents are marked as a point.

  It is possible that some accidents can not be georeferenced. This will be because some disagreements exist between the accident information and the road catalog (wrong date, different holders for the same road, etc.). These disagreements are able to be reviewed and corrected and georeferenced again.

- **Alphanumeric search**: This is a tool made for locating accidents in the most easy and fast way. It is possible to locate accidents using parameters as holder, date, road type, etc. or their combinations. The result of the searching allows to access to the maintenance tool and modify it if necessary. Also, the result will be shown graphically too. Depending on the user permission, some searches will be possible or not.

  This tool provides the options of generate accident reports and statistic from different parameters and data from the accidents. It is very usefull for the technical experts to take decisions in order to get better road conditions and less accidents. An example is shown in Figure 4.

- **Generic queries**: With this tool the user can build queries, as complexes as necessary. The user specifies the table where the required information is stored and the fields. Then with different operators and the ordination criteria the query will be built. Obviously, it will be necessary to know the structure of the database therefore this is an advanced tool.

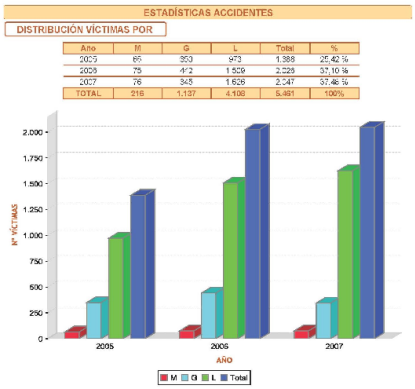

Figure 4: Accidents statistics

The queries will be stored in the database and can be executed wherever the user wants. The result can be exported to Excel or to a pdf file.

6 Traffic density

A good knowledge of traffic density carried by the roads allows the experts to climb the route. Thus, it makes them possible to take decissions about the geometric characteristics of the road.

With this tool we will be able to:

- **Loading traffic density data into the database**. In this module the traffic density are loaded to de database. It necessary to know the correspondence between fields, since in this case the data is imported from another database, not from an XML file. This step will be done for advanced users, because it requires advanced knowledge of data structure.

- **Browse data from road stretches**. The traffic density tries to measure traffic distribution during a day at a specific point and averaged over a year. This tools allows users to search and consult this measures from the different road stretches. It allows too, to check which data are taken and which not. Then, the technicians can know the state of every stretch, making possible a better planning in the traffic density plan. When the users have permissions, it will be able to change data, both the segment of the road, and the data associated with that segment.

- **Build statistic graphics from road stretches**. It provides information about time evolution (hourly and monthly) in a road stretch. Also it is possible to generate graphics from average hourly

and monthly volume.

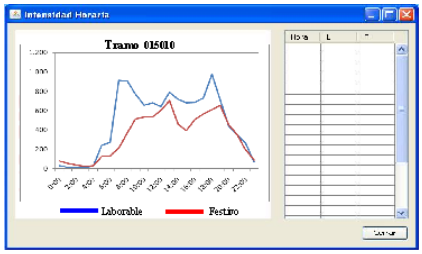

Figure 5: Graphic of traffic density

7 Conclusions and future work

With this extension we incorporate a new way of working within the Highways Agency. It has been necessary to know the needs of each of department and to find out how to improve the procedures.

Moreover, it was imperative that the tool would support the historic feature that the catalog had. Therefore it was necessary to take into account the time parameter.

This tool, once built, is of great help to the technicians because they can work much more quickly and to make use of information previously discarded (previous system was not able to handle it).

This tool is having a very good reception from the staff of the Highways Agency, therefore there are new tools, such as:

- Routing
- Fleet management
- Traffic management
- Mapping generalization
- Road reports management

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