SIGFRUT: a WEBGIS application for designing agricultural plantations and installations

Irene Compte, Antoni Hernández, Francesco Marucci, Ferran Orduña. SIGTE (GIS & RS Center), University of Girona; Plaça Ferrater Mora, 1; 17071 Girona, SPAIN. info@sigte.udg.es; http://www.sigte.udg.es

Summary
The SIGFRUT project is set within what we call GIS applications in a Web environment (the acronym GIS is SIG in Spanish). We are all familiar with Internet map servers or IMS, but these types of applications are basically simple map viewers and do not have any more functional features than the classic tools of visualization and consultation. GIS functionality in web applications is not new and is available in several commercial products, but often the problem is that obtaining one of these products requires a substantial economic investment, which only large companies or public bodies can afford. This article shows how, with little or no investment in terms of software and cartography, we can create an application in a web environment that has advanced map editing and spatial data entry functions without the need for the server to contain the reference map database. We present an application devised for the online design of plantations and agricultural facilities, generated by a combination of open source tools and technologies.

Keywords: WebGIS, spatial data entry, PostGIS, SVG, WMS.

Introduction
SIGFRUT originated due to a request from a company called Nova Fruticultura, S.L, which installs agricultural facilities in fruit plantations, especially systems for protection against hailstone.

They needed a tool that, on the one hand, would enable them to design the layout of an agricultural plantation, i.e., the arrangement and direction of the rows, and calculate the total number of plants and the number of posts that serve as supports for a subsequent installation of an anti-hail system. On the other hand, the application would also be required to serve as a tool that would deal with the whole installation project, planning for the necessary material and elaborating the final budget.

They were familiar with IMS and GIS functionality in web applications. But the economic investment required for some commercial products, which only large companies or public bodies can afford, was an issue for this small company. Beyond the cost issue, it was also known that with most IMS applications we cannot perform advanced spatial data entry or map editing, because they are basically simple map viewers and do not have any more functional features than the classic tools of visualization and consultation. Therefore, they do not usually incorporate advanced tools or functions for editing or analysis.

Having these two requirements –cost and functionality limits-, the project was set to design a flexible program that enables the users to draw their own plantation through user-friendly editing tools. In this way, the client can obtain a map of the future plantation, as well as an approximate figure for the final number of rows, plants and posts.

A second phase of the project consists of an internal web application in which the company managers will have more advanced editing tools with which to finish the plantation design more precisely, and where they will be able to make an exact calculation of the material needed for the installation: how many frontal and lateral posts and struts, how much wire and protective netting, etc., from which they can calculate the final budget.
HOW THE APPLICATION WORKS

The general operation of the application is simple. The user has to locate the field with the aid of the aerial photography or cadastral survey available in the application, draw the perimeter of the field and then define the direction of the rows, the correct distance between them and the distance between the plants. The system then takes care of the rest: it automatically calculates and draws the number of rows and plants that the field will have according to the parameters entered, and then draws them on the map.

Bearing in mind that the user will generally be unfamiliar with this type of application, an assistant has been devised to guide the user at each step until the final design of the plantation is obtained.

In order to access the programme for the first time, users must be registered. Registration is free and requires only basic information to identify the user. Once registered, the user can create a new field or inspect, or modify, plantations that he or she has designed previously, to which only the user and the system administrator have access.

Once we have defined the name of the field that we are going to design, a menu of tools appears that serves to help us to locate our field. First, we can choose a county, municipality, place name or UTM coordinates that will situate us in more or less detail, depending on the option chosen.

From here on, the application offers the classic tools of zoom and pan that serve to navigate around the map and get greater detail of the field. For cartographic reference, we can choose to view the 1:5,000 scale colour orthophoto map, the cadastral survey or both at the same time.
After locating and centring our parcel, the application offers the editing options with which we will draw the perimeter of our field, define the distance between rows and their direction, as well as the distance between plants and the edges of the field. To make it easier, the application offers the tools in the order that the user will need them. Thus, first it shows the tool we need to draw the perimeter of the field, to erase some of it if necessary and to make on-screen measurements.

Once the digitalization of the field is completed, the system calculates the surface area, (which is shown in the map along with the name of the field) and then activates the tools for the design of the alleys or the rows. Here we have to indicate the distance between the rows, as well as the margin that we want to leave between the edge of the field and the first row of plants.

Next, we have to define the direction or orientation that the rows will have. We want to get maximum yield from the available land by finding a way to fit in the greatest number of plants. This is perhaps the most important part of the process since, depending on the shape of the field, the direction given to the rows will determine, to a great extent, the number and length of the rows and therefore the final number of plants and posts.

The direction is defined on the map interactively in different ways: making it parallel to one of the limits or edges of the field; drawing a “master line” from which the rest of the rows are generated according to the distance and margins established previously or by interactively marking on the field the direction the rows will follow. If the distribution proposed by the application is not to our liking, we can always erase and redefine the design before calculating the total number of plants and posts.
In order to calculate this total, we simply define the distance we want there to be between each plant/tree and between the posts. We can also define the direction of alignment of plants and posts (which, by default, will be perpendicular to the rows) by selecting the side of the field from which we want to align plants and posts. Since the calculation of the plants and posts is independent, we can calculate either total or both at the same time.

These kinds of agricultural installations always need a head post at the beginning and end of each row; therefore, independently of the distance defined, the system always calculates these posts automatically and gives them a code which is different from the other posts so that, on the map, they appear with a different symbol.

Figure 3: The installations map of a field, for the two different users (Internet—left—, and administrator—right—).

Once the design of the field is concluded, the application can then generate or print out a report of the results showing the total number of rows, plants, interior posts and head posts, as well as the surface area and all the parameters introduced during the design process.

The report also includes the map of the plantation, with the layers of information that we have decided to view: orthophoto, cadastral, rows, plants, posts, etc. Lastly, it provides a breakdown of each row indicating the total length of each row, the number of plants, interior posts, head posts and total number of posts.
Figure 4: The final report is automatically sent to the Internet user by e-mail.

The second part of the application consists of the design of the anti-hail installation itself. This is a restricted-access intranet facility, which provides the system administrator with a set of tools of advanced design. This section contains all the functional characters that enable the administrator user to complete the data relating to the fruit farm installation and in which all the material needed to cover the plantation with a protective net can be included.

The key feature of this section is that it has to automatically generate the different types of posts that make up the structure of the installation. Depending on their position, there are head posts, side posts, interior posts or corner posts. As well as automatically generating this information, the application has a tool for manually changing the type of post.

Once the structure and layout of the different types of posts has been defined, the application will generate, automatically or manually with certain specific functions, the rest of the elements needed to complete the installation: the number and type of posts and the anchoring, the length of wire in metres, the number of rings and the total square metres of protective netting as well as colour and type.

All of this data, whether generated automatically by the application or created or modified by the user with the tools provided, is stored in a linked database. In a future phase of the project, another separate Database application will calculate the final cost of all the necessary materials, assigning prices to them, and will automatically generate the final budget for the installation.
TECHNOLOGY AND SOFTWARE USED
The nucleus of the application is based on PostgreSQL. PostgreSQL is a popular and powerful open source database manager, which first appeared in the 1980’s in Berkeley University (California). In terms of power, it is on a par with Oracle or the Microsoft SQL Server. This is where all the information generated during the design of the field is stored, and it is also where we store the municipalities’ capitals and the boundaries of the different administration levels of Spain, in order to make it easier to geographically locate a field.

PostgreSQL incorporates an extension called PostGIS for storing georeferenced geographical objects (in this case, parcels, rows, posts or trees). This function is the equivalent of Oracle Spatial or ArcSDE, and is based on the standards of the Open Geospatial Consortium (OGC). PostGIS provides the PostgreSQL engine with geospatial storage and analysis functions. It will become, in short, a bridge between the database and the GIS application.

The graphic representation of the geographical objects stored in the PostgreSQL database manager was achieved using Scalable Vector Graphics (SVG), which is a graphics language developed from XML. SVG technology was developed for the visualisation of vector graphs in web environments. SVG rivals Macromedia Flash in terms of power, the difference being that SVG is an open standard.

SVG has some big advantages compared to classic raster formats (TIF, JPEG, PNG), the main one being that it is an editable format, but no less important is its excellent graphic visualisation which, among other things, enables slides to be generated. Furthermore, since it is a vectorial format, innumerable zooms can be carried out while maintaining the graphical quality intact and avoiding the unpleasant pixelated effect.

The visualisation of the reference cartography – orthophoto maps, topographies and cadastral surveys – is achieved by making a Web Map Service (WMS) request. The WMS standard of the Open Geospatial Consortium enables the visual superimposition of Geographical information located in different types of servers, and does so in a way that is completely transparent for the end user. Furthermore, the remote server can be requested to provide more information associated with certain elements of the map (which can be selected, for example, by clicking on a pixel of the element).

As far as the visualisation of 1:5,000 scale orthophotos is concerned, covering the territory of Spain is something of a problem because not all the Autonomous Communities offer this information via a WMS service. At present, only the orthophoto maps of Catalonia can be viewed, via the WMS Galileo server of the ICC (Institut Cartogràfic de Catalunya – Cartographic Institute of Catalonia) but connections will soon be made to the map servers of those communities that offer this service.

In order to view the cadastral survey, the application connects to the WMS of the Oficina Virtual de Catastro (Virtual Cadastral Office), that offers coverage of the entire territory of Spain.

CONCLUSIONS
In conclusion, it is important to point out that the development of the applications described in this article has been possible thanks largely to the fact that two key obstacles have been overcome which, until recently, have slowed down expansion and access to geographical information systems.

The first of these factors concerns access to software. The development and growth of open source software entails not only an increase in the number of products but also a significant increase in the features and functions on offer. In this sense, PostgreSQL is an attractive and serious alternative to
Oracle Spatial which, in terms of cost and degree of specialisation, is wholly unsuitable for many projects.

The second and most important factor is the increasing free access to cartography and the development of remote access services to it, as is the case of WMS specification. In effect, one of the main obstacles that many projects are up against is obtaining reference map databases. When the field of study is reduced to a small area, this may not be such a big problem, but when, as in the case in question here, the field of study consists of an area as large as the whole of Spain, it is not only a question of cost that we are dealing with, but of how to manage and store such a large volume of data in one server. Consequently, the project described here would have been completely unviable without the help of WMS services.

In this sense, we should highlight the work of the Open Geospatial Consortium in developing standards for accessing spatial data and services relating to localisation, as well as the role of the SDIs (Infraestructuras de Datos Especiales - Spatial Data Infrastructures) who catalogue all of this information and make it available to the public.

Overcoming the two problems just described is revitalizing the sector and significantly reducing the cost of implementing GIS while at the same time facilitating access to them for small and medium-sized businesses.

INTERESTING LINKS
SIGFRUT http://www.sigfrut.com
SVG utilities and PostgreSQL http://www.carto.net
PostgreSQL http://www.postgresql.org/
Open Geospatial Consortium http://www.opengeospatial.org/
Infraestructura de Datos Espaciales de España (IDEE) http://www.ideal.es
Infraestructura de Dades Espacials de Catalunya (IDEC) http://www.geoportal-idec.net
Global Spatial Data Infrastructure (GSDI) http://www.gdsi.org
Geoservicios http://www.geograma.com