

Using Geographical Information Systems to browse touristic information

Nieves R. Brisaboa, Antonio Fariña, Miguel R. Luaces, José R. Paramá,

Miguel R. Penabad, Ángeles S. Places, José R. Viqueira

Departamento de Computación
Universidade da Coruña
Campus de Elviña s/n
15071 A Coruña, Spain

{brisaboa, parama, penabad}@udc.es, asplaces@mail2.udc.es

Corresponding author:

Miguel Rodríguez Penabad

Postal address:

Facultade de Informática, Departamento de Computación
Universidade da Coruña,
Campus de Elviña s/n,
15071 A Coruña
Spain

E-mail address: penabad@udc.es

Phone: +34 981 167000 ext. 1254

Fax: +34 981 167160

Dr. Nieves R. Brisaboa has Ph.D. degrees in Psychology and Computer Science. She is currently a full professor in the Computer Science faculty at the University of A Coruña, teaching Databases courses (basics and advanced). She is the head of the Database Lab, and her main research interests are Deductive Databases, Geographical Information Systems, and de design of Digital Libraries.

Antonio Fariña has a Master in Computer Science, and he is currently working in his Ph.D. dissertation, the formal specification of a physical model for a relational algebra Spatio-Temporal databases. He has also worked in the design and implementation of Geographical Information systems.

Miguel R. Luaces has a Master in Computer Science, and is now working on his Ph.D. dissertation, “Supporting spatio-temporal data types in an extensible DBMS development environment”. He has also worked in the design and implementation of Geographical Information systems.

Dr. José R. Paramá has his Ph.D. in Computer Science. He is an associate professor at the Computer Science faculty in the University of A Coruña, teaching Databases courses. His main areas of interest are Semantic query optimization for Deductive Databases, GIS and Digital Libraries.

Dr. Miguel R. Penabad has his Ph.D. in Computer Science. He is an assistant professor at the Computer Science faculty in the University of A Coruña, teaching Data Structures and Databases courses. His main areas of research are: Syntactic query optimization for Deductive Databases, GIS and Digital Libraries and their user interfaces.

Ángeles S. Places has a Master in Computer Science, and she is currently working in her Ph.D. dissertation, the design and implementation of a broker system to federate digital libraries using ontologies. She has also worked on the design and implementation of user interfaces for digital libraries.

José R. Viqueira has a Master in Computer Science, and he is working on his Ph.D. dissertation, “Formal extension of the relation model for the management of spatial and spatio-temporal data”. He has also worked in the design and implementation of Geographical Information Systems.

Using Geographical Information Systems to browse touristic information

Abstract. The current expansion of Internet makes it one of the most popular places to publish and search for almost any kind of information. In particular, touristic information, not only about tours or information about resources, places, museums or monuments, but also cultural tourism, has gained much attention in the last years.

We propose the use of geographical information systems technology (GIS) that provides interfaces capable of displaying *interactive* maps with information associated to the elements present in such maps.

In this paper, we present a Web interface to access touristic information about Galicia (Spain) using GIS technology to easily find any touristic or cultural information. This interface is enclosed in the Galician Virtual Library (<http://bvg.udc.es>) Web site.

Keywords. Internet, Tourism, Cultural heritage, Web Interfaces, GIS.

1 Introduction

The popularization of Internet has created a new forum to interchange information in a faster and cheaper way since information does not have to pass through all the process needed to publish a book, brochure or journal. Therefore, Internet has become a suitable medium to spread any type of information that tourism, like almost any field, can take advantage of.

Due to this expansion, the design of suitable Web interfaces to search and view information in an easy and intuitive way for non-experienced users has attracted a lot of attention in the last years. This issue is especially important when we deal with touristic information because, apart from the different skill levels of the users, these information systems mix data from different sources (maps, images, sound, video, text, etc.). Most of the interfaces that we can find nowadays in the Web use text plus *static* images, or can even include a combination of text, images, sound and video with maps. Although this approach can be useful, it is often “static”, in the sense that users can only perform operations such as zoom a map or watch a video, but not really interact with the Web page.

We believe that an ideal interface for a Web page with tourism information will offer the previous information, but also the possibility of *interacting* with it. For example, if a user is interested in archaeological places, she can hide on the map the rest of the information, such as museums, hotels, etc., and have a clear view of what she is looking for. Another possibility, especially useful for cultural tourism, is to have some predefined routes, such as literary or pilgrimage itineraries of special interest for the country or region. Additionally, such Web page might include e-commerce capabilities, including hotel reservations or travel tickets.

We have followed two main guidelines to develop an intuitive and easy to use Web interface for a cultural, literary and tourism portal that is called *Galician Virtual Library* (available at <http://bvg.udc.es>). These guidelines are the use of cognitive metaphors and the navigational and browsing approach. Using a cognitive metaphor implies the use of “something” of the real world well known by the user; if the user knows how it looks like and how it works, she will feel comfortable using it. Given that we are offering, among other data, geographical information (where a beach or a museum is placed, for example), this lead us to use a map of Galicia as the main cognitive metaphor of our system. This also implied the use of a Geographical Information System (GIS) subsystem to manage the data and reference it geographically. Our experience in the development of applications with GIS systems (Brisaboa, Coteló Lema, Luaces & Viqueira, 2001; Brisaboa, Coteló Lema, Fariña, Luaces, Viqueira, 2001) helped us to easily integrate the database and the GIS subsystem.

With this goal in mind we developed a Web interface, included in our *Galician Virtual Library*, that offers a service called “*Virtual Tour through Galicia*”. This new service offers information about Galician culture (Galicia is the region in the Northwest of Spain), including monuments or museums and our natural and touristic resources (beaches, country houses, spas, etc.), which will permit a sort of “cultural tourism” through Galicia. We are specially interested in cultural tourism because, as we shall see in Section 4.1, Galicia has much to offer in this sense, and will also benefit from the cultural heritage of the visiting tourists. Regarding these, we can distinguish several types of tourists, among which we can find the following:

- Galician people that want to learn more about our region and its history.

- The Galician diaspora: including first, second and third generation. This is especially important since almost 25% of Galician people emigrated to Europe and the Americas at the end of the 19th century and the first half of the 20th.
- Tourists from the Iberian peninsula (Spain and Portugal), with partial knowledge of Galicia, but not about our culture and heritage and our pride about it.
- Tourists that will come to Galicia, or even to Spain, for the first time, and have no knowledge of our culture.

With these prospective tourists in mind, we have put a lot of effort into the design of a Web interface for this system, which uses a GIS (Chias, 1997; Esri, 1997; Worboys, 1995; Laurini & Thompson, 1992) to wrap a multimedia database that stores the information of places with any cultural interest, or having touristic or natural resources. All these places are shown in an interactive map, as well as multimedia information associated to them. We must note, however, that at this point our interface is displayed entirely in Galician. Thus, only people knowing this language (probably the two first types of prospective tourists shown above) will be able to use it. It is our intention to offer translations of the interface to several languages (Spanish, English, etc.) in the near future.

The rest of this paper is organized as follows. First, a general overview of the GIS systems and the design of user interfaces is given, in sections 2 and 3. Section 4 describes the Galician Virtual Library, the framework where the Virtual Tour through Galicia is located. Then, in Section 5, the technical details about the system are given, and the description of how its interface works is detailed in Section 6. The last section offers our conclusions.

2 Geographic Information Systems

The exponential improvement in the performance of computer systems has made possible the appearance of new tools to manipulate geographic (spatial) characteristics of objects, allowing their graphical representation on a map. Geographic Information Systems (GIS) make a step forward over traditional information systems, offering an appropriated environment for the capture, storage and management of both non-geographic and geographic information.

The inclusion of Spatial information in the SQL:1999 standard (Zetie, 1995) or the developments by the Open GIS Consortium (<http://www.opengis.org>) are a good measure of the importance of the management of spatial, and therefore geographic, information. By geographic information we mean information about the spatial location of objects. This information can be as simple as the position in the map of all the museums on a country or as complex as the partition of a country in zones with regard to their climate, administrative areas, etc.

In this section we shall briefly review some of the characteristics of a Geographical Information System.

It is known that GIS have a very strong graphical component, since the easiest way to evaluate geographic information is visually. However, a GIS provides much more than pure graphics processing. While geographic information is fundamental, there can be equally important information that can be accessed through the GIS. This information ranges from the common structured data stored in a relational database to multimedia information, and it is usually linked to a specific spatial “place”. Therefore, we shall deal with the following types of information:

- Traditional, relational or structured data: It is the kind of information used in relational databases, such as numeric values, strings of characters, or dates. For example, the name of a river or the population of a town belong to this type.
- Multimedia data: It includes images, videos, or sounds. For example, a picture of a museum or a national anthem are multimedia information.
- Spatial data: It is the information managed by a GIS, and is defined below.

The spatial information can be stored using a variety of formats, the most common being vector and raster formats. Vector formats allow for higher precision and more complex algorithms, and are suitable for discrete domains (representing separate, individual spatial objects). Raster formats represent a (continuous) space using a finite set of cells (pixels), and is suitable to deal with continuous spaces, approximately representing geographical positions. Using any of these formats, the entities that must be geographically referenced will have associated a *geometry* attribute, and this attribute can be any of the following three types:

- A *point*, which is a simple point in a Euclidean plane. It is used to store the position of an object.

- A *line*, which is a collection of segments, commonly used to describe routes or roads.
- An *area*, which is a collection of polygons (that can contain or not one or more holes), used to represent a surface.

In addition, geographic elements are usually arranged in layers. A *layer* groups elements that belong to the same category. For example, we can use a layer to manage the rivers in a map, and a different one to deal with the network of roads in the same map. These layers can be managed as a whole, so for example all roads can be displayed at the same time, or a query that affects all rivers can be performed.

Figure 1 shows a map of a region where three layers (natural spaces, rivers, and museums) are shown, and the remaining ones are hidden. Using layers is one of the techniques we offer to provide the user the ability to interact with the map.

The rest of the (non spatial) information used in a GIS, whose nature and quantity depends on the use of the GIS, is usually managed by a DBMS, but always linked to a geographic element. Figure 2 shows a window with the structured information (like the name of the place) and multimedia (its picture) obtained from a geographic location. This window appears when we click on the object (in this case, a castle) that is found in the map.

3 Designing User Interfaces

Designing and implementing friendly and easy to use interfaces has gained a lot of attention in the last years, going from the original and deprecated idea that the interface is a “sugar layer” for an application, to consider it as important as any other aspect of any software application. This aspect is fundamental when building a Web application, where we can find users with very different skill levels. It is, therefore, crucial that any user with minimum skills in the use of a Web browser will be able to use our system and find all the information of interest for him or her.

In order to achieve this goal, we have decided to use different techniques well known in the Human Computer Interaction research field (Preece, 1994; Schneiderman, 1997; Zetie, 1995). We have focused our attention in the use of two of these techniques: the use of cognitive metaphors (also known as analogies) and the browsing and navigational approach.

The *cognitive metaphor* technique is based on a simple, yet effective, principle: it proposes the use of something known by the user, translated into a new domain, in our case a graphical interface. A common example of a widely used analogy is the calculator present in any operating system, such as Microsoft Windows. It is clear that most users will know how a calculator looks like, and how it works. Thus, using a program that presents a similar aspect and has the same functionalities as a real calculator should not present any problem for a common user. As we shall see in Section 6, we have chosen to use a map of Galicia as a cognitive metaphor for our system.

A second aspect of our interface that makes it very easy to use is the *browsing and navigational approach*. This technique intends to lead the user to get the information she wants through several easy steps. The usual way of obtaining a concise answer to a query is to offer a powerful and very complex interface, where the user can perform intricate queries that are answered with a very precise response. Instead, we believe it is preferable to offer a simple interface, very easy to use, to perform a simple query, and then guide the user through a set of steps that refine it and finally give the desired answer. Starting from almost all the available information in the database, the user can, in an intuitive and easy way, narrow the quantity (and type) of information that is shown, until finally the desired information is obtained. We use the term *browsing approach* to represent the technique that allows users to look through several elements, as browsing through the pages of a book, and the *navigational approach* enables the “hyperlink jump” using visual elements. This approach, and some other aspects that are particular for our system are discussed below.

The reasons that lead us to use the browsing and navigational approach come from some studies in the Human Computer Interaction field. These studies referred to the design of Web interfaces for text retrieval, but they are also applicable here. They indicate that users rather build single queries, so retrieving a large set of results and then navigate through them, than build more complex queries that retrieve a little set of results or perhaps a unique response. For example, in (Lucas, 2001), some studies done by popular search engines like Excite or Altavista, can be found, showing that most of the queries, about 72%, consist of up two words, and nearly 80%

of all queries did not include operators, neither boolean operators (AND, OR) nor the symbols “+” that forces a word to be included in the document, or “-” that forces a word to not appear.

Below we shall show the intended use of our interface, and how the described techniques were applied to ease the use of our interface.

3.1 Specific issues concerning our system

The system we are describing is intended to be used as a touristic guide through Galicia. However, it is not our intention to offer “classical” touristic services for mass tourism, so we do not offer (for the time being) information such as location or availability of hotels. Because of its history, and also by its topography, Galicia is better known by visiting small villages or places that, apart from their beauty, have a considerable historical interest. These small places are proud of their local community, their heritage, their local mythology, and always welcome visitors.

Thus, our goal is to provide potential tourists with the necessary information to build their proper routes, so they can easily make a plan for an enjoyable cultural tourism. These potential tourists, who travel for fun, culture and adventure, want to know places and people, and mix with local activities. This experiential tourism has various kinds of synergies and indirect benefits, helping to bridge cultural gaps, and would be promoted by offering the appropriate services in a Web page.

Taking these aspects into account, we want to offer a tool to not only search for a specific place, but also to be able to organize different types of journeys. For example, users will be able to plan a cultural journey visiting museums and monuments, or a more “adventurous” one going through rivers, landscapes and nature spaces, resting in the spas or country houses found in the route.

As discussed in the introduction, there are several types of potential tourists, and it is our goal to fulfil the necessities of all of them. Thus, for example, we offer literary routes that are useful for people with some knowledge about our culture. It will be very interesting for a child studying Ánxel Fole (a prominent 20th-century Galician writer) to know the route he travelled, in order to better understand his works. For a broader audience, we can find pilgrimage itineraries to the Apostle St. James (Santiago) tomb. Specific places of interest, such as beaches, spas, museums, and the network of roads to reach them, are also available.

If tourists were to plan these trips classically, they would take a map to locate the places of interest. Therefore, we shall use a map as the main cognitive metaphor for our interface. We have the advantage that almost everybody can use a map, because they *understand* it. That is, finding a blue line is immediately identified as a river, or a black triangle is interpreted as a summit or a mountain.

The browsing and navigational approach is also implemented naturally. Any user can “browse” through the map just by moving the mouse pointer over it, which is quite close to what we do with a natural map. Who has not moved his finger along a road in a map to find the next cross to some town? Additionally, the navigational approach will be implemented by having “active” elements that will lead to some information when they are clicked, such as showing the picture and the available information when we click on a monument. These aspects are shown in detail in Section 6.

4 The Galician Virtual Library project

The “Virtual Tour Through Galicia” is accessed from the Galician Virtual Library Web site (<http://bvg.udc.es>). The Galician Virtual Library is a project that was created with two main goals: to spread the Galician culture and literature, and to offer a centralized access point to any kind of information about Galicia, in order to overcome the lack of systematization present in the current contents of Galician Web pages, which are decentralized and scattered, without a common link. With these goals in mind, we try to offer a centralized point to access any type of information about Galicia, its culture, and its literature, but also other important aspects such as touristic information, newspapers, universities, etc.

The rest of this section will give a brief overview of the history of Galicia, and the main characteristics of the Galician Virtual Library.

4.1 A brief history of Galicia and the Galician Language

Galicia is a region in Spain that occupies an area of 29.432 km² in the Northwest of the Iberian Peninsula, located just at the north of Portugal. It is due to this proximity that deep linguistic, cultural and economic ties have traditionally joined Galicia and Portugal. Nowadays, about 2.800.000 people are living in Galicia. Most of them, around a 70%, claim to speak Galician and, about a 99%, claim they understand it perfectly.

The first great culture to appear in Galicia were the Megalithic culture and the Bronze Age. From these eras, we have thousands of “mámoas” (a type of tomb or sepulchre) throughout the entire territory, as well as splendid pieces of gold and bronze jewels, weapons, and many other kind of artefacts, that can be seen today in museums. In the second half of the Iron Age, the Era of the “Castros” (forts or stonewalled metropolis) flourished, which are now very interesting touristic places.

The Romans conquered Galicia and transformed it into a province of the Empire, calling it Gallaecia. Galician, the current official language in Galicia (in conjunction with Spanish), comes from the Latin brought by the Romans, but it also includes many words coming from previous cultures like the Celts. In the last years of the Roman Empire the Swabians reach Galicia, which finally integrate with the Galician-Roman population until their defeat at the hands of the Visigoths.

Islam arrived in the south of Galicia, and it was only the north that was maintained as the last bastion of the Reconquest (of Spain). The Reconquest religious war, in the Middle Ages, was to bestow an extremely important role upon Galicia with the discovery of the Apostle's tomb (St. James or Santiago). Santiago de Compostela was the opposing religious center to Mecca, reinforced by the fact that knights going in Pilgrimage obtained the pardon and the same advantages as if they went to the Holy War against the Muslims. All of Europe was to make its way to Compostela and the Pilgrim's road to Santiago was to become a cultural highway along which Romanic art and the trobadoresque lyric would spread. Becoming a religious center greatly contributed to the preservation of its cultural identity.

The variation of Latin produced in the Northwest of the Iberian Peninsula caused a new language, Galician-Portuguese, the language of the western peninsula from 12th to 15th centuries. In this stage, the “golden age” of Galician literature, was when Galician-Portuguese lyrical poetry merges, strongly enforced by the pilgrimage to Santiago. At this time, Galician was something of an international language, being used not only by writers but also in royal and feudal courts.

In the Modern Ages, Portugal and Spain became two independent countries. While in Portugal the Portuguese became its official language, the Galician in Spain was excluded from official texts in benefit of Spanish, and survived only orally through its people. This era is known as the “Séculos Escuros” or The Dark Centuries, where the Galician suffered a high level of dialectalization of the language. The “Rexurdimento” or Revival period occurred in the 19th Century. The recovery of Galicia was literary but also cultural, political and historical. Writers of this age had to “invent” an orthography because Galician language had not been written for three centuries. At the end of the Spanish Civil War and the start of Franco's regime the Galician was also deprecated, until the last years of the 20th century, with the democracy, when it became alive again, being protected by law and spoken by a quite large number of people. So, in the last years of 20th century, Galician literature was rapidly gaining importance.

At the same time, during the 19th and 20th centuries, due to their poor economic status, Galician people emigrated to different countries. The emigration was mainly to Latin America in the 19th century, with almost 25% of the population (to the point that it is common to use the word “gallego” —Galician— as a synonym for Spaniard in Latin American countries like Argentina). After the Civil War people emigrated to Europe, especially to Germany. These people and their descendants still maintain a close contact with Galicia, so we can consider the Galician a very scattered community. It is important to note that, for a region with less than 3 million inhabitants, the Galician diaspora is formed by about 500.000 people, including first, second and third generation Galicians. The Galician Government is making a great effort to bring such people to Galicia, especially third generation children, in order for them to know their roots and understand their parents and grandparents culture and pride.

4.2 The Galician Virtual Library Web page

Considering the history of Galicia, as well as all the social and linguistic characteristics discussed above, our project was to build a Web page, a sort or portal, with the following goals:

- *To spread the Galician culture and literature.* This includes current writers but also classical ones coming from the different stages of the literary history of Galicia. It is also our intention to offer a platform to encourage new authors, and publish their works on the Web.
- *To offer a centralized access point to any kind of information about Galicia.* The Galician community, mainly due to the emigration, is scattered around the world. The Web pages that offer any kind of information about Galicia are also scattered and lack a systematic organization. With these facts in mind, we try to offer a centralized point to access any type of information about Galicia, its culture, and its literature, but also other important aspects such as touristic information, newspapers, universities, etc.

With these goals in mind, the inauguration of the *Galician Virtual Library (BVG)* took place in February of 2002, and it is available at <http://bvg.udc.es>.



Figure 3 shows its main entrance. The description of this virtual library is beyond the scope of this work, but we shall highlight its main parts in order to focus on the *Virtual Tour through Galicia*. The main page contains several well differentiated parts:

- The **Virtual Library**, in the central part. It provides access to the literary works available in the library, in a variety of formats (HTML pages, digitized pages of antique books, and even audio and videos).

Notice that in the whole Virtual Library we make extensive use of cognitive metaphors and the browsing and navigational approach. For example, the TV and video set lead to the available videos, and the shelves and drawers are a visual and intuitive way to classify the available writings.

Our catalogue includes about 201 authors and more than 2200 works, from which 342 works are available for reading, either as texts, HTML pages, or images (a total amount of 1640 digitalized pages). There are also 30 audio files (authors reading their works, or prominent writers reading classical books) and 17 video files of the same nature. These works include classical authors, but also new ones, who can send their contributions by a special service offered by the Virtual Library, the “New authors” section or “Sección de Novos”, which now contains 35 new works. The works presented by new authors are available for reading, and the public can comment on these works, so the new authors can obtain opinions and feedback on their works. There is also a “competition” where new authors get marks for their works, and the winner will become a “regular” author in our library.

In order to provide a medium to offer a direct communication among “regular” authors and their public, each one has his or her own Web page on the Virtual Library, where his/her biography (autobiography, if the author is alive) is available, as well as his/her books. In addition, all authors have a “News” section, where they can inform the public of incoming events. It is also possible for any user to send a message or comment to the author, thus promoting the direct communication between writers and readers.

- A **description of our project** and its members, including a “News” section, located on the left of this page. This section offers news in general (forthcoming interesting events) or news in the Web pages of the authors included in the library.

- A set of organized **links to interesting Web pages about Galicia**. It is a categorized list that includes institutional Web pages, universities, publishing companies, and Galician Webs in general.
- The *Virtual Tour through Galicia*, which is accessed by clicking in the map in the lower center part of the page. Its description is the main goal of this paper, so it will be described in the next sections.

5 Data and technology used to build the Virtual Tour

We shall describe in this section the data model of the information managed by the Virtual Tour, in order to give an idea of the type and quantity of the information being managed. Then, we shall briefly comment on the technology used to build it.

5.1 Data model

Before detailing the information stored in our database, whose Entity-Relationship model is shown in

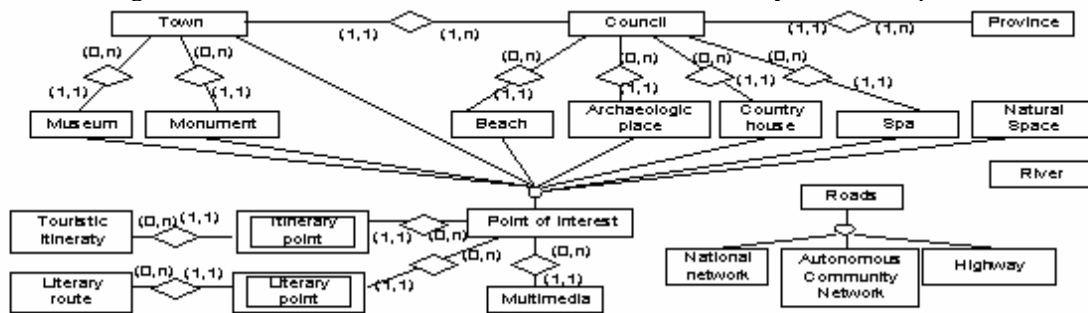


Figure 4, and due to the different nature of this same information, we first need to classify it into the 3 categories described in Section 2:

- Relational data (alphanumeric), such as the name and address of a museum, a phone number, or the name of a road.
- Geographic information: Those entities that must be geographically referenced will have associated a *geometry* attribute, and this attribute can be any of the three defined geometric types: a *point*, a *line*, or an *area*.
- Multimedia information: Mainly, the multimedia information used in our system consists on pictures, but we plan to extend it with videos and sounds, as we already did with the Virtual Library.

The different entities that form our data model can be classified in the following categories:

- Territorial structure: As in the rest of Spain, the Autonomous Community of Galicia is divided in provinces, each having a number of councils. Finally, each council can have one or more towns. In particular, Galicia is divided in 4 provinces. The two first entities, province and council, are geographically represented using an *area* geometry attribute, and towns are represented by points. The importance of this category of information is, as we shall see, that they conform the best references for the user when navigating through the map.
- Network of Roads: This category includes only entities of type *Road*. There is information for the most important roads in Galicia (autonomic and national roads, and highways), and they are geographically represented using attributes of type *line*, without any multimedia information.
- Cultural entities: This category includes archaeological places, museums and monuments like churches or palaces. There is usually multimedia information associated to these entities, and the geographical information depends on the cultural entity. Archaeological places are represented by points, and museums and monuments have not specific geographical information. However, since they are buildings and they are

located in a town (geographically referenced by a point), it is also possible to know their approximate location.

- Touristic resources: It includes spas and country houses, as well as bed and breakfast services in interesting natural places. Elements in this category are represented by a point, and they can also contain multimedia information.
- Nature: Used to represent mainly beaches, natural spaces and rivers, this category stores multimedia information about these places. They are geographically represented by objects of type point, area, and line, respectively.
- Literary Routes and Touristic Itineraries: They form points of interest, which are composed of a number of entities of the previous categories except rivers, roads, councils and provinces, with a line geographical attribute that links them and shows the communication lines that can be used to traverse the route or itinerary.

5.2 Used Technology and Architecture of the System

We have integrated in the *Virtual Tour through Galicia* Web pages different formats and technologies, some of them fairly new in Internet, in order to offer the users the possibility to quickly and easily search for information about Galicia.

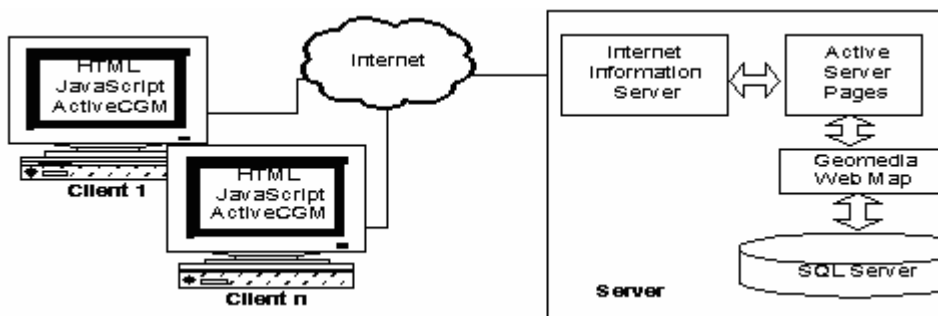


Figure 5 shows the different components that had to be integrated to develop the system. The task of publishing geographical information on the Web implies the design and implementation of a client/server application, where the server stores the geographical data as well as the “traditional” and multimedia data. The server builds the maps and transfers them embedded in an HTML page to the client, which can be any Web browser. The browser interprets the information and shows the map to the user. It is clear that both the server and the browser must be extensible, that is, they must be able to use objects knowing only their interfaces, but not how they are internally implemented.

The data is stored in a database managed by the MS SQL Server DBMS. This database stores, besides traditional (relational) data, like alphanumeric information, multimedia elements and spatial information. The spatial information is managed by Geomedia WebMap (see, for example, Limp & Harmon, 1998), a product by Intergraph Corporation that allows to store geographical information associated to database tuples. It also offers a programming interface that allows Web pages designers to build maps with the information available from the database.

The geographical information is internally stored in a spatial column in the tables that use it. This column stores, in a binary proprietary format, the description of the geometric object associated with the tuple.

The programming interface used by Geomedia WebMap is based in the Microsoft COM (Component Object Model) technology, which permits to use the components available in a system from any programming language, because it is based in a binary and network standard that uses a machine-level language for the communication. These components are treated as black boxes that hide their implementations, and show their functionalities through a public interface. Geomedia WebMap components allow the programmer to make a connection to any data source and select the information that shall be displayed, which is returned by WebMap as a map.

In order to show a map in an HTML page, we need to build dynamic pages that are able to use the COM components of Geomedia WebMap to dynamically generate the maps requested by the user. We have chosen Internet Information Server, from Microsoft, as our Web server because it allows creating dynamic HTML pages

using the ASP (Active Server Pages) technology. Using ASP, a Web page can include sequences of commands that are executed in the server, so the integration with other products that use the COM technology is very easy to implement.

Summarizing, in order to show a map in an HTML page, we embed in the page parts of ASP code that use COM objects (from Geomedia) to query the database managed by SQL Server, and produce a map that is transferred to the user embedded in an HTML page.

The client (the browser) receives a Web page with an embedded map. The format of the data in this map depends on how the map is used, so Geomedia offers several image formats, including raster and vector ones. We have chosen the CGM format, a standard vector format used to represent images and define additional information or metadata. Besides, using the CGM format allows for the use (on the client side) of the ActiveCGM (an ActiveX) component from Micrografx. This component allows to extend the client, in this case the Web browser, to display the map (in CGM format), and allows the developer to add dynamic characteristics to the maps. Unlike using image formats, using the CGM format to represent and show the map, the developer can link each graphic element with the information stored in the database, zoom any part of it without performing another query, etc.

Finally, the scripting language JavaScript was used to implement (in the browser) the activity related with the actions of the user on the interface.

6 The interface to the Virtual Tour through Galicia

The design of the Web page that offers the Virtual Tour through Galicia has been developed taking into account the ideas described in Section 3, the use of cognitive metaphors and the browsing and navigational approach. We shall describe in this section how the interface works, while noting when and where these techniques were applied.

The system we are describing is intended to be used not only to search for information about interesting places in Galicia, but also to plan itineraries to get a better knowledge of the Galician culture. For this purpose, we use an interactive map of Galicia as the main cognitive metaphor.

As discussed in Section 3, the main advantage of using a map is that almost everybody is able to *understand* and *interpret* a map. All the different geographic elements are quickly identified (for those elements not very common on maps, such as spas or country houses, there will be a legend explaining their meaning).

A real map only helps on finding place, but it does not usually offer any way of obtaining more information about it. In our system, when a user moves the mouse over an area, it is highlighted showing its name, and if she clicks in an area, a popup window shows some information about the place. For example, moving the mouse over the map, the councils are highlighted and their names are shown. Clicking in any of them, a new window informs the user about the number of monuments, beaches, archaeological places, etc., located in this council.

Before entering into detail on how the interface works, we have to note an aspect of the system that must be considered only when it is used for the first time. As indicated before, the interface uses the ActiveCGM component in order to show the map and interact with it. This component is not usually installed in many computers, so it needs to be downloaded (just the first time the system is used) and installed. This is automatically done by the MS Internet Explorer, and the system only takes some time to download and install it. For Netscape Navigator users, a new page informs that the necessary plug-in must be downloaded and installed in order to see the map, and provides the necessary links to do it. In any case, the system informs the user of these aspects, in order to avoid any type of confusion. It also offers a detailed help in case there is any problem with the visualization of the map, so the user can appropriately configure the browser.

6.1 The Virtual Tour Web page layout

The Web page for the Virtual Tour, shown in

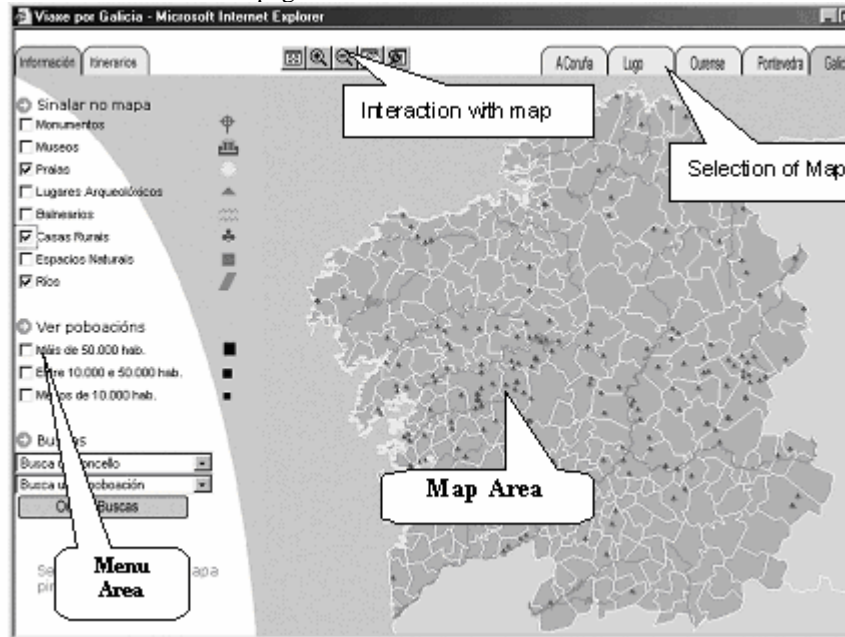


Figure 6, offers two main areas: the *Map area*, and the *Menu area*. The map area basically displays a map, either of the whole of Galicia or one of its provinces, and allows the user to get information about any element that is displayed. The menu area, as well as the row of tabs on the top right corner of the page, helps us to implement the browsing and navigational approach, allowing to select the information of interest (that will be displayed on the map), or to search for a given place.

The map, shown on the right part of the interface, displays in its initial stage the 4 provinces and its councils, but other elements can also be displayed, as shown below. As it would be expected, all the maps are sensitive. Moving the mouse pointer over a geographic object, it is activated, changing its color and showing its name (this improves the metaphor of reading a map pointing elements with a finger, also implementing the browsing approach). These elements can also be clicked, and as a result a new window, with information of the object, is shown. Figure 2 shows an example of this: when a monument is clicked, in this case a castle (“Castelo de San Antón”), a picture of it is shown, along with the information available for it. This is how we have implemented the navigational approach.

6.2 Basic interaction

Apart from the mentioned aspects of active elements that are highlighted by moving the mouse and the appearance of new windows with information about a clicked element, users can modify the information displayed in the current map, in two basic ways:

– Choose a different map or modify the current one:

The map that is initially presented shows the whole map of Galicia, with its 4 provinces and all their councils. By selecting the appropriate tab on the top of the map, it is changed, showing the appropriate map. Choosing a province map (using the tabs labelled with the names of the provinces: A Coruña, Lugo, Ourense and Pontevedra), only the councils of the selected province are shown (with more detail), and all visualization and search operations are restricted to the selected province.

This has the side effect of decreasing the amount of information present in the maps, thus increasing its response time. Changing to a new map shows it in its initial stage, that is, it only shows the councils and provinces. Besides, only those councils belonging to the current province can be accessed.

In addition, we can find a row of buttons, located on the top of the map, that allow the user to modify the current map. This row is composed of 5 buttons that permit to increase or decrease the zoom of the map, move it, reset the scale to its original, or open an additional window that acts as a magnifying glass, enlarging the area of the map around the mouse pointer location.

– **Modify the type of information shown in the current map:**

We have shown in Section 5.1 that there are several categories of information linked to the geographic places, such as networks of roads, monuments, or beaches. The Menu Area in the left of the page can be used in order to select the categories to be displayed. This can be done because of the layered structure of the maps, where each layer groups geographic entities of the same category (beaches, museums, routes, etc.) that can be displayed or not. Thus, by checking several check boxes, their associated layers can be superposed, building a complex map.

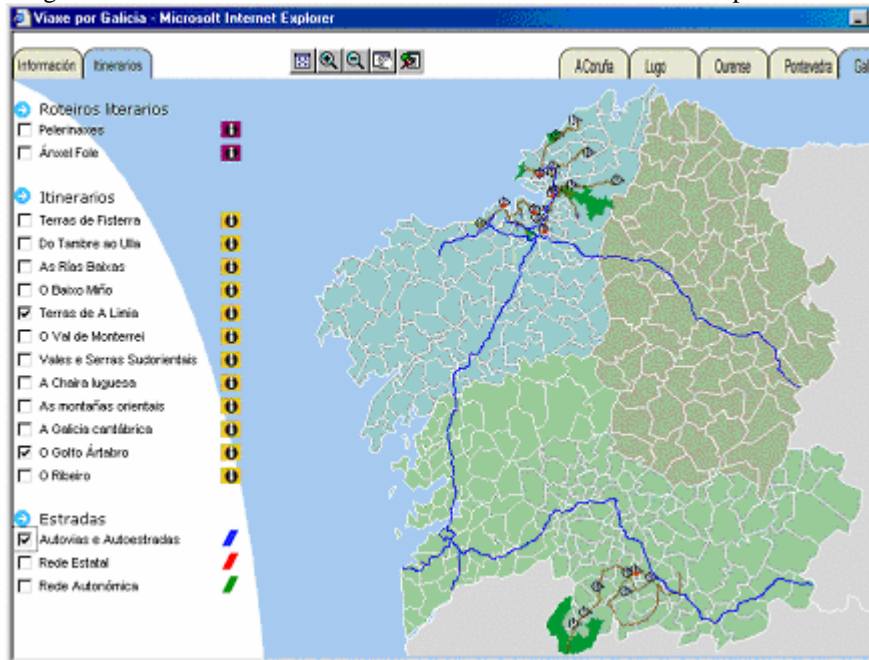
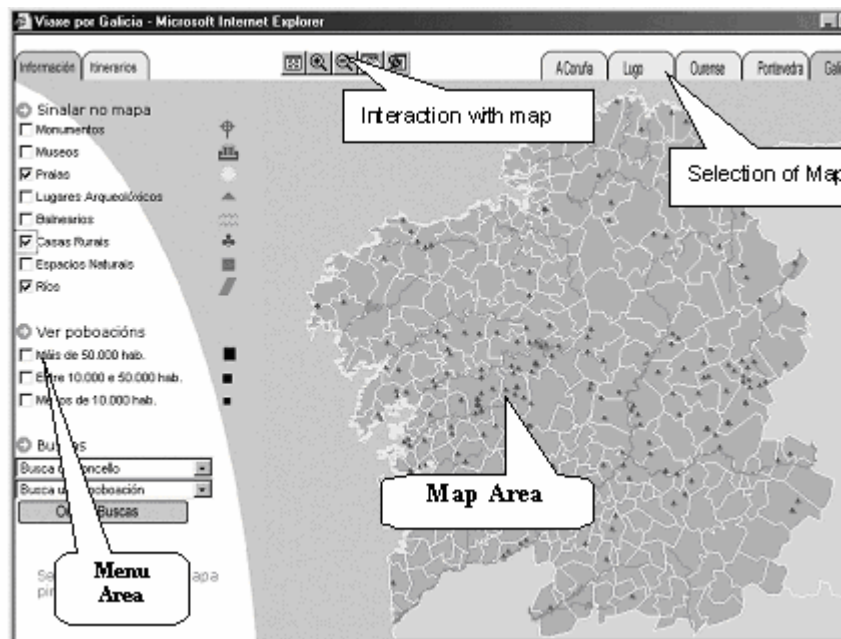


Figure 7 shows the map containing councils and provinces (this information is always shown), beaches, rivers, and country houses.

This layered structure of the map has two main advantages: to avoid performing unnecessary complex queries to access the information of one or several elements, thus improving the response time of the system, and to help implementing the browsing and navigational approach, because the information that is of no interest for a given user is hidden and the interesting elements are more easily found. As an example, if a user wants to locate the archaeological places near the coast, the user can activate the archaeological places layer, and visually identify which ones are near the coast.



As shown in

Figure 6, the menu area has two tabs: “Information” and “Itineraries”. Both are composed by a set of check boxes that will tell the map to show the associated layer or to hide it, depending on whether the checkbox is checked or unchecked.

The “Information” tab can be used to activate or deactivate layers composed of individual elements, such as museums, beaches, spas, country houses, or nature spaces. The second tab, “Itineraries”, is used to display several touristic itineraries and literary routes on the map. The elements of interest that are close to the route, as well as its trajectory, are displayed in the map. This menu also permits the visualization of the different networks of roads existing in Galicia or in the selected province.

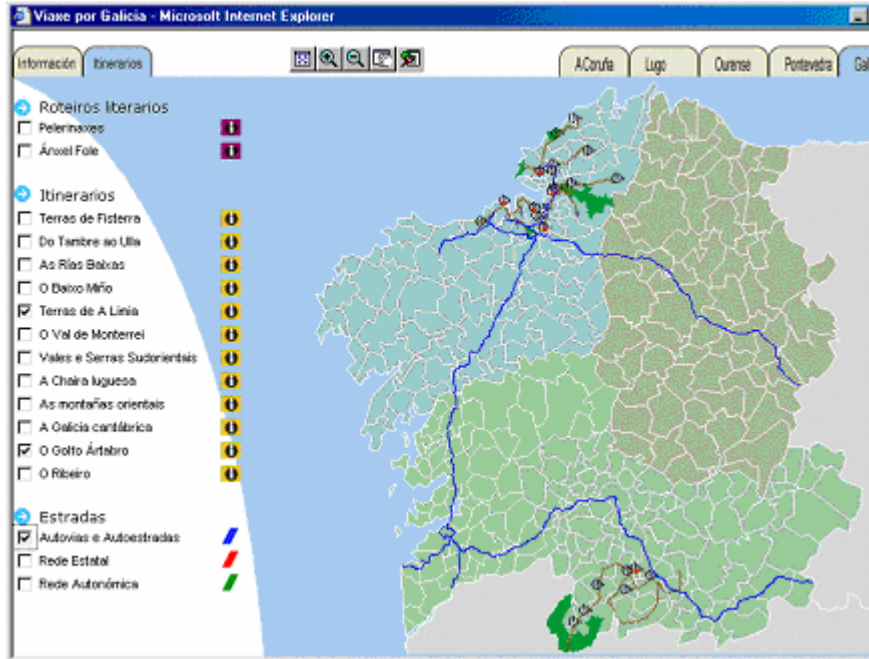


Figure 7 shows a map with two itineraries and the network of highways in Galicia. Also, note the “Itineraries” menu on the left of the page in the same figure.

As discussed before, the use of itineraries can have different uses depending on the level of knowledge of the prospective tourist about Galicia and its culture, ranging from “area” routes to literary or pilgrimage itineraries.

– **Perform searches:**

Users are also allowed to perform searches, using the *search area* at the bottom of the menu area. It offers a simple interface to search for different elements. The most common queries, searching for councils and towns, are also the most easily done: the name is selected from a list. As a result, the element is displayed in the map. This can be done because the alphanumeric information about the element, and its geographical location, are linked in the database.

Searches about touristic or cultural elements are performed using a very simple interface where the user checks the category of the element she is searching for, and types its name or part of it (a simple approximation using Text Retrieval techniques is used, so it is not necessary to write the whole name). The result of the query is a list with the names of all elements that match the selection criteria. For each one of them, it is possible to get the information available for it (*browse* through them), or to display it blinking in the map, so it can be more easily found.

6.3 Planning a journey

The goal that lead us to build the Virtual Tour through Galicia was to offer a tool that could be used to plan a journey through the Galician territory. Not especially interested in mass tourism (but not discarding it either), our main intended audience was people looking for a cultural and “adventurous” tourism. These tourists usually like to plan their trips in a way that allows them to mix with local traditions and people, at the same time as they enjoy pleasant places and absorb the history and culture of the places they travel through. If this kind of tourism is to be done by going through small, scattered villages and places, the need for a well planned trip is obvious.

This is especially important in Galicia, because, due to its topography and countryside culture, most of the places worth visiting are scattered throughout all the Galician territory. We do not avoid, however, larger cities, because as we all know many museums, monuments or rest spaces are located close to them.

With these facts in mind, a prospective tourist can use our map to plan a trip through Galicia. The use of the Map Area of the Virtual Tour helps in this task because individual categories of information can be shown (using the “Information” tab) so they can visually find the “shortest path” that covers all the places of interest. The ability to display also the network of roads helps to make detailed plans for the journey.

On the other hand, users can also take advantage of “predefined” journeys. By using the “Itineraries” tab on the Menu Area, they can choose to follow the path some significant people followed before, for example important authors like Ánxel Fole, or pilgrimage routes. For this reason, several routes are made available, being highlighted on the map (if the user chooses so), and showing the interesting touristic places around the route. Of course, since all the available information can be displayed on the maps, users can choose to partially follow a predefined path but, at some point, deviate from it and travel to other places more attractive to them. Thus, users can easily “personalize” the predefined routes.

7 Conclusions

Internet has become very popular in the recent years, and many Web pages are opened each day. Tourism is not apart from this new technology, however the particular characteristics of touristic information, specially its spatial nature, turn the design of easy to use and friendly touristic Web interfaces a difficult task.

The design of most of the Web pages with touristic information up to now was based in a somehow static idea, with a mixture of text and noninteractive maps. In this work, we have the use of the well known GIS technology mixed with multimedia databases to improve touristic Web interfaces and offer the ability of interaction with the maps. Although GIS are widely used in some fields like civil engineering or public services, we think that they can be also a valuable tool in the case of touristic information.

Additionally, we have also proposed two well know techniques used in the Human Computer Interaction research field, the analogies and the browsing approach, to build easy to use and intuitive interfaces. The level of acceptance and the feedback from the users that consulted our Virtual Tour through Galicia make us believe users in general can greatly benefit from these approaches, so the philosophy followed to build our system can be used to build any other touristic portal.

As a future work, we have several tasks to accomplish. One of these tasks is the translation of the Web site to several languages, such as Spanish or English, which will allow non-Galician speakers to use it. It would be also desirable to be able to offer through our system a sort of “forum” for the interested users, specially the Galician diaspora, which will improve the sense of community among them. Finally, we leave also as a future work the integration in the Virtual Tour through Galicia of a number of services of invaluable interest for users planning to visit Galicia, like the possibility of reserving hotel rooms, or buy travel tickets, thus integrating e-commerce solutions in the system.

8 References

- Brisaboa, N.R., Cotelo Lema, J.A., Fariña, A., Luaces, M.R., Viqueira, J.R. (2001). *S.I.T.P.A.C: A Territorial Information System for A Coruña Province*, Colima, México: Proceedings of 8th CIICC'01.
- Brisaboa, N.R., Cotelo Lema, J.A., Luaces, M.R., Viqueira, J.R. (2001). *State of the Art and Requirements in GIS*, Aguascalientes, México: Proceedings of the 3^{er}. ENC' 01.
- Chias, P.(1997). *Los sistemas de información geográfica*. Dpto. de Publicaciones de Arquitectura, Universidad Politécnica de Madrid.
- Esri (1997). *Understanding GIS, The ARC/INFO Method*. E. S. R. I. Fourth edition. 1997.
- Fredrick Limp, W., Harmon, D. (1998). *Inside Geomedia*. OnWord Press.
- ISO (2002). ISO/IEC 13249-3:2002, Information Technology – Database Languages – SQL Multimedia and Application Packages – Part 3: Spatial, International Organization for Standardization (ISO), Working Draft.

- Laurini, R., Thompson, D. (1992). *Fundamentals of Spatial Information Systems*. London Academic Press.
- Lucas, W. (2001) Search engines, relevancy, and the World wide Web. In Goyal, A. (ed.), *Text Databases & Document Management: Theory & Practice*. Idea Group Publishing.
- Preece, J. (1994). *Human-Computer Interaction*. Addison Wesley.
- Schneiderman, B. (1997). *Designing the User Interface*. Addison Wesley.
- Worboys, M. F. (1995). *GIS: A Computing Perspective*. Ed London Taylor Francis. 1995.
- Zetie, C. (1995). *Practical user interface design: Making GUIs work*. McGraw Hill.

FIGURE LEGENDS:

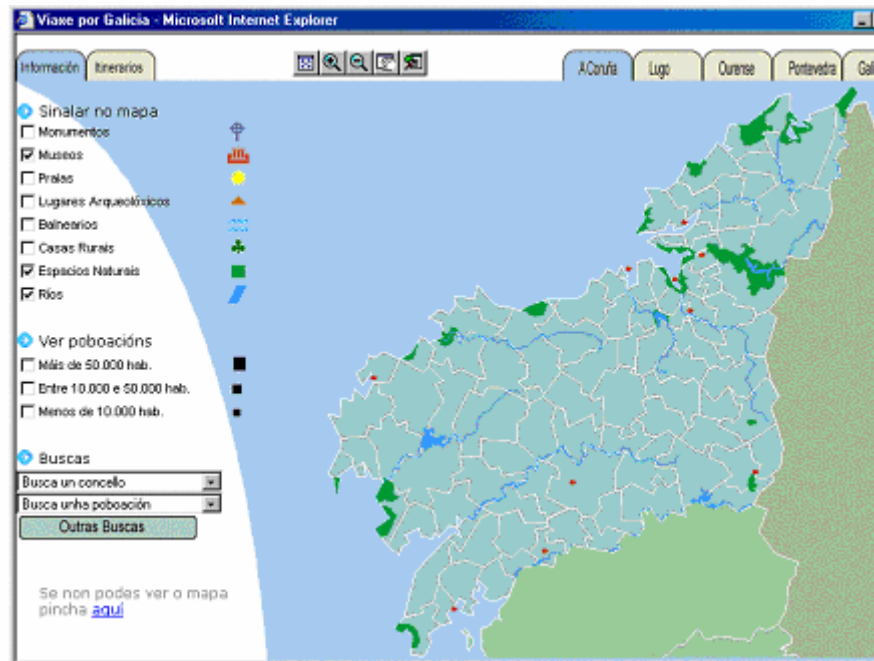


Figure 1. A map showing several layers



Figure 2. Accessing information linked to a location



Figure 3. The Galician Virtual Library

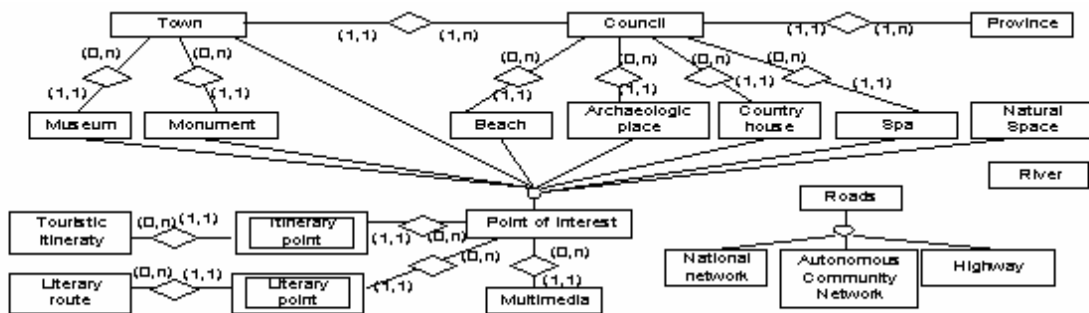


Figure 4. Entity-Relationship model for the Virtual Tour

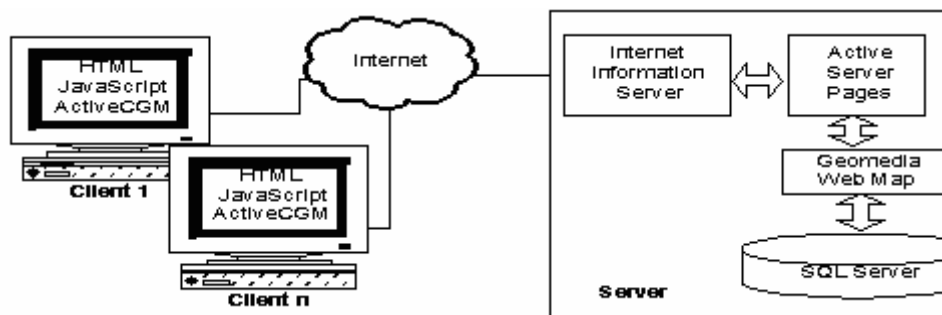


Figure 5. Architecture of the system

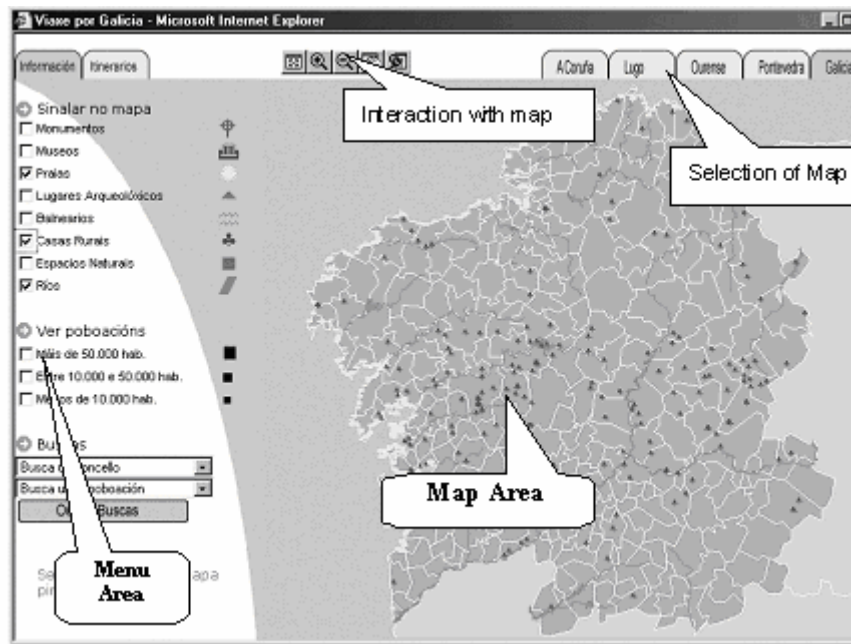


Figure 6. An overview of the system

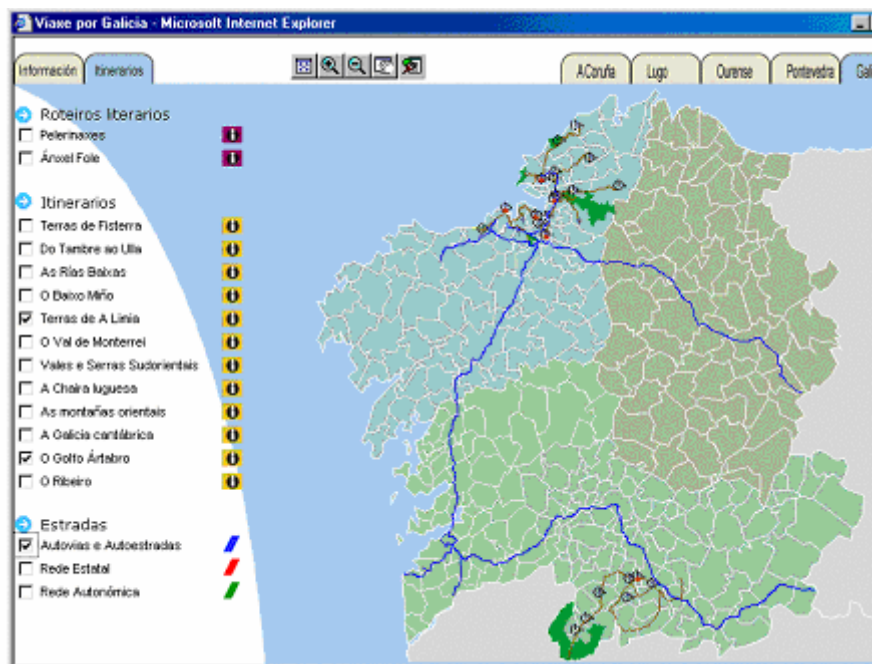


Figure 7. Itineraries and road networks