A Modular Approach to Support GIS Functionality in Tourism Applications

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Abstract

Geographic Information Systems (GIS) is a rapidly expanding field enabling the development of applications that manage and use geographic information in combination with other media. This technology, offers great opportunities for the development of modern tourism applications using maps to present information to the users in a natural and effective way. One approach to provide GIS functionality to applications is to exploit the facilities offered by modern operating systems for interoperability. This paper presents such an effort to build tools incorporating MS Windows OLE technology to provide GIS functionality to applications developed for the MS Windows platform. The first tool is Map Studio, a GIS editor used to prepare maps. The second is Map Control, an ActiveX control which can be used by an application in order to present and browse the maps created with Map Studio integrating them with other media or data coming from relational databases.

1. Introduction

Maps are a natural means of indexing and presenting tourism related information. Travelers are using maps to navigate during their travels and for preparing their routes. Moreover, maps exploit the two dimensional capabilities of human vision and present the information in a compact and easy to read way. Today, due to advances in modern telecommunication and information technologies, there is an increasing effort in the development of Geographic Information Systems (GIS).

Among the application fields that exploit these advances in order to provide powerful services is tourism [6][7][8], culture and education. However, most GIS, that have been developed up to now are operating in workstations and mainframes. Only a small number of GIS is operating in the most popular platform, PC/Windows. Moreover, these few GIS are far more complicated and sophisticated than a usual tourism application developer could handle and exploit. In order to overcome these obstacles and provide an easy to use GIS tool appropriate for tourism application development, Map Studio and (ActiveX) Map Control were designed and developed.

In this paper, we'll present R&D activities that took place in MUSIC that lead us to the creation of an easily adaptable Integrated Environment for the development of efficient applications with need for Geographic functionality.

In section 2 we present the data model of Map Studio and Map Control and implementation issues are discussed in sec. 3. Section 4 explains the process of developing applications, while related work is presented in sec. 5. Finally, sec. 6 concludes and presents directions for future work.

2. Terminology - The Map Model

In this section we describe the data model used in our development system. The data model [9][10] describes in detail the geometrical and topological attributes of geographic objects and it is complemented with presentation attributes, appropriate spatial access methods and graph and geometrical algorithms.

The basic object is the *Map* consisting of a stack of *Layers* (Figure 1) which may contain either vector or raster data [12][13]. Each Layer is defined as a set of non-overlapping geographic objects called *LayerObjects* which can be either *Positions (points)*, *Routes (polygonal lines that start and end to Positions)* or *Regions (polygonal areas surrounded by Routes)*.

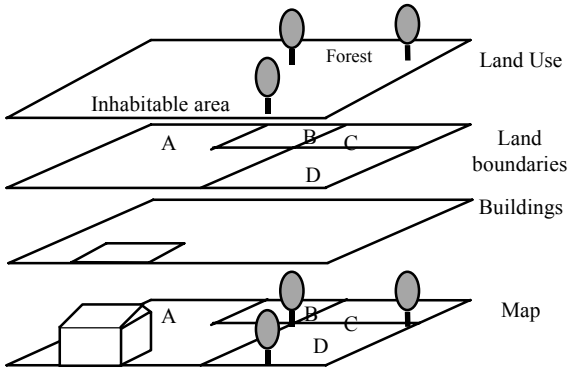

Figure 1 - A Map consisting of a stack of Layers

Topological relations –neighbours– are described using two logical graphs. The first graph associates *Positions* with the *Routes* that start and/or end to them, while the second one associates *Regions* with the *Routes* that define them.

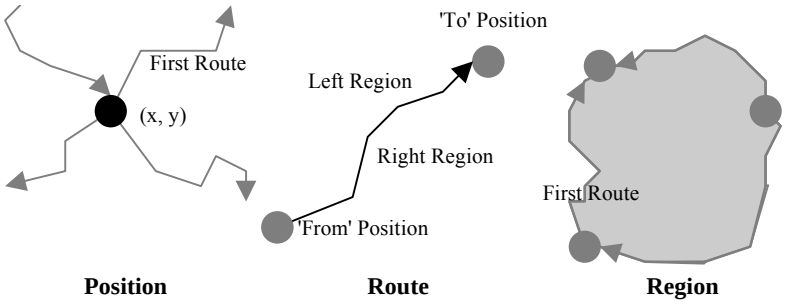

Figure 2 - LayerObjects and their attributes

Furthermore, a Map defines a set of *Drawing Styles* specifying the presentation attributes –i.e. the appearance– of geographic objects and are used to render individual LayerObjects or entire Layers.

3. Implementation

Most Geographical Information Systems, that have been developed up to now are operating in workstations and mainframes. Only a small number of them is operating in the most popular platform, PC/Windows. Moreover, these few GIS are far more complicated and sophisticated than a usual tourism application developer could handle and exploit. In order to overcome these obstacles and provide an easy to use GIS tool appropriate for tourism application development, *Map Studio* and *Map Control* were designed and developed.

3.1 Map Studio

With Tourism Application Development and the related requirements in mind, MUSIC's Tourism Application Development section proceeded in the design and the implementation of a simple –yet powerful– environment for the creation of Tourism Applications with embedded GIS functionality, named *Map Studio* [3][4].

Based on the rich vector model described in sec. 2, maps created with Map Studio integrate geometrical and topological information as well as support for object identifiers in order to provide links to data residing in external relational databases. Concentrating on efficiency, appropriate spatial access data structures –like Quad Trees [11]– have been implemented, while the actual size of the geographical data can be minimised using a compression technique inspired by the differential encoding scheme.

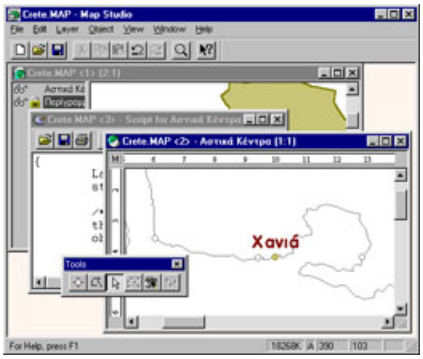

Figure 3 - Map Studio's user interface

Map Studio is a compact GIS capable of supporting interactive (WYSIWYG) editing of small to medium scale geographic maps consisting of vector and raster layers, which provides a graphical user interface that conforms to the Windows 95 User Interface Guidelines specification, as seen in Figure 3. Moreover, it supports *Object Linking and Embedding (OLE)*, a standard for application interoperability and data exchange which is dominating the Windows platform. Map Studio is capable of

acting as both an *OLE Server* and an *OLE Client*. This means that Map Studio allows other applications –such as Word Processors– to incorporate maps in their "documents" while in the same time it can *link to –external–* or *embed* data produced by other OLE Server applications –like typical multimedia data– in its maps. These non-native OLE objects are contained in a special Layer embedded in the map.

In its original design specification, Map Studio incorporated a language introduced in MUSIC named *Object Based Language (OBL)* [5] which was intended to be used as the language the Application Developer should learn and use to create a Tourism Application. Recent advances in the OLE standard –namely OLE Automation and OCX/ActiveX Controls– and their wide spreading among application developers world-wide, lead us to abandon this idea and support the ActiveX standard. The outcome was Map Control, which will be described in the following section.

3.2 ActiveX Map Control

As we mentioned above, *Object Linking and Embedding (OLE)* is a standard for application interoperability and data exchange between applications designed for the Windows platform. OLE is actually a set of related technologies as illustrated in Figure 4. A particular subset of OLE technologies –namely OLE Automation and OCX/ActiveX Controls– were adopted in order to fulfil the original goal of providing an Integrated Environment for the Development of Tourism App–lications with embedded GIS functionality. An in-depth analysis of these technologies is clearly out of the scope of this paper and the interested reader should consult the related bibliography [14]. However, for those who are completely unfamiliar with them we provide a brief description in[1]. The resume of the conformance to these standards is that:

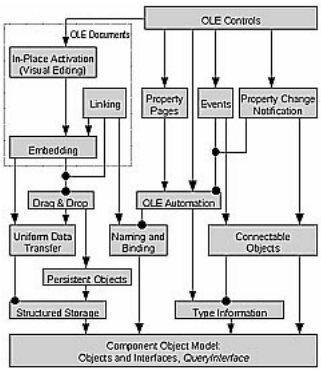

Figure 4 - OLE Architecture

"an application developer can use any development environment[2] and language that supports ActiveX Controls and OLE Automation in order to create an application".

As a result of the utilisation of OLE Automation and ActiveX Controls standards to the Map Studio philosophy, *ActiveX Map Control* was developed. Map Control is a software component which can provide any application with the appropriate functionality required to effectively handle Geographic Inform–

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[1] *OLE Automation* is a subset of the OLE standard, that specifies a way for an application to expose "*objects*" which it uses internally in addition to the requirements of a development environment where these *objects* can be used to create client applications that use this functionality.
ActiveX Controls, formerly known as OLE Custom Controls (OCX) is yet another subset of the OLE standard that is based in OLE Automation and specifies how a specific sort of functionality –expressed as libraries of OLE Automation *objects*– may be packaged into small, ready-to-use independent components, appropriate for Desktop and Internet-based Applications.

[2] Currently Microsoft's Visual Basic and Visual C++ and Borland's Delphi and PowerBuilder are the most popular among others

ation. To accomplish this, Map Control incorporates Map Studio's map viewing capabilities in order to display maps created with Map Studio. Editing features have been intentionally left out, in order to keep its size as small as possible, thus making it a convenient choice –considering code transmission speed and related costs– for Internet-based applications. This cannot be considered as an inconvenience as long as the control was designed to work in conjunction with Map Studio, as seen in Figure 5.

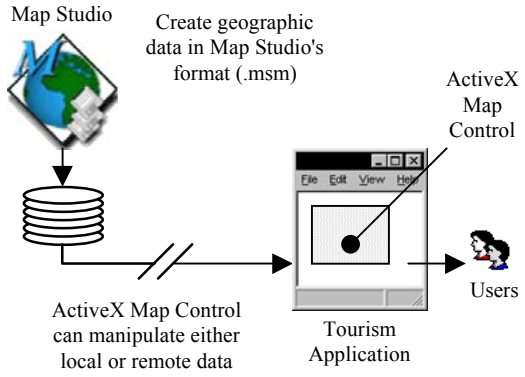

Figure 5 - Using Map Studio and Map Control in application development

4. Developing Applications

Figure 5 illustrates the methodology that should be followed in order to incorporate geographical information a Tourism application using Map Studio and Map Control. As a first step, geographic data is created using the interactive editing characteristics of Map Studio. The data can either accompany the application, or it can be stored in a remote WWW server. Then the application developer creates the application which incorporates Map Control, using a development environment of his choice. Map Control is then responsible to manage and manipulate the data, as directed by the functionality the developer uses in the application.

4.1 Objects, Properties, Methods and Events

Map Control exposes the appropriate objects (the *Map* being displayed, the *Layers* it consists of, the *LayerObjects* which are defined in each Layer, the *DrawingStyle* used to render each object and a lot more) in a way that is well-defined and can be considered known to millions of developers world-wide: OLE Automation's *Object* metaphor, each with its own set of *Properties* and *Methods*. Map Control exports over 20 programmable objects wich support over 80 Properties and 30 Methods in total. The exported functionality allows the application developer to otherwise manipulate the geographical information. As an example, he/she can:

- link map objects with data residing in external relational databases,
- add and remove *Layers* and *LayerObjects*,
- alter the appearance of –or completely hide and show– *Layers* and *LayerObjects*.

In addition, the application programmer can *handle* various defined *Events* –such as user interaction– by writing code that is automatically called when certain occasions occur. As another example, application code may alter the appearance of a *LayerObject* (expressed by its *Style* property) in response to the *EnterObject* and *LeaveObject* events (the mouse cursor "entering" and "leaving" an object's boundary) in order to highlight the "active" object (the object to receive the *ClickObject* event if the user "clicks" the left mouse button).

4.2 Development Environment

The resulting Map Control has been thoroughly tested in numerous applications created with the most popular development environments that support ActiveX controls and OLE Automation, i.e. MS Visual Basic, Borland Delphi and MS Visual C++. In addition, we have also tested Map Control over the Internet, a platform that is of great importance for MUSIC, that's why we'll dedicate the following section to analyse these applications.

4.3 Pilot Applications

In order to fully exploit and extend the functionality Map Studio and Map Control can provide, we've used this combination of tools –and we plan to continue using them– in WWW-based applications developed in the context of R&D programmes funded by the Eurpoean Union. This work will be explained in detail here.

4.3.1 Facilities of the city of Chania

Probably the most interesting application built with ActiveX Map Control up to now is a WWW–based Information System, named "Facilities of the city of Chania" [15], created for the Municipality of Chania. It is a multilingual[3] Information System created to provide WWW users with extensive information about the facilities offered by companies and organisations that belong to the private and public sector in the area of the city of Chania. While the main target group of the system is tourists and people interested in visiting Chania as tourists in the future, it is obvious that local inhabitants can also benefit from the information the system can provide since the Greek language is supported.

In this project, ActiveX Map Control is used to graphically project the facilities offered in the area of the city of Chania onto a self-contained, vectorised townscape of Chania. In order to accomplish this goal, the system makes extensive use of state-of-the-art Internet technologies such as ActiveX controls, Server-Side Scripts (Active Server Pages[4]) and Client-Side Scripts (VBScript).

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[3] Greek and English languages are currently supported

[4] Active Server Pages (ASP) is an extension to HTML implemented in Microsoft's IIS Web Server which combines common HTML and a scripting language. We use this scripting language to access our facilities database.

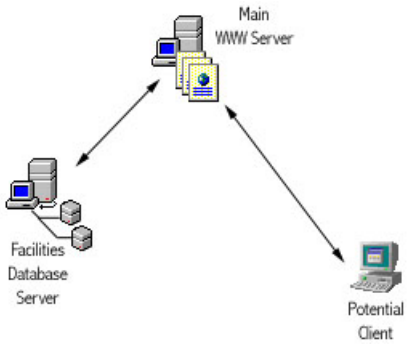

Figure 6 - System's Architecture

The distributed system's architecture is illustrated in Figure 6. There is a Main HTTP WWW server which serves as the entry point to the system, and provides the Potential Clients with the geographical data and the necessary software which displays and manages the data. Furthermore, in conjunction with the Facilities Database Server, it displays the facility data using the well-known "World Wide Web Page" metaphor. While the server side –and the services implemented therein– is represented as two independent machines –as in the current pilot implementation– it can be hosted in a single Windows NT server running Microsoft's IIS Web Server.

As seen in the screen shots below (Figure 7), the main page of the system utilises a city map of Chania which allows the user to retrieve information about a location –a street, a square or some other Area of Interest– using a simple point-and-click user-interface every computer user is assumed to be familiar with. In order to improve its usability, the system also offers well known navigation features (scrolling and zooming), as well as a search tool through which the user can find a location by selecting its name from a drop-down list of known names. After selecting a location using one of the methods described above, the system displays applicable information

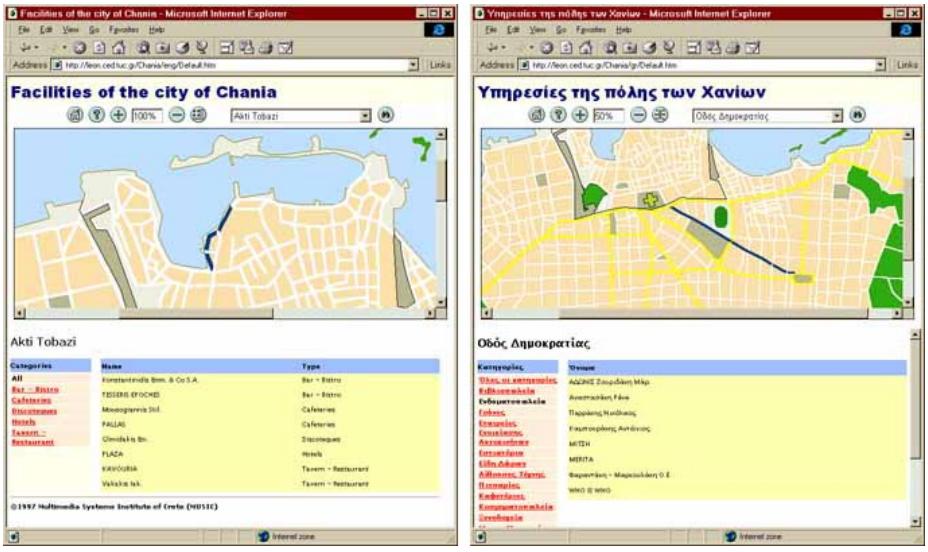

Figure 7 - The Facilities of the city of Chania WWW-based Information System. English version is shown to the left while the Greek is shown to the right.

on the facilities associated with the location and allows the user to filter out unwanted information later by choosing the facility categories he/she desires.

4.3.2 The Campiello Project

The Campiello Project aims to experiment the use of innovative human computer interaction technologies to develop new links between the local communities and the visitors of the Historical Cities of Art and Culture. Two cities have been chosen as context of the experiment: Venezia in Italy and Chania in Crete (Greece). These two cities share some features that allow to develop the experiment in an integrated way (e.g. they have antique linkages and they have similar antique urban structures.)

The system is based on a multimedia high band net (able to manipulate images, maps of the city, indication on archaeological sites, music and sounds), connected to Internet and based on Intranet and Web technologies, integrated with the following components:

- a shared information environment to support the relations between the different actors, and the creation of a common knowledge base, to maintain the history of the interactions, to enhance the participation, the communication and the exchange of information among people;
- a collaborative space that is the virtual place for co-operation within the local community: representations and metaphors to visualise the community, the participants, the information, the patterns of relations;
- various "interaction devices" (or access terminals) for individual or collective use, strongly integrated in physical environments, easy to use by heterogeneous users (citizens, elderly, students, visitors);
- a knowledge base.

GIS technology provided by ActiveX Map Control is used in combination with 3-D virtual reality techniques to provide a virtual space in which the user will be able to move and interact with other users.

5. Related Work and R&D Programmes

5.1 MagicTour

The aim of the MagicTour Project [8] was to provide an easy to use and task oriented authoring system for supporting the automatic generation of a wide spectrum of tourism applications based on multimedia and geographical information systems technologies.

Through the utilisation of GIS technology, new classes of operations based on adjacency, distance, proximity calculus and route optimisation were made available to the final user in addition to more traditional multimedia data navigation and presentation functionality.

The pilot tourism applications fell into three categories that depended upon different classes of potential users:

- Tour operators, for the preparation, updating and consultation of packages and catalogues.
- Tourist offices of a country, a region or a city, so as to offer multimedia and geographical information regarding various tourist resources.
- Travel Agencies, that will propose in addition various services and solutions to potential customers.

5.2 Commercial Tools

Many commercial GIS packages have been developed up to now. However, most of them have been inappropriate for Tourism applications, because they:

- did not support a way through which another application could take advantage of the functionality they offer,
- were monolithic, extremely complicated and sophisticated, requiring extremely powerful workstations to run and too much time to learn and use,
- were very expensive.

Large vendors of the GIS market are currently moving towards the adaptation of the component software paradigm and offer products similar to Map Control. Among others, we may distinct MapObjects and MapObjectsLT (ESRI), MapWare (GeoSystems), MapX (MapInfo), GeoPoint (Visual Components) and Enigma+ (TIMC).

6. Conclusions and Future Work

In this paper we presented MUSIC's efforts that lead us to the creation of an easily adaptable Integrated Environment for the development of efficient applications which require Geographic functionality. The result was a combination of tools, namely Map Studio, a map editor, and Map Control, a software component responsible for manipulating and rendering maps created with Map Studio.

The flexibility of these tools and the implied methodology makes us believe that it is worthwhile taking the effort to continue working towards the extension of the functionality they provide. Currently, we focus on the adaptation of algorithms from graph theory –e.g. finding shortest paths and optimal routes using proper variations of the well known A* algorithm– and the automatic placement of text and graphic labels that describe the geographic objects of a map in order to minimise the overlaps between them.

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