Chapter 3

Integrating Multimedia GIS Technologies in a Recommendation System for Geotourism

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Abstract. In this paper a combination of traditional GIS along with multimedia, remotely sensed and GPS derived data is realised. Such a combination results in a multimedia GIS for accurate and valuable information concerning geotourism. A special feature of the multimedia GIS that was developed is that it contains information about the environmental challenges and sustainable development issues for geosites. This paper focuses on the incorporation of this multimedia GIS has been incorporated in a recommendation system for geotourism. The proposed recommendation system has the ability to personalise its interaction to each individual user. In this respect the user is proposed to visit the touristic sights that have geological interest and seems to be of his/her interests, needs and knowledge.

1 Introduction

Geotourism is based on the magic of discovery and the power of authenticity experienced through the contact with the natural heritage. Geotourism is a form of cultural-environmental tourism that can be developed in areas with important geological monuments, which are exploited in order to attract visitors with special interests. These monuments are called Geotopes or geosites. The Geotopes are the meeting places of elements recording the geological history of each region, witnessing the everlasting evolution of life on Earth. Sites such as caves, gorges, fossilized areas, large geological rifts, ancient mines, geological formations or landscapes chiselled by natural forces throughout the geological ages have a special scientific and aesthetic value and could become areas with significant tourist interest.

The Greek region constitutes one of the most significant environmental and cultural reserves on Earth, strewn with unique and significant natural geological monuments. These geotopes have different characteristics and attract different kind of tourists.

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However, finding the geotope that would fit best a user's interests, knowledge and needs is a rather difficult task. This task is mainly addressed by recommender system. Indeed, recommender systems for tourism have attracted a lot of interest lately as the touristic industry expands rapidly.

In view of the above we have run the first phases of software's life-cycle for the development of a recommendation system for geotourism in Greece. A software life-cycle consists of four phases: Requirements specification, Design, Implementation and Testing. In this paper we mainly focus on Requirements specification, Design and some implementation issues of the recommendation system for geotourism in Greece.

The main characteristic of the proposed recommender system is that it provides personalized recommendations. Lately personalised recommendation systems have been gaining interest in tourism to assist users with their travel plans (Ricci 2002, Ricci & Werthner 2002, Wallace et al. 2003, Loh et al. 2003). Personalisation involves the design of enabling systems to capture of infer the needs of each person and then to satisfy those needs in a known context (Riecken 2000). A personalisation system is based on three main functionalities: content selection, user model adaptation and presentation of results (Mizarro & Tasso 2002, Diaz & Gervas 2005, Diaz et al. 2008). By content selection, one may refer to selecting destination, tourist attractions, accommodations, routes or all the above for planning a whole trip. Most of the recommendation systems, like the one described in this paper, focus on selecting the destination except from a few exceptions (Ardissono et al. 2003, Niaraki & Kim 2009).

In order to choose the destination that would fit best the user's interests and requirements, the recommendation system should incorporate a user model. Several approaches have been proposed in the international literature for the elaboration of this information in order to evaluate the alternative destinations. For example, Huang and Bian (2009) uses AHP theory (Saaty 1980) and Chin & Porage (2001) the Multi Attribute Utility Theory (Vinke 1992) for evaluating the available travelling opportunities and proposes the user the one that fits best his/her needs and preferences. In our approach we use a simple multi-criteria decision making theory, Simple Additive Weighting (SAW) (Fishburn 1967; Hwang and Yoon, 1981) in combination with stereotypes and individual user modelling for modelling the users' preferences.

Another characteristic of some recommender systems is that they incorporate GIS to improve the presentation of the recommendations and, therefore, increase the interactivity of their systems. The project CReation of User-friendly Mobile services Personalised for Tourism (CRUMPET) (Posland et al. 2001, Laukkanen et al. 2002, Schmidt-Belz et al. 2002; Zipf 2002) and the SPETA system (Garcia-Crespo et al. 2009) use GIS in order to provide user-friendly mobile services for tourism. A quite different approach is employed by Niaraki & Kim (2009), who use a GIS in a personalised ontology-based route planning system. However, the approach described is quite different as it uses a multimedia GIS and the domain of geotourism is a special case of tourism.

The use of GIS as a basis for a system related to geotourism is reasonable as the majority of touristic information is spatially related. The GIS system allows for the combined presentation of various data types and allows the user to determine the distances between various points of interest. On the other hand, a very popular and widely used digital form of data is multimedia. Multimedia data types i.e. text, images, audio and video and provides such an atmosphere in which user feels comfortable with the system environment before addressing issues of data analysis. The combination of multimedia along with traditional GIS can improve the performance of GIS turning it into a more realistic tool for spatial analysis that has full capability to provide services to both technical and non-technical users. This will allow more clear and transparent view of overall situation and better understanding of its spatiotemporal implications. These characteristics initiated various Mutlimedia GIS (MMGIS) implementations (Bakourou et al. 2002), (Ayeni et al. 2004), (Bordoni & Colagrossi 1999), (Frech et al. 2003), (Papadimitriou & Roustanis, 2007). The integration of Multimedia and GIS can be viewed in two ways (Soomro et al. 1999): a) “GIS in Multimedia”: where multimedia-authoring tools are used to blend different data types (text, image, video, audio) and spatial analytical function to boost traditional GIS or in other words MM has capabilities to incorporate GIS and b) “Multimedia in GIS” where the traditional GIS will encompass the capabilities to take care of multimedia or in other words GIS has capabilities to incorporate MM data types. The MMGIS developed in this study falls to the second category. The TNTmips V 7.3 that supports fully integrated GIS, image processing, CAD, TIN, Desktop cartography and geospatial database management has been used for the processing of data and the MMGIS implementation.

2 Requirements Analysis and MMGIS Database Design

Tourism in general is not just business but has also to do with emotional experiences; [Werthner, 2001] and lifestyle. Geotourism, in particular, can also improve a visitor’s knowledge and environmental consciousness. In order to capture requirements for the recommender system that incorporates the MMGIS, an empirical study was conducted. The empirical study participated tourists of different interests, needs and knowledge that were visiting two different Geotopes, the island of Zakynthos and the wider region of Micro and Macro Prespa lakes in Greece (Fig. 1). Both areas are of great ecological importance and constitute geotopos.

Zakynthos has attracted the international interest because the loggerhead turtle *Caretta-caretta*, one of the endangered species protected by international conventions and by Greek legislation, lays its eggs on the island. Zakynthos has a great number of geosites representing active and evolving geomorphological landforms, including tectonically active fault scarps, geothermal fields, karst and caves, and coastal and fluvial landforms. The Prespa region, on the other hand, is also considered to be an ecosystem of global significance and has been identified as one of Europe's 24 major transboundary "ecological bricks". The area is quite mountainous with interesting geomorphological features, important mines and lakes.

During the empirical study, information characterizing current and future needs of geotourism community was gathered. The study also revealed that people interested in Geotourism or other kinds of natural tourism are also interested in current environmental challenges and sustainable development. Therefore, the system should address these new trends along with providing potential users with valuable, accurate and up to date information regarding the geosites. In this respect the GIS would prove to be very useful. More specifically, the system should be designed to address various environmental issues such as biodiversity, land cover changes, deforestation, water pollution, etc.

Remotely sensed data constitute a valuable tool for obtaining such environmental information. A special interest was given to the way of data visualization using 3D views, virtual flights and panoramas. 3D renderings could also have considerable impact in the way the geosities are perceived.

Fig. 1. Overview of the study area.

The data that were gathered, were categorized: Each category constitutes a layer or a sub layer in the designed GIS database:

Geological: Geological / geophysical / geomorphological features, mountains, lineaments, cliffs, waters, falls, springs, beaches.
Ecological: beaches, national parks, protected areas, forest reserves, botanical gardens etc.
Cultural: Museum, art collections, cultural, religious and national monuments.
Other: sporting facilities, travel and accommodation facilities, tourism Centers and agents, and other related to tourism data.

Sources of data include existing maps, plan and charts, textbooks, and Internet websites. The existing map data have been converted into digital form. The old map data were used in order to compare the possible changes that have taken place in the area. Satellite images were used for visualization due to their ability to show spatial patterns of land cover. Combinations of different resolution data using data fusion techniques based on HIS colour model proved to be effective as far as the interpretation of features of interest is concerned (Charou et al. 2003). Satellite images were processed and new image products addressing the detection of changes of land cover were generated.

3D views constitute a novel form of information presentation. They are very suitable for the visualization of a region as they give the user a particularly realistic impression. They provide information not only about distances but also about gradients along a chosen route. 3D views as well as virtual flights and panoramas permit users to view the area from a variety of angles giving them a comprehensive overview of the region (Almer et al. 2000). In order to generate 3D views, virtual flights and panoramas as realistic as possible, Digital Elevation Models (DEMs) were prepared and integrated with satellite data.

Walking and cycling are amongst the most popular activities associated with geotourism. Accurate information concerning geotouristic bike and/or hiking routes are of a great importance for these activities. To this end, GPS surveys on selected routes were carried out and GPS data were integrated with satellite data and Digital Elevation Models for a better representation.

Digital cameras and digital video cameras were also used to capture data. Video clips with sound were hot-linked with the other types of data in the TNT mips environment using Script files thereby creating a multimedia GIS database containing digital photos, audio and video files.

3 Design of the Recommendation System

Travel preferences are often hidden and are not explicitly known when users start to plan their trips, particularly if visiting an unfamiliar place (Viappianni et al. 2002; Loh et al 2003). The system should contain a large amount of detailed up-to-date information about the possible destinations (Fesenmaier & Jeng 2000, Ardissono et al. 2003). Therefore, the system contains information about the places of Greece that have geological interest as well as related information about each place of interest.

The system architecture consists of:

- The User Modeling component, which initializes, updates and maintains information about each user and the stereotypes
- The Recommender, which selects the place of interests and ranks them to suggest the best one. The selections process in the recommendation system consists of two stages: estimating travelers' preferences, and subsequently evaluating available destinations.
- The Personalisation component, which is responsible for dynamically updating the pages of the web store.
- The GIS module that is responsible for presenting the information in the GIS.

In order to estimate the traveler's preferences, the system incorporates a user modelling component. This component maintains information about the interests, needs and background knowledge of all potential users. As Kobsa (2001) point out, a user modeling system has to carry out the following tasks:

- Learn the interests and preferences of users based on their usage of the application
- Predict interest and preferences of individual users based on assumptions about homogeneous user subgroups (stereotypes)
- Infer additional interest and preferences using domain knowledge
- Store, update and delete explicitly provided information and implicitly acquired assumptions.

Taking into account these requirements, the user modelling component of the proposed system maintains information about each individual user that interacts with the system. Additionally, the system uses stereotypical knowledge for modelling the users for whom it has not gathered enough information yet. As Rich (1989, 1999) points out a stereotype represents information that enables the system to make a large number of plausible inferences on the basis of a substantially smaller number of observations. Stereotypes constitute a common user modelling technique for drawing assumptions about users belonging to different groups and, therefore, it has been used in a wide range of applications such as e-learning systems (Alepis & Virvou 2006, Kabassi et al. 2006), help systems (Virvou & Kabassi 2004), recommendation systems (Virvou et al. 2006, Chin & Porage 2001) etc.

More specifically, the user modeling component of the system maintains information about a user's interests, economical preferences, time constraints and background knowledge. The first three criteria have been referred in many other recommender systems for tourism. However, background knowledge is a new criterion that has been added in this system due to geotourism. The user should have the knowledge to understand the geological phenomenon that exists in the evaluated and selected destination. The information that is stored in the user model is acquired explicitly by the user as it is beyond the system's scope to check the users' knowledge on the subject of geology or related research areas. However, information that involves the interests of the particular user is acquired explicitly in the beginning and this information is constantly updated during the user's interaction with the system.

The system uses a content-based filtering for personalization. Content-based filtering suggests to a user items or services which are similar to those he/she bought or searched in the past, by matching the characteristic of the item or service with the characteristics of the user that is maintained in his/her user model. The main advantage of content-based filtering is that it is based only on facts that involve the particular user and, therefore, are true. Of course, in some cases this advantage may be also disadvantage as the particular method may lead to overspecialized suggestions that include only items excessively similar to those the user already knows (Adomavicius and Tuzhilin, 2005). Another advantage of content-based filtering that derives from the fact that it is based on information for each individual user is that it may also capture changes on the user's preferences.

Another aspect of the recommendation system involves the enhancement of it decision making process. Ricci (2002) stated that a recommender system could provide valuable information to assist consumers' decision-making process. The decision making theories that seem to be more appropriate for computer problems are the multi-criteria ones. This is due to the fact that computer problems usually involve several objectives and criteria. Decision making theories provide precise mathematical methods for combining criteria and rank the alternatives from best to worst and determine a subset of actions considered to be the best in order to make the final decision.

As a result different decision making theories have been used in recommendation systems for tourism. For example, Chin & Porage (2001) the Multi-Attribute Utility theory (MAUT) (Vinke 1992) in combination with stereotypes to evaluate the available travelling opportunities and proposes the user the one that fits best his/her needs and preferences. The system described in this paper uses Simple Additive Weighting (SAW) (Fishburn 1967, Huang & Yoon 1984) for evaluating the different alternatives and select the one that seems to be the most appropriate for the particular user.

4 Implementation Issues of Multimedia GIS

A number of geological features were digitized from the Geological maps of the Institute of Geological & Mineral Exploration IGME (scale 1: 50.000). More specifically, geologic layers (vector) containing the hydrological network, lithological unit boundaries and tectonics (faulting and bedding system) were created.

A similar procedure was followed in the digitization of the soil maps (land use and land capability for forestry) of the Ministry of Agriculture (scale 1: 20.000) and Topographic Maps of the Geographic Service of the Army (scale 1:50.000). Topographical data include the coastline, the main and secondary road network, caves, meteorological stations and village polygons (outline of village limits). Following the digitization of the maps, georeferencing of them was performed with TNT mips software, by choosing specific GCPs in the corresponding maps and the digitized coastline.

Additionally, multisensor satellite data such as LANDSAT-ETM, SPOT, ASTER and MERIS data having various acquisition dates have been processed. In order to prepare these satellite images for further processing, geometric and radiometric corrections were performed. When necessary, data have been re-projected into the local Greek Geodetic system georeference -Egsa 87. For MERIS data georeferencing has been made using the tie-points provided with the images. In order to combine different resolution data, data fusion techniques were used. The multitemporal satellite data were analysed in order to indentify and present changes of land cover during the last 15 years.

Digital elevation models for the areas of interest based on fused LANDSAT and SPOT with 10m spatial resolution RGB satellite data were generated and used for the construction of 3D views (Fig. 2). The ideal way to visualize geospatial data in 3D is to "fly" over and around a 3D scene interactively and examine features from any direction in real time. Virtual flights were generated by selecting an elevation raster (or other surface raster) to define the terrain and optionally selectthe same raster or an image of the same area to use as an overlay (drape layer) (Fig. 3).

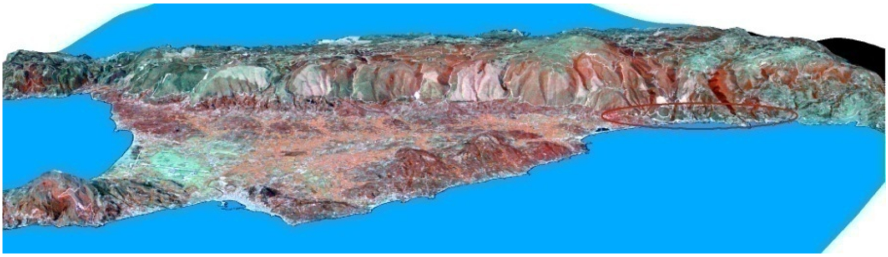

Fig. 2. A 3D View of the Zakynthos island.

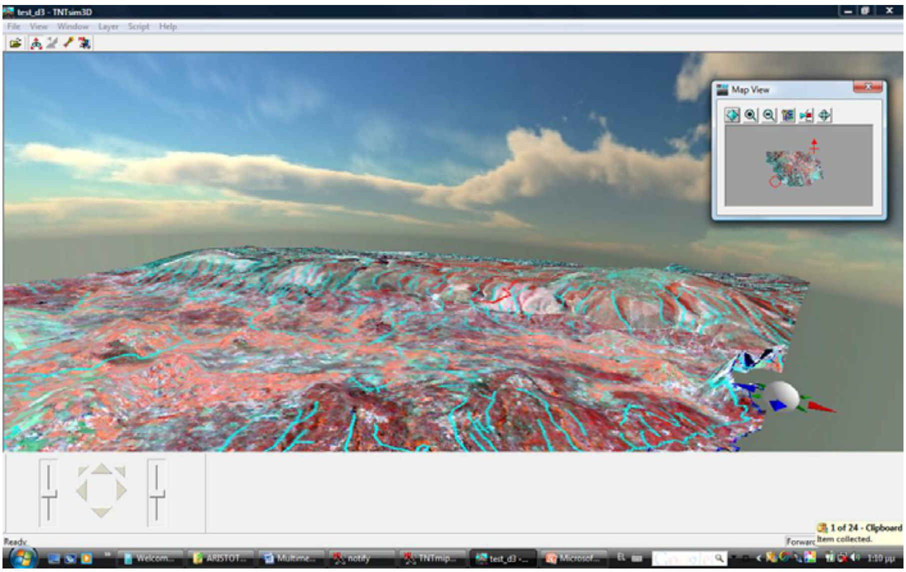

Fig. 3. A Screenshot of a virtual flight over the Zakynthos island.

A Thales Navigation Mobile Mapper GPS unit with post processing capabilities was used to delineate various footpaths, routes and points of interest. Mapping was performed when ideal satellite and PDOP numbers were available. The goal of successful mapping was to have the highest number of satellites combined with the lowest number for the PDOP. The minimum number of satellites that could enable accurate mapping was five. The highest number PDOP allowable for mapping was eight. At the end of each survey, data was uploaded into the computer and exported into the TNT mips. More specifically, for every footpath, several maps and various diagrams related to the description of the land cover, the landscape, the degree of difficulty (slopes) and distances were created.

The available satellite data offers the possibility to identify the surface extent of the lakes of the region and to map the coastlines of various lakes in different dates (Charou et all 2004). On the basis of the available maps and satellite data, digital elevation models were used in order to delineate various features (Fig. 4). Additionally, MERIS data have been proven capable of estimate land cover changes (Stefouli et al. 2008, Charou et al. 2004) in the broader area of Prespa region.

Fig. 4. Selected GIS maps of Prespa region

The analysis also revealed the devastating effect that forest fires had in Western Balkan peninsula during summer 2007 (Fig. 5). Significant land cover changes occurred in the area due to fire events and these were detected using MERIS data. A superposition of Corine 2000 reveals that significant land cover changes have occurred between the years 2000 to 2007.

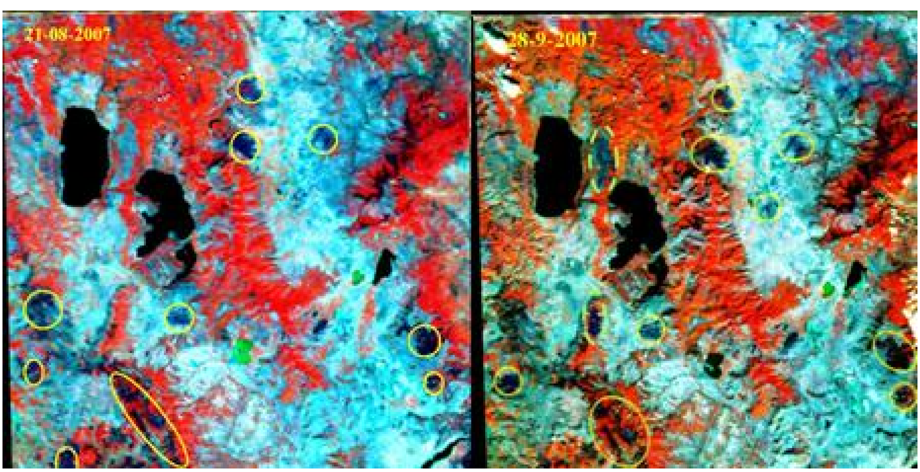

Fig. 5. Burnt areas (yellow curves) in Prespes test area using MERIS data.

Finally field –collected Multimedia data containing digital photos, audio and video files were linked to their locations and used to populate the mmgis database. Video was used to show background, point scenes, or transition and audio to provide realism by communicating the notion of space. The link between geographic features and multimedia ïïïïï is done using script files. All data have been organized in a form of an informational Atlas.

5 Conclusions

In this paper, we describe the way that new and innovative technologies such as 3D views and multimedia were combined with traditional GIS to develop a MMGIS for geotourism. The combination of data from different sources linked by the powerful prospects of new Earth Observation data and techniques resulted in the development of new knowledge that can be used for ïï ï ï ï ïïïï ï geotourism. For this purpose, it has been used in a recommendation system for geotourism.

For the system's requirements specification, an empirical study with the participation of tourists in geosites was conducted. The empirical study revealed the kind of information that would attract the possible end users of a recommender system for geotourism as well as the individual characteristics of such users. Therefore, during the design phase of the system the architecture and the personalisation procedure of the system were specified. In order to estimate the traveler's preferences, the system incorporates a user modeling component. This component maintains information about the interests, needs and background knowledge of all potential users. This information is further used by the system in order to select the kind of information that will present to the user as well as the geosites that is possible to interest him/her. Then, it provides the geotourism community accurate and valuable information for the geosites. For this purpose, up to date satellite images, maps and multimedia data were used. The system can be used both in computers and handheld devices.

The proposed system could also be used as a tool to learn about current environmental challenges and it is designed to address sustainable development issues including biodiversity, land cover changes, deforestation, water pollution, etc. The proposed approach could easily be modified to reach various target groups for other forms of natural tourism (eco, adventure) or Cultural Tourism (rural, popular cultural heritage - events, religious and product) tourism.

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