Implementation Issues of a Knowledge-based Geographical Information System

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Abstract. A growing amount of data and information have important spatial dimensions. The research presented in this paper introduces a user context approach for adaptive Geographical Information System (GIS). The spatial properties of the GIS components categorize different configurations as a support for the derivation of user groups. The interfaces and functionalities offered by the adaptive GIS are generalized within each group, and derived from the interface usages. The spatial behaviors that reflect user experiences within a group favor collaborative exchanges. A prototype applied to … validates the approach and the methodology developed.

1. Introduction

The Geographical Information (GI) industry is a specialized component of the broader information technology sector and has scientific and technical links to many other disciplines such as environmental science, engineering, computer science, health delivery, logistics, planning and resource management. Geographical information is fundamental to our everyday lives. Satellite images bring daily weather reports; global positioning systems monitor the location of thousands of trucks and taxis; real estate sales use geographic information systems; and maps of all kinds are produced, displayed and analyzed using the Geographical Information (GIS) technology. Given the popularity of geographical data it is desirable the system should deliver the geographical data interested to the user may interact with. Within an adaptive GIS, geographical data should be presented to the user with a specific attention to her/his characteristics. However, these systems are usually targeted to scientists for the environment and other users who are not specialists find them confusing. A remedy to this problem is the development of systems with an ability to adapt their behaviour to the interests and other features of individual users and groups of users (Virvou 2001).
A Geographic Information System (GIS) has been developed for the convergence of tourist information in relation to population settlements, surrounding social conditions, spatial characteristics, location and the natural environment. Valuable information on tourist locations and selective information like main and secondary road network, accommodations and cultural sites

2. Data used

A number of topographic features were digitized from 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 and village polygons (outline of village limits). A similar procedure was followed in the digitization of the geological maps of the Institute of Geological & Mineral Exploration IGME (scale 1: 50,000) and soil maps (land use and land capability for forestry) Ministry of Agriculture (scale 1: 50,000). Geologic layers (vector) containing the hydrological network, lithological unit boundaries, tectonics (faulting and bedding system) were created. 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.

Two Landsat 7 Enhanced Thematic Mapper Plus (ETM+) scenes have been used, with acquisition dates 28/07/1999 and 15/08/2000 respectively. Various image processing and vector GIS techniques have been applied for the analysis of the satellite imagery (Table 1) and results are presented in Figure 1?

Table 1: PRE-PROCESSING / IMAGE ENHANCEMENT / CLASSIFICATION

<table>
<thead>
<tr>
<th>Technique</th>
<th>Result</th>
</tr>
</thead>
<tbody>
<tr>
<td>Georeferencing</td>
<td>Image map output in Hellenic Projection System of 1987</td>
</tr>
<tr>
<td>Color Composites</td>
<td>Best combinations for Landsat data are achieved using bands TM 1,3, 4, 5 as well as real color composites.</td>
</tr>
<tr>
<td>Intensity Hue Saturation HIS Images</td>
<td>Images are enhanced while shadow is suppressed.</td>
</tr>
<tr>
<td>Unsupervised classification techniques</td>
<td>Interpretation of spectral characteristics of images. Easy discrimination of land cover classes.</td>
</tr>
<tr>
<td>Automatic conversion of raster to vector data</td>
<td>Map output. Inform the GIS database with the output vector data</td>
</tr>
<tr>
<td>Collection / input / coding, Storage/ Management, Retrieval, Processing / analysis, Presentation / Display, &amp; Map</td>
<td>Creation of a relational database of the collected data, map making. Evaluation of temporal</td>
</tr>
</tbody>
</table>
making changes, map updating.

Figure 1: A combination of raster (pseudocolor composite RGB -543 of a Landsat-7 ETM) and vector data (administrative boundaries and water basin boundary) in the GIS environment

Accurate mapping of the most important sites of cultural and/or natural heritage, as well as mountainous footpaths of Zakynthos was carried out using GPS Thales [5]. For each path a description of the type of the path, the terrain involved, experience needed, estimated time required and a classification of the paths according to the difficulty is attempted.

3. Adaptation of Geographical Information

The main feature of ADAPTIGIS is that it can adapt its interaction with each user. For this purpose the system uses adaptive hypermedia techniques. The two main adaptive hypermedia techniques that exist are: (i) adaptive presentation, where adaptation is performed at the content level and (ii) adaptive navigation support, which is performed at the link level (Brusilovsky, 1996). Both these technologies have been evaluated and the results offer strong evidence that their use in an Adaptive Hypermedia System can improve human-computer interaction (e.g. De Bra et al, 1999; Murray et al, 2000).
In order to evaluate different information, the system uses a simple decision making model. The maps are ranked and the highest value indicates which piece of information is more likely to be of interest to the user that interacts with the system.

Specifically, every time a user interacts with the system, s/he selects a part of Zakynthos that s/he is interested in (e.g. Zante Town). In order to select which kind of information for that particular part of Zakynthos it will present, ADAPTIGIS takes into account the activated stereotypes for the particular user. For example, if a user has selected Zante Town and the system has maintained in its user model that s/he is ‘Resident’, then the user will be presented with a chart showing the roads of the town as the value of the multi-criteria function was 0.70 for that information, which is the highest value of all.

Moreover, ADAPTIGIS uses adaptive link annotation techniques to present other information that are believed to be of interest to the user for the particular case. The idea of adaptive link annotation is to augment links with some form of comments, which can tell the user more about the current state of the nodes behind the annotated links. ADAPTIGIS uses different font types and icons to provide adaptive navigation support. Whenever a link appears on a page, the font type and the icon that appears in front of the link are annotated so as to reflect how interesting a particular topic would be.

In the above mentioned example that a resident would be presented a chart with the roads of Zante Town, ADAPTIGIS would also propose some other information in the form of links. Therefore, the link ‘Cultural info’ would be the system’s second suggestion, as its value of the multi-criteria function was 0.55, which is the second higher weight and reveals that the user would probably find this particular topic rather interesting. The links of ‘Geological data’ and ‘Topographical data’ would considered to be less interesting for the user as their values of the multi-criteria function was just 0.4, which shows that the user may want to access such information. Finally, the topics ‘Summer resorts’ and ‘Satellite data’ would be in smaller fonts, as their small weight of interest shows that the user would probably find such information boring.

Finally, ADAPTIGIS uses also adaptive presentation techniques in order to present information in a way that would be comprehensible to the user interacting with the system. For this purpose the system consults the stereotype that is related to the user’s level of expertise in computer skills. More specifically, if the user is an expert with respect to his/her computer skills then a detail presentation of the topic is selected. If the user is novice, on the other hand, then the user is presented with the same information in stages, as novice users is generally difficult to comprehend large amounts of information in a computer screen.

4. Conclusions

References

Bogdan Moisuc, Jérôme Gensel, Paule-Annick Davoine and Hervé Martin: Designing Adaptive Spatio-temporal Information Systems for Natural Hazard Risks with ASTIS