Multi-Dimensional Time Series Similarity

► Trajectories, Discovering Similar

Multilateration

► Indoor Localization

Multimedia Atlas Information Systems

LORENZ HURNI
Institute of Cartography, ETH Zurich, Zurich, Switzerland

Synonyms

Cartographic information system; Atlas information system; Atlas, electronic; Atlas, interactive; Atlas, multimedia; Atlas, virtual; Google Earth; Digital Earth

Definition

Multimedia atlas information systems (MAIS) are systematic, targeted collections of spatially related knowledge in electronic form, allowing a user-oriented communication for information and decision-making purposes. As in a conventional atlas, a MAIS mainly consists of a harmonized collection of maps with different topics, scales, and/or from different regions. The maps usually come in standardized scales or degrees of generalization, respectively. The different map types have a common legend and symbolization. The access to the maps is granted through thematic or geographic indexes. MAIS dispose of special interactive functions for geographic and thematic navigation, querying, analysis and visualization in 2D and 3D mode. Unlike in many geographic information systems (GIS) applications, the data in MAIS is cartographically edited and the functionality is intentionally limited in order to provide a user-targeted set of data as well as adapted analysis and visualization functions. In multimedia atlases, additional related multimedia information, like graphics, diagrams, tables, text, images, videos, animations, and audio documents, are linked to the geographic entities. Efficient management of the increasing amount of information led to the development of database-driven MAIS. Most MAIS are based on CD-ROM, DVD or increasingly on web technologies (intranet, internet).

Historical Background

The technological leap, which caused the transition from analog to digital cartography in the 1980s, has also stimulated the development of interactive atlases. GIS, computer aided design (CAD) systems, desktop publishing (DTP) systems and the thereby-evoked releases of geometric and thematic cartographic data were the catalysts of both digital and interactive cartography. It is disputed which atlas was the first digital one: Some authors claim an early version of the *Electronic Atlas of Canada* was the first digital atlas [1], others consider that it was the *Electronic Atlas of Arkansas* [2]. Early digital atlases had a rather limited functionality, like name search, zoom, and layer selection. Other atlases like the PC version of the *National Atlas of Sweden* were based on commercial GIS software. In the following years, interactive atlases were evolving with respect to content, data and technology. In several countries national atlases on CD-ROM were produced, either as a digital version of a conventional paper atlas (such as the *National Atlas of Germany*), or as entirely interactive version (such as the *Atlas of Switzerland*). In the late 1990s, national mapping authorities began to publish their topographical map series on CD-ROM/DVD. A third group of atlases are counterpieces to conventional world or school atlases, such as *Microsoft Encarta*, which, however, is today integrated in the *Encarta* encyclopedia. Technologically, the first atlases were based on raster data maps like most of the electronic national map series. Modern interactive atlases make use of vector data sets and/or statistical data which are symbolized and visualized on the fly (e. g., the *Tirol Atlas*). The atlases evolved from CD-ROM, then DVD to web-based or combined interactive atlases.

Multimedia Atlas Information Systems, Table 1 Aspects of cartographic expression forms, after [3]

Aspects of cartographic expression forms	Ordering of aspects
Display media	Print, screen, projection
Dimension of representation	2D, pseudo-3D, 3D
Degree of dynamics	Static, cinematographic, dynamic
Degree of interaction	Noninteractive, partially interactive, interactive
Channels of representation	Visual, acoustic, haptic
User–map relation	Separating, integrative, amplification of reality

Scientific Fundamentals

For the case of interactive maps on new media, the classical graphical variables and their expressions are extended as shown in Table 1 [3].
The added values and advantages of MAIS compared to paper atlases can be summed up as follows: interactivity, navigation, maps as interface, exploration, cus-

M

Multimedia Atlas Information Systems, Table 2 Main functions in a multimedia atlas information system (MAIS) [6]

Function Groups	Function subgroups	Functions
General functions		Mode selection, language selection, file import/export, printing, placing bookmarks, hot spots, forward/backward, settings (preferences), tooltips, display of system state, help, imprint, home, exit
Navigation functions	Spatial navigation	Spatial unit selection, enlarge/reduce of map extend (zoom in, zoom out, magnifier), move map (pan, scroll), reference map/globe, map rotation, determination of location (coordinates, altitude), line of sight and angle, placement of pins, spatial/geographical index, spatial/geographical search, tracking
	Thematic navigation	Theme selection and change, index of themes, search by theme, theme favorites
	Temporal navigation	Time selection (positioning of time line, selection of time period), animation (start/stop etc.)
Didactic functions	Explanatory functions	Guided tours, preview, explanatory texts, graphics, images, sounds, films
	Self-control functions	Quizzes, games
Cartographic and visualization functions	Map manipulation	Switch on/off layers, switch on/off legend categories, modification of symbolization, change of projection
	Redlining	Addition of user defined map elements, addition of labels (labeling)
	Explorative data analysis	Modification of classification, modification of appearance/state (brightness, position of sun), map comparison, selection of data
GIS functions	Space and object oriented query functions	Spatial query/position query (coordinates query/query of altitude), measurement/query of distance and area, creating profile
	Thematic query functions	Thematic queries (data/attribute queries), access to statistical table data
	Analysis functions	Buffering, intersection, aggregation and overlapping (transparent overlapping/fading), terrain analysis (exposition, slope etc.)

tomized/customizable to user's need, updatable, dynamics/animation, multimedia integration [4,5].

The degree of interactivity, a very significant element of the usability of a cartographic application, is mainly based on the richness of available cartographic functions. Table 2 shows the most important functions, arranged in five main groups [6].

Complementary, MAIS can be characterized according to the basic concepts as shown in Table 3. Today, most atlases still consist of raster and vector base data, but a transition to relational or object-oriented vector data can be observed. Most atlases are still bound to classic computer interfaces like keyboards, mice and screens. Internet and mobile technologies will increase the degree of system distributivity. With respect to interactivity, atlases are arranged into three groups: View-only atlases, interactive atlases and analytical atlases [7]. The latter can be subdivided into simple, constructive, and automatic analytical atlas types [8]. Furthermore, many atlases serve no longer as a main, but as one out of several possible interfaces to the data, e. g., in the Encarta encyclopedia.

Today's MAIS comprise of basic topographic and thematic data and software allowing the creation of maps on demand, as in GIS [9]. However the differences between MAIS and GIS can be perceived when comparing three approaches for applying GIS to the development of MAIS [10,11]. The concept "multimedia in GIS" proposes the integration of multimedia functionality in GIS, mainly at the cost of user-friendliness. "GIS in multimedia" incorporated explicitly defined and developed GIS functions in a cartographic multimedia environment. The third concept "GIS analysis for multimedia atlases" combines a GIS, the authoring system and a multimedia map extension (GIS data converter) in one common multimedia atlas development environment. Table 4 shows the main differences between GIS and MAIS [12].

Key Applications

World Atlases, School Atlases

Interactive world atlases mainly consist of physical (and some thematic) maps of the world with search and index functions. The most prominent example is Microsoft's *Encarta* atlas which is now integrated in the interactive *Encarta* encyclopedia. This allows the linking of places with multimedia elements of the encyclopedia and vice versa. A special version of the world atlases are school atlases which also include more thematic maps and numerous exemplary maps for didactic purposes. An example is the Austrian atlas *Geothek* by Ed Hölzel publishers.

Multimedia Atlas Information Systems, Table 3 Main characteristics and concepts of MAIS [8]. *OO* object-oriented, *PDA* Portable Digital Assistant, *UMN* University of Minnesota, *WMS* Web Map Service, *LBS* location-based services

Main characteristic	Characteristic /functionality	Subgroups/remarks	Examples
Data type and modeling	Raster		Raster GIS, map layers in raster format
	Vector	Sequentially attributive (file-oriented)	DTP files with attributes
		Relational-topological	Database-based system (geometry and thematic data)
		Object-oriented-topological	OO-geo-databases
Medium, communication channel	Text		Keyboard, alphanumeric output
	Language		Voice output in car navigation systems
	Screen	Stationary screens	Computer screen
		Portable screens	PDA, mobile phone
Degree of system distributivity	Off-line	Local system (client based)	MAIS on CD/DVD
	On-line (1 : 1)	Client/server based	UMN Map Server
	Distributed (1 : *n*)	One client/several server	WMS
	Multiple distributed (*n* : *m*)	Several clients/several server	LBS networks
Degree of interactivity	View only	Display of prepared maps	Information maps on the Internet
	Interactive	Queries by criteria, adjustment of output/display	MAIS like *Atlas of Switzerland* V1
	Simple analytical	Combined queries, more complex (GIS-like) analysis functions	MAIS with GIS functions, data however prepared (*Atlas of Switzerland* V2 partially)
	Constructive analytical	Direct processing of user data, design possibilities	Web-GIS, projection web services
	Automatic analytical	Automatic data analysis and rule-based processing	Cartographic real-time web information systems, e. g., on-line avalanche maps, radar precipitation maps, egocentric real-time information display on LBS, online generalization
Priority of cartographic functionality	Map information systems	Map functions as main interaction tools	MAIS, web map information systems
	General information systems	Map functions as further query and export/display possibility	Digital encyclopedias (e. g., Encarta), environmental information systems, Real estate portals

National Atlases, Regional Atlases

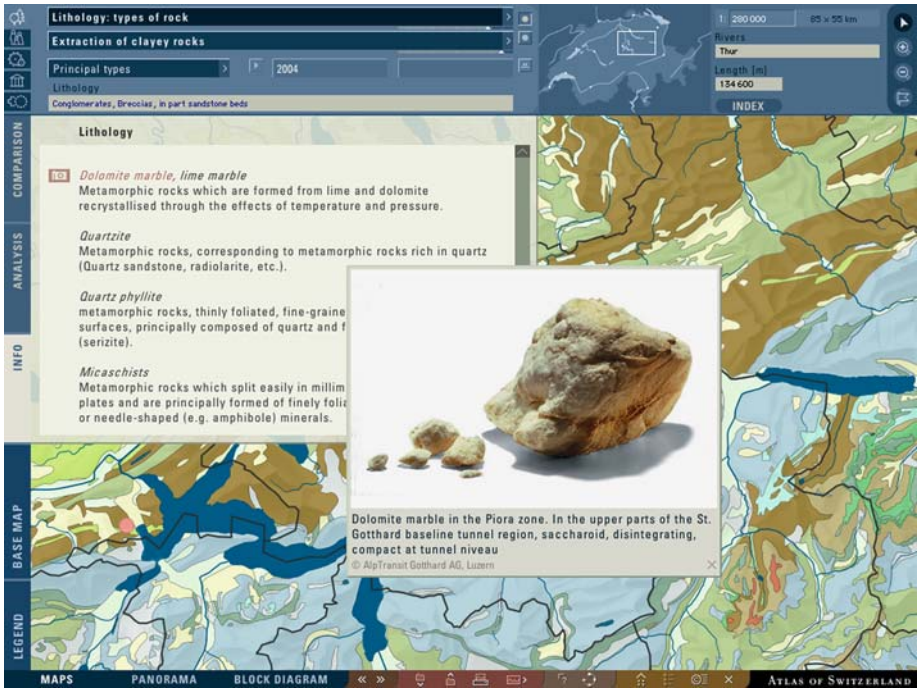
National and regional atlases depict a country or a region in a broad variety of mainly thematic maps. Today many national atlases have been converted from the printed to the interactive form. There also exist mixed versions like the *National Atlas of Germany* which consists of a series of theme books and accompanying CD-ROMs with the full text, the maps plus some additional interactive maps [13]. An example for an entirely digital atlas is the DVD-based *Atlas of Switzerland* which consists of 1,000 interactive maps derived on the fly from digital topographic, environmental and statistical base data, combined with multimedia elements (Fig. 1) [14].

Topographic Atlases

Many national or state mapping authorities publish their topographic map series on CD-ROM or DVD. In mostca ses, the maps are stored in raster format, but enriched with place names and vector line data for routes and trails. Many products offer the possibility of importing own data like GPS tracks or drawing map overlays. Simple analyses like measurement functions, profiles and 3D displays are possible. Examples are e. g., the *TOPO! Interactive Maps* with US Geological Survey map sheets, published by National Geographic and the *Swiss Map* DVDs with the *Swiss National Map Series*. Other atlases display georeferenced satellite or aerial images.

Thematic Atlases, Statistical Atlases

Numerous atlases cover specific thematic topics like geology, hydrology, climate, planning, history, etc., both in 2D and 3D (Fig. 2). Statistical atlases allow the visualization of statistical data as choropleth or diagram maps, usually



Multimedia Atlas Information Systems, Figure 1 Example of a multimedia national atlas: lithology map in the *Atlas of Switzerland*, combined with text and image information. © Atlas of Switzerland

Multimedia Atlas Information Systems, Table 4 Differences between GIS and multimedia atlas information systems (*MAIS*); adapted after [12]

	GIS	MAIS
Target users	Experts	Nonexperts (and experts)
Use of interface	Complex	Easy
Control of functions and data	By users	By authors
Guidance	Minimal	Distinct
Flow of information	Unstructured	Structured (narrative)
Main focus	Handling, analysis and presentation of data	Visualization of themes
Data	Raw, not integrated	Edited, integrated
Data model	Primary model	Secondary model
Covered area	Open	Usually predefined: regional, national
Computation time	Short to long	Short
Purpose	Open for any kind of data and analysis	Specific purpose

on the basis of administrative boundaries (e. g., the *Geoclip* statistical atlas web service).

Future Directions

A major focus will be the further development of geodata models and structures. Up to now, geodata have been managed and processed in relatively specialized systems like GIS. Data are enriched with graphical attributes for cartographic visualization and thematic attributes. In the future this attributation will be handled the other way round: Thematic data will be stored in standardized, distributed databases and they will additionally be annotated with spatial information, i. e., they will be georeferenced. Search engines could be equipped with a geographical search function.

Specific cartographic functions will be developed further, e. g., automatic generalization functions, rule-based display functions or analysis functions. Real-time data, for instance, will be analyzed automatically and visualized on the fly. The integration of user-generated data will be simplified and a MAIS will become a collaborative platform that can constantly be maintained and updated by the users.

Cross References

- ▶ Data Analysis, Spatial
- ▶ Distributed Geospatial Computing (DGC)
- ▶ Exploratory Visualization
- ▶ Scalable Vector Graphics (SVG)
- ▶ Visualizing Constraint Data
- ▶ Web Feature Service (WFS) and Web Map Service (WMS)

Recommended Reading

1. Ormeling, F.: Atlas information systems. In: Proceedings of the 17th International Cartographic Conference, Barcelona, 3–9 September 1995, pp. 2127–2133

Multimedia Atlas Information Systems, Figure 2 Example of a 3D atlas: 3D display of evaporation data as overlay on a digital elevation model, combined with a satellite image and atmospheric effects. The user-defined profile shows both a topographic and thematic section (*lower right*). © Atlas of Switzerland

2. Siekierska, E., Williams, D.: National atlas of Canada on the internet and schoolnet. In: Köbben, B., Ormeling, F., Trainor, T. (eds.) Seminar on Electronic Atlases II, pp. 19–23. ICA Commission on National and Regional Atlases, Prague (1996)
3. Buziek, G.: Eine Konzeption der kartographischen Visualisierung. Habilitation thesis, University of Hannover (2002)
4. Ormeling, F.: Functionality of electronic school atlases. In: Köbben, B., Ormeling, F., Trainor, T. (eds.) Seminar on Electronic Atlases II, pp. 33–39. ICA Commission on National and Regional Atlases, Prague (1997)
5. Borchert, A.: Multimedia atlas concepts. In: Cartwright, W., Peterson, M., Gartner, G. (eds.) Multimedia Cartography, pp. 75–86. Springer, Berlin Heidelberg New York (1999)
6. Cron, J.: Graphische Benutzeroberflächen interaktiver Atlanten – Konzept zur Strukturierung und praktischen Umsetzung der Funktionalität; mit Kriterienkatalog. Diploma thesis, Hochschule für Technik und Wirtschaft, Dresden and Institute o Cartography, ETH Zurich (2006). Available via http://www.ika.ethz.ch/teaching/Diplomarbeit-Cron.pdf; http://www.ika.ethz.ch/teaching/Diplomarbeit-Cron-Katalog.pdf
7. Siekierska, E.M., Taylor, D.R.F.: Electronic mapping and electronic atlases: new cartographic products for the information era—the electronic atlas of Canada. CISM J. ACSGC **45**, 11–21 (1991)
8. Hurni, L.: Interaktive Karteninformationssysteme – quo vaditis? Kartogr. Nachr. **56**, 136–142 (2006)
9. Da Silva Ramos, C., Cartwright, W.,: Atlases from paper to digital medium. In: Stefanakis, E., Peterson, M.P., Armenakis, C., Delis, V.(eds.) Geographic Hypermedia–Concepts and Systems. Lecture Notes in Geoinformation and Cartography:, pp. 97–19. Springer, Berlin Heidelberg New York (2006)
10. Bär, H.R., Sieber, R.: Towards high standard interactive atlases: the GIS and multimedia cartography approach. In: Proceedings of the 19th International Cartographic Conference, Ottawa, 14–21 August 1999, pp. 235–241
11. Schneider, B.: GIS Functionality in Multimedia Atlases: Spatial Analysis for Everyone. In: Proceedings of the 20th International Cartographic Conference Beijing, 6–10 August 2001, pp. 829–840
12. Schneider, B.: Integration of Analytical GIS-functions in Multimedia Atlas Information Systems. In: Proceedings of the 19th International Cartographic Congress Ottawa, 14–21 August 1999, pp. 243–250
13. Hanewinkel, C., Tzschaschel, S.: Germany in maps – a multipurpose toolbox In: Proceedings of the 22th International Cartographic Conference A Coruña, 9–16 July 2005: CD-ROM
14. Sieber, R., Huber, S.: Atlas of Switzerland 2 – A highly interactive thematic national atlas. In: Cartwright, W., Peterson, M.P., Gartner, G.(eds.) Multimedia Cartography. 2nd edn., pp. 161–182. Springer, Berlin Heidelberg New York (2007)

Multimedia Indexing

► Indexing, Hilbert R-tree, Spatial Indexing, Multimedia Indexing

Multiple Resolution Database

► Abstraction of GeoDatabases