Volume 3

Next Generation Geospatial Information

Our significantly improved abilities to collect and store geospatial information have resulted in rapidly increasing amounts of heterogeneous geospatial data, an issue that poses new challenges and opportunities. As these rich sources of data are made available, users rely, now more than ever, on the geospatial data infrastructure. The availability and accessibility of such data, as well as the ability to effectively manage, model, index and query the data are both becoming cornerstones in numerous applications. Moreover, the ability to formalize and represent data is becoming key to integration and inter-operability, and with the introduction of distributed geospatial data infrastructure and the implementation of web-based services, the impact of such issues is evident. Inspired by these challenges, this book on Next Generation Geospatial Information offers a collection of refereed original contributions from leading experts in spatial information modeling, image processing and analysis, database management, ontologies and data mining. It provides a unique insight into the current state-of-the-art and future challenges in geo-spatial information through four thematic chapters. Each chapter represents a primary research theme, namely distributed geospatial data infrastructure, image-based geospatial information management and modeling, indexing and querying geospatial databases, and ontology and semantics for geospatial data.

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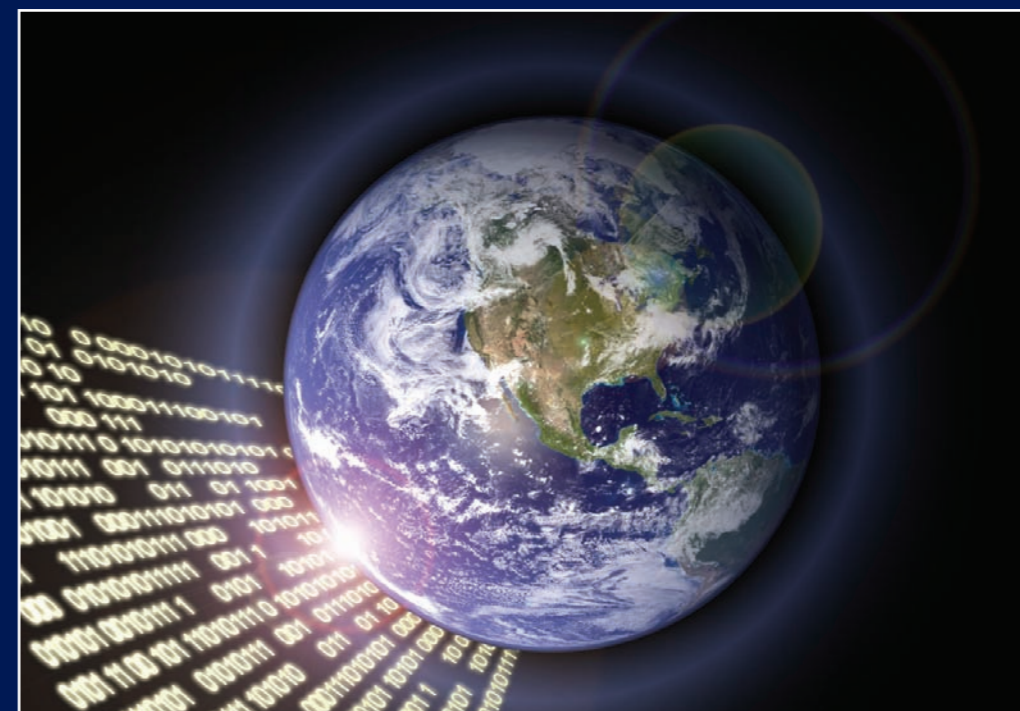
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Agouris, Croitoru

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From Digital Image Analysis to SpatioTemporal Databases

Edited by Peggy Agouris and Arie Croitoru

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Preface

In recent years, our world has become almost transparent. A growing number of imagery satellites are orbiting the earth, constantly observing and collecting imagery and related data. A number of these satellites already provide sub-meter resolution imagery that is widely available. On the surface, a rapidly increasing number of terrestrial digital imaging and video sensors are being deployed and integrated with other widely popular mobile electronic devices. In conjunction, an increasing number of GPS receivers are being used for fast data collection and on-the-fly mapping. GPS receivers embedded in other mobile devices are also providing constant location data while roaming our cities, road networks and sea ports. These trends are likely to intensify further: it is estimated that more than 40 new commercial imagery satellites will be deployed over the next decade, while almost all cellular phones are expected to have a mega-pixel imaging component before 2010. With an expected yearly growth rate of 18 percent, many mobile devices will also provide location and real-time sensory data using embedded GPS receivers.

This proliferation of data collection tools results in ever-increasing volumes of heterogeneous geospatial data which poses new challenges as well as new opportunities. As these rich sources of data are made available, users rely, now more than ever, on the geospatial data infrastructure. The availability and accessibility of such data, as well as the ability to effectively manage, model, index and query the data are becoming a cornerstone in numerous applications and services. In addition, the ability to formalize and represent the data (in particular the ability to provide ontology and semantics for geospatial data) is becoming key to integration and interoperability. The impact and importance of these issues is becoming even more evident with the introduction of distributed geospatial data infrastructure and with the implementation of web-based data delivery and analysis services.

Perhaps one of the most profound examples of the challenges posed by user communities can be found in the study of invasive species, as described in the keynote contribution. This emerging interdisciplinary science, which has been recognized as a major challenge in environmental sciences, heavily relies on readily available geospatial information, as well as on other sensory inputs. The studied phenomena have various spatial scales and therefore require multiple data inputs of various types and in various resolutions. Furthermore, such phenomena can only be modeled in time, thus the modeling problem becomes spatio-temporal. To meet such demanding requirements, multiple distributed data sources are used together with effective information, imagery management and query capabilities.

Challenges similar to those reflected in the case of invasive species served as the motivation for the NG2I 2003 workshop. Held in Cambridge, Massachusetts and titled "*Next Generation Geospatial Information*", this workshop hosted various high-quality original contributions and live demonstrations. In an attempt to provide an insight into the current state-of-the-art in the field and address the interdisciplinary objectives of the workshop, the program committee reviewed and carefully selected 16 of the contributions presented during the event to be published in these proceedings. The papers are grouped into four thematic chapters:

❖ Chapter 1, "*Distributed Geospatial Data Infrastructure*", addresses the distributed nature of the currently available spatial data infrastructure, with contributions on the usage of the World Wide Web as a geospatial database, web-based mediation for geospatial information, continuous generalization, and the utilization of mobile agents in a distributed geospatial infrastructure.
❖ Chapter 2, "*Image-Based Geospatial Information Management and Modeling*", addresses the management, processing and modeling of imagery, with contributions on change detection and updating, semi-automated feature extraction, and image selection for Virtual Reality environments.

- ❖ Chapter 3, "*Indexing and Querying Geospatial Databases*", addresses various indexing techniques and query processing methods for spatial data, with contributions on indexing for location-based services, spatio-temporal modeling and indexing, correlation-based geospatial data querying, and indexing for thematic mapping.
- ❖ Chapter 4, "*Ontology and Semantics for Geospatial Data*", addresses the role of ontology and semantics in geospatial data processing, with contributions on ontology and semantics in data integration, querying, enhancement, and verification.

While it is difficult to fully describe the fruitful interactions and discussions that were held during the workshop and although it may prove difficult to capture its unique interdisciplinary atmosphere, we have made every effort to deliver the true spirit of this event. In doing so, we have strived to communicate the scientific and technical contents of the workshop through these proceedings. We do hope that the readers find this collection of contributions of benefit.

We would like to thank the program committee and all the workshop participants and presenters for their significant contributions. We would also like to thank all those individuals who contributed to the organization and administration of the workshop. In particular, we would like to thank Vijay Venkataraman, chair of the workshop's organizing committee, for his tireless efforts during the organization of the workshop and the production of this book, and Blane Shaw for his valuable help with all relevant administrative details.

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Orono, Maine 2004

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