GEOSPATIAL IT FOR MOBILE FIELD DATA COLLECTION

BY SARAH NUSSER, LESLIE MILLER, KEITH CLARKE, AND MICHAEL GOODCHILD

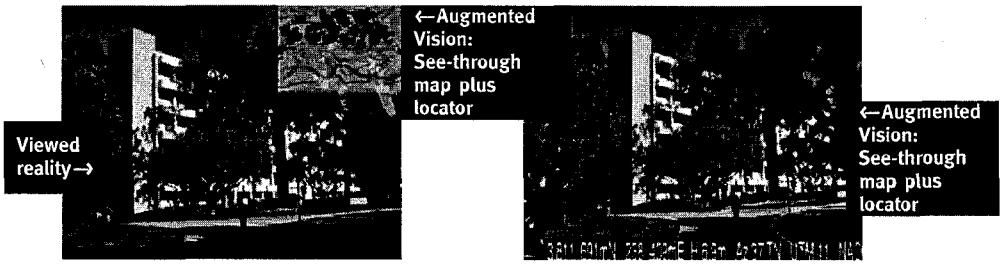
Federal statistical agencies generate critical data about the nation's population, economy, and natural resources. This data is gathered largely by mobile field data collection. Although geospatial information is an essential reference material in the field and serves as a base for recording spatially linked data, it is nearly always used in printed form due to limitations in mobile computing systems and tools for handling geospatial data. The ability to interact with digital geospatial data in the field offers significant enhancements for data quality and operational efficiencies. However, basic research is needed on extensible infrastructure designs for limited field computing environments and appropriate field tools for mobile data gatherers.

Project Battuta (dg.statlab.iastate.edu/dg) seeks to enable access to and use of digital geospatial information for field data gatherers who do not have extensive training in spatial analysis or information systems. We assume users need seamless access not only to geospatial information resources prepared for the field campaign, but also to data available online.

Mobile field computing environments vary widely, but generally offer extremely limited computing resources, visual display, and bandwidth relative to the usual resources required for distributed geospatial data. The key to handling heterogeneity in the field is an infrastructure design that provides flexibility in the location of computing tasks and returns information in forms appropriate for the field computing environment. Our view agent infrastructure model addresses these issues with several components. Wrappers are used for encapsulating not only the data sources, but the mobile field environment as well, localizing the details associated with heterogeneity in data sources and field environments. Within the boundaries of the wrappers, mediators and object-oriented views implemented as mobile agents work in a relatively homogeneous environment of manipulating XML-encoded data to generate query results.

Mediators receive a request from the user application via the field wrapper, and generate a sequence of mobile view agents to search for, retrieve, and process data. The internal infrastructure environment is populated with computation servers to provide an infrastructure location for processing, especially for combining data from multiple sources. Each

Figure 1 (a). The Project Battuta prototype wearable system includes a digital compass, GPS receiver, and displays computer output through a viewer clipped to a regular pair of glasses.



(b) Some ideas for appropriate interfaces to assist a user in navigation include displaying Web resources, floating arrow glyph indicating a path, and augmented information superimposed on a real structure such as a building.

computation server has a local object-oriented data warehouse equipped with a set of tools for working with geospatial data. Since the prospect of query reuse is likely for a field worker, we store the final and intermediate results in the data warehouse, allowing the warehouse to act as an active cache. Even when field computing capacity is ample, the warehouse is used to process data so that network traffic can be minimized.

Because it will not always be possible to rely on infrastructure computing resources, tools are needed for working with geospatial data in the field. We are focusing on field-based data integration in the face of positional inaccuracies to handle conflation, or the combination of geospatial data sets that represent at least in part the same phenomena in overlapping geographic areas. Conflation software has been developed to remove unacceptable differences in two sources, such as a road network and an orthophotograph, using Global Positioning System (GPS)-determined positions or a positionally accurate source. A second field tool being developed will enable users to adaptively select samples in response to new information gathered in the field, such as the identification of a contaminant hot spot or a rare species.

An intriguing advance in field data collection is the ability to combine GPS-derived positional context with geospatial data. Related projects sponsored by collaborating agencies are demonstrating the enhancements these tools bring to field operations. We are extending this integration of user perspective, digital information resources, and surrounding reality through visual augmentation, designed to combine spatial information such as user position, digital maps, and auxiliary information about a household, with views of the physical environment. Using a prototype wearable system, with input from a digital compass and GPS receiver and output to a viewer clipped to a pair of glasses (Figure 1a), we are exploring a navigation mode that leads the user through geographic space, using prior paths or computed navigation information. A second mode focuses on positioning, where assistance to the user in geographic positioning and spatial alignment are given. We are investigating aspects of the user interface that such a system would require, including icons and graphics for the two modes, and map-based displays within the visual interface (Figure 1b).

Project Battuta investigations are being explored via a testbed for environmental and demographic surveys, and are readily extensible to less structured information gathering settings such as crisis management and law enforcement. ■

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SARAH NUSSER (nusser@iastate.edu) is an associate professor in the Department of Statistics and the director of the Center for Survey Statistics and Methodology at Iowa State University, Ames.
LESLIE MILLER (lmiller@iastate.edu) is a professor in the computer science department at Iowa State University, Ames.
KEITH CLARKE (kclark@ncgia.ucsb.edu) is a research cartographer and a professor in the geography department at the University of California, Santa Barbara.
MICHAEL GOODCHILD (good@geog.ucsb.edu) is a professor in the geography department and the director of the Center for Spatially Integrated Social Science at the University of California, Santa Barbara.