Part II

Geographic Context-Awareness
Evolution of Geographic Information

Visualization

Feature (Contents)

Context

1\textsuperscript{st} Generation
- Paper Map
  + Digital Maps
  + Geographic Databases

2\textsuperscript{nd} Generation
- Digital GI
  + Mobility
  + Location-Awareness
  + GI Streaming

3\textsuperscript{rd} Generation
- Web GI
  + Accessibility
  + Ease of Use
  + Context-Awareness
- Mobile GI
  + Accessibility

4\textsuperscript{th} Generation
- Ubiquitous GI
  + Mobility
  + Location-Awareness
  + GI Streaming
UBGI: Definition

Geographic Information

- provided to users at anytime, anywhere, and with any device
- upon his/her contexts

the surroundings, circumstances, environment, background or settings which determine, specify, or clarify the meaning of an event (in Wikipedia), including the location of users, applications, hard/software environments

“Users” includes not only human beings but also applications and devices with communication.
UBGI and Context-Awareness

the surroundings, circumstances, environment, background or settings

which determine, specify, or clarify the meaning of

an event

Geographic Context

Location of Mobile Features

For UBGI
Geographic Context-Awareness

Static Context
- Geographic Information

Dynamic Context
- Geo-Services, Weather, Traffic Condition, Context of services, Data from Sensor, etc.

Geographic Context

My Status + Location, Speed, Orientation

Internal Context
Ease of Use and Context

GI for Experts  →  GI with Ease of Use
1. Select the optimal path
2. A gas station is on this street at the right side.
3. My director will arrive to the meeting room within 15 min.
4. Catherine registers this shop on the map
5. Three empty parking lots are found

Traffic information server
Global broadcasting traffic information
Local broadcasting service on the information about the stores of this street
Transmission of traffic information to the server
Sink node of velocity sensors planted on the streets
2 Km
Transmission of parking information to the server
Parking lot information server
Streaming service on parking lot information near to the FAO

1. Select the optimal path
2. A gift shop is found on the street
4. Catherine registers this shop on the map
5. Three empty parking lots are found

Traffic information server
Global broadcasting traffic information
Local broadcasting service on the information about the stores of this street
Transmission of traffic information to the server
Sink node of velocity sensors planted on the streets
2 Km
Transmission of parking information to the server
Parking lot information server
Streaming service on parking lot information near to the FAO
Contexts in this example

Static Context (stored in Geographic DB)
- Road Networks
- Buildings
- Stores and Gas Stations
- Indoor Structures
- Parking Lots

Dynamic Context (collected from Geo-Sensors)
- Speed Sensors on Roads
- Sensors on Parking Lot

Geographic Context Awareness

Internal Context (stored or collected from Local Devices)
- Location
- Speed and Orientation
- Remaining Gas Level
- Destination
- My Schedule
- Gifts to Buy
Geographic Context-Awareness in this example

Representation of Contexts

- **Static Context**
  - Road Networks
  - Parking Lots
  - Stores and Gas Stations

- **Dynamic Context**
  - Fuel Level
  - Traffic Conditions

- **Individual Context**
  - Location
  - Speed and Direction
  - Destination
  - My Schedule

Providing Contexts

Interpretation of Contexts

User

Geographic Context-Awareness
Three Aspects of Context-Awareness

1. Representing Geographic Context
2. Geographic Context Awareness
3. Providing Geographic Context

Services (Context aware services)

Context Modeling

Context Provider
An Overall Architecture for UBGI Services

Wireless Communication
- Global Broadcasting
- Infrastructure Network (MANET)

UBGI Common Services
- Indoor Service
- 3-D GI Service
- Context-Aware Mapping
- Service in Seamless Space

UBGI Middleware
- Geo-Labeling
- Context Streaming
- Binding Services and Operations
- UBGI Feature Catalog
- In-Network Processing Manager
  - Geo-Sensor Network
  - P2P
  - Data on Air

UBGI Provider
- Mobility Management in Seamless Space
- Indoor GI Server
- 3-D GI Server
- Geographic Context Stream Server
- Centralized Geographic Databases
- Geo-Sensors
- Local Databases
How to Identify and Retrieve Geographic Information in Mobile Environment?

We need a Mechanism to Identify a Geographic Object (Feature) and Retrieve its information.

Geographic Information

I Geo-Labeling

We need a Mechanism to Identify a Geographic Object (Feature) and Retrieve its information.

My Status + Location, Speed, Orientation Internal Context

Dynamic Context

Static Context

Context Awareness

Object Identifier or Foreign Key like DB?

Geo-Labeling
Geo-Labels

Clicking on the real world:
We have a database for this feature. But …

Databases

How to bring the data to this PDA?
How to identify this feature in the real world without OID or foreign key?
How to assign an identifier to each feature?

We have a PDA for displaying the data about this feature.
Example: iPointer™

- in http://www.i-spatialtech.com/ipointer.htm
Example: Panoramic View Computation

3-D Spatial Database at the Server

Displayed on screen of PDA

- in Proc. W2GIS 2006, Rainer Simon et al.
Geo-Label on Paper Maps

We have a database for these features. But …

How to bring the data to this PDA?

How to identify this feature in the real world without OID or foreign key?

How to assign an identifier to each feature?

We have a PDA for displaying the data about this feature.
Example: Interactive Paper Maps

- Developed by Paper++ Project at globis of ETHZ

- In http://www.paperplusplus.net/
Context Streaming

- Seamlessly providing context

How to provide context
- Pull-Protocol: Scalability Problem at Server
- Streaming by Broadcasting

Some Issues
- When to broadcast
- What to broadcast
  - Broadcasting only changes of status
Context-Aware Mapping

Static Context
Geographic Information

Dynamic Context
Geo-Sensor

How to cook GI, stream data from sensors, and internal states?

Requirements
- Geographic Awareness,
- Real-Time,
- Scalability, and
- Mobility

My Status + Location, Speed, Orientation

Internal Context

Agent: Geographic Contextual Reasoning
Context-Aware Mapping

Filtering
Remove unnecessary geographic context

Contextual Reasoning
Context Mining

Geographic Context

My Context
Context-Aware Mapping

Static Context (Geographic DB) - All features in a given area
Dynamic Context - Traffic condition

GML

Internal Context
- Driving a car in a highway
- Almost empty fuel level

Context Aware Mapping
Display gas stations on right side of the highway along the optimal route

Mobile Client

For example, the document in GML contains a set of tags for context-aware mapping
Example:
If a professor is in a lecture room and more than 15 students are in the same room, he is giving a class.
⇒ a spatio-temporal predicate
Example of Context-Aware Mapping

- An Experiment at UCSD by B. Hall and M. Trivedi for Tele-Exploration

If an accident is found
Summary: Part II

Geographic Context
- A Central Concept of Ubiquitous GIS

Two Aspects
- Logical and Functional Issues of Geographic Context
- Physical and Implementation Issues