GEO-NAVIGATION: AN AUGMENTED REALITY PERSPECTIVE

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AGILE 2000, Espoo

Geo-Navigation and Augmented Reality

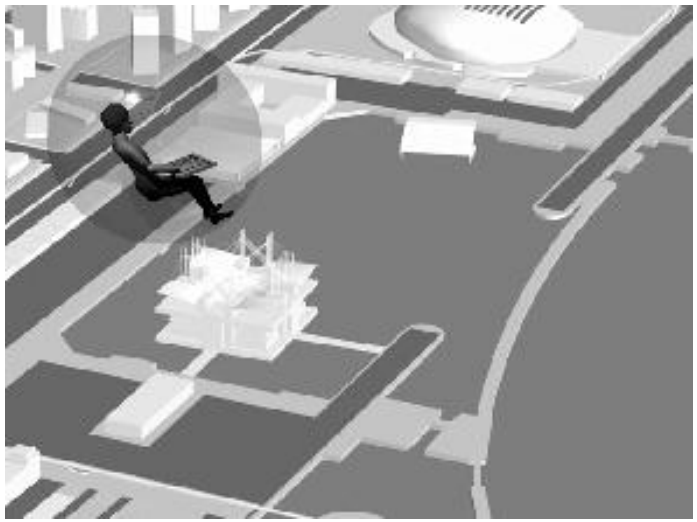
- Motivation
- Navigation
  - Wayfinding
  - Navigational tools
- Augmented reality (AR)
  - Underlying technologies
  - Geo AR applications
- Summary and conclusions

Motivation

- Mobile computing will overcome desktop computing by 2005
- Third generation mobile phones will bring wireless access to broadband Internet by 2002
- There is a need for improved navigation and exploration tools

Navigation

- Wayfinding
- Navigational tools



Wayfinding

- Wayfinding:
  - how to reach a destination
- Wayfinding stages:
  - acquiring spatial information
  - developing an overal wayfinding plan
  - plan is implemented into physical actions

Passini, R. (1992). Wayfinding in Architecture. New York: Van Nostrand Reinhold.

Spatial information

- Cognitive mapping
  - five key features:
    - paths
    - path intersections: nodes
    - landmarks
    - districts
    - boundaries

Lynch, K. (1960). The Image of the City. Cambridge, MA: MIT Press

Spatial information

- Locational information
  - distance information
  - direction information
- Attribute information
  - descriptive attributes
    - sensory features
  - evaluative attributes
    - tags attached to places
- Time related information

Wayfinding plan

- Plan is based on:
  - landmark knowledge
    - information about specific locations
  - procedure knowledge
    - information about the sequence of actions to follow a route (starting point, anchor points, destination point)
  - survey knowledge
    - acquired from maps and other tools

Wayfinding plan

- Other factors:
  - experience
  - ability differences
  - motivation
  - environmental layout and structure

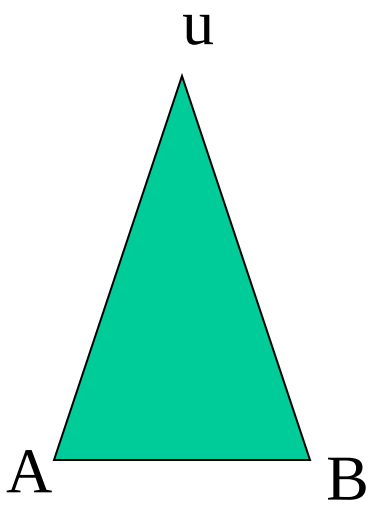
Chen, J.L. and Stanney, K. (1999). “A Theoretical Model of Wayfinding in Virtual Environments”. Presence, 8, 6, 671-685

Navigational tools

- Tools that can display an individual's current position
- Tools that can display an individual's current orientation
- Tools that can log an individual's movements
- Tools that augment the surrounding environment
- Guide navigational systems

Navigational tools

- Tools that display current position, orientation and log an individual's movements
  - ground-based RF systems
  - satellite based systems



Navigational tools

- Common navigational tool of choice:
  - GPS
    - accuracy within 20 meters since Clinton´s decision
    - may be augmented (i.e., Galileo initiative)
    - main problems:
      - dense urban areas
      - interiors

http://www.gypsy.com/gpsinfo

http://www.cnde.iastate.edu/gps.html

Navigational tools

- DoCoMo tool of choice:
  - SnapTrack
    - distributed server-aided DSP based processing system
    - lower cost for user (5 Euros per user)
    - up to 5 meters accuracy

http://www.snaptrack.com

Navigational tools

- GPS positioning system:
  - determining the code phases (pseudo-ranges) to the various GPS satellites
  - determining the time-of-applicability for the pseudo-ranges
  - demodulating the satellite navigation message
  - computing the position of the receiving antenna using the pseudo-ranges, timing and navigation message data

Navigational tools

- SnapTrack system:
  - Network of GPS reference receivers gathers navigation messages and differential corrections from all satellites in view
  - Location server receives and stores data from the GPS reference network, provides aiding data to mobile units and performs navigation solutions with the pseudo-range measurements from the handset

Navigational tools

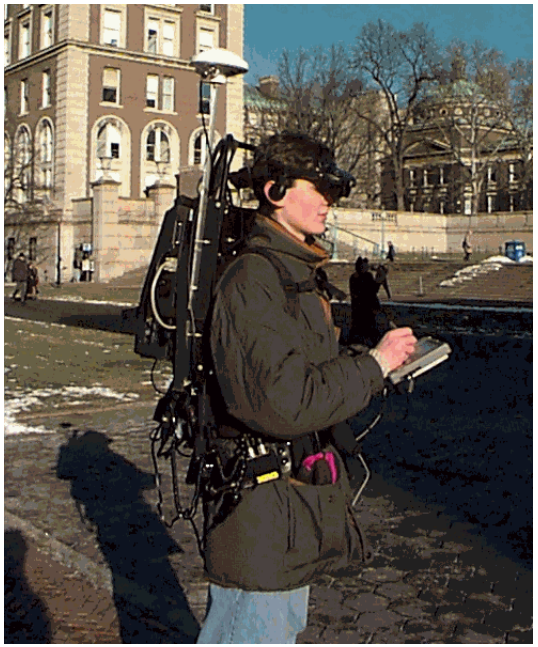
- SnapTrack system (cont.):
  - handset receives aiding data (a list of satellites in view and their Doppler effects). These data enables the handset to extract pseudo-range information from its snapshot of GPS data

Navigational tools

- Tools that solve the positioning problems and can aid in augmenting the environment:
  - Via Digital (iilab, Nokia, Telecel, Geodan):
    - network of anchors (emitters, sensors) located in nodes and landmarks
    - anchors emit/receive codes from mobile units
    - codes are related to position and are associated to URLs
    - cost to user: 0 Euros
    - infrastructure cost: 1 Euro per anchor

Augmented reality

Superimposition of attribute information (text, static or dynamic images) on real images in real time in a mobile computing environment



Jim Vallino's site at

http.//www.cs.rit.edu/~jrv/research.ar

Augmented reality

- Augmented Reality versus Virtual Reality
  - Advantages
    - applies real images in the background
    - minimizes “motion sickness”
  - Disadvantages:
    - requires “image registration”
    - increases system latencies (frame rate, update rate, sensor delays)

Augmented reality

- Underlying technologies
- Geo AR applications

AR underlying technologies

- AR environments need to be implemented to facilitate:
  - image registration
    - use of emitters/sensors to provide control points for rubber sheet image processing
  - real time monitoring and querying of information systems
    - use of sensors
    - access to multimedia spatial information systems

AR underlying technologies

- AR environments imply:
  - emitters
  - sensors
  - displays
  - interfaces
  - multimedia geo-information processing systems and embedded databases

AR underlying technologies

- Emitters
  - visible light (information to the user)
    - video
    - laser
  - invisible (information to the system)
    - RF
    - infra-red

http://www.infocharms.com

AR underlying technologies

- Sensors
  - physical
  - chemical
  - biological
  - optical

Sensors connected to portable devices

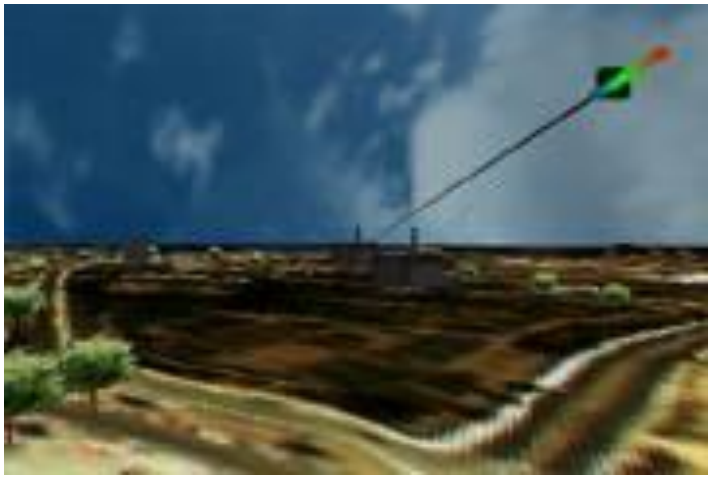
http://www.imagiworks.com

AR underlying technologies

- Displays
  - mobile phones
    - http://www.ee.oulu.fi/~tino/pihvi.html
  - head-mounted displays
    - http://www.microopticalcorp.com
  - any surface where images may be projected
    - http://www.ultimatedisplays.com

AR underlying technologies

- Interfaces
  - pen-based input
  - tangible interfaces
  - voice
  - gestures
  - eye contact

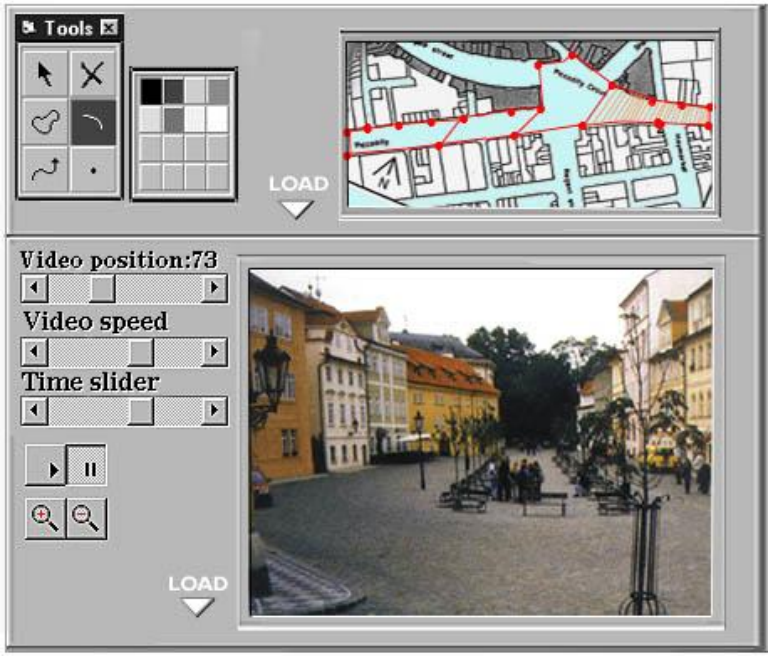


Hiroshi Ishii work at http://media.mit.edu/~ishii

University of Washington site em
http://www.hitl.washington.edu

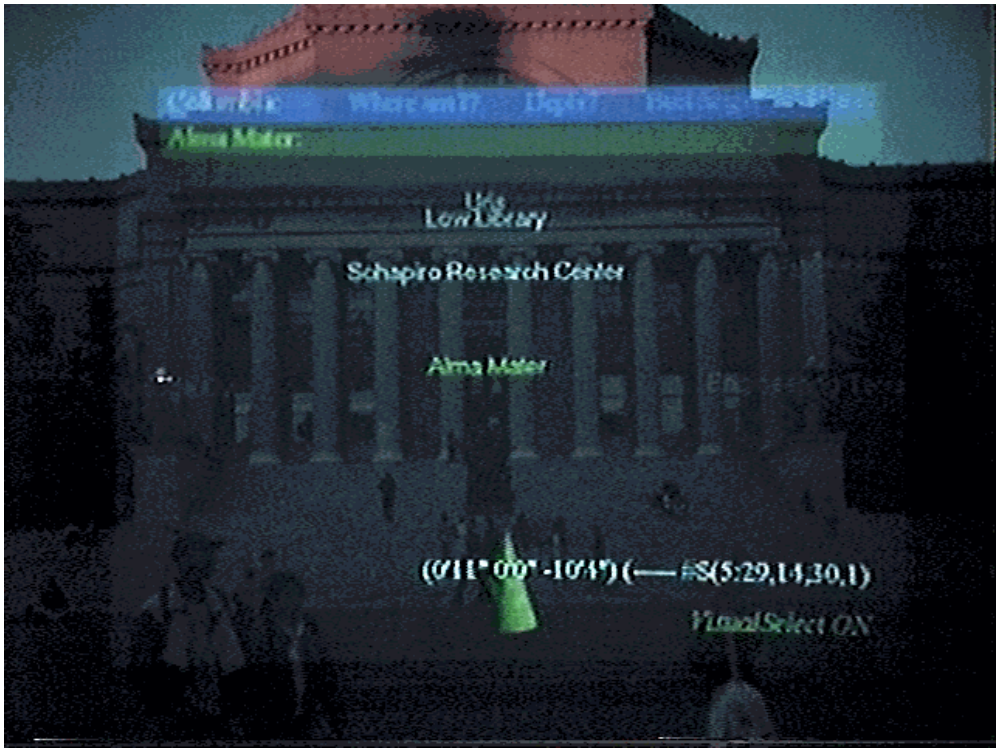
AR underlying technologies

- Multimedia geo-information processing system
- Embedded databases in mobile devices



Geo AR applications

- Urban navigation
  (http://www.cs.columbia.edu/graphics)



Geo AR applications

- Superimposition of the original digital terrain model on a quarry

Geo AR applications

- Visualization of underground networks in a city

Summary and conclusions

- Navigation will imply the use of augmented reality technologies
- AR's major issue is image registration in real time
- Infrastructures to support AR are needed
- AR environments as proposed here are required
- Networks of sensors/emitters will complement GPS in urban environments