cityware urban design & pervasive systems

> Instrumenting the city: developing methods for observing and understanding the digital cityscape

Eamonn O'Neill, Vassilis Kostakos Tim Kindberg, Ava Fatah gen. Schiek, Alan Penn, Danaë Stanton Fraser and Tim Jones

UbiComp 2006, 17-23 September, Orange County, CA



- Understanding urban ubiquitous computing as a system
- Space syntax: the city as a spatial system
- Architectural spaces & interaction spaces
 - mobile wireless interaction spaces
- Augmenting space syntax empirical methods: gatecounts and static snapshots
- Developing visualisations & analytical methods
- Data: patterns of Bluetooth presence & naming practices

Ubicomp city as system

- Urban ubiquitous computing is the development of a system of systems
- Understanding the ubicomp city as a system
 - its physical and digital forms and their relationships with people's behaviours in the city
- Development, use and refinement of methods
 - observing, recording, modelling, analysing
- Space syntax already has methods physical form
- Can we "digitally augment" these methods to take account of the digital form of the city?

Syntax and the city

- Space syntax analyses cities as systems of spatial elements and their relationships
- Investigates the influence of this system of interconnected spaces on the behaviour of people, particularly movement & encounter
- Has an established body of theory, methods and tools
- How can we draw together this systemic understanding of the built environment with a systemic understanding of ubiquitous computing?

Space & interaction space

- Architectural space
 - designed by architects
 - space within which people behave, move, encounter
 - defined by the characteristics of walls, doors, chairs etc
- Interaction space
 - space within which an artefact is usable
 - defined by the characteristics of the artefact and by the architectural space in which it is situated

Wireless interaction spaces

- Humans "join" the (ubiquitous) system through interaction spaces
 - fixed and mobile
 - visual, auditory and wireless
- Fixed wireless interaction spaces defined by an access point and characteristics of the environment
 e.g. 802.11, GSM/GPRS or 3G "hotspot"/coverage
- Mobile wireless interaction spaces typically created by small, personal devices such as mobile phones
 e.g. Bluetooth, NFC, P2P WiFi

Developing empirical methods

- A primary concern of space syntax is the relationship between architectural spaces and people's movements around the city
- The wireless interaction spaces created by mobile Bluetooth devices map closely to these movements
- We augmented established space syntax empirical methods to include observing and recording the movements of these mobile wireless interaction spaces
- This observational study gives us "ground truth" about part of the system of interaction spaces out there

Space syntax methods

Gatecounts

- used to establish flows of people at sampled locations within the city
- a gate is a conceptual line across a street
- observers stand on the street and count the number of people crossing the gate in either direction

• Static snapshots

- open spaces considered external (e.g. a square) or internal (e.g. a café)
- understanding how people appropriate and make use of a particular space, and how these patterns of use bring people into contact with each other
- observers record people's movements in and out of the space, as well as the types of activity taking place in the space

Gatecounts



Static Snapshots



Augmented gatecounts

- I0 gatecounts throughout the city
 - Pedestrian count plus Bluetooth count
 - 30 minutes at each location iterated over 2 days
 - Variety of traffic flows and spaces
- 2 long-term gatecounts: campus and city centre street
 - 24 hour continuous scanning
 - 3+ months running time
- Not "lines" across the street





Augmented static snapshots

- 2 long-term scanners in pub and café
 - 24 hour continuous scanning
 - 3+ months running time
- 30-minute observations in each: recorded people's positions, behaviours and movements through space
- Correlated these observations with the data recorded by our Bluetooth scanners
- Generated aggregate data which were unavailable using conventional space syntax methods



Bluetooth visibility

 Around 7.5% of observed pedestrians had discoverable Bluetooth devices



Bluetooth names

- Bluetooth names from long-term scanning sites
 - street: 771 names
 - campus: 625 names
 - pub: 307 names
- User-defined names
 - street: 58%
 - **–** campus: 76%
 - **–** pub: 88%
- No intentional context, further research ongoing
- But (maybe) Bluetooth naming gives rise to a real rather than merely potential interaction space

Data visualisations & analytical methods

- Persistent vs transient devices
- Timeline visualisations
- Duration of presence
- Patterns of copresence

Persistent vs. transient



Timeline view



Gatecount timelines



Gatecount 5







20 0.0 5.0 10.0 15.0 20.0 25.0 30.0 Minutes











Duration of presence



Patterns of copresence





Power laws and exponential decays



Take home points

- Urban ubiquitous computing is the development of a system (of systems)
- May be characterised as a system of architectural spaces and interaction spaces
- Augmenting space syntax empirical methods: gatecounts & static snapshots
- Developing data visualisations & analytical methods
- Patterns of Bluetooth presence & naming practices
- www.cityware.org.uk