Bridging the Social-Technical Gap in Location-Aware Computing

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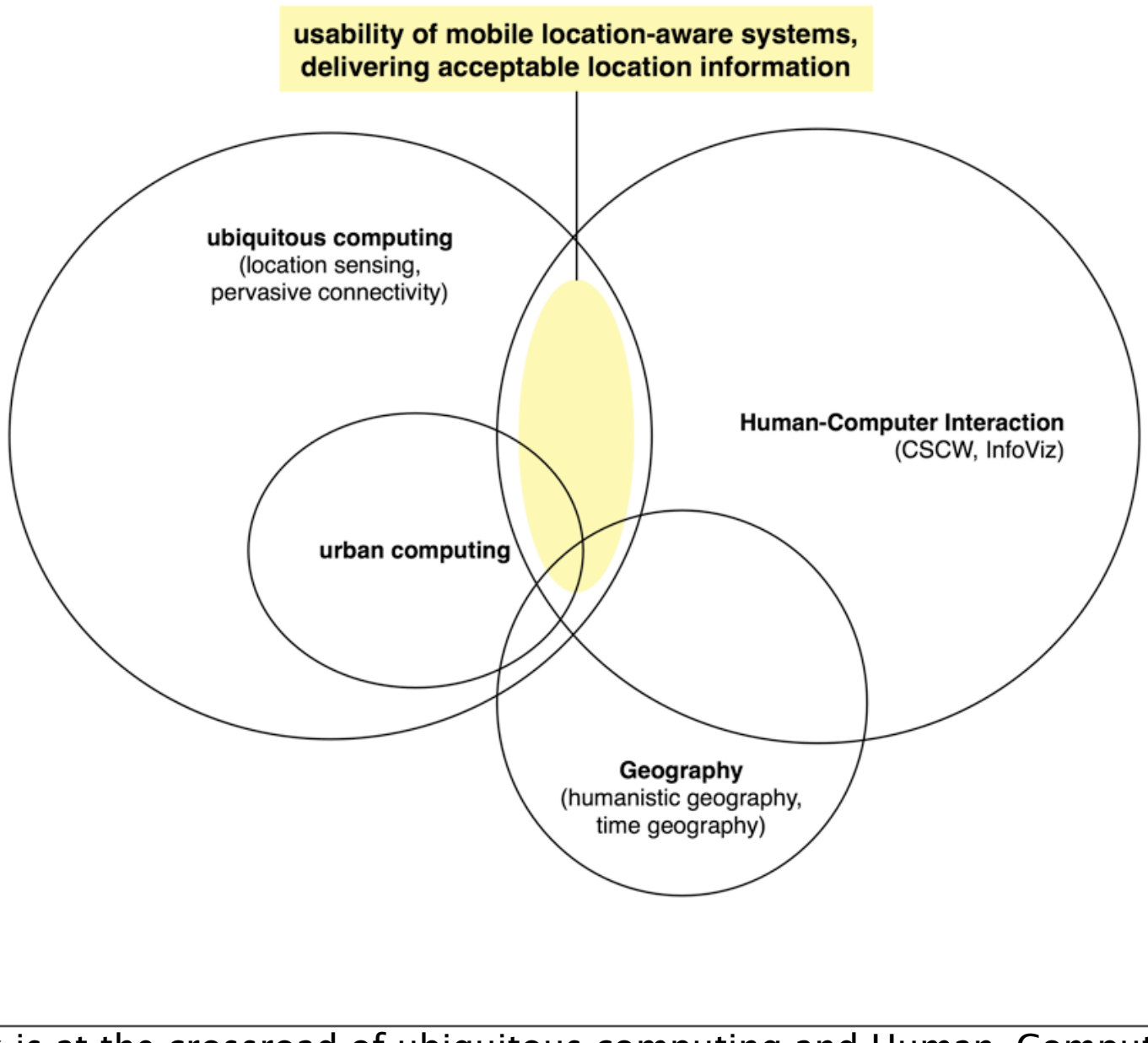
I am a PhD student in Computer Science and Digital Communications at the Pompeu Fabra University in Barcelona. I am in the middle of my second year and it is my pleasure to present you today the state of my thesis work.

Scope

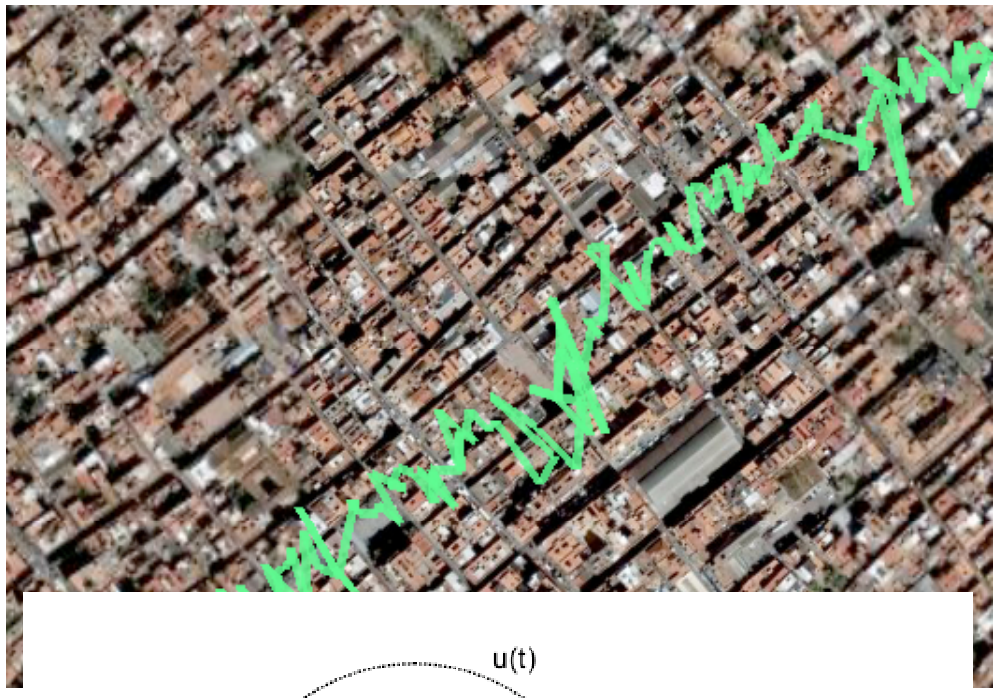


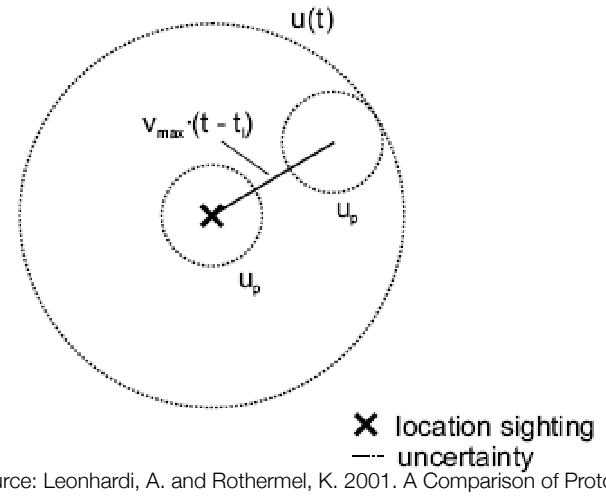
My research work is at the crossroad of ubiquitous computing and Human-Computer Interaction. More specifically, I am interested in the integration of location sensing and wireless technologies in environments supporting collaboration in urban spaces. I aim at studying the use of mobile location-aware systems to understand how to deliver acceptable location information.

Location-aware applications

By location-aware applications, I refer to system ran on mobile devices that are often multi-users and provide services such as tracking,location of others (loved ones, objects, pets)or tagging the environment. This picture shows the canonical example of what I refer to as “location-awareness application”.

Location quality and timeliness



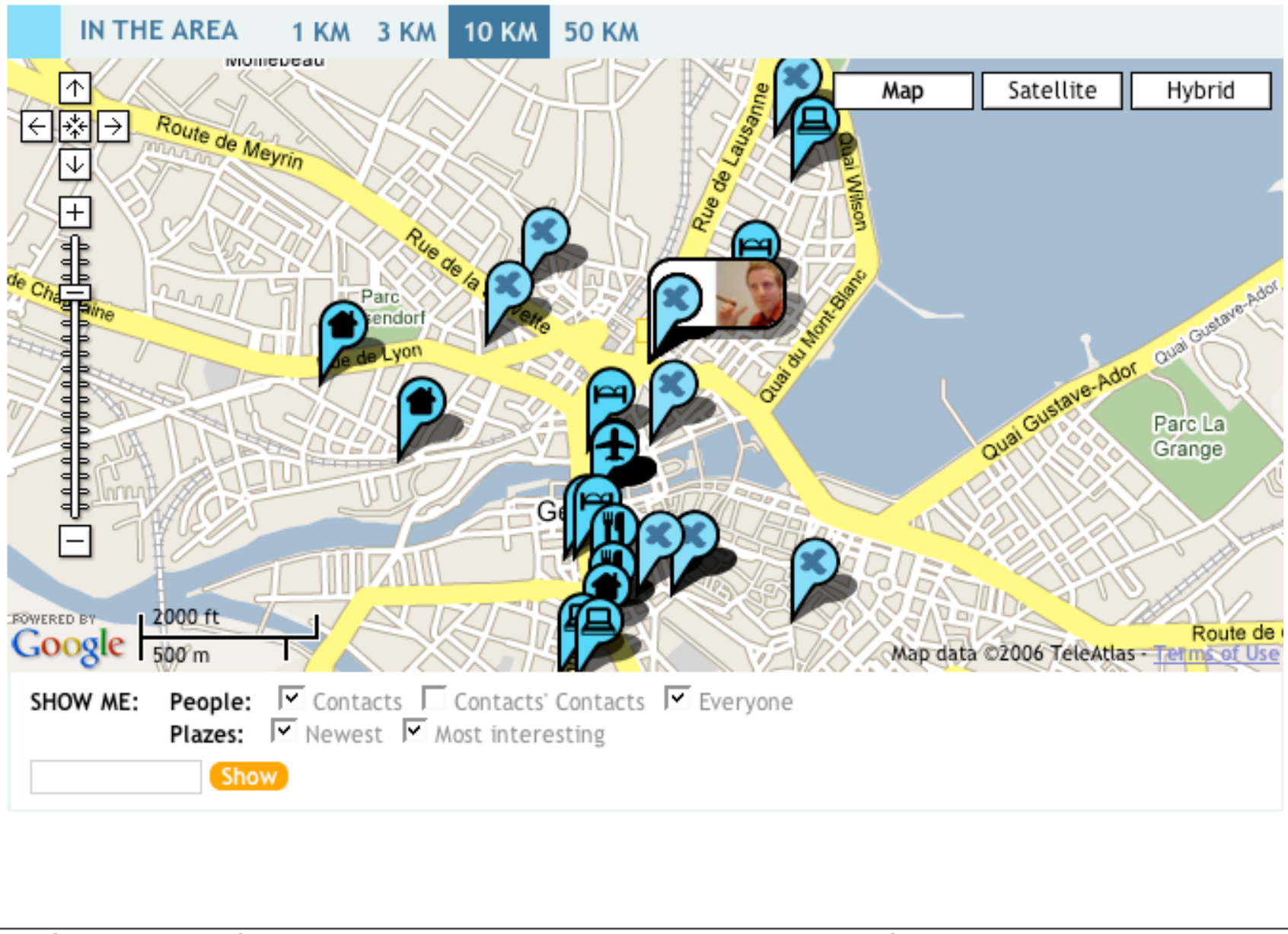


Source: Leonhardi, A. and Rothermel, K. 2001. A Comparison of Protocols for Updating Location Information. Cluster Computing 4, 4 (Oct. 2001), 355-367

Location awareness does not always come seamlessly (upper right pictures). Location sensing technologies face limitations and problems in terms of service coverage, stability (lower center), connectivity, mobility, cost, privacy and accuracy (upper right). Therefore, the advantage of location information can be obscured by these problems affecting the quality and timeliness of the data.

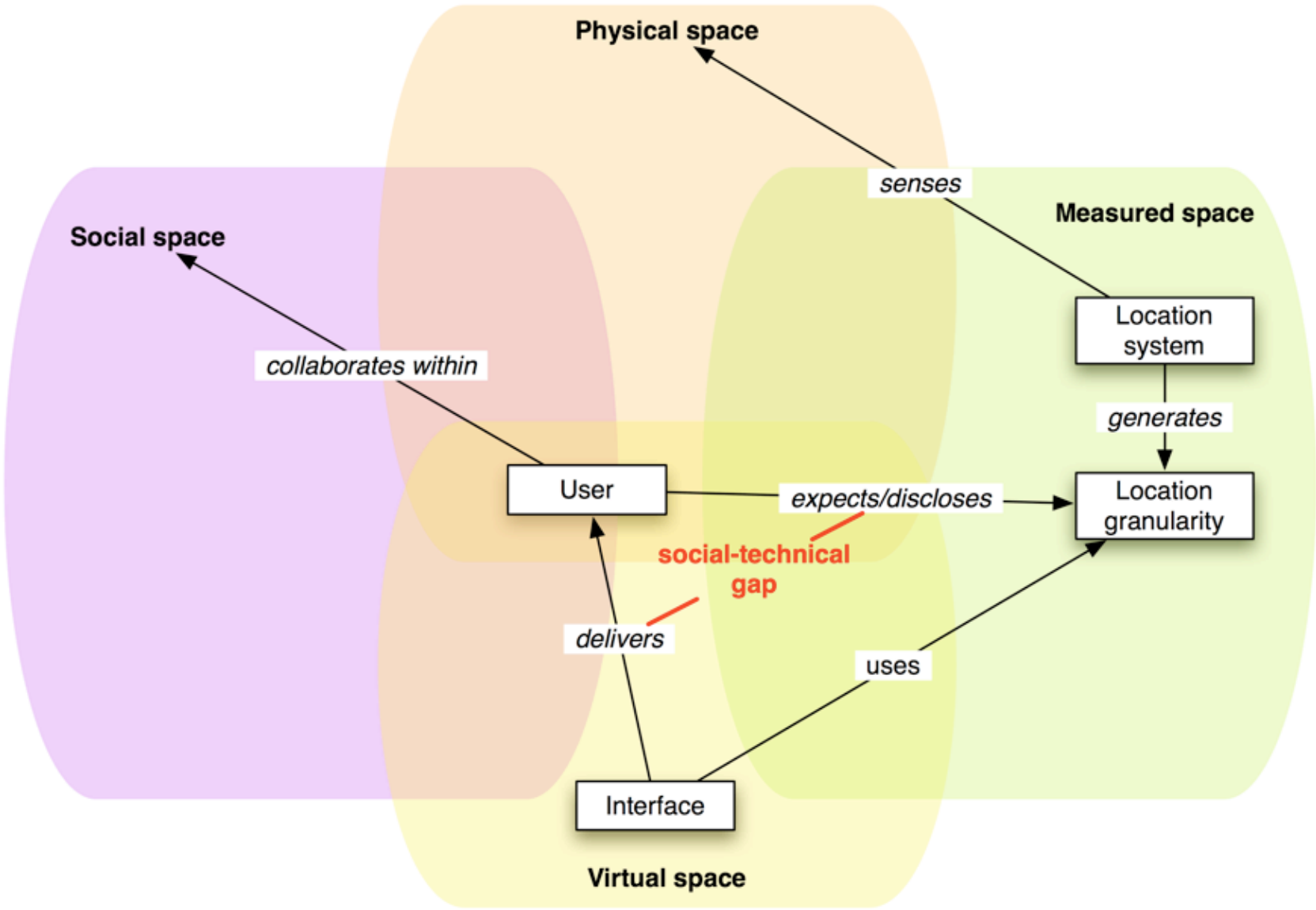
The difficulties to sense the physical space generate spatial uncertainty. Leonhardi, A. and Rothermel (2001) modeled this uncertainty has follow: a location sighting is performed with a precision of Up. The data are distributed at a miximal speed of vmax. In consequence, when the location information is updated the space in which the sensed person/object could be is in the space u(t)

Location information granularity



Location information often carries a granularity that sometimes fails to be taken into consideration by designer of location-aware system. Here is an example of Plazes, a popular location-aware application. The airport of Geneva is located in the middle of the river simply because the city considers it as the center of the city. In addition, I am at the train station, while I only wanted to mention that I was present in Geneva in the morning. So how to mix location information that have different levels of granularity?

The social-technical gap



My current (simplified) model of spatial uncertainty reveals 4 interconnected spaces. The physical (real-world), the measured space (what sensors perceived from the physical world), the virtual space (the digital representation of the measured space and the social space
(partially inspired by Managing Multiple Spaces, Dix et al. 2005).

A user lives between physical, virtual and social spaces. He/She relies on the interface delivering information delivered by location systems. These information are either sensed or self-disclosed by the users.

Location system systems deliver their measure of the physical world with a certain quality and timeliness. These information form a certain granularity of the location.

The spatial uncertainty lies on the mismatch between the granularity of the information expected by the user and the information displayed by the interface based on the data delivered by the measured space.

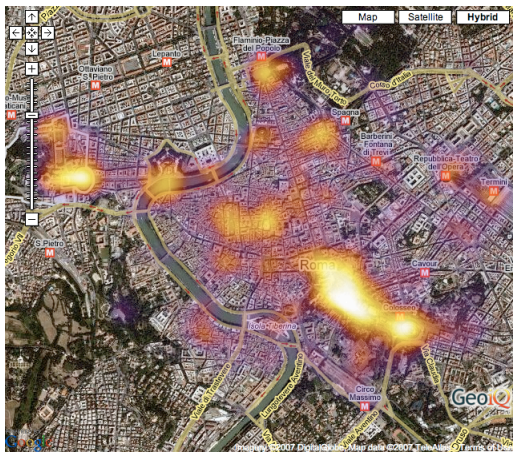
In summary, users must coordinate their distributed activities in spite of these problems generating (spatial) uncertainty. This reveals a techno-social gap (Ackerman, M., 2000, The Intellectual Challenge of CSCW: The Gap Between Social Requirements and Technical Feasibility) that exposes the need to handle inadequate location information without undermining the benefits of location-aware systems. Systems cannot fully support the flexible, nuanced, and contextualized social world uncovered

Research questions

How to build a collaborative location-aware system that takes into account the spatial uncertainty inherent to ubiquitous technologies?

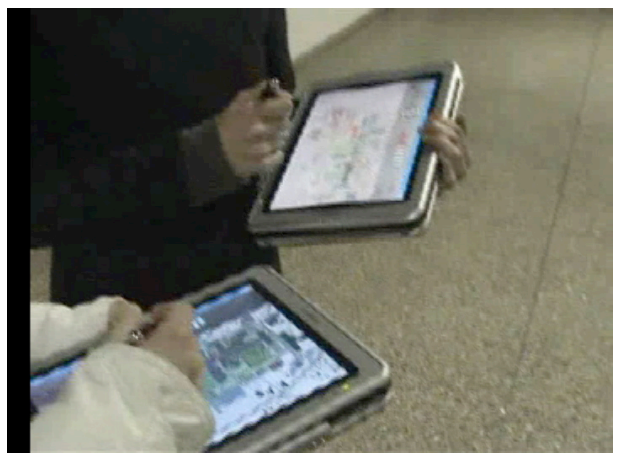
- what level of location information quality and timeliness must be delivered in order to be useful and relevant?
- what parameters influence successful spatial uncertainty visualization?
- what is the balance between implicit and explicit forms of human interaction with a location-aware system that communicates the inherent uncertainty of its location information?

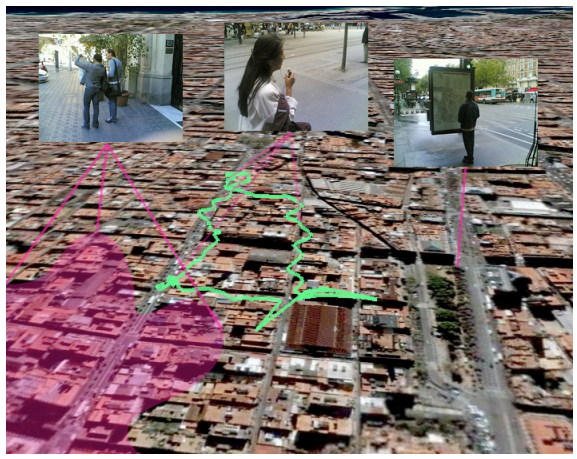
Approach



case studies of the ubicomp of the present

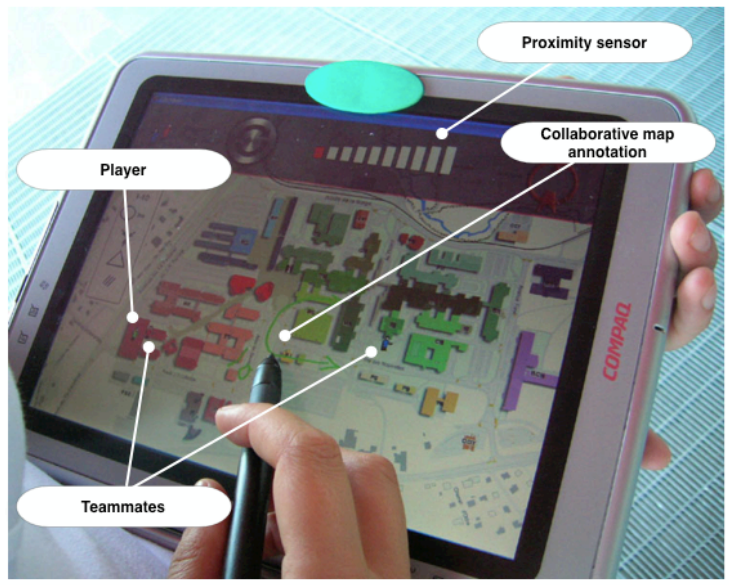
deploy real-world field experiments





In my approach, I study the authentic human and collaborative use of the ubicomp of the present and deploy real-world experiments to mature the practice of HCI evaluation. It aims at demonstrating the principles and lessons that can be applied more generally in systems for mobile work in vast work settings.

Field experiment: CatchBob!



- Various players reactions to uncertainty: Believing, not understanding, overcoming
- Various sources of spatial uncertainty
- Players without a location awareness tool took better advantage of the annotation feature: picking up the relevant fact
- Automatic location-awareness ≠ Giving a location (act of communication carrying intentions)

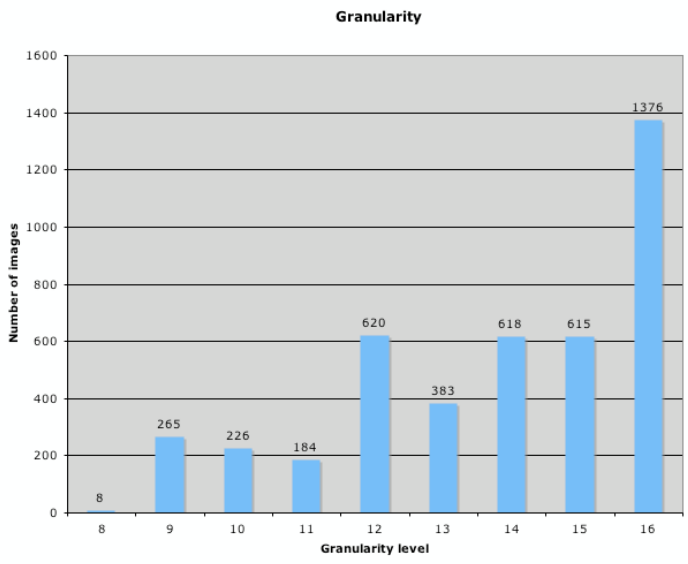
CatchBob! is a collaborative pervasive game. Explore the sources of spatial uncertainty and analyze players' behaviors towards spatial uncertainty. Individual and collaborative aspects of spatial uncertainty.

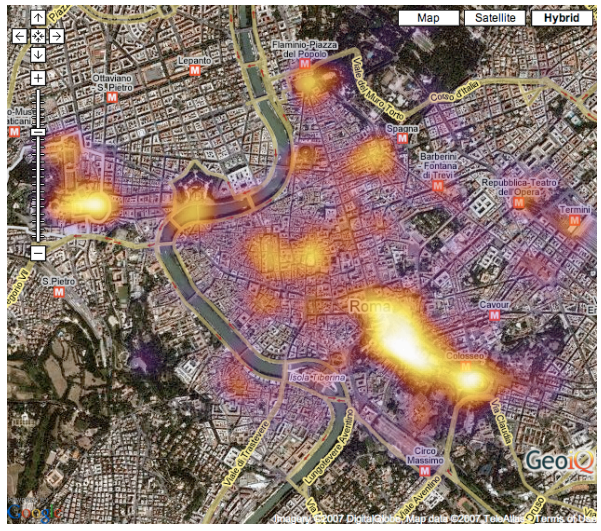
I define three main sources of spatial uncertainty.
The location quality predicted through sensor measurements and observations. Uncertainty is generated by patchy location service, fluctuating signal strength, deviations in positioning, devices limited resources, but also from processing the measured data themselves.
The location timeliness indicated by the time that has elapsed since the location was acquired. The temporal accuracy of a location is influenced by the network connectivity, communication latency and location update mechanism.
Location presentation, i.e., the ways which deliver location information to the user. Geometric, symbolic and map representation can be misleading or ambiguous.

Case study: Tracing the visitor's eye

Context: evaluate the potential of using people-generated geotagged information to contribute urban understanding.

- **Aim 1**: identify users behaviors when explicitly disclosing location information (where, what, when, history of use).
- **Aim 2**: analyze how Flickr users take advantage of the accuracy feature to georeference their images





Work in progress. Flickr: Collaborative platform to share geotagged information. Explicit Spatio-temporal data analysis. studying how people explicitly position and disclose spatio-temporal information in order to understand their use and need of quality of location information in a urban space. I collected over 1mio geotagged photos of 10 cities.
Spatio-temporal data analysis. Analyze the flow of visitors (within the city, in and out of the city), the areas of attractions

Case study: Taxi drivers use of GPS

Context: Barcelona taxi drivers who use GPS navigation systems. Ethnographic study

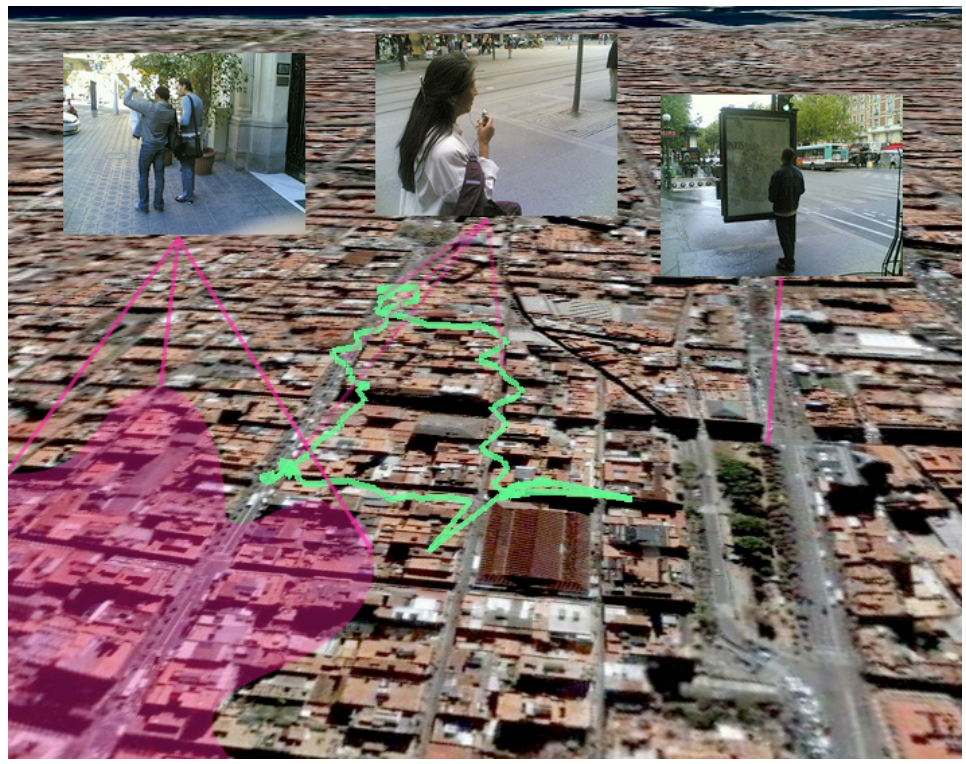
- **Aim**: identify the main issues embedded in the interaction of mobile workers with location information that fails to match a relevant quality
- **Aim:** Where and when is it used?
- **How:** focused ethnography, semi-structured interviews

Work in progress. personal use of a a location-aware system (taxi drivers using their navigation system). Identify the main issues embedded in the interaction of mobile workeds with location information that fails to match a relevant quality.

Field experiment: Enhancing urban tourism experience

Context: Give an awareness to citizens and/or tourists on their behaviors and surroundings in a urban space.

- **Aim 1**: Evaluate design strategies to manage spatial uncertainty based on what has been learned in the first 3 studies
- **How**: Compare approaches (Does it work?)
- **How**: Study the contextual impact of the approach (Where and when?)



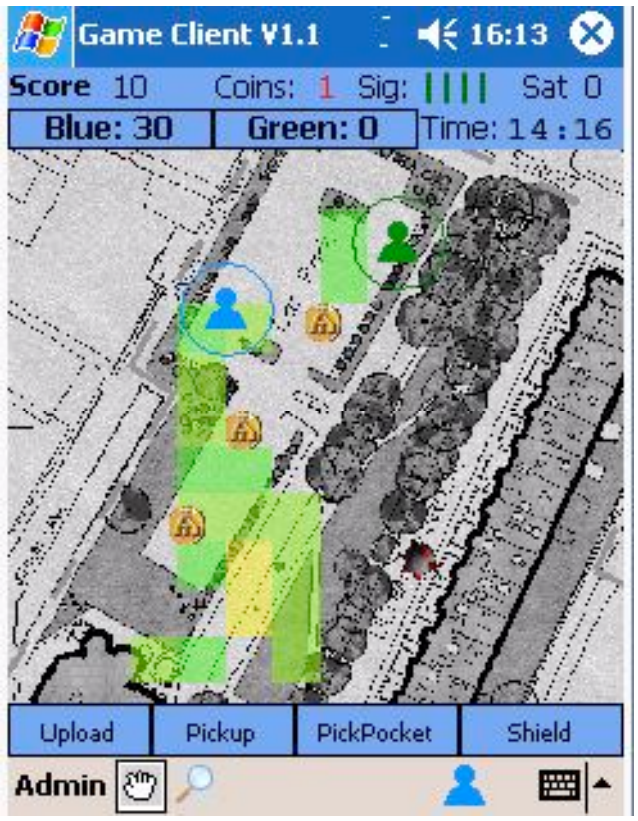
I plan to setup a collaborative pervasive system used in the scale of a city to analyze the integration of location information granularity in the design of the application, to evaluate strategies to manage spatial uncertainty. (design-science research). To do so, I will perform comparison between several approaches and study where and when do they apply).

Articulation

Type	Context	Objective	Method
Field experiment 1	collaborative pervasive game	Explore the sources of spatial uncertainty and analyze players' behaviors towards spatial uncertainty	mixed, exploratory
Case study 1	sharing and geotagging photos	Identify the uses of location information granularity	descriptive, exploratory
Case study 2	taxi drivers use of GPS	Identify the main issues when a location-aware system does not match expectations (co-evolution)	ethnographic, exploratory
Field experiment 2	collaborative urban-scale environment	Analyze the integration of location information granularity in the design of the application. to evaluate strategies to manage spatial uncertainty.	mixed

Field experiment: design strategies

- Seamful design (when to reveal, hide the limitations of a technological solution)
- Assist not automate
- Location is more than GIS information
- Influence the middleware design
- Ambiguity as resource for design



I consider different design strategies. Seamful design (right picture) suggests the reveal the limitations and problems of a system for users to act upon them. As seen in CatchBob! automating location awareness has its impact on the use of the information. Finally, “Location is more than GIS information”. It’s more than geographical coordinates, it can also be whether a user is indoor/ outdoor, whether the movile device can hear you’re on busy street. It’s about richer information. A good example is Jabberwocky (left picture) that allows to see the presence of familiar strangers in the vicinity, anonymized.

Conclusion

“Let’s do smart things with stupid technology today, rather than wait and do stupid things with smart technology tomorrow?”

William Buxton

Discussion