Works in Progress

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Urban Computing and Mobile Devices

EDITOR'S INTRO

In this issue's Works in Progress department, we have 12 urban computing and mobile device entries that span a wide range of computing and social areas. The first entry examines how an urban environment could operate as a large-scale, real-time control system. One project focuses on annotating public spaces and sharing the tags with others. Two projects tie together social networking in cyberspace with local urban communities. Two projects examine computing and social interactions in physical spaces. Two entries explore how to combine synthetic and physical views of urban environments. Four entries investigate how we explore urban spaces, interact with technology in those spaces, and create shared community histories. —*Anthony D. Joseph*

WIKICITY: REAL-TIME URBAN ENVIRONMENTS

Francesco Calabrese, Kristian Kloeckl, and Carlo Ratti, *Massachusetts Institute of Technology*

Developers have created real-time control systems in various engineering applications, dramatically increasing systems' efficiency by saving energy, regulating the dynamics, and increasing robustness and disturbance tolerance. But can a city function as a real-time control system? MIT's WikiCity project aims to find out.

A real-time control system has four key components:

- an entity to be controlled in an uncertain environment,
- sensors that can acquire information about the entity's state in real time,
- intelligence that can evaluate system performance against desired outcomes, and
- physical actuators that can act on the system to realize the control strategy.

A city could fit the first two definitions. For example, the Real Time Rome project (http://senseable.mit.edu/realtimerome) uses cell phones and GPS devices to collect the movement patterns of people and transportation systems and their spatial and social use of streets and neighborhoods.

But how could we actuate the city? Although it already contains several classes of actuators, such as traffic lights and remotely updated street signs, its inhabitants are a much more flexible actuator. Consequently, we're creating a platform for storing and exchanging location- and time-sensitive data, making such data accessible to users through mobile devices, Web interfaces, and physical interface objects (see figure 1). This platform lets people become distributed intelligent actuators, pursuing individual interests in cooperation and competition with others and thus becoming prime actors in improving urban systems' efficiency.

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MOBILE LOCATION BOOKMARKING

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Marcus Foth, *Queensland University of Technology*

Mobile Location Bookmarking, an urban community platform, lets residents use their mobile phones to leave virtual notes at places of interest and share their experiences with other residents in real time. Using keywords, residents retrieve bookmarked locations and use them as a location-based city guide. Users can retrieve a list of annotations depending on their current position and the tags they used to describe their entries. So, searching for "tennis" might return entries about the local tennis club, a sports equipment store, or any facility that other users have tagged as such. Because all notes include their GPS position, the system can automatically generate directions.

The system leverages residents' collective intelligence to create and categorize information about any site in the city. The principle corresponds with the folksonomy paradigm of Web 2.0 applications such as Flickr (www.flickr.com) and del.icio.us (http://del.icio.us). Other location-based city services, such as Lancaster University's GUIDE project (www.guide.lancs.ac.uk/overview.html), are controlled by a single entity, making it hard to keep information up-to-date. Because our system builds on user-generated content, it implicitly responds

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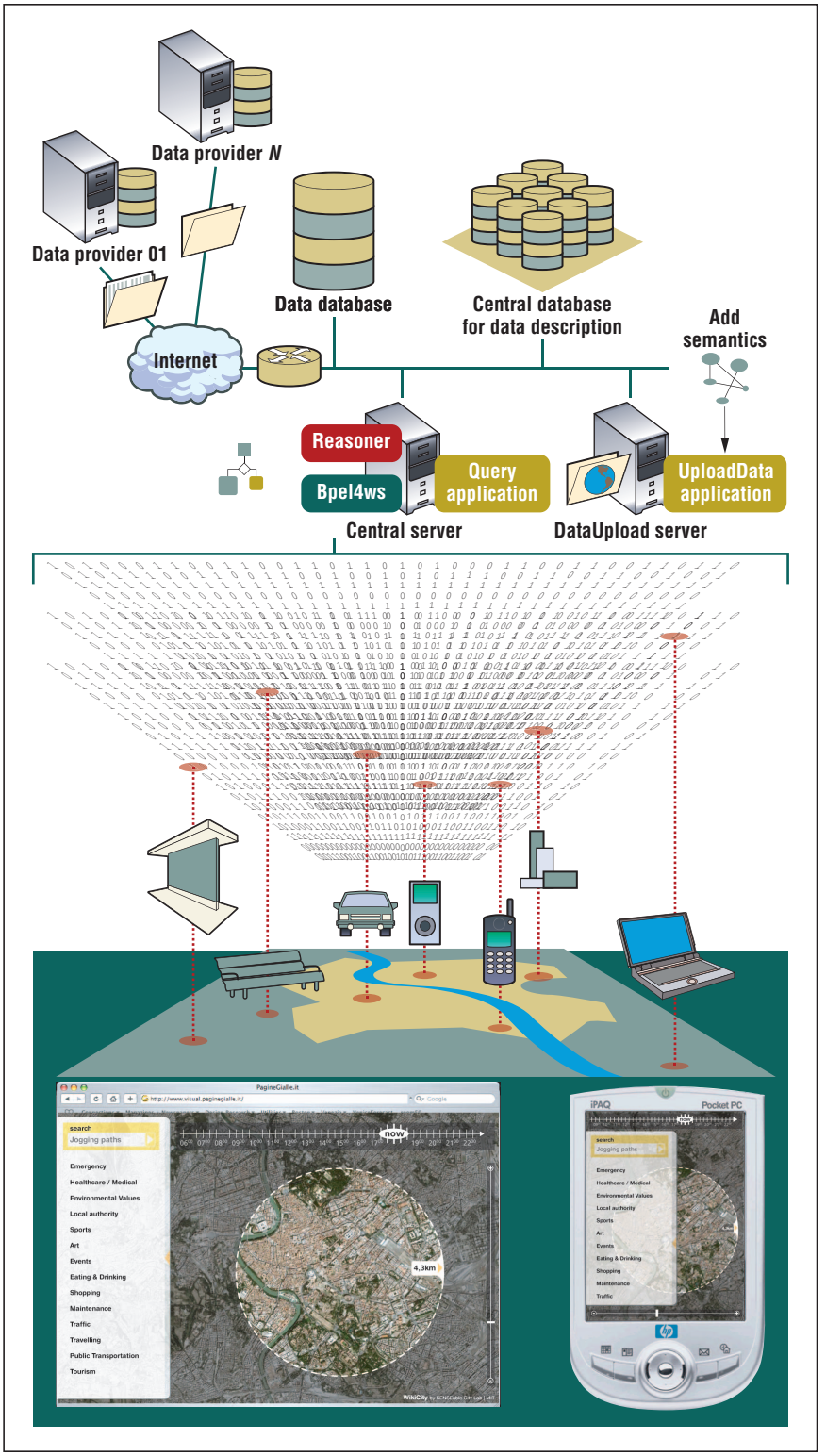

Figure 1. WikiCity explores different interface modalities that create connections between the virtual data and the actual physical world where users access these data. The system is based on a common, semantically defined format for interchange of locational data and a distributed platform that can collect and manage such data in real time.

to residents' developing interests, such as new urban hotspots or keywords.

To appropriately aggregate the large number of comments on a small mobile display, we encourage users to rate other entries for quality and usefulness. An internal ranking system ensures that users receive the most popular location bookmarks first.

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MYCORNR

***Angela Button**, Queensland University of Technology*

MyCornr gives urban residents a personal, bounded space on the Web where they can coordinate their online information, communication, content, and entertainment. This gives users greater control over the constant influx of information and communication that typifies their digital lives. MyCornr also provides relevant, filtered local information and avenues for social networking with proximate communication partners.

MyCornr is a widgetized Web page with a communications hub that lets users access multiple communication accounts. It also provides links to and data from the user's local and global social networks, online content, and entertainment. In addition, MyCornr has a customizable information delivery service that provides access to both local and global information sources. Users can select syndicated feeds that meet their needs or design and share their own feeds with friends.

MyCornr lets users move from a safe, controlled personal space to the neighborhood space—and only then to the sometimes overwhelming global expanse of the Internet. MyCornr recognizes that humans exist as individuals, physically within a place. It values the ability to access local community social networks and information sources, thereby transforming everyday Internet use into an eminently meaningful experience.

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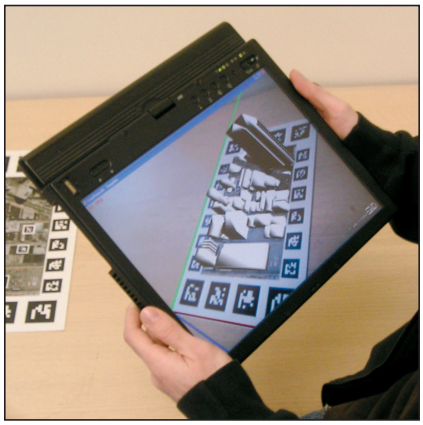

Figure 2. A situated visualization of a site plan with augmented structures.

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SOCIAL PATCHWORK: URBAN HISTORY LINES

Marcus Foth and Helen Klaebe, *Queensland University of Technology*

The Kelvin Grove Urban Village (KGUV; www.kgurbanvillage.com.au)—an AU$400 million urban renewal project in inner-city Brisbane, Australia—seeks to integrate residential, commercial, educational, social, and cultural facilities. Both developers (the Queensland government and Queensland University of Technology) expect the initiative to be fully developed and occupied by 2010, when it will comprise more than 1,000 residential units for more than 2,000 residents. The master plan calls for R&D of appropriate systems that can run on the KGUV's information and communication technology infrastructure.

As part of the KGUV development, the Social Patchwork project is rolling out a suite of engagement tools to explore the use of narrative and new media in community engagement and urban planning. Its History Lines component visualizes residential history and migrational churn. It brings a cross section of new residents together to map where they've lived in the past. When we collate the longitude and latitude coordinates and augment them with short personal narratives, overlapping and common lines become visible. The stories at these intersections stimulate interest and offer opportunities for further networking. Social Patchwork tests how urban computing can facilitate a social network of storytelling themed around community history and place making.

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WI-FI HOTSPOTS

Laura Forlano, *Columbia University and NYCwireless*

Cities across the United States—including Philadelphia, San Francisco, Boston, Minneapolis, and Austin, Texas—are currently implementing ambitious plans to build municipal wireless networks to promote economic development and digital inclusion. These projects make several assumptions about these networks' payoffs without the benefit of research on users' communication practices. There has been little research on this subject. In addition, people often consider the widespread use of these technologies in urban settings a matter of convenience, ubiquity, and "anytime, anywhere" access. In contrast to these assumptions, I argue that Wi-Fi hotspots are important sites of informal face-to-face interaction, social support, collaboration, and community on the basis of nearly three years of research on community wireless organizations, new models for managing the electromagnetic spectrum, and emergent work practices among Wi-Fi users.

Using a sociotechnical perspective grounded in actor-network theory and the ritual view of communications, my project is an ethnography of Wi-Fi hotspots at three New York city sites: Starbucks, Bryant Park, and the JetBlue terminal at John F. Kennedy International Airport. For the project, I analyzed more than 600 responses to a survey of Wi-Fi hotspot users and conducted 50 in-depth interviews with community wireless leaders, experts, and survey respondents. I also participated in 100 hours of ethnographic observation, documented in 500 photos from around the world. I conducted the survey between October 2006 and April 2007 with support from Microsoft Research and in partnership with NYCwireless, a community wireless group, and the Downtown Alliance, a business development district. In order to gather comparative international data, I also deployed the survey in Montreal and Budapest in partnership with local community wireless groups.

My research concludes that the (re-) emergence of community forms of organizing—from building wireless infrastructure to spectrum management and emergent work practices—both complement and contradict hierarchical and network-based forms of organizing. With respect to new work practices, support for these forms of organizing—occurring at the intersection of social practices, spaces, and technologies—comes from evidence that people have complex, deliberate rationales for choosing specific Wi-Fi hotspots as work places and that they form communities around them. For example, one Wi-Fi user that I interviewed commutes 40 minutes to a particular Wi-Fi hotspot where he works side-by-side with several other freelancers. He has three regular workspaces: a "preproduction" space, a "production" space and a "deadline" space, all Starbucks cafés in New York city.

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SITE VISIT BY SITUATED VISUALIZATION

Sean White, Petia Morozov, and Steven Feiner, *Columbia University*

At Columbia University, we're investigating how mobile computing can advance architectural site analysis practices prior to design activity. We aim to address a site's physical location and

appearance as well as its spatial and temporal surroundings, the multiple histories in which it has participated, and its social, political, environmental, and cultural characteristics. We based our primary tools and methodologies on more than a decade of mobile augmented reality research by Columbia University's Computer Graphics and User Interfaces Lab.[1] These practices and technologies were further developed in Spring 2007 through a 3D user interface design course (www.cs.columbia.edu/graphics/courses/csw4172) in collaboration with faculty and students from the Graduate School of Architecture, Planning, and Preservation. Students focused on the 17-acre site of Columbia's proposed Manhattanville expansion (http://neighbors.columbia.edu/pages/manplanning), using curated data collected specifically for the project, as well as existing geographic information system data.

Our mobile prototypes augment 2D paper site plans (see figure 2), 3D stereolithographic site models, and actual 3D physical sites. The primary platform is a laptop computer with an attached camera that records the physical scene. Computer vision algorithms recognize and track printed paper markers in the scene in real time, making it possible to overlay relevant information interactively on top of what the camera sees. This lets us create live "situated visualizations" that depict otherwise invisible characteristics of a site and its surroundings, enabling design and planning professionals to analyze multiple sets of concerns comprehensively in order to propose swifter and more informed design responses.

For more information, contact Sean White at swhite@cs.columbia.edu, Petia Morozov at pm2176@columbia.edu, or Steven Feiner at feiner@cs.columbia.edu.

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TRACING THE VISITOR'S EYE

Fabien Girardin and Josep Blat, *Pompeu Fabra University*
Nicolas Nova, *Swiss Federal Institute of Technology*

Urban computing encompasses how people experience the city with the support of technologies. Our approach is to examine people's experience of pervasive systems to better understand urban environments.

Mobile devices' large-scale deployment in recent years has led to a voluminous increase in the records of where and when people have traveled. By analyzing spatiotemporal data (that is, latitude, longitude, and timestamp), we can derive high-level human behavior such as mobility mode. Urban planners, traffic engineers, and tourism authorities could profit from deploying new technologies to better understand how people and crowds explicitly consume space.

Investigations of spatiotemporal patterns have rendered a quantitative understanding of the city.[1–3] We intend to leverage implicit spatiotemporal data with the richness of people-generated information. Our approach is to consider uploading, tagging, and disclosing a photo's location as an act of communication rather than a pure implicit history of physical presence.

For this purpose, we retrieved more than 1 million photographs from Flickr (www.flickr.com). We designed geovisualizations on the basis of the time, explicit location, and descriptions of photos. They reveal patterns of tourists and citizens exploring a city, such as the flow of people between city attractions, the biggest areas of influence, and activities that happen during the day versus the night or during the weekday versus the weekend. As a result, we're evaluating the potential of using people-generated geo-tagged information to contribute to urban understanding.

For more information, contact Fabien Girardin at Fabien.Girardin@upf.edu or see www.girardin.org/fabien/tracing.

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AMBIENT MAP MAKING OF URBAN IDENTITIES

M.P. Pieniazek, *University of Salford*

Digital media practices and technologies can potentially infuse the streetscape with a publicly authored identity, inclusive dialogue, and oral histories. Past projects have redefined the design paradigm for sustainable and inclusive public spaces by transferring editorial ownership directly to the community. Central to this paradigm is the practice of ambient map making, which aims to engender inclusion, representation, and collective archiving across a community.

The Digital Urban Village Green project seeks to regenerate a deindustrialized urban community. This project investigates ambient map making's deliverable value and relevance to local identity, dialogue, and shared memory. Prototyping of key elements is now under way. These elements range from a literal tablet for sharing aural and visual histories to more ambient installations that reflect physical movement through the community.

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MEETING BY MOVING, MEDIATED THROUGH MUSIC

Rob Tieben, Koen van Boerdonk, Sietske Klooster, and Elise van den Hoven, *Eindhoven University of Technology*

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Figure 3. The dynamic variation of bodily contact through the screen determines the music's composition.

Each year, the Dutch Lowlands Festival creates a unique, relaxed atmosphere where 55,000 visitors come to appreciate live music, movies, stand-up comedy, and street performances. Building on this experimental environment, we designed a flexible, opaque screen that facilitates a meeting between strangers, who can create music together through bodily contact (see figure 3). Dynamic variation of bodily contact through the screen determines the music's composition and helps people feel connected.

During the iterative design research process, we applied Choreography of Interaction, a movement-based design approach. Our first working prototype incorporated 18 randomly divided, unnoticeable sensors, which were directly coupled to music samples. User evaluation showed that people searched the screen for the music instead of focusing on each other through the screen.

We determined that the variables of musical composition needed to reflect the dynamic variation of bodily contact more coherently. We created a prototype that incorporates 120 sensors and that we can program differently to translate bodily contact into musical composition. This lets us create and evaluate interaction variants that presumably will lead to different gradations of experiences. We are now preparing a test to find the appropriate coupling between dynamic variation of bodily contact and musical composition that establishes a meeting experience through the screen.

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ONTOLOGIES AND SERVICES SUPPORT

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Integrating computing solutions to create and deploy embedded services in urban environments is also a means of developing complex systems that support the huge number of sensors, devices, systems, and networks using multiple heterogeneous technologies. In urban environments such as cafés, restaurants, and public transportation systems, people can configure personalized services using urban public interaction facilities such as displays, smart posters, and personal devices. In the future, we'll see societies where people and computing systems communicate transparently to create embedded services automatically. However, the multiplicity and heterogeneity of technologies in wireless networks, fixed networks, and mobile devices is a barrier to achieving seamless interoperability.

Our work focuses on facilitating human interaction in the societies and interacting systems to manage and support new services in urban environments. We provide an ontology-based solution for managing embedded services that use multiple technologies, called Ontology for Support and Management of pervasive services (OSM; http://nmg.upc.es/ontologies). Our solution promotes the systems' interoperability and provides the information necessary to support management operations in embedded service systems. We aim to use contextual information from urban environments such as personal profiles and wireless and mobile devices and network technologies to better customize and deploy the services. Our solution will support the interoperability and extensibility required in the systems that handle end-user embedded services in urban environments endowing with the semantic enrichment necessary to support such services in a more dynamic way.

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OBSERVING INTERACTION WITH PUBLIC DISPLAYS

Daniel Michelis, Berlin University of the Arts and University of St. Gallen

Long before the computer was developed, people used mirrors as a medium for visual simulation. The mirror was the central instrument for creating a virtual world.[1] Today, digital technologies

emulate this ability, creating new opportunities to satisfy the age-old desire to experience fictional worlds.[2]

I have conducted an experimental study on interaction with public displays to examine public interaction behavior. My research focuses on the role that intrinsic motivation plays in interaction and public display use. In 2006, I observed nearly 5,000 passersby in 13 experiments that I based on interactive public displays from the media-facade Magical Mirrors (www.magicalmirrors.de). Prior to the investigation, I installed Magical Mirrors, which are four interactive life-size LED screens (see figure 4).

To investigate intrinsically motivating elements in human-computer interaction, I developed a broad taxonomy of motivating factors that serve as a design orientation for intrinsically motivating interactions. The taxonomy differentiates between individual and interpersonal motivating factors. The investigations aim to understand the role these motivating factors play in human-computer interaction and if (and in which form) they influence motivating public display use.

I'm currently assessing the results, but I've made some initial notes. The experiments revealed that groups of passersby exhibit a special dynamic. Once the first person of a group actively participates in the interaction, he or she draws the attention of the other group members. Typically, the others initially stand by and hesitantly observe the interaction. In the parts of the investigation in which more than one display was available, the other members of the group used the free displays and explored the interaction possibilities. Little by little, the entire group participated in the interaction. In the cases where there was only one display, the group became impatient and the active person was summoned to rejoin the group. Also, when passersby were no longer shown the mirror images, usage decreased significantly, indicating that one's own image can make public interaction more attractive.

Figure 4. Public installation of Magical Mirrors.

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DATASCAPE: FROM VIRTUAL TO HYBRID WORLDS

***Eric Kabisch**, University of California, Irvine*

Datascape is a periscope device that allows a view of invisible data about the surrounding city. As people travel through geographic space, they explore a 3D virtual topography built from georeferenced data sets, such as demographic marketing profiles. Movement through the city also controls a dynamic soundtrack generated from local information. A typical drive around town thus becomes a sonic and visual exploration of hidden narratives that envelop the city.

Instead of viewing virtual worlds as separate from the physical world, Datascape is concerned with the worlds of data that exist as another dimension, a substrate spread out over our cities and rural landscapes. Datascape reveals existing narratives by creating a hybrid environment where traversal of physical space is enhanced by a view into this alternate dimension. Datascape is an example of how we might re-envision the relationship between synthetic worlds and our physical world by moving from virtual to hybrid environments. In crafting user-generated landscapes and narratives that are coincident and juxtaposed with our physical world and its institutional descriptions and narratives, we might arrive at new resonances and enable direct encounters between computer-generated and physical worlds.

I began developing Datascape in late 2004 and first exhibited it in spring 2006. Datascape is undergoing an iterative process of exhibition, design, and development. I have exhibited the project as a stationary installation and am currently developing it as a vehicle installation.

For more information, contact Eric Kabisch at e@fluxt.com or see http://e.fluxt.com/datascape.

For more urban computing works in progress, see the July issue of *IEEE Distributed Systems Online* at http://dsonline.computer.org.