Urban Computing

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Welcome to this special issue on urban computing—the integration of computing, sensing, and actuation technologies into everyday urban settings and lifestyles. Those settings include, for example, streets, squares, pubs, shops, buses, and cafés—any space in the semipublic realms of our towns and cities. Only in the last few years have researchers paid much attention to technologies in these spaces. Pervasive computing has largely been applied either in relatively homogeneous rural areas, where researchers have added sensors in places such as forests, vineyards, and glaciers or, on the other hand, in small-scale, well-defined patches of the built environment such as smart houses or rooms.

Urban settings are challenging places for experimentation and deployment, and they remain little explored as pervasive environments for largely practical reasons. For one thing, they're complex in terms of ownership. For example, placing sensors in a city will typically require permission from many stakeholders. Urban settings also tend to be far more dynamic and dense in terms of what and who would participate in an application or system. People constantly enter and leave urban spaces, occupying them with highly variable densities and even changing their usage patterns between day and night.

The basis for a mass phenomenon

Despite the complexities, urban computing is, in a limited sense, already a mass phenomenon. Roughly half the world's population lives in urban environments. In addition to PDAs and laptops, most people have mobile phones, and most mobile phones have capabilities beyond simple voice calls. Connectivity is extensive. Mobile phones are increasingly equipped with Bluetooth for short-range communication, in addition to long-range cellular data connections. Wi-Fi networks are also commonplace.

And the technology is put to more interesting

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uses than you might at first think. Users have appropriated some technologies in ways that their designers didn't necessarily envisage, just as they appropriated the short-message service for text messaging. In the UK, for example, people routinely swap content between their mobile phones over Bluetooth in urban settings such as pubs and schools. That amounts to a highly dynamic, socially driven, peer-to-peer network that's pervasively embedded in cities.

In the call for articles, we included questions about how to understand such urban uses of by-now familiar technologies. But we mainly wanted to understand how to produce fully integrated designs specifically for urban settings and how to overcome the deployment challenges. Successful integration requires taking several facets of the environment into account at once. Urban settings frame social behaviors. They encompass architectural forms and features that might not be harmonious with given technologies, and they're variably permeated by wireless networks and fixed and mobile devices.

In this issue

The articles we selected confirm that urban computing is a practical reality but that research is still at an early stage, with much of the subject still to be mapped out systematically. Like cities themselves, urban computing includes a broad range of opportunities and issues.

In the first article, "NAVITIME: Supporting Pedestrian Navigation in the Real World," Masatoshi Arikawa, Shin'ichi Konomi, and Keisuke Ohnishi describe an urban navigation application in Japan with almost two million users. NAVITIME runs on mobile phones, many of which include integrated GPS. A minority use case is in-car navigation. Many people outside Japan are familiar with in-car navigation systems, but in Japan, people are using NAVITIME mostly for personal navigation as they walk or take public transportation—particularly in Tokyo. This is yet another example of how Japan often leads the rest of the world when it comes to pervasive computing. NAVITIME provides comprehensive navigation information, including maps, timetables, prices, and even carbon footprints for various journey options. It's an impressive large-scale system. However, its deployment details reveal that its application in the city isn't well understood in all respects. The authors describe their preliminary investigations into how the technology affects users' behaviors and perceptions of their city. They also look at how users recognize and adapt to the loss of GPS or the wireless network when they enter transportation systems or walk beneath tall buildings.

More and more people are engaging in urban computing—from making phone calls or exchanging files over Bluetooth to navigating across the city. One problem we face is how to gather large-scale data about these personal electronic activities. We must also relate that data to what else we know about urban phenomena such as the density of commercial or residential properties. By making these links, we can better understand where the technology is used and what roles it plays in individual and social behaviors. In "Cellular Census: Explorations in Urban Data Collection," Jonathan Reades, Francesco Calabrese, Andres Sevtsuk, and Carlo Ratti grapple with the problem of characterizing patterns of mobile phone traffic in Rome. Using data they obtained from a wireless carrier, the authors ultimately aim to match usage characteristics to urban space utilization. So far, they've only been able to note differing patterns across space and time and to suggest statistical links to, for example, residential versus commercial versus leisure usage. But this work paves the way for more in-depth analysis. It also opens a debate on the extent to which mobile phone data can and, given privacy considerations, should be used for this purpose.

The remaining two articles address the design of novel urban-computing applications. The first aims to enhance a particular urban setting. In "Undergound Aesthetics: Rethinking Urban Computing," Arianna Bassoli, Johanna Brewer, Karen Martin, Paul Dourish, and Scott Mainwaring consider the London Under-

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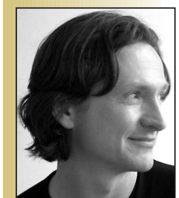

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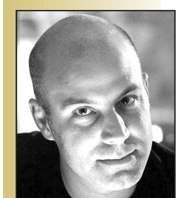

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ground as a target application domain. They provide extracts from an ethnographic study of passengers and propose a design for a music-sharing application. They base their proposal on observations of the roles that media such as music and newspapers play on underground journeys, together with the possibilities that Bluetooth presents for transferring content between passengers.

Finally, in "Mobile Social Software: Facilitating Serendipity or Encouraging Homogeneity?" Jennifer Thom-Santelli takes a critical view of the urban applications that have been designed so far. She looks at new urban technologies' social and political implications, arguing that the current approach to design and deployment tends to favor only the same privileged social group as that of the designers. She's concerned that this will lead increasingly to a digital divide in our cities that matches the material divide between inner-city and suburban areas. She proposes a different approach to design, appealing to the provocative nature of the arts as a model. Through examples, she argues that this approach would more likely take account of difficult inner-city problems, such as gentrification and disadvantage, and extend urban applications' reach beyond privileged groups. As Thom-Santelli says, the value of a city is in its diversity.

We hope you'll find these articles as thought-provoking as we did. It should be clear by now that urban computing research has only just begun. We'd like this special issue to spark a new generation of researchers to take up the challenges laid down here.

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